Curriculum Book
and
Assessment and Evaluation Scheme

based on

Outcome Based Education (OBE)
and
Choice-Based Credit System (CBCS)

in

Bachelor of Science (Hons.) in Biology
B. Sc. Hons. (Biology)

4 Year Degree Program

Revised as on 01 August 2023
Applicable w.e.f. Academic Session 2023-24

AKS University

Satna 485001, Madhya Pradesh, India

Faculty of Life Sciences and Technology
Department of Biotechnology

Dr. Kamlesh Choure
Professor & Head
Department of Biotechnology
AKS University, Satna (MP) 485001

DEAN
Faculty of Life Sciencer
AKS University, Satna (M.P.)

Professor B.A. Chopade
Vice-Chancellor
AKS University
Satna, 485001 (M.P.)

Curriculum & Syllabus of B.Sc. (Hons.) Biology Program

(Revised as of 2023)

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AKS University

Faculty of Life Sciences and Technology

Department of Biotechnology

Curriculum of B.Sc. (Hons.) Biology Program

(Revised as on 2023)

Foreword

I am delighted to see that the Biological Sciences Department's redesigned curriculum for the B.Sc. (Hons.) (Biology) Programme smoothly incorporates the newest technological developments while adhering to NEP -2020 and UGC criteria. The curriculum has been redesigned with consideration to include the Sustainable Development Goals and NEP-2020 guidelines.

The alignment of course outcomes (COs), Programme Outcomes (POs), and Programme Specific Outcomes (PSOs) has been intricately executed, aligning perfectly with the requisites of NEP-2020 and NAAC standards. I hold the belief that this revised syllabus will significantly enhance the skills and employability of our students.

With immense satisfaction, I hereby present the revised curriculum for the B.Sc. (Hons.)- Biology program for implementation in the upcoming session.

Er. Anant Soni
Pro Chancellor & Chairman
AKS University, Satna

01 August 2023

AKS University, ***Faculty of Life Sciences and Technology***

Department of Biotechnology

Curriculum of B.Sc. (Hons.) Biology Program

(Revised as on 2023)

From the Desk of the Vice-Chancellor

AKS University is currently undergoing a process to revamp its curriculum into an outcome-based approach, to enhance the teaching and learning process. The foundation of quality of quality education lies in the implementation of a curriculum that aligns with both societal and industrial needs, focusing on relevant outcomes. This entails dedicated and inspired faculty members, as well as impactful industry internships. Hence, it is of utmost importance to begin this endeavor by crafting an outcome-based curriculum in collaboration with academia and industry experts. This curriculum design should be informed by the latest technological advancements, market demands, the guidelines outlined in the National Education Policy (NEP) of 2020, and sustainable goals.

I'm delighted to learn that the revised curriculum has been meticulously crafted by the Biological Sciences Department, in consultation with an array of experts from the Biological Sciences industry, research institutes, and academia. This curriculum effectively integrates the principles outlined in the NEP-2020 guidelines, as well as sustainable goals. It also adeptly incorporates the latest advancements in Biological Sciences manufacturing technology.

The curriculum tailored for the Indian Biological Sciences industry prioritizes the production of cost-effective, high-quality microbial products while emphasizing energy optimization. It integrates insights on waste heat recovery systems to minimize power consumption in biotechnological plants, fostering independent thinking among students for potential enhancements. This holistic approach not only equips students with essential knowledge but also nurtures a culture of innovation, preparing them to make meaningful contributions to the industry's advancement.

I am confident that the updated curriculum for B.Sc. (Hons.) Biology will not only enhance students' technical skills but also contribute significantly to their employability. During the process of revising the curriculum, I am pleased to observe that the Biological Sciences department has diligently adhered to the guidelines provided by the UGC. Additionally, they have maintained a total credit requirement of 92 for the M. Sc. Microbiology program.

It's worth noting that curriculum revision is an ongoing and dynamic process, designed to address the continuous evolution of technological advancements and both local and global concerns. This ensures that the curriculum remains responsive and attuned to the changing landscape of education and industry. AKS University warmly invites input and suggestions from industry expert technocrats and Alumni students to enhance the curriculum and make it more student-centered. Your valuable insights will greatly contribute to shaping an education that best serves the needs and aspirations of our students.

AKS University, Satna

01 August 2023

Professor B. A. Chopade

Vice-Chancellor

Preface

As part of our commitment to ongoing enhancement, the Department of Biological Sciences consistently reviews and updates its B.Sc. (Hons) Biology curriculum every three years. Through this process, we ensure that the curriculum remains aligned with the latest technological advancements, as well as local and global industrial and social demands.

During this procedure, the existing curriculum for the B. Sc.(Hons.) Biology Program undergoes evaluation by a panel of technocrats, industry specialists, and academics. Following meticulous scrutiny, the revised curriculum has been formulated and is set to be implemented starting from August 01, 2023. This implementation is contingent upon the endorsement of the curriculum by the University's Board of Studies and Governing Body.

This curriculum closely adheres to the NEP model syllabus distributed in 2020. It seamlessly integrates the guidelines set forth by the Ministry of Higher Education, Government of India, through NEP- 2020, as well as the principles of Sustainable Development Goals. To foster the holistic skill development of students, a range of practical activities, including Hands-On Training, Industrial Visits, Project planning and execution, Report Writing, Seminars, and Industrial on-the-job training, have been incorporated. Furthermore, in alignment with UGc's directives, the total credit allocation for the B. Sc.(Hons.) Biological Sciences program is capped at 13 credits.

This curriculum is enriched with course components in alignment with UGC guidelines, encompassing various disciplines such as Major Courses, Minor Course, Generic Electives, Skill Enhancement Course, Ability Enhancement Core Courses, and Discipline Specific Courses.

To ensure a comprehensive learning experience, detailed evaluation schemes and rubrics have also been meticulously provided.

For each course, a thorough mapping of Course Outcomes, Program Outcomes, and Programme Specific Outcomes has been undertaken. As the course syllabus is meticulously developed, various elements such as session outcomes, laboratory instruction, classroom instruction, self-learning activities, assignments, and mini-projects are meticulously outlined.

We hold the belief that this dynamic curriculum will undoubtedly enhance the independent thinking, skills, and overall employability of the students.

OVERVIEW OF THE DEPARTMENT

The Department of Biotechnology is established in 2006 with the objective to provide excellent and sensible teaching with maximum practical and research exposure to create skilled and well-trained bio-technocrats and entrepreneurs as per academia and industry needs in the frontier areas of Biological sciences. We, at the Department of Biotechnology, endorse each student by providing them maximum practical approach to understand their subjects in a better way of global standards and making them technologically advanced and ethically of high quality to serve the society.

VISION

The vision of the department is to dedicate research for Human and Environmental welfare. To become a center of excellence for Biological Sciences education, research, training, and entrepreneurship under the direction of good scientific principles, excellent instruction, and an ambition for continuous improvisation.

MISSION

At the Biotechnology Department, our mission is to be at the forefront of biological innovation, research, and education. We are committed to advancing the frontiers of biology through cutting-edge research, interdisciplinary collaboration, and the development of skilled and ethical professionals. Our aim is to address global challenges, improve human well-being, and contribute to sustainable development through the application of biological solutions by following aspects:

M1. To develop a strong Biological Sciences program based on quality education, research and training.

M2. To impart quality education to the students and enhance their skills which will make them globally competitive.

M3. To create trained Biological Sciences professionals who can contribute to the continuous improvement of biological services and products.

M4. To design scientific and/or technical resources as per biology industry demands.

M5. To develop as a benchmark University in emerging technologies.

M6. To provide state-of-the-art teaching learning process and R&D environment.

M7. To harness human capital for sustainable competitive edge and social relevance.

PROGRAM OUTCOMES (POs)

PO1: Capable of demonstrating comprehensive knowledge and understanding of major concepts, theoretical principles and experimental findings of the laws of nature that govern all natural processes, develop a sense of inquisitiveness that would lead them to explore the reasons and logic behind scientific phenomena/principles through established methods of observation, modelling, experimentation and calculations.

PO2: Demonstrate knowledge for in-depth scientific, analytical and critical thinking to identify, formulate and solve the issues related to Biology Industry, Pharma industry, Medical or hospital related organizations, Regulatory Agencies, & Academia.

PO3:Perceive things and the events that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) in the light of scientific principles.

PO4: Develop state-of-the-art laboratory skills like proper handling of scientific instruments, knowledge of SOPs on laboratory protocols, planning and executionin the areas of biological sciences.

PO5: Apply the scientific research method to design, execute and analyze an experiment and also demonstrate the scientific procedures, experimental observation and inferences derived from collected practical data.

PO6: Inculcate critical thinking abilities, problem-solving through accuracy and validity of practical knowledge, and to validate their assumptions and ideas based on accurate results from careful research and observations

PO7: Elevate the student's awareness about the issues of environmental deterioration, pollution and sustainable development. Developing critical problem-solving approach for these societal concerns via bioremediation and integrated management.

PO8: Design solutions for complex scientific problemsand design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO9: Recognize the need for, and have the preparation and ability toengage in independent and life-long learning in the broadest context of technological change aimed at personal development and for improving knowledge/skill development and reskilling.

PO10: Development of effective professional communication skills for speak, read and write up in scientific literature and other social media platform related to Biological Sciences by connecting people, ideas, books, media and technology.

PO11: Expand their learning avenues through use of multiple learning resources to keep themselves abreast of the scientific developments worldwide; take up advanced studies in the fields of Biological sciences.

PO12: Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.

GRADUATE ATTRIBUTES (GA)

The Graduate Attributes are the knowledge skills and attitudes which the students have at thetime of graduation. These attributes are generic and are common to all programs.

1. Technical Knowledge: Apply the knowledge of mathematics, science, engineeringfundamentals, and a specialization to identify the solutions of complex biological science based challenges.

2. Problem Findings: Identify, formulate, review and analyze complex biological problem searching substantiated conclusions using multidisciplinary approach.

3. Skill Development: Design solutions for complex problems and design system components orprocesses that meet the specified needs with appropriate consideration for the public health andsafety, and the cultural, societal, and environmental considerations with core and soft skills.

4. Research Oriented Learning: Use research-based knowledge and research methodsincluding design of experiments, analysis and interpretation of data, and synthesis of theinformation to provide valid conclusions.

5. Technical Development: Create, select, and apply appropriate techniques, resources, andmodern IT tools including prediction and modeling to complex activities with an understanding of the limitations.

6. Contribution in Society Development: Apply reasoning informed by the contextualknowledge to assess societal, health, safety, legal and cultural issues and the consequentresponsibilities relevant to the professional practice.

7. Environment and Sustainability: Understand the impact of the professional technicalsolutions in societal and environmental contexts, and demonstrate the knowledge of, and needfor sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the biological procedures.

9. 3Ts: Function effectively as a member or a leader in diverse teams, and in multidisciplinarywork styles empowering Time, Team and Task management

10. Project and Practical Skills: Demonstrate knowledge and understanding of theBiological Sciences principles and apply these to one's own work, as a member and leader in a team,to manage projects and in multidisciplinary environments.

11. Life-long Learning: Recognize the need for, and have the preparation and ability to engagein independent and life-long learning in the broadest context of technological change.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Recognized as technologists and leaders, who would help solve industry's scientificproblems

PEO2: Demonstrate professional integrity and ethical attitude with awareness of global andnational competencies and think about the social entailment of their work, especially its impacton safety, health and environment for sustainable development.

PEO3: Create new opportunities through innovations in startup sector and pursue highereducation in multidisciplinary domains of Biological Sciences

PEO4: Apply the acquired practical skills and broad biotechnological training in product,process and inculcate leadership qualities for innovative entrepreneurship to meet the societaldemands.

PEO5: Develop leadership qualities and propose techno-economic and social considerations,and aptitude for life-long learning, and get introduced to professional ethics and ethos.

PROGRAM SPECIFIC OBJECTIVES (PSOs)

PSO1: To impart an ability to apply biological skills (including botany, zoology, chemistry) and its applications in core and allied fields.

PSO2: To provide students with the concepts and research approacheswith professional ethics in analytical, scientific and technical domains for their higher career in the field of biological sciences and develop their scientific interest.

PSO3: To impart in-depth practical oriented knowledge and transferable skills to students in various thrust areas of Biological Sciences, so as to meet the demands of industry and academia for job trades and employment opportunities.

B.Sc. Biology Programme: Curriculum

Four-Year Full Time Degree Programme

B.Sc. – First Semester

(Undergraduate Certificate in Botany/Zoology/Chemistry)

S. No.	Subject	Subject Code	Subject/Paper Title	Subject area	Periods			Credit	Marks Distribution		
					L	T	P		Internal	External	Total
Major Subject (Choose Any One)											
1.	Botany	01BO101	Basic Botany	MJ 1	4	-	-	4	50	50	100
2.		01BO101-L	Basic Botany Lab	MJ 1 P	-	-	4	2	50	50	100
3.	Zoology	01ZO102	Animal Diversity: Non-Chordata	MJ 1	4	-	-	4	50	50	100
4.		01ZO102-L	Invertebrata Lab	MJ 1 P	-	-	4	2	50	50	100
5.	Chemistry	01CH103	Analytical Chemistry	MJ 1	4	-	-	4	50	50	100
6.		01CH103-L	Analytical Processes and Techniques Lab	MJ 1 P	-	-	4	2	50	50	100
Minor Subject (Choose Any one)											
7.	Botany	02BO111	Basic Botany	MI 1	4	-	-	4	50	50	100
8.		02BO111-L	Basic Botany Lab	MI 1 P	-	-	4	2	50	50	100
9.	Zoology	02ZO112	Animal Diversity: Non-Chordata	MI 1	4	-	-	4	50	50	100
10.		02ZO112-L	Invertebrate Lab	MI 1 P	-	-	4	2	50	50	100
11.	Chemistry	02CH113	Analytical Chemistry	MI 1	4	-	-	4	50	50	100
12.		02CH113-L	Analytical Processes and Techniques Lab	MI 1 P	-	-	4	2	50	50	100
Generic Elective Course (Choose Any One) (*Student can opt second group of Minor Subject as a generic elective course but credit will be 3:1).*											
13.	Botany	03BO121	Basic Botany	GEC 1	3	-	-	3	50	50	100
14.		03BO121-L	Basic Botany Lab	GEC 1 P	-	-	2	1	50	50	100
15.	Zoology	03ZO122	Animal Diversity: Non-Chordata	GEC 1	3	-	-	3	50	50	100
16.		03ZO122-L	Invertebrata Lab	GEC 1 P	-	-	2	1	50	50	100
17.	Chemistry	03CH123	Analytical Chemistry	GEC 1	3	-	-	3	50	50	100
18.		03CH123-L	Analytical Processes and Techniques Lab	GEC 1 P	-	-	2	1	50	50	100
Ability Enhancement Course											
19	English	0SSD02	English Language	AEC 1	2	-	-	2	50	50	100
20	SDG	0SDG01	Sustainable Development Goals	AEC 2	2	-	-	2	50	50	100
				TOTAL	**15**	**-**	**10**	**20**	**400**	**400**	**800**

B.Sc. (Hons.) in Botany/Zoology/Chemistry
Four-Year Full Time Degree Programme
B.Sc. – Second Semester
(Undergraduate Certificate in Botany/Zoology/Chemistry)

S.No.	Subject	Subject Code	Subject/Paper Title	Subject area	Periods			Credit	Marks Distribution		
					L	T	P		Internal	External	Total
Major Subject (Choose Any one)											
1	Botany	01BO201	Applied Botany	MJ 2	4	-	-	4	50	50	100
2		01BO251	Applied Botany Lab	MJ 2 P	-	-	4	2	50	50	100
3	Zoology	01ZO202	Cell Biology, Reproductive Biology and Developmental Biology	MJ 2	4	-	-	4	50	50	100
4		01ZO252	Cytology, Reproductive Biology and Embryology Lab	MJ 2 P	-	-	4	2	50	50	100
5	Chemistry	01CH203	Fundamentals of Chemistry	MJ 2	4	-	-	4	50	50	100
6		01CH253	Qualitative & Quantitative Chemical Analysis Lab	MJ 2 P	-	-	4	2	50	50	100
Minor Subject (Choose Any one)											
7	Botany	02BO211	Applied Botany	MI 2	4	-	-	4	50	50	100
8		02BO261	Applied Botany Lab	MI 2 P	-	-	4	2	50	50	100
9	Zoology	02ZO212	Cell Biology, Reproductive Biology and Developmental Biology	MI 2	4	-	-	4	50	50	100
10		02ZO262	Cytology, Reproductive Biology and Embryology Lab	MI 2 P	-	-	4	2	50	50	100
12	Chemistry	02CH213	Fundamentals of Chemistry	MI 2	4	-	-	4	50	50	100
13		02CH263	Qualitative & Quantitative Chemical Analysis Lab	MI 2 P	-	-	4	2	50	50	100
Generic Elective Course (Choose Any One) (*Student can opt second group of Minor Subject as a generic elective course but credit will be 3:1.)*											
14	Botany	03BO221	Applied Botany	GEC 2	3	-	-	3	50	50	100
15		03BO271	Applied Botany Lab	GEC 2P	-	-	2	1	50	50	100
16	Zoology	03ZO222	Cell Biology, Reproductive Biology and Developmental Biology	GEC 2	3	-	-	3	50	50	100
17		03ZO272	Cytology, Reproductive Biology and Embryology Lab	GEC 2P	-	-	2	1	50	50	100
18	Chemistry	03CH223	Fundamentals of Chemistry	GEC 2	3	-	-	3	50	50	100
19		03CH273	Qualitative & Quantitative Chemical Analysis Lab	GEC 2P	-	-	2	1	50	50	100
Ability Enhancement Course											
20	Hindi	0IKS04	Indian Knowledge System	AEC 3	2	-	-	2	50	50	100
21	Environment	0EVS03	Environmental Studies	AEC 4	2	-	-	2	50	50	100
				TOTAL	**15**	**-**	**10**	**20**	**400**	**400**	**800**

B.Sc. (Hons.) in Botany/Zoology/Chemistry
Four-Year Full Time Degree Programme
B.Sc. – Third Semester
(Undergraduate Diploma in Botany/Zoology/Chemistry)

S.No.	Subject	Subject Code	Subject/Paper Title	Subject area	Periods			Credit	Marks Distribution		
					L	T	P		Internal	External	Total
Major Subject (Choose Any One)											
1.	Botany	01BO301	Plant Anatomy and Embryology	MJ 3	4	-	-	4	50	50	100
2.		01BO301-L	Plant Anatomy and Embryology Lab	MJ 3 P	-	-	4	2	50	50	100
3.	Zoology	01ZO302	Diversity of Chordates and Comparative Anatomy	MJ 3	4	-	-	4	50	50	100
4.		01ZO302-L	Chordate Zoology Lab	MJ 3 P	-	-	4	2	50	50	100
5.	Chemistry	01CH303	Reactions, Reagents and Mechanism in Organic Chemistry	MJ 3	4	-	-	4	50	50	100
6.		01CH303-L	Organic Qualitative Analysis, Reactions and Synthesis Lab	MJ 3 P	-	-	4	2	50	50	100
Minor Subject (Choose Any one)											
7.	Botany	02BO311	Plant Anatomy and Embryology	MI 3	4	-	-	4	50	50	100
8.		02BO311-L	Plant Anatomy and Embryology Lab	MI 3 P	-	-	4	2	50	50	100
9.	Zoology	02ZO312	Diversity of Chordates and Comparative Anatomy	MI 3	4	-	-	4	50	50	100
10.		02ZO312-L	Chordate Zoology Lab	MI 3 P	-	-	4	2	50	50	100
11.	Chemistry	02CH313	Reactions, Reagents and Mechanism in Organic Chemistry	MI 3	4	-	-	4	50	50	100
12.		02CH313-L	Organic Qualitative Analysis, Reactions and Synthesis Lab	MI 3 P	-	-	4	2	50	50	100
Generic Elective Course (Choose Any One) • *Student can opt second group of Minor Subject as a generic elective course but credit will be 3:1.*											
13.	Botany	03BO321	Plant Anatomy and Embryology	GEC 3	3	-	-	3	50	50	100
14.		03BO321-L	Plant Anatomy and Embryology Lab	GEC 3 P	-	-	2	1	50	50	100
15.	Zoology	03ZO322	Diversity of Chordates and Comparative Anatomy	GEC 3	3	-	-	3	50	50	100
16.		03ZO322-L	Chordate Zoology Lab	GEC 3 P	-	-	2	1	50	50	100
17.	Chemistry	03CH323	Reactions, Reagents and Mechanism in Organic Chemistry	GEC 3	3	-	-	3	50	50	100
18.		03CH323-L	Organic Qualitative Analysis, Reactions and Synthesis Lab	GEC 3 P	-	-	2	1	50	50	100
Skill Enhancement Course											
19.	SEC	0MT001	Principles of Managements	SEC 1	2	-	-	2	50	50	100
20.	SEC	0FC001	Fundamentals of computer & programming	SEC 2	2	-	-	2	50	50	100
				TOTAL	**14**	**-**	**12**	**20**	**400**	**400**	**800**

B.Sc. (Hons.)in Botany/Zoology/Chemistry
Four-Year Full Time Degree Programme
B.Sc. – Fourth Semester
(Undergraduate Diploma in Botany/Zoology/Chemistry)

S.No.	Subject	Subject Code	Subject/Paper Title	Subject area	Periods			Credit	Marks Distribution		
					L	T	P		Internal	External	Total
Major Subject											
1.	Botany	01BO401	Industrial Botany	MJ 4	4	-	-	4	50	50	100
2.		01BO451	Industrial Botany Lab	MJ 4 P	-	-	4	2	50	50	100
3.	Zoology	01ZO402	Biochemistry and Physiology	MJ 4	4	-	-	4	50	50	100
4.		01ZO452	Biochemistry and Physiology Lab	MJ 4 P	-	-	4	2	50	50	100
5.	Chemistry	01CH403	Transition Elements, Chemi-energetics and Phase Equilibria	MJ 4	4	-	-	4	50	50	100
6.		01CH453	Metal Complex Preparation, Thermochemistry & Phase Equilibria Experiment Lab	MJ 4 P	-	-	4	2	50	50	100
Minor Subject (Choose Any one)											
7.	Botany	02BO411	Industrial Botany	MI 4	4	-	-	4	50	50	100
8.		02BO461	Industrial Botany Lab	MI 4 P	-	-	4	2	50	50	100
9.	Zoology	02ZO412	Biochemistry and Physiology	MI 4	4	-	-	4	50	50	100
10.		02ZO462	Biochemistry and Physiology Lab	MI 4 P	-	-	4	2	50	50	100
11.	Chemistry	02CH413	Transition Elements, Chemi-energetics and Phase Equilibria	MI 4	4	-	-	4	50	50	100
12.		02CH463	Metal Complex Preparation, Thermochemistry & Phase Equilibria Experiment Lab	MI 4 P	-	-	4	2	50	50	100
Generic Elective Course (Choose Any One) • *Student can opt second group of Minor Subject as a generic elective course but credit will be 3:1.*											
13.	Botany	03BO421	Industrial Botany	GEC 4	3	-	-	3	50	50	100
14.		03BO471	Industrial Botany Lab	GEC 4 P	-	-	2	1	50	50	100
15.	Zoology	03ZO422	Biochemistry and Physiology	GEC 4	3	-	-	3	50	50	100
16.		03ZO472	Biochemistry and Physiology Lab	GEC 4 P	-	-	2	1	50	50	100
17.	Chemistry	03CH423	Transition Elements, Chemi-energetics and Phase Equilibria	GEC 4	3	-	-	3	50	50	100
18.		03CH473	Metal Complex Preparation, Thermochemistry & Phase Equilibria Experiment Lab	GEC 4 P	-	-	2	1	50	50	100
Skill Enhancement Course											
19.	SEC	0EN401	Entrepreneurship Development	SEC 3	2	-	-	2	50	50	100
20.	SEC	0FS402	Basics of Forensic Science	SEC 4	2	-	-	2	50	50	100
				TOTAL	**15**	**-**	**10**	**20**	**400**	**400**	**800**

B.Sc. (Hons.)in Botany/Zoology/Chemistry
Four-Year Full Time Degree Programme
B.Sc. – Fifth Semester
(Undergraduate Degree in Botany/Zoology/Chemistry)

S.No.	Subject	Subject Code	Subject/Paper Title	Subject area	Periods			Credit	Marks Distribution		
					L	T	P		Internal	External	Total
Major Subject (Choose Any One)											
1.	Botany	01BO501	Plant Physiology and Metabolism	MJ 4	4	-	-	4	50	50	100
2.		01BO451	Plant Physiology and Metabolism Lab	MJ 4 P	-	-	4	2	50	50	100
3.	Zoology	01ZO502	Aquaculture	MJ 4	4	-	-	4	50	50	100
4.		01ZO552	Applied Aquaculture Lab	MJ 4 P	-	-	4	2	50	50	100
5.	Chemistry	01CH503	Green and Agriculture Chemistry	MJ 4	4	-	-	4	50	50	100
6.		01CH553	Green and Agriculture Chemistry Lab	MJ 4 P	-	-	4	2	50	50	100
Major DSC (Choose Any one)											
7.	Botany	05BO501	Ecology and Forestry	MI 4	3	-	-	3	50	50	100
8.		05BO551	Ecology and Forestry Lab	MI 4 P	-	-	2	1	50	50	100
9.	Zoology	05ZO502	Wild Life Conservation and Management	MI 4	3	-	-	3	50	50	100
10.		05ZO552	Importance of Wild Life Lab	MI 4 P	-	-	2	1	50	50	100
11.	Chemistry	05CH503	Laboratory Skills, Techniques and Management	MI 4	3	-	-	3	50	50	100
12.		05CH553	Exercises for Development of Lab Skills Lab	MI 4 P	-	-	2	1	50	50	100
Skill Enhancement Course											
7	SEC	04OF501	Organic Farming and Agriculture Technology	SEC 5	2	-	-	2	50	50	100
8		04OF551	Organic Farming and Agriculture Technology Lab	SEC 5 P	-		2	1	50	50	100
9		04YS502	Yoga Science	SEC 6 P	-	-	2	1	50	50	100
Field Project											
10	FP	06FP501	Field Project/ Internship/ Apprenticeship	FP1	-	-	12	6	50	50	100
				TOTAL	**9**	**-**	**22**	**20**	**400**	**400**	**800**

B.Sc. (Hons.)in Botany/Zoology/Chemistry
Four-Year Full Time Degree Programme
B.Sc. – Sixth Semester
(Undergraduate Degree in Botany/Zoology/Chemistry)

S.No.	Subject	Subject Code	Subject/Paper Title	Subject area	Periods			Credit	Marks Distribution		
					L	T	P		Internal	External	Total
Major Subject (Choose Any One)											
1.	Botany	01BO601	Cytology Plant Breeding and Biotechnology	MJ 4	4	-	-	4	50	50	100
2.		01BO651	Cytology Plant Breeding and Biotechnology Lab	MJ 4 P	-	-	4	2	50	50	100
3.	Zoology	01ZO602	Insect Taxonomy and Applied Entomology	MJ 4	4	-	-	4	50	50	100
4.		01ZO652	Applied Entomology Lab	MJ 4 P	-	-	4	2	50	50	100
5.	Chemistry	01CH603	Polymer Chemistry	MJ 4	4	-	-	4	50	50	100
6.		01CH653	Polymer Chemistry Lab	MJ 4 P	-	-	4	2	50	50	100
Major DSC 1 (Choose Any one)											
7.	Botany	05BO601	Biodiversity and Economic Botany	MI 4	3	-	-	3	50	50	100
8.		05BO651	Biodiversity and Economic Botany Lab	MI 4 P	-	-	2	1	50	50	100
9.	Zoology	05ZO602	Ecology, Biodiversity and Evolution		3	-	-	3	50	50	100
10.		05ZO652	Environmental Biology Lab		-	-	2	1	50	50	100
11.	Chemistry	05CH603	Biophysical, Bioinorganic and Organo-metallic Chemistry	MI 4	3	-	-	3	50	50	100
12.		05CH653	Synthesis and Analytical Techniques Lab	MI 4 P	-	-	2	1	50	50	100
Major DSC 2 (Choose Any one)											
13.	Botany	05BO604	Ethnobotany		3	-	-	3	50	50	100
14.		05BO654	Ethnobotany Lab		-	-	2	1	50	50	100
15.	Zoology	05ZO605	Genetics	MI 4	3	-	-	3	50	50	100
16.		05ZO655	Experimental Genetics Lab	MI 4 P	-	-	2	1	50	50	100
17.	Chemistry	05CH606	Pharmaceutical and Medicinal Chemistry		3	-	-	3	50	50	100
18.		05CH656	Pharmaceutical and Medicinal Chemistry Lab		-	-	2	1	50	50	100
Field Project											
10	FP	06FP601	Field Project/ Internship/ Apprenticeship	FP1	-	-	12	6	50	50	100
				TOTAL	**9**	**-**	**22**	**20**	**400**	**400**	**800**

B.Sc. (Hons.) in Botany/Zoology/Chemistry
Four-Year Full Time Degree Programme
B.Sc. – Seventh Semester
(Honors in Botany/Zoology/Chemistry)

S.No.	Subject	Subject Code	Subject/Paper Title	Subject area	Periods			Credit	Marks Distribution		
					L	T	P		Internal	External	Total
Major Subject (Choose Any One)											
1.	Botany	01BO701	Mycology and Plant Pathology	MJ 5	4	-	-	4	50	50	100
2.		01BO751	Mycology and Plant Pathology Lab	MJ 5 P	-	-	4	2	50	50	100
3.	Zoology	01ZO702	Genetics and Molecular Biology	MJ 5	4	-	-	4	50	50	100
4.		01ZO752	Genetics and Molecular Biology Lab	MJ 5 P	-	-	4	2	50	50	100
5.	Chemistry	01CH703	Group Theory and Spectroscopy	MJ 5	4	-	-	4	50	50	100
6.		01CH753	Group Theory and Spectroscopy Lab	MJ 5 P	-	-	4	2	50	50	100
Major (DSC) (Choose Any One)											
7.	Botany	05BO701	Plant Tissue Culture and Biotechnology	MJD2	3	-	-	3	50	50	100
8.		05BO751	Plat tissue Culture Lab	MJD2P	-	-	2	1	50	50	100
9.	Zoology	05ZO702	Immunology	MJD2	3	-	-	3	50	50	100
10.		05ZO752	Immunology Lab	MJD2P	-	-	2	1	50	50	100
11.	Chemistry	05CH703	Industrial Chemistry	MJD2	3	-	-	3	50	50	100
12.		05CH753	Industrial Chemistry Lab	MJD2P	-	-	2	1	50	50	100
Minor Subject											
13.	RM	02RM701(A/B/C)	Research Methodology (Botany/Zoology/ Chemistry)	MI5	3	-	-	3	50	50	100
14.	RM	02RM751	Research Methodology Lab	MI5	-	-	2	1	50	50	100
Skill Enhancement Course											
15	FP	06FP701	Field Project/ Internship/ Apprenticeship	FP3	-	-	12	6	50	50	100
				TOTAL	**10**	**-**	**20**	**20**	**350**	**350**	**700**

B.Sc. (Hons.) in Botany/Zoology/Chemistry
Four-Year Full Time Degree Programme
B.Sc. – Eighth Semester
(Honors in Botany/Zoology/Chemistry)

S.No.	Subject	Subject Code	Subject/Paper Title	Subject area	Periods			Credit	Marks Distribution		
					L	T	P		Internal	External	Total
Major Subject (Core) (Choose Any One)											
1.	Botany	01BO801	Diversity of Plants	MJ 5	4	-	-	4	50	50	100
2.		01BO851	Diversity of Plants Lab	MJ 5 P	-	-	4	2	50	50	100
3.	Zoology	01ZO802	Museology and Taxidermy	MJ 5	4	-	-	4	50	50	100
4.		01ZO852	Museology and Taxidermy Lab	MJ 5 P	-	-	4	2	50	50	100
5.	Chemistry	01CH803	Diffraction Methods And Spectroscopy II	MJ 5	4	-	-	4	50	50	100
6.		01CH853	Diffraction Methods And Spectroscopy II Lab	MJ 5 P	-	-	4	2	50	50	100
Minor Subject (Choose Any One)											
7.	Botany	02BO801	Industrial Microbiology	MI 6	3	-	-	3	50	50	100
8.		02BO851	Industrial Microbiology Lab	MI6P	-	-	2	1	50	50	100
9.	Zoology	02ZO802	Ethology and Biostatistics	MI 6	3	-	-	3	50	50	100
10.		02ZO852	Ethology and Biostatistics Lab	MI6P	-	-	2	1	50	50	100
11.	Chemistry	02CH803	Chemistry of Materials	MI 6	3	-	-	3	50	50	100
12.		02CH853	Chemistry of Materials Lab	MI6P	-	-	2	1	50	50	100
Skill Enhancement Course											
13.	SEC	06FP801	Field Project/ Internship/ Apprenticeship	FP2		-	20	10	50	50	100
				TOTAL	**7**	**-**	**26**	**20**	**250**	**250**	**500**

Program name	Bachelor of Science (B. Sc.)- Botany	
Semester	1st	
Course Code:	01BO101	
Course title:	Basic Botany	**Curriculum Developer**: Nitin Singh Parihar, Lab Assistant
Pre-requisite:	To study this course, A student must have had the subject Biology/ Life Sciences/ Agriculture in class 12th	
Rationale:	Applied botany overall, this unit provides a robust foundation in plant biology, combining historical context, morphological studies, and cellular biology with practical microscopy skills. This comprehensive approach ensures students are well-prepared for advanced botanical studies and research, fostering a deeper understanding and appreciation of plant sciences.	
Course Outcomes (COs):	**CO1:** To understand the structure and function of various plant organs. Students will classify and describe different types of leaves, inflorescences, flowers, and fruits. **CO2:** To demonstrate the different reproductive methods and life cycles of algae, Bryophytes, and Gymnosperms. **CO3:** Students will describe the stellar organization, reproduction, heterospory, and seed habit in pteridophytes, Gymnosperms, and Paleobotany. **CO4:** To understand the modes of nutrition and types of reproduction in fungi and the economic importance of fungi **CO5:** To understand the overview of various types of microbes, including archaebacteria, eubacteria, cyanobacteria, mycoplasma, actinomycetes, and viruses.	

Scheme of Studies:

Board of Study	CourseCode	Course Title	Scheme of studies (Hours/Week)					Total Credits(C) (L:T:P=4:0:2)
			CI	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Major	01BO101	Applied Botany	4	2	1	2	9	4+2=6

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)		
			Progressive Assessment (PRA)	End Yearly (ESA)	Total Marks (PRA+ ESA)
Major	01BO101	Applied Botany	Total Marks (CA+CT+SA+CAT+AT) **30**	**70**	**100**

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	12	6	1	5	24

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CIs)	Self-Learning (SL)
CO1: To Understand the structure and function of various plant organs. Students will classify and describe different types of leaves, inflorescences, flowers, and fruits.			**Unit-1**	
	SO1.1 Students will be able to describe the importance of botany in historical and cultural contexts, with a focus on contributions from ancient Indian civilizations.	**LI1.1** to perform a morphological study of different types of Flowers	**CI1.1** Introduction to Botany and Indian Contributions	**SL1.1** Search various reference books and other study materials to start learning about plants, understand their ecological roles, and explore their potential applications.
	SO1.2 Students can differentiate between lower and higher plants based on morphological characteristics such as size, complexity, and reproductive structures.	**LI1.2** To understand and observe the different components of plant cells through microscopic examination and diagrammatic representation	**CI1.2** Morphological Characteristics of Lower Plants (Angiosperms)	**SL1.2** Explore the historical evolution and recent advancements in animal biotechnology.
	SO1.3 Students can classify higher plants based on their structural features, including roots, stems, leaves, and flowers.	**LI1.3** To study the structure of a typical plant cell using an onion peel and observe its cellular components under a microscope.	**CI 1.3** Morphological Characteristics of Higher Plants (Angiosperms).	**SL1.3** Understand the essential infrastructure and equipment needed for an animal biotechnology laboratory.

	SO4. Students can identify and differentiate between different types of leaves based on their shapes, arrangements, and venation patterns.		**CI 1.4** Types of Leaves	**SL1.4** Learn about different types of leaves.
	SO1.5 Students will be able to classify inflorescence types and explain their significance in plant reproduction and species identification.		**CI 1.5** Types of Inflorescence	**SL1.5** Learn about different types of Inflorescence.
	SO1.6 Students will be able to describe the parts of a flower and their roles in reproduction, with a focus on angiosperms.		**CI 1.6** Structure of Flowers	
	SO1.7 Students will be able to differentiate between different types of fruits and explain their development and dispersal mechanisms.		**CI 1.7** Types of Fruits	
	SO1.8 Students will be able to identify and describe the structure and function of plant cell organelles, including the cell membrane, nucleus, chloroplasts, and vacuoles.		**CI 1.8** Structure of Plant Cells.	
	SO1.9 Students will be able to compare and contrast prokaryotic and eukaryotic cells, emphasizing the		**CI1.9** Prokaryotic and Eukaryotic Cells	

	differences in structure, organization, and genetic material.			
	SO1.10 Students will be able to differentiate between mitosis and meiosis, explaining their roles in growth, repair, and reproduction in plants.		**CI1.10** Types of Cell Division	
	SO1.11 Students will be able to explain the principles of magnification and resolving power in light microscopes and demonstrate proper microscope usage.		**CI1.11** Microscope Structure and Function of Light Microscope	
	SO1.12 Students will be able to describe the principles and applications of different types of microscopes, including bright field, phase contrast, scanning electron microscopy (SEM), and transmission electron microscopy (TEM).		**CI1.12** Various Types of Microscopes: Bright Field, Phase Contrast, SEM, and TEM	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Describe in detail the history of electron microscopy (TEM).
	SW1.2 Mini Project	Describe and define light microscopes and demonstrate proper microscope usage.
	SW1.3 Other Activities (Specify)	Explain the Structure of Plant Cells.

Item	CI	LI	SW	SL	Total
Approx. Hours	12	6	1	5	24

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CIs)	Self-Learning (SL)
CO2: To demonstrate the different reproductive methods and life cycles of algae, Bryophytes, and Gymnosperms.			**Unit-2**	
	SO2.1 Students will be able to describe the basic characteristics of algae.	**LI2.1** To perform detailed observation of different types of Algae.	**CI2.1** Overview of algae; definition, general characteristics	**SL2.1** Search various reference books and other study materials to start learning the Overview of algae.
	SO2.2 Students will classify algae based on their thallus organization.	**LI2.2** To perform a transfer in Morphological Characteristics of Higher Plants	**CI2.2** Discuss the range of thallus organization in algae.	
	SO2.3 Students will differentiate between asexual and sexual reproduction in algae.	**LI2.3** To perform a transfer in Morphological Characteristics of Bryophytes.	**CI2.3** Types of reproduction in algae (asexual and sexual).	**SL2.2** Gain proficiency in Morphological Characteristics of Higher Plants.
	SO2.4 Students will identify and compare various life cycles in algae.		**CI2.4** Different types of life cycles exhibited by algae.	**SL2.3** Acquire knowledge of the Different types of life cycles exhibited by algae.
	SO2.5 Students will explain the ecological roles of algae in nature.		**CI2.5** Importance of algae in ecosystems.	
	SO2.6 Students will analyze the economic significance of algae		**CI2.6** Discuss the economic uses of algae (e.g., food, biofuels, pharmaceuticals).	**SL2.4** Gain proficiency in the economic uses of algae.

	SO2.7 Students will be able to describe the basic characteristics of Bryophytes.		**CI2.7** Overview of Bryophytes; definition, general characteristics.	**SL2.5** Search various reference books and other study materials to learn the Bryophytes.
	SO2.8 Students will classify Bryophytes based on their thallus organization and morphology.		**CI2.8** Range of thallus organization and morphology in Bryophytes.	
	SO2.9 Students will identify and describe the anatomy of Bryophytes.		**CI2.9** Internal and external features of Bryophytes.	
	SO2.10 Students will compare the reproductive strategies of different Bryophyte species.		**CI2.10** Modes of reproduction in Bryophytes (sexual and asexual).	
	SO2.11 Students will explain the ecological roles of Bryophytes in their habitats.		**CI2.11** Importance of Bryophytes in ecosystems.	
	SO2.12 Students will evaluate the economic significance of Bryophytes.		**CI2.12** Economic uses of Bryophytes (e.g., ecological indicators, horticulture).	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Describe and define the Bryophytes.
	SW2.2 Mini Project	Detail study of anatomy of Bryophytes.
	SW2.3 Other Activities (Specify)	compare various life cycles in algae.

Item	CI	LI	SW	SL	Total
Approx. Hours	12	6	1	5	24

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CIs)	Self-Learning (SL)
CO3: Students will describe the stellar organization, reproduction, heterospory, and seed habit in pteridophytes, Gymnosperms, and Paleobotany.			**Unit-3**	
	SO3.1 Students will be able to describe the general characteristics of Pteridophytes.	**LI3.1** To perform detailed morphological observation of Pteridophytes.	**CI3.1** Overview of Pteridophytes; definition, general characteristics.	**SL3.1** Search various reference books and other study materials to learn about transgenesis and gene transfer methods.
	SO3.2 Students will identify and classify different morphological features of Pteridophytes.	**LI3.2** To demonstrate the Gymnosperms	**CI3.2** Study of the morphology of Pteridophytes (e.g., leaves, stems, roots).	
	SO3.3 Students will analyze the stellar organization and its significance in Pteridophytes	**LI3.3** To study the external morphology and internal anatomy of the needle of *Pinus*, a representative gymnosperm.	**CI3.3** Types of stellar organization found in Pteridophytes.	
	SO3.4 Students will compare the reproductive strategies of different Pteridophyte species.		**CI3.4** Modes of reproduction in Pteridophytes (e.g., spores, gametophyte development).	**SL3.2** Search various reference books and other study materials for reproduction in Pteridophytes
	SO3.5 Students will differentiate between homospory and heterospory, and understand the concept		**CI3.5** Explanation of heterospory and seed habit in Pteridophytes.	

	of seed habit in Pteridophytes.			
	SO3.6 Students will evaluate the economic significance of Pteridophytes.		**CI3.6** Discuss the economic uses of Pteridophytes (e.g., ornamental plants, medicinal plants).	**SL3.3** Explore the economic uses of Pteridophytes
	SO3.7 Students will be able to describe the general characteristics and distribution of Gymnosperms.	.	**CI3.7** Overview of Gymnosperms; definition, general characteristics, and distribution.	**SL3.4** Search various reference books and other study materials for Overview of Gymnosperms
	SO3.8 Students will analyze the economic significance of Gymnosperms.		**CI3.8** Discuss the economic uses of Gymnosperms (e.g., timber, paper production, pharmaceuticals).	
	SO3.9 Students will understand the significant contributions of Indian scientists in the field of Paleobotany.		**CI3.9** Overview of India's contribution to Paleobotany (e.g., fossil discoveries, research).	
	SO3.10 Students will be able to explain the concept of fossils and describe the Geological Time Scale.		**CI3.10** Brief Introduction of Paleobotany	**SL3.5** Search various reference books and study about Paleobotany
	SO3.11 Students will analyze recent developments and research methods in Paleobotany.		**CI3.11** Study of current trends and advancements in Paleobotanical research.	

	SO3.12 Students will demonstrate a comprehensive understanding of the topics covered through discussions, quizzes, or assignments.		**CI3.12** Review and integrate concepts from Pteridophytes, Gymnosperms, and Paleobotany.	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Describe the transgenesis palaeobotany
	SW3.2 Mini Project	Describe the Pteridophytes
	SW3.3 Other Activities (Specify)	Explain in detail gymnosperms.

Item	**CI**	**LI**	**SW**	**SL**	**Total**
Approx. Hours	12	6	1	5	24

Course outcomes (COs)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CIs)**	**Self-Learning (SL)**
CO4: To understand the modes of nutrition and types of reproduction in fungi and the economic importance of fungi			**Unit-4**	
	SO4. 1 Students will gain an overview of fungal diversity and classification.	**LI4.1** To demonstrate and visualize the Fungal Cells.	**CI4.1** Define fungi and discuss their general characteristics.	**SL4.1** Search various reference books and other study materials to start learning about fungi and discuss their general characteristics
	SO4.2 Students will	**LI4.2** To introduce fungi in	**CI4.2** Study the composition of the	**SL4.2** To independently

	understand the unique composition of the fungal cell wall.	medicine, industry, and agriculture.	fungal cell wall, focusing on chitin and other polysaccharides	explore thecomposition of the fungal cell wall and focusing on chitin and other polysaccharides.
	SO4.3 Students will be able to classify fungi based on their nutritional modes.	**LI4.3** To introduce the structure of lichens.	**CI4.3** Explain the heterotrophic modes of nutrition in fungi: saprophytic, parasitic, and mutualistic.	
	SO4.4 Students will understand the different types of asexual and sexual reproduction in fungi.		**CI4.4** Explain the Types of Reproduction in Fungi.	**SL4.3** To independently Explain the Types of Reproduction in Fungi.
	SO4.5 Students will understand the various reproductive structures in fungi.		**CI4.5** Describe various fungal reproductive structures, such as spores, sporangia, and fruiting bodies, and Provide diagrams and examples of each structure.	
	SO4.6 Students will recognize the economic importance of fungi in various fields		**CI4.6** Discuss the beneficial roles of fungi in medicine, industry, and agriculture.	**SL4.4** To independently explore the beneficial roles of fungi in medicine, industry, and agriculture.
	SO4.7 students will understand the concept and significance of parasexuality in fungi		**CI4.7** discusses examples of fungi exhibiting Para sexuality.	
	SO4.8 Students will understand the concept and types of mycorrhizae.		**CI4.8** Discuss the types of mycorrhizal associations ecological and agricultural importance of mycorrhizal associations.	
	SO4.9 Students will understand the definition and unique symbiotic nature of lichens.		**CI4.9** Describe the general characteristics and structure of lichens.	**SL4.5** Search various reference books and other study materials to start learning about the general

				characteristics and structure of lichens.
	SO4.10 Students will understand the classification of lichens based on morphology.		**CI4.10** Explain the classification of lichens based on their morphology: crustose, foliose, and fruticose.	
	SO4.11 Students will understand the role of lichens in different ecosystems.		**CI4.11** Explain the ecological importance of lichens in various habitats.	
	SO4.12 Students will understand the economic and cultural importance of lichens		**CI4.12** Explain the cultural significance of lichens in various traditions and practices	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Describe the cultural importance of lichens
	SW4.2 Mini Project	Explain in detail to lichens based on morphology..
	SW4.3 Other Activities (Specify)	Write a one review article fungi in various fields

Item	CI	LI	SW	SL	Total
Approx. Hours	12	6	1	8	27

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CIs)	Self-Learning (SL)
CO5: To understand the overview of various types of microbes, including archaebacteria, eubacteria, cyanobacteria, mycoplasma, actinomycetes, and viruses			**Unit-5**	
	SO5.1 Students will gain an initial understanding of the diversity of microbes.	**LI5.1** To analyse the Archaebacteria	**CI5.1** Provide an overview of the different types of microbes.	**SL5.1** Search various reference books and other study materials to start the learning about overview of the different types of microbes.
	SO5.2 Students will recognize the diversity within microbial life.	**LI5.2** To perform morphological characterisation of Cyanobacteria	**CI5.2** Briefly outlines the main categories of microbes: Archaebacteria, Eubacteria, Cyanobacteria, Mycoplasma, Actinomycetes, and Viruses.	**SL5.2** Explore the various types of Microbes.
	SO5.3 Students will understand the unique characteristics of Archaebacteria.	**LI5.3** Observation of Cytopathic Effects in Cell Cultures	**CI5.3** Discuss the characteristics, habitats, and importance of Archaebacteria.	**SL5.3** Search various reference books and other study materials to start learning about the overview of the different types of microbes.
	SO5.4 Students will understand the classification and characteristics of Eubacteria.		**CI5.4** Discuss the role of Eubacteria in various ecosystems.	**SL5.4** Explore the role of Eubacteria in various ecosystems
	SO5.5 Students will understand the characteristics and		**CI5.5** Describe the characteristics, photosynthetic capabilities, and ecological importance of	**SL5.5** Search various reference books and other study materials to start

	significance of Cyanobacteria.		Cyanobacteria.	learning about the overview of the Cynobacteria.
	SO5.6 Students will understand the unique characteristics of Mycoplasma.		**CI5.6** Discuss the unique features of Mycoplasma, including their lack of a cell wall. .	
	SO5.7 Students will understand the characteristics and ecological significance of Actinomycetes. .		**CI5.7** Explain the characteristics, habitat, and importance of Actinomycetes.	
	SO5.8 Students will understand the basic structure and classification of viruses.		**CI5.8** Provide an overview of the structure and classification of viruses.	**SL5.6** Search various reference books and other study materials to start the learning the overview of the Viruses.
	SO5.9 Students will understand the reproductive strategies of viruses		**CI5.9** Explain the life cycle of viruses, including lytic and lysogenic cycles.	
	SO5.10 Students will recognize the positive impact of microbes in various fields.		**CI5.10** Discuss the beneficial roles of microbes in agriculture, industry, medicine, and the environment	**SL5.7** Explore the roles of microbes in agriculture, industry, medicine, and the environment
	SO5.11 Students will understand the negative impacts of harmful microbes.		**CI5.11** Explain the harmful roles of microbes, including pathogenicity and spoilage.	**SL5.8** Explore the harmful roles of microbes, including pathogenicity and spoilage.
	SO5.12 Students will have a consolidated understanding of the unit on microbes.		**CI5.12** Summarize the key points covered in the unit.	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Explain in detail understanding of the unit on microbes.
	SW5.2 Mini Project	Describe in the microbes in various fields.
	SW5.3 Other Activities (Specify)	One case research study structure and classification of viruses.

Course duration (in hours) to attain Course Outcomes:

Course Title: Basic Botany **Course Code:** 01BO101

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1: To Understand the structure and function of various plant organs. Students will classify and describe different types of leaves, inflorescences, flowers, and fruits..	12	6	5	1	24
CO2: To demonstrate the different reproductive methods and life cycles of algae, Bryophytes, and Gymnosperms.	12	6	5	1	24
CO3: Students will describe the stellar organization, reproduction, heterospory, and seed habit in pteridophytes, Gymnosperms, and Paleobotany.	12	6	5	1	24
CO4: To understand the modes of nutrition and types of reproduction in fungi and the economic importance of fungi	12	6	5	1	24
CO5: To understand the overview of various types of microbes, including archaebacteria, eubacteria, cyanobacteria, mycoplasma, actinomycetes, and viruses	12	6	8	1	27
Total Hours	60	30	28	05	123

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcomes:

Course Title: Basic Botany **Course Code:** 01BO101

***Legend*: R,** Remember; **U,** Understand; **A,** Apply; **A,** Analyze

Course Outcomes	Marks Distribution				Total Marks
	R	U	A	A	
CO1 To Understand the structure and function of various plant organs. Students will classify and describe different types of leaves, inflorescences, flowers, and fruits.	4	4	6	4	18
CO2: To demonstrate the different reproductive methods and life cycles of algae, Bryophytes, and Gymnosperms.	4	6	6	4	20
CO3: Students will describe the stellar organization, reproduction, heterospory, and seed habit in pteridophytes, Gymnosperms, and Paleobotany.	4	4	6	8	22
CO4: To understand the modes of nutrition and types of reproduction in fungi and the economic importance of fungi	4	4	6	6	20
CO5: To understand the overview of various types of microbes, including archaebacteria, eubacteria, cyanobacteria, mycoplasma, actinomycetes, and viruses	4	4	4	8	20
Total Marks	20	22	28	30	100

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1.	Oladele Ogunseitan, Microbial Diversity: Form and Function in Prokaryotes, Wiley Blackwell.2008.
2.	Pelczar, M.J et al., Microbiology, Tata McGraw-Hill Co, New Delhi, 5th edition, 2001. .
3.	Presscott, L. Harley, J. and Klein, D., Microbiology, Tata McGraw-Hill Co. New Delhi, 6thedn., 2005.
4.	Fritsch F.E., The Structure & Reproduction of Algae, Vol. 1 & Vol. II., Cambridge University Press, Cambridge, U.K. 1945.
5.	Smith, G.M., Cryptogamic Botany, Vol. I: Algae, Fungi, & Lichens, McGraw-Hill Book Co., New York, 1955.
6.	lanMorris, An Introduction to the Algae, Hutchinson, London, 1967.

7.	Parihar, N.S., An Introduction to Embryophyta: Bryophyte, Vol.I, Central Book Depot, Allahabad, 1965.
8.	Bierhorst, D.W., Morphology of Vascular Plants, The MacMillan Co.,N.Y. and Collier-MacMillan Ltd., London, 1971.
9.	Sporme, K.R., The Morphology of Gymnosperms: The Structure and Evolution of Primitive seed Plants, Hutchinson University Library, London, 1971
10.	Dutta, S.C., An introduction to Gymnosperms, Kalyani Publishers, New Delhi, 1984.
11.	Bhatnagar, S.P. andAlok Moitra, Gymnosperms, New age International (P.) Ltd., New Delhi, 2000.

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Visit to animal biotechnology lab and stem cells biology lab
7. Demonstration
8. ICT Based teaching Learning
9. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Sc. Botany
Semester: 1st Semester
Course Title: Basic Botany
Course Code: 01BO101

CO/PO/PSO Mapping															
Course Outcome (Cos)	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1: To Understand the structure and function of various plant organs. Students will classify and describe different types of leaves, inflorescences, flowers, and fruits.	3	2	-	2	2	1	-	-	1	1	2	-	2	2	2
CO2: To demonstrate the different reproductive methods and life cycles of algae, Bryophytes, and Gymnosperms.	3	3	1	2	3	1	-	-	-	2	3	1	2	2	3
CO3: Students will describe the stellar organization, reproduction, heterospory, and seed habit in pteridophytes, Gymnosperms, and Paleobotany..	2	1	1	2	2	2	-	2	-	2	1	1	3	2	1
CO4: To understand the modes of nutrition and types of reproduction in fungi and the economic importance of fungi	2	3	-	3	2	2	-	2	-	2	2	1	3	2	2
CO5: To understand the overview of various types of microbes, including archaebacteria, eubacteria, cyanobacteria, mycoplasma, actinomycetes, and viruses	3	3	-	3	2	2	2	2	1	2	2	2	3	2	2

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO1** To Understand the structure and function of various plant organs. Students will classify and describe different types of leaves, inflorescences, flowers, and fruits.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	LI 1 LI 2 LI 3	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9,1.1 0, 1.11, 1.12	1SL-1,2,3,4,5
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO2:** To demonstrate the different reproductive methods and life cycles of algae, Bryophytes, and Gymnosperms.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9 SO2.10 SO2.11 SO2.12	LI 1 LI 2 LI 3	2.1,2.2,2.3,2.4,2.5, 2.6,2.7,2.8,2.9,2.1 0, 2.11, 2.12	2SL-1,2,3,4,5
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO3:** Students will describe the stellar organization, reproduction, heterospory, and seed habit in pteridophytes, Gymnosperms, and Paleobotany..	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9 SO3.10 SO3.11 SO3.12	LI 1 LI 2 LI 3	3.1,3.2,3.3,3.4,3.5, 3.6,3.7,3.8,3.9, 3.10, 3.11, 3.12	3SL-1,2,3,4,5
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO4:** To understand the modes of nutrition and types of reproduction in fungi and the economic importance of fungi .	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8 SO4.9 SO4.10 SO4.11 SO4.12	LI 1 LI 2 LI 3	4.1,4.2,4.3,4.4,4.5, 4.6,4.7,4.8,4.9,4.1 0, 4.11, 4.12	4SL-1,2,3,4,5
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO5:** To understand the overview of various types of microbes, including archaebacteria, eubacteria, cyanobacteria, mycoplasma, actinomycetes, and viruses	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9 SO5.10 SO5.11 SO5.12	LI 1 LI2 LI 3	5.1,5.2,5.3,5.4,5.5, 5.6,5.7,5.8,5.9, 5.10, 5.11, 5.12	5SL-1,2,3,4,5,6,7,8

Program Name	**Bachelor of Science (B.Sc.)- Biology**	
Semester	1st	
Course Code:	01ZO102	
Course title:	Animal diversity: Non chordata	**Curriculum Developer**: MR. AMIT BAGRI
Pre-requisite:	Student should have basic knowledge of Non chordate animals.	
Rationale:	• This core course will gain an overall understanding of the origin of life, diverse forms of organisms to which the taxon classified. This course will also help to provide descriptive asses about the animal architecture and function during the course of evolution and will create the awareness of the economic importance and significance of invertebrates.	
Course Outcomes (COs):	01ZO102 **.1.** Gain knowledge about importance of systematic, taxonomy, structural organization of the animals and will appreciate diversity of non-Chordates. **01ZO102 .2.** To describe unique characters of protozoa and coelenterate. **01ZO102 .3.** To recognize life functions and characters of Platyhelminthes, Nemathelminths and Annelida 01ZO102 **.4.** To critically analyze organization, complexity and characteristic features of Arthropoda and Mollusca along with their significance and interactions with the environment. 01ZO102 .**5.** To Learn about the importance of systematics, taxonomy and structural organization Echinodermata and hemichordate.	

Scheme of Studies:

Board of Study	**Course Code**	**Course Title**	**Scheme of studies (Hours/Week)**					**Total Credits(C) (L:T:P=4:0:2)**
			Cl	LI	SW	SL	**Total Study Hours (CI+LI+SW+SL)**	
Major	01ZO102	Animal diversity: Non chordata	4	2	1	2	9	4+2=6

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)		
Major	01ZO102	Animal diversity: Non chordata	**15**	**20**	**10**	**5**	**50**	**50**	**100**

Scheme of Assessment: Practical

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)		
Major	01ZO102	Animal diversity non chordata	35	5	5	5	50	50	50

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	6	01	05	24

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**

01ZO102 1. Gain knowledge about importance of systematic, taxonomy, structural organization of the animals and will appreciate diversity of non-Chordates.	**SO1.1** Summarize concept of Taxonomy	1.1. Study of museum specimens and slides relevant to the invertebrates.	**Unit-1 Taxonomy, phylogeny and Protozoa** **1.1** Elementary knowledge of Zoological Nomenclature and International Code	1.1. define taxonomy
	SO1.2 classification of Animal kingdom	1.2. What are the benefits of integrating museum specimen data with other types of biological data?	**1.2**Classification of Animal Kingdom upto phylum of acoelomate and coelomate non chordates.	1.2. define ICZN and phylogeny
	SO1.3 Protozoa classification and characters		**1.3** Definition and Examples	1.3. Protozoans' animals body structure and characters
	SO1.4 Define phylogeny and example		**1.4** Phylum Protozoa General character of the phylum and outline classification	1.4. Learn about protozoan diseases
	SO1.5 Plasmodium Vivax life cycle and history	1.3. How do museums ensure the accessibility of their collections to researchers and the public?	**1.5** Structure, life history and pathogenicity of malarial parasite	1.5. learn about life cycle.
	SO1.6 explain the importance of zoological nomenclature?		1.6 How is the importance of zoological nomenclature?	
	SO1.7 describe the homonym in zoological nomenclature?		1.7 What is a homonym in zoological nomenclature?	
	SO1.8 explain binomial nomenclature?		1.8 What is binomial nomenclature?	
	SO1.9 explain Plasmodium vivax, and how does it cause malaria		1.9 What is Plasmodium vivax, and how does it cause malaria	
	SO1.10 describe the treatment options for Plasmodium vivax malaria		1.10 What are the treatment options for Plasmodium vivax malaria	
	SO1.11 explain the challenges in controlling Plasmodium vivax malaria?		1.11 What are the challenges in controlling Plasmodium vivax malaria?	
	SO1.12 explain the geographic distribution of Plasmodium vivax?		1.12 What is the geographic distribution of Plasmodium vivax?	

Suggested Sessional Work (SW):*anyone*	**SW1.1** Assignments	Write about the history of Phylogeny and types.
	SW1.2 Mini Project	Write about General characters and classification of protozoa.
	SW1.3 Other Activities (Specify)	Collection of explants materials and their culture initiation.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	05	24

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
01ZO102 .2. To describe unique characters of protozoa and coelenterate.	**SO2.1** define porifera phylum	2.1. locally available small non chordates and their larvae.	**Unit-2 Porifera and coelenterata** **2.1** Phylum porifera General character of the phylum and outline classification	2.1. Know about the general characters of Phylum Porifera.
	SO2.2 study of sycon	2.2. Examination of pond water study of different kinds of microscopic non chordate organism.	**2.2** Type study of sycon	2.2. learn about sycon,
	SO2.3 define canal system of Sponges		**2.3** Canal system of sponges	2.3. learn about canal system of sponges,
	SO2.4 define phylum coelenterata		**2.4** Phylum Coelenterate General character of the phylum and outline classification	2.4. Know about the general characters of Phylum coelenterate,
	SO2.5 Study of obelia		**2.5** Type study of Obelia	2.5. learn about obelia,
	SO2.6 study of coral reef formation.	2.3. What impact does water temperature, pH, and other chemical parameters have on the presence and behavior of these organisms?	**2.6** Corals and coral reef formation	2.6. learn about corals and coral reef formation.
	SO2.7 explain		**2.7** How are sponges classified within Phylum Porifera?	
	SO2.8 describe sponges feed and obtain nutrients?		**2.8** How do sponges feed and obtain nutrients?	
	SO2.9 describe sponges reproduce?		**2.9** How do sponges reproduce?	
	SO2.10 explain spicules and spongin, and what is their function in sponges?		**2.10** What are spicules and spongin, and what is their function in sponges?	
	SO2.11 explain sponges defend themselves against predators?		**2.11** How do sponges defend themselves against predators?	
	SO2.12 describe the main threats to sponge populations?		**2.12** What are the main threats to sponge populations?	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Write about General characters and classification of porifera.
	SW2.2 Mini Project	Write about the Canal system of sponges
	SW2.3 Other Activities (Specify)	write the diagram of obelia?

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	07	26

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
01ZO102 .3. To recognize life functions and characters of Platyhelminthes, Nemathelminths and Annelida	**SO3.1** Explain the Platyhelminthes phylum	3.1. Parasitic Adaptation of any one parasite.	**Unit-3 Platyhelminthes, Nemathelminths and Annelida** **3.1 1** Phylum Platyhelminthes General character of the phylum and outline classification	3.1. Know about the general characters of Phylum Platyhelminthes
	SO3.2 define the life cycle of liver fluke	.	**3.2** External morphology and life history of liver fluke	3.2. learn about live cycle of liver fluke
	SO3.3 Explain the Nemathelminths phylum	3.2. What morphological adaptations does Plasmodium falciparum have for surviving in red blood cells?	**3.3** Phylum Nemathelminths General character of the phylum and outline classification	3.3. Know about the general characters of Phylum Nemathelminths
	SO3.4 Explain the Pathogenic symptoms of Nematodes and diseases	3.3. What adaptations contribute to the virulence of Plasmodium falciparum?	**3.4** Pathogenic symptoms of nematodes and diseases	3.4. learn about Pathogenic symptoms of nematodes and diseases
	SO3.5 Explain the Annelida phylum		**3.5** Phylum Annelida General character of the phylum and outline classification	3.5. Know about the general characters of Phylum Annelida
	SO3.6 define Earthworm		**3.6** type study of Earthworm	3.6. study of earthworm
	SO3.7 Explain the structure and significance of trochophore larva.		**3.7** structure and significance of trochophore larvae	3.7. learn about structure and significance of trochophore larvae.
	SO3.8 Explain liver flukes, and which species are most commonly known?		**3.8** What are liver flukes, and which species are most commonly known?	
	SO3.9 explain the intermediate hosts in the life cycle of liver flukes?		**3.9** What are the intermediate hosts in the life cycle of liver flukes?	
	SO3.10 describe liver fluke infections diagnosed in humans and animals?		**3.10** How are liver fluke infections diagnosed in humans and animals?	
	SO3.11 explain the strategies for controlling liver fluke infections in livestock?		3.11 What are the strategies for controlling liver fluke infections in livestock?	
	SO3.12 describe changes in land use and agricultural practices affect liver fluke prevalence?		3.12 How can changes in land use and agricultural practices affect liver fluke prevalence?	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Write about General characters and classification of Nemathelminths.
	SW3.2 Mini Project	Write about the Pathogenic symptoms of nematodes and diseases
	SW3.3 Other Activities (Specify)	Write the diagram of liver fluke

Item	Cl	LI	SW	SL	Total
Approx.Hrs	12	06	01	07	26

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
01ZO102 .4. To critically analyze organization, complexity and characteristic features of Arthropoda and Mollusca along with their significance and interactions with the environment.	**SO4.1** study of general characters of Arthropoda	4.1. Study about cockroach digestive system, nervous system	**Unit-4 Arthropoda and Mollusca** **4.1** Phylum Arthropoda General character of the phylum and outline classification	4.1. Read the general characters of Arthropoda
	SO4.2 study of prawn		**4.2** Type study of Prawn	4.2. study of Prawn
	SO4.3 Observing the role of crustacea larvae	4.2. Economic Importance of insects.	**4.3** Larval forms of crustacea	4.3. Understand the larval forms of crustacea
	SO4.4 Understand the various vector of human disease	4.3. TYPES OF mouth parts.	**4.4** Insects as a vector of human disease	4.4. learn about Insects as a vector of human disease
	SO4.5 Explain the Mollusca phylum		**4.5** Phylum Mollusca General character of the phylum and outline classification	4.5. Know about the general characters of Phylum Mollusca
	SO4.6 study of Pila		**4.6** Type study of Pila.	4.6. study of Pila.
	SO4.7 Explain the Structure and Significance of glochidium larvae		**4.7** Structure and Significance of glochidium larvae	4.7. learn about Structure and Significance of glochidium larvae.
	SO4.8 explain the exoskeleton of arthropods benefit their survival?		**4.8** How does the exoskeleton of arthropods benefit their survival?	
	SO4.9 describe the different types of appendages found in arthropods, and what functions do they serve?		**4.9** What are the different types of appendages found in arthropods, and what functions do they serve?	
	SO4.10 explain arthropods contribute to their ecosystems?		**4.10** How do arthropods contribute to their ecosystems?	
	SO4.11 describe arthropods classified within their phylum, and what criteria are used for classification?		**4.11** How are arthropods classified within their phylum, and what criteria are used for classification?	
	SO4.12 explain the different modes of reproduction in arthropods?		**4.12** What are the different modes of reproduction in arthropods?	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Write about General characters and classification of Arthropoda
	SW4.2 Mini Project	Write about the Structure and Significance of glochidium larvae.
	SW4.3 Other Activities (Specify)	write the diagram of Prawn

Item	Cl	LI	SW	SL	Total
Approx.Hrs	12	06	01	06	25

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Classroom Instruction(CI)	Self-Learning(SL)
01ZO102 .5. To Learn about the importance of systematics, taxonomy and structural organization Echinodermata and hemichordate	**SO5.1** Explain the Echinodermata phylum	5.1. locally available small non chordates and their larvae	**Unit-5 Echinodermata and Hemichordates** 5.1 Phylum Echinodermata General character of the phylum and outline classification	5.1. Read the general characters of Echinodermata.
	SO5.2 study about External features and water vascular System of starfish	5.2 Larval forms of Echinodermata	5.2 External features and water vascular System of starfish	5.2. learn about about External features and water vascular System of starfish
	SO5.3 Identify Larval forms of Echinodermata	5.3 Structure and Significance of Tornaria larvae?	5.3 Larval forms of Echinodermata	5.3. learn about Larval forms of Echinodermata
	SO5.4 Explain the Hemi chordata phylum		5.4 Phylum Hemichordates General character of the phylum and outline classification	5.4. Read the general characters of Hemichordates
	SO5.5 Identify different External morphology of Balanoglossus.		5.5 Balanoglossus – External morphology	5.5. Study about Balanoglossus – External morphology
	SO5.6 Identify Larval forms of Tornaria larvae.		5.6 Structure and Significance of Tornaria larvae	5.6. learn about Structure and Significance of Torn aria larvae.
	SO5.7 explain the structure and function of the water vascular system in echinoderms?		5.7 What is the structure and function of the water vascular system in echinoderms?	
	SO5.8 describe the role of the calcareous endoskeleton in echinoderms?		5.8 What is the role of the calcareous endoskeleton in echinoderms?	
	SO5.9 explain the digestive adaptations of echinoderms?		5.9 What are the digestive adaptations of echinoderms?	
	SO5.10 describe echinoderms reproduce, and what are the different modes of reproduction?		5.10 How do echinoderms reproduce, and what are the different modes of reproduction?	
	SO5.11 explain the evolutionary origins of echinoderms?		5.11 What are the evolutionary origins of echinoderms?	
	SO5.12 describe the main threats to echinoderm populations?		5.12 What are the main threats to echinoderm populations?	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Write about General characters and classification of Echinodermata
	SW5.2 Mini Project	Write about the Structure and Significance of Tornaria larvae
	SW5.3 Other Activities (Specify)	Write the diagram of Balanoglossus.

Course duration (in hours) to attain Course Outcomes:

Course Title: Animal diversity: Non-Chordata **Course Code:** 01ZO102

Course Outcomes(COs)	Class lecture (CI)	Laboratory Instruction(LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li + CI + SL + SW)
01ZO102 .1. Gain knowledge about importance of systematic, taxonomy, structural organization of the animals and will appreciate diversity of non-Chordates.	12	06	1	5	24
01ZO102 .2. To describe unique characters of protozoa and coelenterate.	12	06	1	5	24
01ZO102 3. To recognize life functions and characters of Platyhelminthes, Nemathelminths and Annelida	12	06	1	7	26
01ZO102.4. To critically analyse organization, complexity and characteristic features of Arthropoda and Mollusca along with their significance and interactions with the environment.	12	06	1	7	26
01ZO102.5. To Learn about the importance of systematics, taxonomy and structural organization Echinodermata and hemichordate.	12	06	1	6	25
Total Hours	60	30	05	30	125

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Animal diversity: Non-Chordata **Course Code:** 01ZO102

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
01ZO102.1. Gain knowledge about importance of systematic, taxonomy, structural organization of the animals and will appreciate diversity of non-Chordates.	3	1	1	4	09
01ZO102.2. To describe unique characters of protozoa and coelenterate.	4	4	1	2	11
01ZO102.3. To recognize life functions and characters of Platyhelminthes, Nemathelminths and Annelida	2	3	3	2	10
01ZO102.4. To critically analyze organization, complexity and characteristic features of Arthropoda and Mollusca along with their significance and interactions with the environment.	2	3	3	2	10
01ZO102.5. To Learn about the importance of systematics, taxonomy and structural organization Echinodermata and hemichordate.	2	3	3	2	10
Total Marks	**13**	**14**	**11**	**12**	**50**

***Legend*: A,** apply; **An,** analyze; **E,** evaluate; **C,** create

Suggested learning Resources:

(a) Books:

S. No.	Title/Author/Publisher details
1	Invertebrate Zoology, Ruppert and R.D. Barnes, Holt Saunders International Edition, VIII Edition 2006

2	The Invertebrates: A New Synthesis, Barnes, R.S.K., Calow, P. et al, Blackwell Science, III & 2002
3	A Textbook of Zoology, J Parker & W.A. Haswell, Low Price Publications ,Delhi VII & 1990
4	Modem Textbook of Invertebrates R. Kotpal, Rastogi Publications, Meerut, 2017
5	

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Demonstration
7. ICT Based teaching Learning
8. Brainstorming

CO, PO and PSO Mapping

Program Name: B.Sc Biology
Semester: 1st Semester
Course Title: Animal diversity: Non chordata
Course Code: 01ZO102

CO/PO/PSO Mapping								
Course Outcome (Cos)	**Program Outcomes (POs)**					**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**
01ZO102. 1. Gain knowledge about importance of systematic, taxonomy, structural organization of the animals and will appreciate diversity of non-Chordates.	2	2	3	2	1	2	2	3
01ZO102 2. To describe unique characters of protozoa and coelenterate.	1	1	2	2	1	2	3	3
01ZO102 3. To recognize life functions and characters of Platyhelminthes, Nemathelminths and Annelida.	2	3	1	3	2	1	1	2
01ZO102 4. To critically analyze organization, complexity and characteristic features of Arthropoda and Mollusca along with their significance and interactions with the environment.	1	2	3	3	2	2	2	2
01ZO102 .5. To Learn about the importance of systematics, taxonomy and structural organization Echinodermata and hemichordate.	2	2	3	2	2	1	2	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5 PSO 1,2,3	**01ZO102 .1.** Gain knowledge about importance of systematic, taxonomy, structural organization of the animals and will appreciate diversity of non-Chordates.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	1.1, 1.2, 1.3	1.1, 1.2, 1.3, 1.4, 1.5 1.6, 1.7, 1.8, 1.9, 1.10, 1.11, 1.12	1SL-1, 2, 3, 4, 5
PO 1,2,3,4,5 PSO 1,2,3	**01ZO102 .2.** To describe unique characters of protozoa and coelenterate.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9 SO2.10 SO2.11 SO2.12	2.1, 2.2, 2.3	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.10, 2.11, 2.12	2SL-1, 2, 3, 4, 5
PO 1,2,3,4,5 PSO 1,2,3	**01ZO102 .3.**To recognize life functions and characters of Platyhelminthes, Nemathelminths and Annelida	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9 SO3.10 SO3.11 SO3.12	3.1, 3.2, 3.3	3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 3.10, 3.11, 3.12	3SL-1, 2, 3, 4, 5, 6, 7
PO 1,2,3,4,5 PSO 1,2,3	**01ZO102 .4.** To critically analyse organization, complexity and characteristic features of Arthropoda and Mollusca along with their significance and interactions with the environment.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6, SO4.7 SO4.8 SO4.9 SO4.10 SO4.11 SO4.12	4.1, 4.2, 4.3	4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12	4SL-1, 2, 3, 4, 5, 6, 7
PO 1,2,3,4,5 PSO 1,2,3	**01ZO102 .5.** To Learn about the importance of systematics, taxonomy and structural organization Echinodermata and hemichordate.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9 SO5.10 SO5.11 SO5.12	5.1, 5.2,5.3	5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10, 5.11, 5.12	5SL-1, 2, 3, 4, 5, 6

B.Sc. Ist Semester

Course Code : 01CH103

Course Title : Analytical Chemistry

Pre-requisite: Students must have fundamental knowledge of mathematics, valence shell electron pair repulsion theory, and different concentration terms to understand the concept of analytical chemistry.

Rationale: The students studying analytical chemistry should possess foundational understanding about basic mathematics, valence shell electron pair repulsion theory, and different concentration terms to understand the basic principle of chromatography and spectroscopic analysis.

Course Outcomes:

After the completion of this course, the learner will able to

01CH103.1: explain basic concept of straight line equation, logarithmic relation, differentiation and integration and run the software's to plot the graphs and draw the structure of different molecules.

01CH103.2: describe the presentation of experimental data and analyze the results in terms of significant figure by applying the concept of concentration terms, error, sampling, precision, accuracy

01CH103.3: explain thermodynamic derivation of law of chemical equilibrium by applying the concept of Gibbs free energy and chemical potential

01CH103.4: **d**iscuss principle of chromatography and analyze different components of a mixture quantitatively by applying chromatographic principle.

01CH103.5: discuss basic concept of spectroscopy and analyze unknown component qualitatively & quantitatively and also identify the functional groups of a molecule on the basis of their stretching and bending vibrations.

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/course.html
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
3. https://swayam.gov.in/explorer?category=Chemistry

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources

AKS University

Faculty of Basic Science

Curriculum of B. Sc.(Honours/ By Research) Program

(Revised as on 01 August 2023)

Scheme of Studies:

Board of Study	Course Code	Course Title				Scheme of studies (Hours/Week)		Total Credits I
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	**01CH103**	**Analytical Chemistry**	4	4	1	1	8	6

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop,field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback ofteacher to ensure outcome of Learning.

Scheme of Assessment: Theory

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (RA)					End Semester Assessment (ESA)	Total Marks (PRA+ESA)
			Class/Home Assignment 5 number marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each	Seminar one + Class activity	Class Attendance (AT)	Total Marks (CA+CT+SA +AT)		
DCC	**01CH103**	Analytical Chemistry	15	20	10	5	50	50	100

Course-Curriculum Detailing:
This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their

mastery of Session Outcomes (Sos), culminating in the overall achievement of Course Outcomes (Cos) upon the course's conclusion.

Unit-1 (01CH103.1): Basics of mathematics and computer for Chemists

Straight line equation, Logarithmic relations, relations, curve sketching, linear graphs & calculation of slopes. Differentiation of functions like kx, e^x, x^n, sinx, Logx, maxima & minima, Integration of some useful relevant functions Introduction to computer, Execution of linear regression x-y Plot Use of software's for drawing structures and molecular formulae.

Activity	Appx Hrs
Cl	12
LI	12
SW	2
SL	1
Total	27

Session Outcomes (SOs)	LI	CI	SL
After the completion of topics students will be able to SO1.1 understand the concept of Straight line equation and calculation of slopes SO1.2 explain logarithmic relations, relations of different functions SO1.3 discuss differentiation of important functions and calculate of maxima & minima SO1.4 discuss integration of some useful relevant functions SO1.5 discusses software's for drawing structures and molecular formulae.	Basic exercises • To introduce software's to draw structure of different compounds • Calibration of different weights and glass apparatus • To prepare solutions of different molarity/normality by weighing and dilution.	**Unit-1 (2CH101.1): Basics of mathematics and computer for Chemists** 1.1 Significance of straight line equation and its applications 1.2 Logarithmic relations 1.3 Curve sketching 1.4 linear graphs & calculation of slopes 1.5 Differentiation of functions like kx, e^x, x^n, sinx, Logx, 1.6 Differentiation of functions like sinx, Logx, 1.7 calculations of maxima & minima 1.8 Integration of some useful relevant functions 1.9 Introduction to computer and execution of linear regression x-y Plot. 1.10 Introduction to software's	• Significance of differentiation and integration • Introduction to window

		1.11 Applications of software for drawing structures and molecular formulae 1.12 Introduction to ChemDraw and Origin	

SW-1 Suggested Sessional Work (SW):
Assignments: curve sketching
Mini Project: Software's for drawing structures and molecular formulae.
Other Activities (Specify): Introduction to graph and its types in different ways to represent data

Unit-2 (01CH103.2): Basic Analytical Chemistry
Introduction to Analytical Chemistry and its interdisciplinary nature, Concept of sampling, Importance of accuracy, precision and source of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures, statistical terms: mean, mean deviation, median standard deviation, Numerical Problems.
Calculations used in Analytical Chemistry
Some Important units of measurements: SI Unit, distinction between mass and weight, mole, mill mole and numerical problems.
Solution and their concentrations: Concept of Molarity, molality, and normality. Expressing the concentration in parts per million (ppm), parts per billion (ppb), Numerical Problems.
Chemical Stoichimetry: Empirical and Molecular Formulas, Stoichemetric Calculations, Numerical Problems.

Activity	AppX Hrs
Cl	13
LI	12
SW	2
SL	1
Total	28

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
After the completion of topics students will be able to **SO2.1** restate concept of sampling, Importance of accuracy, precision and source of error in analytical measurements. **SO2.2** explain experimental data in terms of significant figure	Quantitative analysis through Titrimetric method • Standardization of NaOH with Oxalic acid. • Determination of carbonate and hydroxide present in mixture	**Unit-2 (2CH101.2): Basic Analytical Chemistry** 2.1 Introduction to Analytical Chemistry and its interdisciplinary nature 2.2 Concept of sampling 2.3 Importance of accuracy, precision 2.4 Source of error in analytical measurements. 2.5 Statistical terms: mean, mean deviation, median standard deviation	• Some Important units of measurements: SI Unit • distinction between mass and weight • mole, mill mole and numerical problems

SO2.3 discuss mathematical terms such as mean, mean deviation, median standard deviation etc **SO2.4** discuss different concentration terms and apply the same concept of to prepare solutions **SO2.5 estimate e**mpirical and molecular formulae	• Determination of carbonate and bicarbonate present in a mixture.	2.6 Solution and their concentrations 2.7 Concept of Molarity, molality, and normality. 2.8 Expressing the concentration in parts per million (ppm), parts per billion (ppb), 2.9 Numerical Problems. 2.10 Chemical Stoichimetry 2.11 Empirical and Molecular Formulae 2.12 Stoichemetric Calculations 2.13 Numerical Problems	

SW-2 Suggested Sessional Work (SW):

Assignments: Presentation of experimental data and results, from the point of view of significant figures

Mini Project:

Other Activities (Specify): Numerical Problems.

Unit-3 (01CH103.3): Chemical Equilibrium

Equilibrium constant and free energy, concept of chemical potential, Thermodynamic derivation of law of chemical equilibrium Temperature dependence of equilibrium constant: Van't Hoff reaction isochors, Van't Hoff reaction isotherm, Le-Chatelier's Principle and its applications.

Activity	AppX Hrs
Cl	11
LI	12
SW	2
SL	1
Total	26

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)

After the completion of topics students will be able to **SO3.1** explain equilibrium constant and free energy **SO3.2** discuss concept of chemical potential **SO3.3** describe thermodynamic derivation of law of chemical equilibrium **SO3.4** explain conceptually Van't Hoff reaction isochors, Van't Hoff reaction isotherm **SO3.5** describe Le-Chatelier's Principle and its applications	• To study the shift of equilibrium between ferric ions and thiocyanate ions by increasing the concentration of either of them. • Determination of free alkali present in different soaps/detergents.	**Unit-3 (2CH101.3): Chemical Equilibrium** 3.1 Introduction to equilibrium constant 3.2 Introduction to free energy 3.3 concept of chemical potential 3.4 Thermodynamic derivation of law of chemical equilibrium 3.5 Discussion of temperature dependence of equilibrium constant 3.6 Van't Hoff reaction isochors, 3.7 Van't Hoff reaction isotherm 3.8 Introduction to Le-Chatelier's Principle 3.9 Applications of Le-Chatelier's Principle 3.10 Solving numerical problems 3.11 Solving numerical problems	• Gibbs free energy • Van't Hoff factors

SW-3 Suggested Sessional Work (SW):

Assignments: Concept of chemical potential

Mini Project:

Other Activities (Specify):

Unit-4 (01CH103.4): Chromatography

Introduction, Principle and Classification Mechanism of separation: adsorption, partition and ion-exchange.
Development of Chromatograms: frontal elution and displacement methods.
Paper Chromatography (ascending, descending and circular), Thin Layer Chromatography (TLC) and Column Chromatography (CC). Gas Chromatography (GC) and High Pressure Liquid Chromatography (HPLC) types of column and column selection, applications, Limitations
Principle and Applications of:

- Flash chromatography,
- Ion-exchange chromatography and
- Chiral chromatography.
-

Activity	AppX Hrs
Cl	13
LI	12
SW	2
SL	1
Total	28

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
After the completion of topics students will be able to **SO4.1** understand basics of separation of components of a mixture **SO4.2** to discuss development of chromatograms **SO4.3** discusses principles of paper chromatography and thin layer chromatography (TLC) **SO4.4** explain column chromatography (CC) and gas chromatography (GC) **SO4.5** discuss the concept of chiral chromatography	Qualitative Analysis • Identification by determination of the Rf values of the given organic / inorganic compounds by paper/ thin layer chromatography. • Systematic identification of organic compound by qualitative analysis	**Unit-4 (2CH101.4): Chromatography** 4.1 Introduction to chromatography 4.2 Discussion of principle involved 4.3 Classification of chromatography 4.4 Mechanism of separation of components in a mixture 4.5 Development of Chromatograms: frontal elution and displacement methods 4.6 Principle of Paper Chromatography (ascending, descending and circular) and Thin Layer Chromatography (TLC) 4.7 Column Chromatography (CC) 4.8 Gas Chromatography (GC) 4.9 High Pressure Liquid Chromatography (HPLC) 4.10 Types of column involved and selection of column 4.11 Principle of Chiral chromatography 4.12 Applications of Chiral chromatography	To understand the chromatographic principle students must read about • Nature of compound (polar/non-polar)

		4.13 Principle and applications of flash chromatography	

SW-4 Suggested Sessional Work (SW)
Assignment: Chromatography (HPLC) types of column and column selection
Mini Project:
Other Activities (Specify): Mechanism of separation of components in a mixture: adsorption, partition and ion-exchange

Unit-5 (01CH103.5): Spectral techniques of analysis
Basics of absorption spectroscopy: Electromagnetic radiation, Spectral; range. Absorbance Absorptivity, Molar Absorptivity, Fundamental Laws of Absorption, Lambert-Beer Law and its limitations Constitution & working of photometer spectrometer, colorimeter.
Ultraviolet (UV) absorption spectroscopy: Presentation and analysis of UV spectra, Types of electronic transitions, effect of conjugation. Concept of chromophore and auxochrome. Bathochromic, hypsochromic, Hyper-chromic and hypo-chromic shifts. UV spectra of conjugated polyenes and enones.
Infra-red (IR) absorption spectroscopy: Molecular vibrations Hooke's law, selection rules, intensity and position of IR bands. Measurement of IR spectrum, finger print region, characteristic absorption of various functional groups and interpretation of IR spectra of simple organic compounds

Activity	AppX Hrs
Cl	11
LI	12
SW	2
SL	1
Total	26

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
After the completion of topics, students will be able to **SO5.**1 understand Basics of absorption spectroscopy **SO5.2** discuss the principle of UV-visible spectroscopy or Lambert-Beer Law and its limitations **SO5.3** apply the concept of UV-visible spectra to calculate	Quantitative Analysis by Colorimeter: • Verification of Lambert-Beer Law • Determination of concentration of colored compounds (e.g. CuSO4, KMnO4) • Verification of Lambert-Beer Law	**Unit-5 (2CH101.5): Spectral techniques of analysis** 4.1 Fundamental Laws of Absorption 4.2 Lambert-Beer Law and its limitations Constitution & working of photometer spectrometer, colorimeter. 4.3 Presentation and analysis of UV spectra 4.4 Types of electronic transitions, effect of conjugation.	Basics of absorption spectroscopy: • Electromagnetic radiation, • Spectral range • Absorbance Absorptivity, Molar Absorptivity

the λ_{max} of conjugated polyenes and enones **SO5.**4 describes Hook's law and correlates it with spectral frequency of functional groups. **SO5.5 explain principle of IR** absorption spectroscopy and measure the characteristic absorption band of various functional groups		4.5 Concept of chromophore and auxochrome. Bathochromic, hypsochromic, Hyper-chromic and hypo-chromic shifts. 4.6 UV spectra of conjugated polyenes and enones. 4.7 Infra-red (IR) absorption spectroscopy 4.8 Molecular vibrations 4.9 Hooke's law, selection rules, intensity and position of IR bands 4.10 Measurement of IR spectrum, finger print region, 4.11 characteristic absorption of various functional groups	

SW-5 Suggested Sessional Work (SW):
Assignments: UV spectra of conjugated polyenes and enones.
Mini Project:
Other Activities (Specify): Interpretation of IR spectra of simple organic compounds

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Laboratory Instruction (LI)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
01CH103.1: explain basic concept of straight line equation, logarithmic relation, differentiation and integration and run the software's to plot the graphs and draw the structure of different molecules.	12	12	02	01	27
01CH103.2: describe the presentation of experimental data and analyze the results in terms of significant figure by applying the concept of concentration terms, error, sampling, precision, accuracy	13	12	02	01	28
01CH103.3: explain thermodynamic derivation of law of chemical equilibrium by applying the concept of Gibbs free energy and chemical potential	11	12	02	01	26
01CH103.4: **d**iscuss principle of chromatography and analyze different components of a mixture quantitatively by applying chromatographic principle.	13	12	02	01	28

01CH103.5: discuss basic concept of spectroscopy and analyze unknown component qualitatively & quantitatively and also identify the functional groups of a molecule on the basis of their stretching and bending vibrations.	11	12	02	01	26
Total Hours	60	60	10	05	135

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	**Basics of mathematics and computer for Chemists**	03	01	01	05
CO-2	**Basic Analytical Chemistry**	02	06	02	10
CO-3	Chemical Equilibrium	03	04	03	10
CO-4	Chromatography	-02	08	05	15
CO-5	**Spectral techniques of analysis**	03	02	05	10
Total		13	21	16	50

Legend: R: Remember, U: Understand, A: Apply

The written examination of 50 marks will be held at the end of semester for Inorganic Chemistry

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to NCL, CSIR laboratories
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT,Blog, Facebook,Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher
1	Organic Chemistry, Sultan Chand and Sons. Delhi.	Soni PL,	Sultan Chand and Sons, . Delhi
2	Chemistry	Srivastava, S. S. Gehlot. A.S.	Ratan Prakashan Temple. Indore.
3	Inorganic Chemicals	Sing, DR, Saxena, G, Singh, B.	Shivlal Aggarwal & Company, Agra
4	Bioinorganic Chemistry	AK Das	Prentice -Hall
5	Inorganic chemistry	Gary L. Miessler	Pearson
6	Inorganic chemistry	VK Jaiswal	Shri Balaji
7	Elementary Organic Spectroscopy	Sharma Y.R.	S Chand, 2013
8	Analytical Chemistr	Gupta Alka L	Pragiti Prakashan 2020
9	Analytical Chemistry	Kaur H,	Pragatic Prakashan 2008
10	Advanced Organic Chemistry	Bahl. A. & Bahal. B.S.	S. Chand. 2010
11	Chromatography	Sharma B.K.	Krishna Prakashan, 2019

Suggested Web Sources:

1. https://celqusb.files.wordpress.com/2017/12/inorganic-chemistry-g-l-miessler-2014.pdf
2. https://www.slideshare.net/MANISHSAHU106/inert-and-labile-complexes
3. https://swayam.gov.in/explorer?category=Chemistry

Mode of Delivery: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point;

LMS/ICT Tools: Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

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Curriculum of B. Sc.(Honours/ By Research) Program

(Revised as on 01 August 2023)

Course Title: Analytical Chemistry **Course Code: 01CH103**

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Knowledge	Research Aptitude	Communication	Problem Solving	Individual and Team	Investigation of	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and	The detailed	To integrate	understand, analyze,	Provide opportunitie
CO1: explain basic concept of straight line equation, logarithmic relation, differentiation and integration and run the software's to plot the graphs and draw the structure of different molecules.	**3**	**1**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**3**	**2**	**2**	**3**	**3**	**1**
CO2: describe the presentation of experimental data and analyze the results in terms of significant figure by applying the concept of concentration terms, error, sampling, precision, accuracy	**2**	**1**	**2**	**2**	**1**	**2**	**3**	**2**	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**1**
CO3: explain thermodynamic derivation of law of chemical equilibrium by applying the concept of Gibbs free energy and chemical potential	**2**	**2**	**1**	**1**	**1**	**2**	**2**	**2**	**1**	**2**	**1**	**2**	**1**	**1**	**2**	**2**
CO4: **d**iscuss principle of chromatography and analyze different components of a mixture quantitatively by applying	**2**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**2**	**3**	**3**	**3**	**3**	**2**

chromatographic principle.																
CO5: discuss basic concept of spectroscopy and analyze unknown component qualitatively & quantitatively and also identify the functional groups of a molecule on the basis of their stretching and bending vibrations.	**2**	**-**	**-**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**3**	**1**	**3**

Legend: **1–Low,** **2–Medium,** **3–High**

AKS University

Faculty of Basic Science

Curriculum of B. Sc.(Honours/ By Research) Program

(Revised as on 01 August 2023)

Course Curriculum Map:

POs &PSOsNo.	COs No. & Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1: explain basic concept of straight line equation, logarithmic relation, differentiation and integration and run the software's to plot the graphs and draw the structure of different molecules.	SO1.1 SO1.2 SO1.3SO1.4 SO1.5		Unit-1. **Basics of mathematics and computer for Chemists** 1.1,1.2,1.3,1.4,1.5,1.6,1.7	• Significance of differentiation and integration • Introduction to window
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO2: describe the presentation of experimental data and analyze the results in terms of significant figure by applying the concept of concentration terms, error, sampling, precision, accuracy	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5		Unit-2 **Basic Analytical Chemistry** 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9	• Some Important units of measurements: SI Unit • distinction between mass and weight • mole, mill mole and numerical problems

PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3: explain thermodynamic derivation of law of chemical equilibrium by applying the concept of Gibbs free energy and chemical potential	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5		Unit-3 : Chemical Equilibrium 3.1, 3.2,3.3,3.4,3.5,3.6,3.7	• Gibbs free energy • Van't Hoff factors
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO4: **d**iscuss principle of chromatography and analyze different components of a mixture quantitatively by applying chromatographic principle.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5		Unit-4 Chromatography 4.1,4.2,4.3,4.4,4.5,4.6,4.7	To understand the chromatographic principle students must read about • Nature of compound (polar/non-polar)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO5: discuss basic concept of spectroscopy and analyze unknown component qualitatively & quantitatively and also identify the functional groups of a molecule on	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5		Unit 5: **Spectral techniques of analysis** 5.1,5.2,5.3,5.4,5.5, 5.6,5.7	Basics of absorption spectroscopy: • Electromagnetic radiation, • Spectral range • AbsorbanceAbsorptivity, Molar Absorptivity

	the basis of their stretching and bending vibrations				

Curriculum Development Team:

1) Dr. Shailendra Yadav, HoD, Department of Chemistry, AKS University, Satna (M.P.).
2) Dr. Dinesh Kumar Mishra, Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
3) Dr. Samit Kumar,Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
4) Dr. Sushma Singh, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
5) Dr. Manoj Kumar Sharma, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
6) Mr. Kanha Singh Tiwari,Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
7) Mrs. Nahid Usamani, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).

Program name	Bachelor of Science (B. Sc.)- Botany	
Semester	1st	
Course Code:	02BO111	
Course title:	Basic Botany	**Curriculum Developer**: Nitin Singh Parihar, Lab Assistant
Pre-requisite:	To study this course, A student must have had the subject Biology/ Life Sciences/ Agriculture in class 12th	
Rationale:	Applied botany overall, this unit provides a robust foundation in plant biology, combining historical context, morphological studies, and cellular biology with practical microscopy skills. This comprehensive approach ensures students are well-prepared for advanced botanical studies and research, fostering a deeper understanding and appreciation of plant sciences.	
Course Outcomes (COs):	**CO1:** To understand the structure and function of various plant organs. Students will classify and describe different types of leaves, inflorescences, flowers, and fruits. **CO2:** To demonstrate the different reproductive methods and life cycles of algae, Bryophytes, and Gymnosperms. **CO3:** Students will describe the stellar organization, reproduction, heterospory, and seed habit in pteridophytes, Gymnosperms, and Paleobotany. **CO4:** To understand the modes of nutrition and types of reproduction in fungi and the economic importance of fungi **CO5:** To understand the overview of various types of microbes, including archaebacteria, eubacteria, cyanobacteria, mycoplasma, actinomycetes, and viruses.	

Scheme of Studies:

Board of Study	CourseCode	Course Title	Scheme of studies (Hours/Week)					Total Credits(C) (L:T:P=4:0:2)
			CI	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Minor	02BO111	Applied Botany	4	2	1	1	8	4+2=6

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)		
			Progressive Assessment (PRA)	End Yearly (ESA)	Total Marks (PRA+ ESA)
Minor	02BO111	Applied Botany	Total Marks (CA+CT+SA+CAT+AT) **30**	**70**	**100**

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	12	6	1	5	24

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CIs)	Self-Learning (SL)
CO1: To Understand the structure and function of various plant organs. Students will classify and describe different types of leaves, inflorescences, flowers, and fruits.			**Unit-1**	
	SO1.1 Students will be able to describe the importance of botany in historical and cultural contexts, with a focus on contributions from ancient Indian civilizations.	**LI1.1** to perform a morphological study of different types of Flowers	**CI1.1** Introduction to Botany and Indian Contributions	**SL1.1** Search various reference books and other study materials to start learning about plants, understand their ecological roles, and explore their potential applications.
	SO1.2 Students can differentiate between lower and higher plants based on morphological characteristics such as size, complexity, and reproductive structures.	**LI1.2** To understand and observe the different components of plant cells through microscopic examination and diagrammatic representation	**CI1.2** Morphological Characteristics of Lower Plants (Angiosperms)	**SL1.2** Explore the historical evolution and recent advancements in animal biotechnology.
	SO1.3 Students can classify higher plants based on their structural features, including roots, stems, leaves, and flowers.	**LI1.3** To study the structure of a typical plant cell using an onion peel and observe its cellular components under a microscope.	**CI 1.3** Morphological Characteristics of Higher Plants (Angiosperms).	**SL1.3** Understand the essential infrastructure and equipment needed for an animal biotechnology laboratory.

	SO4. Students can identify and differentiate between different types of leaves based on their shapes, arrangements, and venation patterns.		**CI 1.4** Types of Leaves	**SL1.4** Learn about different types of leaves.
	SO1.5 Students will be able to classify inflorescence types and explain their significance in plant reproduction and species identification.		**CI 1.5** Types of Inflorescence	**SL1.5** Learn about different types of Inflorescence.
	SO1.6 Students will be able to describe the parts of a flower and their roles in reproduction, with a focus on angiosperms.		**CI 1.6** Structure of Flowers	
	SO1.7 Students will be able to differentiate between different types of fruits and explain their development and dispersal mechanisms.		**CI 1.7** Types of Fruits	
	SO1.8 Students will be able to identify and describe the structure and function of plant cell organelles, including the cell membrane, nucleus, chloroplasts, and vacuoles.		**CI 1.8** Structure of Plant Cells.	
	SO1.9 Students will be able to compare and contrast prokaryotic and eukaryotic cells, emphasizing the		**CI1.9** Prokaryotic and Eukaryotic Cells	

	differences in structure, organization, and genetic material.			
	SO1.10 Students will be able to differentiate between mitosis and meiosis, explaining their roles in growth, repair, and reproduction in plants.		**CI1.10** Types of Cell Division	
	SO1.11 Students will be able to explain the principles of magnification and resolving power in light microscopes and demonstrate proper microscope usage.		**CI1.11** Microscope Structure and Function of Light Microscope	
	SO1.12 Students will be able to describe the principles and applications of different types of microscopes, including bright field, phase contrast, scanning electron microscopy (SEM), and transmission electron microscopy (TEM).		**CI1.12** Various Types of Microscopes: Bright Field, Phase Contrast, SEM, and TEM	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Describe in detail the history of electron microscopy (TEM).
	SW1.2 Mini Project	Describe and define light microscopes and demonstrate proper microscope usage.
	SW1.3 Other Activities (Specify)	Explain the Structure of Plant Cells.

Item	CI	LI	SW	SL	Total
Approx. Hours	12	6	1	5	24

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CIs)	Self-Learning (SL)
CO2: To demonstrate the different reproductive methods and life cycles of algae, Bryophytes, and Gymnosperms.			**Unit-2**	
	SO2.1 Students will be able to describe the basic characteristics of algae.	**LI2.1** To perform detailed observation of different types of Algae.	**CI2.1** Overview of algae; definition, general characteristics	**SL2.1** Search various reference books and other study materials to start learning the Overview of algae.
	SO2.2 Students will classify algae based on their thallus organization.	**LI2.2** To perform a transfer in Morphological Characteristics of Higher Plants	**CI2.2** Discuss the range of thallus organization in algae.	
	SO2.3 Students will differentiate between asexual and sexual reproduction in algae.	**LI2.3** To perform a transfer in Morphological Characteristics of Bryophytes.	**CI2.3** Types of reproduction in algae (asexual and sexual).	**SL2.2** Gain proficiency in Morphological Characteristics of Higher Plants.
	SO2.4 Students will identify and compare various life cycles in algae.		**CI2.4** Different types of life cycles exhibited by algae.	**SL2.3** Acquire knowledge of the Different types of life cycles exhibited by algae.
	SO2.5 Students will explain the ecological roles of algae in nature.		**CI2.5** Importance of algae in ecosystems.	
	SO2.6 Students will analyze the economic significance of algae		**CI2.6** Discuss the economic uses of algae (e.g., food, biofuels, pharmaceuticals).	**SL2.4** Gain proficiency in the economic uses of algae.

	SO2.7 Students will be able to describe the basic characteristics of Bryophytes.		**CI2.7** Overview of Bryophytes; definition, general characteristics.	**SL2.5** Search various reference books and other study materials to learn the Bryophytes.
	SO2.8 Students will classify Bryophytes based on their thallus organization and morphology.		**CI2.8** Range of thallus organization and morphology in Bryophytes.	
	SO2.9 Students will identify and describe the anatomy of Bryophytes.		**CI2.9** Internal and external features of Bryophytes.	
	SO2.10 Students will compare the reproductive strategies of different Bryophyte species.		**CI2.10** Modes of reproduction in Bryophytes (sexual and asexual).	
	SO2.11 Students will explain the ecological roles of Bryophytes in their habitats.		**CI2.11** Importance of Bryophytes in ecosystems.	
	SO2.12 Students will evaluate the economic significance of Bryophytes.		**CI2.12** Economic uses of Bryophytes (e.g., ecological indicators, horticulture).	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Describe and define the Bryophytes.
	SW2.2 Mini Project	Detail study of anatomy of Bryophytes.
	SW2.3 Other Activities (Specify)	compare various life cycles in algae.

Item	CI	LI	SW	SL	Total
Approx. Hours	12	6	1	5	24

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CIs)	Self-Learning (SL)
CO3: Students will describe the stellar organization, reproduction, heterospory, and seed habit in pteridophytes, Gymnosperms, and Paleobotany.			**Unit-3**	
	SO3.1 Students will be able to describe the general characteristics of Pteridophytes.	**LI3.1** To perform detailed morphological observation of Pteridophytes.	**CI3.1** Overview of Pteridophytes; definition, general characteristics.	**SL3.1** Search various reference books and other study materials to learn about transgenesis and gene transfer methods.
	SO3.2 Students will identify and classify different morphological features of Pteridophytes.	**LI3.2** To demonstrate the Gymnosperms	**CI3.2** Study of the morphology of Pteridophytes (e.g., leaves, stems, roots).	
	SO3.3 Students will analyze the stellar organization and its significance in Pteridophytes	**LI3.3** To study the external morphology and internal anatomy of the needle of *Pinus*, a representative gymnosperm.	**CI3.3** Types of stellar organization found in Pteridophytes.	
	SO3.4 Students will compare the reproductive strategies of different Pteridophyte species.		**CI3.4** Modes of reproduction in Pteridophytes (e.g., spores, gametophyte development).	**SL3.2** Search various reference books and other study materials for reproduction in Pteridophytes
	SO3.5 Students will differentiate between homospory and heterospory, and understand the concept		**CI3.5** Explanation of heterospory and seed habit in Pteridophytes.	

	of seed habit in Pteridophytes.			
	SO3.6 Students will evaluate the economic significance of Pteridophytes.		**CI3.6** Discuss the economic uses of Pteridophytes (e.g., ornamental plants, medicinal plants).	**SL3.3** Explore the economic uses of Pteridophytes
	SO3.7 Students will be able to describe the general characteristics and distribution of Gymnosperms.	.	**CI3.7** Overview of Gymnosperms; definition, general characteristics, and distribution.	**SL3.4** Search various reference books and other study materials for Overview of Gymnosperms
	SO3.8 Students will analyze the economic significance of Gymnosperms.		**CI3.8** Discuss the economic uses of Gymnosperms (e.g., timber, paper production, pharmaceuticals).	
	SO3.9 Students will understand the significant contributions of Indian scientists in the field of Paleobotany.		**CI3.9** Overview of India's contribution to Paleobotany (e.g., fossil discoveries, research).	
	SO3.10 Students will be able to explain the concept of fossils and describe the Geological Time Scale.		**CI3.10** Brief Introduction of Paleobotany	**SL3.5** Search various reference books and study about Paleobotany
	SO3.11 Students will analyze recent developments and research methods in Paleobotany.		**CI3.11** Study of current trends and advancements in Paleobotanical research.	

	SO3.12 Students will demonstrate a comprehensive understanding of the topics covered through discussions, quizzes, or assignments.		**CI3.12** Review and integrate concepts from Pteridophytes, Gymnosperms, and Paleobotany.	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Describe the transgenesis palaeobotany
	SW3.2 Mini Project	Describe the Pteridophytes
	SW3.3 Other Activities (Specify)	Explain in detail gymnosperms.

Item	CI	LI	SW	SL	Total
Approx. Hours	12	6	1	5	24

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CIs)	Self-Learning (SL)
CO4: To understand the modes of nutrition and types of reproduction in fungi and the economic importance of fungi			**Unit-4**	
	SO4. 1 Students will gain an overview of fungal diversity and classification.	**LI4.1** To demonstrate and visualize the Fungal Cells.	**CI4.1** Define fungi and discuss their general characteristics.	**SL4.1** Search various reference books and other study materials to start learning about fungi and discuss their general characteristics
	SO4.2 Students will	**LI4.2** To introduce fungi in	**CI4.2** Study the composition of the	**SL4.2** To independently

	understand the unique composition of the fungal cell wall.	medicine, industry, and agriculture.	fungal cell wall, focusing on chitin and other polysaccharides	explore thecomposition of the fungal cell wall and focusing on chitin and other polysaccharides.
	SO4.3 Students will be able to classify fungi based on their nutritional modes.	**LI4.3** To introduce the structure of lichens.	**CI4.3** Explain the heterotrophic modes of nutrition in fungi: saprophytic, parasitic, and mutualistic.	
	SO4.4 Students will understand the different types of asexual and sexual reproduction in fungi.		**CI4.4** Explain the Types of Reproduction in Fungi.	**SL4.3** To independently Explain the Types of Reproduction in Fungi.
	SO4.5 Students will understand the various reproductive structures in fungi.		**CI4.5** Describe various fungal reproductive structures, such as spores, sporangia, and fruiting bodies, and Provide diagrams and examples of each structure.	
	SO4.6 Students will recognize the economic importance of fungi in various fields		**CI4.6** Discuss the beneficial roles of fungi in medicine, industry, and agriculture.	**SL4.4** To independently explore the beneficial roles of fungi in medicine, industry, and agriculture.
	SO4.7 students will understand the concept and significance of parasexuality in fungi		**CI4.7** discusses examples of fungi exhibiting Para sexuality.	
	SO4.8 Students will understand the concept and types of mycorrhizae.		**CI4.8** Discuss the types of mycorrhizal associations ecological and agricultural importance of mycorrhizal associations.	
	SO4.9 Students will understand the definition and unique symbiotic nature of lichens.		**CI4.9** Describe the general characteristics and structure of lichens.	**SL4.5** Search various reference books and other study materials to start learning about the general

				characteristics and structure of lichens.
	SO4.10 Students will understand the classification of lichens based on morphology.		**CI4.10** Explain the classification of lichens based on their morphology: crustose, foliose, and fruticose.	
	SO4.11 Students will understand the role of lichens in different ecosystems.		**CI4.11** Explain the ecological importance of lichens in various habitats.	
	SO4.12 Students will understand the economic and cultural importance of lichens		**CI4.12** Explain the cultural significance of lichens in various traditions and practices	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Describe the cultural importance of lichens
	SW4.2 Mini Project	Explain in detail to lichens based on morphology..
	SW4.3 Other Activities (Specify)	Write a one review article fungi in various fields

Item	CI	LI	SW	SL	Total
Approx. Hours	12	6	1	8	27

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CIs)	Self-Learning (SL)
CO5: To understand the overview of various types of microbes, including archaebacteria, eubacteria, cyanobacteria, mycoplasma, actinomycetes, and viruses			**Unit-5**	
	SO5.1 Students will gain an initial understanding of the diversity of microbes.	**LI5.1** To analyse the Archaebacteria	**CI5.1** Provide an overview of the different types of microbes.	**SL5.1** Search various reference books and other study materials to start the learning about overview of the different types of microbes.
	SO5.2 Students will recognize the diversity within microbial life.	**LI5.2** To perform morphological characterisation of Cyanobacteria	**CI5.2** Briefly outlines the main categories of microbes: Archaebacteria, Eubacteria, Cyanobacteria, Mycoplasma, Actinomycetes, and Viruses.	**SL5.2** Explore the various types of Microbes.
	SO5.3 Students will understand the unique characteristics of Archaebacteria.	**LI5.3** Observation of Cytopathic Effects in Cell Cultures	**CI5.3** Discuss the characteristics, habitats, and importance of Archaebacteria.	**SL5.3** Search various reference books and other study materials to start learning about the overview of the different types of microbes.
	SO5.4 Students will understand the classification and characteristics of Eubacteria.		**CI5.4** Discuss the role of Eubacteria in various ecosystems.	**SL5.4** Explore the role of Eubacteria in various ecosystems
	SO5.5 Students will understand the characteristics and significance of Cyanobacteria.		**CI5.5** Describe the characteristics, photosynthetic capabilities, and ecological importance of Cyanobacteria.	**SL5.5** Search various reference books and other study materials to start learning about the overview of the Cynobacteria.
	SO5.6 Students will		**CI5.6** Discuss the unique features of	

	understand the unique characteristics of Mycoplasma.		Mycoplasma, including their lack of a cell wall. .	
	SO5.7 Students will understand the characteristics and ecological significance of Actinomycetes. .		**CI5.7** Explain the characteristics, habitat, and importance of Actinomycetes.	
	SO5.8 Students will understand the basic structure and classification of viruses.		**CI5.8** Provide an overview of the structure and classification of viruses.	**SL5.6** Search various reference books and other study materials to start the learning the overview of the Viruses.
	SO5.9 Students will understand the reproductive strategies of viruses		**CI5.9** Explain the life cycle of viruses, including lytic and lysogenic cycles.	
	SO5.10 Students will recognize the positive impact of microbes in various fields.		**CI5.10** Discuss the beneficial roles of microbes in agriculture, industry, medicine, and the environment	**SL5.7** Explore the roles of microbes in agriculture, industry, medicine, and the environment
	SO5.11 Students will understand the negative impacts of harmful microbes.		**CI5.11** Explain the harmful roles of microbes, including pathogenicity and spoilage.	**SL5.8** Explore the harmful roles of microbes, including pathogenicity and spoilage.
	SO5.12 Students will have a consolidated understanding of the unit on microbes.		**CI5.12** Summarize the key points covered in the unit.	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Explain in detail understanding of the unit on microbes.
	SW5.2 Mini Project	Describe in the microbes in various fields.
	SW5.3 Other Activities (Specify)	One case research study structure and classification of viruses.

Course duration (in hours) to attain Course Outcomes:

Course Title: Basic Botany **Course Code:** 02BO111

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1: To Understand the structure and function of various plant organs. Students will classify and describe different types of leaves, inflorescences, flowers, and fruits..	12	6	5	1	24
CO2: To demonstrate the different reproductive methods and life cycles of algae, Bryophytes, and Gymnosperms.	12	6	5	1	24
CO3: Students will describe the stellar organization, reproduction, heterospory, and seed habit in pteridophytes, Gymnosperms, and Paleobotany.	12	6	5	1	24
CO4: To understand the modes of nutrition and types of reproduction in fungi and the economic importance of fungi	12	6	5	1	24
CO5: To understand the overview of various types of microbes, including archaebacteria, eubacteria, cyanobacteria, mycoplasma, actinomycetes, and viruses	12	6	8	1	27
Total Hours	60	30	28	05	123

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcomes:

Course Title: Basic Botany **Course Code:** 02BO111

***Legend*: R,** Remember; **U,** Understand; **A,** Apply; **A,** Analyze

Course Outcomes	Marks Distribution				Total Marks
	R	U	A	A	
CO1 To Understand the structure and function of various plant organs. Students will classify and describe different types of leaves, inflorescences, flowers, and fruits.	4	4	6	4	18
CO2: To demonstrate the different reproductive methods and life cycles of algae, Bryophytes, and Gymnosperms.	4	6	6	4	20
CO3: Students will describe the stellar organization, reproduction, heterospory, and seed habit in pteridophytes, Gymnosperms, and Paleobotany.	4	4	6	8	22
CO4: To understand the modes of nutrition and types of reproduction in fungi and the economic importance of fungi	4	4	6	6	20
CO5: To understand the overview of various types of microbes, including archaebacteria, eubacteria, cyanobacteria, mycoplasma, actinomycetes, and viruses	4	4	4	8	20
Total Marks	20	22	28	30	100

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1.	Oladele Ogunseitan, Microbial Diversity: Form and Function in Prokaryotes, Wiley Blackwell.2008.
2.	Pelczar, M.J et al., Microbiology, Tata McGraw-Hill Co, New Delhi, 5th edition, 2001. .
3.	Presscott, L. Harley, J. and Klein, D., Microbiology, Tata McGraw-Hill Co. New Delhi, 6thedn., 2005.
4.	Fritsch F.E., The Structure & Reproduction of Algae, Vol. 1 & Vol. II., Cambridge University Press, Cambridge, U.K. 1945.
5.	Smith, G.M., Cryptogamic Botany, Vol. I: Algae, Fungi, & Lichens, McGraw-Hill Book Co., New York, 1955.
6.	lanMorris, An Introduction to the Algae, Hutchinson, London, 1967.

7.	Parihar, N.S., An Introduction to Embryophyta: Bryophyte, Vol.I, Central Book Depot, Allahabad, 1965.
8.	Bierhorst, D.W., Morphology of Vascular Plants, The MacMillan Co.,N.Y. and Collier-MacMillan Ltd., London, 1971.
9.	Sporme, K.R., The Morphology of Gymnosperms: The Structure and Evolution of Primitive seed Plants, Hutchinson University Library, London, 1971
10.	Dutta, S.C., An introduction to Gymnosperms, Kalyani Publishers, New Delhi, 1984.
11.	Bhatnagar, S.P. andAlok Moitra, Gymnosperms, New age International (P.) Ltd., New Delhi, 2000.

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Visit to animal biotechnology lab and stem cells biology lab
7. Demonstration
8. ICT Based teaching Learning
9. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Sc. Botany

Semester: Ist Semester

Course Title: Basic Botany

Course Code: 02BO111

CO/PO/PSO Mapping															
Course Outcome (Cos)	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1: To Understand the structure and function of various plant organs. Students will classify and describe different types of leaves, inflorescences, flowers, and fruits.	3	2	-	2	2	1	-	-	1	1	2	-	2	2	2
CO2: To demonstrate the different reproductive methods and life cycles of algae, Bryophytes, and Gymnosperms.	3	3	1	2	3	1	-	-	-	2	3	1	2	2	3
CO3: Students will describe the stellar organization, reproduction, heterospory, and seed habit in pteridophytes, Gymnosperms, and Paleobotany..	2	1	1	2	2	2	-	2	-	2	1	1	3	2	1
CO4: To understand the modes of nutrition and types of reproduction in fungi and the economic importance of fungi	2	3	-	3	2	2	-	2	-	2	2	1	3	2	2
CO5: To understand the overview of various types of microbes, including archaebacteria, eubacteria, cyanobacteria, mycoplasma, actinomycetes, and viruses	3	3	-	3	2	2	2	2	1	2	2	2	3	2	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO1** To Understand the structure and function of various plant organs. Students will classify and describe different types of leaves, inflorescences, flowers, and fruits.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	LI 1 LI 2 LI 3	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9,1.1 0, 1.11, 1.12	1SL-1,2,3,4,5
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO2:** To demonstrate the different reproductive methods and life cycles of algae, Bryophytes, and Gymnosperms.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9 SO2.10 SO2.11 SO2.12	LI 1 LI 2 LI 3	2.1,2.2,2.3,2.4,2.5, 2.6,2.7,2.8,2.9,2.1 0, 2.11, 2.12	2SL-1,2,3,4,5
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO3:** Students will describe the stellar organization, reproduction, heterospory, and seed habit in pteridophytes, Gymnosperms, and Paleobotany..	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9 SO3.10 SO3.11 SO3.12	LI 1 LI 2 LI 3	3.1,3.2,3.3,3.4,3.5, 3.6,3.7,3.8,3.9, 3.10, 3.11, 3.12	3SL-1,2,3,4,5
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO4:** To understand the modes of nutrition and types of reproduction in fungi and the economic importance of fungi .	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8 SO4.9 SO4.10 SO4.11 SO4.12	LI 1 LI 2 LI 3	4.1,4.2,4.3,4.4,4.5, 4.6,4.7,4.8,4.9,4.1 0, 4.11, 4.12	4SL-1,2,3,4,5
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO5:** To understand the overview of various types of microbes, including archaebacteria, eubacteria, cyanobacteria, mycoplasma, actinomycetes, and viruses	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9 SO5.10 SO5.11 SO5.12	LI 1 LI2 LI 3	5.1,5.2,5.3,5.4,5.5, 5.6,5.7,5.8,5.9, 5.10, 5.11, 5.12	5SL-1,2,3,4,5,6,7,8

Program Name	**Bachelor of Science (B.Sc.)- Biology**	
Semester	1st	
Course Code:	02ZO112	
Course title:	Animal diversity: Non chordata	**Curriculum Developer**: MR. AMIT BAGRI
Pre-requisite:	Student should have basic knowledge of Non chordate animals.	
Rationale:	• This core course will gain an overall understanding of the origin of life, diverse forms of organisms to which the taxon classified. This course will also help to provide descriptive asses about the animal architecture and function during the course of evolution and will create the awareness of the economic importance and significance of invertebrates.	
Course Outcomes (COs):	02ZO112 **.1.** Gain knowledge about importance of systematic, taxonomy, structural organization of the animals and will appreciate diversity of non-Chordates. **02ZO112 .2.** To describe unique characters of protozoa and coelenterate. **02ZO112 .3.** To recognize life functions and characters of Platyhelminthes, Nemathelminths and Annelida 02ZO112 **.4.** To critically analyze organization, complexity and characteristic features of Arthropoda and Mollusca along with their significance and interactions with the environment. 02ZO112 .**5.** To Learn about the importance of systematics, taxonomy and structural organization Echinodermata and hemichordate.	

Scheme of Studies:

Board of Study	**Course Code**	**Course Title**	**Scheme of studies (Hours/Week)**					**Total Credits(C) (L:T:P=4:0:2)**
			Cl	LI	SW	SL	**Total Study Hours (CI+LI+SW+SL)**	
Minor	02ZO112	Animal diversity: Non chordata	4	2	1	2	9	4+2=6

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)		
Minor	02ZO112	Animal diversity: Non chordata	**15**	**20**	**10**	**5**	**50**	**50**	**100**

Scheme of Assessment: Practical

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)		
Minor	02ZO112	Animal diversity non chordata	35	5	5	5	50	50	50

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	6	01	05	24

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
02ZO112 1. Gain knowledge about importance of systematic, taxonomy, structural organization of the animals and will appreciate diversity of non-Chordates.	**SO1.1** Summarize concept of Taxonomy	1.1. Study of museum specimens and slides relevant to the invertebrates.	**Unit-1 Taxonomy, phylogeny and Protozoa** **1.1** Elementary knowledge of Zoological Nomenclature and International Code	1.1. define taxonomy
	SO1.2 classification of Animal kingdom	1.2. What are the benefits of integrating museum specimen data with other types of biological data?	**1.2**Classification of Animal Kingdom upto phylum of acoelomate and coelomate non chordates.	1.2. define ICZN and phylogeny
	SO1.3 Protozoa classification and characters		**1.3** Definition and Examples	1.3. Protozoans' animals body structure and characters
	SO1.4 Define phylogeny and example		**1.4** Phylum Protozoa General character of the phylum and outline classification	1.4. Learn about protozoan diseases
	SO1.5 Plasmodium Vivax life cycle and history	1.3. How do museums ensure the accessibility of their collections to researchers and the public?	**1.5** Structure, life history and pathogenicity of malarial parasite	1.5. learn about life cycle.
	SO1.6 explain the importance of zoological nomenclature?		1.6 How is the importance of zoological nomenclature?	
	SO1.7 describe the homonym in zoological nomenclature?		1.7 What is a homonym in zoological nomenclature?	
	SO1.8 explain binomial nomenclature?		1.8 What is binomial nomenclature?	
	SO1.9 explain Plasmodium vivax, and how does it cause malaria		1.9 What is Plasmodium vivax, and how does it cause malaria	
	SO1.10 describe the treatment options for Plasmodium vivax malaria		1.10 What are the treatment options for Plasmodium vivax malaria	
	SO1.11 explain the challenges in controlling Plasmodium vivax malaria?		1.11 What are the challenges in controlling Plasmodium vivax malaria?	
	SO1.12 explain the geographic distribution of Plasmodium vivax?		1.12 What is the geographic distribution of Plasmodium vivax?	

Suggested Sessional Work (SW):*anyone*	**SW1.1** Assignments	Write about the history of Phylogeny and types.
	SW1.2 Mini Project	Write about General characters and classification of protozoa.
	SW1.3 Other Activities (Specify)	Collection of explants materials and their culture initiation.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	05	24

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
02ZO112 .2. To describe unique characters of protozoa and coelenterate.	**SO2.1** define porifera phylum	2.1. locally available small non chordates and their larvae.	**Unit-2 Porifera and coelenterata** **2.1** Phylum porifera General character of the phylum and outline classification	2.1. Know about the general characters of Phylum Porifera.
	SO2.2 study of sycon	2.2. Examination of pond water study of different kinds of microscopic non chordate organism.	**2.2** Type study of sycon	2.2. learn about sycon,
	SO2.3 define canal system of Sponges		**2.3** Canal system of sponges	2.3. learn about canal system of sponges,
	SO2.4 define phylum coelenterata		**2.4** Phylum Coelenterate General character of the phylum and outline classification	2.4. Know about the general characters of Phylum coelenterate,
	SO2.5 Study of obelia		**2.5** Type study of Obelia	2.5. learn about obelia,
	SO2.6 study of coral reef formation.	2.3. What impact does water temperature, pH, and other chemical parameters have on the presence and behavior of these organisms?	**2.6** Corals and coral reef formation	
	SO2.7 explain		**2.7** How are sponges classified within Phylum Porifera?	
	SO2.8 describe sponges feed and obtain nutrients?		**2.8** How do sponges feed and obtain nutrients?	
	SO2.9 describe sponges reproduce?		**2.9** How do sponges reproduce?	
	SO2.10 explain spicules and spongin, and what is their function in sponges?		**2.10** What are spicules and spongin, and what is their function in sponges?	
	SO2.11 explain sponges defend themselves against predators?		**2.11** How do sponges defend themselves against predators?	
	SO2.12 describe the main threats to sponge populations?		**2.12** What are the main threats to sponge populations?	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Write about General characters and classification of porifera.
	SW2.2 Mini Project	Write about the Canal system of sponges
	SW2.3 Other Activities (Specify)	write the diagram of obelia?

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	07	26

Course Outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
02ZO112 .3. To recognize life functions and characters of Platyhelminthes, Nemathelminths and Annelida	**SO3.1** Explain the Platyhelminthes phylum	3.1. Parasitic Adaptation of any one parasite.	**Unit-3 Platyhelminthes, Nemathelminths and Annelida** **3.1 1** Phylum Platyhelminthes General character of the phylum and outline classification	3.1. Know about the general characters of Phylum Platyhelminthes
	SO3.2 define the life cycle of liver fluke	.	**3.2** External morphology and life history of liver fluke	3.2. learn about live cycle of liver fluke
	SO3.3 Explain the Nemathelminths phylum	3.2. What morphological adaptations does Plasmodium falciparum have for surviving in red blood cells?	**3.3** Phylum Nemathelminths General character of the phylum and outline classification	3.3. Know about the general characters of Phylum Nemathelminths
	SO3.4 Explain the Pathogenic symptoms of Nematodes and diseases	3.3. What adaptations contribute to the virulence of Plasmodium falciparum?	**3.4** Pathogenic symptoms of nematodes and diseases	3.4. learn about Pathogenic symptoms of nematodes and diseases
	SO3.5 Explain the Annelida phylum		**3.5** Phylum Annelida General character of the phylum and outline classification	3.5. Know about the general characters of Phylum Annelida
	SO3.6 define Earthworm		**3.6** type study of Earthworm	3.6. study of earthworm
	SO3.7 Explain the structure and significance of trochophore larva.		**3.7** structure and significance of trochophore larvae	3.7. learn about structure and significance of trochophore larvae.
	SO3.8 Explain liver flukes, and which species are most commonly known?		**3.8** What are liver flukes, and which species are most commonly known?	
	SO3.9 explain the intermediate hosts in the life cycle of liver flukes?		**3.9** What are the intermediate hosts in the life cycle of liver flukes?	
	SO3.10 describe liver fluke infections diagnosed in humans and animals?		**3.10** How are liver fluke infections diagnosed in humans and animals?	
	SO3.11 explain the strategies for controlling liver fluke infections in livestock?		3.11 What are the strategies for controlling liver fluke infections in livestock?	
	SO3.12 describe changes in land use and agricultural practices affect liver fluke prevalence?		3.12 How can changes in land use and agricultural practices affect liver fluke prevalence?	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Write about General characters and classification of Nemathelminths.
	SW3.2 Mini Project	Write about the Pathogenic symptoms of nematodes and diseases
	SW3.3 Other Activities (Specify)	Write the diagram of liver fluke

Item	Cl	LI	SW	SL	Total
Approx.Hrs	12	06	01	07	26

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
02ZO112 .4. To critically analyze organization, complexity and characteristic features of Arthropoda and Mollusca along with their significance and interactions with the environment.	**SO4.1** study of general characters of Arthropoda	4.1. Study about cockroach digestive system, nervous system	**Unit-4 Arthropoda and Mollusca** **4.1** Phylum Arthropoda General character of the phylum and outline classification	4.1. Read the general characters of Arthropoda
	SO4.2 study of prawn		**4.2** Type study of Prawn	4.2. study of Prawn
	SO4.3 Observing the role of crustacea larvae	4.2. Economic Importance of insects.	**4.3** Larval forms of crustacea	4.3. Understand the larval forms of crustacea
	SO4.4 Understand the various vector of human disease	4.3. TYPES OF mouth parts.	**4.4** Insects as a vector of human disease	4.4. learn about Insects as a vector of human disease
	SO4.5 Explain the Mollusca phylum		**4.5** Phylum Mollusca General character of the phylum and outline classification	4.5. Know about the general characters of Phylum Mollusca
	SO4.6 study of Pila		**4.6** Type study of Pila.	4.6. study of Pila.
	SO4.7 Explain the Structure and Significance of glochidium larvae		**4.7** Structure and Significance of glochidium larvae	4.7. learn about Structure and Significance of glochidium larvae.
	SO4.8 explain the exoskeleton of arthropods benefit their survival?		**4.8** How does the exoskeleton of arthropods benefit their survival?	
	SO4.9 describe the different types of appendages found in arthropods, and what functions do they serve?		**4.9** What are the different types of appendages found in arthropods, and what functions do they serve?	
	SO4.10 explain arthropods contribute to their ecosystems?		**4.10** How do arthropods contribute to their ecosystems?	
	SO4.11 describe arthropods classified within their phylum, and what criteria are used for classification?		**4.11** How are arthropods classified within their phylum, and what criteria are used for classification?	
	SO4.12 explain the different modes of reproduction in arthropods?		**4.12** What are the different modes of reproduction in arthropods?	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Write about General characters and classification of Arthropoda
	SW4.2 Mini Project	Write about the Structure and Significance of glochidium larvae.
	SW4.3 Other Activities (Specify)	write the diagram of Prawn

Item	Cl	LI	SW	SL	Total
Approx.Hrs	12	06	01	06	25

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Classroom Instruction(CI)	Self-Learning(SL)
02ZO112 .5. To Learn about the importance of systematics, taxonomy and structural organization Echinodermata and hemichordate	**SO5.1** Explain the Echinodermata phylum	5.1. locally available small non chordates and their larvae	**Unit-5 Echinodermata and Hemichordates** 5.1 Phylum Echinodermata General character of the phylum and outline classification	5.1. Read the general characters of Echinodermata.
	SO5.2 study about External features and water vascular System of starfish	5.2 Larval forms of Echinodermata	5.2 External features and water vascular System of starfish	5.2. learn about about External features and water vascular System of starfish
	SO5.3 Identify Larval forms of Echinodermata	5.3 Structure and Significance of Tornaria larvae?	5.3 Larval forms of Echinodermata	5.3. learn about Larval forms of Echinodermata
	SO5.4 Explain the Hemi chordata phylum		5.4 Phylum Hemichordates General character of the phylum and outline classification	5.4. Read the general characters of Hemichordates
	SO5.5 Identify different External morphology of Balanoglossus.		5.5 Balanoglossus – External morphology	5.5. Study about Balanoglossus – External morphology
	SO5.6 Identify Larval forms of Tornaria larvae.		5.6 Structure and Significance of Tornaria larvae	5.6. learn about Structure and Significance of Torn aria larvae.
	SO5.7 explain the structure and function of the water vascular system in echinoderms?		5.7 What is the structure and function of the water vascular system in echinoderms?	
	SO5.8 describe the role of the calcareous endoskeleton in echinoderms?		5.8 What is the role of the calcareous endoskeleton in echinoderms?	
	SO5.9 explain the digestive adaptations of echinoderms?		5.9 What are the digestive adaptations of echinoderms?	
	SO5.10 describe echinoderms reproduce, and what are the different modes of reproduction?		5.10 How do echinoderms reproduce, and what are the different modes of reproduction?	
	SO5.11 explain the evolutionary origins of echinoderms?		5.11 What are the evolutionary origins of echinoderms?	
	SO5.12 describe the main threats to echinoderm populations?		5.12 What are the main threats to echinoderm populations?	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Write about General characters and classification of Echinodermata
	SW5.2 Mini Project	Write about the Structure and Significance of Tornaria larvae
	SW5.3 Other Activities (Specify)	Write the diagram of Balanoglossus.

Course duration (in hours) to attain Course Outcomes:

Course Title: Animal diversity: Non-Chordata **Course Code:** 02ZO112

Course Outcomes(COs)	Class lecture (CI)	Laboratory Instruction(LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li + CI + SL + SW)
02ZO112 .1. Gain knowledge about importance of systematic, taxonomy, structural organization of the animals and will appreciate diversity of non-Chordates.	12	06	1	5	24
02ZO112 .2. To describe unique characters of protozoa and coelenterate.	12	06	1	5	24
02ZO112 3. To recognize life functions and characters of Platyhelminthes, Nemathelminths and Annelida	12	06	1	7	26
02ZO112.4. To critically analyse organization, complexity and characteristic features of Arthropoda and Mollusca along with their significance and interactions with the environment.	12	06	1	7	26
02ZO112.5. To Learn about the importance of systematics, taxonomy and structural organization Echinodermata and hemichordate.	12	06	1	6	25
Total Hours	60	30	05	30	125

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Animal diversity: Non-Chordata **Course Code:** 02ZO112

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
02ZO112.1. Gain knowledge about importance of systematic, taxonomy, structural organization of the animals and will appreciate diversity of non-Chordates.	3	1	1	4	09
02ZO112.2. To describe unique characters of protozoa and coelenterate.	4	4	1	2	11
02ZO112.3. To recognize life functions and characters of Platyhelminthes, Nemathelminths and Annelida	2	3	3	2	10
02ZO112.4. To critically analyze organization, complexity and characteristic features of Arthropoda and Mollusca along with their significance and interactions with the environment.	2	3	3	2	10
02ZO112.5. To Learn about the importance of systematics, taxonomy and structural organization Echinodermata and hemichordate.	2	3	3	2	10
Total Marks	**13**	**14**	**11**	**12**	**50**

***Legend*: A,** apply; **An,** analyze; **E,** evaluate; **C,** create

Suggested learning Resources:

(a) Books:

S. No.	Title/Author/Publisher details
1	Invertebrate Zoology, Ruppert and R.D. Barnes, Holt Saunders International Edition, VIII Edition 2006
2	The Invertebrates: A New Synthesis, Barnes, R.S.K., Calow, P. et al, Blackwell Science, III & 2002

3	A Textbook of Zoology, J Parker & W.A. Haswell, Low Price Publications ,Delhi VII & 1990
4	Modem Textbook of Invertebrates R. Kotpal, Rastogi Publications, Meerut, 2017
5	

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Demonstration
7. ICT Based teaching Learning
8. Brainstorming

CO, PO and PSO Mapping

Program Name: B.Sc Biology
Semester: 1st Semester
Course Title: Animal diversity: Non chordata
Course Code: 02ZO112

CO/PO/PSO Mapping								
Course Outcome (Cos)	**Program Outcomes (POs)**					**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**
02ZO112. 1. Gain knowledge about importance of systematic, taxonomy, structural organization of the animals and will appreciate diversity of non-Chordates.	2	2	3	2	1	2	2	3
02ZO112 2. To describe unique characters of protozoa and coelenterate.	1	1	2	2	1	2	3	3
02ZO112 3. To recognize life functions and characters of Platyhelminthes, Nemathelminths and Annelida.	2	3	1	3	2	1	1	2
02ZO112 4. To critically analyze organization, complexity and characteristic features of Arthropoda and Mollusca along with their significance and interactions with the environment.	1	2	3	3	2	2	2	2
02ZO112 .5. To Learn about the importance of systematics, taxonomy and structural organization Echinodermata and hemichordate.	2	2	3	2	2	1	2	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5 PSO 1,2,3	**02ZO112 .1.** Gain knowledge about importance of systematic, taxonomy, structural organization of the animals and will appreciate diversity of non-Chordates.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	1.1, 1.2, 1.3	1.1, 1.2, 1.3, 1.4, 1.5 1.6, 1.7, 1.8, 1.9, 1.10, 1.11, 1.12	1SL-1, 2, 3, 4, 5
PO 1,2,3,4,5 PSO 1,2,3	**02ZO112 .2.** To describe unique characters of protozoa and coelenterate.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9 SO2.10 SO2.11 SO2.12	2.1, 2.2, 2.3	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.10, 2.11, 2.12	2SL-1, 2, 3, 4, 5
PO 1,2,3,4,5 PSO 1,2,3	**02ZO112 .3.**To recognize life functions and characters of Platyhelminthes, Nemathelminths and Annelida	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9 SO3.10 SO3.11 SO3.12	3.1, 3.2, 3.3	3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 3.10, 3.11, 3.12	3SL-1, 2, 3, 4, 5, 6, 7
PO 1,2,3,4,5 PSO 1,2,3	**02ZO112 .4.** To critically analyse organization, complexity and characteristic features of Arthropoda and Mollusca along with their significance and interactions with the environment.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6, SO4.7 SO4.8 SO4.9 SO4.10 SO4.11 SO4.12	4.1, 4.2, 4.3	4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12	4SL-1, 2, 3, 4, 5, 6, 7
PO 1,2,3,4,5 PSO 1,2,3	**02ZO112 .5.** To Learn about the importance of systematics, taxonomy and structural organization Echinodermata and hemichordate.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9 SO5.10 SO5.11 SO5.12	5.1, 5.2,5.3	5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10, 5.11, 5.12	5SL-1, 2, 3, 4, 5, 6

B.Sc. Ist Semester

Course Code : 02CH113

Course Title : Analytical Chemistry

Pre-requisite: Students must have fundamental knowledge of mathematics, valence shell electron pair repulsion theory, and different concentration terms to understand the concept of analytical chemistry.

Rationale: The students studying analytical chemistry should possess foundational understanding about basic mathematics, valence shell electron pair repulsion theory, and different concentration terms to understand the basic principle of chromatography and spectroscopic analysis.

Course Outcomes:

After the completion of this course, the learner will able to

02CH113.1: explain basic concept of straight line equation, logarithmic relation, differentiation and integration and run the software's to plot the graphs and draw the structure of different molecules.

02CH113.2: describe the presentation of experimental data and analyze the results in terms of significant figure by applying the concept of concentration terms, error, sampling, precision, accuracy

02CH113.3: explain thermodynamic derivation of law of chemical equilibrium by applying the concept of Gibbs free energy and chemical potential

02CH113.4: **d**iscuss principle of chromatography and analyze different components of a mixture quantitatively by applying chromatographic principle.

02CH113.5: discuss basic concept of spectroscopy and analyze unknown component qualitatively & quantitatively and also identify the functional groups of a molecule on the basis of their stretching and bending vibrations.

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/course.html
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
3. https://swayam.gov.in/explorer?category=Chemistry

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources

AKS University

Faculty of Basic Science

Curriculum of B. Sc.(Honours/ By Research) Program

(Revised as on 01 August 2023)

Scheme of Studies:

Board of Study	Course Code	Course Title				Scheme of studies (Hours/Week)		Total Credits I
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	**02CH113**	**Analytical Chemistry**	4	4	1	1	8	6

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop,field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback ofteacher to ensure outcome of Learning.

Scheme of Assessment: Theory

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (RA)					End Semester Assessment (ESA)	Total Marks (PRA+ESA)
			Class/Home Assignment 5 number marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each	Seminar one + Class activity	Class Attendance (AT)	Total Marks (CA+CT+SA +AT)		
DCC	**02CH113**	Analytical Chemistry	15	20	10	5	50	50	100

Course-Curriculum Detailing:
This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their

mastery of Session Outcomes (Sos), culminating in the overall achievement of Course Outcomes (Cos) upon the course's conclusion.

Unit-1 (02CH113.1): Basics of mathematics and computer for Chemists

Straight line equation, Logarithmic relations, relations, curve sketching, linear graphs & calculation of slopes. Differentiation of functions like kx, e^x, x^n, sinx, Logx, maxima & minima, Integration of some useful relevant functions Introduction to computer, Execution of linear regression x-y Plot Use of software's for drawing structures and molecular formulae.

Activity	Appx Hrs
Cl	12
LI	12
SW	2
SL	1
Total	27

Session Outcomes (SOs)	LI	CI	SL
After the completion of topics students will be able to SO1.1 understand the concept of Straight line equation and calculation of slopes SO1.2 explain logarithmic relations, relations of different functions SO1.3 discuss differentiation of important functions and calculate of maxima & minima SO1.4 discuss integration of some useful relevant functions SO1.5 discusses software's for drawing structures and molecular formulae.	Basic exercises • To introduce software's to draw structure of different compounds • Calibration of different weights and glass apparatus • To prepare solutions of different molarity/normality by weighing and dilution.	**Unit-1 (2CH101.1): Basics of mathematics and computer for Chemists** 1.1 Significance of straight line equation and its applications 1.2 Logarithmic relations 1.3 Curve sketching 1.4 linear graphs & calculation of slopes 1.5 Differentiation of functions like kx, e^x, x^n, sinx, Logx, 1.6 Differentiation of functions like sinx, Logx, 1.7 calculations of maxima & minima 1.8 Integration of some useful relevant functions 1.9 Introduction to computer and execution of linear regression x-y Plot. 1.10 Introduction to software's	• Significance of differentiation and integration • Introduction to window

		1.11 Applications of software for drawing structures and molecular formulae 1.12 Introduction to ChemDraw and Origin	

SW-1 Suggested Sessional Work (SW):
Assignments: curve sketching
Mini Project: Software's for drawing structures and molecular formulae.
Other Activities (Specify): Introduction to graph and its types in different ways to represent data

Unit-2 (02CH113.2): Basic Analytical Chemistry
Introduction to Analytical Chemistry and its interdisciplinary nature, Concept of sampling, Importance of accuracy, precision and source of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures, statistical terms: mean, mean deviation, median standard deviation, Numerical Problems.
Calculations used in Analytical Chemistry
Some Important units of measurements: SI Unit, distinction between mass and weight, mole, mill mole and numerical problems.
Solution and their concentrations: Concept of Molarity, molality, and normality. Expressing the concentration in parts per million (ppm), parts per billion (ppb), Numerical Problems.
Chemical Stoichimetry: Empirical and Molecular Formulas, Stoichemetric Calculations, Numerical Problems.

Activity	AppX Hrs
Cl	13
LI	12
SW	2
SL	1
Total	28

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
After the completion of topics students will be able to **SO2.1** restate concept of sampling, Importance of accuracy, precision and source of error in analytical measurements. **SO2.2** explain experimental data in terms of significant figure	Quantitative analysis through Titrimetric method • Standardization of NaOH with Oxalic acid. • Determination of carbonate and hydroxide present in mixture	**Unit-2 (2CH101.2): Basic Analytical Chemistry** 2.1 Introduction to Analytical Chemistry and its interdisciplinary nature 2.2 Concept of sampling 2.3 Importance of accuracy, precision 2.4 Source of error in analytical measurements. 2.5 Statistical terms: mean, mean deviation, median standard deviation	• Some Important units of measurements: SI Unit • distinction between mass and weight • mole, mill mole and numerical problems

SO2.3 discuss mathematical terms such as mean, mean deviation, median standard deviation etc **SO2.4** discuss different concentration terms and apply the same concept of to prepare solutions **SO2.5 estimate e**mpirical and molecular formulae	• Determination of carbonate and bicarbonate present in a mixture.	2.6 Solution and their concentrations 2.7 Concept of Molarity, molality, and normality. 2.8 Expressing the concentration in parts per million (ppm), parts per billion (ppb), 2.9 Numerical Problems. 2.10 Chemical Stoichimetry 2.11 Empirical and Molecular Formulae 2.12 Stoichemetric Calculations 2.13 Numerical Problems	

SW-2 Suggested Sessional Work (SW):

Assignments: Presentation of experimental data and results, from the point of view of significant figures

Mini Project:

Other Activities (Specify): Numerical Problems.

Unit-3 (02CH113.3): Chemical Equilibrium

Equilibrium constant and free energy, concept of chemical potential, Thermodynamic derivation of law of chemical equilibrium Temperature dependence of equilibrium constant: Van't Hoff reaction isochors, Van't Hoff reaction isotherm, Le-Chatelier's Principle and its applications.

Activity	AppX Hrs
Cl	11
LI	12
SW	2
SL	1
Total	26

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)

After the completion of topics students will be able to **SO3.1** explain equilibrium constant and free energy **SO3.2** discuss concept of chemical potential **SO3.3** describe thermodynamic derivation of law of chemical equilibrium **SO3.4** explain conceptually Van't Hoff reaction isochors, Van't Hoff reaction isotherm **SO3.5** describe Le-Chatelier's Principle and its applications	• To study the shift of equilibrium between ferric ions and thiocyanate ions by increasing the concentration of either of them. • Determination of free alkali present in different soaps/detergents.	**Unit-3 (2CH101.3): Chemical Equilibrium** 3.1 Introduction to equilibrium constant 3.2 Introduction to free energy 3.3 concept of chemical potential 3.4 Thermodynamic derivation of law of chemical equilibrium 3.5 Discussion of temperature dependence of equilibrium constant 3.6 Van't Hoff reaction isochors, 3.7 Van't Hoff reaction isotherm 3.8 Introduction to Le-Chatelier's Principle 3.9 Applications of Le-Chatelier's Principle 3.10 Solving numerical problems 3.11 Solving numerical problems	• Gibbs free energy • Van't Hoff factors

SW-3 Suggested Sessional Work (SW):

Assignments: Concept of chemical potential

Mini Project:

Other Activities (Specify):

Unit-4 (02CH113.4): Chromatography

Introduction, Principle and Classification Mechanism of separation: adsorption, partition and ion-exchange.
Development of Chromatograms: frontal elution and displacement methods.
Paper Chromatography (ascending, descending and circular), Thin Layer Chromatography (TLC) and Column Chromatography (CC). Gas Chromatography (GC) and High Pressure Liquid Chromatography (HPLC) types of column and column selection, applications, Limitations
Principle and Applications of:

- Flash chromatography,
- Ion-exchange chromatography and
- Chiral chromatography.
-

Activity	AppX Hrs
Cl	13
LI	12
SW	2
SL	1
Total	28

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
After the completion of topics students will be able to **SO4.1** understand basics of separation of components of a mixture **SO4.2** to discuss development of chromatograms **SO4.3** discusses principles of paper chromatography and thin layer chromatography (TLC) **SO4.4** explain column chromatography (CC) and gas chromatography (GC) **SO4.5** discuss the concept of chiral chromatography	Qualitative Analysis • Identification by determination of the Rf values of the given organic / inorganic compounds by paper/ thin layer chromatography. • Systematic identification of organic compound by qualitative analysis	**Unit-4 (2CH101.4): Chromatography** 4.1 Introduction to chromatography 4.2 Discussion of principle involved 4.3 Classification of chromatography 4.4 Mechanism of separation of components in a mixture 4.5 Development of Chromatograms: frontal elution and displacement methods 4.6 Principle of Paper Chromatography (ascending, descending and circular) and Thin Layer Chromatography (TLC) 4.7 Column Chromatography (CC) 4.8 Gas Chromatography (GC) 4.9 High Pressure Liquid Chromatography (HPLC) 4.10 Types of column involved and selection of column 4.11 Principle of Chiral chromatography 4.12 Applications of Chiral chromatography	To understand the chromatographic principle students must read about • Nature of compound (polar/non-polar)

		4.13 Principle and applications of flash chromatography	

SW-4 Suggested Sessional Work (SW)
Assignment: Chromatography (HPLC) types of column and column selection
Mini Project:
Other Activities (Specify): Mechanism of separation of components in a mixture: adsorption, partition and ion-exchange

Unit-5 (02CH113.5): Spectral techniques of analysis
Basics of absorption spectroscopy: Electromagnetic radiation, Spectral; range. Absorbance Absorptivity, Molar Absorptivity, Fundamental Laws of Absorption, Lambert-Beer Law and its limitations Constitution & working of photometer spectrometer, colorimeter.
Ultraviolet (UV) absorption spectroscopy: Presentation and analysis of UV spectra, Types of electronic transitions, effect of conjugation. Concept of chromophore and auxochrome. Bathochromic, hypsochromic, Hyper-chromic and hypo-chromic shifts. UV spectra of conjugated polyenes and enones.
Infra-red (IR) absorption spectroscopy: Molecular vibrations Hooke's law, selection rules, intensity and position of IR bands. Measurement of IR spectrum, finger print region, characteristic absorption of various functional groups and interpretation of IR spectra of simple organic compounds

Activity	AppX Hrs
Cl	11
LI	12
SW	2
SL	1
Total	26

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
After the completion of topics. students will be able to **SO5.**1 understand Basics of absorption spectroscopy **SO5.2** discuss the principle of UV-visible spectroscopy or Lambert-Beer Law and its limitations **SO5.3** apply the concept of UV-visible spectra to calculate	Quantitative Analysis by Colorimeter: • Verification of Lambert-Beer Law • Determination of concentration of colored compounds (e.g. CuSO4, KMnO4) • Verification of Lambert-Beer Law	**Unit-5 (2CH101.5): Spectral techniques of analysis** 4.1 Fundamental Laws of Absorption 4.2 Lambert-Beer Law and its limitations Constitution & working of photometer spectrometer, colorimeter. 4.3 Presentation and analysis of UV spectra 4.4 Types of electronic transitions, effect of conjugation.	Basics of absorption spectroscopy: • Electromagnetic radiation, • Spectral range • Absorbance Absorptivity, Molar Absorptivity

the λ_{max} of conjugated polyenes and enones **SO5.**4 describes Hook's law and correlates it with spectral frequency of functional groups. **SO5.5 explain principle of IR** absorption spectroscopy and measure the characteristic absorption band of various functional groups		4.5 Concept of chromophore and auxochrome. Bathochromic, hypsochromic, Hyper-chromic and hypo-chromic shifts. 4.6 UV spectra of conjugated polyenes and enones. 4.7 Infra-red (IR) absorption spectroscopy 4.8 Molecular vibrations 4.9 Hooke's law, selection rules, intensity and position of IR bands 4.10 Measurement of IR spectrum, finger print region, 4.11 characteristic absorption of various functional groups	

SW-5 Suggested Sessional Work (SW):
Assignments: UV spectra of conjugated polyenes and enones.
Mini Project:
Other Activities (Specify): Interpretation of IR spectra of simple organic compounds

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Laboratory Instruction (LI)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
02CH113.1: explain basic concept of straight line equation, logarithmic relation, differentiation and integration and run the software's to plot the graphs and draw the structure of different molecules.	12	12	02	01	27
02CH113.2: describe the presentation of experimental data and analyze the results in terms of significant figure by applying the concept of concentration terms, error, sampling, precision, accuracy	13	12	02	01	28
02CH113.3: explain thermodynamic derivation of law of chemical equilibrium by applying the concept of Gibbs free energy and chemical potential	11	12	02	01	26
02CH113.4: **d**iscuss principle of chromatography and analyze different components of a mixture quantitatively by applying chromatographic principle.	13	12	02	01	28

02CH113.5: discuss basic concept of spectroscopy and analyze unknown component qualitatively & quantitatively and also identify the functional groups of a molecule on the basis of their stretching and bending vibrations.	11	12	02	01	26
Total Hours	60	60	10	05	135

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	**Basics of mathematics and computer for Chemists**	03	01	01	05
CO-2	**Basic Analytical Chemistry**	02	06	02	10
CO-3	Chemical Equilibrium	03	04	03	10
CO-4	Chromatography	-02	08	05	15
CO-5	**Spectral techniques of analysis**	03	02	05	10
Total		13	21	16	50

Legend: R: Remember, U: Understand, A: Apply

The written examination of 50 marks will be held at the end of semester for Inorganic Chemistry

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to NCL, CSIR laboratories
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT,Blog, Facebook,Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher
1	Organic Chemistry, Sultan Chand and Sons. Delhi.	Soni PL,	Sultan Chand and Sons, . Delhi
2	Chemistry	Srivastava, S. S. Gehlot. A.S.	Ratan Prakashan Temple. Indore.
3	Inorganic Chemicals	Sing, DR, Saxena, G, Singh, B.	Shivlal Aggarwal & Company, Agra
4	Bioinorganic Chemistry	AK Das	Prentice -Hall
5	Inorganic chemistry	Gary L. Miessler	Pearson
6	Inorganic chemistry	VK Jaiswal	Shri Balaji
7	Elementary Organic Spectroscopy	Sharma Y.R.	S Chand, 2013
8	Analytical Chemistr	Gupta Alka L	Pragiti Prakashan 2020
9	Analytical Chemistry	Kaur H,	Pragatic Prakashan 2008
10	Advanced Organic Chemistry	Bahl. A. & Bahal. B.S.	S. Chand. 2010
11	Chromatography	Sharma B.K.	Krishna Prakashan, 2019

Suggested Web Sources:

1. https://celqusb.files.wordpress.com/2017/12/inorganic-chemistry-g-l-miessler-2014.pdf
2. https://www.slideshare.net/MANISHSAHU106/inert-and-labile-complexes
3. https://swayam.gov.in/explorer?category=Chemistry

Mode of Delivery: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point;

LMS/ICT Tools: Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

AKS University

Faculty of Basic Science

Curriculum of B. Sc.(Honours/ By Research) Program

(Revised as on 01 August 2023)

Course Title: Analytical Chemistry **Course Code: 02CH113**

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Knowledge	Research Aptitude	Communication	Problem Solving	Individual and Team	Investigation of	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and	The detailed	To integrate	understand, analyze,	Provide opportunitie
CO1: explain basic concept of straight line equation, logarithmic relation, differentiation and integration and run the software's to plot the graphs and draw the structure of different molecules.	**3**	**1**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**3**	**2**	**2**	**3**	**3**	**1**
CO2: describe the presentation of experimental data and analyze the results in terms of significant figure by applying the concept of concentration terms, error, sampling, precision, accuracy	**2**	**1**	**2**	**2**	**1**	**2**	**3**	**2**	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**1**
CO3: explain thermodynamic derivation of law of chemical equilibrium by applying the concept of Gibbs free energy and chemical potential	**2**	**2**	**1**	**1**	**1**	**2**	**2**	**2**	**1**	**2**	**1**	**2**	**1**	**1**	**2**	**2**
CO4: **d**iscuss principle of chromatography and analyze different components of a mixture quantitatively by applying	**2**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**2**	**3**	**3**	**3**	**3**	**2**

chromatographic principle.																
CO5: discuss basic concept of spectroscopy and analyze unknown component qualitatively & quantitatively and also identify the functional groups of a molecule on the basis of their stretching and bending vibrations.	**2**	**-**	**-**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**3**	**1**	**3**

Legend: **1–Low,** **2–Medium,** **3–High**

AKS University

Faculty of Basic Science

Curriculum of B. Sc.(Honours/ By Research) Program

(Revised as on 01 August 2023)

Course Curriculum Map:

POs &PSOsNo.	COs No. & Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1: explain basic concept of straight line equation, logarithmic relation, differentiation and integration and run the software's to plot the graphs and draw the structure of different molecules.	SO1.1 SO1.2 SO1.3SO1.4 SO1.5		Unit-1. **Basics of mathematics and computer for Chemists** 1.1,1.2,1.3,1.4,1.5,1.6,1.7	• Significance of differentiation and integration • Introduction to window
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO2: describe the presentation of experimental data and analyze the results in terms of significant figure by applying the concept of concentration terms, error, sampling, precision, accuracy	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5		Unit-2 **Basic Analytical Chemistry** 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9	• Some Important units of measurements: SI Unit • distinction between mass and weight • mole, mill mole and numerical problems

PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3: explain thermodynamic derivation of law of chemical equilibrium by applying the concept of Gibbs free energy and chemical potential	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5		Unit-3 : Chemical Equilibrium 3.1, 3.2,3.3,3.4,3.5,3.6,3.7	• Gibbs free energy • Van't Hoff factors
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO4: **d**iscuss principle of chromatography and analyze different components of a mixture quantitatively by applying chromatographic principle.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5		Unit-4 Chromatography 4.1,4.2,4.3,4.4,4.5,4.6,4.7	To understand the chromatographic principle students must read about • Nature of compound (polar/non-polar)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO5: discuss basic concept of spectroscopy and analyze unknown component qualitatively & quantitatively and also identify the functional groups of a molecule on	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5		Unit 5: **Spectral techniques of analysis** 5.1,5.2,5.3,5.4,5.5, 5.6,5.7	Basics of absorption spectroscopy: • Electromagnetic radiation, • Spectral range • AbsorbanceAbsorptivity, Molar Absorptivity

	the basis of their stretching and bending vibrations				

Curriculum Development Team:

1) Dr. Shailendra Yadav, HoD, Department of Chemistry, AKS University, Satna (M.P.).
2) Dr. Dinesh Kumar Mishra, Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
3) Dr. Samit Kumar,Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
4) Dr. Sushma Singh, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
5) Dr. Manoj Kumar Sharma, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
6) Mr. Kanha Singh Tiwari,Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
7) Mrs. Nahid Usamani, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).

Program name	Bachelor of Science (B. Sc.)- Botany	
Semester	Ist	
Course Code:	03BO121	
Course title:	Basic Botany	**Curriculum Developer**: Nitin Singh Parihar, Lab Assistant
Pre-requisite:	To study this course, A student must have had the subject Biology/ Life Sciences/ Agriculture in class 12th	
Rationale:	Applied botany overall, this unit provides a robust foundation in plant biology, combining historical context, morphological studies, and cellular biology with practical microscopy skills. This comprehensive approach ensures students are well-prepared for advanced botanical studies and research, fostering a deeper understanding and appreciation of plant sciences.	
Course Outcomes (COs):	**CO1:** To understand the structure and function of various plant organs. Students will classify and describe different types of leaves, inflorescences, flowers, and fruits. **CO2:** To demonstrate the different reproductive methods and life cycles of algae, Bryophytes, and Gymnosperms. **CO3:** Students will describe the stellar organization, reproduction, heterospory, and seed habit in pteridophytes, Gymnosperms, and Paleobotany. **CO4:** To understand the modes of nutrition and types of reproduction in fungi and the economic importance of fungi **CO5:** To understand the overview of various types of microbes, including archaebacteria, eubacteria, cyanobacteria, mycoplasma, actinomycetes, and viruses.	

Board of Study	CourseCode	Course Title	Scheme of studies (Hours/Week)	Total Credits(C)

			CI	LI	SW	SL	**Total Study Hours (CI+LI+SW+SL)**	
Generic Elective	03BO121	Applied Botany	3	1	1	1	6	3+1=4

Scheme of Studies:

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title	**Scheme of Assessment (Marks)**		
			Progressive Assessment (PRA)	End Yearly (ESA)	Total Marks (PRA+ ESA)
Generic Elective	03BO121	Applied Botany	Total Marks (CA+CT+SA+CAT+AT) **30**	**70**	**100**

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and	

session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.	

Item	CI	LI	SW	SL	Total
Approx. Hours	9	4	1	5	19

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CIs)	Self-Learning (SL)
CO1: To Understand the structure and function of various plant organs. Students will classify and describe different types of leaves, inflorescences, flowers, and fruits.			**Unit-1**	
	SO1.1 Students will be able to describe the importance of botany in historical and cultural contexts, with a focus on contributions from ancient Indian civilizations.	**LI1.1** to perform a morphological study of different types of Flowers	**CI1.1** Introduction to Botany and Indian Contributions	**SL1.1** Search various reference books and other study materials to start learning about plants, understand their ecological roles, and explore their potential applications.
	SO1.2 Students can differentiate between lower and higher plants based on morphological characteristics such as size, complexity, and reproductive structures.	**LI1.2** To understand and observe the different components of plant cells through microscopic examination and diagrammatic representation	**CI1.2** Morphological Characteristics of Lower Plants (Angiosperms)	**SL1.2** Explore the historical evolution and recent advancements in animal biotechnology.
	SO1.3 Students can classify higher plants based on their structural features, including roots, stems, leaves, and flowers.		**CI 1.3** Morphological Characteristics of Higher Plants (Angiosperms).	**SL1.3** Understand the essential infrastructure and equipment needed for an animal biotechnology laboratory.
	SO4. Students can identify and differentiate between different types of leaves based on their shapes,		**CI 1.4** Types of Leaves	**SL1.4** Learn about different types of leaves.

	arrangements, and venation patterns.			
	SO1.5 Students will be able to classify inflorescence types and explain their significance in plant reproduction and species identification.		**CI 1.5** Types of Inflorescence	**SL1.5** Learn about different types of Inflorescence.
	SO1.6 Students will be able to describe the parts of a flower and their roles in reproduction, with a focus on angiosperms.		**CI 1.6** Structure of Flowers	
	SO1.7 Students will be able to differentiate between different types of fruits and explain their development and dispersal mechanisms.		**CI 1.7** Types of Fruits	
	SO1.8 Students will be able to identify and describe the structure and function of plant cell organelles, including the cell membrane, nucleus, chloroplasts, and vacuoles.		**CI 1.8** Structure of Plant Cells.	
	SO1.9 Students will be able to compare and contrast prokaryotic and eukaryotic cells, emphasizing the differences in structure, organization, and genetic material.		**CI1.9** Prokaryotic and Eukaryotic Cells	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Describe in detail the history of electron microscopy (TEM).
	SW1.2 Mini Project	Describe and define light microscopes and demonstrate proper microscope usage.
	SW1.3 Other Activities (Specify)	Explain the Structure of Plant Cells.

Item	CI	LI	SW	SL	Total
Approx. Hours	9	4	1	5	19

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CIs)	Self-Learning (SL)
CO2: To demonstrate the different reproductive methods and life cycles of algae, Bryophytes, and Gymnosperms.			**Unit-2**	
	SO2.1 Students will be able to describe the basic characteristics of algae.	**LI2.1** To perform detailed observation of different types of Algae.	**CI2.1** Overview of algae; definition, general characteristics	**SL2.1** Search various reference books and other study materials to start learning the Overview of algae.
	SO2.2 Students will classify algae based on their thallus organization.	**LI2.2** To perform a transfer in Morphological Characteristics of Higher Plants	**CI2.2** Discuss the range of thallus organization in algae.	
	SO2.3 Students will differentiate between asexual and sexual reproduction in algae.		**CI2.3** Types of reproduction in algae (asexual and sexual).	**SL2.2** Gain proficiency in Morphological Characteristics of Higher Plants.

	SO2.4 Students will identify and compare various life cycles in algae.		**CI2.4** Different types of life cycles exhibited by algae.	**SL2.3** Acquire knowledge of the Different types of life cycles exhibited by algae.
	SO2.5 Students will explain the ecological roles of algae in nature.		**CI2.5** Importance of algae in ecosystems.	
	SO2.6 Students will analyze the economic significance of algae		**CI2.6** Discuss the economic uses of algae (e.g., food, biofuels, pharmaceuticals).	**SL2.4** Gain proficiency in the economic uses of algae.
	SO2.7 Students will be able to describe the basic characteristics of Bryophytes.		**CI2.7** Overview of Bryophytes; definition, general characteristics.	**SL2.5** Search various reference books and other study materials to learn the Bryophytes.
	SO2.8 Students will classify Bryophytes based on their thallus organization and morphology.		**CI2.8** Range of thallus organization and morphology in Bryophytes.	
	SO2.9 Students will identify and describe the anatomy of Bryophytes.		**CI2.9** Internal and external features of Bryophytes.	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Describe and define the Bryophytes.
	SW2.2 Mini Project	Detail study of anatomy of Bryophytes.
	SW2.3 Other Activities (Specify)	compare various life cycles in algae.

Item	CI	LI	SW	SL	Total
Approx. Hours	9	4	1	4	18

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CIs)	Self-Learning (SL)
CO3: Students will describe the stellar organization, reproduction, heterospory, and seed habit in pteridophytes, Gymnosperms, and Paleobotany.			**Unit-3**	
	SO3.1 Students will be able to describe the general characteristics of Pteridophytes.	**LI3.1** To perform detailed morphological observation of Pteridophytes.	**CI3.1** Overview of Pteridophytes; definition, general characteristics.	**SL3.1** Search various reference books and other study materials to learn about transgenesis and gene transfer methods.
	SO3.2 Students will identify and classify different morphological features of Pteridophytes.	**LI3.2** To demonstrate the Gymnosperms	**CI3.2** Study of the morphology of Pteridophytes (e.g., leaves, stems, roots).	
	SO3.3 Students will analyze the stellar organization and its significance in Pteridophytes		**CI3.3** Types of stellar organization found in Pteridophytes.	
	SO3.4 Students will compare the reproductive strategies of different Pteridophyte species.		**CI3.4** Modes of reproduction in Pteridophytes (e.g., spores, gametophyte development).	**SL3.2** Search various reference books and other study materials for reproduction in Pteridophytes
	SO3.5 Students will differentiate between homospory and heterospory, and understand the concept of seed habit in Pteridophytes.		**CI3.5** Explanation of heterospory and seed habit in Pteridophytes.	
	SO3.6 Students will evaluate the economic significance of Pteridophytes.		**CI3.6** Discuss the economic uses of Pteridophytes (e.g., ornamental plants, medicinal plants).	**SL3.3** Explore the economic uses of Pteridophytes

	SO3.7 Students will be able to describe the general characteristics and distribution of Gymnosperms.	.	**CI3.7** Overview of Gymnosperms; definition, general characteristics, and distribution.	**SL3.4** Search various reference books and other study materials for Overview of Gymnosperms
	SO3.8 Students will analyze the economic significance of Gymnosperms.		**CI3.8** Discuss the economic uses of Gymnosperms (e.g., timber, paper production, pharmaceuticals).	
	SO3.9 Students will understand the significant contributions of Indian scientists in the field of Paleobotany.		**CI3.9** Overview of India's contribution to Paleobotany (e.g., fossil discoveries, research).	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Describe the transgenesis palaeobotany
	SW3.2 Mini Project	Describe the Pteridophytes
	SW3.3 Other Activities (Specify)	Explain in detail gymnosperms.

Item	CI	LI	SW	SL	Total
Approx. Hours	9	2	1	5	17

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CIs)	Self-Learning (SL)
CO4: To understand the modes of nutrition and types of reproduction in fungi and the economic importance of fungi			**Unit-4**	
	SO4. 1 Students will gain an overview of fungal diversity and classification.	**LI4.1** To demonstrate and visualize the Fungal Cells.	**CI4.1** Define fungi and discuss their general characteristics.	**SL4.1** Search various reference books and other study materials to start learning about fungi and discuss their general characteristics
	SO4.2 Students will understand the unique composition of the fungal cell wall.		**CI4.2** Study the composition of the fungal cell wall, focusing on chitin and other polysaccharides	**SL4.2** To independently explore the composition of the fungal cell wall and focusing on chitin and other polysaccharides.
	SO4.3 Students will be able to classify fungi based on their nutritional modes.		**CI4.3** Explain the heterotrophic modes of nutrition in fungi: saprophytic, parasitic, and mutualistic.	
	SO4.4 Students will understand the different types of asexual and sexual reproduction in fungi.		**CI4.4** Explain the Types of Reproduction in Fungi.	**SL4.3** To independently Explain the Types of Reproduction in Fungi.

	SO4.5 Students will understand the various reproductive structures in fungi.		**CI4.5** Describe various fungal reproductive structures, such as spores, sporangia, and fruiting bodies, and Provide diagrams and examples of each structure.	
	SO4.6 Students will recognize the economic importance of fungi in various fields		**CI4.6** Discuss the beneficial roles of fungi in medicine, industry, and agriculture.	**SL4.4** To independently explore the beneficial roles of fungi in medicine, industry, and agriculture.
	SO4.7 students will understand the concept and significance of parasexuality in fungi		**CI4.7** discusses examples of fungi exhibiting Para sexuality.	
	SO4.8 Students will understand the concept and types of mycorrhizae.		**CI4.8** Discuss the types of mycorrhizal associations ecological and agricultural importance of mycorrhizal associations.	
	SO4.9 Students will understand the definition and unique symbiotic nature of lichens.		**CI4.9** Describe the general characteristics and structure of lichens.	**SL4.5** Search various reference books and other study materials to start learning about the general characteristics and structure of lichens.

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Describe the cultural importance of lichens
	SW4.2 Mini Project	Explain in detail to lichens based on morphology..
	SW4.3 Other Activities (Specify)	Write a one review article fungi in various fields

Item	CI	LI	SW	SL	Total
Approx. Hours	9	2	1	6	18

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CIs)	Self-Learning (SL)
CO5: To understand the overview of various types of microbes, including archaebacteria, eubacteria, cyanobacteria, mycoplasma, actinomycetes, and viruses			**Unit-5**	
	SO5.1 Students will gain an initial understanding of the diversity of microbes.	**LI5.1** To analyse the Archaebacteria	**CI5.1** Provide an overview of the different types of microbes.	**SL5.1** Search various reference books and other study materials to start the learning about overview of the different types of microbes.
	SO5.2 Students will recognize the diversity within microbial life.		**CI5.2** Briefly outlines the main categories of microbes: Archaebacteria, Eubacteria, Cyanobacteria, Mycoplasma, Actinomycetes, and Viruses.	**SL5.2** Explore the various types of Microbes.
	SO5.3 Students will understand the unique characteristics of Archaebacteria.		**CI5.3** Discuss the characteristics, habitats, and importance of Archaebacteria.	**SL5.3** Search various reference books and other study materials to start learning about the overview of the different types of microbes.

	SO5.4 Students will understand the classification and characteristics of Eubacteria.		**CI5.4** Discuss the role of Eubacteria in various ecosystems.	**SL5.4** Explore the role of Eubacteria in various ecosystems
	SO5.5 Students will understand the characteristics and significance of Cyanobacteria.		**CI5.5** Describe the characteristics, photosynthetic capabilities, and ecological importance of Cyanobacteria.	**SL5.5** Search various reference books and other study materials to start learning about the overview of the Cynobacteria.
	SO5.6 Students will understand the unique characteristics of Mycoplasma.		**CI5.6** Discuss the unique features of Mycoplasma, including their lack of a cell wall. .	
	SO5.7 Students will understand the characteristics and ecological significance of Actinomycetes. .		**CI5.7** Explain the characteristics, habitat, and importance of Actinomycetes.	
	SO5.8 Students will understand the basic structure and classification of viruses.		**CI5.8** Provide an overview of the structure and classification of viruses.	**SL5.6** Search various reference books and other study materials to start the learning the overview of the Viruses.
	SO5.9 Students will understand the reproductive strategies of viruses		**CI5.9** Explain the life cycle of viruses, including lytic and lysogenic cycles.	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Explain in detail understanding of the unit on microbes.
	SW5.2 Mini Project	Describe in the microbes in various fields.
	SW5.3 Other Activities (Specify)	One case research study structure and classification of viruses.

Course duration (in hours) to attain Course Outcomes:

Course Title: Basic Botany **Course Code:** 03BO121

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1: To Understand the structure and function of various plant organs. Students will classify and describe different types of leaves, inflorescences, flowers, and fruits..	9	4	5	1	19
CO2: To demonstrate the different reproductive methods and life cycles of algae, Bryophytes, and Gymnosperms.	9	4	5	1	19
CO3: Students will describe the stellar organization, reproduction, heterospory, and seed habit in pteridophytes, Gymnosperms, and Paleobotany.	9	4	4	1	18
CO4: To understand the modes of nutrition and types of reproduction in fungi and the economic importance of fungi	9	2	5	1	17
CO5: To understand the overview of various types of microbes, including archaebacteria, eubacteria, cyanobacteria, mycoplasma, actinomycetes, and viruses	9	2	6	1	18
Total Hours	45	16	25	05	91

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcomes:

Course Title: Basic Botany **Course Code:** 03BO121

***Legend*: R,** Remember; **U,** Understand; **A,** Apply; **A,** Analyze

Course Outcomes	**Marks Distribution**				**Total Marks**
	R	**U**	**A**	**A**	
CO1 To Understand the structure and function of various plant organs. Students will classify and describe different types of leaves, inflorescences, flowers, and fruits.	4	4	6	4	18
CO2: To demonstrate the different reproductive methods and life cycles of algae, Bryophytes, and Gymnosperms.	4	6	6	4	20
CO3: Students will describe the stellar organization, reproduction, heterospory, and seed habit in pteridophytes, Gymnosperms, and Paleobotany.	4	4	6	8	22
CO4: To understand the modes of nutrition and types of reproduction in fungi and the economic importance of fungi	4	4	6	6	20
CO5: To understand the overview of various types of microbes, including archaebacteria, eubacteria, cyanobacteria, mycoplasma, actinomycetes, and viruses	4	4	4	8	20
Total Marks	20	22	28	30	100

Suggested learning Resources:

(a) Books:

S.No.	**Title/Author/Publisher details**
1.	Oladele Ogunseitan, Microbial Diversity: Form and Function in Prokaryotes, Wiley Blackwell.2008.
2.	Pelczar, M.J et al., Microbiology, Tata McGraw-Hill Co, New Delhi, 5th edition, 2001. .
3.	Presscott, L. Harley, J. and Klein, D., Microbiology, Tata McGraw-Hill Co. New Delhi, 6thedn., 2005.
4.	Fritsch F.E., The Structure & Reproduction of Algae, Vol. 1 & Vol. II., Cambridge University Press, Cambridge, U.K. 1945.

5.	Smith, G.M., Cryptogamic Botany, Vol. I: Algae, Fungi, & Lichens, McGraw-Hill Book Co., New York, 1955.
6.	lanMorris, An Introduction to the Algae, Hutchinson, London, 1967.
7.	Parihar, N.S., An Introduction to Embryophyta: Bryophyte, Vol.I, Central Book Depot, Allahabad, 1965.
8.	Bierhorst, D.W., Morphology of Vascular Plants, The MacMillan Co.,N.Y. and Collier-MacMillan Ltd., London, 1971.
9.	Sporme, K.R., The Morphology of Gymnosperms: The Structure and Evolution of Primitive seed Plants, Hutchinson University Library, London, 1971
10.	Dutta, S.C., An introduction to Gymnosperms, Kalyani Publishers, New Delhi, 1984.
11.	Bhatnagar, S.P. andAlok Moitra, Gymnosperms, New age International (P.) Ltd., New Delhi, 2000.

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Visit to animal biotechnology lab and stem cells biology lab
7. Demonstration
8. ICT Based teaching Learning
9. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Sc. Botany

Semester: Ist Semester

Course Title: Basic Botany

Course Code: 03BO121

CO/PO/PSO Mapping															
Course Outcome (Cos)	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1: To Understand the structure and function of various plant organs. Students will classify and describe different types of leaves, inflorescences, flowers, and fruits.	3	2	-	2	2	1	-	-	1	1	2	-	2	2	2
CO2: To demonstrate the different reproductive methods and life cycles of algae, Bryophytes, and Gymnosperms.	3	3	1	2	3	1	-	-	-	2	3	1	2	2	3
CO3: Students will describe the stellar organization, reproduction, heterospory, and seed habit in pteridophytes, Gymnosperms, and Paleobotany..	2	1	1	2	2	2	-	2	-	2	1	1	3	2	1
CO4: To understand the modes of nutrition and types of reproduction in fungi and the economic importance of fungi	2	3	-	3	2	2	-	2	-	2	2	1	3	2	2
CO5: To understand the overview of various types of microbes, including archaebacteria, eubacteria, cyanobacteria, mycoplasma, actinomycetes, and viruses	3	3	-	3	2	2	2	2	1	2	2	2	3	2	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO1** To Understand the structure and function of various plant organs. Students will classify and describe different types of leaves, inflorescences, flowers, and fruits.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9	LI 1 LI 2 LI 3	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9	1SL-1,2,3,4,5
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO2:** To demonstrate the different reproductive methods and life cycles of algae, Bryophytes, and Gymnosperms.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9	LI 1 LI 2	2.1,2.2,2.3,2.4,2.5, 2.6,2.7,2.8,2.9	2SL-1,2,3,4,5
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO3:** Students will describe the stellar organization, reproduction, heterospory, and seed habit in pteridophytes, Gymnosperms, and Paleobotany..	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9	LI 1 LI 2	3.1,3.2,3.3,3.4,3.5, 3.6,3.7,3.8,3.9	3SL-1,2,3,4
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO4:** To understand the modes of nutrition and types of reproduction in fungi and the economic importance of fungi .	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8 SO4.9	LI 1 LI 2 LI 3	4.1,4.2,4.3,4.4,4.5, 4.6,4.7,4.8,4.9	4SL-1,2,3,4,5
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO5:** To understand the overview of various types of microbes, including archaebacteria, eubacteria, cyanobacteria, mycoplasma, actinomycetes, and viruses	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9	LI 1 LI 2	5.1,5.2,5.3,5.4,5.5, 5.6,5.7,5.8,5.9	5SL-1,2,3,4,5,6

Program Name	**Bachelor of Science (B.Sc.)- Biology**	
Semester	1st	
Course Code:	03ZO122	
Course title:	Animal diversity: Non chordate	**Curriculum Developer**: MR. AMIT BAGRI
Pre-requisite:	Student should have basic knowledge of Non chordate animals.	
Rationale:	• This core course will gain an overall understanding of the origin of life, diverse forms of organisms to which the taxon classified. This course will also help to provide descriptive asses about the animal architecture and function during the course of evolution and will create the awareness of the economic importance and significance of invertebrates.	
Course Outcomes (COs):	**03ZO122 .1.** Gain knowledge about importance of systematic, taxonomy, structural organization of the animals and will appreciate diversity of non-Chordates. **03ZO122 .2.** To describe unique characters of protozoa and coelenterate. **03ZO122 .3.** To recognize life functions and characters of Platyhelminthes, Nemathelminths and Annelida **03ZO122 .4.** To critically analyze organization, complexity and characteristic features of Arthropoda and Mollusca along with their significance and interactions with the environment. **03ZO122 .5.** To Learn about the importance of systematics, taxonomy and structural organization Echinodermata and hemichordate.	

Scheme of Studies:

Board of Study	**Course Code**	**Course Title**	**Scheme of studies (Hours/Week)**					**Total Credits(C) (L:T:P=3:0:1)**
			Cl	LI	SW	SL	**Total Study Hours (CI+LI+SW+SL)**	
Generic Elective	03ZO122	Animal diversity: Non chordata	3	1	1	1	6	3+1=4

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)		
Generic Elective	**03ZO122**	Animal diversity: Non chordate	**15**	**20**	**10**	**5**	**50**	**50**	**100**

Scheme of Assessment: Practical

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)		
Generic Elective	**03ZO122**	Animal diversity non chordate	35	5	5	5	50	50	50

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	06	01	05	21

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**

03ZO122. 1 Gain knowledge about importance of systematic, taxonomy, structural organization of the animals and will appreciate diversity of non-Chordates.	**SO1.1** Summarize concept of Taxonomy	1.1. Study of museum specimens and slides relevant to the invertebrates.	**Unit-1 Taxonomy, phylogeny and Protozoa** **1.1** Elementary knowledge of Zoological Nomenclature and International Code	1.1. define taxonomy
	SO1.2 classification of Animal kingdom	1.2. What are the benefits of integrating museum specimen data with other types of biological data?	**1.2**Classification of Animal Kingdom up to phylum of acoelomate and coelomate non chordates.	1.2. define ICZN and phylogeny
	SO1.3 Protozoa classification and characters	1.3 study of binomial nomenclature	**1.3** Definition and Examples	1.3. Protozoans' animals body structure and characters
	SO1.4 Define phylogeny and example		**1.4** Phylum Protozoa General character of the phylum and outline classification	1.4. Learn about protozoan diseases
	SO1.5 Plasmodium Vivax life cycle and history		**1.5** Structure, life history and pathogenicity of malarial parasite	1.5. learn about life cycle.
	SO1.6 explain the importance of zoological nomenclature?		1.6 How is the importance of zoological nomenclature?	
	SO1.7 describe the homonym in zoological nomenclature?		1.7 What is a homonym in zoological nomenclature?	
	SO1.8 explain binomial nomenclature?		1.8 What is binomial nomenclature?	
	SO1.9 explain Plasmodium vivax, and how does it cause malaria		1.9 What is Plasmodium vivax, and how does it cause malaria	

Suggested Sessional Work (SW):*anyone*	**SW1.1** Assignments	Write about the history of Phylogeny and types.
	SW1.2 Mini Project	Write about General characters and classification of protozoa.
	SW1.3 Other Activities (Specify)	Collection of explants materials and their culture initiation.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	06	01	05	21

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
03ZO122 .2. To describe unique characters of protozoa and coelenterate.	**SO2.1** define porifera phylum	2.1. locally available small non chordates and their larvae.	**Unit-2 Porifera and coelenterate** **2.1** Phylum porifera General character of the phylum and outline classification	2.1. Know about the general characters of Phylum Porifera.
	SO2.2 study of sycon	2.2. Examination of pond water study of different kinds of microscopic non chordate organism.	**2.2** Type study of sycon	2.2. learn about sycon,
	SO2.3 define canal system of Sponges		**2.3** Canal system of sponges	2.3. learn about canal system of sponges,
	SO2.4 define phylum coelenterata		**2.4** Phylum Coelenterate General character of the phylum and outline classification	2.4. Know about the general characters of Phylum coelenterate,
	SO2.5 Study of obelia		**2.5** Type study of Obelia	2.5. learn about obelia,
	SO2.6 study of coral reef formation.	2.3. What impact does water temperature, pH, and other chemical parameters have on the presence and behavior of these organisms?	**2.6** Corals and coral reef formation	
	SO2.7 explain		**2.7** How are sponges classified within Phylum Porifera?	
	SO2.8 describe sponges feed and obtain nutrients?		**2.8** How do sponges feed and obtain nutrients?	
	SO2.9 describe sponges reproduce?		**2.9** How do sponges reproduce?	

Suggested Sessional Work (SW):*anyone*		
	SW2.1 Assignments	Write about General characters and classification of porifera.
	SW2.2 Mini Project	Write about the Canal system of sponges
	SW2.3 Other Activities (Specify)	write the diagram of obelia?

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	06	01	05	21

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
03ZO122 .3. To recognize life functions and characters of Platyhelminthes, Nemathelminths and Annelida	**SO3.1** Explain the Platyhelminthes phylum	3.1. Parasitic Adaptation of any one parasite.	**Unit-3 Platyhelminthes, Nemathelminths and Annelida** **3.1 1** Phylum Platyhelminthes General character of the phylum and outline classification	3.1. Know about the general characters of Phylum Platyhelminthes
	SO3.2 define the life cycle of liver fluke	.	**3.2** External morphology and life history of liver fluke	3.2. learn about live cycle of liver fluke
	SO3.3 Explain the Nemathelminths phylum	3.2. What morphological adaptations does Plasmodium falciparum have for surviving in red blood cells?	**3.3** Phylum Nemathelminths General character of the phylum and outline classification	3.3. Know about the general characters of Phylum Nemathelminths
	SO3.4 Explain the Pathogenic symptoms of Nematodes and diseases	3.3 study of Earthworm	**3.4** Pathogenic symptoms of nematodes and diseases	3.4. learn about Pathogenic symptoms of nematodes and diseases
	SO3.5 Explain the Annelida phylum		**3.5** Phylum Annelida General character of the phylum and outline classification	3.5. Know about the general characters of Phylum Annelida
	SO3.6 define Earthworm		**3.6** type study of Earthworm	
	SO3.7 Explain the structure and significance of trochophore larva.		**3.7** structure and significance of trochophore larvae	
	SO3.8 Explain liver flukes, and which species are most commonly known?		**3.8** What are liver flukes, and which species are most commonly known?	
	SO3.9 explain the intermediate hosts in the life cycle of liver flukes?		**3.9** What are the intermediate hosts in the life cycle of liver flukes?	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Write about General characters and classification of Nemathelminths.
	SW3.2 Mini Project	Write about the Pathogenic symptoms of nematodes and diseases
	SW3.3 Other Activities (Specify)	Write the diagram of liver fluke

Item	Cl	LI	SW	SL	Total
Approx.Hrs	09	06	01	07	23

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
03ZO122 .4. To critically analyze organization, complexity and characteristic features of Arthropoda and Mollusca along with their significance and interactions with the environment.	**SO4.1** study of general characters of Arthropoda	4.1. Study about cockroach digestive system, nervous system	**Unit-4 Arthropoda and Mollusca** **4.1** Phylum Arthropoda General character of the phylum and outline classification	4.1. Read the general characters of Arthropoda
	SO4.2 study of prawn		**4.2** Type study of Prawn	4.2. study of Prawn
	SO4.3 Observing the role of crustacea larvae	4.2. Economic Importance of insects.	**4.3** Larval forms of crustacea	4.3. Understand the larval forms of crustacea
	SO4.4 Understand the various vector of human disease	4.3 study of Pila.	**4.4** Insects as a vector of human disease	4.4. learn about Insects as a vector of human disease
	SO4.5 Explain the Mollusca phylum		**4.5** Phylum Mollusca General character of the phylum and outline classification	4.5. Know about the general characters of Phylum Mollusca
	SO4.6 study of Pila		**4.6** Type study of Pila.	4.6. study of Pila.
	SO4.7 Explain the Structure and Significance of glochidium larvae		**4.7** Structure and Significance of glochidium larvae	4.7. learn about Structure and Significance of glochidium larvae.
	SO4.8 explain the exoskeleton of arthropods benefit their survival?		**4.8** How does the exoskeleton of arthropods benefit their survival?	
	SO4.9 describe the different types of appendages found in arthropods, and what functions do they serve?		**4.9** What are the different types of appendages found in arthropods, and what functions do they serve?	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Write about General characters and classification of Arthropoda
	SW4.2 Mini Project	Write about the Structure and Significance of glochidium larvae.
	SW4.3 Other Activities (Specify)	write the diagram of Prawn

Item	Cl	LI	SW	SL	Total
Approx. Hrs	10	06	01	06	23

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
03ZO122 .5. To Learn about the importance of systematics, taxonomy and structural organization Echinodermata and hemichordate	**SO5.1** Explain the Echinodermata phylum	5.1. locally available small non chordates and their larvae	**Unit-5 Echinodermata and Hemichordates** 5.1 Phylum Echinodermata General character of the phylum and outline classification	5.1. Read the general characters of Echinodermata.
	SO5.2 study about External features and water vascular System of starfish	5.2 Larval forms of Echinodermata	5.2 External features and water vascular System of starfish	5.2. learn about about External features and water vascular System of starfish
	SO5.3 Identify Larval forms of Echinodermata	5.3 Balanoglossus – External morphology	5.3 Larval forms of Echinodermata	5.3. learn about Larval forms of Echinodermata
	SO5.4 Explain the Hemi chordata phylum		5.4 Phylum Hemichordates General character of the phylum and outline classification	5.4. Read the general characters of Hemichordates
	SO5.5 Identify different External morphology of Balanoglossus.		5.5 Balanoglossus – External morphology	5.5. Study about Balanoglossus – External morphology
	SO5.6 Identify Larval forms of Tornaria larvae.		5.6 Structure and Significance of Tornaria larvae	5.6. learn about Structure and Significance of Torn aria larvae.
	SO5.7 explain the structure and function of the water vascular system in echinoderms?		5.7 What is the structure and function of the water vascular system in echinoderms?	
	SO5.8 describe the role of the calcareous endoskeleton in echinoderms?		5.8 What is the role of the calcareous endoskeleton in echinoderms?	
	SO5.9 explain the digestive adaptations of echinoderms?		5.9 What are the digestive adaptations of echinoderms?	
	SO5.10 describe echinoderms reproduce, and what are the different modes of reproduction?		5.10 How do echinoderms reproduce, and what are the different modes of reproduction?	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Write about General characters and classification of Echinodermata
	SW5.2 Mini Project	Write about the Structure and Significance of Tornaria larvae
	SW5.3 Other Activities (Specify)	Write the diagram of Balanoglossus.

Course duration (in hours) to attain Course Outcomes:

Course Title: Animal diversity: Non-Chordata **Course Code:** 03ZO122

Course Outcomes(COs)	Class lecture (CI)	Laboratory Instruction(LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li + CI + SL + SW)
03ZO122 .1. Gain knowledge about importance of systematic, taxonomy, structural organization of the animals and will appreciate diversity of non-Chordates.	09	06	1	5	21
03ZO122 .2. To describe unique characters of protozoa and coelenterate.	09	06	1	5	21
03ZO122 3. To recognize life functions and characters of Platyhelminthes, Nemathelminths and Annelida	09	06	1	5	21
03ZO122 .4. To critically analyse organization, complexity and characteristic features of Arthropoda and Mollusca along with their significance and interactions with the environment.	09	06	1	7	23
03ZO122 .5. To Learn about the importance of systematics, taxonomy and structural organization Echinodermata and hemichordate.	10	06	1	6	23
Total Hours	46	30	05	28	109

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Animal diversity: Non-Chordata **Course Code:** 03ZO122

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
03ZO122 .1. Gain knowledge about importance of systematic, taxonomy, structural organization of the animals and will appreciate diversity of non-Chordates.	3	1	1	4	09
03ZO122 .2. To describe unique characters of protozoa and coelenterate.	4	4	1	2	11
03ZO122 .3. To recognize life functions and characters of Platyhelminthes, Nemathelminths and Annelida	2	3	3	2	10
03ZO122 .4. To critically analyze organization, complexity and characteristic features of Arthropoda and Mollusca along with their significance and interactions with the environment.	2	3	3	2	10
03ZO122 .5. To Learn about the importance of systematics, taxonomy and structural organization Echinodermata and hemichordate.	2	3	3	2	10
Total Marks	**13**	**14**	**11**	**12**	**50**

***Legend*: A,** apply; **An,** analyze; **E,** evaluate; **C,** create

Suggested learning Resources:

(a) Books:

S. No.	Title/Author/Publisher details
1	Invertebrate Zoology, Ruppert and R.D. Barnes, Holt Saunders International Edition, VIII Edition 2006
2	The Invertebrates: A New Synthesis, Barnes, R.S.K., Calow, P. et al, Blackwell Science, III & 2002
3	A Textbook of Zoology, J Parker & W.A. Haswell, Low Price Publications ,Delhi VII & 1990
4	Modem Textbook of Invertebrates R. Kotpal, Rastogi Publications, Meerut, 2017

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Demonstration
7. ICT Based teaching Learning
8. Brainstorming

CO, PO and PSO Mapping

Program Name: B.Sc Biology
Semester: 1st Semester
Course Title: Animal diversity: Non chordata
Course Code: 03ZO122

CO/PO/PSO Mapping								
Course Outcome (Cos)	**Program Outcomes (POs)**					**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**
03ZO122 1. in knowledge about importance of systematic, taxonomy, structural organization of the animals and will appreciate diversity of non-Chordates.	2	2	3	2	1	2	2	3
03ZO122 2. To describe unique characters of protozoa and coelenterate.	1	1	2	2	1	2	3	3
03ZO122 3. To recognize life functions and characters of Platyhelminthes, Nemathelminths and Annelida.	2	3	1	3	2	1	1	2
03ZO122 4. To critically analyze organization, complexity and characteristic features of Arthropoda and Mollusca along with their significance and interactions with the environment.	1	2	3	3	2	2	2	2
03ZO122 .5. To Learn about the importance of systematics, taxonomy and structural organization Echinodermata and hemichordate.	2	2	3	2	2	1	2	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5 PSO 1,2,3	**03ZO122 .1.** Gain knowledge about importance of systematic, taxonomy, structural organization of the animals and will appreciate diversity of non-Chordates.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.	1.1, 1.2, 1.3,	1.1, 1.2, 1.3, 1.4, 1.5 1.6, 1.7, 1.8, 1.9	1SL-1, 2, 3, 4, 5
PO 1,2,3,4,5 PSO 1,2,3	**03ZO122 .2.** To describe unique characters of protozoa and coelenterate.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9	2.1, 2.2, 2.3	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9	2SL-1, 2, 3, 4, 5
PO 1,2,3,4,5 PSO 1,2,3	**03ZO122 .3.**To recognize life functions and characters of Platyhelminthes, Nemathelminths and Annelida	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9	3.1, 3.2, 3.3	3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9	3SL-1, 2, 3, 4, 5
PO 1,2,3,4,5 PSO 1,2,3	**03ZO122 .4.** To critically analyse organization, complexity and characteristic features of Arthropoda and Mollusca along with their significance and interactions with the environment.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6, SO4.7 SO4.8 SO4.9	4.1, 4.2, 4.3	4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9	4SL-1, 2, 3, 4, 5, 6, 7
PO 1,2,3,4,5 PSO 1,2,3	**03ZO122 .5.** To Learn about the importance of systematics, taxonomy and structural organization Echinodermata and hemichordate.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9 SO5.10	5.1, 5.2,5.3	5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10	5SL-1, 2, 3, 4, 5, 6

B.Sc. Ist Semester

Course Code : 03CH123

Course Title : Analytical Chemistry

Pre-requisite: Students must have fundamental knowledge of mathematics, valence shell electron pair repulsion theory, and different concentration terms to understand the concept of analytical chemistry.

Rationale: The students studying analytical chemistry should possess foundational understanding about basic mathematics, valence shell electron pair repulsion theory, and different concentration terms to understand the basic principle of chromatography and spectroscopic analysis.

Course Outcomes:

After the completion of this course, the learner will able to

03CH123.1: explain basic concept of straight line equation, logarithmic relation, differentiation and integration and run the software's to plot the graphs and draw the structure of different molecules.

03CH123.2: describe the presentation of experimental data and analyze the results in terms of significant figure by applying the concept of concentration terms, error, sampling, precision, accuracy

03CH123.3: explain thermodynamic derivation of law of chemical equilibrium by applying the concept of Gibbs free energy and chemical potential

03CH123.4: **d**iscuss principle of chromatography and analyze different components of a mixture quantitatively by applying chromatographic principle.

03CH123.5: discuss basic concept of spectroscopy and analyze unknown component qualitatively & quantitatively and also identify the functional groups of a molecule on the basis of their stretching and bending vibrations.

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/course.html
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
3. https://swayam.gov.in/explorer?category=Chemistry

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources

AKS University

Faculty of Basic Science

Curriculum of B. Sc.(Honours/ By Research) Program

(Revised as on 01 August 2023)

Scheme of Studies:

Board of Study	Course Code	Course Title				Scheme of studies (Hours/Week)		Total Credits I
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	**03CH123**	**Analytical Chemistry**	4	4	1	1	8	6

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop,field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback ofteacher to ensure outcome of Learning.

Scheme of Assessment: Theory

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (RA)					End Semester Assessment (ESA)	Total Marks (PRA+ESA)
			Class/Home Assignment 5 number marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each	Seminar one + Class activity	Class Attendance (AT)	Total Marks (CA+CT+SA +AT)		
DCC	**03CH123**	Analytical Chemistry	15	20	10	5	50	50	100

Course-Curriculum Detailing:
This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their

mastery of Session Outcomes (Sos), culminating in the overall achievement of Course Outcomes (Cos) upon the course's conclusion.

Unit-1 (03CH123.1): Basics of mathematics and computer for Chemists

Straight line equation, Logarithmic relations, relations, curve sketching, linear graphs & calculation of slopes. Differentiation of functions like kx, e^x, x^n, sinx, Logx, maxima & minima, Integration of some useful relevant functions Introduction to computer, Execution of linear regression x-y Plot Use of software's for drawing structures and molecular formulae.

Activity	Appx Hrs
Cl	12
LI	12
SW	2
SL	1
Total	27

Session Outcomes (SOs)	LI	CI	SL
After the completion of topics students will be able to SO1.1 understand the concept of Straight line equation and calculation of slopes SO1.2 explain logarithmic relations, relations of different functions SO1.3 discuss differentiation of important functions and calculate of maxima & minima SO1.4 discuss integration of some useful relevant functions SO1.5 discusses software's for drawing structures and molecular formulae.	Basic exercises • To introduce software's to draw structure of different compounds • Calibration of different weights and glass apparatus • To prepare solutions of different molarity/normality by weighing and dilution.	**Unit-1 (2CH101.1): Basics of mathematics and computer for Chemists** 1.1 Significance of straight line equation and its applications 1.2 Logarithmic relations 1.3 Curve sketching 1.4 linear graphs & calculation of slopes 1.5 Differentiation of functions like kx, e^x, x^n, sinx, Logx, 1.6 Differentiation of functions like sinx, Logx, 1.7 calculations of maxima & minima 1.8 Integration of some useful relevant functions 1.9 Introduction to computer and execution of linear regression x-y Plot. 1.10 Introduction to software's	• Significance of differentiation and integration • Introduction to window

		1.11 Applications of software for drawing structures and molecular formulae 1.12 Introduction to ChemDraw and Origin	

SW-1 Suggested Sessional Work (SW):
Assignments: curve sketching
Mini Project: Software's for drawing structures and molecular formulae.
Other Activities (Specify): Introduction to graph and its types in different ways to represent data

Unit-2 (03CH123.2): Basic Analytical Chemistry
Introduction to Analytical Chemistry and its interdisciplinary nature, Concept of sampling, Importance of accuracy, precision and source of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures, statistical terms: mean, mean deviation, median standard deviation, Numerical Problems.
Calculations used in Analytical Chemistry
Some Important units of measurements: SI Unit, distinction between mass and weight, mole, mill mole and numerical problems.
Solution and their concentrations: Concept of Molarity, molality, and normality. Expressing the concentration in parts per million (ppm), parts per billion (ppb), Numerical Problems.
Chemical Stoichimetry: Empirical and Molecular Formulas, Stoichemetric Calculations, Numerical Problems.

Activity	AppX Hrs
Cl	13
LI	12
SW	2
SL	1
Total	28

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
After the completion of topics students will be able to **SO2.1** restate concept of sampling, Importance of accuracy, precision and source of error in analytical measurements. **SO2.2** explain experimental data in terms of significant figure	Quantitative analysis through Titrimetric method • Standardization of NaOH with Oxalic acid. • Determination of carbonate and hydroxide present in mixture	**Unit-2 (2CH101.2): Basic Analytical Chemistry** 2.1 Introduction to Analytical Chemistry and its interdisciplinary nature 2.2 Concept of sampling 2.3 Importance of accuracy, precision 2.4 Source of error in analytical measurements. 2.5 Statistical terms: mean, mean deviation, median standard deviation	• Some Important units of measurements: SI Unit • distinction between mass and weight • mole, mill mole and numerical problems

SO2.3 discuss mathematical terms such as mean, mean deviation, median standard deviation etc **SO2.4** discuss different concentration terms and apply the same concept of to prepare solutions **SO2.5 estimate e**mpirical and molecular formulae	• Determination of carbonate and bicarbonate present in a mixture.	2.6 Solution and their concentrations 2.7 Concept of Molarity, molality, and normality. 2.8 Expressing the concentration in parts per million (ppm), parts per billion (ppb), 2.9 Numerical Problems. 2.10 Chemical Stoichimetry 2.11 Empirical and Molecular Formulae 2.12 Stoichemetric Calculations 2.13 Numerical Problems	

SW-2 Suggested Sessional Work (SW):

Assignments: Presentation of experimental data and results, from the point of view of significant figures

Mini Project:

Other Activities (Specify): Numerical Problems.

Unit-3 (03CH123.3): Chemical Equilibrium

Equilibrium constant and free energy, concept of chemical potential, Thermodynamic derivation of law of chemical equilibrium Temperature dependence of equilibrium constant: Van't Hoff reaction isochors, Van't Hoff reaction isotherm, Le-Chatelier's Principle and its applications.

Activity	AppX Hrs
Cl	11
LI	12
SW	2
SL	1
Total	26

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)

After the completion of topics students will be able to **SO3.1** explain equilibrium constant and free energy **SO3.2** discuss concept of chemical potential **SO3.3** describe thermodynamic derivation of law of chemical equilibrium **SO3.4** explain conceptually Van't Hoff reaction isochors, Van't Hoff reaction isotherm **SO3.5** describe Le-Chatelier's Principle and its applications	• To study the shift of equilibrium between ferric ions and thiocyanate ions by increasing the concentration of either of them. • Determination of free alkali present in different soaps/detergents.	**Unit-3 (2CH101.3): Chemical Equilibrium** 3.1 Introduction to equilibrium constant 3.2 Introduction to free energy 3.3 concept of chemical potential 3.4 Thermodynamic derivation of law of chemical equilibrium 3.5 Discussion of temperature dependence of equilibrium constant 3.6 Van't Hoff reaction isochors, 3.7 Van't Hoff reaction isotherm 3.8 Introduction to Le-Chatelier's Principle 3.9 Applications of Le-Chatelier's Principle 3.10 Solving numerical problems 3.11 Solving numerical problems	• Gibbs free energy • Van't Hoff factors

SW-3 Suggested Sessional Work (SW):

Assignments: Concept of chemical potential

Mini Project:

Other Activities (Specify):

Unit-4 (03CH123.4): Chromatography

Introduction, Principle and Classification Mechanism of separation: adsorption, partition and ion-exchange.
Development of Chromatograms: frontal elution and displacement methods.
Paper Chromatography (ascending, descending and circular), Thin Layer Chromatography (TLC) and Column Chromatography (CC). Gas Chromatography (GC) and High Pressure Liquid Chromatography (HPLC) types of column and column selection, applications, Limitations
Principle and Applications of:

- Flash chromatography,
- Ion-exchange chromatography and
- Chiral chromatography.
-

Activity	AppX Hrs
Cl	13
LI	12
SW	2
SL	1
Total	28

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
After the completion of topics students will be able to **SO4.1** understand basics of separation of components of a mixture **SO4.2** to discuss development of chromatograms **SO4.3** discusses principles of paper chromatography and thin layer chromatography (TLC) **SO4.4** explain column chromatography (CC) and gas chromatography (GC) **SO4.5** discuss the concept of chiral chromatography	Qualitative Analysis • Identification by determination of the Rf values of the given organic / inorganic compounds by paper/ thin layer chromatography. • Systematic identification of organic compound by qualitative analysis	**Unit-4 (2CH101.4): Chromatography** 4.1 Introduction to chromatography 4.2 Discussion of principle involved 4.3 Classification of chromatography 4.4 Mechanism of separation of components in a mixture 4.5 Development of Chromatograms: frontal elution and displacement methods 4.6 Principle of Paper Chromatography (ascending, descending and circular) and Thin Layer Chromatography (TLC) 4.7 Column Chromatography (CC) 4.8 Gas Chromatography (GC) 4.9 High Pressure Liquid Chromatography (HPLC) 4.10 Types of column involved and selection of column 4.11 Principle of Chiral chromatography 4.12 Applications of Chiral chromatography	To understand the chromatographic principle students must read about • Nature of compound (polar/non-polar)

		4.13 Principle and applications of flash chromatography	

SW-4 Suggested Sessional Work (SW)
Assignment: Chromatography (HPLC) types of column and column selection
Mini Project:
Other Activities (Specify): Mechanism of separation of components in a mixture: adsorption, partition and ion-exchange

Unit-5 (03CH123.5): Spectral techniques of analysis
Basics of absorption spectroscopy: Electromagnetic radiation, Spectral; range. Absorbance Absorptivity, Molar Absorptivity, Fundamental Laws of Absorption, Lambert-Beer Law and its limitations Constitution & working of photometer spectrometer, colorimeter.
Ultraviolet (UV) absorption spectroscopy: Presentation and analysis of UV spectra, Types of electronic transitions, effect of conjugation. Concept of chromophore and auxochrome. Bathochromic, hypsochromic, Hyper-chromic and hypo-chromic shifts. UV spectra of conjugated polyenes and enones.
Infra-red (IR) absorption spectroscopy: Molecular vibrations Hooke's law, selection rules, intensity and position of IR bands. Measurement of IR spectrum, finger print region, characteristic absorption of various functional groups and interpretation of IR spectra of simple organic compounds

Activity	AppX Hrs
Cl	11
LI	12
SW	2
SL	1
Total	26

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
After the completion of topics. students will be able to **SO5.**1 understand Basics of absorption spectroscopy **SO5.2** discuss the principle of UV-visible spectroscopy or Lambert-Beer Law and its limitations **SO5.3** apply the concept of UV-visible spectra to calculate	Quantitative Analysis by Colorimeter: • Verification of Lambert-Beer Law • Determination of concentration of colored compounds (e.g. CuSO4, KMnO4) • Verification of Lambert-Beer Law	**Unit-5 (2CH101.5): Spectral techniques of analysis** 4.1 Fundamental Laws of Absorption 4.2 Lambert-Beer Law and its limitations Constitution & working of photometer spectrometer, colorimeter. 4.3 Presentation and analysis of UV spectra 4.4 Types of electronic transitions, effect of conjugation.	Basics of absorption spectroscopy: • Electromagnetic radiation, • Spectral range • Absorbance Absorptivity, Molar Absorptivity

the λ_{max} of conjugated polyenes and enones **SO5.**4 describes Hook's law and correlates it with spectral frequency of functional groups. **SO5.5 explain principle of IR** absorption spectroscopy and measure the characteristic absorption band of various functional groups		4.5 Concept of chromophore and auxochrome. Bathochromic, hypsochromic, Hyper-chromic and hypo-chromic shifts. 4.6 UV spectra of conjugated polyenes and enones. 4.7 Infra-red (IR) absorption spectroscopy 4.8 Molecular vibrations 4.9 Hooke's law, selection rules, intensity and position of IR bands 4.10 Measurement of IR spectrum, finger print region, 4.11 characteristic absorption of various functional groups	

SW-5 Suggested Sessional Work (SW):
Assignments: UV spectra of conjugated polyenes and enones.
Mini Project:
Other Activities (Specify): Interpretation of IR spectra of simple organic compounds

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Laboratory Instruction (LI)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
03CH123.1: explain basic concept of straight line equation, logarithmic relation, differentiation and integration and run the software's to plot the graphs and draw the structure of different molecules.	12	12	02	01	27
03CH123.2: describe the presentation of experimental data and analyze the results in terms of significant figure by applying the concept of concentration terms, error, sampling, precision, accuracy	13	12	02	01	28
03CH123.3: explain thermodynamic derivation of law of chemical equilibrium by applying the concept of Gibbs free energy and chemical potential	11	12	02	01	26
03CH123.4: **d**iscuss principle of chromatography and analyze different components of a mixture quantitatively by applying chromatographic principle.	13	12	02	01	28

03CH123.5: discuss basic concept of spectroscopy and analyze unknown component qualitatively & quantitatively and also identify the functional groups of a molecule on the basis of their stretching and bending vibrations.	11	12	02	01	26
Total Hours	60	60	10	05	135

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	**Basics of mathematics and computer for Chemists**	03	01	01	05
CO-2	**Basic Analytical Chemistry**	02	06	02	10
CO-3	Chemical Equilibrium	03	04	03	10
CO-4	Chromatography	-02	08	05	15
CO-5	**Spectral techniques of analysis**	03	02	05	10
Total		13	21	16	50

Legend: R: Remember, U: Understand, A: Apply

The written examination of 50 marks will be held at the end of semester for Inorganic Chemistry

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to NCL, CSIR laboratories
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT,Blog, Facebook,Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher
1	Organic Chemistry, Sultan Chand and Sons. Delhi.	Soni PL,	Sultan Chand and Sons, . Delhi
2	Chemistry	Srivastava, S. S. Gehlot. A.S.	Ratan Prakashan Temple. Indore.
3	Inorganic Chemicals	Sing, DR, Saxena, G, Singh, B.	Shivlal Aggarwal & Company, Agra
4	Bioinorganic Chemistry	AK Das	Prentice -Hall
5	Inorganic chemistry	Gary L. Miessler	Pearson
6	Inorganic chemistry	VK Jaiswal	Shri Balaji
7	Elementary Organic Spectroscopy	Sharma Y.R.	S Chand, 2013
8	Analytical Chemistr	Gupta Alka L	Pragiti Prakashan 2020
9	Analytical Chemistry	Kaur H,	Pragatic Prakashan 2008
10	Advanced Organic Chemistry	Bahl. A. & Bahal. B.S.	S. Chand. 2010
11	Chromatography	Sharma B.K.	Krishna Prakashan, 2019

Suggested Web Sources:

1. https://celqusb.files.wordpress.com/2017/12/inorganic-chemistry-g-l-miessler-2014.pdf
2. https://www.slideshare.net/MANISHSAHU106/inert-and-labile-complexes
3. https://swayam.gov.in/explorer?category=Chemistry

Mode of Delivery: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point;

LMS/ICT Tools: Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

AKS University

Faculty of Basic Science

Curriculum of B. Sc.(Honours/ By Research) Program

(Revised as on 01 August 2023)

Course Title: Analytical Chemistry **Course Code: 03CH123**

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Knowledge	Research Aptitude	Communication	Problem Solving	Individual and Team	Investigation of	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and	The detailed	To integrate	understand, analyze,	Provide opportunitie
CO1: explain basic concept of straight line equation, logarithmic relation, differentiation and integration and run the software's to plot the graphs and draw the structure of different molecules.	**3**	**1**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**3**	**2**	**2**	**3**	**3**	**1**
CO2: describe the presentation of experimental data and analyze the results in terms of significant figure by applying the concept of concentration terms, error, sampling, precision, accuracy	**2**	**1**	**2**	**2**	**1**	**2**	**3**	**2**	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**1**
CO3: explain thermodynamic derivation of law of chemical equilibrium by applying the concept of Gibbs free energy and chemical potential	**2**	**2**	**1**	**1**	**1**	**2**	**2**	**2**	**1**	**2**	**1**	**2**	**1**	**1**	**2**	**2**
CO4: **d**iscuss principle of chromatography and analyze different components of a mixture quantitatively by applying	**2**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**2**	**3**	**3**	**3**	**3**	**2**

chromatographic principle.																
CO5: discuss basic concept of spectroscopy and analyze unknown component qualitatively & quantitatively and also identify the functional groups of a molecule on the basis of their stretching and bending vibrations.	**2**	**-**	**-**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**3**	**1**	**3**

Legend: **1–Low,** **2–Medium,** **3–High**

AKS University

Faculty of Basic Science

Curriculum of B. Sc.(Honours/ By Research) Program

(Revised as on 01 August 2023)

Course Curriculum Map:

POs &PSOsNo.	COs No. & Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1: explain basic concept of straight line equation, logarithmic relation, differentiation and integration and run the software's to plot the graphs and draw the structure of different molecules.	SO1.1 SO1.2 SO1.3SO1.4 SO1.5		Unit-1. **Basics of mathematics and computer for Chemists** 1.1,1.2,1.3,1.4,1.5,1.6,1.7	• Significance of differentiation and integration • Introduction to window
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO2: describe the presentation of experimental data and analyze the results in terms of significant figure by applying the concept of concentration terms, error, sampling, precision, accuracy	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5		Unit-2 **Basic Analytical Chemistry** 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9	• Some Important units of measurements: SI Unit • distinction between mass and weight • mole, mill mole and numerical problems

PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3: explain thermodynamic derivation of law of chemical equilibrium by applying the concept of Gibbs free energy and chemical potential	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5		Unit-3 : Chemical Equilibrium 3.1, 3.2,3.3,3.4,3.5,3.6,3.7	• Gibbs free energy • Van't Hoff factors
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO4: **d**iscuss principle of chromatography and analyze different components of a mixture quantitatively by applying chromatographic principle.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5		Unit-4 Chromatography 4.1,4.2,4.3,4.4,4.5,4.6,4.7	To understand the chromatographic principle students must read about • Nature of compound (polar/non-polar)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO5: discuss basic concept of spectroscopy and analyze unknown component qualitatively & quantitatively and also identify the functional groups of a molecule on	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5		Unit 5: **Spectral techniques of analysis** 5.1,5.2,5.3,5.4,5.5, 5.6,5.7	Basics of absorption spectroscopy: • Electromagnetic radiation, • Spectral range • AbsorbanceAbsorptivity, Molar Absorptivity

	the basis of their stretching and bending vibrations				

Curriculum Development Team:

1) Dr. Shailendra Yadav, HoD, Department of Chemistry, AKS University, Satna (M.P.).
2) Dr. Dinesh Kumar Mishra, Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
3) Dr. Samit Kumar,Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
4) Dr. Sushma Singh, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
5) Dr. Manoj Kumar Sharma, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
6) Mr. Kanha Singh Tiwari,Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
7) Mrs. Nahid Usamani, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).

ABILITY ENHANCEMENT COURSE ON SUSTAINABLE DEVELOPMENT GOALS (SDGs)
FOR B.Sc. (HONS) BIOTECHNOLOGY

Course Code: 0SDG01

Course Title : **Sustainable Development Goals (SDGs)**

Pre-requisite: Student should have basic knowledge of Environment, Natural resources, Climate change and sustainability.

Rationale: To inculcate the knowledge base on sustainable development with a view to balance our economic, environmental and social needs, allowing prosperity for now and future generations. To train students to undertake major initiatives in the efficient management of natural resources and the prevention of environmental pollution with focus on Sustainable Development.
To use environmental management tools that help to improve the quality of environment, to assess local vulnerabilities with respect to climate, natural disasters and to achieve sustainable developmental needs.

Course Outcomes:

0SDG01.1: Examine critically the 17 newly minted UN Sustainable Development Goals and understand the historical evolution, key theories, and concepts of sustainable development.

0SDG01.2: Identify and apply methods for assessing the achievement of sustainable development and discover the science, technology, economics, and politics underlying the concepts of sustainability.

0SDG01.3: Understand the implications of overuse of resources, population growth and economic growth and sustainability and explore the challenges the society faces in making transition to renewable resource use.

0SDG01.4: Develop skills to understand attitudes on individuals, society and their role regarding causes and solutions in the field of sustainable development and apply critical thinking skills to evaluate the quality, credibility and limitations of an argument for solution.

0SDG01.5: Describe the steps of the design thinking methodology and how design thinking can accelerate effective SDG implementation. Deepen knowledge and pedagogical tools to incorporate values-based education for sustainable development in educational programmes and processes.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hour (CI+LI+SW+SL)	
AEC	0SDG01	Sustainable Development Goal	2	0	1	1	4	2

Legend: **CI:** Class room Instruction (Includes different instructional strategies i.e.Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini projectetc.),
SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure out come of Learning.

Scheme of Assessment:

Theory

Board of Study	Cous e Code	Course Title	**Scheme of Assessment (Marks)**							
			Progressive Assessment (PRA)						**End Semeste r Assess ment**	**Total Marks**
			Class/Ho me Assignm ent 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Semi nar one (SA)	Class Activit y any one (CAT)	Class Attendanc e (AT)	Total Marks (CA+CT+ SA+CAT +AT)	**(ESA)**	(PRA+ ESA)
AEC	0SDG 102	Sustaina ble Develop ment Goal	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

0SDG01.1: Examine critically the 17 newly minted UN Sustainable Development Goals and understand the historical evolution, key theories, and concepts of sustainable development.

Approximate Hours

Item	AppX Hrs
Cl	06
LI	0
SW	1
SL	1
Total	**8**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
SO1.1 Understand about Sustainable Development **SO1.2** Understand the Need and Importance of SDGs **SO1.3** Understand the historical evolution of SDGs **SO1.4** Gain knowledge of SDGs Different goals and their importance **SO1.5** Explain the Challenges & strategies of attaining SDGs in countries..		**Unit-1.0 Introduction to Sustainable Development** 1.1 Need and Importance of Sustainable Development 1.2 Historical & Policy perspectives of Sustainable Development 1.3 Sustainable Development: World and India Perspective 1.4 Introduction to 17 SDGs 1.5 Specific learning objectives for different SDGs 1.6 Challenges & strategies of attaining SDGs in developed and developing nations	Different SDG goals details and its importance

SW-1 Suggested Sessional Work (SW):

a. Assignments:
Overview of SDGs, Sustainable Consumption and Production, Details of 17 SDGs

b. Other Activities (Specify):
Note down the different challenges in our state and district to achieve SDG

0SDG01.2: Identify and apply methods for assessing the achievement of sustainable development and discover the science, technology, economics, and politics underlying the concepts of sustainability and measuring.

Approximate Hours

Item	AppX Hrs
Cl	06
LI	0
SW	1
SL	1
Total	8

Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
SO2.1 Explain Sustainable Development **SO2.2** Understand the NEP-2020 and SDG **SO2.3** Discuss higher Education role to achieve SDGs **SO2.4** Explain how education for Sustainable Development **SO2.**5 Explain the measuring techniques for Sustainability .		**Unit-2.0** Special focus on SDG 4- Quality Education and Lifelong Learning: 2.1 Focus of NEP-2020 on SDG 2.2 Education for Sustainable Development (ESD): 2.3 Berlin Declaration 2021 on ESD 2.4 Integration of ESD in curriculum and textbooks 2.5 Tools, Systems, and Innovation for Sustainability 2.6 Measuring Sustainability: How do we measure sustainability	1 NEP2020 objectives and concept for SDGs 2. Concept ,Tools and techniques for measuring sustainability

SW-1 Suggested Sessional Work (SW):

c. Assignments:
Education role to achieve SDGs, The role of education in Sustainable Development , Measuring techniques of sustainability, Sustainability Indicators

d. Other Activities (Specify): Seminar and group discussion on ESD and measuring sustainability Millennium Development Goals (MDGs)

0SDG01.3: Understand the implications of overuse of resources, population growth and economic growth and sustainability and explore the challenges the society faces in making transition to renewable resource use.

Approximate Hours

Item	AppX Hrs
Cl	06
LI	0
SW	1
SL	1
Total	8

Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
SO3.1 Understand current economic issues in the context of the global sustainable development debate. **SO3.2** Outline of health, hygiene and water sanitation issues. **SO3.3** Discuss the renewable energy resources and its importance in present scenario **SO3.4** Explain the importance of sustainable production and consumption **SO3.**5 Explain the problems and solution in rural and urban areas.		**Unit-3.0 Understanding the SDGs** 3.1 Circular economy (basic model of reuse, recycle, and reduce) 3.2 Rural & urban Problems & Challenges 3.3 Sustainable production and consumption 3.4 Renewable energy 3.5 Health & Hygiene, water , sanitation & water management 3.6 Waste Management	1. Water treatment and management practices. 2. Non renewable energy resources.

SW-1 Suggested Sessional Work (SW):

Smart cities

e. Assignments:

Ecofriendly energy resources importance, types of waste and its management, Urban Problems & Challenges

Other Activities (Specify):

Visit of waste water treatment plant, Visit of water treatment process.

0SDG01.4: Develop skills to understand attitudes on individuals, society and their role regarding causes and solutions in the field of sustainable development and apply critical thinking skills to evaluate the quality, credibility and limitations of an argument for solution.

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Approximate Hours

Item	AppX Hrs
Cl	06
LI	0
SW	1
SL	1
Total	8

Session Outcomes (SOs)	Laboratory Instruction	Classroom Instruction (CI)	lf Learning (SL)

	(LI)		
SO4.1 Understand environmental sustainability is crucial in reducing the impacts of climate change **SO4.2** Discuss causes of emission of GHGs and its consequences **SO4.3** Explain how climate change and sustainable development both play a role in shaping the human and environmental factors of the world. **SO4.4** Explain the importance of sustainable production and consumption **SO4.**5 Climate change is disrupting national economies and affecting lives and livelihoods, especially for the most vulnerable and its mitigation.		**Unit-4.0 Climate Change, Energy and Sustainable Development** 4.1 The greenhouse effect: Causes and Consequences 4.2 Climate Change: A Threat to Sustainable Development 4.3 Adaptation to Current and Future Climate Regimes 4.4 The consequences: crop failure 4.5 Solutions technology and lifestyle changes 4.6 Mitigating Climate Change	**1** Agreement on Climate Change, Trade, and Sustainability Carbon Credit, carbon trading Kyoto Protocol

SW-1 Suggested Sessional Work (SW):

f. Assignments:
Urban Sustainability and Climate Change, Sustainable Development Policies, Agreement on Climate Change, Trade and Sustainability, Resilient cities – What makes a city sustainable, green, and resilient

Other Activities (Specify):

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0SDG01.5 Describe the steps of the design thinking methodology and how design thinking can accelerate effective SDG implementation. Deepen knowledge and pedagogical tools to incorporate values-based education for sustainable development in educational programmes and processes.

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Approximate Hours

Item	AppX Hrs
Cl	06
LI	0
SW	1
SL	1
Total	8

Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
SO4.1 Understand the relevance and the concept of sustainability and the global initiatives in this direction **SO4.2** Understand role of Corporations and Ecological Sustainability**.** **SO4.3** Explain role of CSR in Sustainability. **SO4.4** Understand the SD challenge for companies, their responsibility and their potentials for action **SO4.5** Discuss the role of world government for world justice and peace		**Unit-5.0 Sustainable Business Practices:** 5.1 Corporate Social Responsibility 5.2 Sustainable products and services 5.3 Business and Environment 5.4 Corporations and Ecological Sustainability 5.5 Life Cycle Assessment: • LCA Overview and Application 5.6 World peace and justice: • United nations goals for peace and justice • World Government for peace	Local to the Global: Can Sustainable Development Work

SW-1 Suggested Sessional Work (SW):

g. Assignments:
Consumption Patterns and Lifestyles, Company Perspectives for Environmental Sustainability, An Introduction to Economic Growth

Other Activities (Specify):
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Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
0SDG01.1: Examine critically the 17 newly minted UN Sustainable Development Goals and understand the historical evolution, key theories, and concepts of sustainable development.	6	1	1	8
0SDG01.2: Identify and apply methods for assessing the achievement of sustainable development and discover the science, technology, economics, and politics underlying the concepts of sustainability.	6	1	1	8
0SDG01.3: Understand the implications of overuse of resources, population growth and economic growth and sustainability and explore the challenges the society faces in making transition to renewable resource use.	6	1	1	8
0SDG01.4 Develop skills to understand attitudes on individuals, society and their role regarding causes and solutions in the field of sustainable development and apply critical thinking skills to evaluate the quality, credibility and limitations of an argument for solution.	6	1	1	8

0SDG01.5: Describe the steps of the design thinking methodology and how design thinking can accelerate effective SDG implementation. Deepen knowledge and pedagogical tools to incorporate values-based education for sustainable development in educational programmes and processes.	6	1	1	8
Total Hours	30	5	5	40

Suggestion for End Semester Assessment

Suggested Specification Table(For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Need and Importance of Sustainable Development	03	01	01	05
CO-2	Education for Sustainable Development (ESD): Tools, Systems, and Innovation for Sustainability	02	06	02	10
CO-3	Discuss the sustainable production and consumption	03	07	05	15
CO-4	How Climate Change may be Threat to Sustainable Development	-	10	05	15
CO-5	Role of Corporations and Ecological Sustainability	03	02	-	05
Total		11	26	13	50

Legend: R: Remember, U: Understand, A: Apply A: Analyse E:Evaluate C:Create

The end of semester assessment for Sustainable Development Goals will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to industry, water treatment plant
7. Demonstration
8. ICTBasedTeachingLearning(VideoDemonstration/TutorialsCBT,Blog,Facebook, Twitter,Whatsapp,Mobile,Onlinesources)
9. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	The Economics of Sustainable Development: The Case of India (Natural Resource Management and Policy)"	Surender Kumar and Shunsuke Managi	Springer Switzerland	2009
2	Corporate Social Responsibility in Developing and Emerging Markets	Onyeka Osuji	Cambridge	New Edition June 2022
3	Smart Cities for Sustainable Development	Ram Kumar Mishra, Ch Lakshmi Kumari, Sandeep Chachra, P.S. Janaki Krishna	Springer Switzerland	March 2022
4	Sustainable Development: Linking Economy, Society, Environment	Tracey Strange and Anne Bayley		
5	Management Of Resources For Sustainable Devpt	Sushma Goyal	The Orient Blackswan	2016
6	Energy, Environment and Sustainable Development: Issues and Policies	S. Ramaswamy Sathis G. Kumar	Regal Publications	2009
7	The New Map: Energy, Climate, and the Clash of Nations	Daniel Yergin	Penguin Press	September 2015
8	Contributions of Education for Sustainable Development (ESD) to Quality Education:	Laurie, R., Nonoyama-Tarumi, Y., Mckeown, R., & Hopkins, C.	A Synthesis of Research. Journal of Education for Sustainable Development, 10(2), 226–242.	2016
9	Sustainable Results in Development: Using the SDGs for Shared Results and Impact	OECD	OECD Publishing, Paris	2019
10	Development Discourse and Global History from colonialism to the sustainable development goals	Ziai, Aram	Routledge, London & New York	2016
11	Sustainable Development Goals An Indian Perspective,	Hazra, Somnath., Bhukta, Anindya	Springer Switzerland	2020
12	Environmental Ecology, Biodiversity and Climate Change	HM Saxena	Rawat Publication	January 2021
13	https://www.un.org/sustainabledevelopment/			
14	https://www.aiu.ac.in/documents/AIU_Publications/UN-SDG goals			
15	https://www.unesco.org/en/education-sustainable-development			

16	https://onlinecourses.nptel.ac.in/noc23_hs57/preview
17	ttps://www.iau-hesd.net/news/5180-berlin-declaration-education-sustainable development-adopted-unesco-esd-conference-17-19

Curriculum Development Team

Professor G C Mishra, Director Cement Technology, AKS University
Professor Kamlesh Choure, Head Dept of Biotechnology AKS University
Professor Mahendra Kumar Tiwari, Head Deptt of Environmental Science, AKS University

COs, POs and PSOs Mapping

Course Code : 0SDG01

Course Title: Sustainable Development Goals (SDGs)

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO 2	PO 3	PO4	PO5	PO 6	PO7	PO8	PO9	PO1 0	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	knowledge	Problem analysis	Design/ development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability:	Ethics	Individual and team work:	Communication:	Project management and finance:	Life-long learning	The ability to apply technical & engineering knowledge to mitigate the consequences of global warming	Ability to understand the Different SD Goals and their significance	Ability to understand the latest Technology to achieve SD	Ability to use the research based innovative knowledge for SDGs
CO1: Examine critically the 17 newly minted UN Sustainable Development Goals and understand the historical evolution, key theories, and concepts of sustainable development.	1	1	1	2	3	2	3	2	2	1	3	2	2	3	3	1

CO2: Identify and apply methods for assessing the achievement of sustainable development and discover the science, technology, economics, and politics underlying the concepts of sustainability.	**1**	**1**	**2**	**2**	**1**	**2**	**3**	**2**	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**1**
CO3: Understand the implications of overuse of resources, population growth and economic growth and sustainability and explore the challenges the society faces in making transition to renewable resource use.	**2**	**2**	**1**	**1**	**1**	**2**	**2**	**2**	**1**	**2**	**1**	**2**	**1**	**1**	**2**	**2**
CO4: Develop skills to understand attitudes on individuals, society and their role	**3**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**2**	**3**	**3**	**3**	**3**	**2**

regarding causes and solutions in the field of sustainable development and apply critical thinking skills to evaluate the quality, credibility and limitations of an argument for solution.															
CO5: Describe the steps of the design thinking methodology and how design thinking can accelerate effective SDG implementation. Deepen knowledge and pedagogical tools to incorporate values-based education for sustainable development in educational programmes and processes	**-**	**-**	**-**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**3**	**1**	**3**

Legend:1–Low,2–Medium, 3–High

Course Curriculum Map:

POs &PSOsNo.	Cos No. & Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction(CI)	Self Learning (SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**CO1:** Examine critically the 17 newly minted UN Sustainable Development Goals and understand the historical evolution, key theories, and concepts of sustainable development.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5		Unit-1.0 Introduction to Sustainable Development: 1.1,1.2,1.3,1.4,1.5,1.6,1.7,	As mentioned in page number 17to 25
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**CO2:** Identify and apply methods for assessing the achievement of sustainable development and discover the science, technology, economics, and politics underlying the concepts of sustainability.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5		Unit-2 Special focus on SDG 4-Quality Education and Lifelong Learning: 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**CO3:** Understand the implications of overuse of resources, population growth and economic growth and sustainability and explore the challenges the society faces in making transition to renewable resource use.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5		Unit-3 : Understanding the SDGs: 3.1, 3.2,3.3,3.4,3.5,3.6,3.7,3.8	

PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**CO4:** Develop skills to understand attitudes on individuals, society and their role regarding causes and solutions in the field of sustainable development and apply critical thinking skills to evaluate the quality, credibility and limitations of an argument for solution.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5		Unit-4 : Climate Change, Energy and Sustainable Development 4.1, 4.2,4.3,4.4,4.5,4.6,4.7	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**CO5:** Describe the steps of the design thinking methodology and how design thinking can accelerate effective SDG implementation. Deepen knowledge and pedagogical tools to incorporate values-based education for sustainable development in educational programmes and processes	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5		Unit 5: Sustainable Business Practices, LCA and World peace and justice 5.1,5.2,5.3,5.4,5.5,5.6	

Program Name	**Bachelor of Science B.Sc. Biology**	
Semester	I	
Course Code:	0SSD02	
Course title:	English Language	**Curriculum Developer**: Mr. Dhirendra Mishra, Teaching Associate
Pre-requisite:	Students should have basic knowledge of Communication Skills	
Rationale:	Communication today is very important both in the business world and in private life. Successful communication helps us better understand people and situations. It helps us overcome diversities, build trust and respect, and create conditions for sharing creative ideas and solving problems.	
Course Outcomes (COs):	**CO1-0SSD02.1:** To enhance the Speaking Skills of the students in such a way where they will be able to communicate effectively with immense self confidence in themselves **CO2-0SSD02.2:** To develop the leadership skills, public speaking skills and social skills in students along with the basic knowledge of how to make an impressive Resume. **CO3-0SSD02.3:** To improve the presentation skills of the students that plays a pivotal role in building and shaping the career of the students **CO4-0SSD02.4:** To focus on improving the fundamental grammar of the students in order to bring accuracy while speaking and writing. **CO5-0SSD02.5:** To make them aware of the Indian Culture and English Language by imbibing the dramas and poetry of some famous Indian English Writers	

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits(C) (L:T:P=2:0:0)
			Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
AEC	0SSD02	English Language	2	0	1	3	6	2

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)		
AEC	0SSD02	English Language	15	20	10	5	50	50	100

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	08	00	01	05	14

Course outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction(CI)	Self-Learning(SL)
CO1-0SSD02.1: To enhance the Speaking Skills of the students in such a way where they will be able to communicate effectively with immense self confidence in themselves	**SO1.1** Anytime we're trying to get people to think of us a certain way, it's an act of self presentation. Generally speaking, we work to present ourselves as favorably as possible		**Unit 1** **Self Grooming, Basic Etiquettes and Presentation Skills** **CI1.1** Self Introduction	**SL1.1** The Role of Education in Life, The Importance of English in Today's World
	SO1.2 Generally, oral presentation is public speaking, either individually or as a group, the aim of which is to providing information entertain, persuade the audience, or educate		**CI 1.2** Oral Presentation	**SL1.2** Dressing and Grooming Etiquettes (Male and Female)
	SO1.3 Understands the role of education in life by oral presentation		**CI 1.3** The Role of Education in Life,	
	SO1.4 Understands the importance of English in today's life by oral presentation		**CI 1.4** The Importance of English in Today's World and Necessity of Uniform in a College	
	SO1.5 Be a professionally refined person. Project a confident image by being well groomed. Building up a good self-image.		**CI 1.5** Dressing and Grooming Etiquettes	**SL1.3** Importance of Body Language **(**Gesture, Posture, Facial Expressions & Sign Language, etc.)
	SO1.6 The most effective communication occurs when the importance of body language in teaching is acknowledged. When these nonverbal cues are in sync with our verbal ones, it creates communication synergy.		**CI1.6** Importance of Body Language	**SL1.4** Role Plays (Hospital Scene, Interaction in the Classroom and Travelling by Train).
	SO1.7 Role play has helped 'enhance active listening skills, social problem solving skills and demonstration of emotional empathy'"		**CI1.7** Role Plays.	**SL1.5** Students will self practice to improve their Interviews skills.
	SO1.8 Getting insight into the candidate's rational knowledge, quick thinking, communication skills and creativity. Verifying if a candidate is a right fit for the company culture and work ethic		**CI1.8** Interviews and their Kinds	

Suggested Sessional Work (SW):*anyone*	**SW1.1** Assignments	Make practice on self introduction
	SW1.2 Mini Project	Write some role play to improve speaking skills and developing self confidence
	SW1.3 Other Activities (Specify)	Attend some publics and socials activities or program to improve self confidence

Item	Cl	LI	SW	SL	Total
Approx.Hrs	06	00	01	03	10

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
CO2-0SSD02.2: To develop the leadership skills, public speaking skills and social skills in students along with the basic knowledge of how to make an impressive Resume.	**SO2.1** Skill development: It helps individuals develop important skills such as communication, critical thinking, problem-solving, and collaboration.		**Unit-II** **Confidence Building Skills and Interview Skills**. **CI2.1** Group Discussion. Impact of Covid-19 on mental health,	**SL2.1** Read the Group Discussion steps and process(Impact of Covid-19 on mental health
	SO2.2 Understand The Impact of Social Media on Our Lives.		**CI2.2** The Impact of Social Media on Our Lives and The Pros and Cons of Technology	
	SO2.3 Know the process and kinds of interviews.		**CI2.3** Interviews and their Kinds	**SL2.2** Read the question which mostly asks during an interview?
	SO2.4 Understand about Debate and their importance.		**CI2.4** Debate (Should the Use of Plastic Be Banned?,	.**SL2.3** Debate students will self practice to improve their skills.
	SO2.5 Know the importance of career.		**CI2.5** Should Parents Decide Which Career Their Children Will Pursue?	
	SO2.6 Understand about Artificial Intelligence Useful or Dangerous?		**CI2.6** Is Artificial Intelligence Useful or Dangerous?	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Write steps of interview.
	SW2.2 Mini Project	Write the steppes of Group Discussion
	SW2.3 Other Activities (Specify)	Some class activities for improvement of team work.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	07	00	01	03	11

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self-Learning(SL)
CO3-0SSD02.3: To improve the presentation skills of the students that plays a pivotal role in building and shaping the career of the students	**SO3.1** Speech/ Anchoring (Occasional Speech, Valedictory Speech, Patriotic Speech),.		**Unit-III** **Public Speaking Skills and Conversational Skills.** **CI 3.1** Speech/ Anchoring	**SL3.1** Take chance for Speech and Anchoring to improve public speaking skills.
	SO3.2 The students will identify words and/or phrases related to the topic. The students will draw inferences relying on the context. The students will express themselves fluently. The students will express themselves with acceptable accuracy		**CI 3.2** Occasional Speech	**SL3.2** Pros and Cons of Online teaching
	SO3.3 The students will identify words and/or phrases related to the topic. The students will draw inferences relying on the context. The students will express themselves fluently. The students will express themselves with acceptable accuracy		**CI 3.3** Valedictory Speech	**SL3.3** Conversational Topics (Inquiry at bank, Airport, Station and Hospitals).
	SO3.4 The students will identify words and/or phrases related to the topic. The students will draw inferences relying on the context. The students will express themselves fluently. The students will express themselves with acceptable accuracy		**CI 3.4** Patriotic Speech	
	SO3.5 Extemporaneous speech has many benefits for both the speaker and the audience For The Speaker.		**CI 3.5** Extempore	
	SO3.6 Understands the pros and cons of online teaching.		**CI 3.6** Pros and Cons of Online teaching,	
	SO3.7 Understands the Environment Conservation and Education of a Girl Child		**CI3.7** Environment Conservation and Education of a Girl Child	

Suggested Sessional Work (SW): *anyone*		
	SW3.1 Assignments	Write key features of Anchoring
	SW3.2 Mini Project	Inquiry at bank.
	SW3.3 Other Activities (Specify)	Occasional Speech

Item	Cl	LI	SW	SL	Total
Approx.Hrs	06	00	01	02	9

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Classroom Instruction(CI)	Self-Learning(SL)
0SSD02CO4: To focus on improving the fundamental grammar of the students in order to bring accuracy while speaking and writing.	**SO4.1** **Prepositions (**Place, Time and Direction),		**Unit-IV** **Functional Grammar and Vocabulary Building:** **CI4.1** 1Prepositions	**SL4.1** Learn about appropriate use of preposition
	SO4.2 Understand the uses of present tense.		**CI4.2** Tenses (Present tense)	**SL4.2** Learn tenses and their use
	SO4.3 Understand the uses of present tense.		**CI4.13** Tenses (Past tense)	
	SO4.4 Understand the uses of present tense.		**CI4.4** Tenses (Future tense)	
	SO4.5 Know the uses of active voice		**CI4.5** Voice (Active - Passive voice)	
	SO4.6 Know the uses of Passive voice.		**CI4.6** Modals	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Write structure of Tense.
	SW4.2 Mini Project	Write the uses of Prepositions **(**Place, Time and Direction),
	SW1.3 Other Activities (Specify)	Uses of tense

Item	Cl	LI	SW	SL	Total
Approx.Hrs	03	00	01	03	7

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Classroom Instruction(CI)	Self-Learning(SL)
CO5-0SSD02.5: To make them aware of the Indian Culture and English Language by imbibing the dramas and poetry of some famous Indian English Writers	**SO5.1** The Axe- R.K. Narayan to know the importance and values of trees.		**Unit-V Indian Writing in English & Hindi** **CI5.1** The Axe- R.K. Narayan	**SL5.1** Read the story Axe
	SO5.2 By reading The Night of the Scorpion- Nissim Ezekiel,the student will understand the Indian culture and English language.		**CI5.2** The Night of the Scorpion- Nissim Ezekiel	**SL5.2** Read the lession the night of the scorpion.
	SO5.3 The Portrait of a Lady - Khushwant Singh.		**CI5.3** The Portrait of a Lady - Khushwant Singh	**SL5.3** Learn about khushwant singh.

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Write about R.K.Narayan
	SW5.2 Mini Project	Make a list of Indian Dramas.
	SW5.3 Other Activities (Specify)	Find out some you tube videos based on Indian poet.

Course duration (in hours) to attain Course Outcomes:

Course Title: English Language **Course Code: 0SSD02**

Course Outcomes(COs)	Class lecture (CI)	Laboratory Instruction(LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1-0SSD02.1: To enhance the Speaking Skills of the students in such a way where they will be able to communicate effectively with immense self confidence in themselves	8	0	5	1	14
CO2-0SSD02.2: To develop the leadership skills, public speaking skills and social skills in students along with the basic knowledge of how to make an impressive Resume.	6	0	3	1	10
CO3-0SSD02.3: To improve the presentation skills of the students that plays a pivotal role in building and shaping the career of the students	7	0	3	1	11
CO4-0SSD02.4: To focus on improving the fundamental grammar of the students in order to bring accuracy while speaking and writing.	6	0	2	1	9
CO5-0SSD02.5: To make them aware of the Indian Culture and English Language by imbibing the dramas and poetry of some famous Indian English Writers	3	0	3	1	7
Total Hours	30	00	16	05	51

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Communication Skills **Course Code: 0SSD02**

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
CO1-0SSD02.1: To enhance the Speaking Skills of the students in such a way where they will be able to communicate effectively with immense self confidence in themselves	2	1	1	1	5
CO2-0SSD02.2: To develop the leadership skills, public speaking skills and social skills in students along with the basic knowledge of how to make an impressive Resume.	2	4	2	2	10
CO3-0SSD02.3: To improve the presentation skills of the students that plays a pivotal role in building and shaping the career of the students	3	5	5	2	15
CO4-0SSD02.4: To focus on improving the fundamental grammar of the students in order to bring accuracy while speaking and writing.	2	3	3	2	10
CO5-0SSD02.5: To make them aware of the Indian Culture and English Language by imbibing the dramas and poetry of some famous Indian English Writers	5	4	1	0	10
Total Marks	**14**	**17**	**12**	**07**	**50**

***Legend*: A,** Apply; **An,** Analyze; **E,** Evaluate; **C,** Create

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1	Dr. Meenu Pandey: Communication Skills, NiraliPraksahan.
2	Dr. Neeta Sharma: Communication Skills, Satya Prakashan.
3	A. J. Thomson & A. V. Martinet: A Practical English Grammar, Oxford University Press..
4	K.P. Thakur: A Practical Guide to English Grammar, Bharti Bhawan Publishers & Distributors
5	Wilfred Funk: Six Weeks to Words of Power, W.R. Goyal Publishers and Distributors.
6	Grant Taylor: English Conversation Practise, Tata McGraw Hill Education Private Limited.

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Industrial Visit.
7. Demonstration
8. ICT Based teaching Learning
9. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Sc Biology
Semester:I Semester
Course Title: English Language
Course Code: 0SSD02

CO/PO/PSO Mapping								
Course Outcome (Cos)	**Program Outcomes (POs)**					**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**
CO1-0SSD02.1: To enhance the Speaking Skills of the students in such a way where they will be able to communicate effectively with immense self confidence in themselves	2	-	-	1	2	2	2	1
CO2-0SSD02.2: To develop the leadership skills, public speaking skills and social skills in students along with the basic knowledge of how to make an impressive Resume.	-	-	-	-	-	1	1	2
CO3-0SSD02.3: To improve the presentation skills of the students that plays a pivotal role in building and shaping the career of the students	-	1	1	1	-	1	1	1
CO4-0SSD02.4: To focus on improving the fundamental grammar of the students in order to bring accuracy while speaking and writing.	-	1	1	-	2	1	1	3
CO5-0SSD02.5: To make them aware of the Indian Culture and English Language by imbibing the dramas and poetry of some famous Indian English Writers	1	1	1	-	-	1	3	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5 PSO 1,2,3	**CO1-0SSD02.1:** To enhance the Speaking Skills of the students in such a way where they will be able to communicate effectively with immense self confidence in themselves	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8		1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8	**1SL-1,2,3**
PO 1,2,3,4,5 PSO 1,2,3	**CO2-0SSD02.2:** To develop the leadership skills, public speaking skills and social skills in students along with the basic knowledge of how to make an impressive Resume.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6		2.1, 2.2, 2.3, 2.4, 2.5, 2.6,	**2SL-1,2,3**
PO 1,2,3,4,5 PSO 1,2,3	**CO3-0SSD02.3:** To improve the presentation skills of the students that plays a pivotal role in building and shaping the career of the students	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7		3.1,3.2,3.3,3.4,3.5 3.6,3.7	**3SL-1,2,3**
PO 1,2,3,4,5 PSO 1,2,3	**CO4-0SSD02.4:** To focus on improving the fundamental grammar of the students in order to bring accuracy while speaking and writing.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6		4.1,4.2,4.3,4.4,4.5 4.6,	**4SL-1,2**
PO 1,2,3,4,5 PSO 1,2,3	**CO5-0SSD02.5:** To make them aware of the Indian Culture and English Language by imbibing the dramas and poetry of some famous Indian English Writers	SO5.1 SO5.2 SO5.3		5.1,5.2,5.3,	**5SL-1,2,3**

Program name	Bachelor of Science (B. Sc.)- Botany	
Semester	2nd Se	
Course Code:	01BO201	
Course title:	Applied Botany	**Curriculum Developer**: Nitin Singh Parihar, Lab Assistant
Pre-requisite:	Students should have basic knowledge of Applied Botany	
Rationale:	Applied botany addresses contemporary challenges such as food security, environmental conservation, and sustainable agriculture. Applied botany is pivotal in advancing societal well-being and ecological balance by studying plant biology and this knowledge to improve crop yields, develop medicines, and mitigate climate change effects.	
Course Outcomes (COs):	**CO1:** To Understand plant functions and apply knowledge to improve crop yield. **CO2**: To demonstrate the impact of pollutants on the environment and human health. **CO3**: To understand ancient and modern agricultural practices. **CO4**: To understand the role of botany in rural development, appreciate the significance of ethnobotany, and recognize ethnomedicinal plants. **CO5**: To understand plant tissue culture, DNA recombinant techniques, the role of recombination, and the significance of bioinformatics in modern plant sciences.	

Scheme of Studies:

Board of Study	CourseCode	Course Title	Scheme of studies (Hours/Week)					Total Credits(C) (L:T:P=3:0:1)
			CI	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Major	01BO201	Applied Botany	4	2	1	2	9	4+0+2=6

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
Major	01BO201	Applied Botany	**15**	**20**	**5**	**5**	**5**	**50**	**50**	**100**

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	12	6	1	5	24

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CIs)	Self-Learning (SL)
CO1 To Understand plant functions and apply knowledge to improve crop yield.			**Unit-1**	
	SO1.1 Students will understand applied botany's definition, scope, and significance.	**LI1.1** Demonstrations of some plant products.	**CI1.1** Introduce students to the field of applied botany and its relevance.	**SL1.1** Search various reference books and other study materials to start learning Botany.
	SO1.2.Students will be able to list and explain the main objectives of applied botany.	**LI1.2** To understand and explore the various applications of botany in enhancing human welfare, focusing on medicinal plants	**CI1.2** Explore the primary objectives of applied botany in scientific research and practical applications.	**SL1.2** Explore the primary objectives of applied botany in scientific research and practical applications.
	SO1.3. Students will identify and explain various ways applied botany impacts everyday life.	**LI1.3** Understand how different cultures around the world use plants.	**CI1.3** Discuss the practical importance of applied botany in agriculture, medicine, and industry.	**SL1.3** Learn about the practical importance of applied botany in agriculture, medicine, and industry.
	SO1.4 Students will describe key historical milestones in the early development of botany.		**CI1.4** Review the early history of botany, including ancient plant studies and herbal medicine.	**SL1.4** Explore the historical evolution and recent advancements in applied botany.

	SO1.5 Students will outline major developments in botany from the Renaissance to the present.		**CI1.5** Understand the evolution of botany into modern science, including significant discoveries and advancements.	**SL1.5** Acquire knowledge about the evolution of botany into modern science, including significant discoveries and advancements.
	SO1.6 Students will explain the various ways plants benefit humans and vice versa.		**CI1.6** Various disciplines of botany and their applications to human welfare	
	SO1.7 Students will identify key ecosystem services provided by plants and their importance to the environment.		**CI1.7** Examine the role of plants in providing ecosystem services such as oxygen production, carbon sequestration, and habitat.	
	SO1.8 Students will understand the principles of plant taxonomy and the classification of plant species.		**CI1.8** Introduce the sub-discipline of taxonomy and systematics and its importance in plant classification.	
	SO1.9 Students will explain basic physiological processes in plants and their importance to plant life.		**CI1.9** Explore plant physiology, including plant growth, photosynthesis, and respiration.	
	SO1.10 Students will identify common plant diseases and discuss methods for their prevention and control**.**		**CI1.10** Understand plant pathology, including the study of plant diseases and their management.	
	SO1.11 Students will analyze plants' economic and cultural significance in various societies.		**CI1.11** Explore economic botany and ethnobotany, focusing on the use of plants in different cultures and economies.	

	SO1.12 Students will evaluate the contributions of botany to human welfare and future potential applications.		**CI1.12** Discuss various applications of botany in biotechnology, agriculture, environmental science, and medicine.	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Describe in detail the history of applied botany.
	SW1.2 Mini Project	Describe and define the botanical methods.
	SW1.3 Other Activities (Specify)	Explain the process of media preparation and sterilization.

Item	CI	LI	SW	SL	Total
Approx. Hours	12	6	1	4	23

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CIs)	Self-Learning (SL)
CO2: To demonstrate the impact of pollutants on the environment and human health.			**Unit-2**	
	SO2.1 Students will be able to define pollution and articulate its significance in environmental science.	**LI2.1** Detection of primary pollutant on the surface of leafe	**CI2.1** Discuss the concept of pollution, including its sources and impacts on the environment and human health..	**SL2.1** Search various reference books and other study materials to start learning about pollution and pollutants
	SO2.2 Students will identify and classify different types of pollution and their specific examples.	**LI2.2** To identify the Air, water, soil, noise, and thermal pollution.	**CI2.2** Explore different types of pollution: air, water, soil, noise, and thermal. Include specific examples and their causes.	**SL2.2** Acquire knowledge of the types of pollution and pollutants.
	SO2.3 Students will distinguish between various types of pollutants and understand their sources..	**LI2.3** To isolate and identify bacteria from contaminated soil samples that can degrade	**CI2.3** Define pollutants, categorizing them into primary and secondary, and differentiate between organic and inorganic pollutants..	

		hydrocarbons (like oil or petroleum).		
	SO2.4 Students will define phytoremediation and understand its significance in reducing environmental pollution.		**CI2.4** Define phytoremediation and explain its role in environmental cleanup, emphasizing its eco-friendly nature.	**SL2.3** Acquire knowledge of Phytoremediation.
	SO2.5 Students will identify specific plants used in phytoremediation for air and water pollution.		**CI2.5** Discuss plants like *Chrysopogon zizanioides* (Vetiver, Poaceae) and *Ficus benjamina* (Weeping Fig, Moraceae), detailing their ability to purify air..	**SL2.4** Acquire knowledge Study Any 5 plants with botanical name, family, and their role in pollution control.
	SO2.6 Students will understand the role of certain plants in soil decontamination and mitigation of noise and thermal pollution.		**CI2.6** Cover plants such as *Eichhornia crassipes* (Water Hyacinth, Pontederiaceae) and *Typha latifolia* (Cattail, Typhaceae) that are effective in water purification.	
	SO2.7 Describe the use of dense plantings like *Quercus suber* (Cork Oak, Fagaceae) for noise reduction and *Aloe vera* (Aloe, Asphodelaceae) for cooling environments..		**CI2.7** Explain the use of dense plantings like *Quercus suber* (Cork Oak, Fagaceae) for noise reduction and *Aloe vera* (Aloe, Asphodelaceae) for cooling environments..	
	SO2.8 Students will define bioremediation and explain its biological basis.		**CI2.8** Define bioremediation, emphasizing its biological approach to pollution control using microorganisms.	
	SO2.9 Students will understand the role of microorganisms in		**CI2.9** Highlight the role of bacteria, fungi, and other microorganisms in breaking down pollutants.	

	bioremediation and identify key organisms involved.			
	SO2.10 Students will analyze real-world applications and case studies, illustrating the effectiveness of bioremediation.		**CI2.10** Review real-world examples and case studies where bioremediation has been successfully applied.	
	SO2.11 Revision and review		**CI2.11** Revision and review	
	SO2.12 Evaluation		**CI2.12** Evaluation	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Describe and define the air pollutants.
	SW2.2 Mini Project	Detail of the bioremediation.
	SW2.3 Other Activities (Specify)	Study one review article on phytoremediation

Item	CI	LI	SW	SL	Total
Approx. Hours	12	6	1	4	23

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CIs)	Self-Learning (SL)
CO3: To understand ancient and modern agricultural practices			**Unit-3**	
	SO3.1 Explain in detail the introduction to ancient agricultural practices.	**LI3.1** To demonstrate the Playhouse	**CI3.1** Brief details the introduction of ancient agricultural practices.	**SL3.1** Search various reference books and other study materials to learn about ancient agricultural practices.
	SO3.2 Explain in detail the Modern agriculture practices.	**LI3.2** To demonstrate the Hydroponics	**CI3.2** Brief details the introduction of Modern agriculture practices.	**SL3.2** Explore the different methods of Modern agriculture practices.

	SO3.3 Explain in detail the Playhouse. Drip irrigation, hydroponics, computer-based agriculture	**LI3.3** To study the methods of vegetative propagation of horticultural plants through stem cuttings.	**CI3.3** Study about the Playhouse, Drip irrigation, hydroponics, computer-based agriculture	
	SO3.4 Explain in detail the Organic farming		**CI3.4** Brief details of the introduction of Organic farming.	**SL3.3** Explore the different methods of Organic farming.
	SO3.5 Explain the objective and technique of Organic farming.		**CI3.5** Brief study of the objective and technique of Organic farming.	
	SO3.6 Explain in detail Horticulture's role in our welfare.		**CI3.6** Brief detail of Horticulture's role in human welfare.	**SL3.4** Explore the different methods of Horticulture
	SO3.7 Explain in detail about the Forestry.		**CI3.7** Detail study about Forestry.	
	SO3.8 Explain in detail the study about branches of Forestry and their role in our welfare.		**CI3.8** To study branches of Forestry and their role in human welfare.	
	SO3.9 Explain in detail the Forestry.		**CI3.9** Detail study about the definition of Forestry. Forestry management practices.	
	SO3.10 Students will understand the role of Forestry management practices.		**CI3.10** To study Forestry management practices.	
	SO3.11 Revision and review		**CI3.11** Revision and review	
	SO3.12 Evaluation		**CI3.12** Evaluation	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Describe the forestry
	SW3.2 Mini Project	Describe the organic farming.
	SW3.3 Other Activities (Specify)	Explain in detail ancient agriculture

Item	CI	LI	SW	SL	Total
Approx. Hours	12	6	1	6	25

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CIs)	Self-Learning (SL)
CO4: To understand the role of botany in rural development, appreciate the significance of ethnobotany, and recognize ethnomedicinal plants.			**Unit-4**	
	SO4.1 Students will understand the basic concepts of botany and its significance in enhancing rural livelihoods. .	**LI4.1** To demonstrate the principles and procedures of Ethnomedicine.	**CI4.1** Overview of botany and its applications in agriculture, forestry, and rural economies.	**SL4.1** Search various reference books and other study materials to learn about the Role of Botany in Rural Development.
	SO4.2 Students will be able to define ethnobotany and explain its importance in cultural and ecological contexts.	**LI4.2** To introduce students to the techniques of traditional medicine systems	**CI4.2** Introduction to ethnobotany, its scope, and the relationship between people and plants.	**SL4.2** To independently explore the principles and techniques of Ethnobotany..
	SO4.3 Students will understand the concept of ethnomedicine and identify its relevance in modern healthcare.	**LI4.3** To observe and describe the external morphology of *Emblica* leaves and stem.	**CI4.3** Definition of ethnomedicine, its significance, and examples from traditional medicine systems.	**SL4.3** To independently explore the examples of Ethnomedicine.

	SO4.4 Students will gain knowledge about the medicinal properties and uses of Neem and Aloe in traditional and modern medicine.		**CI4.4** Detailed study of Neem (Azadirachta indica) and Aloe (Aloe vera), including local and botanical names, family, and uses.	
	SO4.5 Students will learn about the importance and applications of Clove and Ginger in ethnomedicine.		**CI4.5** Detailed study of Clove (Syzygium aromaticum) and Ginger (Zingiber officinale), including local and botanical names, family, and uses.	
	SO4.6 Students will understand the medicinal significance of Tulsi, Turmeric, and Giloy.		**CI4.6** Examination of Tulsi (Ocimum tenuiflorum), Turmeric (Curcuma longa), and Giloy (Tinospora cordifolia), including local and botanical names, family, and uses.	**SL4.5** To independently explore Examination of Tulsi (Ocimum tenuiflorum), Turmeric (Curcuma longa), and Giloy (Tinospora cordifolia), including local and botanical names, family, and uses.
	SO4.7 Students will identify the uses and benefits of Emblica, Ashwagandha, and Arandi in traditional medicine.		**CI4.7** Study of Emblica (Phyllanthus emblica), Ashwagandha (Withania somnifera), and Arandi (Ricinus communis), including local and botanical names, family, and uses.	**SL4.6**Search various reference books and other study materials to learn about the Importance of Emblica (Phyllanthus emblica), Ashwagandha (Withania somnifera), and Arandi (Ricinus communis), including local and botanical names, family, and uses.
	SO4.8 Students will be able to define ethno-fibres and understand their significance in rural economies.		**CI4.8** Definition and importance of ethno-fibres, focusing on cultural and economic aspects.	

	SO4.9 Students will understand the uses and importance of Jute, Coconut, and Elephant Grass in rural livelihoods.		**CI4.9** Study of Jute (Corchorus spp.), Coconut (Cocos nucifera), and Elephant Grass (Pennisetum purpureum), including local and botanical names, family, and uses.	
	SO4.10 Students will define ethno-food crops and recognize their importance in nutrition and culture.		**CI4.10** Definition and overview of ethno-food crops, their role in food security, and cultural significance**.**	
	SO4.11 Students will learn about the nutritional and cultural value of these ethno-food crops.		**CI4.11** Detailed study of Garadu (Pueraria tuberosa), Singada (Trapa natans), Kutaki (Picrorhiza kurroa), and Sama (Echinochloa spp.), including local and botanical names, family, and uses.	
	SO4.12 Revision and review		**CI4.12** Revision and review	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Describe the animal cloning and its applications.
	SW4.2 Mini Project	Explain in detail to stem cells technology and their applications.
	SW4.3 Other Activities (Specify)	Write a one review article on artificial insemination in animal cells.

Item	CI	LI	SW	SL	Total
Approx. Hours	12	6	1	7	26

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CIs)	Self-Learning (SL)
CO5: To understand plant tissue culture, DNA recombinant techniques, the role of recombination, and the significance of bioinformatics in modern plant sciences.			**Unit-5**	
	SO5.1 Explain in detail the introduction to Plant tissue culture.	**LI5.1** To prepare media used in Plant tissue culture	**CI5.1** Brief in detail Definition of Plant tissue culture.	**SL5.1** Search various reference books and other study materials about Plant tissue culture.
	SO5.2 Explain in detail the types of Plant Tissue Culture.	**LI5.2** To perform the DNA Extraction technique.	**CI5.2** Study the types of Plant Tissue Culture.	
	SO5.3 Explain in detail the Importance of Plant Tissue Culture	**LI5.3** Demonstrate how to use Bioinformatics tools.	**CI5.3** Study the Importance of Plant Tissue Culture	
	SO5.4 Explain in detail the Introduction of the Recombinant DNA technique.		**CI5.4** Detail explanation Introduction of Recombinant DNA technique.	**SL5.2** Explore the Various sources to know about Plant Tissue Culture.
	SO5.5 Explain in detail human genetic engineering.		**CI5.5** To Study tools and the importance of Recombinant DNA Technology.	**SL5.3** Search various reference study materials for learning Recombinant DNA Technology.
	SO5.6 Describe and define the gene therapy for genetic disorders.		**CI5.6** Discuss the Role of recombination in the present era	
	SO5.7 Explain in detail the gene therapy for cancer.		**CI5.7** Brief detail introduction of Bioinformatics.	**SL5.4** Explore the Bioinformatics techniques.

	SO5.8 Discuss the ethical issues in genetic modification.		**CI5.8** Discuss the concepts of Bioinformatics.	
	SO5.9 Discuss the regulatory frameworks and future directions towards genetic modification and gene therapy.		**CI5.9** To Study Tools Use in Bioinformatics.	**SL5.5** Search various reference books and other study materials about Plant tissue culture.
	SO5.10 Explain in detail the bioinformatics software		**CI5.10** To Study Brief detailed introduction of bioinformatics software.	**SL5.6** Search various reference books and other study materials about Plant tissue culture.
	SO5.11 Discuss the GFBLAST and ASTA Importance of bioinformatics		**CI5.11** To Study to Basic idea GFBLAST and ASTA Importance of bioinformatics	**SL5.7**Search various reference books and other study materials about Plant tissue culture.
	SO5.12 Explain in detail the Keywords/Tags: Applied Botany, History of Botany evolution of Botany.		**CI5.12** Discuss the detail explanation Keywords/Tags: Applied Botany, History of Botany evolution of Botany.	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Explain in detail genetic modifications in medicine.
	SW5.2 Mini Project	Describe in detail the gene therapy.
	SW5.3 Other Activities (Specify)	One case research study on gene therapy for genetic disorder.

Course duration (in hours) to attain Course Outcomes:

Course Title: Applied Botany **Course Code: 01BO201**

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1: To Understand plant functions and apply knowledge to improve crop yield.	12	6	5	1	24
CO2: To demonstrate the impact of pollutants on the environment and human health.	12	6	4	1	23
CO3: To understand ancient and modern agricultural practices.	12	6	4	1	23
CO4: To understand the role of botany in rural development, appreciate the significance of ethnobotany, and recognize ethnomedicinal plants.	12	6	6	1	25
CO5: To understand plant tissue culture, DNA recombinant techniques, the role of recombination, and the significance of bioinformatics in modern plant sciences.	12	6	7	1	26
Total Hours	60	30	26	05	121

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcomes:

Course Title: Applied Botany **Course Code:** 01BO201

***Legend*: R,** Remember; **U,** Understand; **A,** Apply; **A,** Analyze

Course Outcomes	Marks Distribution				Total Marks
	R	U	A	A	
CO1: To Understand plant functions and apply knowledge to improve crop yield .	4	4	6	4	18
CO2: To demonstrate the impact of pollutants on the environment and human health.	4	6	6	4	20

CO3: To understand ancient and modern agricultural practices	4	4	6	8	22
CO4: To understand the role of botany in rural development, appreciate the significance of ethnobotany, and recognize ethnomedicinal plants.	4	4	6	6	20
CO5: To understand plant tissue culture, DNA recombinant techniques, the role of recombination, and the significance of bioinformatics in modern plant sciences.	4	4	4	8	20
Total Marks	20	22	28	30	100

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1.	LevetinE. and Mcmahon K. "Plants and Society" McGraw Hill Education. 2007
2.	MaitiR., Rodriguez H. G. and Thakur A. S. "Applied Botany" American Academic Press. 2017
3.	Negi 5. 5. "Forest Botany"M/s Bishen Singh Mafendra Pal Singh. 2012.
4.	Agrahari R. P. "Environmental Ecology, Biodiversity, Climate Change and Disaster Management" McGraw Hill Education, 2020
5.	Sharma D. K. "Biodiversity Conservation: Current Status and Future Strategies"Write and Print Publication. 2017
6.	Singh J. "Biodiversity Environment and Sustainability"MD Publications Pvt Ltd/2008 7. Gupta P. K. "Molecular Biology and Genetic Engineering"Rastogi Publications. 2005

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion

5. Role play
6. Visit to animal biotechnology lab and stem cells biology lab
7. Demonstration
8. ICT Based teaching Learning
9. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Sc. Botany

Semester: 2nd Semester

Course Title: Applied Botany

Course Code: 01BO201

CO/PO/PSO Mapping															
Course Outcome (Cos)	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1: To Understand plant functions and apply knowledge to improve crop yield	3	2	-	2	2	1	-	-	1	1	2	-	2	2	2
CO2: To demonstrate the impact of pollutants on the environment and human health.	3	3	1	2	3	1	-	-	-	2	3	1	2	2	3
CO3: To understand ancient and modern agricultural practices	2	1	1	2	2	2	-	2	-	2	1	1	3	2	1
CO4: To understand the role of botany in rural development, appreciate the significance of ethnobotany, and recognize ethnomedicinal plants.	2	3	-	3	2	2	-	2	-	2	2	1	3	2	2
CO5: To understand plant tissue culture, DNA recombinant techniques, the role of recombination, and the significance of bioinformatics in modern plant sciences.	3	3	-	3	2	2	2	2	1	2	2	2	3	2	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2,3	**CO1:** To Understand plant functions and apply knowledge to improve crop yield	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	LI 1 LI 2 LI 3	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9,1.10, 1.11, 1.12	1SL-1,2,3,4,5
PO1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2,3	**CO2:** To demonstrate the impact of pollutants on the environment and human health.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9 SO2.10 SO2.11 SO2.12	LI 1 LI 2 LI 3	2.1,2.2,2.3,2.4,2.5 , 2.6,2.7,2.8,2.9,2.10, 2.11, 2.12	2SL-1,2,3,4
PO1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2,3	**CO3:** To understand ancient and modern agricultural practices	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9 SO3.10 SO3.11 SO3.12	LI 1 LI 2 LI 3	3.1,3.2,3.3,3.4,3.5 ,3.6,3.7,3.8,3.9, 3.10, 3.11, 3.12	3SL-1,2,3,4
PO1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2,3	**CO4:** To understand the role of botany in rural development, appreciate the significance of ethnobotany, and recognize ethnomedicinal plants. .	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8 SO4.9 SO4.10 SO4.11 SO4.12	LI 1 LI 2 LI 3	4.1,4.2,4.3,4.4,4.5 ,4.6,4.7,4.8,4.9,4.10, 4.11, 4.12	4SL-1,2,3,4,5,6
PO1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2,3	**CO5:** To understand plant tissue culture, DNA recombinant techniques, the role of recombination, and the significance of bioinformatics in modern plant sciences.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9 SO5.10 SO5.11 SO5.12	LI 1 LI 2 LI 3	5.1,5.2,5.3,5.4,5.5 ,5.6,5.7,5.8,5.9, 5.10, 5.11, 5.12	5SL-1,2,3,4,5,6,7

Program Name	**Bachlor of Science (B.Sc.)- Biology**	
Semester	2nd	
Course Code:	01ZO202	
Course title:	Cell Biology, Reproductive Biology And Developmental Biology	**Curriculum Developer**: MR. AMIT BAGRI
Pre-requisite:	Student should have basic knowledge of Cell Biology, Reproductive Biology And Developmental Biology.	
Rationale:	This core course will the essential overview of cells, its structure and components, outline and summarize the transport systems of the cell and developmental process that leads to the development and differentiation of the body as well as different developmental stages in vertebrates. This course will help to knowledge of latest reproductive trends, reproductive techniques to be applied for human welfare.	
Course Outcomes (COs):	01ZO202 **.1.** Develop deeper understanding of what is life and function of cell membrane and other cell organelles. **01ZO202 .2.** Understand the nature and basic concept of developmental biology. 01ZO202 **.3.** Understand the importance latest reproductive trends, reproductive techniques to be applied for human welfare. 01ZO202 **.4.** Describe the general pattern and sequential developmental stages and developmental processes lead to establishment of body plan of multicellular organisms. 01ZO202 **.5.** Understand about evolutionary development of various animal.	

Scheme of Studies:

Board of Study	**Course Code**	**Course Title**	**Scheme of studies (Hours/Week)**					**Total Credits(C) (L:T:P=4:0:2)**
			Cl	LI	SW	SL	**Total Study Hours(CI+LI+SW+SL)**	
Major	01ZO202	Cell Biology, Reproductive Biology And Developmental Biology	4	2	1	2	9	4+2= 6

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)		
Major	01ZO202	Cell Biology, Reproductive Biology And Developmental Biology	**15**	**20**	**10**	**5**	**50**	**50**	**100**

Scheme of Assessment: Practical

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)		
Major	01ZO202	Cell Biology, Reproductive Biology And Developmental Biology	35	5	5	5	50	50	50

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	06	25

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
01ZO202 .1. Develop deeper understanding of what is life and function of cell membrane and other cell organelles.	**SO1.1** Summarize concept of Prokaryotic and Eukaryotic cells	1.1. Spotting related to the cytology a. Prokaryotic and Eukaryotic cells.	**Unit-1 Cell Biology** **1.1** Concept of Prokaryotic and Eukaryotic cells.	1.1. define Prokaryotic and Eukaryotic cells
	SO1.2 Study about Structure and Function of Plasma membrane	1.2. Stage of mitotic cell division	**1.2** Structure and Function of Plasma membrane.	1.2. define Structure and Function of Plasma membrane.
	SO1.3 define of Structure and Function of Golgi body, Mitochondria, ER, Ribosome , Lysosome	1.3. Stage of meiotic cell division	**1.3** Structure and Function of Golgi body, Mitochondria, ER, Ribosome ,Lysosome	1.3. learn about Structure and Function of Golgi body, Mitochondria, ER, Ribosome, Lysosome
	SO1.4 Study about Structure and Function of Nucleus		**1.4** Structure and Function of Nucleus.	1.4. Learn about Structure and Function of Nucleus.
	SO1.5 Study about Structure and Function of Chromosome		**1.5** Structure and Function of Chromosome	1.5. Learn about Structure and Function of Chromosome.
	SO1.6 Study of Cell cycle and their Significance		**1.6** Cell cycle and their Significance	1.6. Define Cell cycle
	SO1.7 explain the main components of the plasma membrane?		1.7 What are the main components of the plasma membrane?	
	SO1.8 explain the fluid mosaic model describe the structure of the plasma membrane?		1.8 How does the fluid mosaic model describe the structure of the plasma membrane?	
	SO1.9 explain cholesterol molecules affect membrane fluidity?		1.9 How do cholesterol molecules affect membrane fluidity?	
	SO1.10 describe the plasma membrane for communication?		1.10 How do cells use the plasma membrane for communication?	
	SO1.11 describe the G-protein-coupled receptors function?		1.11 How do G-protein-coupled receptors function?	
	SO1.12 explain the cells maintain the asymmetry of the plasma membrane		1.12 How do cells maintain the asymmetry of the plasma membrane	

Suggested Sessional Work (SW):*anyone*	**SW1.1** Assignments	Write about the history Concept of Prokaryotic and Eukaryotic cells.
	SW1.2 Mini Project	Write about the Structure and Function of Chromosome.
	SW1.3 Other Activities (Specify)	Write the diagram of Mitochondria, ER, Ribosome ,Lysosome.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	05	24

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
01ZO202 .2. Understand the nature and basic concept of developmental biology.	**SO2.1** define Structure of male reproductive system of lepus.	1.1. T.S. Testis of mammal	**Unit-2 Reproductive Biology** **2.1** Structure of male reproductive system of lepus.	1.1. Know about the Structure of male reproductive system of lepus.
	SO2.2 study of Structure of female reproductive system of lepus.	1.2. T.S. Ovary of mammal	**2.2** Structure of female reproductive system of lepus.	1.2. learn about the Structure of female reproductive system of lepus
	SO2.3 define Histology of Testis , And Ovary of Lepus	1.3. Development stage of frog embryology	**2.3** Histology of Testis, And Ovary of Lepus.	1.3. learn about Histology of Testis, And Ovary of Lepus.
	SO2.4 define Gametogenesis, spermatogenesis and oogenesis		**2.4** Gametogenesis, spermatogenesis and oogenesis	1.4. Know about the Gametogenesis, spermatogenesis and oogenesis
	SO2.5 Study of Types of egg based and distribution of yolk		**2.5** Types of egg based and distribution of yolk	1.5. learn about the Types of egg based and distribution of yolk.
	SO2.6 explain the histology and why is it important in medical science?		2.6 What is histology and why is it important in medical science?	
	SO2.7 discuss the key differences between epithelial and connective tissues?		**2.7** What are the key differences between epithelial and connective tissues?	
	SO2.8 explain the structure and function of simple squamous epithelium		**2.8** Describe the structure and function of simple squamous epithelium	
	SO2.9 describe the main components of bone tissue, and how are they organized?		**2.9** What are the main components of bone tissue, and how are they organized?	
	SO210 explain the some common histological changes seen in cancerous tissues?		**2.10** What are some common histological changes seen in cancerous tissues?	
	SO2.11 describe the histopathological features of chronic inflammation.		**2.11** Describe the histopathological features of chronic inflammation.	
	SO2.12 explain types of egg?		**2.12 types of egg?**	

Suggested Sessional Work (SW):*anyone*	**SW2.1** Assignments	Write about the Structure of female reproductive system of lepus
	SW2.2 Mini Project	Write about the Gametogenesis, spermatogenesis and oogenesis
	SW2.3 Other Activities (Specify)	write the diagram of Histology of Testis.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	04	23

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
01ZO202 .3. Understand the importance latest reproductive trends, reproductive techniques to be applied for human welfare.	**SO3.1** define the Gene bank, Sperm bank, Superovulation, cryopreservation	3.1Can you provide examples of successful restoration projects using gene bank resources?	**3.1** Gene bank, Sperm bank, Superovulation, cryopreservation	3.1. learn about Gene bank, Sperm bank, Superovulation, cryopreservation
	SO3.2 Explain the IVF, ET, ZIFT, ICSI	3.2How has the Svalbard Global Seed Vault contributed to global seed conservation efforts?	**3.2** IVF, ET, ZIFT, ICSI	3.2 Know about the IVF, ET, ZIFT, ICSI
	SO3.3 Explain the placentation – types, examples, and function	3.3What are the latest technological advancements in gene banking and genetic conservation?	**3.3** placentation – types, examples, and function	3.3. learn about the placentation – types, examples, and function
	SO3.4 Explain the placenta banking, and preservation benefits		**3.4** placenta banking , preservation benefits	3.4. Know about the placenta banking , preservation benefits
	SO3.5 What is a gene bank, and what are its primary functions?		3.5 What is a gene bank, and what are its primary functions?	
	SO3.6 explain gene bank?		3.6 what is gene bank and types?	
	SO3.7 How do gene banks contribute to biodiversity conservation?		3.7 How do gene banks contribute to biodiversity conservation?	
	SO3.8 What are the methods used to preserve genetic material in gene banks?		3.8 What are the methods used to preserve genetic material in gene banks?	
	SO3.9 What are the protocols for accessing genetic material from a gene bank?		3.9 What are the protocols for accessing genetic material from a gene bank?	
	SO3.10 What are the challenges associated with maintaining genetic diversity in gene banks?		3.10 What are the challenges associated with maintaining genetic diversity in gene banks?	
	SO3.11 How has the Svalbard Global Seed Vault contributed to global seed conservation efforts?		3.11 How has the Svalbard Global Seed Vault contributed to global seed conservation efforts?	
	SO3.12 What are the latest technological advancements in gene banking and genetic conservation?		3.12 What are the latest technological advancements in gene banking and genetic conservation?	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Write about Gene bank, Sperm bank, Superovulation, cryopreservation
	SW3.2 Mini Project	Write about the placentation – types, examples, and function
	SW3.3 Other Activities (Specify)	write the IVF and ET.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	12	06	01	05	24

Suggested Sessional Work (SW): any one	SW4.1 Assignments	Write about study of embryonic development of frog up to the formation of the three germinal layers			
	SW4.2 Mini Project	Explain the parthenogenesis			
	SW4.3 Other Activities (Specify)	write the fertilization.			

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
01ZO202 .4. Describe the general pattern and sequential developmental stages and developmental processes lead to establishment of body plan of multicellular organisms.	**SO4.1** study of fertilization	1. Squash preparation of grasshopper testis to understand the stage of meiosis.	**Unit-4 Developmental biology** **4.1** fertilization	1. Read the fertilization
	SO4.2 study of embryonic development of frog up to the formation of the three germinal layers	2. Explain the parthenogenesis	**4.2** embryonic development of frog up to the formation of the three germinal layers	2. study of embryonic development of frog up to the formation of the three germinal layers
	SO4.3 Observing the role of fate map construction of frog	3. types of parthenogenesis?	**4.3** fate map construction of frog	3. Understand the fate map construction of frog
	SO4.4 Understand the metamorphosis of tadpol larvae		**4.4** metamorphosis of tadpol larvae	4. learn about metamorphosis of tadpol larvae
	SO4.5 Explain the parthenogenesis		**4.5** parthenogenesis	5. Know about the parthenogenesis
	SO4.6 explain Types of parthenogenesis?		SO4.6 Types of parthenogenesis?	
	SO4.7 describe Obligate Parthenogenesis		SO4.7 What is Obligate Parthenogenesis	
	SO4.8 describe Facultative Parthenogenesis		SO4.8 what is Facultative Parthenogenesis	
	SO4.9 explain Automictic Parthenogenesis		SO4.9 what is Automictic Parthenogenesis	
	SO4.10 discuses Apomictic Parthenogenesis		SO4.10 what is Apomictic Parthenogenesis	
	SO4.11 explain Thelytoky		SO4.11 what is Thelytoky	
	SO4.12 explain Arrhenotoky		SO4.12what is Arrhenotoky	

Item	Cl	LI	SW	SL	Total
Approx.Hrs	12	06	01	04	23

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Classroom Instruction(CI)	Self-Learning(SL)
01ZO202 .5. Understand about evolutionary development of various animal.	**SO5.1** Explain the structure of hen's egg	1. Development stage of frog embryology	**Unit-5 Embryonic development of chick** **5.1** structure of hen's egg	1. Read the structure of hen's egg
	SO5.2 study about Embryonic development of chick embryo up to the formation of primitive streak	2. Development stage of chick embryology	**5.2** Embryonic development of chick embryo up to the formation of primitive streak	2. learn about about Embryonic development of chick embryo up to the formation of primitive streak
	SO5.3 Identify fate map construction in chick	3. How does telolecithal yolk distribution impact embryonic development?	**5.3** fate map construction in chick	3. learn about fate map construction in chick
	SO5.4 Explain the Extra embryonic membranes of chick formation and function		**5.4** Extra embryonic membranes of chick formation and function	4. Read the Extra embryonic membranes of chick formation and function
	SO5.5 explain the main stages of embryonic development?		SO5.5 What are the main stages of embryonic development?	
	SO5.6 describe the types of animals exhibit holoblastic cleavage?		SO5.6 What types of animals exhibit holoblastic cleavage?	
	SO5.7 explain holoblastic cleavage differ in animals with large yolks versus small yolks?		SO5.7 How does holoblastic cleavage differ in animals with large yolks versus small yolks?	
	SO5.8 explain animals typically have meroblastic cleavage?		SO5.8 Which animals typically have meroblastic cleavage?	
	SO5.9 explain the amount of yolk affect meroblastic cleavage?		SO5.9 How does the amount of yolk affect meroblastic cleavage?	
	SO5.10 explain isolecithal eggs influence the pattern of cleavage		SO5.10 How do isolecithal eggs influence the pattern of cleavage?	
	SO5.11 explain telolecithal yolk distribution impact embryonic development?		SO5.11 How does telolecithal yolk distribution impact embryonic development?	
	SO5.12 describe the examples of animals with telolecithal eggs?		SO5.12 What are some examples of animals with telolecithal eggs?	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Write about Embryonic development of chick embryo up to the formation of primitive streak
	SW5.2 Mini Project	Explain the Extra embryonic membranes of chick formation and function
	SW5.3 Other Activities (Specify)	Identify fate map construction in chick.

Course duration (in hours) to attain Course Outcomes:
Course Title: Cell Biology, Reproductive Biology And Developmental Biology **Course Code:** 01ZO202

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction(LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
01ZO202 **.1.** Develop deeper understanding of what is life and function of cell membrane and other cell organells.	12	06	5	1	25
01ZO202 .2. Understand the nature and basic concept of developmental biology.	12	06	5	1	24
01ZO202 .3. Understand the importance latest reproductive trends, reproductive techniques to be applied for human welfare.	12	06	5	1	22
01ZO202 .4. Describe the general pattern and sequential developmental stages and developmental processes lead to establishment of body plan of multicellular organisms.	12	06	7	1	24
01ZO202 .5. Understand about evolutionary development of various animal.	12	06	6	1	23
Total Hours	60	30	28	5	118

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:
Course Title: Cell Biology, Reproductive Biology and Developmental Biology **Course Code:** 01ZO202

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
02ZO202**.1.** Develop deeper understanding of what is life and function of cell membrane and other cell organells.	3	2	2	2	09
02ZO202**.2.** Understand the nature and basic concept of developmental biology.	2	4	3	2	11
02ZO202**.3.** Understand the importance latest reproductive trends, reproductive techniques to be applied for human welfare.	2	3	3	2	10
02ZO202**.4.** Describe the general pattern and sequential developmental stages and developmental processes lead to establishment of body plan of multicellular organisms	3	2	2	3	10
02ZO202**.5.** Understand about evolutionary development of various animal.	3	2	2	3	10
Total Marks	**13**	**13**	**12**	**12**	**50**

***Legend*:A,** Apply;**An,** Analyze;**E,** Evaluate;**C,** Create

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details

1	A Textbook of embryology Arumugam Saaras Publication 2005
2	Textbook on Fundamentals and Applications of Nanotechnology V.B. Rastogi KNRN Publication 2020
3	Cell biology, Genetics and evolution, P.K. Gupta , Rastogi publication 2013
4	A Textbook of Cytology Verma & Agarwal, S. Chand & Co. 1999

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Demonstration
7. ICT Based teaching Learning
8. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Sc. Biology
Semester: 2nd Semester
Course Title: Cell Biology, Reproductive Biology And Developmental Biology
Course Code: 01ZO202

CO/PO/PSO Mapping								
Course Outcome (Cos)	**Program Outcomes (POs)**					**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**
01ZO202 **.1.** Develop deeper understanding of what is life and function of cell membrane and other cell organelles.	2	2	3	2	1	3	2	3
01ZO202 **.2.** Understand the nature and basic concept of developmental biology.	1	1	3	2	1	2	3	3
01ZO202 **.3.** Understand the importance latest reproductive trends, reproductive techniques to be applied for human welfare.	2	2	2	1	1	3	2	3
01ZO202 **.4.** Describe the general pattern and sequential developmental stages and developmental processes lead to establishment of body plan of multicellular organisms	1	1	3	3	2	1	1	3
01ZO202 **.5.** Understand about evolutionary development of various animal.	2	1	2	3	1	1	1	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5 PSO 1,2,3	01ZO202 **1.** Develop deeper understanding of what is life and function of cell membrane and other cell organelles.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	1.1,1.2,1.3	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9,1.10,1.11,1.12	1SL-1,2,3,4,5,6
PO 1,2,3,4,5 PSO 1,2,3	01ZO202 **.2.** Understand the nature and basic concept of developmental biology.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	2.1, 2.2, 2.	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9,1.10,1.11,1.12	2SL-1,2,3,4,5
PO 1,2,3,4,5 PSO 1,2,3	01ZO202 **.3.** Understand the importance latest reproductive trends, reproductive techniques to be applied for human welfare.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	3.1,3.2,3.3,3	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9,1.10,1.11,1.12	3SL-1,2,3,4
PO 1,2,3,4,5 PSO 1,2,3	01ZO202 **.4.** Describe the general pattern and sequential developmental stages and developmental processes lead to establishment of body plan of multicellular organisms	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	4.1,4.2,4.3	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9,1.10,1.11,1.12	4SL-1,2,3,4,5
PO 1,2,3,4,5 PSO 1,2,3	01ZO202 **.5.** Understand about evolutionary development of various animal.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	5.1,5.2,5.3	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9,1.10,1.11,1.12	5SL-1,2,3,4

B.Sc. IInd Semester

Course Code: 01CH203

Course Title: Fundamentals Of Chemistry

Pre- requisite: To study this course our students must have had the subject Chemistry in class +2 or equivalent.

Rationale: Up on completion of the course student shall be able to learn about Chemical techniques, Elementary idea of the properties of the elements, Acid-Base concept and Fundamentals of Organic Chemistry Structure.

Course Outcomes:- By the end of this course students will learn the following aspects of Chemistry:

1. Various theories and principles applied to reveal atomic structure.
2. Significance of quantum numbers.
3. Concept of Periodic table & periodic properties of elements of elements.
4. Theories related to chemical bonding.
5. Acid-base concept, ph, buffer and Properties of electrolytes and Basics and mechanism of chemical kinetics.
6. Factors responsible for reactivity of organic molecules.

Unit -1

Atomic Structure:

Dual nature of particles and waves, de Broglie's equation, Heisenberg's Uncertainty principle and its significance. Quantum numbers and their significance. Rules for filling electrons in various orbitals, Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau principle and its limitations, Variation of orbital energy with atomic number. Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

UNIT -2

Periodic table & periodic properties

Effective nuclear number (EAN), shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table., Atomic radii (van der Waals) lonic and crystal radii, Covalent radii (octahedral and tetrahedral) lonization energy and factors affecting ionization energy, Applications of it.

Electronegativity- Pauling's/ Mulliken's electronegativity scales, Variation of electronegativity with bond order, partial charge.

UNIT-3

Chemical Bonding

Ionic bonding & Energy: lattice & solvation energies and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy. Born-Haber cycle and its applications Covalent character in ionic compounds, polarizing power and polarizability, Fajans rules.

Covalent bonding: Lewis structure, Valence Bond theory (Heitler- London approach).

Hybridization- Concept, types (SP, SP2, SP3 ,dSP2 ,d2SP suitable examples of inorganic and organic molecules

Valence shell electron pair repulsion theory (VSEPR) theory: Assumptions, need of theory, application of theory to explain geometries or shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements as: NH3, H2O, SF4, CIF3, PCl5, SF6, XeF4

Molecular orbital (MO) concept of bonding

The approximations of the theory, Linear combination of atomic orbitals (LCAO) (elementary pictorial approach) Rules for the LCAO method, bonding and antibonding MOs. Characteristics for ss, sp and p - p combinations of atomic orbitals, nonbonding combination of orbitals. MO diagrams of homonuclear diatomic molecules: H2, N2, O2 F2 and their ions. Molecular orbitals of heteronuclear diatomic molecules: NO, CO.

Unit-4

Acid-Base concept &Ionic Equilibria:

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water .Common ion effect, Salt hydrolysis-calculation of hydrolysis constant. Solubility and solubility product of sparingly soluble salts-applications of solubility product.

Arrhenius concept, Bronsted-Lowry's concept, conjugate acids and bases, relative strength of acids, Lewis concept. pH, buffer solutions. Acid-base neutralisation curves, Handerson equation.

Chemical kinetics

Rate of reaction, Definition and difference of order and molecularity. Derivation of rate constants for first, second, third and zero order reactions and examples. Derivation for half-life period. Methods to determine the order of reactions. Effect of

temperature on rate of reaction. Arrhenius equation, concept of activation energy.

Unit-5 Structure, reactivity and stereochemistry of organic molecules:

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis.Reactive Intermediates: Carbocations, Carbanions and free radicals. Nucleophiles and electrophiles. Determination of configuration of geometric isomers. E & Z system of nomenclature, Elements of symmetry, molecular chirality, enantiomers& their properties,stereogenic centre, optical activity of enantiomers. Concept of chirality (up to two carbon atoms): chiral and achiral molecules with two stereogenic centres, diastereomers, threo and erythroisomers, meso. isomer, resolution of enantiomers, inversion, retention and racemization. Relative and absolute configuration, sequence rules, D & L. and R & S systems of nomenclature. Conformations and Conformational analysis Conformations of ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newman, Sawhorse and Fischer representations.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (Cl+LI+SW+SL)	
Program Core (PCC)	01CH203	FUNDAMENTAL CHEMISTRY	4	4	1	1	6	6

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial

(T) And others),

LI: Laboratory Instruction (Includes Practical performances in laboratory workshop,field or other locations using different instructional strategies)

SW: Sessional Work (includes assignment, seminar, mini project etc.),

SL: Self Learning,

C: Credits

Note: SW & SL has to be planned and performed under the continuous guidance and feedback ofteacher to ensure outcome of Learning.

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA +AT)		
DCC	01CH203	Fundamentals of Chemistry (Paper I)	15	20	10	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

01CH203- . Various theories and principles applied to reveal atomic structure, Significance of quantum numbers.

Approximate Hours

Activity	Apex Hrs
Cl	12
LI	12
SW	2
SL	1
Total	27

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO1.1 Discuss about development and limitations of atomic models, De Broglie's equation, Heisenberg's SO1.2 Restate quantum numbers and their significance. Uncertainty principle and its significance. SO1.3 Explain and apply the concept of rules for filling electrons in various orbital's and its limitations. SO1.4 Explain and apply the variation of orbital energy with atomic number. Electronic configurations of the atoms SO1.5 Describe broader vision of exchange of energy and relative energies of atomic orbitals. .	**Unit-1** **Qualitative inorganic analysis** **1.1** Identification of simple inorganic mixture (5 radicals) with two/three acidic and two/three basic radicals (including typical combinations), **1.2** special emphasis on learning theoretical concepts of strong, moderate and weak electrolytes, **1.3** ionic products, common ion effect. Solubility and solubility product.	**Atomic Structure:** 1.1 Dual nature of particles and waves, de Broglie's equation, Heisenberg's. 1.2 Uncertainty principle and its significance. Quantum numbers and their significance. 1.3 Rules for filling electrons in various orbitals, Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau principle and its limitations. 1.4 Variation of orbital energy with atomic number. Electronic configurations of the atoms. 1.5 Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.	Electronic configurations of the 1 to 30 elements in periodic table.

SW-1 Suggested Sessional Work (SW):

a. Assignments:

Explain Dual nature of particles and waves, de Broglie's equation and Heisenberg's.

b. Mini Project:

Concept of Quantum numbers and their significance

c. Other Activities (Specify):

Electronic configurations of the atoms and Stability of half-filled & completely filled orbitals.

01CH203-Concept of Periodic table & periodic properties of elements of elements..

Approximate Hours

Activity	AppX Hrs
Cl	13
LI	12
SW	2
SL	1
Total	28

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 Discuss about brief history of development of periodic table and its significance. SO2.2 Restate Effective nuclear number (EAN), shielding or screening effect & Slater rules. SO2.3 Explain and apply the concept of Atomic radii and crystal radii. SO2.4 Explain and apply the variation lonization energy and factors affecting it. SO2.5 Describe broader vision of Electronegativity and types of electronegativity scales .	1. Detection of hetero-elements (N, S, Cl, Br, I) in organic compounds 2. Functional group tests for alcohol, aldehyde, carboxylic acid. carbohydrate, phenols, nitro, amine and amide. 3.Quantitative analysis of acid, alkali and buffer solutions	**Periodic table & periodic properties** 2.1 Brief history of development of periodic table and its significance. 2.2 Effective nuclear number (EAN), shielding or screening effect. Slater rules, variation of effective nuclear charge in periodic table. 2.3 Atomic radii (vander Waals) lonic and crystal radii, Covalent radii (octahedral and tetrahedral). 2.4 lonization energy and factors affecting ionization energy, Applications of it. 2.5 Electronegativity- Pauling's/ Mulliken's electronegativity scales, Variation of	Determination of Effective nuclear number (EAN) by Slater rules for some elements of s & p block.

		electronegativity with bond order, partial charge.	

SW-2 Suggested Sessional Work (SW):

A .Assignments:

Determination of Effective nuclear number (EAN) by Slater rules for some elements of s & p block.

b. Mini Project:

lonization energy and factors affecting ionization energy, Applications of it.

c. Other Activities (Specify):

Write an essay on Atomic radii (vander Waals) lonic and crystal radii.

01CH203-Theories related to chemical bonding.

Approximate Hours

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Activity	AppX Hrs
Cl	11
LI	12
SW	2
SL	1
Total	26

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Discussion about Ionic bonding & Energy: lattice & solvation energies. SO3.2 Restate Born-Landé equation for calculation of lattice energy. Born-Haber cycle. SO3.3 Explain and apply the concept of Covalent character, polarizability and Fajans rules. SO3.4 Explain and apply the Covalent bonding by VBT, Hybridization, (VSEPR) theory.	**Unit -3** **Ionic Equilibria** 1. Measurement of pH of different solutions of acids and alkalies using pH- meter (may use aerated drinks, fruit juices, shampoos and soaps) Note-use dilute solutions of soups and shampoos to prevent damage to the glass electrode 2. Measurement of the pH of buffer solutions and comparison of the values with theoretical values.	**UNIT-3** **Chemical Bonding** 3.1 Ionic bonding & Energy: lattice & solvation energies and their importance. 3.2 Statement of Born-Landé equation for calculation of lattice energy. Born-Haber cycle and its applications. 3.3 Covalent character in ionic compounds, polarizing power and polarizability, Fajans rules. 3.4 Covalent bonding, Lewis structure, VBT, Hybridization, (VSEPR) theory.	Discuss hybridization with suitable examples of linear, trigonal planar, square planar etc.

SO3.5 Describe broader concept of Molecular orbital (MO) bonding & MO diagram,(LCAO). .	3. Preparation of buffer solutions and determination of their pH and buffer capacity: (1) Sodium acetate-acetic acid (ii) Ammonium chloride-ammonium hydroxide	3.5Molecular orbital (MO) concept of bonding (LCAO)MO diagrams of homonuclear diatomic molecules: H2, N2, O2 F2 and their ions. Molecular orbitals of heteronuclear diatomic molecules: NO, CO.	

SW-3 Suggested Sessional Work (SW):

a. Assignments:

Discuss hybridization with suitable examples of linear, trigonal planar, square planar etc.

b. Mini Project:

Hybridization- Concept, types (SP, SP2, SP3 , dSP2 ,d2SP suitable examples of inorganic and organic molecules

c. Other Activities (Specify):

Explanatory note on Rules for the LCAO method, bonding and anti-bonding MOs. Characteristics for ss, sp and p - p combinations of atomic orbitals, nonbonding combination of orbitals.

01CH203- Acid-base concept, ph, buffer and Properties of electrolytes and Basics and mechanism of chemical kinetics.

Activity	AppX Hrs
Cl	13
LI	12
SW	2
SL	1
Total	28

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Discussion about electrolytes and its types degree of ionization, factors affecting it. SO4.2 Restate common ion effect Solubility and solubility product.		**Unit-4** **Acid-Base concept &Ionic Equilibria:** 4.1 Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. 4.2 Common ion effect, Salt hydrolysis. Solubility and solubility product of	Discuss degree of ionization, factors affecting degree of ionization.

SO4.3 Explain and apply the concept of acids and bases, relative strength pH, buffer solutions. SO4.4 Explain and apply Rate of reaction, order and molecularity. SO4.5 Describe broader concept of first, second, third and zero order reactions.		sparingly soluble salts-applications of solubility product. 4.3 Arrhenius concept, Bronsted-Lowry's concept, conjugates acids and bases, relative strength of acids, Lewis concept. pH, buffer solutions. 4.4 Chemical kinetics Rate of reaction, Definition and difference of order and molecularity. 4.5 Derivation of rate constants for first, second, third and zero order reactions and examples. Derivation for half-life period.	

SW-4 Suggested Sessional Work (SW):

Assignments:

pH, buffer solutions. Acid-base neutralization curves, Henderson equation

Mini Project:

Methods to determine the order of reactions.

Other Activities (Specify):

Solubility and solubility product of sparingly soluble salts-applications of solubility product.

01CH203-Factors responsible for reactivity of organic molecules.

Activity	AppX Hrs
Cl	11
LI	12
SW	2
SL	1
Total	26

Session Outcomes (SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Discussion about Electronic Displacements SO4.2 Restate Cleavage of Bonds and explain reactive Intermediates like Carbocations, Carbanions & FR.	.	**Unit-5 Structure, reactivity and stereochemistry of organic molecules:** 5.1 Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation.	chiral and achiral molecules with two stereogeniccentres, diastereomers, threo and erythroisomers, meso isomer.

SO4.3 Explain and apply the concept of configuration of geometric isomers. E & Z, D & L system of nomenclature. SO4.4 Explain and apply configuration of geometric isomers. SO4.5 Describe broader concept Relative and absolute configuration. Conformations isomerism.		5.2 Cleavage of Bonds: Homolysis and Heterolysis. Reactive Intermediates Carbocations, Carbanions and free radicals. Nucleophiles and electrophiles. 5.3 Determination of configuration of geometric isomers. E & Z , D & L system of nomenclature. 5.4symmetry, chirality, enantiomer stereogeniccentre, optical activity diastereomers, threo and erythroisomers, meso , Isomer. 5.5 Relative and absolute configuration, sequence rules, Conformations of ethane, butane and cyclohexane. Sawhorse and Fischer representations .	

SW-5 Suggested Sessional Work (SW):

Assignments:

Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation.

Mini Project:

Conformations and Conformational analysis Conformations of ethane, butane and cyclohexane.

Other Activities (Specify):

Elements of symmetry, molecular chirality, enantiomers& their properties, stereogeniccentre, optical activity .

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Laboratory Instruction (LI)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
01CH203 **Various theories and principles applied to reveal atomic structure. Significance of quantum numbers.**	12	12	02	01	27
01CH203- **Concept of Periodic table & periodic properties of elements of elements.**.	13	12	02	01	28

01CH203 **Theories related to chemical bonding**	11	12	02	01	26
01CH203 **Acid-base concept, ph, buffer and Properties of electrolytes and Basics and mechanism of chemical kinetics**	13	12	02	01	28
01CH203 **Factors responsible for reactivity of organic molecule**	11	12	02	01	26
Total Hours	60	60	10	05	135

Suggestion for End Semester Assessment

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	**Atomic Structure**	03	01	01	05
CO-2	**Periodic table & periodic properties**	02	06	02	10
CO-3	**Chemical Bonding**	03	04	03	10
CO-4	**Acid-Base concept &Ionic Equilibria:**	-02	08	05	15
CO-5	**Structure, reactivity and stereochemistry of organic molecules**	03	02	-05	10
Total		13	21	16	50

Suggested Specification Table (For ES

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for Organic Chemistry I will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks.Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture

2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to NCL, CSIR laboratories
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT,Blog, Facebook,Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorm

Suggested Learning Resources:

(a) Books :

S. No.	Title	Author	Publisher	Edition & Year
1	Concise Inorganic Chemistry	Lee, J.D.	ELBS	1991
2	J., Chemistry For B.Sc. Ist Year	Khera, H.C., Gurtu, J.N., Singh	Pragati prakashan	First Edition 2010
3	Molecular Modeling in Drug Design	Rebecca Wade and Outi Salo-Ahen ,	MDPI	March 2019
4	Bariyar, A. & Goyal, S	B.Sc. Chemistry Combined	Krishna Educational Publishers Year: 2019	2021
5	Puri, B. R., Pathania, M.S., Sharma, L. R	Physical Principles Chemistry	Vishal Publishing Co.	2020.

Mode of Delivery: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point;

LMS/ICT Tools: Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Course Title: FUNDAMENTAL CHEMISTRY **Course Code : 01CH203**

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO 8**	**PO9**	**PO 10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
	Know ledge	**Rese arch Apti tude**	**Commu nication**	**Pro ble m Solv ing**	**Indiv idual and Team Wor k**	Investi gation of Proble ms	**Mo der n Too l usa ge**	**Scie nce and Soc iety**	**Life-Lon g Lear ning**	**Et hic s**	**Project Manag ement**	**Enviro nment and sustain ability**	**The detailed function al knowle dge of theoreti cal concept s and experim ental aspects of chemist ry**	**To integrat e the gained knowled ge with various contemp orary and evolving areas in chemica l sciences like analytic al, syntheti c, pharma ceutical etc.**	**unders tand, analyze , plan and implem ent qualita tive as well as quantit ative analyti cal synthet ic and pheno menon-based proble ms in chemic al science s.**	**Provid e opport unities to excel in acade mics, resear ch or Indust ry by resear ch based innova tive knowl edge for sustain able develo pment in chemic al science**
01CH203 Various theories and principles applied to reveal atomic	**3**	**1**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**3**	**2**	**2**	**3**	**3**	**1**

structure, Significance of quantum numbers.																
01CH203 Concept of Periodic table & periodic properties of elements of elements..	**2**	**1**	**2**	**2**	**1**	**2**	**3**	**2**	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**1**
01CH203 Theories related to chemical bonding	**2**	**2**	**1**	**1**	**1**	**2**	**2**	**2**	**1**	**2**	**1**	**2**	**1**	**1**	**2**	**2**
01CH203 Factors responsible for reactivity of organic molecules	**2**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**2**	**3**	**3**	**3**	**3**	**2**
01CH203 Related the structure and physical	**2**	**1**	**1**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**3**	**1**	**3**

properties of drugs to their pharmacological activity. Explain physio-chemical properties related to QSAR.																

Legend:1–Low,2–Medium, 3–High

POs &PSOsNo.	Cos No. &Titles	SOsNo.	Laboratory instruction (LI)	Classroom Instruction(CI)	Self Learning(SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	01CH203 **1:** Various theories and principles applied to reveal atomic structure, Significance of quantum numbers .	SO1.1SO1.2SO1.3SO1.4 SO1.5		Unit-1.0 Symmetry and Group Theory 1.1,1.2,1.3,1.4,1.5,1.6,1.7	Character tables and their use in spectroscopy.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	01CH203 Concept of Periodic table & periodic properties of elements of elements..	SO2.1SO2.2SO2.3 SO2.4 SO2.5		Unit-2 **Vibrational Spectroscopy** 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9	Resonance Raman Spectroscopy, coherent anti-stokes Raman Spectroscopy (CARS).
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	01CH203 Theories related to chemical bonding	SO3.1SO3.2 SO3.3 SO3.4 SO3.5		Unit-3 : **Mössbauer Spectroscopy** 3.1, 3.2,3.3,3.4,3.5,3.6,3.7	Nature of M-L bond, coordination number, structure and detection of oxidation state.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	01CH203 Factors responsible for reactivity of organic molecules	SO4.1SO4.2SO4.3SO4.4 SO4.5		Unit-4 : : **Magnetic Resonance Spectroscopy** 4.1, 4.2,4.3,4.4,4.5,4.6,4.7	Quadrupole nuclei, quadrupole moments, electric field gradient, coupling constant splitting. Applications

PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	01CH203 Related the structure and physical properties of drugs to their pharmacological activity. Explain physio-chemical properties related	SO5.1SO5.2SO5.3SO5.4 SO5.5		**Unit 5: X-ray Diffraction , Electron Diffraction** **Neutron Diffraction** 5.1,5.2,5.3,5.4,5.5,5.6,5.7	Low energy electron diffraction and structure of surfaces. ,

Curriculum Development Team:

1. Dr. Shailendra Yadav, HoD, Department of Chemistry, AKS University, Satna (M.P.).
2. Dr. Dinesh Kumar Mishra, Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
3. Dr. Samit Kumar,Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
4. Dr. Sushma Singh, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
5. Dr. Manoj Kumar Sharma, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
6. Mr. Kanha Singh Tiwari,Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
7. Mrs. Nahid Usamani, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).

Program name	Bachelor of Science (B. Sc.)- Botany	
Semester	2nd	
Course Code:	02BO211	
Course title:	Applied Botany	**Curriculum Developer**: Nitin Singh Parihar, Lab Assistant
Pre-requisite:	Students should have basic knowledge of Applied Botany	
Rationale:	Applied botany addresses contemporary challenges such as food security, environmental conservation, and sustainable agriculture. Applied botany is pivotal in advancing societal well-being and ecological balance by studying plant biology and this knowledge to improve crop yields, develop medicines, and mitigate climate change effects.	
Course Outcomes (COs):	**CO1:** To Understand plant functions and apply knowledge to improve crop yield. **CO2**: To demonstrate the impact of pollutants on the environment and human health. **CO3**: To understand ancient and modern agricultural practices. **CO4**: To understand the role of botany in rural development, appreciate the significance of ethnobotany, and recognize ethnomedicinal plants. **CO5**: To understand plant tissue culture, DNA recombinant techniques, the role of recombination, and the significance of bioinformatics in modern plant sciences.	

Scheme of Studies:

Board of Study	CourseCode	Course Title	Scheme of studies (Hours/Week)					Total Credits(C) (L:T:P=3:0:1)
			CI	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Minor	02BO211	Applied Botany	4	2	1	2	9	4+0+2=6

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
Minor	02BO211	Applied Botany	**15**	**20**	**5**	**5**	**5**	**50**	**50**	**100**

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	12	6	1	5	24

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CIs)	Self-Learning (SL)
CO1 To Understand plant functions and apply knowledge to improve crop yield.			**Unit-1**	
	SO1.1 Students will understand applied botany's definition, scope, and significance.	**LI1.1** Demonstrations of some plant products.	**CI1.1** Introduce students to the field of applied botany and its relevance.	**SL1.1** Search various reference books and other study materials to start learning Botany.
	SO1.2.Students will be able to list and explain the main objectives of applied botany.	**LI1.2** To understand and explore the various applications of botany in enhancing human welfare, focusing on medicinal plants	**CI1.2** Explore the primary objectives of applied botany in scientific research and practical applications.	**SL1.2** Explore the primary objectives of applied botany in scientific research and practical applications.
	SO1.3. Students will identify and explain various ways applied botany impacts everyday life.	**LI1.3** Understand how different cultures around the world use plants.	**CI1.3** Discuss the practical importance of applied botany in agriculture, medicine, and industry.	**SL1.3** Learn about the practical importance of applied botany in agriculture, medicine, and industry.
	SO1.4 Students will describe key historical milestones in the early development of botany.		**CI1.4** Review the early history of botany, including ancient plant studies and herbal medicine.	**SL1.4** Explore the historical evolution and recent advancements in applied botany.

	SO1.5 Students will outline major developments in botany from the Renaissance to the present.		**CI1.5** Understand the evolution of botany into modern science, including significant discoveries and advancements.	**SL1.5** Acquire knowledge about the evolution of botany into modern science, including significant discoveries and advancements.
	SO1.6 Students will explain the various ways plants benefit humans and vice versa.		**CI1.6** Various disciplines of botany and their applications to human welfare	
	SO1.7 Students will identify key ecosystem services provided by plants and their importance to the environment.		**CI1.7** Examine the role of plants in providing ecosystem services such as oxygen production, carbon sequestration, and habitat.	
	SO1.8 Students will understand the principles of plant taxonomy and the classification of plant species.		**CI1.8** Introduce the sub-discipline of taxonomy and systematics and its importance in plant classification.	
	SO1.9 Students will explain basic physiological processes in plants and their importance to plant life.		**CI1.9** Explore plant physiology, including plant growth, photosynthesis, and respiration.	
	SO1.10 Students will identify common plant diseases and discuss methods for their prevention and control**.**		**CI1.10** Understand plant pathology, including the study of plant diseases and their management.	
	SO1.11 Students will analyze plants' economic and cultural significance in various societies.		**CI1.11** Explore economic botany and ethnobotany, focusing on the use of plants in different cultures and economies.	

	SO1.12 Students will evaluate the contributions of botany to human welfare and future potential applications.		**CI1.12** Discuss various applications of botany in biotechnology, agriculture, environmental science, and medicine.	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Describe in detail the history of applied botany.
	SW1.2 Mini Project	Describe and define the botanical methods.
	SW1.3 Other Activities (Specify)	Explain the process of media preparation and sterilization.

Item	CI	LI	SW	SL	Total
Approx. Hours	12	6	1	4	23

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CIs)	Self-Learning (SL)
CO2: To demonstrate the impact of pollutants on the environment and human health.			**Unit-2**	
	SO2.1 Students will be able to define pollution and articulate its significance in environmental science.	**LI2.1** Detection of primary pollutant on the surface of leafe	**CI2.1** Discuss the concept of pollution, including its sources and impacts on the environment and human health..	**SL2.1** Search various reference books and other study materials to start learning about pollution and pollutants
	SO2.2 Students will identify and classify different types of pollution and their specific examples.	**LI2.2** To identify the Air, water, soil, noise, and thermal pollution.	**CI2.2** Explore different types of pollution: air, water, soil, noise, and thermal. Include specific examples and their causes.	**SL2.2** Acquire knowledge of the types of pollution and pollutants.
	SO2.3 Students will distinguish between various types of pollutants and understand their sources..	**LI2.3** To isolate and identify bacteria from contaminated soil samples that can degrade	**CI2.3** Define pollutants, categorizing them into primary and secondary, and differentiate between organic and inorganic pollutants..	

		hydrocarbons (like oil or petroleum).		
	SO2.4 Students will define phytoremediation and understand its significance in reducing environmental pollution.		**CI2.4** Define phytoremediation and explain its role in environmental cleanup, emphasizing its eco-friendly nature.	**SL2.3** Acquire knowledge of Phytoremediation.
	SO2.5 Students will identify specific plants used in phytoremediation for air and water pollution.		**CI2.5** Discuss plants like *Chrysopogon zizanioides* (Vetiver, Poaceae) and *Ficus benjamina* (Weeping Fig, Moraceae), detailing their ability to purify air..	**SL2.4** Acquire knowledge Study Any 5 plants with botanical name, family, and their role in pollution control.
	SO2.6 Students will understand the role of certain plants in soil decontamination and mitigation of noise and thermal pollution.		**CI2.6** Cover plants such as *Eichhornia crassipes* (Water Hyacinth, Pontederiaceae) and *Typha latifolia* (Cattail, Typhaceae) that are effective in water purification.	
	SO2.7 Describe the use of dense plantings like *Quercus suber* (Cork Oak, Fagaceae) for noise reduction and *Aloe vera* (Aloe, Asphodelaceae) for cooling environments..		**CI2.7** Explain the use of dense plantings like *Quercus suber* (Cork Oak, Fagaceae) for noise reduction and *Aloe vera* (Aloe, Asphodelaceae) for cooling environments..	
	SO2.8 Students will define bioremediation and explain its biological basis.		**CI2.8** Define bioremediation, emphasizing its biological approach to pollution control using microorganisms.	
	SO2.9 Students will understand the role of microorganisms in		**CI2.9** Highlight the role of bacteria, fungi, and other microorganisms in breaking down pollutants.	

	bioremediation and identify key organisms involved.			
	SO2.10 Students will analyze real-world applications and case studies, illustrating the effectiveness of bioremediation.		**CI2.10** Review real-world examples and case studies where bioremediation has been successfully applied.	
	SO2.11 Revision and review		**CI2.11** Revision and review	
	SO2.12 Evaluation		**CI2.12** Evaluation	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Describe and define the air pollutants.
	SW2.2 Mini Project	Detail of the bioremediation.
	SW2.3 Other Activities (Specify)	Study one review article on phytoremediation

Item	CI	LI	SW	SL	Total
Approx. Hours	12	6	1	4	23

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CIs)	Self-Learning (SL)
CO3: To understand ancient and modern agricultural practices			**Unit-3**	
	SO3.1 Explain in detail the introduction to ancient agricultural practices.	**LI3.1** To demonstrate the Playhouse	**CI3.1** Brief details the introduction of ancient agricultural practices.	**SL3.1** Search various reference books and other study materials to learn about ancient agricultural practices.
	SO3.2 Explain in detail the Modern agriculture practices.	**LI3.2** To demonstrate the Hydroponics	**CI3.2** Brief details the introduction of Modern agriculture practices.	**SL3.2** Explore the different methods of Modern agriculture practices.

	SO3.3 Explain in detail the Playhouse. Drip irrigation, hydroponics, computer-based agriculture	**LI3.3** To study the methods of vegetative propagation of horticultural plants through stem cuttings.	**CI3.3** Study about the Playhouse, Drip irrigation, hydroponics, computer-based agriculture	
	SO3.4 Explain in detail the Organic farming		**CI3.4** Brief details of the introduction of Organic farming.	**SL3.3** Explore the different methods of Organic farming.
	SO3.5 Explain the objective and technique of Organic farming.		**CI3.5** Brief study of the objective and technique of Organic farming.	
	SO3.6 Explain in detail Horticulture's role in our welfare.		**CI3.6** Brief detail of Horticulture's role in human welfare.	**SL3.4** Explore the different methods of Horticulture
	SO3.7 Explain in detail about the Forestry.		**CI3.7** Detail study about Forestry.	
	SO3.8 Explain in detail the study about branches of Forestry and their role in our welfare.		**CI3.8** To study branches of Forestry and their role in human welfare.	
	SO3.9 Explain in detail the Forestry.		**CI3.9** Detail study about the definition of Forestry. Forestry management practices.	
	SO3.10 Students will understand the role of Forestry management practices.		**CI3.10** To study Forestry management practices.	
	SO3.11 Revision and review		**CI3.11** Revision and review	
	SO3.12 Evaluation		**CI3.12** Evaluation	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Describe the forestry
	SW3.2 Mini Project	Describe the organic farming.
	SW3.3 Other Activities (Specify)	Explain in detail ancient agriculture

Item	CI	LI	SW	SL	Total
Approx. Hours	12	6	1	6	25

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CIs)	Self-Learning (SL)
CO4: To understand the role of botany in rural development, appreciate the significance of ethnobotany, and recognize ethnomedicinal plants.			**Unit-4**	
	SO4.1 Students will understand the basic concepts of botany and its significance in enhancing rural livelihoods. .	**LI4.1** To demonstrate the principles and procedures of Ethnomedicine.	**CI4.1** Overview of botany and its applications in agriculture, forestry, and rural economies.	**SL4.1** Search various reference books and other study materials to learn about the Role of Botany in Rural Development.
	SO4.2 Students will be able to define ethnobotany and explain its importance in cultural and ecological contexts.	**LI4.2** To introduce students to the techniques of traditional medicine systems	**CI4.2** Introduction to ethnobotany, its scope, and the relationship between people and plants.	**SL4.2** To independently explore the principles and techniques of Ethnobotany..
	SO4.3 Students will understand the concept of ethnomedicine and identify its relevance in modern healthcare.	**LI4.3** To observe and describe the external morphology of *Emblica* leaves and stem.	**CI4.3** Definition of ethnomedicine, its significance, and examples from traditional medicine systems.	**SL4.3** To independently explore the examples of Ethnomedicine.

	SO4.4 Students will gain knowledge about the medicinal properties and uses of Neem and Aloe in traditional and modern medicine.		**CI4.4** Detailed study of Neem (Azadirachta indica) and Aloe (Aloe vera), including local and botanical names, family, and uses.	
	SO4.5 Students will learn about the importance and applications of Clove and Ginger in ethnomedicine.		**CI4.5** Detailed study of Clove (Syzygium aromaticum) and Ginger (Zingiber officinale), including local and botanical names, family, and uses.	
	SO4.6 Students will understand the medicinal significance of Tulsi, Turmeric, and Giloy.		**CI4.6** Examination of Tulsi (Ocimum tenuiflorum), Turmeric (Curcuma longa), and Giloy (Tinospora cordifolia), including local and botanical names, family, and uses.	**SL4.5** To independently explore Examination of Tulsi (Ocimum tenuiflorum), Turmeric (Curcuma longa), and Giloy (Tinospora cordifolia), including local and botanical names, family, and uses.
	SO4.7 Students will identify the uses and benefits of Emblica, Ashwagandha, and Arandi in traditional medicine.		**CI4.7** Study of Emblica (Phyllanthus emblica), Ashwagandha (Withania somnifera), and Arandi (Ricinus communis), including local and botanical names, family, and uses.	**SL4.6**Search various reference books and other study materials to learn about the Importance of Emblica (Phyllanthus emblica), Ashwagandha (Withania somnifera), and Arandi (Ricinus communis), including local and botanical names, family, and uses.
	SO4.8 Students will be able to define ethno-fibres and understand their significance in rural economies.		**CI4.8** Definition and importance of ethno-fibres, focusing on cultural and economic aspects.	

	SO4.9 Students will understand the uses and importance of Jute, Coconut, and Elephant Grass in rural livelihoods.		**CI4.9** Study of Jute (Corchorus spp.), Coconut (Cocos nucifera), and Elephant Grass (Pennisetum purpureum), including local and botanical names, family, and uses.	
	SO4.10 Students will define ethno-food crops and recognize their importance in nutrition and culture.		**CI4.10** Definition and overview of ethno-food crops, their role in food security, and cultural significance**.**	
	SO4.11 Students will learn about the nutritional and cultural value of these ethno-food crops.		**CI4.11** Detailed study of Garadu (Pueraria tuberosa), Singada (Trapa natans), Kutaki (Picrorhiza kurroa), and Sama (Echinochloa spp.), including local and botanical names, family, and uses.	
	SO4.12 Revision and review		**CI4.12** Revision and review	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Describe the animal cloning and its applications.
	SW4.2 Mini Project	Explain in detail to stem cells technology and their applications.
	SW4.3 Other Activities (Specify)	Write a one review article on artificial insemination in animal cells.

Item	CI	LI	SW	SL	Total
Approx. Hours	12	6	1	7	26

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CIs)	Self-Learning (SL)
CO5: To understand plant tissue culture, DNA recombinant techniques, the role of recombination, and the significance of bioinformatics in modern plant sciences.			**Unit-5**	
	SO5.1 Explain in detail the introduction to Plant tissue culture.	**LI5.1** To prepare media used in Plant tissue culture	**CI5.1** Brief in detail Definition of Plant tissue culture.	**SL5.1** Search various reference books and other study materials about Plant tissue culture.
	SO5.2 Explain in detail the types of Plant Tissue Culture.	**LI5.2** To perform the DNA Extraction technique.	**CI5.2** Study the types of Plant Tissue Culture.	
	SO5.3 Explain in detail the Importance of Plant Tissue Culture	**LI5.3** Demonstrate how to use Bioinformatics tools.	**CI5.3** Study the Importance of Plant Tissue Culture	
	SO5.4 Explain in detail the Introduction of the Recombinant DNA technique.		**CI5.4** Detail explanation Introduction of Recombinant DNA technique.	**SL5.2** Explore the Various sources to know about Plant Tissue Culture.
	SO5.5 Explain in detail human genetic engineering.		**CI5.5** To Study tools and the importance of Recombinant DNA Technology.	**SL5.3** Search various reference study materials for learning Recombinant DNA Technology.
	SO5.6 Describe and define the gene therapy for genetic disorders.		**CI5.6** Discuss the Role of recombination in the present era	
	SO5.7 Explain in detail the gene therapy for cancer.		**CI5.7** Brief detail introduction of Bioinformatics.	**SL5.4** Explore the Bioinformatics techniques.

	SO5.8 Discuss the ethical issues in genetic modification.		**CI5.8** Discuss the concepts of Bioinformatics.	
	SO5.9 Discuss the regulatory frameworks and future directions towards genetic modification and gene therapy.		**CI5.9** To Study Tools Use in Bioinformatics.	**SL5.5** Search various reference books and other study materials about Plant tissue culture.
	SO5.10 Explain in detail the bioinformatics software		**CI5.10** To Study Brief detailed introduction of bioinformatics software.	**SL5.6** Search various reference books and other study materials about Plant tissue culture.
	SO5.11 Discuss the GFBLAST and ASTA Importance of bioinformatics		**CI5.11** To Study to Basic idea GFBLAST and ASTA Importance of bioinformatics	**SL5.7**Search various reference books and other study materials about Plant tissue culture.
	SO5.12 Explain in detail the Keywords/Tags: Applied Botany, History of Botany evolution of Botany.		**CI5.12** Discuss the detail explanation Keywords/Tags: Applied Botany, History of Botany evolution of Botany.	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Explain in detail genetic modifications in medicine.
	SW5.2 Mini Project	Describe in detail the gene therapy.
	SW5.3 Other Activities (Specify)	One case research study on gene therapy for genetic disorder.

Course duration (in hours) to attain Course Outcomes:

Course Title: Applied Botany **Course Code: 02BO211**

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1: To Understand plant functions and apply knowledge to improve crop yield.	12	6	5	1	24
CO2: To demonstrate the impact of pollutants on the environment and human health.	12	6	4	1	23
CO3: To understand ancient and modern agricultural practices.	12	6	4	1	23
CO4: To understand the role of botany in rural development, appreciate the significance of ethnobotany, and recognize ethnomedicinal plants.	12	6	6	1	25
CO5: To understand plant tissue culture, DNA recombinant techniques, the role of recombination, and the significance of bioinformatics in modern plant sciences.	12	6	7	1	26
Total Hours	60	30	26	05	121

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcomes:

Course Title: Applied Botany **Course Code:** 02BO211

***Legend*: R,** Remember; **U,** Understand; **A,** Apply; **A,** Analyze

Course Outcomes	Marks Distribution				Total Marks
	R	U	A	A	
CO1: To Understand plant functions and apply knowledge to improve crop yield .	4	4	6	4	18
CO2: To demonstrate the impact of pollutants on the environment and human health.	4	6	6	4	20

CO3: To understand ancient and modern agricultural practices	4	4	6	8	22
CO4: To understand the role of botany in rural development, appreciate the significance of ethnobotany, and recognize ethnomedicinal plants.	4	4	6	6	20
CO5: To understand plant tissue culture, DNA recombinant techniques, the role of recombination, and the significance of bioinformatics in modern plant sciences.	4	4	4	8	20
Total Marks	20	22	28	30	100

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1.	LevetinE. and Mcmahon K. "Plants and Society" McGraw Hill Education. 2007
2.	MaitiR., Rodriguez H. G. and Thakur A. S. "Applied Botany" American Academic Press. 2017
3.	Negi 5. 5. "Forest Botany"M/s Bishen Singh Mafendra Pal Singh. 2012.
4.	Agrahari R. P. "Environmental Ecology, Biodiversity, Climate Change and Disaster Management" McGraw Hill Education, 2020
5.	Sharma D. K. "Biodiversity Conservation: Current Status and Future Strategies"Write and Print Publication. 2017
6.	Singh J. "Biodiversity Environment and Sustainability"MD Publications Pvt Ltd/2008 7. Gupta P. K. "Molecular Biology and Genetic Engineering"Rastogi Publications. 2005

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion

5. Role play
6. Visit to animal biotechnology lab and stem cells biology lab
7. Demonstration
8. ICT Based teaching Learning
9. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Sc. Botany

Semester: 2nd Semester

Course Title: Applied Botany

Course Code: 02BO211

CO/PO/PSO Mapping															
Course Outcome (Cos)	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1: To Understand plant functions and apply knowledge to improve crop yield	3	2	-	2	2	1	-	-	1	1	2	-	2	2	2
CO2: To demonstrate the impact of pollutants on the environment and human health.	3	3	1	2	3	1	-	-	-	2	3	1	2	2	3
CO3: To understand ancient and modern agricultural practices	2	1	1	2	2	2	-	2	-	2	1	1	3	2	1
CO4: To understand the role of botany in rural development, appreciate the significance of ethnobotany, and recognize ethnomedicinal plants.	2	3	-	3	2	2	-	2	-	2	2	1	3	2	2
CO5: To understand plant tissue culture, DNA recombinant techniques, the role of recombination, and the significance of bioinformatics in modern plant sciences.	3	3	-	3	2	2	2	2	1	2	2	2	3	2	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO1:** To Understand plant functions and apply knowledge to improve crop yield	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	LI 1 LI 2 LI 3	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9,1.1 0, 1.11, 1.12	1SL-1,2,3,4,5
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO2:** To demonstrate the impact of pollutants on the environment and human health.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9 SO2.10 SO2.11 SO2.12	LI 1 LI 2 LI 3	2.1,2.2,2.3,2.4,2.5, 2.6,2.7,2.8,2.9,2.1 0, 2.11, 2.12	2SL-1,2,3,4
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO3:** To understand ancient and modern agricultural practices	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9 SO3.10 SO3.11 SO3.12	LI 1 LI 2 LI 3	3.1,3.2,3.3,3.4,3.5, 3.6,3.7,3.8,3.9, 3.10, 3.11, 3.12	3SL-1,2,3,4
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO4:** To understand the role of botany in rural development, appreciate the significance of ethnobotany, and recognize ethnomedicinal plants. .	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8 SO4.9 SO4.10 SO4.11 SO4.12	LI 1 LI 2 LI 3	4.1,4.2,4.3,4.4,4.5, 4.6,4.7,4.8,4.9,4.1 0, 4.11, 4.12	4SL-1,2,3,4,5,6
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO5:** To understand plant tissue culture, DNA recombinant techniques, the role of recombination, and the significance of bioinformatics in modern plant sciences.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9 SO5.10 SO5.11 SO5.12	LI 1 LI 2 LI 3	5.1,5.2,5.3,5.4,5.5, 5.6,5.7,5.8,5.9, 5.10, 5.11, 5.12	5SL-1,2,3,4,5,6,7

Program Name	**Bachlor of Science (B.Sc.)- Biology**	
Semester	2nd	
Course Code:	02ZO212	
Course title:	Cell Biology, Reproductive Biology And Developmental Biology	**Curriculum Developer**: MR. AMIT BAGRI
Pre-requisite:	Student should have basic knowledge of Cell Biology, Reproductive Biology And Developmental Biology.	
Rationale:	This core course will the essential overview of cells, its structure and components, outline and summarize the transport systems of the cell and developmental process that leads to the development and differentiation of the body as well as different developmental stages in vertebrates. This course will help to knowledge of latest reproductive trends, reproductive techniques to be applied for human welfare.	
Course Outcomes (COs):	02ZO212 **.1.** Develop deeper understanding of what is life and function of cell membrane and other cell organelles. **02ZO212 .2.** Understand the nature and basic concept of developmental biology. 02ZO212 **.3.** Understand the importance latest reproductive trends, reproductive techniques to be applied for human welfare. 02ZO212 **.4.** Describe the general pattern and sequential developmental stages and developmental processes lead to establishment of body plan of multicellular organisms. 02ZO212 **.5.** Understand about evolutionary development of various animal.	

Scheme of Studies:

Board of Study	**Course Code**	**Course Title**	**Scheme of studies (Hours/Week)**					**Total Credits(C) (L:T:P=4:0:2)**
			Cl	LI	SW	SL	**Total Study Hours(CI+LI+SW+SL)**	
Minor	02ZO212	Cell Biology, Reproductive Biology And Developmental Biology	4	2	1	1	6	4+2= 6

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)		
Minor	02ZO212	Cell Biology, Reproductive Biology And Developmental Biology	**15**	**20**	**10**	**5**	**50**	**50**	**100**

Scheme of Assessment: Practical

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)		
Major	02ZO212	Cell Biology, Reproductive Biology And Developmental Biology	35	5	5	5	50	50	50

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	06	25

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
02ZO212 .1. Develop deeper understanding of what is life and function of cell membrane and other cell organelles.	**SO1.1** Summarize concept of Prokaryotic and Eukaryotic cells	1.1. Spotting related to the cytology a. Prokaryotic and Eukaryotic cells.	**Unit-1 Cell Biology** **1.1** Concept of Prokaryotic and Eukaryotic cells.	1.1. define Prokaryotic and Eukaryotic cells
	SO1.2 Study about Structure and Function of Plasma membrane	1.2. Stage of mitotic cell division	**1.2** Structure and Function of Plasma membrane.	1.2. define Structure and Function of Plasma membrane.
	SO1.3 define of Structure and Function of Golgi body, Mitochondria, ER, Ribosome , Lysosome	1.3. Stage of meiotic cell division	**1.3** Structure and Function of Golgi body, Mitochondria, ER, Ribosome ,Lysosome	1.3. learn about Structure and Function of Golgi body, Mitochondria, ER, Ribosome, Lysosome
	SO1.4 Study about Structure and Function of Nucleus		**1.4** Structure and Function of Nucleus.	1.4. Learn about Structure and Function of Nucleus.
	SO1.5 Study about Structure and Function of Chromosome		**1.5** Structure and Function of Chromosome	1.5. Learn about Structure and Function of Chromosome.
	SO1.6 Study of Cell cycle and their Significance		**1.6** Cell cycle and their Significance	1.6. Define Cell cycle
	SO1.7 explain the main components of the plasma membrane?		1.7 What are the main components of the plasma membrane?	
	SO1.8 explain the fluid mosaic model describe the structure of the plasma membrane?		1.8 How does the fluid mosaic model describe the structure of the plasma membrane?	
	SO1.9 explain cholesterol molecules affect membrane fluidity?		1.9 How do cholesterol molecules affect membrane fluidity?	
	SO1.10 describe the plasma membrane for communication?		1.10 How do cells use the plasma membrane for communication?	
	SO1.11 describe the G-protein-coupled receptors function?		1.11 How do G-protein-coupled receptors function?	
	SO1.12 explain the cells maintain the asymmetry of the plasma membrane		1.12 How do cells maintain the asymmetry of the plasma membrane	

Suggested Sessional Work (SW):*anyone*	**SW1.1** Assignments	Write about the history Concept of Prokaryotic and Eukaryotic cells.
	SW1.2 Mini Project	Write about the Structure and Function of Chromosome.
	SW1.3 Other Activities (Specify)	Write the diagram of Mitochondria, ER, Ribosome ,Lysosome.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	05	24

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
02ZO212 .2. Understand the nature and basic concept of developmental biology.	**SO2.1** define Structure of male reproductive system of lepus.	1.1. T.S. Testis of mammal	**Unit-2 Reproductive Biology** **2.1** Structure of male reproductive system of lepus.	1.1. Know about the Structure of male reproductive system of lepus.
	SO2.2 study of Structure of female reproductive system of lepus.	1.2. T.S. Ovary of mammal	**2.2** Structure of female reproductive system of lepus.	1.2. learn about the Structure of female reproductive system of lepus
	SO2.3 define Histology of Testis , And Ovary of Lepus	1.3. Development stage of frog embryology	**2.3** Histology of Testis, And Ovary of Lepus.	1.3. learn about Histology of Testis, And Ovary of Lepus.
	SO2.4 define Gametogenesis, spermatogenesis and oogenesis		**2.4** Gametogenesis, spermatogenesis and oogenesis	1.4. Know about the Gametogenesis, spermatogenesis and oogenesis
	SO2.5 Study of Types of egg based and distribution of yolk		**2.5** Types of egg based and distribution of yolk	1.5. learn about the Types of egg based and distribution of yolk.
	SO2.6 explain the histology and why is it important in medical science?		2.6 What is histology and why is it important in medical science?	
	SO2.7 discuss the key differences between epithelial and connective tissues?		**2.7** What are the key differences between epithelial and connective tissues?	
	SO2.8 explain the structure and function of simple squamous epithelium		**2.8** Describe the structure and function of simple squamous epithelium	
	SO2.9 describe the main components of bone tissue, and how are they organized?		**2.9** What are the main components of bone tissue, and how are they organized?	
	SO210 explain the some common histological changes seen in cancerous tissues?		**2.10** What are some common histological changes seen in cancerous tissues?	
	SO2.11 describe the histopathological features of chronic inflammation.		**2.11** Describe the histopathological features of chronic inflammation.	
	SO2.12 explain types of egg?		**2.12 types of egg?**	

Suggested Sessional Work (SW):*anyone*	**SW2.1** Assignments	Write about the Structure of female reproductive system of lepus
	SW2.2 Mini Project	Write about the Gametogenesis, spermatogenesis and oogenesis
	SW2.3 Other Activities (Specify)	write the diagram of Histology of Testis.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	04	23

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
02ZO212 .3. Understand the importance latest reproductive trends, reproductive techniques to be applied for human welfare.	**SO3.1** define the Gene bank, Sperm bank, Superovulation, cryopreservation	3.1Can you provide examples of successful restoration projects using gene bank resources?	**3.1** Gene bank, Sperm bank, Superovulation, cryopreservation	3.1. learn about Gene bank, Sperm bank, Superovulation, cryopreservation
	SO3.2 Explain the IVF, ET, ZIFT, ICSI	3.2How has the Svalbard Global Seed Vault contributed to global seed conservation efforts?	**3.2** IVF, ET, ZIFT, ICSI	3.2 Know about the IVF, ET, ZIFT, ICSI
	SO3.3 Explain the placentation – types, examples, and function	3.3What are the latest technological advancements in gene banking and genetic conservation?	**3.3** placentation – types, examples, and function	3.3. learn about the placentation – types, examples, and function
	SO3.4 Explain the placenta banking, and preservation benefits		**3.4** placenta banking , preservation benefits	3.4. Know about the placenta banking , preservation benefits
	SO3.5 What is a gene bank, and what are its primary functions?		3.5 What is a gene bank, and what are its primary functions?	
	SO3.6 explain gene bank?		3.6 what is gene bank and types?	
	SO3.7 How do gene banks contribute to biodiversity conservation?		3.7 How do gene banks contribute to biodiversity conservation?	
	SO3.8 What are the methods used to preserve genetic material in gene banks?		3.8 What are the methods used to preserve genetic material in gene banks?	
	SO3.9 What are the protocols for accessing genetic material from a gene bank?		3.9 What are the protocols for accessing genetic material from a gene bank?	
	SO3.10 What are the challenges associated with maintaining genetic diversity in gene banks?		3.10 What are the challenges associated with maintaining genetic diversity in gene banks?	
	SO3.11 How has the Svalbard Global Seed Vault contributed to global seed conservation efforts?		3.11 How has the Svalbard Global Seed Vault contributed to global seed conservation efforts?	
	SO3.12 What are the latest technological advancements in gene banking and genetic conservation?		3.12 What are the latest technological advancements in gene banking and genetic conservation?	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Write about Gene bank, Sperm bank, Superovulation, cryopreservation
	SW3.2 Mini Project	Write about the placentation – types, examples, and function
	SW3.3 Other Activities (Specify)	write the IVF and ET.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	12	06	01	05	24

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
02ZO212 .4. Describe the general pattern and sequential developmental stages and developmental processes lead to establishment of body plan of multicellular organisms.	**SO4.1** study of fertilization	1. Squash preparation of grasshopper testis to understand the stage of meiosis.	**Unit-4 Developmental biology** **4.1** fertilization	1. Read the fertilization
	SO4.2 study of embryonic development of frog up to the formation of the three germinal layers	2. Explain the parthenogenesis	**4.2** embryonic development of frog up to the formation of the three germinal layers	2. study of embryonic development of frog up to the formation of the three germinal layers
	SO4.3 Observing the role of fate map construction of frog	3. types of parthenogenesis?	**4.3** fate map construction of frog	3. Understand the fate map construction of frog
	SO4.4 Understand the metamorphosis of tadpol larvae		**4.4** metamorphosis of tadpol larvae	4. learn about metamorphosis of tadpol larvae
	SO4.5 Explain the parthenogenesis		**4.5** parthenogenesis	5. Know about the parthenogenesis
	SO4.6 explain Types of parthenogenesis?		SO4.6 Types of parthenogenesis?	
	SO4.7 describe Obligate Parthenogenesis		SO4.7 What is Obligate Parthenogenesis	
	SO4.8 describe Facultative Parthenogenesis		SO4.8 what is Facultative Parthenogenesis	
	SO4.9 explain Automictic Parthenogenesis		SO4.9 what is Automictic Parthenogenesis	
	SO4.10 discuses Apomictic Parthenogenesis		SO4.10 what is Apomictic Parthenogenesis	
	SO4.11 explain Thelytoky		SO4.11 what is Thelytoky	
	SO4.12 explain Arrhenotoky		SO4.12what is Arrhenotoky	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Write about study of embryonic development of frog up to the formation of the three germinal layers
	SW4.2 Mini Project	Explain the parthenogenesis
	SW4.3 Other Activities (Specify)	write the fertilization.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	12	06	01	04	23

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Classroom Instruction(CI)	Self-Learning(SL)
02ZO212 .5. Understand about evolutionary development of various animal.	**SO5.1** Explain the structure of hen's egg	1. Development stage of frog embryology	**Unit-5 Embryonic development of chick** **5.1** structure of hen's egg	1. Read the structure of hen's egg
	SO5.2 study about Embryonic development of chick embryo up to the formation of primitive streak	2. Development stage of chick embryology	**5.2** Embryonic development of chick embryo up to the formation of primitive streak	2. learn about about Embryonic development of chick embryo up to the formation of primitive streak
	SO5.3 Identify fate map construction in chick	3. How does telolecithal yolk distribution impact embryonic development?	**5.3** fate map construction in chick	3. learn about fate map construction in chick
	SO5.4 Explain the Extra embryonic membranes of chick formation and function		**5.4** Extra embryonic membranes of chick formation and function	4. Read the Extra embryonic membranes of chick formation and function
	SO5.5 explain the main stages of embryonic development?		SO5.5 What are the main stages of embryonic development?	
	SO5.6 describe the types of animals exhibit holoblastic cleavage?		SO5.6 What types of animals exhibit holoblastic cleavage?	
	SO5.7 explain holoblastic cleavage differ in animals with large yolks versus small yolks?		SO5.7 How does holoblastic cleavage differ in animals with large yolks versus small yolks?	
	SO5.8 explain animals typically have meroblastic cleavage?		SO5.8 Which animals typically have meroblastic cleavage?	
	SO5.9 explain the amount of yolk affect meroblastic cleavage?		SO5.9 How does the amount of yolk affect meroblastic cleavage?	
	SO5.10 explain isolecithal eggs influence the pattern of cleavage		SO5.10 How do isolecithal eggs influence the pattern of cleavage?	
	SO5.11 explain telolecithal yolk distribution impact embryonic development?		SO5.11 How does telolecithal yolk distribution impact embryonic development?	
	SO5.12 describe the examples of animals with telolecithal eggs?		SO5.12 What are some examples of animals with telolecithal eggs?	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Write about Embryonic development of chick embryo up to the formation of primitive streak
	SW5.2 Mini Project	Explain the Extra embryonic membranes of chick formation and function
	SW5.3 Other Activities (Specify)	Identify fate map construction in chick.

Course duration (in hours) to attain Course Outcomes:
Course Title: Cell Biology, Reproductive Biology And Developmental Biology **Course Code:** 02ZO212

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction(LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
02ZO212 **.1.** Develop deeper understanding of what is life and function of cell membrane and other cell organells.	12	06	5	1	25
02ZO212 .2. Understand the nature and basic concept of developmental biology.	12	06	5	1	24
02ZO212 .3. Understand the importance latest reproductive trends, reproductive techniques to be applied for human welfare.	12	06	5	1	22
02ZO212 .4. Describe the general pattern and sequential developmental stages and developmental processes lead to establishment of body plan of multicellular organisms.	12	06	7	1	24
02ZO212 .5. Understand about evolutionary development of various animal.	12	06	6	1	23
Total Hours	60	30	28	5	118

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:
Course Title: Cell Biology, Reproductive Biology and Developmental Biology **Course Code:** 02ZO212

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
02ZO202**.1.** Develop deeper understanding of what is life and function of cell membrane and other cell organells.	3	2	2	2	09
02ZO202**.2.** Understand the nature and basic concept of developmental biology.	2	4	3	2	11
02ZO202**.3.** Understand the importance latest reproductive trends, reproductive techniques to be applied for human welfare.	2	3	3	2	10
02ZO202**.4.** Describe the general pattern and sequential developmental stages and developmental processes lead to establishment of body plan of multicellular organisms	3	2	2	3	10
02ZO202**.5.** Understand about evolutionary development of various animal.	3	2	2	3	10
Total Marks	**13**	**13**	**12**	**12**	**50**

***Legend*:A,** Apply;**An,** Analyze;**E,** Evaluate;**C,** Create

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1	A Textbook of embryology Arumugam Saaras Publication 2005
2	Textbook on Fundamentals and Applications of Nanotechnology V.B. Rastogi KNRN Publication 2020
3	Cell biology, Genetics and evolution, P.K. Gupta , Rastogi publication 2013
4	A Textbook of Cytology Verma & Agarwal, S. Chand & Co. 1999

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Demonstration
7. ICT Based teaching Learning
8. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Sc. Biology
Semester: 2nd Semester
Course Title: Cell Biology, Reproductive Biology And Developmental Biology
Course Code: 02ZO212

CO/PO/PSO Mapping								
Course Outcome (Cos)	**Program Outcomes (POs)**					**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**
02ZO212 **.1.** Develop deeper understanding of what is life and function of cell membrane and other cell organelles.	2	2	3	2	1	3	2	3
02ZO212 **.2.** Understand the nature and basic concept of developmental biology.	1	1	3	2	1	2	3	3
02ZO212 **.3.** Understand the importance latest reproductive trends, reproductive techniques to be applied for human welfare.	2	2	2	1	1	3	2	3
02ZO212 **.4.** Describe the general pattern and sequential developmental stages and developmental processes lead to establishment of body plan of multicellular organisms	1	1	3	3	2	1	1	3
02ZO212 **.5.** Understand about evolutionary development of various animal.	2	1	2	3	1	1	1	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5 PSO 1,2,3	02ZO212 **1.** Develop deeper understanding of what is life and function of cell membrane and other cell organelles.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	1.1,1.2,1.3	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9,1.10,1.11,1.12	1SL-1,2,3,4,5,6
PO 1,2,3,4,5 PSO 1,2,3	02ZO212 **.2.** Understand the nature and basic concept of developmental biology.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	2.1, 2.2, 2.	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9,1.10,1.11,1.12	2SL-1,2,3,4,5
PO 1,2,3,4,5 PSO 1,2,3	02ZO212 **.3.** Understand the importance latest reproductive trends, reproductive techniques to be applied for human welfare.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	3.1,3.2,3.3,3	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9,1.10,1.11,1.12	3SL-1,2,3,4
PO 1,2,3,4,5 PSO 1,2,3	02ZO212 **.4.** Describe the general pattern and sequential developmental stages and developmental processes lead to establishment of body plan of multicellular organisms	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	4.1,4.2,4.3	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9,1.10,1.11,1.12	4SL-1,2,3,4,5
PO 1,2,3,4,5 PSO 1,2,3	02ZO212 **.5.** Understand about evolutionary development of various animal.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	5.1,5.2,5.3	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9,1.10,1.11,1.12	5SL-1,2,3,4

B.Sc. IInd Semester

Course Code: 02CH213

Course Title: Fundamentals Of Chemistry

Pre- requisite: To study this course our students must have had the subject Chemistry in class +2 or equivalent.

Rationale: Up on completion of the course student shall be able to learn about Chemical techniques, Elementary idea of the properties of the elements, Acid-Base concept and Fundamentals of Organic Chemistry Structure.

Course Outcomes:- By the end of this course students will learn the following aspects of Chemistry:

1. Various theories and principles applied to reveal atomic structure.
2. Significance of quantum numbers.
3. Concept of Periodic table & periodic properties of elements of elements.
4. Theories related to chemical bonding.
5. Acid-base concept, ph, buffer and Properties of electrolytes and Basics and mechanism of chemical kinetics.
6. Factors responsible for reactivity of organic molecules.

Unit -1

Atomic Structure:

Dual nature of particles and waves, de Broglie's equation, Heisenberg's Uncertainty principle and its significance. Quantum numbers and their significance. Rules for filling electrons in various orbitals, Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau principle and its limitations, Variation of orbital energy with atomic number. Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

UNIT -2

Periodic table & periodic properties

Effective nuclear number (EAN), shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table., Atomic radii (van der Waals) lonic and crystal radii, Covalent radii (octahedral and tetrahedral) lonization energy and factors affecting ionization energy, Applications of it.

Electronegativity- Pauling's/ Mulliken's electronegativity scales, Variation of electronegativity with bond order, partial charge.

UNIT-3

Chemical Bonding

Ionic bonding & Energy: lattice & solvation energies and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy. Born-Haber cycle and its applications Covalent character in ionic compounds, polarizing power and polarizability, Fajans rules.

Covalent bonding: Lewis structure, Valence Bond theory (Heitler- London approach).

Hybridization- Concept, types (SP, SP2, SP3 ,dSP2 ,d2SP suitable examples of inorganic and organic molecules

Valence shell electron pair repulsion theory (VSEPR) theory: Assumptions, need of theory, application of theory to explain geometries or shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements as: NH3, H2O, SF4, CIF3, PCl5, SF6, XeF4

Molecular orbital (MO) concept of bonding

The approximations of the theory, Linear combination of atomic orbitals (LCAO) (elementary pictorial approach) Rules for the LCAO method, bonding and antibonding MOs. Characteristics for ss, sp and p - p combinations of atomic orbitals, nonbonding combination of orbitals. MO diagrams of homonuclear diatomic molecules: H2, N2, O2 F2 and their ions. Molecular orbitals of heteronuclear diatomic molecules: NO, CO.

Unit-4

Acid-Base concept &Ionic Equilibria:

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water .Common ion effect, Salt hydrolysis-calculation of hydrolysis constant. Solubility and solubility product of sparingly soluble salts-applications of solubility product.

Arrhenius concept, Bronsted-Lowry's concept, conjugate acids and bases, relative strength of acids, Lewis concept. pH, buffer solutions. Acid-base neutralisation curves, Handerson equation.

Chemical kinetics

Rate of reaction, Definition and difference of order and molecularity. Derivation of rate constants for first, second, third and zero order reactions and examples. Derivation for half-life period. Methods to determine the order of reactions. Effect of

temperature on rate of reaction. Arrhenius equation, concept of activation energy.

Unit-5 Structure, reactivity and stereochemistry of organic molecules:

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis.Reactive Intermediates: Carbocations, Carbanions and free radicals. Nucleophiles and electrophiles. Determination of configuration of geometric isomers. E & Z system of nomenclature, Elements of symmetry, molecular chirality, enantiomers& their properties,stereogenic centre, optical activity of enantiomers. Concept of chirality (up to two carbon atoms): chiral and achiral molecules with two stereogenic centres, diastereomers, threo and erythroisomers, meso. isomer, resolution of enantiomers, inversion, retention and racemization. Relative and absolute configuration, sequence rules, D & L. and R & S systems of nomenclature. Conformations and Conformational analysis Conformations of ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newman, Sawhorse and Fischer representations.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (Cl+LI+SW+SL)	
ProgramCore (PCC)	02CH213	FUNDAMENTAL CHEMISTRY	4	4	1	1	6	6

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial

(T) And others),

LI: Laboratory Instruction (Includes Practical performances in laboratory workshop,field or other locations using different instructional strategies)

SW: Sessional Work (includes assignment, seminar, mini project etc.),

SL: Self Learning,

C: Credits

Note: SW & SL has to be planned and performed under the continuous guidance and feedback ofteacher to ensure outcome of Learning.

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment5 number 3 marks each (CA)	Class Test2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA +AT)		
DCC	02CH213	Fundamentals of Chemistry (Paper I)	15	20	10	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

02CH213- . Various theories and principles applied to reveal atomic structure, Significance of quantum numbers.

Approximate Hours

Activity	Apex Hrs
Cl	12
LI	12
SW	2
SL	1
Total	27

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO1.1 Discuss about development and limitations of atomic models, De Broglie's equation, Heisenberg's SO1.2 Restate quantum numbers and their significance. Uncertainty principle and its significance. SO1.3 Explain and apply the concept of rules for filling electrons in various orbital's and its limitations. SO1.4 Explain and apply the variation of orbital energy with atomic number. Electronic configurations of the atoms SO1.5 Describe broader vision of exchange of energy and relative energies of atomic orbitals. .	**Unit-1** **Qualitative inorganic analysis** **1.1** Identification of simple inorganic mixture (5 radicals) with two/three acidic and two/three basic radicals (including typical combinations), **1.2** special emphasis on learning theoretical concepts of strong, moderate and weak electrolytes, **1.3** ionic products, common ion effect. Solubility and solubility product.	**Atomic Structure:** 1.1 Dual nature of particles and waves, de Broglie's equation, Heisenberg's. 1.2 Uncertainty principle and its significance. Quantum numbers and their significance. 1.3 Rules for filling electrons in various orbitals, Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau principle and its limitations. 1.4 Variation of orbital energy with atomic number. Electronic configurations of the atoms. 1.5 Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.	Electronic configurations of the 1 to 30 elements in periodic table.

SW-1 Suggested Sessional Work (SW):

a. Assignments:

Explain Dual nature of particles and waves, de Broglie's equation and Heisenberg's.

b. Mini Project:

Concept of Quantum numbers and their significance

c. Other Activities (Specify):

Electronic configurations of the atoms and Stability of half-filled & completely filled orbitals.

02CH213-Concept of Periodic table & periodic properties of elements of elements..

Approximate Hours

Activity	AppX Hrs
Cl	13
LI	12
SW	2
SL	1
Total	28

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 Discuss about brief history of development of periodic table and its significance. SO2.2 Restate Effective nuclear number (EAN), shielding or screening effect & Slater rules. SO2.3 Explain and apply the concept of Atomic radii and crystal radii. SO2.4 Explain and apply the variation lonization energy and factors affecting it. SO2.5 Describe broader vision of Electronegativity and types of electronegativity scales .	1. Detection of hetero-elements (N, S, Cl, Br, I) in organic compounds 2. Functional group tests for alcohol, aldehyde, carboxylic acid. carbohydrate, phenols, nitro, amine and amide. 3.Quantitative analysis of acid, alkali and buffer solutions	**Periodic table & periodic properties** 2.1 Brief history of development of periodic table and its significance. 2.2 Effective nuclear number (EAN), shielding or screening effect. Slater rules, variation of effective nuclear charge in periodic table. 2.3 Atomic radii (vander Waals) lonic and crystal radii, Covalent radii (octahedral and tetrahedral). 2.4 lonization energy and factors affecting ionization energy, Applications of it. 2.5 Electronegativity- Pauling's/ Mulliken's electronegativity scales, Variation of	Determination of Effective nuclear number (EAN) by Slater rules for some elements of s & p block.

		electronegativity with bond order, partial charge.	

SW-2 Suggested Sessional Work (SW):

A .Assignments:

Determination of Effective nuclear number (EAN) by Slater rules for some elements of s & p block.

b. Mini Project:

lonization energy and factors affecting ionization energy, Applications of it.

c. Other Activities (Specify):

Write an essay on Atomic radii (vander Waals) lonic and crystal radii.

02CH213-Theories related to chemical bonding.

Approximate Hours

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Activity	AppX Hrs
Cl	11
LI	12
SW	2
SL	1
Total	26

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Discussion about Ionic bonding & Energy: lattice & solvation energies. SO3.2 Restate Born-Landé equation for calculation of lattice energy. Born-Haber cycle. SO3.3 Explain and apply the concept of Covalent character, polarizability and Fajans rules. SO3.4 Explain and apply the Covalent bonding by VBT, Hybridization, (VSEPR) theory.	**Unit -3** **Ionic Equilibria** 1. Measurement of pH of different solutions of acids and alkalies using pH- meter (may use aerated drinks, fruit juices, shampoos and soaps) Note-use dilute solutions of soups and shampoos to prevent damage to the glass electrode 2. Measurement of the pH of buffer solutions and comparison of the values with theoretical values.	**UNIT-3** **Chemical Bonding** 3.1 Ionic bonding & Energy: lattice & solvation energies and their importance. 3.2 Statement of Born-Landé equation for calculation of lattice energy. Born-Haber cycle and its applications. 3.3 Covalent character in ionic compounds, polarizing power and polarizability, Fajans rules. 3.4 Covalent bonding, Lewis structure, VBT, Hybridization, (VSEPR) theory.	Discuss hybridization with suitable examples of linear, trigonal planar, square planar etc.

SO3.5 Describe broader concept of Molecular orbital (MO) bonding & MO diagram,(LCAO). .	3. Preparation of buffer solutions and determination of their pH and buffer capacity: (1) Sodium acetate-acetic acid (ii) Ammonium chloride-ammonium hydroxide	3.5Molecular orbital (MO) concept of bonding (LCAO)MO diagrams of homonuclear diatomic molecules: H2, N2, O2 F2 and their ions. Molecular orbitals of heteronuclear diatomic molecules: NO, CO.	

SW-3 Suggested Sessional Work (SW):

a. Assignments:

Discuss hybridization with suitable examples of linear, trigonal planar, square planar etc.

b. Mini Project:

Hybridization- Concept, types (SP, SP2, SP3 , dSP2 ,d2SP suitable examples of inorganic and organic molecules

c. Other Activities (Specify):

Explanatory note on Rules for the LCAO method, bonding and anti-bonding MOs. Characteristics for ss, sp and p - p combinations of atomic orbitals, nonbonding combination of orbitals.

02CH213- Acid-base concept, ph, buffer and Properties of electrolytes and Basics and mechanism of chemical kinetics.

Activity	AppX Hrs
Cl	13
LI	12
SW	2
SL	1
Total	28

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Discussion about electrolytes and its types degree of ionization, factors affecting it. SO4.2 Restate common ion effect Solubility and solubility product.		**Unit-4** **Acid-Base concept &Ionic Equilibria:** 4.1 Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. 4.2 Common ion effect, Salt hydrolysis. Solubility and solubility product of	Discuss degree of ionization, factors affecting degree of ionization.

SO4.3 Explain and apply the concept of acids and bases, relative strength pH, buffer solutions. SO4.4 Explain and apply Rate of reaction, order and molecularity. SO4.5 Describe broader concept of first, second, third and zero order reactions.		sparingly soluble salts-applications of solubility product. 4.3 Arrhenius concept, Bronsted-Lowry's concept, conjugates acids and bases, relative strength of acids, Lewis concept. pH, buffer solutions. 4.4 Chemical kinetics Rate of reaction, Definition and difference of order and molecularity. 4.5 Derivation of rate constants for first, second, third and zero order reactions and examples. Derivation for half-life period.	

SW-4 Suggested Sessional Work (SW):

Assignments:

pH, buffer solutions. Acid-base neutralization curves, Henderson equation

Mini Project:

Methods to determine the order of reactions.

Other Activities (Specify):

Solubility and solubility product of sparingly soluble salts-applications of solubility product.

02CH213-Factors responsible for reactivity of organic molecules.

Activity	AppX Hrs
Cl	11
LI	12
SW	2
SL	1
Total	26

Session Outcomes (SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Discussion about Electronic Displacements SO4.2 Restate Cleavage of Bonds and explain reactive Intermediates like Carbocations, Carbanions & FR.	.	**Unit-5 Structure, reactivity and stereochemistry of organic molecules:** 5.1 Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation.	chiral and achiral molecules with two stereogeniccentres, diastereomers, threo and erythroisomers, meso isomer.

SO4.3 Explain and apply the concept of configuration of geometric isomers. E & Z, D & L system of nomenclature. SO4.4 Explain and apply configuration of geometric isomers. SO4.5 Describe broader concept Relative and absolute configuration. Conformations isomerism.		5.2 Cleavage of Bonds: Homolysis and Heterolysis. Reactive Intermediates Carbocations, Carbanions and free radicals. Nucleophiles and electrophiles. 5.3 Determination of configuration of geometric isomers. E & Z , D & L system of nomenclature. 5.4symmetry, chirality, enantiomer stereogeniccentre, optical activity diastereomers, threo and erythroisomers, meso , Isomer. 5.5 Relative and absolute configuration, sequence rules, Conformations of ethane, butane and cyclohexane. Sawhorse and Fischer representations .	

SW-5 Suggested Sessional Work (SW):

Assignments:

Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation.

Mini Project:

Conformations and Conformational analysis Conformations of ethane, butane and cyclohexane.

Other Activities (Specify):

Elements of symmetry, molecular chirality, enantiomers& their properties, stereogeniccentre, optical activity .

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Laboratory Instruction (LI)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
02CH213 **Various theories and principles applied to reveal atomic structure. Significance of quantum numbers.**	12	12	02	01	27
02CH213- **Concept of Periodic table & periodic properties of elements of elements.**.	13	12	02	01	28

02CH213 **Theories related to chemical bonding**	11	12	02	01	26
02CH213 **Acid-base concept, ph, buffer and Properties of electrolytes and Basics and mechanism of chemical kinetics**	13	12	02	01	28
02CH213 **Factors responsible for reactivity of organic molecule**	11	12	02	01	26
Total Hours	60	60	10	05	135

Suggestion for End Semester Assessment

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	**Atomic Structure**	03	01	01	05
CO-2	**Periodic table & periodic properties**	02	06	02	10
CO-3	**Chemical Bonding**	03	04	03	10
CO-4	**Acid-Base concept &Ionic Equilibria:**	-02	08	05	15
CO-5	**Structure, reactivity and stereochemistry of organic molecules**	03	02	-05	10
Total		13	21	16	50

Suggested Specification Table (For ES

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for Organic Chemistry I will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks.Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture

2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to NCL, CSIR laboratories
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT,Blog, Facebook,Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorm

Suggested Learning Resources:

(a) Books :

S. No.	Title	Author	Publisher	Edition & Year
1	Concise Inorganic Chemistry	Lee, J.D.	ELBS	1991
2	J., Chemistry For B.Sc. Ist Year	Khera, H.C., Gurtu, J.N., Singh	Pragati prakashan	First Edition 2010
3	Molecular Modeling in Drug Design	Rebecca Wade and Outi Salo-Ahen ,	MDPI	March 2019
4	Bariyar, A. & Goyal, S	B.Sc. Chemistry Combined	Krishna Educational Publishers Year: 2019	2021
5	Puri, B. R., Pathania, M.S., Sharma, L. R	Physical Principles Chemistry	Vishal Publishing Co.	2020.

Mode of Delivery: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point;

LMS/ICT Tools: Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Course Title: FUNDAMENTAL CHEMISTRY **Course Code : 02CH213**

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO 8**	**PO9**	**PO 10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
	Know ledge	**Rese arch Apti tude**	**Commu nication**	**Pro ble m Solv ing**	**Indiv idual and Team Wor k**	Investi gation of Proble ms	**Mo der n Too l usa ge**	**Scie nce and Soc iety**	**Life-Lon g Lear ning**	**Et hic s**	**Project Manag ement**	**Enviro nment and sustain ability**	**The detailed function al knowle dge of theoreti cal concept s and experim ental aspects of chemist ry**	**To integrat e the gained knowled ge with various contemp orary and evolving areas in chemica l sciences like analytic al, syntheti c, pharma ceutical etc.**	**unders tand, analyze , plan and implem ent qualita tive as well as quantit ative analyti cal synthet ic and pheno menon-based proble ms in chemic al science s.**	**Provid e opport unities to excel in acade mics, resear ch or Indust ry by resear ch based innova tive knowl edge for sustain able develo pment in chemic al science**
02CH213 Various theories and principles applied to reveal atomic	**3**	**1**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**3**	**2**	**2**	**3**	**3**	**1**

structure, Significance of quantum numbers.																
02CH213 Concept of Periodic table & periodic properties of elements of elements..	**2**	**1**	**2**	**2**	**1**	**2**	**3**	**2**	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**1**
02CH213 Theories related to chemical bonding	**2**	**2**	**1**	**1**	**1**	**2**	**2**	**2**	**1**	**2**	**1**	**2**	**1**	**1**	**2**	**2**
02CH213 Factors responsible for reactivity of organic molecules	**2**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**2**	**3**	**3**	**3**	**3**	**2**
02CH213 Related the structure and physical	**2**	**1**	**1**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**3**	**1**	**3**

properties of drugs to their pharmacological activity. Explain physio-chemical properties related to QSAR.																

Legend:1–Low,2–Medium, 3–High

POs &PSOsNo.	Cos No. &Titles	SOsNo.	Laboratory instruction (LI)	Classroom Instruction(CI)	Self Learning(SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	02CH213 **1:** Various theories and principles applied to reveal atomic structure, Significance of quantum numbers .	SO1.1SO1.2SO1.3SO1.4 SO1.5		Unit-1.0 Symmetry and Group Theory 1.1,1.2,1.3,1.4,1.5,1.6,1.7	Character tables and their use in spectroscopy.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	02CH213 Concept of Periodic table & periodic properties of elements of elements..	SO2.1SO2.2SO2.3 SO2.4 SO2.5		Unit-2 **Vibrational Spectroscopy** 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9	Resonance Raman Spectroscopy, coherent anti-stokes Raman Spectroscopy (CARS).
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	02CH213 Theories related to chemical bonding	SO3.1SO3.2 SO3.3 SO3.4 SO3.5		Unit-3 : **Mössbauer Spectroscopy** 3.1, 3.2,3.3,3.4,3.5,3.6,3.7	Nature of M-L bond, coordination number, structure and detection of oxidation state.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	02CH213 Factors responsible for reactivity of organic molecules	SO4.1SO4.2SO4.3SO4.4 SO4.5		Unit-4 : : **Magnetic Resonance Spectroscopy** 4.1, 4.2,4.3,4.4,4.5,4.6,4.7	Quadrupole nuclei, quadrupole moments, electric field gradient, coupling constant splitting. Applications

PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	02CH213 Related the structure and physical properties of drugs to their pharmacological activity. Explain physio-chemical properties related	SO5.1SO5.2SO5.3SO5.4 SO5.5		**Unit 5: X-ray Diffraction , Electron Diffraction** **Neutron Diffraction** 5.1,5.2,5.3,5.4,5.5,5.6,5.7	Low energy electron diffraction and structure of surfaces. ,

Curriculum Development Team:

1. Dr. Shailendra Yadav, HoD, Department of Chemistry, AKS University, Satna (M.P.).
2. Dr. Dinesh Kumar Mishra, Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
3. Dr. Samit Kumar,Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
4. Dr. Sushma Singh, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
5. Dr. Manoj Kumar Sharma, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
6. Mr. Kanha Singh Tiwari,Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
7. Mrs. Nahid Usamani, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).

Program name	Bachelor of Science (B. Sc.)- Botany	
Semester	2nd	
Course Code:	03BO221	
Course title:	Applied Botany	**Curriculum Developer**: Nitin Singh Parihar, Lab Assistant
Pre-requisite:	Students should have basic knowledge of Applied Botany	
Rationale:	Applied botany addresses contemporary challenges such as food security, environmental conservation, and sustainable agriculture. Applied botany is pivotal in advancing societal well-being and ecological balance by studying plant biology and this knowledge to improve crop yields, develop medicines, and mitigate climate change effects.	
Course Outcomes (COs):	**CO1:** To Understand plant functions and apply knowledge to improve crop yield. **CO2**: To demonstrate the impact of pollutants on the environment and human health. **CO3**: To understand ancient and modern agricultural practices. **CO4**: To understand the role of botany in rural development, appreciate the significance of ethnobotany, and recognize ethnomedicinal plants. **CO5**: To understand plant tissue culture, DNA recombinant techniques, the role of recombination, and the significance of bioinformatics in modern plant sciences.	

Scheme of Studies:

Board of Study	CourseCode	Course Title	Scheme of studies (Hours/Week)					Total Credits(C) (L:T:P=3:0:1)
			CI	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Generic Elective	03BO221	Applied Botany	3	1	1	1	6	3+0+1=4

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
Generic Elective	03BO221	Applied Botany	**15**	**20**	**5**	**5**	**5**	**50**	**50**	**100**

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	9	6	1	5	21

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CIs)	Self-Learning (SL)
CO1 To Understand plant functions and apply knowledge to improve crop yield.			**Unit-1**	
	SO1.1 Students will understand applied botany's definition, scope, and significance.	**LI1.1** Demonstrations of some plant products.	**CI1.1** Introduce students to the field of applied botany and its relevance.	**SL1.1** Search various reference books and other study materials to start learning Botany.
	SO1.2.Students will be able to list and explain the main objectives of applied botany.	**LI1.2** To understand and explore the various applications of botany in enhancing human welfare, focusing on medicinal plants	**CI1.2** Explore the primary objectives of applied botany in scientific research and practical applications.	**SL1.2** Explore the primary objectives of applied botany in scientific research and practical applications.
	SO1.3. Students will identify and explain various ways applied botany impacts everyday life.	**LI1.3** Understand how different cultures around the world use plants.	**CI1.3** Discuss the practical importance of applied botany in agriculture, medicine, and industry.	**SL1.3** Learn about the practical importance of applied botany in agriculture, medicine, and industry.
	SO1.4 Students will describe key historical milestones in the early development of botany.		**CI1.4** Review the early history of botany, including ancient plant studies and herbal medicine.	**SL1.4** Explore the historical evolution and recent advancements in applied botany.

	SO1.5 Students will outline major developments in botany from the Renaissance to the present.		**CI1.5** Understand the evolution of botany into modern science, including significant discoveries and advancements.	**SL1.5** Acquire knowledge about the evolution of botany into modern science, including significant discoveries and advancements.
	SO1.6 Students will explain the various ways plants benefit humans and vice versa.		**CI1.6** Various disciplines of botany and their applications to human welfare	
	SO1.7 Students will identify key ecosystem services provided by plants and their importance to the environment.		**CI1.7** Examine the role of plants in providing ecosystem services such as oxygen production, carbon sequestration, and habitat.	
	SO1.8 Students will understand the principles of plant taxonomy and the classification of plant species.		**CI1.8** Introduce the sub-discipline of taxonomy and systematics and its importance in plant classification.	
	SO1.9 Students will explain basic physiological processes in plants and their importance to plant life.		**CI1.9** Explore plant physiology, including plant growth, photosynthesis, and respiration.	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Describe in detail the history of applied botany.
	SW1.2 Mini Project	Describe and define the botanical methods.
	SW1.3 Other Activities (Specify)	Explain the process of media preparation and sterilization.

Item	CI	LI	SW	SL	Total
Approx. Hours	9	4	1	4	18

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CIs)	Self-Learning (SL)
CO2: To demonstrate the impact of pollutants on the environment and human health.			**Unit-2**	
	SO2.1 Students will be able to define pollution and articulate its significance in environmental science.	**LI2.1** Detection of primary pollutant on the surface of leafe	**CI2.1** Discuss the concept of pollution, including its sources and impacts on the environment and human health..	**SL2.1** Search various reference books and other study materials to start learning about pollution and pollutants
	SO2.2 Students will identify and classify different types of pollution and their specific examples.	**LI2.2** To identify the Air, water, soil, noise, and thermal pollution.	**CI2.2** Explore different types of pollution: air, water, soil, noise, and thermal. Include specific examples and their causes.	**SL2.2** Acquire knowledge of the types of pollution and pollutants.
	SO2.3 Students will distinguish between various types of pollutants and understand their sources..		**CI2.3** Define pollutants, categorizing them into primary and secondary, and differentiate between organic and inorganic pollutants..	
	SO2.4 Students will define phytoremediation and understand its significance in reducing environmental pollution.		**CI2.4** Define phytoremediation and explain its role in environmental cleanup, emphasizing its eco-friendly nature.	**SL2.3** Acquire knowledge of Phytoremediation.
	SO2.5 Students will identify specific plants used in phytoremediation for air and water pollution.		**CI2.5** Discuss plants like *Chrysopogon zizanioides* (Vetiver, Poaceae) and *Ficus benjamina* (Weeping Fig, Moraceae), detailing their ability to purify air..	**SL2.4** Acquire knowledge Study Any 5 plants with botanical name, family, and their role in pollution control.
	SO2.6 Students will understand the role of certain plants in soil decontamination and		**CI2.6** Cover plants such as *Eichhornia crassipes* (Water Hyacinth, Pontederiaceae) and *Typha*	

	mitigation of noise and thermal pollution.		*latifolia* (Cattail, Typhaceae) that are effective in water purification.	
	SO2.7 Describe the use of dense plantings like *Quercus suber* (Cork Oak, Fagaceae) for noise reduction and *Aloe vera* (Aloe, Asphodelaceae) for cooling environments..		**CI2.7** Explain the use of dense plantings like *Quercus suber* (Cork Oak, Fagaceae) for noise reduction and *Aloe vera* (Aloe, Asphodelaceae) for cooling environments..	
	SO2.8 Students will define bioremediation and explain its biological basis.		**CI2.8** Define bioremediation, emphasizing its biological approach to pollution control using microorganisms.	
	SO2.9 Students will understand the role of microorganisms in bioremediation and identify key organisms involved.		**CI2.9** Highlight the role of bacteria, fungi, and other microorganisms in breaking down pollutants.	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Describe and define the air pollutants.
	SW2.2 Mini Project	Detail of the bioremediation.
	SW2.3 Other Activities (Specify)	Study one review article on phytoremediation

Item	CI	LI	SW	SL	Total
Approx. Hours	9	6	1	4	20

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CIs)	Self-Learning (SL)
			Unit-3	

CO3: To understand ancient and modern agricultural practices	**SO3.1** Explain in detail the introduction to ancient agricultural practices.	**LI3.1** To demonstrate the Playhouse	**CI3.1** Brief details the introduction of ancient agricultural practices.	**SL3.1** Search various reference books and other study materials to learn about ancient agricultural practices.
	SO3.2 Explain in detail the Modern agriculture practices.	**LI3.2** To demonstrate the Hydroponics	**CI3.2** Brief details the introduction of Modern agriculture practices.	**SL3.2** Explore the different methods of Modern agriculture practices.
	SO3.3 Explain in detail the Playhouse. Drip irrigation, hydroponics, computer-based agriculture	**LI3.3** To study the methods of vegetative propagation of horticultural plants through stem cuttings.	**CI3.3** Study about the Playhouse, Drip irrigation, hydroponics, computer-based agriculture	
	SO3.4 Explain in detail the Organic farming		**CI3.4** Brief details of the introduction of Organic farming.	**SL3.3** Explore the different methods of Organic farming.
	SO3.5 Explain the objective and technique of Organic farming.		**CI3.5** Brief study of the objective and technique of Organic farming.	
	SO3.6 Explain in detail Horticulture's role in our welfare.		**CI3.6** Brief detail of Horticulture's role in human welfare.	**SL3.4** Explore the different methods of Horticulture
	SO3.7 Explain in detail about the Forestry.		**CI3.7** Detail study about Forestry.	
	SO3.8 Explain in detail the study about branches of Forestry and their role in our welfare.		**CI3.8** To study branches of Forestry and their role in human welfare.	
	SO3.9 Explain in detail the Forestry.		**CI3.9** Detail study about the definition of Forestry. Forestry management practices.	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Describe the forestry
	SW3.2 Mini Project	Describe the organic farming.
	SW3.3 Other Activities (Specify)	Explain in detail ancient agriculture

Item	CI	LI	SW	SL	Total
Approx. Hours	9	4	1	6	20

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CIs)	Self-Learning (SL)
CO4: To understand the role of botany in rural development, appreciate the significance of ethnobotany, and recognize ethnomedicinal plants.			**Unit-4**	
	SO4.1 Students will understand the basic concepts of botany and its significance in enhancing rural livelihoods. .	**LI4.1** To demonstrate the principles and procedures of Ethnomedicine.	**CI4.1** Overview of botany and its applications in agriculture, forestry, and rural economies.	**SL4.1** Search various reference books and other study materials to learn about the Role of Botany in Rural Development.
	SO4.2 Students will be able to define ethnobotany and explain its importance in cultural and ecological contexts.	**LI4.2** To introduce students to the techniques of traditional medicine systems	**CI4.2** Introduction to ethnobotany, its scope, and the relationship between people and plants.	**SL4.2** To independently explore the principles and techniques of Ethnobotany..
	SO4.3 Students will understand the concept of ethnomedicine and identify its relevance in modern healthcare.		**CI4.3** Definition of ethnomedicine, its significance, and examples from traditional medicine systems.	**SL4.3** To independently explore the examples of Ethnomedicine.
	SO4.4 Students will gain knowledge about the medicinal properties and uses of Neem and Aloe in		**CI4.4** Detailed study of Neem (Azadirachta indica) and Aloe (Aloe vera), including local and botanical names, family, and uses.	

	traditional and modern medicine.			
	SO4.5 Students will learn about the importance and applications of Clove and Ginger in ethnomedicine.		**CI4.5** Detailed study of Clove (Syzygium aromaticum) and Ginger (Zingiber officinale), including local and botanical names, family, and uses.	
	SO4.6 Students will understand the medicinal significance of Tulsi, Turmeric, and Giloy.		**CI4.6** Examination of Tulsi (Ocimum tenuiflorum), Turmeric (Curcuma longa), and Giloy (Tinospora cordifolia), including local and botanical names, family, and uses.	**SL4.5** To independently explore Examination of Tulsi (Ocimum tenuiflorum), Turmeric (Curcuma longa), and Giloy (Tinospora cordifolia), including local and botanical names, family, and uses.
	SO4.7 Students will identify the uses and benefits of Emblica, Ashwagandha, and Arandi in traditional medicine.		**CI4.7** Study of Emblica (Phyllanthus emblica), Ashwagandha (Withania somnifera), and Arandi (Ricinus communis), including local and botanical names, family, and uses.	**SL4.6**Search various reference books and other study materials to learn about the Importance of Emblica (Phyllanthus emblica), Ashwagandha (Withania somnifera), and Arandi (Ricinus communis), including local and botanical names, family, and uses.
	SO4.8 Students will be able to define ethno-fibres and understand their significance in rural economies.		**CI4.8** Definition and importance of ethno-fibres, focusing on cultural and economic aspects.	

	SO4.9 Students will understand the uses and importance of Jute, Coconut, and Elephant Grass in rural livelihoods.		**CI4.9** Study of Jute (Corchorus spp.), Coconut (Cocos nucifera), and Elephant Grass (Pennisetum purpureum), including local and botanical names, family, and uses.	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Describe the animal cloning and its applications.
	SW4.2 Mini Project	Explain in detail to stem cells technology and their applications.
	SW4.3 Other Activities (Specify)	Write a one review article on artificial insemination in animal cells.

Item	**CI**	**LI**	**SW**	**SL**	**Total**
Approx. Hours	9	6	1	5	21

Course outcomes (COs)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CIs)**	**Self-Learning (SL)**
CO5: To understand plant tissue culture, DNA recombinant techniques, the role of recombination, and the significance of bioinformatics in modern plant sciences.			**Unit-5**	
	SO5.1 Explain in detail the introduction to Plant tissue culture.	**LI5.1** To prepare media used in Plant tissue culture	**CI5.1** Brief in detail Definition of Plant tissue culture.	**SL5.1** Search various reference books and other study materials about Plant tissue culture.
	SO5.2 Explain in detail the types of Plant Tissue Culture.	**LI5.2** To perform the DNA Extraction technique.	**CI5.2** Study the types of Plant Tissue Culture.	

	SO5.3 Explain in detail the Importance of Plant Tissue Culture	**LI5.3** Demonstrate how to use Bioinformatics tools.	**CI5.3** Study the Importance of Plant Tissue Culture	
	SO5.4 Explain in detail the Introduction of the Recombinant DNA technique.		**CI5.4** Detail explanation Introduction of Recombinant DNA technique.	**SL5.2** Explore the Various sources to know about Plant Tissue Culture.
	SO5.5 Explain in detail human genetic engineering.		**CI5.5** To Study tools and the importance of Recombinant DNA Technology.	**SL5.3** Search various reference study materials for learning Recombinant DNA Technology.
	SO5.6 Describe and define the gene therapy for genetic disorders.		**CI5.6** Discuss the Role of recombination in the present era	
	SO5.7 Explain in detail the gene therapy for cancer.		**CI5.7** Brief detail introduction of Bioinformatics.	**SL5.4** Explore the Bioinformatics techniques.
	SO5.8 Discuss the ethical issues in genetic modification.		**CI5.8** Discuss the concepts of Bioinformatics.	
	SO5.9 Discuss the regulatory frameworks and future directions towards genetic modification and gene therapy.		**CI5.9** To Study Tools Use in Bioinformatics.	**SL5.5** Search various reference books and other study materials about Plant tissue culture.

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Explain in detail genetic modifications in medicine.
	SW5.2 Mini Project	Describe in detail the gene therapy.
	SW5.3 Other Activities (Specify)	One case research study on gene therapy for genetic disorder.

Course duration (in hours) to attain Course Outcomes:

Course Title: Applied Botany **Course Code: 03BO221**

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1: To Understand plant functions and apply knowledge to improve crop yield.	9	6	5	1	21
CO2: To demonstrate the impact of pollutants on the environment and human health.	9	4	4	1	18
CO3: To understand ancient and modern agricultural practices.	9	6	4	1	20
CO4: To understand the role of botany in rural development, appreciate the significance of ethnobotany, and recognize ethnomedicinal plants.	9	4	6	1	20
CO5: To understand plant tissue culture, DNA recombinant techniques, the role of recombination, and the significance of bioinformatics in modern plant sciences.	9	6	5	1	21
Total Hours	45	26	24	05	100

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcomes:

Course Title: Applied Botany **Course Code:** 03BO221

***Legend*: R,** Remember; **U,** Understand; **A,** Apply; **A,** Analyze

Course Outcomes	Marks Distribution				Total Marks
	R	U	A	A	
CO1: To Understand plant functions and apply knowledge to improve crop yield .	4	4	6	4	18
CO2: To demonstrate the impact of pollutants on the environment and human health.	4	6	6	4	20

CO3: To understand ancient and modern agricultural practices	4	4	6	8	22
CO4: To understand the role of botany in rural development, appreciate the significance of ethnobotany, and recognize ethnomedicinal plants.	4	4	6	6	20
CO5: To understand plant tissue culture, DNA recombinant techniques, the role of recombination, and the significance of bioinformatics in modern plant sciences.	4	4	4	8	20
Total Marks	20	22	28	30	100

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1.	LevetinE. and Mcmahon K. "Plants and Society" McGraw Hill Education. 2007
2.	MaitiR., Rodriguez H. G. and Thakur A. S. "Applied Botany" American Academic Press. 2017
3.	Negi 5. 5. "Forest Botany"M/s Bishen Singh Mafendra Pal Singh. 2012.
4.	Agrahari R. P. "Environmental Ecology, Biodiversity, Climate Change and Disaster Management" McGraw Hill Education, 2020
5.	Sharma D. K. "Biodiversity Conservation: Current Status and Future Strategies"Write and Print Publication. 2017
6.	Singh J. "Biodiversity Environment and Sustainability"MD Publications Pvt Ltd/2008 7. Gupta P. K. "Molecular Biology and Genetic Engineering"Rastogi Publications. 2005
7.	Sharma V., Munjal A. and Shankar A. "Bioinformatics" Rastogi Publications. 2008

(b) Online Resources:
Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Visit to animal biotechnology lab and stem cells biology lab
7. Demonstration
8. ICT Based teaching Learning
9. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Sc. Botany

Semester: 2nd Semester

Course Title: Applied Botany

Course Code: 03BO221

CO/PO/PSO Mapping															
Course Outcome (Cos)	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1: To Understand plant functions and apply knowledge to improve crop yield	3	2	-	2	2	1	-	-	1	1	2	-	2	2	2
CO2: To demonstrate the impact of pollutants on the environment and human health.	3	3	1	2	3	1	-	-	-	2	3	1	2	2	3
CO3: To understand ancient and modern agricultural practices	2	1	1	2	2	2	-	2	-	2	1	1	3	2	1
CO4: To understand the role of botany in rural development, appreciate the significance of ethnobotany, and recognize ethnomedicinal plants.	2	3	-	3	2	2	-	2	-	2	2	1	3	2	2
CO5: To understand plant tissue culture, DNA recombinant techniques, the role of recombination, and the significance of bioinformatics in modern plant sciences.	3	3	-	3	2	2	2	2	1	2	2	2	3	2	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO1,2,3,4,5,6,7,8,9, PSO 1,2,3	**CO1:** To Understand plant functions and apply knowledge to improve crop yield	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9	LI 1 LI 2 LI 3	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9	1SL-1,2,3,4,5
PO1,2,3,4,5,6,7,8,9, PSO 1,2,3	**CO2:** To demonstrate the impact of pollutants on the environment and human health.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9	LI 1 LI 2	2.1,2.2,2.3,2.4,2.5, 2.6,2.7,2.8,2.9,	2SL-1,2,3,4
PO1,2,3,4,5,6,7,8,9, PSO 1,2,3	**CO3:** To understand ancient and modern agricultural practices	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9	LI 1 LI 2 LI 3	3.1,3.2,3.3,3.4,3.5, 3.6,3.7,3.8,3.9	3SL-1,2,3,4
PO1,2,3,4,5,6,7,8,9, PSO 1,2,3	**CO4:** To understand the role of botany in rural development, appreciate the significance of ethnobotany, and recognize ethnomedicinal plants. .	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8 SO4.9	LI 1 LI 2	4.1,4.2,4.3,4.4,4.5, 4.6,4.7,4.8,4.9	4SL-1,2,3,4,5,6
PO1,2,3,4,5,6,7,8,9, PSO 1,2,3	**CO5:** To understand plant tissue culture, DNA recombinant techniques, the role of recombination, and the significance of bioinformatics in modern plant sciences.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9	LI 1 LI 2 LI 3	5.1,5.2,5.3,5.4,5.5, 5.6,5.7,5.8,5.9	5SL-1,2,3,4,5,6,5

Program Name	**Bachelor of Science (B.Sc.)- Biology**	
Semester	2nd	
Course Code:	03ZO222	
Course title:	Cell Biology, Reproductive Biology And Developmental Biology	**Curriculum Developer**: MR. AMIT BAGRI
Pre-requisite:	Student should have basic knowledge of Cell Biology, Reproductive Biology And Developmental Biology.	
Rationale:	This core course will the essential overview of cells, its structure and components, outline and summarize the transport systems of the cell and developmental process that leads to the development and differentiation of the body as well as different developmental stages in vertebrates. This course will help to knowledge of latest reproductive trends, reproductive techniques to be applied for human welfare.	
Course Outcomes (COs):	03ZO222 **.1.** Develop deeper understanding of what is life and function of cell membrane and other cell organelles. 03ZO222 **.2.** Understand the nature and basic concept of developmental biology. 03ZO222 **.3.** Understand the importance latest reproductive trends, reproductive techniques to be applied for human welfare. 03ZO222 **.4.** Describe the general pattern and sequential developmental stages and developmental processes lead to establishment of body plan of multicellular organisms. 03ZO222 **.5.** Understand about evolutionary development of various animal.	

Scheme of Studies:

Board of Study	**Course Code**	**Course Title**	**Scheme of studies (Hours/Week)**					**Total Credits(C) (L:T:P=3:0:1)**
			Cl	LI	SW	SL	**Total Study Hours(CI+LI+SW+SL)**	
Generic Elective	03ZO222	Cell Biology, Reproductive Biology And Developmental Biology	3	1	1	1	6	3+1= 4

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)		
Generic Elective	03ZO222	Cell Biology, Reproductive Biology And Developmental Biology	**15**	**20**	**10**	**5**	**50**	**50**	**100**

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)		
Generic Elective	03ZO222	Cell Biology, Reproductive Biology And Developmental Biology	35	5	5	5	50	50	50

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.	**Approximate Hours** **Item** | Cl | LI | SW | SL | Total **Approx. Hrs** | 09 | 04 | 01 | 06 | 20

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
03ZO222 **.1.** Develop deeper understanding of what is life and function of cell membrane and other cell organelles.	**SO1.1** Summarize concept of Prokaryotic and Eukaryotic cells	1.1. Spotting related to the cytology a. Prokaryotic and Eukaryotic cells.	**Unit-1 Cell Biology** **1.1** Concept of Prokaryotic and Eukaryotic cells.	1.1. define Prokaryotic and Eukaryotic cells
	SO1.2 Study about Structure and Function of Plasma membrane	1.2. Stage of mitotic cell division	**1.2** Structure and Function of Plasma membrane.	1.2. define Structure and Function of Plasma membrane.
	SO1.3 define of Structure and Function of Golgi body, Mitochondria, ER, Ribosome , Lysosome		**1.3** Structure and Function of Golgi body, Mitochondria, ER, Ribosome ,Lysosome	1.3. learn about Structure and Function of Golgi body, Mitochondria, ER, Ribosome, Lysosome
	SO1.4 Study about Structure and Function of Nucleus		**1.4** Structure and Function of Nucleus.	1.4. Learn about Structure and Function of Nucleus.
	SO1.5 Study about Structure and Function of Chromosome		**1.5** Structure and Function of Chromosome	1.5. Learn about Structure and Function of Chromosome.
	SO1.6 Study of Cell cycle and their Significance		**1.6** Cell cycle and their Significance	1.6. Define Cell cycle
	SO1.7 explain the main components of the plasma membrane?		1.7 What are the main components of the plasma membrane?	
	SO1.8 explain the fluid mosaic model describe the structure of the plasma membrane?		1.8 How does the fluid mosaic model describe the structure of the plasma membrane?	
	SO1.9 explain cholesterol molecules affect membrane fluidity?		1.9 How do cholesterol molecules affect membrane fluidity?	

Suggested Sessional Work (SW):*anyone*	**SW1.1** Assignments	Write about the history Concept of Prokaryotic and Eukaryotic cells.
	SW1.2 Mini Project	Write about the Structure and Function of Chromosome.
	SW1.3 Other Activities (Specify)	Write the diagram of Mitochondria, ER, Ribosome ,Lysosome.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	04	01	05	19

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
03ZO222 **.2.** Understand the nature and basic concept of developmental biology.	**SO2.1** define Structure of male reproductive system of lepus.	1.1. T.S. Testis of mammal	**Unit-2 Reproductive Biology** **2.1** Structure of male reproductive system of lepus.	1.1. Know about the Structure of male reproductive system of lepus.
	SO2.2 study of Structure of female reproductive system of lepus.	1.2. T.S. Ovary of mammal	**2.2** Structure of female reproductive system of lepus.	1.2. learn about the Structure of female reproductive system of lepus
	SO2.3 define Histology of Testis , And Ovary of Lepus		**2.3** Histology of Testis, And Ovary of Lepus.	1.3. learn about Histology of Testis, And Ovary of Lepus.
	SO2.4 define Gametogenesis, spermatogenesis and oogenesis		**2.4** Gametogenesis, spermatogenesis and oogenesis	1.4. Know about the Gametogenesis, spermatogenesis and oogenesis
	SO2.5 Study of Types of egg based and distribution of yolk		**2.5** Types of egg based and distribution of yolk	1.5. learn about the Types of egg based and distribution of yolk.
	SO2.6 explain the histology and why is it important in medical science?		2.6 What is histology and why is it important in medical science?	
	SO2.7 discuss the key differences between epithelial and connective tissues?		**2.7** What are the key differences between epithelial and connective tissues?	
	SO2.8 explain the structure and function of simple squamous epithelium		**2.8** Describe the structure and function of simple squamous epithelium	
	SO2.9 describe the main components of bone tissue, and how are they organized?		**2.9** What are the main components of bone tissue, and how are they organized?	

Suggested Sessional Work (SW):*anyone*	**SW2.1** Assignments	Write about the Structure of female reproductive system of lepus
	SW2.2 Mini Project	Write about the Gametogenesis, spermatogenesis and oogenesis
	SW2.3 Other Activities (Specify)	write the diagram of Histology of Testis.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	02	01	04	16

Course Outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
03ZO222 **.3.** Understand the importance latest reproductive trends, reproductive techniques to be applied for human welfare.	**SO3.1** define the Gene bank, Sperm bank, Superovulation, cryopreservation	3.1Can you provide examples of successful restoration projects using gene bank resources?	**3.1** Gene bank, Sperm bank, Superovulation, cryopreservation	3.1. learn about Gene bank, Sperm bank, Superovulation, cryopreservation
	SO3.2 Explain the IVF, ET, ZIFT, ICSI		**3.2** IVF, ET, ZIFT, ICSI	3.2 Know about the IVF, ET, ZIFT, ICSI
	SO3.3 Explain the placentation – types, examples, and function		**3.3** placentation – types, examples, and function	3.3. learn about the placentation – types, examples, and function
	SO3.4 Explain the placenta banking, and preservation benefits		**3.4** placenta banking , preservation benefits	3.4. Know about the placenta banking, preservation benefits
	SO3.5 What is a gene bank, and what are its primary functions?		3.5 What is a gene bank, and what are its primary functions?	
	SO3.6 explain gene bank?		3.6 what is gene bank and types?	
	SO3.7 How do gene banks contribute to biodiversity conservation?		3.7 How do gene banks contribute to biodiversity conservation?	
	SO3.8 What are the methods used to preserve genetic material in gene banks?		3.8 What are the methods used to preserve genetic material in gene banks?	
	SO3.9 What are the protocols for accessing genetic material from a gene bank?		3.9 What are the protocols for accessing genetic material from a gene bank?	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Write about Gene bank, Sperm bank, Superovulation, cryopreservation
	SW3.2 Mini Project	Write about the placentation – types, examples, and function
	SW3.3 Other Activities (Specify)	write the IVF and ET.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	02	01	04	16

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
03ZO222 **.4.** Describe the general pattern and sequential developmental stages and developmental processes lead to establishment of body plan of multicellular organisms.	**SO4.1** study of fertilization	1. Squash preparation of grasshopper testis to understand the stage of meiosis.	**Unit-4 Developmental biology** **4.1** fertilization	1. Read the fertilization
	SO4.2 study of embryonic development of frog up to the formation of the three germinal layers		**4.2** embryonic development of frog up to the formation of the three germinal layers	2. study of embryonic development of frog up to the formation of the three germinal layers
	SO4.3 Observing the role of fate map construction of frog		**4.3** fate map construction of frog	3. Understand the fate map construction of frog
	SO4.4 Understand the metamorphosis of tadpol larvae		**4.4** metamorphosis of tadpol larvae	4. learn about metamorphosis of tadpol larvae
	SO4.5 Explain the parthenogenesis		**4.5** parthenogenesis	5. Know about the parthenogenesis
	SO4.6 explain Types of parthenogenesis?		SO4.6 Types of parthenogenesis?	
	SO4.7 describe Obligate Parthenogenesis		SO4.7 What is Obligate Parthenogenesis	
	SO4.8 describe Facultative Parthenogenesis		SO4.8 what is Facultative Parthenogenesis	
	SO4.9 explain Automictic Parthenogenesis		SO4.9 what is Automictic Parthenogenesis	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Write about study of embryonic development of frog up to the formation of the three germinal layers
	SW4.2 Mini Project	Explain the parthenogenesis
	SW4.3 Other Activities (Specify)	write the fertilization.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	09	04	01	04	19

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Classroom Instruction(CI)	Self-Learning(SL)
03ZO222 **.5.** Understand about evolutionary development of various animal.	**SO5.1** Explain the structure of hen's egg	1. Development stage of frog embryology	**Unit-5 Embryonic development of chick** **5.1** structure of hen's egg	1. Read the structure of hen's egg
	SO5.2 study about Embryonic development of chick embryo up to the formation of primitive streak	2. Development stage of chick embryology	**5.2** Embryonic development of chick embryo up to the formation of primitive streak	2. learn about about Embryonic development of chick embryo up to the formation of primitive streak
	SO5.3 Identify fate map construction in chick		**5.3** fate map construction in chick	3. learn about fate map construction in chick
	SO5.4 Explain the Extra embryonic membranes of chick formation and function		**5.4** Extra embryonic membranes of chick formation and function	4. Read the Extra embryonic membranes of chick formation and function
	SO5.5 explain the main stages of embryonic development?		SO5.5 What are the main stages of embryonic development?	
	SO5.6 describe the types of animals exhibit holoblastic cleavage?		SO5.6 What types of animals exhibit holoblastic cleavage?	
	SO5.7 explain holoblastic cleavage differ in animals with large yolks versus small yolks?		SO5.7 How does holoblastic cleavage differ in animals with large yolks versus small yolks?	
	SO5.8 explain animals typically have meroblastic cleavage?		SO5.8 Which animals typically have meroblastic cleavage?	
	SO5.9 explain the amount of yolk affect meroblastic cleavage?		SO5.9 How does the amount of yolk affect meroblastic cleavage?	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Write about Embryonic development of chick embryo up to the formation of primitive streak
	SW5.2 Mini Project	Explain the Extra embryonic membranes of chick formation and function
	SW5.3 Other Activities (Specify)	Identify fate map construction in chick.

Course duration (in hours) to attain Course Outcomes:

Course Title: Cell Biology, Reproductive Biology And Developmental Biology **Course Code:** 03ZO222

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction(LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
03ZO222 **.1.** Develop deeper understanding of what is life and function of cell membrane and other cell organells.	09	04	5	1	25
03ZO222 **.2.** Understand the nature and basic concept of developmental biology.	09	04	5	1	24
03ZO222 **.3.** Understand the importance latest reproductive trends, reproductive techniques to be applied for human welfare.	09	02	4	1	22
03ZO222 **.4.** Describe the general pattern and sequential developmental stages and developmental processes lead to establishment of body plan of multicellular organisms.	09	02	5	1	24
03ZO222 **.5.** Understand about evolutionary development of various animal.	09	04	4	1	23
Total Hours	45	16	23	5	118

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Cell Biology, Reproductive Biology And Developmental Biology **Course Code:** 03ZO222

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
03ZO222**1.** Develop deeper understanding of what is life and function of cell membrane and other cell organells.	3	2	2	2	09
03ZO222**.2.** Understand the nature and basic concept of developmental biology.	2	4	3	2	11
03ZO222**.3.** Understand the importance latest reproductive trends, reproductive techniques to be applied for human welfare.	2	3	3	2	10
03ZO222**.4.** Describe the general pattern and sequential developmental stages and developmental processes lead to establishment of body plan of multicellular organisms	3	2	2	3	10
03ZO222**.5.** Understand about evolutionary development of various animal.	3	2	2	3	10
Total Marks	**13**	**13**	**12**	**12**	**50**

***Legend*:A,** Apply;**An,** Analyze;**E,** Evaluate;**C,** Create

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1	A Textbook of embryology Arumugam Saaras Publication 2005
2	Textbook on Fundamentals and Applications of Nanotechnology V.B. Rastogi KNRN Publication 2020
3	Cell biology, Genetics and evolution, P.K. Gupta , Rastogi publication 2013
4	A Textbook of Cytology Verma & Agarwal, S. Chand & Co. 1999

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Demonstration
7. ICT Based teaching Learning
8. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Sc. Biology
Semester: 2nd Semester
Course Title: Cell Biology, Reproductive Biology and Developmental Biology
Course Code: 03ZO222

CO/PO/PSO Mapping								
Course Outcome (Cos)	**Program Outcomes (POs)**					**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**
03ZO222 **.1.** Develop deeper understanding of what is life and function of cell membrane and other cell organelles.	2	2	3	2	1	3	2	3
03ZO222 **.2.** Understand the nature and basic concept of developmental biology.	1	1	3	2	1	2	3	3
03ZO222 **.3.** Understand the importance latest reproductive trends, reproductive techniques to be applied for human welfare.	2	2	2	1	1	3	2	3
03ZO222 **.4.** Describe the general pattern and sequential developmental stages and developmental processes lead to establishment of body plan of multicellular organisms	1	1	3	3	2	1	1	3
03ZO222 **.5.** Understand about evolutionary development of various animal.	2	1	2	3	1	1	1	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5 PSO 1,2,3	03ZO222**1.** Develop deeper understanding of what is life and function of cell membrane and other cell organelles.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	1.1,1.2,1.3	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9,1.10,1.11,1.12	1SL-1,2,3,4,5,6
PO 1,2,3,4,5 PSO 1,2,3	03ZO222 **.2.** Understand the nature and basic concept of developmental biology.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	2.1, 2.2, 2.	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9,1.10,1.11,1.12	2SL-1,2,3,4,5
PO 1,2,3,4,5 PSO 1,2,3	03ZO222 **.3.** Understand the importance latest reproductive trends, reproductive techniques to be applied for human welfare.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	3.1,3.2,3.3,3	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9,1.10,1.11,1.12	3SL-1,2,3,4
PO 1,2,3,4,5 PSO 1,2,3	03ZO222 **.4.** Describe the general pattern and sequential developmental stages and developmental processes lead to establishment of body plan of multicellular organisms	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	4.1,4.2,4.3	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9,1.10,1.11,1.12	4SL-1,2,3,4,5
PO 1,2,3,4,5 PSO 1,2,3	03ZO222 **.5.** Understand about evolutionary development of various animal.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	5.1,5.2,5.3	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9,1.10,1.11,1.12	5SL-1,2,3,4

B.Sc. IInd Semester

Course Code: 03CH223

Course Title: Fundamentals Of Chemistry

Pre- requisite: To study this course our students must have had the subject Chemistry in class +2 or equivalent.

Rationale: Up on completion of the course student shall be able to learn about Chemical techniques, Elementary idea of the properties of the elements, Acid-Base concept and Fundamentals of Organic Chemistry Structure.

Course Outcomes:- By the end of this course students will learn the following aspects of Chemistry:

1. Various theories and principles applied to reveal atomic structure.
2. Significance of quantum numbers.
3. Concept of Periodic table & periodic properties of elements of elements.
4. Theories related to chemical bonding.
5. Acid-base concept, ph, buffer and Properties of electrolytes and Basics and mechanism of chemical kinetics.
6. Factors responsible for reactivity of organic molecules.

Unit -1

Atomic Structure:

Dual nature of particles and waves, de Broglie's equation, Heisenberg's Uncertainty principle and its significance. Quantum numbers and their significance. Rules for filling electrons in various orbitals, Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau principle and its limitations, Variation of orbital energy with atomic number. Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

UNIT -2

Periodic table & periodic properties

Effective nuclear number (EAN), shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table., Atomic radii (van der Waals) lonic and crystal radii, Covalent radii (octahedral and tetrahedral) lonization energy and factors affecting ionization energy, Applications of it.

Electronegativity- Pauling's/ Mulliken's electronegativity scales, Variation of electronegativity with bond order, partial charge.

UNIT-3

Chemical Bonding

Ionic bonding & Energy: lattice & solvation energies and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy. Born-Haber cycle and its applications Covalent character in ionic compounds, polarizing power and polarizability, Fajans rules.

Covalent bonding: Lewis structure, Valence Bond theory (Heitler- London approach).

Hybridization- Concept, types (SP, SP2, SP3 ,dSP2 ,d2SP suitable examples of inorganic and organic molecules

Valence shell electron pair repulsion theory (VSEPR) theory: Assumptions, need of theory, application of theory to explain geometries or shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements as: NH3, H2O, SF4, CIF3, PCl5, SF6, XeF4

Molecular orbital (MO) concept of bonding

The approximations of the theory, Linear combination of atomic orbitals (LCAO) (elementary pictorial approach) Rules for the LCAO method, bonding and antibonding MOs. Characteristics for ss, sp and p - p combinations of atomic orbitals, nonbonding combination of orbitals. MO diagrams of homonuclear diatomic molecules: H2, N2, O2 F2 and their ions. Molecular orbitals of heteronuclear diatomic molecules: NO, CO.

Unit-4

Acid-Base concept &Ionic Equilibria:

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water .Common ion effect, Salt hydrolysis-calculation of hydrolysis constant. Solubility and solubility product of sparingly soluble salts-applications of solubility product.

Arrhenius concept, Bronsted-Lowry's concept, conjugate acids and bases, relative strength of acids, Lewis concept. pH, buffer solutions. Acid-base neutralisation curves, Handerson equation.

Chemical kinetics

Rate of reaction, Definition and difference of order and molecularity. Derivation of rate constants for first, second, third and zero order reactions and examples. Derivation for half-life period. Methods to determine the order of reactions. Effect of

temperature on rate of reaction. Arrhenius equation, concept of activation energy.

Unit-5 Structure, reactivity and stereochemistry of organic molecules:

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis.Reactive Intermediates: Carbocations, Carbanions and free radicals. Nucleophiles and electrophiles. Determination of configuration of geometric isomers. E & Z system of nomenclature, Elements of symmetry, molecular chirality, enantiomers& their properties,stereogenic centre, optical activity of enantiomers. Concept of chirality (up to two carbon atoms): chiral and achiral molecules with two stereogenic centres, diastereomers, threo and erythroisomers, meso. isomer, resolution of enantiomers, inversion, retention and racemization. Relative and absolute configuration, sequence rules, D & L. and R & S systems of nomenclature. Conformations and Conformational analysis Conformations of ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newman, Sawhorse and Fischer representations.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (Cl+LI+SW+SL)	
Program Core (PCC)	03CH223	FUNDAMENTAL CHEMISTRY	4	4	1	1	6	6

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial

(T) And others),

LI: Laboratory Instruction (Includes Practical performances in laboratory workshop,field or other locations using different instructional strategies)

SW: Sessional Work (includes assignment, seminar, mini project etc.),

SL: Self Learning,

C: Credits

Note: SW & SL has to be planned and performed under the continuous guidance and feedback ofteacher to ensure outcome of Learning.

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment5 number 3 marks each (CA)	Class Test2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA +AT)		
DCC	03CH223	Fundamentals of Chemistry (Paper I)	15	20	10	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

03CH223- . Various theories and principles applied to reveal atomic structure, Significance of quantum numbers.

Approximate Hours

Activity	Apex Hrs
Cl	12
LI	12
SW	2
SL	1
Total	27

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO1.1 Discuss about development and limitations of atomic models, De Broglie's equation, Heisenberg's SO1.2 Restate quantum numbers and their significance. Uncertainty principle and its significance. SO1.3 Explain and apply the concept of rules for filling electrons in various orbital's and its limitations. SO1.4 Explain and apply the variation of orbital energy with atomic number. Electronic configurations of the atoms SO1.5 Describe broader vision of exchange of energy and relative energies of atomic orbitals. .	**Unit-1** **Qualitative inorganic analysis** **1.1** Identification of simple inorganic mixture (5 radicals) with two/three acidic and two/three basic radicals (including typical combinations), **1.2** special emphasis on learning theoretical concepts of strong, moderate and weak electrolytes, **1.3** ionic products, common ion effect. Solubility and solubility product.	**Atomic Structure:** 1.1 Dual nature of particles and waves, de Broglie's equation, Heisenberg's. 1.2 Uncertainty principle and its significance. Quantum numbers and their significance. 1.3 Rules for filling electrons in various orbitals, Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau principle and its limitations. 1.4 Variation of orbital energy with atomic number. Electronic configurations of the atoms. 1.5 Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.	Electronic configurations of the 1 to 30 elements in periodic table.

SW-1 Suggested Sessional Work (SW):

a. Assignments:

Explain Dual nature of particles and waves, de Broglie's equation and Heisenberg's.

b. Mini Project:

Concept of Quantum numbers and their significance

c. Other Activities (Specify):

Electronic configurations of the atoms and Stability of half-filled & completely filled orbitals.

03CH223-Concept of Periodic table & periodic properties of elements of elements..

Approximate Hours

Activity	AppX Hrs
Cl	13
LI	12
SW	2
SL	1
Total	28

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 Discuss about brief history of development of periodic table and its significance. SO2.2 Restate Effective nuclear number (EAN), shielding or screening effect & Slater rules. SO2.3 Explain and apply the concept of Atomic radii and crystal radii. SO2.4 Explain and apply the variation lonization energy and factors affecting it. SO2.5 Describe broader vision of Electronegativity and types of electronegativity scales .	1. Detection of hetero-elements (N, S, Cl, Br, I) in organic compounds 2. Functional group tests for alcohol, aldehyde, carboxylic acid. carbohydrate, phenols, nitro, amine and amide. 3.Quantitative analysis of acid, alkali and buffer solutions	**Periodic table & periodic properties** 2.1 Brief history of development of periodic table and its significance. 2.2 Effective nuclear number (EAN), shielding or screening effect. Slater rules, variation of effective nuclear charge in periodic table. 2.3 Atomic radii (vander Waals) lonic and crystal radii, Covalent radii (octahedral and tetrahedral). 2.4 lonization energy and factors affecting ionization energy, Applications of it. 2.5 Electronegativity- Pauling's/ Mulliken's electronegativity scales, Variation of	Determination of Effective nuclear number (EAN) by Slater rules for some elements of s & p block.

		electronegativity with bond order, partial charge.	

SW-2 Suggested Sessional Work (SW):

A .Assignments:

Determination of Effective nuclear number (EAN) by Slater rules for some elements of s & p block.

b. Mini Project:

lonization energy and factors affecting ionization energy, Applications of it.

c. Other Activities (Specify):

Write an essay on Atomic radii (vander Waals) lonic and crystal radii.

03CH223-Theories related to chemical bonding.

Approximate Hours

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Activity	AppX Hrs
Cl	11
LI	12
SW	2
SL	1
Total	26

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Discussion about Ionic bonding & Energy: lattice & solvation energies. SO3.2 Restate Born-Landé equation for calculation of lattice energy. Born-Haber cycle. SO3.3 Explain and apply the concept of Covalent character, polarizability and Fajans rules. SO3.4 Explain and apply the Covalent bonding by VBT, Hybridization, (VSEPR) theory.	**Unit -3** **Ionic Equilibria** 1. Measurement of pH of different solutions of acids and alkalies using pH- meter (may use aerated drinks, fruit juices, shampoos and soaps) Note-use dilute solutions of soups and shampoos to prevent damage to the glass electrode 2. Measurement of the pH of buffer solutions and comparison of the values with theoretical values.	**UNIT-3** **Chemical Bonding** 3.1 Ionic bonding & Energy: lattice & solvation energies and their importance. 3.2 Statement of Born-Landé equation for calculation of lattice energy. Born-Haber cycle and its applications. 3.3 Covalent character in ionic compounds, polarizing power and polarizability, Fajans rules. 3.4 Covalent bonding, Lewis structure, VBT, Hybridization, (VSEPR) theory.	Discuss hybridization with suitable examples of linear, trigonal planar, square planar etc.

SO3.5 Describe broader concept of Molecular orbital (MO) bonding & MO diagram,(LCAO). .	3. Preparation of buffer solutions and determination of their pH and buffer capacity: (1) Sodium acetate-acetic acid (ii) Ammonium chloride-ammonium hydroxide	3.5Molecular orbital (MO) concept of bonding (LCAO)MO diagrams of homonuclear diatomic molecules: H2, N2, O2 F2 and their ions. Molecular orbitals of heteronuclear diatomic molecules: NO, CO.	

SW-3 Suggested Sessional Work (SW):

a. Assignments:

Discuss hybridization with suitable examples of linear, trigonal planar, square planar etc.

b. Mini Project:

Hybridization- Concept, types (SP, SP2, SP3 , dSP2 ,d2SP suitable examples of inorganic and organic molecules

c. Other Activities (Specify):

Explanatory note on Rules for the LCAO method, bonding and anti-bonding MOs. Characteristics for ss, sp and p - p combinations of atomic orbitals, nonbonding combination of orbitals.

03CH223- Acid-base concept, ph, buffer and Properties of electrolytes and Basics and mechanism of chemical kinetics.

Activity	AppX Hrs
Cl	13
LI	12
SW	2
SL	1
Total	28

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Discussion about electrolytes and its types degree of ionization, factors affecting it. SO4.2 Restate common ion effect Solubility and solubility product.		**Unit-4** **Acid-Base concept &Ionic Equilibria:** 4.1 Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. 4.2 Common ion effect, Salt hydrolysis. Solubility and solubility product of	Discuss degree of ionization, factors affecting degree of ionization.

SO4.3 Explain and apply the concept of acids and bases, relative strength pH, buffer solutions. SO4.4 Explain and apply Rate of reaction, order and molecularity. SO4.5 Describe broader concept of first, second, third and zero order reactions.		sparingly soluble salts-applications of solubility product. 4.3 Arrhenius concept, Bronsted-Lowry's concept, conjugates acids and bases, relative strength of acids, Lewis concept. pH, buffer solutions. 4.4 Chemical kinetics Rate of reaction, Definition and difference of order and molecularity. 4.5 Derivation of rate constants for first, second, third and zero order reactions and examples. Derivation for half-life period.	

SW-4 Suggested Sessional Work (SW):

Assignments:

pH, buffer solutions. Acid-base neutralization curves, Henderson equation

Mini Project:

Methods to determine the order of reactions.

Other Activities (Specify):

Solubility and solubility product of sparingly soluble salts-applications of solubility product.

03CH223-Factors responsible for reactivity of organic molecules.

Activity	AppX Hrs
Cl	11
LI	12
SW	2
SL	1
Total	26

Session Outcomes (SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Discussion about Electronic Displacements SO4.2 Restate Cleavage of Bonds and explain reactive Intermediates like Carbocations, Carbanions & FR.	.	**Unit-5 Structure, reactivity and stereochemistry of organic molecules:** 5.1 Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation.	chiral and achiral molecules with two stereogeniccentres, diastereomers, threo and erythroisomers, meso isomer.

SO4.3 Explain and apply the concept of configuration of geometric isomers. E & Z, D & L system of nomenclature. SO4.4 Explain and apply configuration of geometric isomers. SO4.5 Describe broader concept Relative and absolute configuration. Conformations isomerism.		5.2 Cleavage of Bonds: Homolysis and Heterolysis. Reactive Intermediates Carbocations, Carbanions and free radicals. Nucleophiles and electrophiles. 5.3 Determination of configuration of geometric isomers. E & Z , D & L system of nomenclature. 5.4symmetry, chirality, enantiomer stereogeniccentre, optical activity diastereomers, threo and erythroisomers, meso , Isomer. 5.5 Relative and absolute configuration, sequence rules, Conformations of ethane, butane and cyclohexane. Sawhorse and Fischer representations .	

SW-5 Suggested Sessional Work (SW):

Assignments:

Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation.

Mini Project:

Conformations and Conformational analysis Conformations of ethane, butane and cyclohexane.

Other Activities (Specify):

Elements of symmetry, molecular chirality, enantiomers& their properties, stereogeniccentre, optical activity .

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Laboratory Instruction (LI)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
03CH223 **Various theories and principles applied to reveal atomic structure. Significance of quantum numbers.**	12	12	02	01	27
03CH223- **Concept of Periodic table & periodic properties of elements of elements.**.	13	12	02	01	28

03CH223 **Theories related to chemical bonding**	11	12	02	01	26
03CH223 **Acid-base concept, ph, buffer and Properties of electrolytes and Basics and mechanism of chemical kinetics**	13	12	02	01	28
03CH223 **Factors responsible for reactivity of organic molecule**	11	12	02	01	26
Total Hours	60	60	10	05	135

Suggestion for End Semester Assessment

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	**Atomic Structure**	03	01	01	05
CO-2	**Periodic table & periodic properties**	02	06	02	10
CO-3	**Chemical Bonding**	03	04	03	10
CO-4	**Acid-Base concept &Ionic Equilibria:**	-02	08	05	15
CO-5	**Structure, reactivity and stereochemistry of organic molecules**	03	02	-05	10
Total		13	21	16	50

Suggested Specification Table (For ES

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for Organic Chemistry I will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks.Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture

2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to NCL, CSIR laboratories
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT,Blog, Facebook,Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorm

Suggested Learning Resources:

(a) Books :

S. No.	Title	Author	Publisher	Edition & Year
1	Concise Inorganic Chemistry	Lee, J.D.	ELBS	1991
2	J., Chemistry For B.Sc. Ist Year	Khera, H.C., Gurtu, J.N., Singh	Pragati prakashan	First Edition 2010
3	Molecular Modeling in Drug Design	Rebecca Wade and Outi Salo-Ahen ,	MDPI	March 2019
4	Bariyar, A. & Goyal, S	B.Sc. Chemistry Combined	Krishna Educational Publishers Year: 2019	2021
5	Puri, B. R., Pathania, M.S., Sharma, L. R	Physical Principles Chemistry	Vishal Publishing Co.	2020.

Mode of Delivery: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point;

LMS/ICT Tools: Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Course Title: FUNDAMENTAL CHEMISTRY **Course Code : 03CH223**

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO 8**	**PO9**	**PO 10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
	Know ledge	**Rese arch Apti tude**	**Commu nication**	**Pro ble m Solv ing**	**Indiv idual and Team Wor k**	Investi gation of Proble ms	**Mo der n Too l usa ge**	**Scie nce and Soc iety**	**Life-Lon g Lear ning**	**Et hic s**	**Project Manag ement**	**Enviro nment and sustain ability**	**The detailed function al knowle dge of theoreti cal concept s and experim ental aspects of chemist ry**	**To integrat e the gained knowled ge with various contemp orary and evolving areas in chemica l sciences like analytic al, syntheti c, pharma ceutical etc.**	**unders tand, analyze , plan and implem ent qualita tive as well as quantit ative analyti cal synthet ic and pheno menon-based proble ms in chemic al science s.**	**Provid e opport unities to excel in acade mics, resear ch or Indust ry by resear ch based innova tive knowl edge for sustain able develo pment in chemic al science**
03CH223 Various theories and principles applied to reveal atomic	**3**	**1**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**3**	**2**	**2**	**3**	**3**	**1**

structure, Significance of quantum numbers.																
03CH223 Concept of Periodic table & periodic properties of elements of elements..	**2**	**1**	**2**	**2**	**1**	**2**	**3**	**2**	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**1**
03CH223 Theories related to chemical bonding	**2**	**2**	**1**	**1**	**1**	**2**	**2**	**2**	**1**	**2**	**1**	**2**	**1**	**1**	**2**	**2**
03CH223 Factors responsible for reactivity of organic molecules	**2**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**2**	**3**	**3**	**3**	**3**	**2**
03CH223 Related the structure and physical	**2**	**1**	**1**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**3**	**1**	**3**

properties of drugs to their pharmacological activity. Explain physio-chemical properties related to QSAR.																

Legend:1–Low,2–Medium, 3–High

POs &PSOsNo.	Cos No. &Titles	SOsNo.	Laboratory instruction (LI)	Classroom Instruction(CI)	Self Learning(SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	03CH223 **1:** Various theories and principles applied to reveal atomic structure, Significance of quantum numbers .	SO1.1SO1.2SO1.3SO1.4 SO1.5		Unit-1.0 Symmetry and Group Theory 1.1,1.2,1.3,1.4,1.5,1.6,1.7	Character tables and their use in spectroscopy.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	03CH223 Concept of Periodic table & periodic properties of elements of elements..	SO2.1SO2.2SO2.3 SO2.4 SO2.5		Unit-2 **Vibrational Spectroscopy** 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9	Resonance Raman Spectroscopy, coherent anti-stokes Raman Spectroscopy (CARS).
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	03CH223 Theories related to chemical bonding	SO3.1SO3.2 SO3.3 SO3.4 SO3.5		Unit-3 : **Mössbauer Spectroscopy** 3.1, 3.2,3.3,3.4,3.5,3.6,3.7	Nature of M-L bond, coordination number, structure and detection of oxidation state.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	03CH223 Factors responsible for reactivity of organic molecules	SO4.1SO4.2SO4.3SO4.4 SO4.5		Unit-4 : : **Magnetic Resonance Spectroscopy** 4.1, 4.2,4.3,4.4,4.5,4.6,4.7	Quadrupole nuclei, quadrupole moments, electric field gradient, coupling constant splitting. Applications

PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	03CH223 Related the structure and physical properties of drugs to their pharmacological activity. Explain physio-chemical properties related	SO5.1SO5.2SO5.3SO5.4 SO5.5		**Unit 5: X-ray Diffraction , Electron Diffraction** **Neutron Diffraction** 5.1,5.2,5.3,5.4,5.5,5.6,5.7	Low energy electron diffraction and structure of surfaces. ,

Curriculum Development Team:

1. Dr. Shailendra Yadav, HoD, Department of Chemistry, AKS University, Satna (M.P.).
2. Dr. Dinesh Kumar Mishra, Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
3. Dr. Samit Kumar,Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
4. Dr. Sushma Singh, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
5. Dr. Manoj Kumar Sharma, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
6. Mr. Kanha Singh Tiwari,Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
7. Mrs. Nahid Usamani, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).

Course Code: 0EVS03

Course Title: Environmental Education

Pre-requisite: To study this course, the student must have a knowledge about the environmental components, pollution, biodiversity, and ecosystem at senior secondary, **Class** 12'h level.

Rationale: The students studying Environmental Science should possess foundational understanding about environment and its components. They should also know the importance of ecosystems in our surroundings.

Course Outcomes:

0EVS03.1: To understand various aspects of life forms, ecological processes, and the impacts on them by the human during Anthropocene era.

0EVS03.2: To build capabilities to identify relevant environmental issues, analyze the various underlying causes, evaluate the practices and policies, and develop framework to make inform decisions.

0EVS03.3: To develop empathy for all life forms, awareness, and responsibility towards environmental protection and naturepreservation.

0EVS03.4: To develop the critical thinking for shaping strategies such as; scientific, social. economic. administrative & legal. environmental protection, conservation of biodiversity. environmental equity and sustainabledevelopment.

0EVS03.5: To prepare for the competitiveexams.

Scheme of Studies:

Board ofStudy	CourseCode	CourseTitle	Scheme of studies(Hours/Week)					TotalCredits (C)
			Cl	LI	SW	SL	Total StudyHours(CI+LI +SW+SL)	
AEC	0EVS03	Environmental Science	2	0	1	1	5	2

Legend: CI: ClassroomInstruction(Includesdifferentinstructionalstrategiesi.e.,Lecture(L)andTutorial (T)andothers),
LI: LaboratoryInstruction(IncludesPracticalperformancesinlaboratoryworkshop, field or other locations using different instructional strategies)
SW: Sessional Work(includesassignment, seminar, miniprojectetc.),
SL: SelfLearning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback ofteacherto ensureoutcomeofLearning.

Scheme of Assessment:

Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment	Total Marks
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	(ESA)	(PRA+ ESA)
AEC	OEVS202	Environmental Science	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

0EVS03.1: To understand various aspects of life forms, ecological

processes, and the impacts on them by the human during Anthropocene era.

Approximate Hours

Item	AppX Hrs.
Cl	08
LI	0
SW	1
SL	2
Total	11

Session Outcomes	Laboratory	ClassroomInstruction	Self-Learning

(SOs)	Instruction (LI)	(CI)	(SL)
SO1.1Know multidisciplinary nature of environmental science. SO1.2 Learn about the natural resources. SO1.3Know the problems associated with land resource. SO1.4Learn the conservation of resources. SO1.5 Know alternative energy resources.	.	**Unit-1 Environment and Natural Resources:** 1.1 The Multidisciplinary nature of environmental studies. 1.2 Scope and Importance of Environmental studies 1.3 Components of Environment: Atmosphere, Hydrosphere, Lithosphere, and Biosphere. 1.4 Brief account of Natural Resources and associated problems 1.5 Land Resource 1.6 Water Resource 1.7 Energy Resource 1.8 Concept of Sustainability and Sustainable Development	i. What is environmental Science? ii. What are resources?

SW-1 SuggestedSessionalWork(SW):

a. Assignments:

- **i.** Write thedefinition and causes of soil erosion.
- **ii.** Define desertification and write its causes.
- **iii.** Describe structure of atmosphere.
- **iv.** Explain lithosphere.

0EVS03.2: To build capabilities to identify relevant environmental issues, analyze the various underlying causes, evaluate the practices and policies, and develop framework to make inform decisions.

Approximate Hours

Item	AppXHrs
CI	05
LI	0
SW	2
SL	2
Total	09

SessionOutcomes (SOs)	LaboratoryInstruction (LI)	ClassroomInstruction (CI)	Self-Learning (SL)
SO2.1 Understand the concept of ecosystem. **SO2.2**Learn the structure of ecosystem. **SO2.3**Know the function of ecosystem. **SO2.4**Describe the structure of forest ecosystem. **SO2.**5 Learn about biodiversity and its conservation.		Unit-2 Biomes, **Ecosystem and Biodiversity** 2.1 Major Biomes: Tropical, Temperate, Forest, Grassland, Desert, Tundra, Wetland, Estuarine and Marine 2.2 Ecosystem: Structure 2.3 Function and types 2.4 their Preservation & Restoration 2.5 Biodiversity and its conservation practices.	i.What is biotic and abiotic components of environment ? ii. What are interactions?

SW-2 SuggestedSessionalWork(SW):

a. Assignments:

i. What do you mean by ecosystem? Describe the structure of ecosystem.
ii. Give a brief classification of ecosystem.
iii. Write the function of an ecosystem.
iv. Define biodiversity write strategies of biodiversity conservation.

b. MiniProject:

Visit to various ecosystem and study biotic and abiotic ecosystem.

0EVS03.3: To develop empathy for all life forms, awareness, and responsibility towards environmental protection and nature preservation.

Approximate Hours

Item	AppXHrs
Cl	07
LI	0
SW	02
SL	2
Total	11

SessionOutcomes (SOs)	LaboratoryInstruction (LI)	ClassroomInstruction (CI)	Self-Learning (SL)
SO3.1. Learn about pollution and its sources. **SO3.2**Know the sources of different pollutant. **SO3.3**Understand the law & legislation related to environment. **SO3.4**Learn the control of pollution. 3.1 **SO3.**5 Describe the role of information technology in environment and human health.		**Unit-3:Environmental Pollution, Management and** Social **Issues:** 3.2 Pollution: Types, Control measures, Management and associated problems. 3.3 Environmental Law and Legislation: Protection and conservation Acts. 3.4 International Agreement &**Program** 3.5 Environmental Movements, communication and public awareness Program. 3.6 National and International organizations related to environment conservation and monitoring. 3.7 Role of information technology in environment and human health.	i. What is pollution basic introduction? ii. What is pollutant?

SW-3 Suggested Sessional Work (SW):

a. Assignments:

i. Write an essay on air pollution.
ii. What do you mean by acid rain write its causes and effects.
iii. Describe the effects of water pollution.
iv. How soil pollution can be control?
v. Describe the role of information technology in environment and human health.
vi. Mention some national and international organizations related to environment conservation and monitoring.

b. Other Activities (Specify):

Visit to different polluted sites and study the source of pollution and their effects.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self-Learning (Sl)	Total hour (Cl+SW+Sl)
0EVS03.1: To understand various aspects of life forms, ecological processes, and the impacts on them by the human during Anthropocene era.	08	1	2	11
0EVS03.2: To build capabilities to identify relevant environmental issues, analyze the various underlying causes, evaluate the practices and policies, and develop framework to make inform decisions.	05	2	2	09
0EVS03.3: To develop empathy for all life forms, awareness, and responsibility towards environmental protection and nature preservation.	07	2	2	11
Total Hours	20	05	06	31

Suggestion for End Semester Assessment

SuggestedSpecificationTable(ForESA)

CO	UnitTitles	MarksDistribution			Total Marks
		R	U	A	
CO-1	**Environment and Natural Resources:**	03	01	01	05
CO-2	Biomes, **Ecosystem and Biodiversity**	02	06	02	10
CO-3	**Environmental Pollution, Management and** Social **Issues**	03	07	05	15
Total		11	26	13	50

Legend: R: Remember, U: Understand, A: Apply

Theendofsemesterassessmentfor Fundamental of Environmental Sciencewillbeheldwith written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wiseteachers for above tasks. Teachers can also design different tasks as per requirement, for endsemesterassessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. CaseMethod
4. GroupDiscussion
5. RolePlay
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/ Tutorials CBT, Blog, Face book, Twitter, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition&Year
1	Ecology; Environment Science and Conservation	Singh; J.S., Singh S.P. and Gupta, S. R	S. Chand publishing, New Delhi.	2018
2	Perspectives in Environmental Studies	Kaushik, Anubha, Kaushik, C.P.	New age International Publishers	2018
3	A Textbook of Environmental Studies	Asthana, D. K Asthana Meera	S. C1iand.Publishing, New Delhi	2007
4	Environmental Law and Policy in India: Cases, Material & Status	Divan, S. and Rosenkranz, A	Oxford University Press, India	2002

Course Code: **0IKS04**

Course Title: Indian Knowledge System

Pre- requisite: Creating awareness among the youths about the true history and past rich culture of India.

Rationale: India has very rich and versatile knowledge system and cultural heritage since antiquity. The Indian Knowledge systems was developed on life science, medical science, literature, drama, art, music, dance, astronomy, mathematics, architecture (Sthapatyaveda), chemistry, aeronautics etc, during ancient period. In this basic course, a special attention is given to the ancient and historical perspective of ideas occurrence in the ancient society, and implication to the concept of material world and religious, social and cultural beliefs. On the closer examination, religion, culture and science have appeared epistemological very rigidly connected in the Indian Knowledge System. This land of Bharat Bhumi has provided invaluable knowledge stuff to the society and the world in all sphere of life.

Course Outcomes:

CO- 0IKS04. 1: To understand the ancient civilization, Indian Knowledge Systems, Concept of Panch Mahabhuta, Origin of name Bharat Varsha, Ancient Rivers, Ancient Universities and ancient agriculture.

CO- 0IKS04.II: Students will have the ability to learn about ancient books, Religious places, basic concept of Indian dance, music and arts, and fundamental aspects of Sangeeta and Natyashashtra etc.

CO- 0IKS04.III: Student will be able to gain knowledge on Vedic Science, Astronomy, Astrovastu, Vedic Mathematics, Aeronautics, Metallurgy, Nakhatras, Panchang, Concept of Zero, Pi and point etc.

CO- I0IKS04. IV: Understanding on ancient Engineering, Science and Technology, Town Planning, Temple architecture, Chemistry and Metallurgy, Metal manufacturing etc.

CO- I0IKS04. V: Student will able to understand about the Life, Nature and Health through basic concept of Ayurveda andYoga, Traditional Medicinal Systems, Ethnomedicine, Nature conservation, World Heritage Sites etc.

Scheme of Studies:

Category of Course	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours CI+LI+SW+SL	
AEC	**0IKS04**	Indian Knowledge System	2		1	1	4	2

Legend:

CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Session Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Proposed examination scheme (Marking) as per the recommendation of University Grant Commission (UGC) for Under Graduate Courses in Fundamentals of Indian Knowledge Systems 2022-23 onwards

S. No.	Category of Course/Subject	Components of Marks				Total
		Semester End Examination (External	Mid Term exam (Internal)	Assignment (Internal)	Practical Exam (Internal)	
1	Only Theory Subject Course					
2	Subject/ Course with theory and Practical					
3	Subject/ Course only Practical					

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

0IKS04. 1. To understand Indian Civilization and Indian Knowledge Systems

Approximate Hours

Item	Approximate Hours
CI	**6**
LI	
SW	**2**
SL	**1**
Total	**9**

Session Outcomes (SOs)	Laboratory	Class room Instruction (CI)	Self Learning

	Instruction (LI)		(SL)
SO 1.1. Understand Overview of Indian Knowledge Systems (IKS) SO 1.2. Understand Classification of Ancient IKS texts SO 1.3. Understand Introduction to Panch Mahabhutas (Earth, Water, Fire, Sky and Air) SO 1.4. Understand Origin of the name Bharatvarsha: the Land of Natural Endowments SO 1.5. Understand Rivers of ancient India (The Ganga, Yamuna, Godawari, Saraswati, Narmada, Sindhu and Kaveri) SO 1.6. Understand Ancient Agriculture and ancient Universities: Takshashila and Nalanda, Gurukul system		**Unit-1. Indian Civilization and Indian Knowledge Systems** 1.1.Overview of Indian Knowledge Systems (IKS) 1.2 Classification of Ancient IKS texts 1.3 Introduction to Panch Mahabhutas (Earth, Water, Fire, Sky and Air) 1.4 Origin of the name Bharatvarsha: the Land of Natural Endowments 1.5 Rivers of ancient India (The Ganga, Yamuna, Godawari, Saraswati, Narmada, Sindhu and Kaveri) 1.6 Agriculture system in ancient India, Ancient Universities: Takshashila and Nalanda, Gurukul system	Golden era of ancient India

SW-1 Suggested Sessional Work (SW):

a. **Assignments:**
   i. Concepts of Panch Mahabhuta, Classification of ancient texts, origin of ancient rivers
b. **Mini Project:**
   i. Ancient Universities: Takshashila and Nalanda,
c. **Other Activities (Specify):**

0IKS04.2: Students will have the ability to apply the knowledge gained about Indian Art, Literature and Religious Places

Approximate Hours

Item	Approximate Hours
CI	**6**
LI	
SW	**2**
SL	**1**
Total	**9**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO 2.1. Understand the Ancient Indian Books: Vedas, Puranas, Shastras, Upanishads, Mahakavyas (Ramayana & Mahabharata), Smrities, Samhitas SO 2.2. Understand the Religious places: Puries, Dhams, Jyotiralinga, Shaktipeeths, Kumbha Mela SO 2.3. Understand the Legendary places of Madhya Pradesh: Ujjain, Chitrakoot, Omkareshwar, Bharhut, Maihar SO 2.4. Understand the Basic concept of Indian Art, Music and Dance, Indian Musical Instruments SO 2.5. Understand the Fundamental aspects of Sangeeta and Natya shastra SO 2.6. Understand the different schools of music, dance and painting in different regions of India		**Unit-2. Indian Art, Literature and Religious Places** 2.1. Ancient Indian Books: Vedas, Puranas, Shastras, Upanishads, Mahakavyas (Ramayana & Mahabharata), Smrities, Samhitas 2.2. Religious places: Puries, Dhams, Jyotiralinga, Shaktipeeths, Kumbha Mela 2.3. Legendary places of Madhya Pradesh: Ujjain, Chitrakoot, Omkareshwar, Bharhut, Maihar 2.4. Basic concept of Indian Art, Music and Dance, Indian Musical Instruments 2.5. Fundamental aspects of Sangeeta and Natya shastra 2.6. Different schools of music, dance and painting in different regions of India	**1.** Indian Art, Music and Dance

SW-2 Suggested Sessional Work (SW):

a. Assignments:

i. Visit of Chitrakoot, Maihar and Bharhuta

b. Mini Project:

ii. Kumbhmela, Story of Ramayana and Mahabharata

c. Other Activities (Specify):

0IKS04. 3: Student will be able to understand Ancient Science, Astronomy and Vedic Mathematics

Approximate Hours

Item	Approximate Hours
CI	**6**
LI	
SW	**2**
SL	**1**
Total	**9**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO 3.1. Understand Vedic Cosmology SO 3.2. Understand the Astronomy, Astrovastu, Vedang Jyotish, Nakshatras, Navagraha, Rashis, Vastushastra and their related plants SO 3.3. Understand the Time and Calendar, Panchang SO 3.4. Understand the Concept of Zero, Point, Pi -number system, Pythagoras SO 3.5. Understand the Vedic Mathematics, Vimana-Aeronautics, Basic idea of planetary model of Aryabhatta SO 3.6. Understand the Varanamala of Hindi language based on classification of sounds on		**Unit-3. Ancient Science, Astronomy, Mathematics** 3.1. Vedic Cosmology 3.2. Astronomy, Astrovastu, Vedang Jyotish, Nakshatras, Navagraha, Rashis, Vastushastra and their related plants 3.3. Time and Calendar, Panchang 3.4. Concept of Zero, Point, Pi -number system, Pythagoras 3.5. Vedic Mathematics, Vimana-Aeronautics, Basic idea of planetary model of Aryabhatta 3.6. Varanamala of Hindi language based on classification of sounds on the basis of their origin, Basic purpose of	1. Ancient Science, Astronomy and Vedic Mathematics

the basis of their origin, Basic purpose of science of Vyakarana		science of Vyakarana.	

SW-2 Suggested Sessional Work (SW):

a. Assignments:

1. Varanamala of Hindi language based on classification of sounds on the basis of their origin

b. Mini Project:

1. Nakshatras, Navagraha and their related plants

c. Other Activities (Specify):

0IKS04. 4: Understand the Engineering, Technology and Architecture

Approximate Hours

Item	Approximate Hours
CI	**6**
LI	
SW	**2**
SL	**1**
Total	**9**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO 4.1. Understand the Engineering Science and Technology in Vedic and Post Vedic Era SO 4.2. Understand the Town and Home planning, Sthapatyaveda SO 4.3. Understand the Chemistry and Metallurgy as gleaned from archeological artifacts SO 4.4. Understand the Chemistry of Dyes, Pigments used in Paintings, Fabrics, Potteries and Glass SO 4.5. Understand the Temple Architecture: Khajuraho,		**Unit-4. Engineering, Technology and Architecture** 4.1.Engineering Science and Technology in Vedic and Post Vedic Era 4.2.Town and Home planning, Sthapatyaveda 4.3.Chemistry and Metallurgy as gleaned from archeological artifacts 4.4 Chemistry of Dyes, Pigments used in Paintings, Fabrics, Potteries and Glass 4.5.Temple Architecture:	2. Ancient Science, Astronomy and Vedic Mathematics

Sanchi Stupa, Chonsath Yogini temple SO 4.6. Understand the Mining and manufacture in India of Iron, Copper, Gold from ancient times		Khajuraho, Sanchi Stupa, Chonsath Yogini temple 4.6.Mining and manufacture in India of Iron, Copper, Gold from ancient times	

SW-2 Suggested Sessional Work (SW):

a. Assignments:

i. Varanamala of Hindi language based on classification of sounds on the basis of their origin

b. Mini Project:

i. Nakshatras, Navagraha and their related plants

c. Other Activities (Specify):

0IKS04. 5: Understand about the Life, Nature and Health

Approximate Hours

Item	Approximate Hours
CI	**6**
LI	
SW	**2**
SL	**1**
Total	**9**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO 5.1. Understand the Fundamentals of Ayurveda (Charaka & Shushruta) and Yogic Science (Patanjali), Ritucharya and Dinacharya SO 5.2. Understand the Traditional system of Indian medicines (Ayurveda, Siddha, Unani and Homoeopathy) SO 5.3. Understand Fundamentals of Ethnobotany and Ethnomedicines of India		**Unit-5. Life, Nature and Health** 5.1.Fundamentals of Ayurveda (Charaka & Shushruta) and Yogic Science (Patanjali), Ritucharya and Dinacharya 5.2. Traditional system of Indian medicines (Ayurveda, Siddha, Unani and Homoeopathy) 5.3.Fundamentals of Ethnobotany and	1. Concept of Ayurveda and Yoga 2. Traditional system of Indian medicines 3. Ethnobotany and Ethnomedicines of India 4. World Heritage

SO 5.4. Understand the Nature Conservation in Indian ancient texts SO 5.5. Understand the Introduction to Plant Science in Vrikshayurveda SO 5.6. Understand the World Heritage Sites of Madhya Pradesh: Bhimbetka, Sanchi, Khajuraho		Ethnomedicines of India 5.4. Nature Conservation in Indian ancient texts 5.5 Introduction to Plant Science in Vrikshayurveda 5.6. World Heritage Sites of Madhya Pradesh: Bhimbetka, Sanchi, Khajuraho	Sites

SW-2 Suggested Sessional Work (SW):

a. Assignments:

i. Visit to world Heritage Site Khajuraho

b. Mini Project:

i. Ritucharya and Dincharya, Ethnomedicinal plants

c. Other Activities (Specify):

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
0IKS04. 1: To understand Indian Civilization and Indian Knowledge Systems	**6**	**2**	**1**	**9**
0IKS04. 2: Students will have the ability to apply the knowledge gained about Indian Art, Literature and Religious Places	**6**	**2**	**1**	**9**
0IKS04. 3: Student will be able to understand the Ancient Science, Astronomy and Vedic Mathematics	**6**	**2**	**1**	**9**
0IKS04. 4: Understand the Engineering, Technology and Architecture	**6**	**2**	**1**	**9**
0IKS04. 5: Understand about the Life, Nature and Health	**6**	**2**	**1**	**9**
Total	**30**	**10**	**5**	**45**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO 1	Indian Civilization and Indian Knowledge Systems	**2**	**5**	**1**	**8**

CO 2	Indian Art, Literature and Religious Places	**2**	**6**	**2**	**8**
CO 3	Ancient Science, Astronomy and Vedic Mathematics	**2**	**6**	**5**	**13**
CO 4	Engineering, Technology and Architecture	**2**	**4**	**4**	**10**
CO 5	Life, Nature and Health	**2**	**5**	**2**	**9**
Total		**10**	**26**	**14**	**50**

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for **Indian Knowledge Systems** will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course teacher for above tasks. Teacher can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to Religious places, World Heritage Sites
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	*An Introduction of Indian Knowledge Systems: Concept and Applications*	Mahadevan, B.; Bhat V. R. and Pavana, Nagendra R. N.	Prentice Hall of India.	2022
2	*Indian Knowledge Systems*: Vol. I and II.	Kapoor, Kapil and Singh, A. K.	D.K. Print World Ltd	2005
3	*Science of Ancient Hindus: Unlocking Nature in Pursuit of Salvation*	Kumar, Alok	Create pace Independent Publishing	2014
4	*A History of Agriculture in India*	Randhava, M.S.	ICAR, New Delhi	1980
5	*Panch Mahabhuta*,	Yogcharya, Jnan	Yog Satsang Ashram	2021

		Dev		
6	*The Indian Rivers*	Singh, Dhruv Sen	Springer	2018
7	*The Wonder That Was India*	Basam, Arthue Llewllyn	Sidgwick & Jackson	1954
8	*Ancient Cities, Sacred Skies: Cosmic Geometries and City Planning in Ancient India*	Malville, J. MacKim & Gujaral, Lalit M.	IGNCA & Aryan Books International, New Delhi	2000
9	*The Natya Shastra of Bharat Muni*	Jha, Narendra	Innovative Imprint, Delhi	2023
10	*Astronomy in India: A Historical Perspective*	Padmanabhan, Thanu	Indian National Science Academy, New Delhi & Springer (India).	2010
11	*History of Astronomy in India* 2nd Ed.	Sen, S.N. and Shukla, K.S.	INSA New Delhi	2001
12	*History of Indian Astronomy A Handbook*	Ramasubramanian, K.; Sule, Aniket and Vahia, Mayank	Science and Heritage Initiative, I.I.T. Mumbai and Tata Institute of Fundamental Research, Mumbai	2016
13	*Indian Mathematics and Astronomy: Some Landmarks*	Rao, Balachandra S.	Jnana Deep Publications, Bangalore, 3rd Edition	. 2004
14	*Vedic Mathematics and Science in Vedas*	Rao, Balachandra S.	Navakarnataka Publications, Bengaluru	2019
15	*A History of Hindu Chemistry*	Ray, Acharya Prafulla Chandra	Repbl Shaibya Prakashan Bibhag, Centenary Edition, Kolkata	1902
16	*Early Indian Architecture: Cities and City Gates*	Coomeraswamy, Anand	Munciram Manoharlal Publishers	2002
17	*Theory and Practices of Temple Architecture in Medieval India: Bhojas samrangasutradhar and the Bhojpur Line Drawings*	Hardy, Adams	Dev Publishers & Distributors.	2015
18	*Indian Science and Technology in Eighteenth Century*	Dharmpal	Academy of Gandhian Studies, Hyderabad.	1971
19	*Science in India: A Historical Perspective*	Subbarayappa, B.V.	Rupa New Delhi	2013
20	*Fine Arts & Technical*	Mishra, Shiv	Krishnadas Academy,	1982

	Sciences in Ancient India with special reference to Someswvara's Manasollasa	Shankar	Varanasi	
21	*Fundamental Principles of Ayurveda,* Volume One	Lad, Vasant D.	The Ayurvedic Press, Alboquerque, New Mexico.	2002
22	*Charak Samhita*, Chaukhamba	Pandey, Kashinath and Chaturvedi Gorakhnath	Vidya Bhawan, Varanasi	
23	*Ayurveda: The Science of Self-Healing*	Lad, Vasant D.	Lotus Press: Santa Fe	1984
24	*Ayurveda: Life, Health and Longevit*	Svoboda, Robert E	Penguin: London	1992
25	*Plants in the Indian Puranas*	Sensarma, P.	Naya Prokash, Calcutta	1989
26	*Indian Cultural Heritage Perspective for Tourism*	Singh, L. K.	Gyan Publishing House, Delhi	2008
27	*Glimpses of Indian Ethnobotany*	Jain, S.K.	Oxford & IBH Publishing Company Private Limited, New Delhi	1981
28	Manual of Ethnobotany	Jain, S.K.	Scientific Publishers, Jodhpur	2010

Curriculum Development Team:

1. Er. Anant Kumar Soni, Hon'ble Pro-Chancellor and Chairman, AKS University, Satna (M.P.).
2. Prof. B.A. Copade, Hon'ble Vice Chancellor, AKS University, Satna (M.P.).
3. Prof. G.C. Mishra, Director, IQAC, AKS University, Satna (M.P.).
4. Prof. R.L.S. Sikarwar, Director, Centre for Traditional Knowledge Research & Application, AKS University, Satna (M.P.).
5. Prof. Kamlesh Chaure, HOD, Department of Biotechnology, AKS University, Satna (M.P.).
6. Dr. Akhilesh Waoo, HoD, Department of Computer Science, AKS University, Satna (M.P.).
7. Dr. Shailendra Yadav, HoD, Department of Chemistry, AKS University, Satna (M.P.).
8. Dr. Kaushik Mukherji, HoD, Department of Management, AKS University, Satna (M.P.).
9. Dr. Neeraj Verma, PG Coordinator, Faculty of Agriculture Science and Technology, AKS University, Satna (M.P.)
10. Dr. Dilip Kumar Tiwari, HoD, Department of Yoga, AKS University, Satna (M.P.).
11. Shri Mirza Shamiullah Beg, Department of Arts, AKS University, Satna (M.P.).
12. Shri Vivek Shrivastava, Examination, AKS University, Satna (M.P.).
13. Shri Manish Agrawal, Department of Mining, AKS University, Satna (M.P.).

Cos,POs and PSOs Mapping

Programme Title: B.Sc. Biology
Course Code: 0IKS04
Course Title: Indian Knowledge System

Course Outcomes	Program Outcomes												Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO-1: To understand the ancient civilization, Indian Knowledge Systems, Concept of Panch Mahabhuta, Origin of name Bharat Varsha, Ancient Rivers, Ancient Universities and ancient agriculture.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO-2: Students will have the ability to learn about ancient books, Religious places, basic concept of Indian dance, music and arts, and fundamental aspects of Sangeeta and Natyashashtra etc.	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
CO-.3: Student will be able to gain knowledge on Vedic Science, Astronomy, Astrovastu, Vedic Mathematics, Aeronautics, Metallurgy, Nakhatras, Panchang, Concept of Zero, Pi and point etc.	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1
CO- 4: Understanding on ancient Engineering, Science and Technology, Town Planning, Temple architecture, Chemistry and Metallurgy, Metal manufacturing etc.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CO- 5: Student will able to understand about the Life, Nature and Health through basic concept of Ayurveda andYoga, Traditional Medicinal Systems, Ethnomedicine, Nature conservation, World Heritage Sites etc.	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2

Legend:1–Low,2–Medium, 3–High

Course Curriculum Map:

POs & PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction(CI)	Self Learning (SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**CO-1:** To understand the ancient civilization, Indian Knowledge Systems, Concept of Panch Mahabhuta, Origin of name Bharat Varsha, Ancient Rivers, Ancient Universities and ancient agriculture.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5		**Unit-1**: Indian Civilization and Indian Knowledge Systems 1.1,1.2,1.3,1.4,1.5,1.6	As mentioned
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**CO-2:** Students will have the ability to learn about ancient books, Religious places, basic concept of Indian dance, music and arts, and fundamental aspects of Sangeeta and Natyashashtra etc.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5		**Unit-2:** Indian Art, Literature and Religious Places 2.1,2.2,2.3,2.4,2.5,2.6	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**CO-.3:** Student will be able to gain knowledge on Vedic Science, Astronomy, Astrovastu, Vedic Mathematics, Aeronautics, Metallurgy, Nakhatras, Panchang, Concept of Zero, Pi and point etc.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5		**Unit-3**: Ancient Science, Astronomy and Vedic Mathematics 3.1, 3.2,3.3,3.4,3.5,3.6	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**CO- 4:** Understanding on ancient Engineering, Science and Technology, Town Planning, Temple architecture, Chemistry and Metallurgy, Metal manufacturing etc.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5		**Unit-4:** Engineering, Technology and Architecture 4.1, 4.2,4.3,4.4,4.5,4.6	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**CO- 5:** Student will able to understand about the Life, Nature and Health through basic concept of Ayurveda andYoga, Traditional Medicinal Systems, Ethnomedicine, Nature conservation, World Heritage Sites etc.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5		Unit 5: **Life, Nature and Health** 5.1,5.2,5.3,5.4,5.5,5.6	

Program name	Bachelor of Science (B. Sc.)Botany	
Semester	3rd Semester	
Course Code:	01BO301	
Course title:	Plant Anatomy and Embryology	**Curriculum Developer**: Priya Dwivedi Lab Demonstrator
Pre-requisite:	Students should have basic knowledge of Plant Anatomy and Embryology.	
Rationale:	Plant Anatomy and Embryology is a fundamental area of study within botany that explores the intricate structures and developmental processes of plants. Understanding the anatomy and embryological development of plants is crucial for several scientific fields, including agriculture, horticulture, ecology, and environmental science. This course/module aims to provide students with a comprehensive understanding of plant structure and development, from the cellular level to the formation of complex tissues and organs, and the processes involved in the formation and development of seeds and embryos.	
Course Outcomes (COs):	**CO1**: Students will learn the internal structure of plants. **CO2**: It will enhance the basic understanding of organization of plant body by cells and tissues. **CO3**: Students will understand the history, importance and types of embryology. **CO4**: Students will understand the dynamic mechanism of plant pollination, fertilization and development. **CO5**: They will have hands on training on section cutting, preparation of slides, study of pollen and ovules.	

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits(C) (L:T:P=4:0:2)
			CI	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
Major	01BO301	Plant Anatomy and Embryology	4	2	1	2	9	4+0+2=6

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
Major	01BO301	Plant Anatomy and Embryology	**15**	**20**	**5**	**5**	**5**	**50**	**50**	**100**

Scheme of Assessment: Practical

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)		
Major	**01BO301**	Plant anatomy and Embryology	35	5	5	5	50	50	50

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	12	6	1	5	24

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)

CO1: Students will learn the internal structure of plants.			**Unit-1**	
	SO 1.1: Describe the characteristics and functions of meristematic tissues.	**LI 1.1**: Discuss the role of meristematic tissues in plant growth and development.	**CI 1.1**: Explain the definition and classification of meristematic tissues (apical, lateral, intercalary).	**SLT 1.1**: Research the importance of meristematic tissues in agriculture and horticulture.
	SO 1.2: Identify different types of meristems based on position and origin.	**LI 1.2**: Analyze how different types of meristems contribute to primary and secondary growth.	**CI 1.2**: Discuss apical, lateral, and intercalary meristems and their roles in plant growth.	**SLT 1.2**: Create a poster illustrating types of meristems and their locations in plants.
	SO 1.3: Understand the organization of the root apex.	**LI 1.3:** Discuss about root cap, and zones of the root apex.	**CI 1.3**: Explain the zones of the root apex, including the role of the root cap.	**SLT 1.3**: Investigate the effects of different soil types on root growth and development.
	SO 1.4: Understand the organization of the shoot apex.		**CI 1.4**: Describe the structure and function of the shoot apex, focusing on the tunica-corpus theory.	**SLT 1.4**: Study how pruning affects shoot apex growth and branching patterns.
	SO 1.5: Differentiate between simple and complex tissues.		**CI 1.5**: Discuss simple and complex tissues with examples and functions in plants.	**SLT 1.5**: Prepare a chart illustrating the differences between simple and complex tissues.
	SO 1.6: Explore special types of tissues and their roles.		**CI 1.6**: Explain special types of tissues, including epidermis, secretory tissues, and laticifers.	
	SO 1.7: Analyze the structure of dicot and monocot roots, stems, and leaves.		**CI 1.7**: Discuss the structure and function of dicot and monocot roots, stems, and leaves with diagrams.	
	SO 1.8: Understand Kranz anatomy and its significance.		**CI 1.8**: Describe Kranz anatomy and its importance in C4 plants.	
	SO 1.9: Explain the structure and function of pits and plasmodesmata.		**CI 1.9**: Discuss pits and plasmodesmata, their structure, and functions in plant cells.	
	SO 1.10: Explore wall ingrowths and transfer cells in plants.		**CI 1.10**: Explain the structure and function of wall ingrowths and transfer cells.	

	SO 1.11: Examine the structure and function of hydathodes, cavities, lithocysts, and laticifers.		**CI 1.11**: Explain hydathodes, cavities, lithocysts, and laticifers and their physiological functions.	
	SO 1.12: Analyze the adaptive and protective roles of plant tissues.		**CI 1.12**: Discuss the protective and adaptive roles of tissues like cuticles, trichomes, and stomata.	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Describe in detail the history of plant tissue.
	SW1.2 Mini Project	Describe the types of plant tissue.
	SW1.3 Other Activities (Specify)	Explain the importance of plant tissue.

Item	**CI**	**LI**	**SW**	**SL**	**Total**
Approx. Hours	12	6	1	5	24

Course outcomes (COs)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CIs)**	**Self-Learning (SL)**
CO2: It will enhance the basic understanding of organization of plant body by cells and tissues.			**Unit-2**	
	SO 2.1: Understand the structure and function of vascular cambium.	**LI 2.1**: Discuss the role of vascular cambium in secondary growth and its seasonal activity.	**CI 2.1**: Explain the structure, function, and seasonal activity of vascular cambium.	**SLT 2.1**: Research how the activity of vascular cambium influences plant growth in different climates.
	SO 2.2: Explain the process of secondary growth in roots and stems.	**LI 2.2**: Analyze the differences in secondary growth between roots and stems of dicots and monocots.	**CI 2.2**: Describe the process of secondary growth in roots and stems, highlighting key differences.	**SLT 2.2**: Compare and contrast secondary growth in woody and herbaceous plants.

	SO 2.3: Differentiate between heartwood and sapwood.	**LI 2.3**: Discuss the formation, structure, and function of heartwood and sapwood in woody plants.	**CI 2.3**: Explain the differences between heartwood and sapwood and their roles in plants.	**SLT 2.3**: Investigate how heartwood and sapwood contribute to the overall strength and durability of trees.
	SO 2.4: Recognize anomalous structures in plant growth.		**CI 2.4**: Describe anomalous structures and their impact on plant morphology.	**SLT 2.4**: Study a case of anomalous growth in a specific plant species and present findings.
	SO 2.5: Understand the adaptive and protective systems in plants.		**CI 2.5**: Discuss the structure and function of adaptive systems like the epidermis and cuticle.	**SLT 2.5**: Analyze how different protective systems help plants adapt to various environmental conditions.
	SO 2.6: Explore adaptations in xerophytes and hydrophytes.		**CI 2.6**: Explain the specific adaptations of xerophytes and hydrophytes to their environments.	
	SO 2.7: Understand the principles of dendrochronology.		**CI 2.7**: Describe dendrochronology and its applications in ecological and historical studies.	
	SO 2.8: Explore the process of cambial activity in relation to wood formation.		**CI 2.8**: Discuss the relationship between cambial activity and wood formation.	
	SO 2.9: Analyze the protective adaptations in plants.		**CI 2.9**: Explain the role of protective adaptations in plant survival.	
	SO 2.10: Discuss the impact of secondary metabolites in plant protection.		**CI 2.10**: Describe the role of secondary metabolites in plant protection.	

	SO 2.11: Examine the role of lignin in plant structure and protection.		**CI 2.11**: Explain the role of lignin in plant structure and protection.	
	SO 2.12: Analyze the effects of environmental stress on secondary growth and adaptive mechanisms.		**CI 2.12**: Discuss the impact of environmental stress on secondary growth and plant adaptation.	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Describe and define the secondary growth.
	SW2.2 Mini Project	Explain the role of lignin in plant structure .
	SW2.3 Other Activities (Specify)	Study one review article on plant protection.

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	12	6	1	2	21

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO3: Students will understand the history, importance and types of embryology.			**Unit-3**	
	SO 3.1: Understand the history and importance of embryology in plant biology.	LI 3.1: Explore the historical development and significance of embryology in plant research.	CI 3.1: Discuss the key milestones in the history of plant embryology and its relevance today.	SLT 3.1: Research the contributions of early botanists to the field of plant embryology and present findings.

	SO 3.2: Analyze the structure of flowers, anthers, and pollen.	LI 3.2: Investigate the anatomy and function of flowers, focusing on anther and pollen development.	CI 3.2: Explain the structure of flowers, anthers, and pollen with diagrams.	SLT 3.2: Dissect a flower to observe its structure and create a detailed sketch of its reproductive organs.
	SO 3.3: Explore the processes of microsporogenesis and megasporogenesis.	LI 3.3: explore the stage and significance of microsporogenesis and megasporogenesis.	CI 3.3: Describe the stages and significance of microsporogenesis and megasporogenesis.	SLT 3.3: Create a flowchart illustrating the processes of microsporogenesis and megasporogenesis.
	SO 3.4: Understand the structure and types of ovules.		CI 3.4: Discuss the structure and types of ovules, highlighting their roles in plant reproduction.	SLT 3.4: Research various types of ovules found in flowering plants and present their evolutionary significance.
	SO 3.5: Explore the types of embryo sacs and their organization.		CI 3.5: Explain the organization and types of embryo sacs in plants.	SLT 3.5: Analyze the differences in embryo sac types among different plant species and their reproductive strategies.
	SO 3.6: Examine the ultrastructure of the mature embryo sac.		CI 3.6: Describe the ultrastructure of the mature embryo sac and its role in fertilization.	
	SO 3.7: Understand the process of double fertilization in angiosperms.		CI 3.7: Explain the process of double fertilization and its role in seed development.	
	SO 3.8: Explore the factors influencing embryo development and seed formation.		CI 3.8: Discuss the stages of embryo development and factors influencing seed formation.	
	SO 3.9: Analyze the significance of seed dispersal mechanisms in plant reproduction.		CI 3.9: Explain different seed dispersal mechanisms and their advantages for plant species.	
	SO 3.10: Understand the role of endosperm in supporting embryo development.		CI 3.10: Describe the structure and function of endosperm in seed development.	

	SO 3.11: Explore the concept of apomixis and its significance in plant reproduction.		CI 3.11: Explain apomixis and its role in plant reproduction, highlighting examples of apomictic species.	
	SO 3.12: Examine the practical applications of embryology in agriculture and horticulture.		CI 3.12: Highlight the applications of plant embryology in modern agriculture and horticulture.	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Describe the endosperm in seed development.
	SW3.2 Mini Project	Detailed study plant biology .
	SW3.3 Other Activities (Specify)	Importance of embryology in plant biology

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	12	6	1	4	23

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO4: Students will understand the dynamic mechanism of plant pollination, fertilization			**Unit-4**	
	SO 4.1: Identify different types of anthers and pollen.	LI 4.1: Explore the morphological diversity of anthers and pollen grains across plant species.	CI 4.1: Describe the structure and types of anthers and pollen, emphasizing their roles in reproduction.	**SL4.1** Search various reference books and other study material to start the learning about Pollen grains..

and development.				
	SO 4.2: Understand pollination mechanisms and adaptations.	LI 4.2: Investigate the diverse pollination strategies and their adaptations in flowering plants.	CI 4.2: Discuss the mechanisms of pollination and the adaptations that facilitate effective pollination.	**SL4.2** Pollination mechanisms and adaptations.
	SO 4.3: Explore pollen-pistil interactions during fertilization.		CI 4.3: Explain the molecular and cellular mechanisms of pollen-pistil interaction.	
	SO 4.4: Understand the process and significance of double fertilization.		CI 4.4: Describe the process of double fertilization and its outcomes in seed development.	**SL4.3** To Understand the significance of double fertilization.
	SO 4.5: Analyze post-fertilization changes in ovules and seeds.	LI 4.3 Investigate the post-fertilization changes and the formation of seed structure.	CI 4.5: Discuss the post-fertilization changes and the formation of seed structures.	
	SO 4.6: Examine seed structure, appendages, and dispersal mechanisms.		CI 4.6: Describe seed structure and the role of appendages in seed dispersal.	**SL4.4** To independently explore the brief in detail Equitable Benefit Sharing of Plant biology.
	SO 4.7: Understand the field of palynology and its scope.		CI 4.7: Discuss the significance of palynology and its applications in scientific research.	
	SO 4.8: Investigate the role of environmental factors in pollination success.		CI 4.8: Explain the impact of environmental conditions on pollination and seed set.	
	SO 4.9: Analyze the genetic and evolutionary implications of self-pollination and cross-pollination.		CI 4.9: Discuss the genetic outcomes and evolutionary significance of different pollination strategies.	
	SO 4.10: Understand the role of pollinators in maintaining biodiversity.		CI 4.10: Describe the ecological importance of pollinators in maintaining plant biodiversity.	

	SO 4.11: Explore the co-evolution of plants and pollinators.		CI 4.11: Explain the concept of co-evolution and provide examples of plant-pollinator interactions.	
	SO 4.12: Examine the impact of human activities on pollination processes.		CI 4.12: Analyze the effects of human activities on pollination and propose solutions to mitigate negative impacts.	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Describe the introduction of Pollination.
	SW4.2 Mini Project	Explain in detail future challenges and opportunities of Plant biology
	SW4.3 Other Activities (Specify)	Write a one review article on educational role of Plant anatomy and embryology.

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	12	6	1	3	22

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO5: They will have hands on training on section cutting, preparation of slides, study of pollen and			**Unit-5**	
	SO 5.1: Identify the types, structure, and functions of endosperm in plants.	LI 5.1: Explore different types of endosperm and their roles in seed development.	CI 5.1: Discuss the structure and functions of endosperm types such as nuclear, cellular, and helobial.	SLT 5.1: Create a comparative analysis of endosperm types and their contributions to seed nutrition.

ovules.				
	SO 5.2: Compare dicot and monocot embryos in terms of structure and development.	LI 5.2: Investigate the key differences between dicot and monocot embryos.	CI 5.2: Explain the structure and development of dicot and monocot embryos.	SLT 5.2: Prepare a detailed diagram comparing the stages of development in dicot and monocot embryos.
	SO 5.3: Analyze the embryo-endosperm relationship in seed development.	LI 5.3 Explore the embryo-endosperm relationship and its significance in seed development.	CI 5.3: Describe the embryo-endosperm relationship and its significance in seed development.	SLT 5.3: Study the impact of endosperm nutrition on the growth and viability of seeds in different plant species.
	SO 5.4: Understand the nutrition of the embryo and its sources.		CI 5.4: Explain the nutrition of the embryo and the role of nutrient sources like endosperm and cotyledons.	
	SO 5.5: Examine unusual features in embryo and endosperm development.		CI 5.5: Discuss examples of unusual features in embryo and endosperm development and their implications.	
	SO 5.6: Explore the concepts of apomixis and polyembryony in plants.		CI 5.6: Explain apomixis and polyembryony, their types, and applications in plant breeding.	
	SO 5.7: Understand the principles and applications of in-vitro fertilization in plant breeding.		CI 5.7: Describe the process of in-vitro fertilization and its significance in modern agriculture.	
	SO 5.8: Analyze the ecological role of seeds in plant life cycles.		CI 5.8: Discuss the ecological importance of seeds in plant life cycles and ecosystems.	
	SO 5.9: Explore the genetic regulation of seed development and maturation.		CI 5.9: Explain the genetic regulation of seed development and its impact on plant breeding.	
	SO 5.10: Understand the mechanisms of seed dormancy and germination.		CI 5.10: Discuss the mechanisms of seed dormancy and germination, emphasizing environmental triggers.	
	SO 5.11: Examine the role of		CI 5.11: Describe the role of seed	

	seed banks in conservation and agriculture.		banks in conservation and agriculture, highlighting key examples.	
	SO 5.12: Explore the impact of climate change on seed development and germination.		CI 5.12: Analyze the impact of climate change on seed development and germination in various ecosystems.	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Explain in detail about medicinal plant.
	SW5.2 Mini Project	Describe in the detail different types of diseases.
	SW5.3 Other Activities (Specify)	One case research study on heart diseases.

Course duration (in hours) to attain Course Outcomes:

Course Title: Plant Anatomy and Embryology **Course Code:** 01BO301

Course Outcomes (COs)	**Class lecture (CI)**	**Laboratory Instruction (LI)**	**Self-Learning (SL)**	**Sessional work (SW)**	**Total Hours (Li+CI+SL+SW)**
CO1: Students will learn the internal structure of plants.	12	6	5	1	24
CO2: It will enhance the basic understanding of organization of plant body by cells and tissues.	12	6	5	1	24
CO3: Students will understand the history, importance and types of embryology.	12	6	2	1	21

CO4: Students will understand the dynamic mechanism of plant pollination, fertilization and development.	12	6	4	1	23
CO5:They will have hands on training on section cutting, preparation of slides, study of pollen and ovules.	12	6	3	1	22
Total Hours	60	30	19	05	114

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcomes:

Course Title: Plant Anatomy and Embryology **Course Code;** 01BO301

Course Outcomes	**Marks Distribution**				**Total Marks**
	R	**U**	**A**	**A**	
CO1: Students will learn the internal structure of plants.	2	2	3	2	9
CO2: It will enhance the basic understanding of organization of plant body by cells and tissues.	2	3	3	2	10
CO3: Students will understand the history, importance and types of embryology.	2	2	3	4	11
CO4: Students will understand the dynamic mechanism of plant pollination, fertilization and development.	2	2	3	3	10
CO5:They will have hands on training on section cutting, preparation of slides, study of pollen and ovules.	2	2	2	4	10
Total Marks	**10**	**11**	**14**	**15**	**50**

***Legend*:R,** Remember; **U,** Understand; **A,** Apply; **A,** Analyze

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1.	.Bhojwani,S.S & bhatnagar , S.P. (2011) Embriology of Angiosperm. Vikash Publication
2.	Dickison, W.C. (2000). Integrative plant anatomy .
3.	Fahn,A.(1974). Plant Anatomy
4.	Mauseth J.D. (1988) Plant Anatomy
5.	Evert , R.F. (2006) Esau's Plant Anatomy

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Visit to animal biotechnology lab and stem cells biology lab
7. Demonstration
8. ICT Based teaching Learning
9. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Sc. BOTANY
Semester: III semester
Course Title: Plant Anatomy and Embryology
Course Code; 01BO301
Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

CO/PO/PSO Mapping															
Course Outcome (Cos)	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1: Students will learn the internal structure of plants.	3	1	1	-	-	1	1	1	1	-	2	1	2	2	2
CO2: It will enhance the basic understanding of organization of plant body by cells and tissues.	3	2	1	2	1	-	-	1	1	-	2	1	2	3	3
CO3: Students will understand the history, importance and types of embryology.	2	1	1	-	-	2	-	2	1	-	1	1	3	2	1
CO4: Students will understand the dynamic mechanism of plant pollination, fertilization and development.	2	3	1	1	-	1	-	1	1	1	2	1	2	2	2
CO5:They will have hands on training on section cutting, preparation of slides, study of pollen and ovules.	2	3	-	1	2	2	1	2	1	2	1	2	2	2	2

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO1**: Students will learn the internal structure of plants.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	LI 1 LI 2 LI3	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9,1.1 0,1.11,1.12	1SL-1,2,3,4,5
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO2**: It will enhance the basic understanding of organization of plant body by cells and tissues.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9 SO2.10 SO2.11 SO2.12	LI 1 LI 2 LI 3	2.1,2.2,2.3,2.4,2.5, 2.6,2.7,2.8,2.9,2.1 0,2.11,2.12	2SL-1,2,3,4,5
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO3**: Students will understand the history, importance and types of embryology.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9 SO3.10 SO3.11 SO3.12	LI 1 LI 2 LI 3	3.1,3.2,3.3,3.4,3.5, 3.6,3.7,3.8,3.9,3.1 0,3.11,3.12	3SL-1,2
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO4**: Students will understand the dynamic mechanism of plant pollination, fertilization and development.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8 SO4.9 SO4.10 SO4.11 SO4.12	LI 1 LI 2 LI 3	4.1,4.2,4.3,4.4,4.5, 4.6,4.7,4.8,4.9,4.1 0,4.11,4.12	4SL-1,2,3,4
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO5**:They will have hands on training on section cutting, preparation of slides, study of pollen and ovules.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9 SO5.10 SO5.11 SO5.12	LI 1 LI2 LI 3	5.1,5.2,5.3,5.4,5.5, 5.6,5.7,5.8,5.9,5.1 0,5.11,5.12	5SL-1,2,3

Program Name	**Bachelor of Science (B.Sc.)- Biology**	
Semester	3rd	
Course Code:	02ZO302	
Course title:	Diversity of Chordates and Comparative Anatomy: Non chordate	**Curriculum Developer**: Mr. AMIT BAGRI
Pre-requisite:	Student should have basic knowledge of Diversity of Chordates and Comparative Anatomy: Non chordate animals.	
Rationale:	This core course will cover the essential aspects of taxonomic position, characteristic features and distribution of different orders of the chordates and non-chordate animals. This course will help to obtain comprehensive knowledge of comparative anatomy of chordates and to recognize their evolutionary trends and evidences, theories and mechanisms of evolution.	
Course Outcomes (COs):	02ZO302**.1** Understand chordate diversity of animals and their taxonomic position**.** 02ZO302**.2.** Identify the morphological and anatomical features and basis of chordate classification 02ZO302**.3.** To recognize economic importance and present status that will develop positive attitude toward conservation of biodiversity. 02ZO302**.4.** Differentiate the organism belonging to different taxa by studying comparative anatomy. 02ZO302**.5.** Describe structural anatomy and organ systems of different groups of animals.	

Scheme of Studies:

Board of Study	**Course Code**	**Course Title**	**Scheme of studies (Hours/Week)**					**Total Credits(C) (L:T:P=4:0:2)**
			Cl	LI	SW	SL	**Total Study Hours(CI+LI+SW+SL)**	
MAJOR	02ZO302	Diversity of Chordates and Comparative Anatomy: Non chordata	4	2	1	2	9	4+2= 6

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)		
MAJOR	02ZO302	Diversity of Chordates and Comparative Anatomy: Non chordate	**15**	**20**	**10**	**5**	**50**	**50**	**100**

Scheme of Assessment: Practical

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)		
Major	02ZO302	Diversity of Chordates and Comparative Anatomy: Non chordate	35	5	5	5	50	50	50

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	06	25

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
02ZO302**.1.** understand chordate diversity of animals and their taxonomic position.	**SO1.1** Study of traditional knowledge on animal science in ancient Indian civilization	1.1. Study of museum specimens and slides.	**Unit-1 introduction of chordates , protochordate, Agnetha** **1.1** traditional knowledge on animal science in ancient Indian civilization classification of phylum chordate	1.1. define traditional knowledge on animal science in ancient Indian civilization
	SO1.2 define about Origin of chordates general characteristics and outline classification of phylum chordate	1.2 protochordate hard mania, Amphioxus	**1.2** Origin of chordates general characteristics and outline	1.2. define Origin of chordates general characteristics and outline classification of phylum chordate
	SO1.3 Define general characteristics and classification of sub phylum Urochordata and cephalochordate	1.3 Name three consequences of the asteroid that hit the Earth 65 million years ago.	**1.3** general characteristics and classification of sub phylum Urochordata and cephalochordate	1.3. learn about general characteristics and classification of sub phylum Urochordata and cephalochordate
	SO1.4 type study of herd mania and retrogressive metamorphosis in ascidian tadpole		**1.4** type study of herd mania and retrogressive metamorphosis in ascidian tadpole	1.4. Learn about type study of herd mania and retrogressive metamorphosis in ascidian tadpole
	SO1.5 type study of amphioxus and its affinities		**1.5** type study of amphioxus and its affinities	1.5. type study of amphioxus and its affinities
	SO1.6 define about comparison of Petromyzon and myxine		**1.6** comparison of Petromyzon and myxine	1.6. comparison of Petromyzon and myxine
	SO1.7 Amphioxus described as a simple organism?		1.7 Why is Amphioxus described as a simple organism?	
	SO1.8 explain positive benefit of having vertebrae for Chordates.		1.8 Name one positive benefit of having vertebrae for Chordates.	
	SO1.9 advantages do animals with jaws have?		1.9 What advantages do animals with jaws have?	
	SO1.10 described protects the brains of fish?		1.10 What protects the brains of fish?	
	SO1.11 discuss one very different looking Chordate		1.11 Name one very different looking Chordate	
	SO1.12 explain three consequences of the asteroid that hit the Earth 65 million years ago.		1.12 Name three consequences of the asteroid that hit the Earth 65 million years ago.	

Suggested Sessional Work (SW):*anyone*	**SW1.1** Assignments	Write about the history traditional knowledge on animal science in ancient Indian civilization
	SW1.2 Mini Project	Write about type study of herdmania and retrogressive metamorphosis in ascidian tadpole
	SW1.3 Other Activities (Specify)	type study of amphioxus and its affinities.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	07	26

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
02ZO302 **.2.** To identify the morphological and anatomical features and basis of chordate classification	**SO2.1** study of General characteristics.	2.1. Study of museum specimens a. fishes: scolidon, stegostoma , torpedo, labeo, eal, flat fish	**Unit-2 Pisces, amphibia and Reptilia** **2.1** General characteristics and classification of Pisces	2.1. study of General characteristics and classification of Pisces
	SO2.2 define accessory respiratory organ.	2.2. Amphibia: chelone, trimix, Varanus, chameleon, draco	**2.2** accessory respiratory organ, parental care in fishes	2.2. learn about accessory respiratory organ, parental care in fishes
	SO2.3 define General characteristics	2.3. reptilian: chelone, Tri onyx, Hemidactylus, Varanus, chameleon, draco, viper, naja	**2.3** General characteristics and classification of amphibia	2.3. learn about General characteristics and classification of amphibia
	SO2.4 study of parental care in amphibia		**2.4** parental care in amphibia and pedomorphosis	2.4. Know about the parental care in amphibia and pedomorphosis
	SO2.5 Study of General characteristics		**2.5** General characteristics and classification of Reptilia	2.5. learn about General characteristics and classification of Reptilia.
	SO2.6 study of difference between poisonous and non-poisonous snakes		**2.6** difference between poisonous and non-poisonous snakes, venom and antivenom	2.6. learn about difference between poisonous and non-poisonous snakes, venom and antivenom
	SO2.7 poison apparatus and biting mechanism in snake?		2.7 poison apparatus and biting mechanism in snake	2.7. study of poison apparatus and biting mechanism in snake.
	SO2.8 explain parental care in fishes		**2.8** study of parental care in fishes	
	SO2.9 explain classification of Reptilia		**2.9** classification of Reptilia	
	SO2.10 described classification of amphibia		**2.10** classification of amphibia	
	SO2.11 explain classification of Pisces		**2.11** classification of Pisces.	
	SO2.12 explain study of pedomorphosis?		**2.12** study of pedomorphosis?	

Suggested Sessional Work (SW):*anyone*	**SW2.1** Assignments	Write about General characteristics and classification of pisces.
	SW2.2 Mini Project	Write about the parental care in ambhibia and paedomorphosis.
	SW2.3 Other Activities (Specify)	write the poison apparatus and biting mechanism in snake.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	07	26

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
02ZO302 **.3.** To know economic importance and present status that will develop positive attitude towards conservation of biodiversity	**SO3.1** Study of Brief introduction of birdman of india – Dr. Salim Ali	3.1. Study of museum specimens	**Unit-3 Aves, Mammalia** **3.1** Brief introduction of birdman of india – Dr. Salim Ali	3.1. Know about the birdman of India – Dr. Salim Ali
	SO3.2 define the General characteristics	3.2. Study of limb bones	**3.2** General characteristics and classification of Aves	3.2. learn about General characteristics and classification of Aves
	SO3.3 Explain the Migration of birds,	3.3 girdles of vertebrates	**3.3** Migration of birds, principles and aerodynamics of flight.	3.3. Know about the Migration of birds, principles and aerodynamics of flight.
	SO3.4 Explain the flights adaptation In birds.		**3.4** flights adaptation In birds.	3.4. learn about flights adaptation In birds
	SO3.5 Explain the General characteristics and	.	**3.5** General characteristics and classification of mammals.	3.5. Know about the General characteristics and classification of mammals.
	SO3.6 define adaptive radiation in mammals?		**3.6** adaptive radiation in mammals with reference to locomotory appendages.	3.6. study of adaptive radiation in mammals with reference to locomotory appendages.
	SO3.7 explain classification of Aves?		**3.7** classification of Aves?	3.7. learn about introduction of ZSI
	SO3.8 described principles and aerodynamics of flight.?		**3.8** principles and aerodynamics of flight.?	
	SO3.9 explain classification of mammals.		**3.9** classification of mammals.	
	SO3.10 explain the introduction of ZSI.		**3.10** explain the introduction of ZSI.	
	SO3.11 explain introduction of ZSI		**3.11** introduction of ZSI	
	SO3.12 described reference to locomotory appendages.?		3.12 reference to locomotory appendages.?	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Study of Brief introduction of birdman of India – Dr. Salim Ali
	SW3.2 Mini Project	Explain the General characteristics and classification of mammals.
	SW3.3 Other Activities (Specify)	Explain the flights adaptation in birds.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	06	25

Course Outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
02ZO302 **.4.** Differentiate the organism belonging to different taxa by studying comparative anatomy.	**SO4.1** study of Comparative study of integument	4.1. Comparative study of heart and brain of vertebrates.	**Unit-4** **Comparative Anatomy of vertebrates** **4.1** Comparative study of integument and its derivatives of vertebrates.	4.1. Read the Comparative study of integument and its derivatives of vertebrates.
	SO4.2 study of Comparative study of appendicular skeleton of vertebrates.	4.2. Study of limb bones and girdles of vertebrates.	**4.2** Comparative study of appendicular skeleton of vertebrates.	4.2. study of Comparative study of appendicular skeleton of vertebrates.
	SO4.3 comparative study of digestive system of vertebrates	4.3. comparative study of respiratory system of vertebrates.	**4.3** comparative study of digestive system of vertebrates	4.3. comparative study of digestive system of vertebrates
	SO4.4 comparative study of respiratory system of vertebrates.		**4.4** comparative study of respiratory system of vertebrates.	4.4. learn about comparative study of respiratory system of vertebrates.
	SO4.5 study of its derivatives of vertebrates.		4.5 study of its derivatives of vertebrates.	4.5. external system of vertebrates
	SO4.6 Explain internal respiratory system of vertebrates?		4.6 internal respiratory system of vertebrates	4.6. berating process of vertebrates
	SO4.7 explain external system of vertebrates		4.7 external system of vertebrates	
	SO4.8 described modification of mammals?		4.8 modification of mammals	
	SO4.9 explain function of digestion in vertebrates.		4.9 function of digestion in vertebrates	
	SO4.10 explain berating process of vertebrates		4.10 berating process of vertebrates	
	SO4.11 Study of limb bones		4.11 Study of limb bones	
	SO4.12 study of girdles of vertebrates.		4.12 study of girdles of vertebrates.	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Write about of Comparative study of integument and its derivatives of vertebrates.
	SW4.2 Mini Project	Write about the comparative study of digestive system of vertebrates.
	SW4.3 Other Activities (Specify)	write the respiratory system of vertebrates

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	06	25

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Classroom Instruction(CI)	Self-Learning(SL)
02ZO302 **.5.** the project, assignment will give them a flavor of research in studying biodiversity, taxonomy beside improving their writing skills and lay foundation of career in zoology.	**SO5.1** Explain the comparative study of aortic arches	5.1. Study of limb bones and girdles of vertebrates	**Unit-5 Comparative Anatomy of vertebrates** **5.1** comparative study of aortic arches and hearts of vertebrates.	5.1. learn about comparative study of aortic arches and hearts of vertebrate
	SO5.2 study about comparative study of brain of vertebrates	5.2. Comparative study of heart and brain of vertebrates.	**5.2** comparative study of brain of vertebrates	5.2. learn about about comparative study of brain of vertebrates
	SO5.3 comparative study of Urinogenital system of vertebrates	5.3. study of eye of mammals.	**5.3** comparative study of Urinogenital system of vertebrates	5.3. learn about comparative study of Urinogenital system of vertebrates
	SO5.4 study of eye of mammals.		**5.4** study of eye and ear of mammals.	5.4. study of eye and ear of mammals.
	SO5.5 study of hearts of vertebrates		SO5.5 study of hearts of vertebrates	5.5. study of hearts of vertebrates
	SO5.6 study of ear of mammals.		SO5.6 study of ear of mammals.	5.6. study of digestive system?
	SO5.7 What is the world's largest and smallest fish in the world?		SO5.7 What is the world's largest and smallest fish in the world?	
	SO5.8 study of internal character of mammals		SO5.8 study of internal character of mammals	
	SO5.9 study of external character of vertebrates?		SO5.9 study of external character of vertebrates?	
	SO5.10 study of digestive system?		SO5.10 study of digestive system?	
	SO5.11 study of berating process of mammals?		SO5.11 study of berating process of mammals?	
	SO5.12 study of kidney?		SO5.12 study of kidney?	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Write study about comparative study of brain of vertebrates
	SW5.2 Mini Project	Write about the comparative study of Urinogenital system of vertebrates
	SW5.3 Other Activities (Specify)	Write the study of eye and ear of mammals.

Course duration (in hours) to attain Course Outcomes:

Course Title: Diversity of Chordates and Comparative Anatomy: Non chordata **Course Code:** 02ZO302

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction(LI)	Sessional work (SW)	Self-Learning (SL)	Total Hours (Li+CI+SL+SW)
S2-ZOOL1T -**A.1** Understand chordate diversity of animals and their taxonomic position**.**	12	06	1	6	25
S2-ZOOL1T -**A.2.** Identify the morphological and anatomical features and basis of chordate classification	12	06	1	7	26
S2-ZOOL1T -**A.3.** To recognize economic importance and present status that will develop positive attitude toward conservation of biodiversity.	12	06	1	7	26
S2-ZOOL1T -**A.4.** Differentiate the organism belonging to different taxa by studying comparative anatomy.	12	06	1	6	25
S2-ZOOL1T -**A.5.** Describe structural anatomy and organ systems of different groups of animals.	12	06	1	6	25
Total Hours	60	30	5	32	127

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Diversity of Chordates and Comparative Anatomy: Non chordate **Course Code:** 02ZO302

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
S2-ZOOL1T -**A.1** Understand chordate diversity of animals and their taxonomic position**.**	2	2	3	2	9
S2-ZOOL1T -**A.2.** Identify the morphological and anatomical features and basis of chordate classification	3	4	2	2	11
S2-ZOOL1T -**A.3.** To recognize economic importance and present status that will develop positive attitude toward conservation of biodiversity.	2	3	3	2	10
S2-ZOOL1T -**A.4.** Differentiate the organism belonging to different taxa by studying comparative anatomy.	3	3	2	2	10
S2-ZOOL1T -**A.5.** Describe structural anatomy and organ systems of different groups of animals.	3	4	1	2	10
Total Marks	**13**	**16**	**11**	**10**	**50**

***Legend*: A,** Apply; **An,** Analyze**,** Evaluate**,** Create

Suggested learning Resources:

(a)

S.No.	Title/Author/Publisher details
1	The Life of Vertebrates, J.Z. Young Oxford University Press III& 2004
2	Comparative Anatomy of Vertebrates , C.G. Kent & R.K. Kart McGraw Hill,Bostan,USA 9 & 2015
3	Morden Textbook of Zoology -Vertebrate R.L Kotpal Rastogi Publication ,Meerut 2000
4	Chordate and Comparative anatomy R.L Kotpal Rastogi Publication 2017
5	

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Demonstration
7. ICT Based teaching Learning
8. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Sc. Biology
Semester: 3rd Semester
Course Title: Diversity of Chordates and Comparative Anatomy: Non chordata
Course Code: 02ZO302

CO/PO/PSO Mapping								
Course Outcome (Cos)	**Program Outcomes (POs)**					**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**
02ZO302**.1** Understand chordate diversity of animals and their taxonomic position**.**	2	1	2	2	2	2	3	3
02ZO302**.2.** Identify the morphological and anatomical features and basis of chordate classification	1	1	2	2	1	2	3	3
02ZO302 **.3.** To recognize economic importance and present status that will develop positive attitude toward conservation of biodiversity.	2	1	3	3	1	1	1	3
02ZO302**.4.** Differentiate the organism belonging to different taxa by studying comparative anatomy.	1	1	3	2	3	1	2	3
02ZO302**.5.** Describe structural anatomy and organ systems of different groups of animals.	2	2	3	3	2	1	1	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5 PSO 1,2,3	02ZO302 **.1** Understand chordate diversity of animals and their taxonomic position**.**	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9 SO5.10 SO5.11 SO5.12	1.1,1.2,1.3	1.1, 1.2, 1.3, 1.4, 1.5 1.6, 1.7, 1.8, 1.9, 1.10, 1.11, 1.12	1SL-1,2,3,4,5,6
PO 1,2,3,4,5 PSO 1,2,3	02ZO302 **.2.** Identify the morphological and anatomical features and basis of chordate classification	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9 SO5.10 SO5.11 SO5.12	2.1, 2.2, 2.3	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.10, 2.11, 2.12	2SL-1,2,3,4,5,6,7
PO 1,2,3,4,5 PSO 1,2,3	02ZO302 **.3.** To recognize economic importance and present status that will develop positive attitude toward conservation of biodiversity.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9 SO5.10 SO5.11 SO5.12	3.1,3.2,3.3	3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 3.10, 3.11, 3.12	3SL-1,2,3,4,5,6,7
PO 1,2,3,4,5 PSO 1,2,3	02ZO302 **.4.** Differentiate the organism belonging to different taxa by studying comparative anatomy.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9 SO5.10 SO5.11 SO5.12	4.1,4.2,4.3	4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12	4SL-1,2,3,4,5,6
PO 1,2,3,4,5 PSO 1,2,3	02ZO302 **.5.** Describe structural anatomy and organ systems of different groups of animals.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9 SO5.10 SO5.11 SO5.12	5.1,5.2,5.3	5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10, 5.11, 5.12	5SL-1,2,3,4,5,6

B.Sc. IIIrd Semester

Course Code	Course Title	L	T	P	Total Credits
01CH303	**Reaction, Reagents and Mechanism in organic Chemistry**	3	1	2	6

Pre-requisite: **Students must have fundamental knowledge of mathematics, valence shell electron pair repulsion theory, and different concentration terms to understand the concept of analytical chemistry.**

Rationale: **The students studying analytical chemistry should possess foundational understanding about basic mathematics, valence shell electron pair repulsion theory, and different concentration terms to understand the basic principle of chromatography and spectroscopic analysis.**

Course Outcomes:

After the completion of this course, the learner will able to

001CH303.1: Explain Nucleophilic substitution , Electrophilic Substitution,Benzyne,SN1, SN2, SNi,SNAr.

001CH303.2:Describe the Additionreaction,Eliminationreactions,chemo-selectivity,orientation and reactivity, Markownikov and Anti markonikov s addition, Saytzeff and Hafmann rule.

001CH303.3: Explain Regent and catalyst, Grignard reagent, N- bromo Succinamide Rearrangement, pinacol pinacolone Benzilic acid and Wagner –meerwein.

001CH303.4: **d**iscuss principle of oxidation reactions, Reduction reactions . Oppenauer oxidation

001CH303.5: discuss basic concept of photo- chemical reaction and Paricyclic Reactions ,Norrish type-I and II reactions and cis- trans isomerisations pericyclic reaction and their classification 2 + 2 and 4 + 2 cycloaadition ,

Reaction,Reagents and Mechanism in organic Chemistry (Paper III)

CLO: - By the end of this course students must have had the subject chemistry in class or equivalent

1. Basic concepts of Nucleophilic substitution , Electrophilic Substitution,Benzyne,SN1, SN2, SNi,SNAr.
2. Addition reaction, Elimination reactions,
3. Regent and catalyst, Grignard reagent, N- bromo Succinamide Rearrangement, pinacol pinacolone Benzilic acid and Wagner –meerwein.
4. oxidation reactions, Reduction reactions
5. Photo-chemical Reactions, Paricyclic Reactions,) 2 + 2 and 4 + 2 cycloaadition

Unit-1 (01CH303.1): (A) Aliphatic nucleophilic substitution: Introduction, the SN1 SN2 and SNi mechanism , Neighbouring group participation, effect of substrate, nucleophilie, leaving group and reaction medium.

(B) Aliphatic Electrophilic Substitution: Elementary treatment.

(C) Aromatic Nucleophilic Substitution: the SNAr,SN1 and benzyne mechanisms, effect of substrate, nucleophile, leaving group and reaction medium.

(D) Aromatic Electrophilic Substitution,: arenium ion mechanism, orientation/directive influence (electronic explanation only) and reactivity, diazonium coupling,vilsmeier reaction.

Keywords/Tags:- Nucleophilic substitution , Electrophilic Substitution,Benzyne,SN1, SN2, SNi,SNAr.

Unit-2 (01CH303.2): -(A)Addition reaction : Introduction, reactions involving addition of nucleophile, electrophile and free radicals regio-selectivity and chemo-selectivity ,orientation and reactivity, Markownikov and Anti markonikov s addition.

(B) Elimination reactions: introduction E1,E2 ,E1cb mechanism,effect of substate attacking species leaving group and reaction medium orientation Saytzeff and Hafmann rule.

Keywords/Tags:-Additionreaction,Eliminationreactions,chemo-selectivity,orientation and reactivity, Markownikov and Anti markonikov s addition, Saytzeff and Hafmann rule.

Unit-3 (01CH303.3): Regent and catalyst: preparation properties and applications of important regents and catalyst in organic synthesis with mechanistic details : Grignard reagent and N- bromo Succinamide (NBS) diazomethane, anhydrous aluminium chloride(AlCl3) sodamide (NaNH2) ziegler natta catalyst.

Rearrangement (Reactions,Mechanism and applications): introduction types of rearrangement , Rearrangement to electron deficient carbon (pinacol pinacolone Benzilic acid and Wagner -meerwein) , rearrangement to electron deficiency nitrogen halfman lotion tests and backman rearrangement to electron deficient oxygen where villager and Deccan to electron rich carboniting aromatic rearrangement freez and clezen,

Keywords/Tags:- Regent and catalyst, Grignard reagent, N- bromo Succinamide Rearrangement, pinacol pinacolone Benzilic acid and Wagner –meerwein.

Unit-4 (01CH303.4): oxidation reactions: Introduction metal based oxidation and nonmetal base oxidation oxidation of electron to carbonil carbonium manganese and silver base regions alkys to apoxide peroxide alkene to die manganese and awesome based to carbonyl with bond cleavage manganese and lead based. Oppenauer oxidation

Oxidation of amino groups to nitro groups : oxidation by alkaline KMno4 oxidation of aliphatic and aromatic Amines by peracids ,oxidation of primary and secondary amines to hydroxylamine by hydrogen peroxide.

Reduction reactions: introduction reduction of carbon - carbon multiple bonds carbonyl group and nitro compounds catalytic hydrogenation : heterogeneous (palladium carbon and raney nickel) homogeneous(wilkinsons catalyst) hydride transfer reagents: sodium borohydride and lithium aluminium hydride, metal based reductions: Birch reduction clemmensen reduction, Reduction of nitro compounds by catalytic hydrogenation and metals (with mechanism).

Keywords/Tags:-. oxidation reactions, Reduction reactions, catalytic hydrogenation and metals

Unit-5 (01CH303.5): Photo-chemical Reactions: Introduction of photo- chemistry ,Electronic excitations Jablonski diagram, Norrish type-I and II reactions and cis- trans isomerisations.

Paricyclic Reactions: Introduction of pericyclic reaction and their classification ,(electrocyclic, Sigmatropic rearrangement and cycloaadition) 2 + 2 and 4 + 2 cycloaadition claisen and cope rearrangement.

Keywords/Tags:- Photo-chemical Reactions, Paricyclic Reactions,) 2 + 2 and 4 + 2 cycloaadition ,

Learning Resources

1. https://nptel.ac.in/course.html
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
3. https://swayam.gov.in/explorer?category=Chemistry

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)						Total CreditsI
			CI	T	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	**01CH303**	**Reaction, Reagents and Mechanism in organic Chemistry**	4	0	2	1	1	8	6

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),

LI: Laboratory Instruction (Includes Practical performances in laboratory workshop,field or other locations using different instructional strategies)

SW: Sessional Work (includes assignment, seminar, mini project etc.),

SL: Self Learning

C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback ofteacher to ensure outcome of Learning.

Scheme of Assessment: Theory

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (RA)					End Semester Assessment (ESA)	Total Marks (PRA+ESA)
			Class/Home Assignment 5 number markseach	Class Test2 (2 best out of 3) 10 markseach	Seminar one	Class	Total Marks (CA+CT+SA		
PCC	**01CH303**	**Reaction, Reagents and Mechanism in organic Chemistry**	15	20	10	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (Sos), culminating in the overall achievement of Course Outcomes (Cos) upon the course's conclusion.

Unit-1 (01CH303.1): (A) Aliphatic nucleophilic substitution: Introduction, the SN1 SN2 and SNi mechanism , Neighbouring group participation, effect of substrate, nucleophilie, leaving group and reaction medium.

(B) Aliphatic Electrophilic Substitution: Elementary treatment.

(C) Aromatic Nucleophilic Substitution: the SNAr,SN1 and benzyne mechanisms, effect of substrate, nucleophile, leaving group and reaction medium.

(D) Aromatic Electrophilic Substitution,: arenium ion mechanism, orientation/directive influence (electronic explanation only) and reactivity, diazonium coupling,vilsmeier reaction.

Activity	Appx Hrs
Cl	12
LI	6
SW	2
SL	1
Total	21

Session Outcomes (SOs)	LI	CI	SL
After the completion of topics: students will be able to SO1.1 Discuss the concept of Aliphatic nucleophilic substitution SO1.2 Explain SN1 SN2 and SNi mechanism SO1.3 discuss differentiation of important Electrophilic Substitution and Nucleophilic Substitution reaction. SO1.4 discuss arenium ion mechanism SO1.5 discusses diazonium coupling,and vilsmeier reaction.		**Unit-1 (01CH303.1):** **1.1 (A) Aliphatic nucleophilic substitution**: Introduction, **1.2** SN1 SN2 and SNi mechanism , **1.3** Neighbouring group participation, effect of substrate, **1.4** nucleophilie, leaving group and reaction medium. **1.5 (B) Aliphatic Electrophilic Substitution**: **1.6** Elementary treatment. **1.7 (C) Aromatic Nucleophilic Substitution**: the SNAr,SN1 **1.8** benzyne mechanisms, effect of substrate, **1.9** nucleophile, leaving group and reaction medium. **1.10 (D) Aromatic Electrophilic Substitution**,: **1.11** arenium ion mechanism, **1.12** orientation/directive influence (electronic explanation only) reactivity, **1.13** diazonium coupling, **1.14** vilsmeier reaction.	• Introduction to nucleophilic substitution • And electrophilic substitution reaction diazonium coupling, • vilsmeier reaction •

SW-1 Suggested Sessional Work (SW):

Assignments: SN1 SN2 and SNi mechanism

Mini Project: Software's for drawing structures and molecular formulae.

Other Activities (Specify): Introduction to graph and its types in different ways to represent data

Unit-2 (01CH303.2): -(A)Addition reaction : Introduction, reactions involving addition of nucleophile, electrophile and free radicals regio-selectivity and chemo-selectivity ,orientation and reactivity, Markownikov and Anti markonikov s addition.

(B) Elimination reactions: introduction E1,E2 ,E1cb mechanism,effect of substate attacking species leaving group and reaction medium orientation Saytzeff and Hafmann rule.

Activity	AppX Hrs
Cl	13
LI	6
SW	2
SL	1
Total	22

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
After the completion of topics students will be able to **SO2.1** explain Addition reaction **SO2.2** explain Elimination reactions **SO2.3** discuss Markownikov and Anti markonikov s addition **SO2.4** discuss E1,E2 ,E1cb mechanism,effect of substate **SO2.5** Estimate Saytzeff and Hafmann rule.	•	**Unit-2 (2CH101.2): -** **(A)Addition reaction** : Introduction, reactions involving addition of nucleophile, electrophile and free radicals regio-selectivity and chemo-selectivity ,orientation and reactivity, Markownikov and Anti markonikov s addition. **(B) Elimination reactions**: introduction E1,E2 ,E1cb mechanism,effect of substate attacking species leaving group and reaction medium orientation Saytzeff and Hafmann rule.	• Addition reaction • Elimination reactions • nucleophile, electrophile and free radicals • Saytzeff and Hafmann rule.

SW-2 Suggested Sessional Work (SW):

Assignments: effect of substate attacking species leaving group and reaction

Mini Project: nucleophile, electrophile and free radicals mechanism

Other Activities (Specify): Saytzeff and Hafmann rule.

Unit-3 (01CH303.3): Regent and catalyst: preparation properties and applications of important regents and catalyst in organic synthesis with mechanistic details : Grignard reagent and N- bromo Succinamide (NBS) diazomethane, anhydrous aluminium chloride(AlCl3) sodamide (NaNH2) ziegler natta catalyst.

Rearrangement (Reactions,Mechanism and applications): introduction types of rearrangement , Rearrangement to electron deficient carbon (pinacol pinacolone Benzilic acid and Wagner -meerwein) , rearrangement to electron deficiency nitrogen halfman lotion tests and backman rearrangement to electron deficient oxygen where villager and Deccan to electron rich carboniting aromatic rearrangement freez and clezen,

Activity	AppX Hrs
Cl	11
LI	4
SW	2
SL	1
Total	18

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
After the completion of topics students will be able to **SO3.1** explain preparation properties and applications of important regents and catalyst Grignard reagent. **SO3.2** discuss concept of anhydrous aluminium chloride(AlCl3) and NBS diazomethane. **SO3.3** describe sodamide (NaNH2) ziegler natta catalyst. **SO3.4** explain Rearrangement to electron deficient carbon. **SO3.5** describe rearrangement to electron deficiency nitrogen	• To study the Determination of free alkali present in different soaps/detergents.	**Unit-3 (2CH101.3): Regent and catalyst**:3.1 preparation properties and applications of important regents and catalyst in organic synthesis with mechanistic details : 3.1 Grignard reagent and N- bromo 3.2 Succinamide (NBS) diazomethane, 3.3 anhydrous aluminium chloride(AlCl3) 3.4 sodamide (NaNH2) ziegler natta catalyst. **Rearrangement (Reactions,Mechanism and applications)**: introduction types of rearrangement , **3.5** Rearrangement to electron deficient carbon	•

halfman lotion tests and backman rearrangement to electron deficient oxygen		**3.6** (pinacol pinacolone Benzilic acid and Wagner -meerwein) , 3.7 rearrangement to electron deficiency nitrogen halfman lotion tests and backman rearrangement to electron deficient oxygen 3.9 villager and Deccan to electron rich carboniting aromatic rearrangement freez and clezen,	

SW-3 Suggested Sessional Work (SW):

Assignments: Concept of chemical potential

Mini Project:

Other Activities (Specify):

Unit-4 (01CH303.4): oxidation reactions: Introduction metal based oxidation and nonmetal base oxidation oxidation of electron to carbonil carbonium manganese and silver base regions alkys to apoxide peroxide alkene to die manganese and awesome based to carbonyl with bond cleavage manganese and lead based. Oppenauer oxidation

Oxidation of amino groups to nitro groups : oxidation by alkaline KMno4 oxidation of aliphatic and aromatic Amines by peracids ,oxidation of primary and secondary amines to hydroxylamine by hydrogen peroxide.

Reduction reactions: introduction reduction of carbon - carbon multiple bonds carbonyl group and nitro compounds catalytic hydrogenation : heterogeneous (palladium carbon and raney nickel) homogeneous(wilkinsons catalyst) hydride transfer reagents: sodium borohydride and lithium aluminium hydride, metal based reductions: Birch reduction clemmensen reduction, Reduction of nitro compounds by catalytic hydrogenation and metals (with mechanism).

Activity	AppX Hrs
Cl	13
LI	6
SW	2
SL	1
Total	21

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
After the completion of topics students will be able to	Qualitative Analysis • Identification by determination of the	**Unit-4 (2CH101.4): oxidation reactions**: Introduction metal based oxidation and nonmetal	To understand the chromatographic

SO4.1 Discuss metal based oxidation and nonmetal base oxidation oxidation of electron to carbonil carbonium manganese. **SO4.2** discuss the Oppenauer oxidation. **SO4.3** discusses oxidation by alkaline KMno4 oxidation of aliphatic and aromatic Amines by peracids **SO4.4** explain column chromatography (CC) and gas chromatography (GC) **SO4.5** discuss the reduction of carbon - carbon multiple bonds carbonyl group and nitro compounds catalytic hydrogenation. **SO4.6** explain Birch reduction clemmensen reduction, Reduction of nitro compounds by catalytic hydrogenation and metals	Rf values of the given organic / inorganic compounds by paper/ thin layer chromatography. • Systematic identification of organic compound by qualitative analysis	base oxidation oxidation of electron to carbonil carbonium manganese and silver base regions alkys to apoxide peroxide alkene to die manganese and awesome based to carbonyl with bond cleavage manganese and lead based. Oppenauer oxidation Oxidation of amino groups to nitro groups : oxidation by alkaline KMno4 oxidation of aliphatic and aromatic Amines by peracids ,oxidation of primary and secondary amines to hydroxylamine by hydrogen peroxide. **Reduction reactions**: introduction reduction of carbon - carbon multiple bonds carbonyl group and nitro compounds catalytic hydrogenation : heterogeneous (palladium carbon and raney nickel) homogeneous(wilkinsons catalyst) hydride transfer reagents: sodium borohydride and lithium aluminium hydride, metal based reductions: Birch reduction clemmensen reduction, Reduction of nitro compounds by catalytic hydrogenation and metals (with mechanism).	principle students must read about • Nature of compound (polar/non-polar)

SW-4 Suggested Sessional Work (SW)

Assignment: Chromatography (HPLC) types of column and column selection

Mini Project:

Other Activities (Specify): Mechanism of separation of components in a mixture: adsorption, partition and ion-exchange

Unit-5 (01CH303.5): Photo-chemical Reactions: Introduction of photo- chemistry ,Electronic Excitations Jablonski diagram, Norrish type-I and II reactions and cis- trans isomerisations.

Paricyclic Reactions: Introduction of pericyclic reaction and their classification ,(electrocyclic, Sigmatropic rearrangement and cycloaadition) 2 + 2 and 4 + 2 cycloaadition claisen and cope rearrangement.

Activity	AppX Hrs
Cl	11
LI	6
SW	2
SL	1
Total	20

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
After the completion of topics. students will be able to **SO5.**1 understand Basics of **Photo-chemical Reactions** **SO5.2** discuss the principle of excitations Jablonski diagram **SO5.3** Norrish type-I and II reactions and cis- trans isomerisations. **SO5.**4 describes pericyclic reaction and their classification. **SO5.5** Explain electrocyclic, Sigmatropic rearrangement and cycloaadition . **SO5.6** Explain 2 + 2 and 4 + 2 cycloaadition claisen and cope rearrangement.	Quantitative Analysis.	**Unit-5 (01CH303.5):** **Photo-chemical Reactions**: Introduction of photo- chemistry ,Electronic excitations Jablonski diagram, Norrish type-I and II reactions and cis- trans isomerisations. **Paricyclic Reactions**: Introduction of pericyclic reaction and their classification ,(electrocyclic, Sigmatropic rearrangement and cycloaadition) 2 + 2 and 4 + 2 cycloaadition claisen and cope rearrangement.	cis- trans isomerisations. • pericyclic reaction and their classification

SW-5 Suggested Sessional Work (SW):

Assignments:.

Mini Project:

Other Activities (Specify):

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Laboratory Instruction (LI)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
01CH303.1: Explain Nucleophilic substitution , Electrophilic Substitution,Benzyne,SN1, SN2, SNi,SNAr.	12	6	02	01	21
01CH303.2: Describe the Additionreaction,Eliminationreactions,chemo-selectivity,orientation and reactivity, Markownikov and Anti markonikov s addition, Saytzeff and Hafmann rule.	13	6	02	01	22
01CH303.3: Explain Regent and catalyst, Grignard reagent, N- bromo Succinamide Rearrangement, pinacol pinacolone Benzilic acid and Wagner – meerwein	11	6	02	01	18
01CH303.4: **d**iscuss principle of oxidation reactions, Reduction reactions . Oppenauer oxidation	13	6	02	01	22
01CH303.5:. discuss basic concept of photo-chemical reaction and Paricyclic Reactions ,Norrish type-I and II reactions and cis- trans isomerisations pericyclic reaction and their classification 2 + 2 and 4 + 2 cycloaadition ,	11	6	02	01	20
Total Hours	60	30	10	05	103

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Aliphatic nucleophilic substitution, Aliphatic Electrophilic Substitution, Aromatic Nucleophilic Substitution, Aromatic Electrophilic Substitution	03	01	01	05
CO-2	Addition reaction, Elimination reactions	02	06	02	10
CO-3	Regent and catalyst, Rearrangement (Reactions,Mechanism and applications	03	04	03	10
CO-4	oxidation reactions and Reduction reactions	-02	08	05	15
CO-5	Photo-chemical Reactions, Paricyclic Reactions	03	02	05	10
Total		13	21	16	50

Legend: **R: Remember, U: Understand, A: Apply**

The written examination of 50 marks will be held at the end of semester for Inorganic Chemistry

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to NCL, CSIR laboratories
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT,Blog, Facebook,Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher
1	Organic Chemistry	Clayden,J.,Greeves,N.and Warren,S.,"Organic Chemistry" Oxford University press, India, 2012, 2nd Edition.	Sultan Chand and Sons, . Delhi
2	Chemistry	Srivastava, S. S. Gehlot. A.S.	Ratan Prakashan Temple. Indore.
3	Inorganic Chemicals	Sing, DR, Saxena, G, Singh, B.	Shivlal Aggarwal & Company, Agra
4	Bioinorganic Chemistry	AK Das	Prentice -Hall
5	Inorganic chemistry	Gary L. Miessler	Pearson
6	Inorganic chemistry	VK Jaiswal	Shri Balaji
7	Elementary Organic Spectroscopy	Sharma Y.R.	S Chand, 2013
8	Analytical Chemistr	Gupta Alka L	Pragiti Prakashan 2020
9	Analytical Chemistry	Kaur H,	Pragatic Prakashan 2008
10	Advanced Organic Chemistry	Bahl. A. & Bahal. B.S.	S. Chand. 2010
11	Chromatography	Sharma B.K.	Krishna Prakashan, 2019

Suggested Web Sources:

1. https://celqusb.files.wordpress.com/2017/12/inorganic-chemistry-g-l-miessler-2014.pdf
2. https://www.slideshare.net/MANISHSAHU106/inert-and-labile-complexes
3. https://swayam.gov.in/explorer?category=Chemistry

Mode of Delivery: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point;

LMS/ICT Tools: Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Cos, Pos and PSOs Mapping

Course Title: Reaction,Reagents and Mechanism in organic Chemistry Course Code: 3CH101

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Knowledge	Research Aptitude	Communication	Problem Solving	Individual and Team Work	Investigation of Problems	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and sustainability	The detailed functional knowledge of theoretical concepts and experimental	To integrate the gained knowledge with various contemporary and	understand, analyze, plan and implement qualitative as well as	Provide opportunities to excel in academics, research or Industry by
CO1: Explain Nucleophilic substitution , Electrophilic Substitution,Benzyne,SN1, SN2, SNi,SNAr.	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1

CO2: Describe the Additionreaction,Eliminationreactions,chemo-selectivity,orientation and reactivity, Markownikov and Anti markonikov s addition, Saytzeff and Hafmann rule.	**2**	**1**	**2**	**2**	**1**	**2**	**3**	**2**	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**1**
CO3: Explain Regent and catalyst, Grignard reagent, N-bromo Succinamide Rearrangement, pinacol pinacolone Benzilic acid and Wagner –meerwein	**2**	**2**	**1**	**1**	**1**	**2**	**2**	**2**	**1**	**2**	**1**	**2**	**1**	**1**	**2**	**2**
CO4: discuss principle of oxidation reactions, Reduction reactions . Oppenauer oxidation	**2**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**2**	**3**	**3**	**3**	**3**	**2**
CO5: discuss basic concept of photo-chemical reaction and Paricyclic Reactions ,Norrish type-I and II reactions and cis-trans isomerisations pericyclic reaction and their classification 2 + 2 and 4 + 2 cycloaadition ,	**2**	**-**	**-**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**3**	**1**	**3**

Legend: 1–Low, 2–Medium, 3–High

Course Curriculum Map:

POs &PSOsNo.	COs No. & Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
PO1,2,3,4,5,6 7,8,9,1 0,11,1 2 PSO 1,2, 3, 4	**CO1:** Explain Nucleophilic substitution , Electrophilic Substitution,Benzyne,SN1, SN2, SNi,SNAr.	SO1.1SO1. 2SO1.3SO 1.4 SO1.5		Unit-1. 1.1,1.2 ,1.3,1.4,1.5,1. 6,1.7	• Significance of differentiation and integration • Introduction to window
PO1,2,3,4,5,6 7,8,9,1 0,11,1 2 PSO 1,2, 3, 4	**CO2:** Describe the Additionreaction,Elimination reactions,chemo-selectivity,orientation and reactivity, Markownikov and Anti markonikov s addition, Saytzeff and Hafmann rule.	SO2.1SO2. 2SO2.3 SO2.4 SO2.5		Unit-2 2.1,2.2,2.3,2. 4,2.5,2.6, 2.7, 2.8,2.9	• Some Important units of measurements: SI Unit • distinction between mass and weight • mole, mill mole and numerical problems
PO1,2,3,4,5,6 7,8,9,1 0,11,1 2 PSO 1,2, 3, 4	**CO3:** Explain Regent and catalyst, Grignard reagent, N-bromo Succinamide Rearrangement, pinacol pinacolone Benzilic acid and Wagner – meerwein	SO3.1SO3. 2 SO3.3 SO3.4 SO3.5		Unit-3 : Chemical Equilibrium 3.1, 3.2,3.3,3.4,3.5,3.6,3 .7	• Gibbs free energy • Van't Hoff factors
PO1,2,3,4,5,6 7,8,9,1 0,11,1 2	**CO4: d**iscuss principle of oxidation reactions, Reduction reactions . Oppenauer oxidation	SO4.1SO4. 2SO4.3SO 4.4 SO4.5		Unit-4: 4.1, 4.2,4.3,4. 4,4.5,4.6, 4.7	To understand the chromatographic

PSO 1,2, 3, 4					principle students must read about • Nature of compound (polar/non-polar)
PO1,2, 3,4,5,6 7,8,9,1 0,11,1 2 PSO 1,2, 3, 4	**CO5:** discuss basic concept of photo- chemical reaction and Paricyclic Reactions ,Norrish type-I and II reactions and cis- trans isomerisations pericyclic reaction and their classification 2 + 2 and 4 + 2 cycloaadition ,	SO5.1SO5. 2SO5.3SO 5.4 SO5.5		Unit 5: 5.1,5.2,5.3,5 .4,5.5,5.6,5. 7	Basics of absorption spectroscopy : • Electro magnetic radiation , • Spectral range • Absorbance Absorptivity, Molar Absorptivity

Curriculum Development Team:

1. Dr. Shailendra Yadav, HoD, Department of Chemistry, AKS University, Satna (M.P.).
2. Dr. Dinesh Kumar Mishra, Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
3. Dr. Samit Kumar,Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
4. Dr. Sushma Singh, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
5. Dr. Manoj Kumar Sharma, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
6. Mr. Kanha Singh Tiwari,Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
7. Mrs. Nahid Usamani, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).

Program name	Bachelor of Science (B. Sc.)Botany	
Semester	3rd Semester	
Course Code:	02BO311	
Course title:	Plant Anatomy and Embryology	**Curriculum Developer**: Priya Dwivedi Lab Demonstrator
Pre-requisite:	Students should have basic knowledge of Plant Anatomy and Embryology.	
Rationale:	Plant Anatomy and Embryology is a fundamental area of study within botany that explores the intricate structures and developmental processes of plants. Understanding the anatomy and embryological development of plants is crucial for several scientific fields, including agriculture, horticulture, ecology, and environmental science. This course/module aims to provide students with a comprehensive understanding of plant structure and development, from the cellular level to the formation of complex tissues and organs, and the processes involved in the formation and development of seeds and embryos.	
Course Outcomes (COs):	**CO1**: Students will learn the internal structure of plants. **CO2**: It will enhance the basic understanding of organization of plant body by cells and tissues. **CO3**: Students will understand the history, importance and types of embryology. **CO4**: Students will understand the dynamic mechanism of plant pollination, fertilization and development. **CO5**: They will have hands on training on section cutting, preparation of slides, study of pollen and ovules.	

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits(C) (L:T:P=4:0:2)
			CI	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
Minor	02BO311	Plant Anatomy and Embryology	4	2	1	2	9	4+0+2=6

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
Minor	02BO311	Plant Anatomy and Embryology	**15**	**20**	**5**	**5**	**5**	**50**	**50**	**100**

Scheme of Assessment: Practical

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)		
Minor	**02BO311**	Plant anatomy and Embryology	35	5	5	5	50	50	50

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	12	6	1	5	24

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)

CO1: Students will learn the internal structure of plants.			**Unit-1**	
	SO 1.1: Describe the characteristics and functions of meristematic tissues.	**LI 1.1**: Discuss the role of meristematic tissues in plant growth and development.	**CI 1.1**: Explain the definition and classification of meristematic tissues (apical, lateral, intercalary).	**SLT 1.1**: Research the importance of meristematic tissues in agriculture and horticulture.
	SO 1.2: Identify different types of meristems based on position and origin.	**LI 1.2**: Analyze how different types of meristems contribute to primary and secondary growth.	**CI 1.2**: Discuss apical, lateral, and intercalary meristems and their roles in plant growth.	**SLT 1.2**: Create a poster illustrating types of meristems and their locations in plants.
	SO 1.3: Understand the organization of the root apex.	**LI 1.3:** Discuss about root cap, and zones of the root apex.	**CI 1.3**: Explain the zones of the root apex, including the role of the root cap.	**SLT 1.3**: Investigate the effects of different soil types on root growth and development.
	SO 1.4: Understand the organization of the shoot apex.		**CI 1.4**: Describe the structure and function of the shoot apex, focusing on the tunica-corpus theory.	**SLT 1.4**: Study how pruning affects shoot apex growth and branching patterns.
	SO 1.5: Differentiate between simple and complex tissues.		**CI 1.5**: Discuss simple and complex tissues with examples and functions in plants.	**SLT 1.5**: Prepare a chart illustrating the differences between simple and complex tissues.
	SO 1.6: Explore special types of tissues and their roles.		**CI 1.6**: Explain special types of tissues, including epidermis, secretory tissues, and laticifers.	
	SO 1.7: Analyze the structure of dicot and monocot roots, stems, and leaves.		**CI 1.7**: Discuss the structure and function of dicot and monocot roots, stems, and leaves with diagrams.	
	SO 1.8: Understand Kranz anatomy and its significance.		**CI 1.8**: Describe Kranz anatomy and its importance in C4 plants.	
	SO 1.9: Explain the structure and function of pits and plasmodesmata.		**CI 1.9**: Discuss pits and plasmodesmata, their structure, and functions in plant cells.	
	SO 1.10: Explore wall ingrowths and transfer cells in plants.		**CI 1.10**: Explain the structure and function of wall ingrowths and transfer cells.	

	SO 1.11: Examine the structure and function of hydathodes, cavities, lithocysts, and laticifers.		**CI 1.11**: Explain hydathodes, cavities, lithocysts, and laticifers and their physiological functions.	
	SO 1.12: Analyze the adaptive and protective roles of plant tissues.		**CI 1.12**: Discuss the protective and adaptive roles of tissues like cuticles, trichomes, and stomata.	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Describe in detail the history of plant tissue.
	SW1.2 Mini Project	Describe the types of plant tissue.
	SW1.3 Other Activities (Specify)	Explain the importance of plant tissue.

Item	**CI**	**LI**	**SW**	**SL**	**Total**
Approx. Hours	12	6	1	5	24

Course outcomes (COs)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CIs)**	**Self-Learning (SL)**
CO2: It will enhance the basic understanding of organization of plant body by cells and tissues.			**Unit-2**	
	SO 2.1: Understand the structure and function of vascular cambium.	**LI 2.1**: Discuss the role of vascular cambium in secondary growth and its seasonal activity.	**CI 2.1**: Explain the structure, function, and seasonal activity of vascular cambium.	**SLT 2.1**: Research how the activity of vascular cambium influences plant growth in different climates.
	SO 2.2: Explain the process of secondary growth in roots and stems.	**LI 2.2**: Analyze the differences in secondary growth between roots and stems of dicots and monocots.	**CI 2.2**: Describe the process of secondary growth in roots and stems, highlighting key differences.	**SLT 2.2**: Compare and contrast secondary growth in woody and herbaceous plants.

	SO 2.3: Differentiate between heartwood and sapwood.	**LI 2.3**: Discuss the formation, structure, and function of heartwood and sapwood in woody plants.	**CI 2.3**: Explain the differences between heartwood and sapwood and their roles in plants.	**SLT 2.3**: Investigate how heartwood and sapwood contribute to the overall strength and durability of trees.
	SO 2.4: Recognize anomalous structures in plant growth.		**CI 2.4**: Describe anomalous structures and their impact on plant morphology.	**SLT 2.4**: Study a case of anomalous growth in a specific plant species and present findings.
	SO 2.5: Understand the adaptive and protective systems in plants.		**CI 2.5**: Discuss the structure and function of adaptive systems like the epidermis and cuticle.	**SLT 2.5**: Analyze how different protective systems help plants adapt to various environmental conditions.
	SO 2.6: Explore adaptations in xerophytes and hydrophytes.		**CI 2.6**: Explain the specific adaptations of xerophytes and hydrophytes to their environments.	
	SO 2.7: Understand the principles of dendrochronology.		**CI 2.7**: Describe dendrochronology and its applications in ecological and historical studies.	
	SO 2.8: Explore the process of cambial activity in relation to wood formation.		**CI 2.8**: Discuss the relationship between cambial activity and wood formation.	
	SO 2.9: Analyze the protective adaptations in plants.		**CI 2.9**: Explain the role of protective adaptations in plant survival.	
	SO 2.10: Discuss the impact of secondary metabolites in plant protection.		**CI 2.10**: Describe the role of secondary metabolites in plant protection.	

	SO 2.11: Examine the role of lignin in plant structure and protection.		**CI 2.11**: Explain the role of lignin in plant structure and protection.	
	SO 2.12: Analyze the effects of environmental stress on secondary growth and adaptive mechanisms.		**CI 2.12**: Discuss the impact of environmental stress on secondary growth and plant adaptation.	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Describe and define the secondary growth.
	SW2.2 Mini Project	Explain the role of lignin in plant structure .
	SW2.3 Other Activities (Specify)	Study one review article on plant protection.

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	12	6	1	2	21

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO3: Students will understand the history, importance and types of embryology.			**Unit-3**	
	SO 3.1: Understand the history and importance of embryology in plant biology.	LI 3.1: Explore the historical development and significance of embryology in plant research.	CI 3.1: Discuss the key milestones in the history of plant embryology and its relevance today.	SLT 3.1: Research the contributions of early botanists to the field of plant embryology and present findings.

	SO 3.2: Analyze the structure of flowers, anthers, and pollen.	LI 3.2: Investigate the anatomy and function of flowers, focusing on anther and pollen development.	CI 3.2: Explain the structure of flowers, anthers, and pollen with diagrams.	SLT 3.2: Dissect a flower to observe its structure and create a detailed sketch of its reproductive organs.
	SO 3.3: Explore the processes of microsporogenesis and megasporogenesis.	LI 3.3: explore the stage and significance of microsporogenesis and megasporogenesis.	CI 3.3: Describe the stages and significance of microsporogenesis and megasporogenesis.	SLT 3.3: Create a flowchart illustrating the processes of microsporogenesis and megasporogenesis.
	SO 3.4: Understand the structure and types of ovules.		CI 3.4: Discuss the structure and types of ovules, highlighting their roles in plant reproduction.	SLT 3.4: Research various types of ovules found in flowering plants and present their evolutionary significance.
	SO 3.5: Explore the types of embryo sacs and their organization.		CI 3.5: Explain the organization and types of embryo sacs in plants.	SLT 3.5: Analyze the differences in embryo sac types among different plant species and their reproductive strategies.
	SO 3.6: Examine the ultrastructure of the mature embryo sac.		CI 3.6: Describe the ultrastructure of the mature embryo sac and its role in fertilization.	
	SO 3.7: Understand the process of double fertilization in angiosperms.		CI 3.7: Explain the process of double fertilization and its role in seed development.	
	SO 3.8: Explore the factors influencing embryo development and seed formation.		CI 3.8: Discuss the stages of embryo development and factors influencing seed formation.	
	SO 3.9: Analyze the significance of seed dispersal mechanisms in plant reproduction.		CI 3.9: Explain different seed dispersal mechanisms and their advantages for plant species.	
	SO 3.10: Understand the role of endosperm in supporting embryo development.		CI 3.10: Describe the structure and function of endosperm in seed development.	

	SO 3.11: Explore the concept of apomixis and its significance in plant reproduction.		CI 3.11: Explain apomixis and its role in plant reproduction, highlighting examples of apomictic species.	
	SO 3.12: Examine the practical applications of embryology in agriculture and horticulture.		CI 3.12: Highlight the applications of plant embryology in modern agriculture and horticulture.	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Describe the endosperm in seed development.
	SW3.2 Mini Project	Detailed study plant biology .
	SW3.3 Other Activities (Specify)	Importance of embryology in plant biology

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	12	6	1	4	23

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO4: Students will understand the dynamic mechanism of plant pollination, fertilization			**Unit-4**	
	SO 4.1: Identify different types of anthers and pollen.	LI 4.1: Explore the morphological diversity of anthers and pollen grains across plant species.	CI 4.1: Describe the structure and types of anthers and pollen, emphasizing their roles in reproduction.	**SL4.1** Search various reference books and other study material to start the learning about Pollen grains..

and development.				
	SO 4.2: Understand pollination mechanisms and adaptations.	LI 4.2: Investigate the diverse pollination strategies and their adaptations in flowering plants.	CI 4.2: Discuss the mechanisms of pollination and the adaptations that facilitate effective pollination.	**SL4.2** Pollination mechanisms and adaptations.
	SO 4.3: Explore pollen-pistil interactions during fertilization.		CI 4.3: Explain the molecular and cellular mechanisms of pollen-pistil interaction.	
	SO 4.4: Understand the process and significance of double fertilization.		CI 4.4: Describe the process of double fertilization and its outcomes in seed development.	**SL4.3** To Understand the significance of double fertilization.
	SO 4.5: Analyze post-fertilization changes in ovules and seeds.	LI 4.3 Investigate the post-fertilization changes and the formation of seed structure.	CI 4.5: Discuss the post-fertilization changes and the formation of seed structures.	
	SO 4.6: Examine seed structure, appendages, and dispersal mechanisms.		CI 4.6: Describe seed structure and the role of appendages in seed dispersal.	**SL4.4** To independently explore the brief in detail Equitable Benefit Sharing of Plant biology.
	SO 4.7: Understand the field of palynology and its scope.		CI 4.7: Discuss the significance of palynology and its applications in scientific research.	
	SO 4.8: Investigate the role of environmental factors in pollination success.		CI 4.8: Explain the impact of environmental conditions on pollination and seed set.	
	SO 4.9: Analyze the genetic and evolutionary implications of self-pollination and cross-pollination.		CI 4.9: Discuss the genetic outcomes and evolutionary significance of different pollination strategies.	
	SO 4.10: Understand the role of pollinators in maintaining biodiversity.		CI 4.10: Describe the ecological importance of pollinators in maintaining plant biodiversity.	

	SO 4.11: Explore the co-evolution of plants and pollinators.		CI 4.11: Explain the concept of co-evolution and provide examples of plant-pollinator interactions.	
	SO 4.12: Examine the impact of human activities on pollination processes.		CI 4.12: Analyze the effects of human activities on pollination and propose solutions to mitigate negative impacts.	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Describe the introduction of Pollination.
	SW4.2 Mini Project	Explain in detail future challenges and opportunities of Plant biology
	SW4.3 Other Activities (Specify)	Write a one review article on educational role of Plant anatomy and embryology.

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	12	6	1	3	22

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO5: They will have hands on training on section cutting, preparation of slides, study of pollen and			**Unit-5**	
	SO 5.1: Identify the types, structure, and functions of endosperm in plants.	LI 5.1: Explore different types of endosperm and their roles in seed development.	CI 5.1: Discuss the structure and functions of endosperm types such as nuclear, cellular, and helobial.	SLT 5.1: Create a comparative analysis of endosperm types and their contributions to seed nutrition.

ovules.				
	SO 5.2: Compare dicot and monocot embryos in terms of structure and development.	LI 5.2: Investigate the key differences between dicot and monocot embryos.	CI 5.2: Explain the structure and development of dicot and monocot embryos.	SLT 5.2: Prepare a detailed diagram comparing the stages of development in dicot and monocot embryos.
	SO 5.3: Analyze the embryo-endosperm relationship in seed development.	LI 5.3 Explore the embryo-endosperm relationship and its significance in seed development.	CI 5.3: Describe the embryo-endosperm relationship and its significance in seed development.	SLT 5.3: Study the impact of endosperm nutrition on the growth and viability of seeds in different plant species.
	SO 5.4: Understand the nutrition of the embryo and its sources.		CI 5.4: Explain the nutrition of the embryo and the role of nutrient sources like endosperm and cotyledons.	
	SO 5.5: Examine unusual features in embryo and endosperm development.		CI 5.5: Discuss examples of unusual features in embryo and endosperm development and their implications.	
	SO 5.6: Explore the concepts of apomixis and polyembryony in plants.		CI 5.6: Explain apomixis and polyembryony, their types, and applications in plant breeding.	
	SO 5.7: Understand the principles and applications of in-vitro fertilization in plant breeding.		CI 5.7: Describe the process of in-vitro fertilization and its significance in modern agriculture.	
	SO 5.8: Analyze the ecological role of seeds in plant life cycles.		CI 5.8: Discuss the ecological importance of seeds in plant life cycles and ecosystems.	
	SO 5.9: Explore the genetic regulation of seed development and maturation.		CI 5.9: Explain the genetic regulation of seed development and its impact on plant breeding.	
	SO 5.10: Understand the mechanisms of seed dormancy and germination.		CI 5.10: Discuss the mechanisms of seed dormancy and germination, emphasizing environmental triggers.	
	SO 5.11: Examine the role of		CI 5.11: Describe the role of seed	

	seed banks in conservation and agriculture.		banks in conservation and agriculture, highlighting key examples.	
	SO 5.12: Explore the impact of climate change on seed development and germination.		CI 5.12: Analyze the impact of climate change on seed development and germination in various ecosystems.	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Explain in detail about medicinal plant.
	SW5.2 Mini Project	Describe in the detail different types of diseases.
	SW5.3 Other Activities (Specify)	One case research study on heart diseases.

Course duration (in hours) to attain Course Outcomes:

Course Title: Plant Anatomy and Embryology **Course Code:** 02BO311

Course Outcomes (COs)	**Class lecture (CI)**	**Laboratory Instruction (LI)**	**Self-Learning (SL)**	**Sessional work (SW)**	**Total Hours (Li+CI+SL+SW)**
CO1: Students will learn the internal structure of plants.	12	6	5	1	24
CO2: It will enhance the basic understanding of organization of plant body by cells and tissues.	12	6	5	1	24
CO3: Students will understand the history, importance and types of embryology.	12	6	2	1	21

CO4: Students will understand the dynamic mechanism of plant pollination, fertilization and development.	12	6	4	1	23
CO5:They will have hands on training on section cutting, preparation of slides, study of pollen and ovules.	12	6	3	1	22
Total Hours	60	30	19	05	114

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcomes:

Course Title: Plant Anatomy and Embryology **Course Code;** 02BO311

Course Outcomes	**Marks Distribution**				**Total Marks**
	R	**U**	**A**	**A**	
CO1: Students will learn the internal structure of plants.	2	2	3	2	9
CO2: It will enhance the basic understanding of organization of plant body by cells and tissues.	2	3	3	2	10
CO3: Students will understand the history, importance and types of embryology.	2	2	3	4	11
CO4: Students will understand the dynamic mechanism of plant pollination, fertilization and development.	2	2	3	3	10
CO5:They will have hands on training on section cutting, preparation of slides, study of pollen and ovules.	2	2	2	4	10
Total Marks	**10**	**11**	**14**	**15**	**50**

***Legend*:R,** Remember; **U,** Understand; **A,** Apply; **A,** Analyze

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1.	.Bhojwani,S.S & bhatnagar , S.P. (2011) Embriology of Angiosperm. Vikash Publication
2.	Dickison, W.C. (2000). Integrative plant anatomy .
3.	Fahn,A.(1974). Plant Anatomy
4.	Mauseth J.D. (1988) Plant Anatomy
5.	Evert , R.F. (2006) Esau's Plant Anatomy

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Visit to animal biotechnology lab and stem cells biology lab
7. Demonstration
8. ICT Based teaching Learning
9. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Sc. BOTANY
Semester: III semester
Course Title: Plant Anatomy and Embryology
Course Code; 02BO311
Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

CO/PO/PSO Mapping															
Course Outcome (Cos)	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1: Students will learn the internal structure of plants.	3	1	1	-	-	1	1	1	1	-	2	1	2	2	2
CO2: It will enhance the basic understanding of organization of plant body by cells and tissues.	3	2	1	2	1	-	-	1	1	-	2	1	2	3	3
CO3: Students will understand the history, importance and types of embryology.	2	1	1	-	-	2	-	2	1	-	1	1	3	2	1
CO4: Students will understand the dynamic mechanism of plant pollination, fertilization and development.	2	3	1	1	-	1	-	1	1	1	2	1	2	2	2
CO5:They will have hands on training on section cutting, preparation of slides, study of pollen and ovules.	2	3	-	1	2	2	1	2	1	2	1	2	2	2	2

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO1**: Students will learn the internal structure of plants.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	LI 1 LI 2 LI3	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9,1.1 0,1.11,1.12	1SL-1,2,3,4,5
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO2**: It will enhance the basic understanding of organization of plant body by cells and tissues.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9 SO2.10 SO2.11 SO2.12	LI 1 LI 2 LI 3	2.1,2.2,2.3,2.4,2.5, 2.6,2.7,2.8,2.9,2.1 0,2.11,2.12	2SL-1,2,3,4,5
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO3**: Students will understand the history, importance and types of embryology.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9 SO3.10 SO3.11 SO3.12	LI 1 LI 2 LI 3	3.1,3.2,3.3,3.4,3.5, 3.6,3.7,3.8,3.9,3.1 0,3.11,3.12	3SL-1,2
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO4**: Students will understand the dynamic mechanism of plant pollination, fertilization and development.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8 SO4.9 SO4.10 SO4.11 SO4.12	LI 1 LI 2 LI 3	4.1,4.2,4.3,4.4,4.5, 4.6,4.7,4.8,4.9,4.1 0,4.11,4.12	4SL-1,2,3,4
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO5**:They will have hands on training on section cutting, preparation of slides, study of pollen and ovules.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9 SO5.10 SO5.11 SO5.12	LI 1 LI2 LI 3	5.1,5.2,5.3,5.4,5.5, 5.6,5.7,5.8,5.9,5.1 0,5.11,5.12	5SL-1,2,3

Program Name	**Bachelor of Science (B.Sc.)- Biology**	
Semester	3rd	
Course Code:	02ZO312	
Course title:	Diversity of Chordates and Comparative Anatomy: Non chordate	**Curriculum Developer**: Mr. AMIT BAGRI
Pre-requisite:	Student should have basic knowledge of Diversity of Chordates and Comparative Anatomy: Non chordate animals.	
Rationale:	This core course will cover the essential aspects of taxonomic position, characteristic features and distribution of different orders of the chordates and non-chordate animals. This course will help to obtain comprehensive knowledge of comparative anatomy of chordates and to recognize their evolutionary trends and evidences, theories and mechanisms of evolution.	
Course Outcomes (COs):	02ZO312**.1** Understand chordate diversity of animals and their taxonomic position**.** 02ZO312**.2.** Identify the morphological and anatomical features and basis of chordate classification 02ZO312**.3.** To recognize economic importance and present status that will develop positive attitude toward conservation of biodiversity. 02ZO312**.4.** Differentiate the organism belonging to different taxa by studying comparative anatomy. 02ZO312**.5.** Describe structural anatomy and organ systems of different groups of animals.	

Scheme of Studies:

Board of Study	**Course Code**	**Course Title**	**Scheme of studies (Hours/Week)**					**Total Credits(C) (L:T:P=4:0:2)**
			Cl	LI	SW	SL	**Total Study Hours(CI+LI+SW+SL)**	
Minor	02ZO312	Diversity of Chordates and Comparative Anatomy: Non chordata	4	2	1	2	9	4+2= 6

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)		
Minor	02ZO312	Diversity of Chordates and Comparative Anatomy: Non chordate	**15**	**20**	**10**	**5**	**50**	**50**	**100**

Scheme of Assessment: Practical

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)		
Minor	02ZO312	Diversity of Chordates and Comparative Anatomy: Non chordate	35	5	5	5	50	50	50

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	06	25

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
02ZO312**.1.** understand chordate diversity of animals and their taxonomic position.	**SO1.1** Study of traditional knowledge on animal science in ancient Indian civilization	1.1. Study of museum specimens and slides.	**Unit-1 introduction of chordates , protochordate, Agnetha** **1.1** traditional knowledge on animal science in ancient Indian civilization classification of phylum chordate	1.1. define traditional knowledge on animal science in ancient Indian civilization
	SO1.2 define about Origin of chordates general characteristics and outline classification of phylum chordate	1.2 protochordate hard mania, Amphioxus	**1.2** Origin of chordates general characteristics and outline	1.2. define Origin of chordates general characteristics and outline classification of phylum chordate
	SO1.3 Define general characteristics and classification of sub phylum Urochordata and cephalochordate	1.3 Name three consequences of the asteroid that hit the Earth 65 million years ago.	**1.3** general characteristics and classification of sub phylum Urochordata and cephalochordate	1.3. learn about general characteristics and classification of sub phylum Urochordata and cephalochordate
	SO1.4 type study of herd mania and retrogressive metamorphosis in ascidian tadpole		**1.4** type study of herd mania and retrogressive metamorphosis in ascidian tadpole	1.4. Learn about type study of herd mania and retrogressive metamorphosis in ascidian tadpole
	SO1.5 type study of amphioxus and its affinities		**1.5** type study of amphioxus and its affinities	1.5. type study of amphioxus and its affinities
	SO1.6 define about comparison of Petromyzon and myxine		**1.6** comparison of Petromyzon and myxine	1.6. comparison of Petromyzon and myxine
	SO1.7 Amphioxus described as a simple organism?		1.7 Why is Amphioxus described as a simple organism?	
	SO1.8 explain positive benefit of having vertebrae for Chordates.		1.8 Name one positive benefit of having vertebrae for Chordates.	
	SO1.9 advantages do animals with jaws have?		1.9 What advantages do animals with jaws have?	
	SO1.10 described protects the brains of fish?		1.10 What protects the brains of fish?	
	SO1.11 discuss one very different looking Chordate		1.11 Name one very different looking Chordate	
	SO1.12 explain three consequences of the asteroid that hit the Earth 65 million years ago.		1.12 Name three consequences of the asteroid that hit the Earth 65 million years ago.	

Suggested Sessional Work (SW):*anyone*	**SW1.1** Assignments	Write about the history traditional knowledge on animal science in ancient Indian civilization
	SW1.2 Mini Project	Write about type study of herdmania and retrogressive metamorphosis in ascidian tadpole
	SW1.3 Other Activities (Specify)	type study of amphioxus and its affinities.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	07	26

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
02ZO312 **.2.** To identify the morphological and anatomical features and basis of chordate classification	**SO2.1** study of General characteristics.	2.1. Study of museum specimens a. fishes: scolidon, stegostoma , torpedo, labeo, eal, flat fish	**Unit-2 Pisces, amphibia and Reptilia** **2.1** General characteristics and classification of Pisces	2.1. study of General characteristics and classification of Pisces
	SO2.2 define accessory respiratory organ.	2.2. Amphibia: chelone, trimix, Varanus, chameleon, draco	**2.2** accessory respiratory organ, parental care in fishes	2.2. learn about accessory respiratory organ, parental care in fishes
	SO2.3 define General characteristics	2.3. reptilian: chelone, Tri onyx, Hemidactylus, Varanus, chameleon, draco, viper, naja	**2.3** General characteristics and classification of amphibia	2.3. learn about General characteristics and classification of amphibia
	SO2.4 study of parental care in amphibia		**2.4** parental care in amphibia and pedomorphosis	2.4. Know about the parental care in amphibia and pedomorphosis
	SO2.5 Study of General characteristics		**2.5** General characteristics and classification of Reptilia	2.5. learn about General characteristics and classification of Reptilia.
	SO2.6 study of difference between poisonous and non-poisonous snakes		**2.6** difference between poisonous and non-poisonous snakes, venom and antivenom	2.6. learn about difference between poisonous and non-poisonous snakes, venom and antivenom
	SO2.7 poison apparatus and biting mechanism in snake?		2.7 poison apparatus and biting mechanism in snake	2.7. study of poison apparatus and biting mechanism in snake.
	SO2.8 explain parental care in fishes		**2.8** study of parental care in fishes	
	SO2.9 explain classification of Reptilia		**2.9** classification of Reptilia	
	SO2.10 described classification of amphibia		**2.10** classification of amphibia	
	SO2.11 explain classification of Pisces		**2.11** classification of Pisces.	
	SO2.12 explain study of pedomorphosis?		**2.12** study of pedomorphosis?	

Suggested Sessional Work (SW):*anyone*	**SW2.1** Assignments	Write about General characteristics and classification of pisces.
	SW2.2 Mini Project	Write about the parental care in ambhibia and paedomorphosis.
	SW2.3 Other Activities (Specify)	write the poison apparatus and biting mechanism in snake.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	07	26

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
02ZO312 **.3.** To know economic importance and present status that will develop positive attitude towards conservation of biodiversity	**SO3.1** Study of Brief introduction of birdman of india – Dr. Salim Ali	3.1. Study of museum specimens	**Unit-3 Aves, Mammalia** **3.1** Brief introduction of birdman of india – Dr. Salim Ali	3.1. Know about the birdman of India – Dr. Salim Ali
	SO3.2 define the General characteristics	3.2. Study of limb bones	**3.2** General characteristics and classification of Aves	3.2. learn about General characteristics and classification of Aves
	SO3.3 Explain the Migration of birds,	3.3 girdles of vertebrates	**3.3** Migration of birds, principles and aerodynamics of flight.	3.3. Know about the Migration of birds, principles and aerodynamics of flight.
	SO3.4 Explain the flights adaptation In birds.		**3.4** flights adaptation In birds.	3.4. learn about flights adaptation In birds
	SO3.5 Explain the General characteristics and	.	**3.5** General characteristics and classification of mammals.	3.5. Know about the General characteristics and classification of mammals.
	SO3.6 define adaptive radiation in mammals?		**3.6** adaptive radiation in mammals with reference to locomotory appendages.	3.6. study of adaptive radiation in mammals with reference to locomotory appendages.
	SO3.7 explain classification of Aves?		**3.7** classification of Aves?	3.7. learn about introduction of ZSI
	SO3.8 described principles and aerodynamics of flight.?		**3.8** principles and aerodynamics of flight.?	
	SO3.9 explain classification of mammals.		**3.9** classification of mammals.	
	SO3.10 explain the introduction of ZSI.		**3.10** explain the introduction of ZSI.	
	SO3.11 explain introduction of ZSI		**3.11** introduction of ZSI	
	SO3.12 described reference to locomotory appendages.?		3.12 reference to locomotory appendages.?	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Study of Brief introduction of birdman of India – Dr. Salim Ali
	SW3.2 Mini Project	Explain the General characteristics and classification of mammals.
	SW3.3 Other Activities (Specify)	Explain the flights adaptation in birds.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	06	25

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
02ZO312 **.4.** Differentiate the organism belonging to different taxa by studying comparative anatomy.	**SO4.1** study of Comparative study of integument	4.1. Comparative study of heart and brain of vertebrates.	**Unit-4** **Comparative Anatomy of vertebrates** **4.1** Comparative study of integument and its derivatives of vertebrates.	4.1. Read the Comparative study of integument and its derivatives of vertebrates.
	SO4.2 study of Comparative study of appendicular skeleton of vertebrates.	4.2. Study of limb bones and girdles of vertebrates.	**4.2** Comparative study of appendicular skeleton of vertebrates.	4.2. study of Comparative study of appendicular skeleton of vertebrates.
	SO4.3 comparative study of digestive system of vertebrates	4.3. comparative study of respiratory system of vertebrates.	**4.3** comparative study of digestive system of vertebrates	4.3. comparative study of digestive system of vertebrates
	SO4.4 comparative study of respiratory system of vertebrates.		**4.4** comparative study of respiratory system of vertebrates.	4.4. learn about comparative study of respiratory system of vertebrates.
	SO4.5 study of its derivatives of vertebrates.		4.5 study of its derivatives of vertebrates.	4.5. external system of vertebrates
	SO4.6 Explain internal respiratory system of vertebrates?		4.6 internal respiratory system of vertebrates	4.6. berating process of vertebrates
	SO4.7 explain external system of vertebrates		4.7 external system of vertebrates	
	SO4.8 described modification of mammals?		4.8 modification of mammals	
	SO4.9 explain function of digestion in vertebrates.		4.9 function of digestion in vertebrates	
	SO4.10 explain berating process of vertebrates		4.10 berating process of vertebrates	
	SO4.11 Study of limb bones		4.11 Study of limb bones	
	SO4.12 study of girdles of vertebrates.		4.12 study of girdles of vertebrates.	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Write about of Comparative study of integument and its derivatives of vertebrates.
	SW4.2 Mini Project	Write about the comparative study of digestive system of vertebrates.
	SW4.3 Other Activities (Specify)	write the respiratory system of vertebrates

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	06	25

Course Outcome (CO)	**Session Outcomes(SOs)**	**Laboratory Instruction(LI)**	**Classroom Instruction(CI)**	**Self-Learning(SL)**
02ZO312 **.5.** the project, assignment will give them a flavor of research in studying biodiversity, taxonomy beside improving their writing skills and lay foundation of career in zoology.	**SO5.1** Explain the comparative study of aortic arches	5.1. Study of limb bones and girdles of vertebrates	**Unit-5 Comparative Anatomy of vertebrates** **5.1** comparative study of aortic arches and hearts of vertebrates.	5.1. learn about comparative study of aortic arches and hearts of vertebrate
	SO5.2 study about comparative study of brain of vertebrates	5.2. Comparative study of heart and brain of vertebrates.	**5.2** comparative study of brain of vertebrates	5.2. learn about about comparative study of brain of vertebrates
	SO5.3 comparative study of Urinogenital system of vertebrates	5.3. study of eye of mammals.	**5.3** comparative study of Urinogenital system of vertebrates	5.3. learn about comparative study of Urinogenital system of vertebrates
	SO5.4 study of eye of mammals.		**5.4** study of eye and ear of mammals.	5.4. study of eye and ear of mammals.
	SO5.5 study of hearts of vertebrates		SO5.5 study of hearts of vertebrates	5.5. study of hearts of vertebrates
	SO5.6 study of ear of mammals.		SO5.6 study of ear of mammals.	5.6. study of digestive system?
	SO5.7 What is the world's largest and smallest fish in the world?		SO5.7 What is the world's largest and smallest fish in the world?	
	SO5.8 study of internal character of mammals		SO5.8 study of internal character of mammals	
	SO5.9 study of external character of vertebrates?		SO5.9 study of external character of vertebrates?	
	SO5.10 study of digestive system?		SO5.10 study of digestive system?	
	SO5.11 study of berating process of mammals?		SO5.11 study of berating process of mammals?	
	SO5.12 study of kidney?		SO5.12 study of kidney?	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Write study about comparative study of brain of vertebrates
	SW5.2 Mini Project	Write about the comparative study of Urinogenital system of vertebrates
	SW5.3 Other Activities (Specify)	Write the study of eye and ear of mammals.

Course duration (in hours) to attain Course Outcomes:

Course Title: Diversity of Chordates and Comparative Anatomy: Non chordata **Course Code:** 02ZO312

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction(LI)	Sessional work (SW)	Self-Learning (SL)	Total Hours (Li+CI+SL+SW)
S2-ZOOL1T **-A.1** Understand chordate diversity of animals and their taxonomic position**.**	12	06	1	6	25
S2-ZOOL1T **-A.2.** Identify the morphological and anatomical features and basis of chordate classification	12	06	1	7	26
S2-ZOOL1T **-A.3.** To recognize economic importance and present status that will develop positive attitude toward conservation of biodiversity.	12	06	1	7	26
S2-ZOOL1T **-A.4.** Differentiate the organism belonging to different taxa by studying comparative anatomy.	12	06	1	6	25
S2-ZOOL1T **-A.5.** Describe structural anatomy and organ systems of different groups of animals.	12	06	1	6	25
Total Hours	60	30	5	32	127

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Diversity of Chordates and Comparative Anatomy: Non chordate **Course Code:** 02ZO312

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
S2-ZOOL1T **-A.1** Understand chordate diversity of animals and their taxonomic position**.**	2	2	3	2	9
S2-ZOOL1T **-A.2.** Identify the morphological and anatomical features and basis of chordate classification	3	4	2	2	11
S2-ZOOL1T **-A.3.** To recognize economic importance and present status that will develop positive attitude toward conservation of biodiversity.	2	3	3	2	10
S2-ZOOL1T **-A.4.** Differentiate the organism belonging to different taxa by studying comparative anatomy.	3	3	2	2	10
S2-ZOOL1T **-A.5.** Describe structural anatomy and organ systems of different groups of animals.	3	4	1	2	10
Total Marks	**13**	**16**	**11**	**10**	**50**

***Legend*: A,** Apply; **An,** Analyze**,** Evaluate**,** Create

Suggested learning Resources:

(a)

S.No.	Title/Author/Publisher details
1	The Life of Vertebrates, J.Z. Young Oxford University Press III& 2004
2	Comparative Anatomy of Vertebrates , C.G. Kent & R.K. Kart McGraw Hill,Bostan,USA 9 & 2015
3	Morden Textbook of Zoology -Vertebrate R.L Kotpal Rastogi Publication ,Meerut 2000
4	Chordate and Comparative anatomy R.L Kotpal Rastogi Publication 2017
5	

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Demonstration
7. ICT Based teaching Learning
8. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Sc. Biology
Semester: 3rd Semester
Course Title: Diversity of Chordates and Comparative Anatomy: Non chordata
Course Code: 02ZO312

CO/PO/PSO Mapping								
Course Outcome (Cos)	**Program Outcomes (POs)**					**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**
02ZO312**.1** Understand chordate diversity of animals and their taxonomic position**.**	2	1	2	2	2	2	3	3
02ZO312**.2.** Identify the morphological and anatomical features and basis of chordate classification	1	1	2	2	1	2	3	3
02ZO312 **.3.** To recognize economic importance and present status that will develop positive attitude toward conservation of biodiversity.	2	1	3	3	1	1	1	3
02ZO312**.4.** Differentiate the organism belonging to different taxa by studying comparative anatomy.	1	1	3	2	3	1	2	3
02ZO312**.5.** Describe structural anatomy and organ systems of different groups of animals.	2	2	3	3	2	1	1	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5 PSO 1,2,3	02ZO312 **.1** Understand chordate diversity of animals and their taxonomic position**.**	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9 SO5.10 SO5.11 SO5.12	1.1,1.2,1.3	1.1, 1.2, 1.3, 1.4, 1.5 1.6, 1.7, 1.8, 1.9, 1.10, 1.11, 1.12	1SL-1,2,3,4,5,6
PO 1,2,3,4,5 PSO 1,2,3	02ZO312 **.2.** Identify the morphological and anatomical features and basis of chordate classification	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9 SO5.10 SO5.11 SO5.12	2.1, 2.2, 2.3	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.10, 2.11, 2.12	2SL-1,2,3,4,5,6,7
PO 1,2,3,4,5 PSO 1,2,3	02ZO312 **.3.** To recognize economic importance and present status that will develop positive attitude toward conservation of biodiversity.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9 SO5.10 SO5.11 SO5.12	3.1,3.2,3.3	3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 3.10, 3.11, 3.12	3SL-1,2,3,4,5,6,7
PO 1,2,3,4,5 PSO 1,2,3	02ZO312 **.4.** Differentiate the organism belonging to different taxa by studying comparative anatomy.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9 SO5.10 SO5.11 SO5.12	4.1,4.2,4.3	4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12	4SL-1,2,3,4,5,6
PO 1,2,3,4,5 PSO 1,2,3	02ZO312 **.5.** Describe structural anatomy and organ systems of different groups of animals.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9 SO5.10 SO5.11 SO5.12	5.1,5.2,5.3	5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10, 5.11, 5.12	5SL-1,2,3,4,5,6

B.Sc. IIIrd Semester

Course Code	Course Title	L	T	P	Total Credits
02CH313	**Reaction, Reagents and Mechanism in organic Chemistry**	3	1	2	6

Pre-requisite: **Students must have fundamental knowledge of mathematics, valence shell electron pair repulsion theory, and different concentration terms to understand the concept of analytical chemistry.**

Rationale: **The students studying analytical chemistry should possess foundational understanding about basic mathematics, valence shell electron pair repulsion theory, and different concentration terms to understand the basic principle of chromatography and spectroscopic analysis.**

Course Outcomes:

After the completion of this course, the learner will able to

002CH313.1: Explain Nucleophilic substitution , Electrophilic Substitution,Benzyne,SN1, SN2, SNi,SNAr.

002CH313.2:Describe the Additionreaction,Eliminationreactions,chemo-selectivity,orientation and reactivity, Markownikov and Anti markonikov s addition, Saytzeff and Hafmann rule.

002CH313.3: Explain Regent and catalyst, Grignard reagent, N- bromo Succinamide Rearrangement, pinacol pinacolone Benzilic acid and Wagner –meerwein.

002CH313.4: **d**iscuss principle of oxidation reactions, Reduction reactions . Oppenauer oxidation

002CH313.5: discuss basic concept of photo- chemical reaction and Paricyclic Reactions ,Norrish type-I and II reactions and cis- trans isomerisations pericyclic reaction and their classification 2 + 2 and 4 + 2 cycloaadition ,

Reaction,Reagents and Mechanism in organic Chemistry (Paper III)

CLO: - By the end of this course students must have had the subject chemistry in class or equivalent

1. Basic concepts of Nucleophilic substitution , Electrophilic Substitution,Benzyne,SN1, SN2, SNi,SNAr.
2. Addition reaction, Elimination reactions,
3. Regent and catalyst, Grignard reagent, N- bromo Succinamide Rearrangement, pinacol pinacolone Benzilic acid and Wagner –meerwein.
4. oxidation reactions, Reduction reactions
5. Photo-chemical Reactions, Paricyclic Reactions,) 2 + 2 and 4 + 2 cycloaadition

Unit-1 (02CH313.1): (A) Aliphatic nucleophilic substitution: Introduction, the SN1 SN2 and SNi mechanism , Neighbouring group participation, effect of substrate, nucleophilie, leaving group and reaction medium.

(B) Aliphatic Electrophilic Substitution: Elementary treatment.

(C) Aromatic Nucleophilic Substitution: the SNAr,SN1 and benzyne mechanisms, effect of substrate, nucleophile, leaving group and reaction medium.

(D) Aromatic Electrophilic Substitution,: arenium ion mechanism, orientation/directive influence (electronic explanation only) and reactivity, diazonium coupling,vilsmeier reaction.

Keywords/Tags:- Nucleophilic substitution , Electrophilic Substitution,Benzyne,SN1, SN2, SNi,SNAr.

Unit-2 (02CH313.2): -(A)Addition reaction : Introduction, reactions involving addition of nucleophile, electrophile and free radicals regio-selectivity and chemo-selectivity ,orientation and reactivity, Markownikov and Anti markonikov s addition.

(B) Elimination reactions: introduction E1,E2 ,E1cb mechanism,effect of substate attacking species leaving group and reaction medium orientation Saytzeff and Hafmann rule.

Keywords/Tags:-Additionreaction,Eliminationreactions,chemo-selectivity,orientation and reactivity, Markownikov and Anti markonikov s addition, Saytzeff and Hafmann rule.

Unit-3 (02CH313.3): Regent and catalyst: preparation properties and applications of important regents and catalyst in organic synthesis with mechanistic details : Grignard reagent and N- bromo Succinamide (NBS) diazomethane, anhydrous aluminium chloride(AlCl3) sodamide (NaNH2) ziegler natta catalyst.

Rearrangement (Reactions,Mechanism and applications): introduction types of rearrangement , Rearrangement to electron deficient carbon (pinacol pinacolone Benzilic acid and Wagner -meerwein) , rearrangement to electron deficiency nitrogen halfman lotion tests and backman rearrangement to electron deficient oxygen where villager and Deccan to electron rich carboniting aromatic rearrangement freez and clezen,

Keywords/Tags:- Regent and catalyst, Grignard reagent, N- bromo Succinamide Rearrangement, pinacol pinacolone Benzilic acid and Wagner –meerwein.

Unit-4 (02CH313.4): oxidation reactions: Introduction metal based oxidation and nonmetal base oxidation oxidation of electron to carbonil carbonium manganese and silver base regions alkys to apoxide peroxide alkene to die manganese and awesome based to carbonyl with bond cleavage manganese and lead based. Oppenauer oxidation

Oxidation of amino groups to nitro groups : oxidation by alkaline KMno4 oxidation of aliphatic and aromatic Amines by peracids ,oxidation of primary and secondary amines to hydroxylamine by hydrogen peroxide.

Reduction reactions: introduction reduction of carbon - carbon multiple bonds carbonyl group and nitro compounds catalytic hydrogenation : heterogeneous (palladium carbon and raney nickel) homogeneous(wilkinsons catalyst) hydride transfer reagents: sodium borohydride and lithium aluminium hydride, metal based reductions: Birch reduction clemmensen reduction, Reduction of nitro compounds by catalytic hydrogenation and metals (with mechanism).

Keywords/Tags:-. oxidation reactions, Reduction reactions, catalytic hydrogenation and metals

Unit-5 (02CH313.5): Photo-chemical Reactions: Introduction of photo- chemistry ,Electronic excitations Jablonski diagram, Norrish type-I and II reactions and cis- trans isomerisations.

Paricyclic Reactions: Introduction of pericyclic reaction and their classification ,(electrocyclic, Sigmatropic rearrangement and cycloaadition) 2 + 2 and 4 + 2 cycloaadition claisen and cope rearrangement.

Keywords/Tags:- Photo-chemical Reactions, Paricyclic Reactions,) 2 + 2 and 4 + 2 cycloaadition ,

Learning Resources

1. https://nptel.ac.in/course.html
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
3. https://swayam.gov.in/explorer?category=Chemistry

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)						Total CreditsI
			CI	T	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	02CH313	Reaction, Reagents and Mechanism in organic Chemistry	4	0	2	1	1	8	6

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),

LI: Laboratory Instruction (Includes Practical performances in laboratory workshop,field or other locations using different instructional strategies)

SW: Sessional Work (includes assignment, seminar, mini project etc.),

SL: Self Learning

C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback ofteacher to ensure outcome of Learning.

Scheme of Assessment: Theory

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (RA)					End Semester Assessment (ESA)	Total Marks (PRA+ESA)
			Class/Home Assignment 5 number markseach	Class Test2 (2 best out of 3) 10 markseach	Seminar one	Class	Total Marks (CA+CT+SA		
PCC	02CH313	Reaction, Reagents and Mechanism in organic Chemistry	15	20	10	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (Sos), culminating in the overall achievement of Course Outcomes (Cos) upon the course's conclusion.

Unit-1 (02CH313.1): (A) Aliphatic nucleophilic substitution: Introduction, the SN1 SN2 and SNi mechanism , Neighbouring group participation, effect of substrate, nucleophilie, leaving group and reaction medium.

(B) Aliphatic Electrophilic Substitution: Elementary treatment.

(C) Aromatic Nucleophilic Substitution: the SNAr,SN1 and benzyne mechanisms, effect of substrate, nucleophile, leaving group and reaction medium.

(D) Aromatic Electrophilic Substitution,: arenium ion mechanism, orientation/directive influence (electronic explanation only) and reactivity, diazonium coupling,vilsmeier reaction.

Activity	Appx Hrs
Cl	12
LI	6
SW	2
SL	1
Total	21

Session Outcomes (SOs)	LI	CI	SL
After the completion of topics: students will be able to SO1.1 Discuss the concept of Aliphatic nucleophilic substitution SO1.2 Explain SN1 SN2 and SNi mechanism SO1.3 discuss differentiation of important Electrophilic Substitution and Nucleophilic Substitution reaction. SO1.4 discuss arenium ion mechanism SO1.5 discusses diazonium coupling,and vilsmeier reaction.		**Unit-1 (02CH313.1):** **1.1 (A) Aliphatic nucleophilic substitution**: Introduction, **1.2** SN1 SN2 and SNi mechanism , **1.3** Neighbouring group participation, effect of substrate, **1.4** nucleophilie, leaving group and reaction medium. **1.5 (B) Aliphatic Electrophilic Substitution**: **1.6** Elementary treatment. **1.7 (C) Aromatic Nucleophilic Substitution**: the SNAr,SN1 **1.8** benzyne mechanisms, effect of substrate, **1.9** nucleophile, leaving group and reaction medium. **1.10 (D) Aromatic Electrophilic Substitution**,: **1.11** arenium ion mechanism, **1.12** orientation/directive influence (electronic explanation only) reactivity, **1.13** diazonium coupling, **1.14** vilsmeier reaction.	• Introduction to nucleophilic substitution • And electrophilic substitution reaction diazonium coupling, • vilsmeier reaction •

SW-1 Suggested Sessional Work (SW):

Assignments: SN1 SN2 and SNi mechanism

Mini Project: Software's for drawing structures and molecular formulae.

Other Activities (Specify): Introduction to graph and its types in different ways to represent data

Unit-2 (02CH313.2): -(A)Addition reaction : Introduction, reactions involving addition of nucleophile, electrophile and free radicals regio-selectivity and chemo-selectivity ,orientation and reactivity, Markownikov and Anti markonikov s addition.

(B) Elimination reactions: introduction E1,E2 ,E1cb mechanism,effect of substate attacking species leaving group and reaction medium orientation Saytzeff and Hafmann rule.

Activity	AppX Hrs
Cl	13
LI	6
SW	2
SL	1
Total	22

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
After the completion of topics students will be able to **SO2.1** explain Addition reaction **SO2.2** explain Elimination reactions **SO2.3** discuss Markownikov and Anti markonikov s addition **SO2.4** discuss E1,E2 ,E1cb mechanism,effect of substate **SO2.5** Estimate Saytzeff and Hafmann rule.	•	**Unit-2 (2CH101.2): -** **(A)Addition reaction** : Introduction, reactions involving addition of nucleophile, electrophile and free radicals regio-selectivity and chemo-selectivity ,orientation and reactivity, Markownikov and Anti markonikov s addition. **(B) Elimination reactions**: introduction E1,E2 ,E1cb mechanism,effect of substate attacking species leaving group and reaction medium orientation Saytzeff and Hafmann rule.	• Addition reaction • Elimination reactions • nucleophile, electrophile and free radicals • Saytzeff and Hafmann rule.

SW-2 Suggested Sessional Work (SW):

Assignments: effect of substate attacking species leaving group and reaction

Mini Project: nucleophile, electrophile and free radicals mechanism

Other Activities (Specify): Saytzeff and Hafmann rule.

Unit-3 (02CH313.3): Regent and catalyst: preparation properties and applications of important regents and catalyst in organic synthesis with mechanistic details : Grignard reagent and N- bromo Succinamide (NBS) diazomethane, anhydrous aluminium chloride(AlCl3) sodamide (NaNH2) ziegler natta catalyst.

Rearrangement (Reactions,Mechanism and applications): introduction types of rearrangement , Rearrangement to electron deficient carbon (pinacol pinacolone Benzilic acid and Wagner -meerwein) , rearrangement to electron deficiency nitrogen halfman lotion tests and backman rearrangement to electron deficient oxygen where villager and Deccan to electron rich carboniting aromatic rearrangement freez and clezen,

Activity	AppX Hrs
Cl	11
LI	4
SW	2
SL	1
Total	18

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
After the completion of topics students will be able to **SO3.1** explain preparation properties and applications of important regents and catalyst Grignard reagent. **SO3.2** discuss concept of anhydrous aluminium chloride(AlCl3) and NBS diazomethane. **SO3.3** describe sodamide (NaNH2) ziegler natta catalyst. **SO3.4** explain Rearrangement to electron deficient carbon. **SO3.5** describe rearrangement to electron deficiency nitrogen	• To study the Determination of free alkali present in different soaps/detergents.	**Unit-3 (2CH101.3): Regent and catalyst**:3.1 preparation properties and applications of important regents and catalyst in organic synthesis with mechanistic details : 3.1 Grignard reagent and N- bromo 3.2 Succinamide (NBS) diazomethane, 3.3 anhydrous aluminium chloride(AlCl3) 3.4 sodamide (NaNH2) ziegler natta catalyst. **Rearrangement (Reactions,Mechanism and applications)**: introduction types of rearrangement , **3.5** Rearrangement to electron deficient carbon	•

halfman lotion tests and backman rearrangement to electron deficient oxygen		**3.6** (pinacol pinacolone Benzilic acid and Wagner -meerwein) , 3.7 rearrangement to electron deficiency nitrogen halfman lotion tests and backman rearrangement to electron deficient oxygen 3.9 villager and Deccan to electron rich carboniting aromatic rearrangement freez and clezen,	

SW-3 Suggested Sessional Work (SW):

Assignments: Concept of chemical potential

Mini Project:

Other Activities (Specify):

Unit-4 (02CH313.4): oxidation reactions: Introduction metal based oxidation and nonmetal base oxidation oxidation of electron to carbonil carbonium manganese and silver base regions alkys to apoxide peroxide alkene to die manganese and awesome based to carbonyl with bond cleavage manganese and lead based. Oppenauer oxidation

Oxidation of amino groups to nitro groups : oxidation by alkaline KMno4 oxidation of aliphatic and aromatic Amines by peracids ,oxidation of primary and secondary amines to hydroxylamine by hydrogen peroxide.

Reduction reactions: introduction reduction of carbon - carbon multiple bonds carbonyl group and nitro compounds catalytic hydrogenation : heterogeneous (palladium carbon and raney nickel) homogeneous(wilkinsons catalyst) hydride transfer reagents: sodium borohydride and lithium aluminium hydride, metal based reductions: Birch reduction clemmensen reduction, Reduction of nitro compounds by catalytic hydrogenation and metals (with mechanism).

Activity	AppX Hrs
Cl	13
LI	6
SW	2
SL	1
Total	21

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
After the completion of topics students will be able to	Qualitative Analysis • Identification by determination of the	**Unit-4 (2CH101.4): oxidation reactions**: Introduction metal based oxidation and nonmetal	To understand the chromatographic

SO4.1 Discuss metal based oxidation and nonmetal base oxidation oxidation of electron to carbonil carbonium manganese. **SO4.2** discuss the Oppenauer oxidation. **SO4.3** discusses oxidation by alkaline KMno4 oxidation of aliphatic and aromatic Amines by peracids **SO4.4** explain column chromatography (CC) and gas chromatography (GC) **SO4.5** discuss the reduction of carbon - carbon multiple bonds carbonyl group and nitro compounds catalytic hydrogenation. **SO4.6** explain Birch reduction clemmensen reduction, Reduction of nitro compounds by catalytic hydrogenation and metals	Rf values of the given organic / inorganic compounds by paper/ thin layer chromatography. • Systematic identification of organic compound by qualitative analysis	base oxidation oxidation of electron to carbonil carbonium manganese and silver base regions alkys to apoxide peroxide alkene to die manganese and awesome based to carbonyl with bond cleavage manganese and lead based. Oppenauer oxidation Oxidation of amino groups to nitro groups : oxidation by alkaline KMno4 oxidation of aliphatic and aromatic Amines by peracids ,oxidation of primary and secondary amines to hydroxylamine by hydrogen peroxide. **Reduction reactions**: introduction reduction of carbon - carbon multiple bonds carbonyl group and nitro compounds catalytic hydrogenation : heterogeneous (palladium carbon and raney nickel) homogeneous(wilkinsons catalyst) hydride transfer reagents: sodium borohydride and lithium aluminium hydride, metal based reductions: Birch reduction clemmensen reduction, Reduction of nitro compounds by catalytic hydrogenation and metals (with mechanism).	principle students must read about • Nature of compound (polar/non-polar)

SW-4 Suggested Sessional Work (SW)

Assignment: Chromatography (HPLC) types of column and column selection

Mini Project:

Other Activities (Specify): Mechanism of separation of components in a mixture: adsorption, partition and ion-exchange

Unit-5 (02CH313.5): Photo-chemical Reactions: Introduction of photo- chemistry ,Electronic Excitations Jablonski diagram, Norrish type-I and II reactions and cis- trans isomerisations.

Paricyclic Reactions: Introduction of pericyclic reaction and their classification ,(electrocyclic, Sigmatropic rearrangement and cycloaadition) 2 + 2 and 4 + 2 cycloaadition claisen and cope rearrangement.

Activity	AppX Hrs
Cl	11
LI	6
SW	2
SL	1
Total	20

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
After the completion of topics. students will be able to **SO5.**1 understand Basics of **Photo-chemical Reactions** **SO5.2** discuss the principle of excitations Jablonski diagram **SO5.3** Norrish type-I and II reactions and cis- trans isomerisations. **SO5.**4 describes pericyclic reaction and their classification. **SO5.5** Explain electrocyclic, Sigmatropic rearrangement and cycloaadition . **SO5.6** Explain 2 + 2 and 4 + 2 cycloaadition claisen and cope rearrangement.	Quantitative Analysis.	**Unit-5 (02CH313.5):** **Photo-chemical Reactions**: Introduction of photo- chemistry ,Electronic excitations Jablonski diagram, Norrish type-I and II reactions and cis- trans isomerisations. **Paricyclic Reactions**: Introduction of pericyclic reaction and their classification ,(electrocyclic, Sigmatropic rearrangement and cycloaadition) 2 + 2 and 4 + 2 cycloaadition claisen and cope rearrangement.	cis- trans isomerisations. • pericyclic reaction and their classification

SW-5 Suggested Sessional Work (SW):

Assignments:.

Mini Project:

Other Activities (Specify):

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Laboratory Instruction (LI)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
02CH313.1: Explain Nucleophilic substitution , Electrophilic Substitution,Benzyne,SN1, SN2, SNi,SNAr.	12	6	02	01	21
02CH313.2: Describe the Additionreaction,Eliminationreactions,chemo-selectivity,orientation and reactivity, Markownikov and Anti markonikov s addition, Saytzeff and Hafmann rule.	13	6	02	01	22
02CH313.3: Explain Regent and catalyst, Grignard reagent, N- bromo Succinamide Rearrangement, pinacol pinacolone Benzilic acid and Wagner – meerwein	11	6	02	01	18
02CH313.4: **d**iscuss principle of oxidation reactions, Reduction reactions . Oppenauer oxidation	13	6	02	01	22
02CH313.5:. discuss basic concept of photo-chemical reaction and Paricyclic Reactions ,Norrish type-I and II reactions and cis- trans isomerisations pericyclic reaction and their classification 2 + 2 and 4 + 2 cycloaadition ,	11	6	02	01	20
Total Hours	60	30	10	05	103

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Aliphatic nucleophilic substitution, Aliphatic Electrophilic Substitution, Aromatic Nucleophilic Substitution, Aromatic Electrophilic Substitution	03	01	01	05
CO-2	Addition reaction, Elimination reactions	02	06	02	10
CO-3	Regent and catalyst, Rearrangement (Reactions,Mechanism and applications	03	04	03	10
CO-4	oxidation reactions and Reduction reactions	-02	08	05	15
CO-5	Photo-chemical Reactions, Paricyclic Reactions	03	02	05	10
Total		13	21	16	50

Legend: **R: Remember, U: Understand, A: Apply**

The written examination of 50 marks will be held at the end of semester for Inorganic Chemistry

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to NCL, CSIR laboratories
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT,Blog, Facebook,Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher
1	Organic Chemistry	Clayden,J.,Greeves,N.and Warren,S.,"Organic Chemistry" Oxford University press, India, 2012, 2nd Edition.	Sultan Chand and Sons, . Delhi
2	Chemistry	Srivastava, S. S. Gehlot. A.S.	Ratan Prakashan Temple. Indore.
3	Inorganic Chemicals	Sing, DR, Saxena, G, Singh, B.	Shivlal Aggarwal & Company, Agra
4	Bioinorganic Chemistry	AK Das	Prentice -Hall
5	Inorganic chemistry	Gary L. Miessler	Pearson
6	Inorganic chemistry	VK Jaiswal	Shri Balaji
7	Elementary Organic Spectroscopy	Sharma Y.R.	S Chand, 2013
8	Analytical Chemistr	Gupta Alka L	Pragiti Prakashan 2020
9	Analytical Chemistry	Kaur H,	Pragatic Prakashan 2008
10	Advanced Organic Chemistry	Bahl. A. & Bahal. B.S.	S. Chand. 2010
11	Chromatography	Sharma B.K.	Krishna Prakashan, 2019

Suggested Web Sources:

1. https://celqusb.files.wordpress.com/2017/12/inorganic-chemistry-g-l-miessler-2014.pdf
2. https://www.slideshare.net/MANISHSAHU106/inert-and-labile-complexes
3. https://swayam.gov.in/explorer?category=Chemistry

Mode of Delivery: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point;

LMS/ICT Tools: Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Cos, Pos and PSOs Mapping

Course Title: Reaction,Reagents and Mechanism in organic Chemistry Course Code: 3CH101

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Knowledge	Research Aptitude	Communication	Problem Solving	Individual and Team Work	Investigation of Problems	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and sustainability	The detailed functional knowledge of theoretical concepts and experimental	To integrate the gained knowledge with various contemporary and	understand, analyze, plan and implement qualitative as well as	Provide opportunities to excel in academics, research or Industry by
CO1: Explain Nucleophilic substitution , Electrophilic Substitution,Benzyne,SN1, SN2, SNi,SNAr.	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1

CO2: Describe the Additionreaction,Eliminationreactions,chemo-selectivity,orientation and reactivity, Markownikov and Anti markonikov s addition, Saytzeff and Hafmann rule.	**2**	**1**	**2**	**2**	**1**	**2**	**3**	**2**	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**1**
CO3: Explain Regent and catalyst, Grignard reagent, N-bromo Succinamide Rearrangement, pinacol pinacolone Benzilic acid and Wagner –meerwein	**2**	**2**	**1**	**1**	**1**	**2**	**2**	**2**	**1**	**2**	**1**	**2**	**1**	**1**	**2**	**2**
CO4: discuss principle of oxidation reactions, Reduction reactions . Oppenauer oxidation	**2**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**2**	**3**	**3**	**3**	**3**	**2**
CO5: discuss basic concept of photo-chemical reaction and Paricyclic Reactions ,Norrish type-I and II reactions and cis-trans isomerisations pericyclic reaction and their classification 2 + 2 and 4 + 2 cycloaadition ,	**2**	**-**	**-**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**3**	**1**	**3**

Legend: 1–Low, 2–Medium, 3–High

Course Curriculum Map:

POs &PSOsNo.	COs No. & Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
PO1,2,3,4,5,6 7,8,9,1 0,11,1 2 PSO 1,2, 3, 4	**CO1:** Explain Nucleophilic substitution , Electrophilic Substitution,Benzyne,SN1, SN2, SNi,SNAr.	SO1.1SO1. 2SO1.3SO 1.4 SO1.5		Unit-1. 1.1,1.2 ,1.3,1.4,1.5,1. 6,1.7	• Significance of differentiation and integration • Introduction to window
PO1,2,3,4,5,6 7,8,9,1 0,11,1 2 PSO 1,2, 3, 4	**CO2:** Describe the Additionreaction,Elimination reactions,chemo-selectivity,orientation and reactivity, Markownikov and Anti markonikov s addition, Saytzeff and Hafmann rule.	SO2.1SO2. 2SO2.3 SO2.4 SO2.5		Unit-2 2.1,2.2,2.3,2. 4,2.5,2.6, 2.7, 2.8,2.9	• Some Important units of measurements: SI Unit • distinction between mass and weight • mole, mill mole and numerical problems
PO1,2,3,4,5,6 7,8,9,1 0,11,1 2 PSO 1,2, 3, 4	**CO3:** Explain Regent and catalyst, Grignard reagent, N-bromo Succinamide Rearrangement, pinacol pinacolone Benzilic acid and Wagner – meerwein	SO3.1SO3. 2 SO3.3 SO3.4 SO3.5		Unit-3 : Chemical Equilibrium 3.1, 3.2,3.3,3.4,3.5,3.6,3 .7	• Gibbs free energy • Van't Hoff factors
PO1,2,3,4,5,6 7,8,9,1 0,11,1 2	**CO4: d**iscuss principle of oxidation reactions, Reduction reactions . Oppenauer oxidation	SO4.1SO4. 2SO4.3SO 4.4 SO4.5		Unit-4: 4.1, 4.2,4.3,4. 4,4.5,4.6, 4.7	To understand the chromatographic

PSO 1,2, 3, 4					principle students must read about • Nature of compound (polar/non-polar)
PO1,2, 3,4,5,6 7,8,9,1 0,11,1 2 PSO 1,2, 3, 4	**CO5:** discuss basic concept of photo- chemical reaction and Paricyclic Reactions ,Norrish type-I and II reactions and cis- trans isomerisations pericyclic reaction and their classification 2 + 2 and 4 + 2 cycloaadition ,	SO5.1SO5. 2SO5.3SO 5.4 SO5.5		Unit 5: 5.1,5.2,5.3,5 .4,5.5,5.6,5. 7	Basics of absorption spectroscopy : • Electro magnetic radiation , • Spectral range • Absorbance Absorptivity, Molar Absorptivity

Curriculum Development Team:

1. Dr. Shailendra Yadav, HoD, Department of Chemistry, AKS University, Satna (M.P.).
2. Dr. Dinesh Kumar Mishra, Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
3. Dr. Samit Kumar,Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
4. Dr. Sushma Singh, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
5. Dr. Manoj Kumar Sharma, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
6. Mr. Kanha Singh Tiwari,Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
7. Mrs. Nahid Usamani, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).

Program name	Bachelor of Science (B. Sc.)Botany	
Semester	3rd Semester	
Course Code:	03BO321	
Course title:	Plant Anatomy and Embryology	**Curriculum Developer**: Priya Dwivedi Lab Demonstrator
Pre-requisite:	Students should have basic knowledge of Plant Anatomy and Embryology.	
Rationale:	Plant Anatomy and Embryology is a fundamental area of study within botany that explores the intricate structures and developmental processes of plants. Understanding the anatomy and embryological development of plants is crucial for several scientific fields, including agriculture, horticulture, ecology, and environmental science. This course/module aims to provide students with a comprehensive understanding of plant structure and development, from the cellular level to the formation of complex tissues and organs, and the processes involved in the formation and development of seeds and embryos.	
Course Outcomes (COs):	**CO1**: Students will learn the internal structure of plants. **CO2**: It will enhance the basic understanding of organization of plant body by cells and tissues. **CO3**: Students will understand the history, importance and types of embryology. **CO4**: Students will understand the dynamic mechanism of plant pollination, fertilization and development. **CO5**: They will have hands on training on section cutting, preparation of slides, study of pollen and ovules.	

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits(C) (L:T:P=4:0:2)
			CI	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
Generic Elective	03BO321	Plant Anatomy and Embryology	3	1	1	1	6	3+0+1=4

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
Generic Elective	03BO321	Plant Anatomy and Embryology	**15**	**20**	**5**	**5**	**5**	**50**	**50**	**100**

Scheme of Assessment: Practical

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)		
Generic Elective	**03BO321**	Plant anatomy and Embryology	35	5	5	5	50	50	50

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	8	4	1	5	18

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO1: Students will learn the internal structure of plants.			**Unit-1**	
	SO 1.1: Describe the characteristics and functions of meristematic tissues.	**LI 1.1**: Discuss the role of meristematic tissues in plant growth and development.	**CI 1.1**: Explain the definition and classification of meristematic tissues (apical, lateral, intercalary).	**SLT 1.1**: Research the importance of meristematic tissues in agriculture and horticulture.
	SO 1.2: Identify different types of meristems based on position and origin.	**LI 1.2**: Analyze how different types of meristems contribute to primary and secondary growth.	**CI 1.2**: Discuss apical, lateral, and intercalary meristems and their roles in plant growth.	**SLT 1.2**: Create a poster illustrating types of meristems and their locations in plants.
	SO 1.3: Understand the organization of the root apex. Understand the organization of the shoot apex.		**CI 1.3**: Explain the zones of the root apex, including the role of the root cap. Describe the structure and function of the shoot apex, focusing on the tunica-corpus theory.	**SLT 1.3**: Investigate the effects of different soil types on root growth and development.
	SO 1.4: Differentiate between simple and complex tissues.		**CI 1.4**: Discuss simple and complex tissues with examples and functions in plants.	**SLT 1.4**: Study how pruning affects shoot apex growth and branching patterns.
	SO 1.5: Explore special types of tissues and their roles.		**CI 1.5**: Explain special types of tissues, including epidermis, secretory tissues, and laticifers.	**SLT 1.5**: Prepare a chart illustrating the differences between simple and complex tissues.
	SO 1.6: Analyze the structure of dicot and monocot roots, stems, and leaves. Understand Kranz anatomy and its significance		**CI 1.6**: Discuss the structure and function of dicot and monocot roots, stems, and leaves with diagrams. Describe Kranz anatomy and its importance in C4 plants.	
	SO 1.7: Explain the structure and function of pits and plasmodesmata. Explore wall ingrowths and transfer cells		**CI 1.7**: Discuss pits and plasmodesmata, their structure, and functions in plant cells. Explain the structure and function of wall ingrowths and transfer cells.	
	SO 1.8: Examine the structure and function of		**CI 1.8**: Explain hydathodes, cavities, lithocysts, and laticifers and their	

	hydathodes, cavities, lithocysts, and laticifers. Analyze the adaptive and protective roles of plant tissues.		physiological functions. Discuss the protective and adaptive roles of tissues like cuticles, trichomes, and stomata.	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Describe in detail the history of plant tissue.
	SW1.2 Mini Project	Describe the types of plant tissue.
	SW1.3 Other Activities (Specify)	Explain the importance of plant tissue.

Item	CI	LI	SW	SL	Total
Approx. Hours	10	4	1	5	20

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO2: It will enhance the basic understanding of organization of plant body by cells and tissues.			**Unit-2**	
	SO 2.1: Understand the structure and function of vascular cambium.	**LI 2.1**: Discuss the role of vascular cambium in secondary growth and its seasonal activity.	**CI 2.1**: Explain the structure, function, and seasonal activity of vascular cambium.	**SLT 2.1**: Research how the activity of vascular cambium influences plant growth in different climates.
	SO 2.2: Explain the process of secondary growth in roots and stems.	**LI 2.2**: Analyze the differences in secondary growth between roots and stems of dicots and monocots.	**CI 2.2**: Describe the process of secondary growth in roots and stems, highlighting key differences.	**SLT 2.2**: Compare and contrast secondary growth in woody and herbaceous plants.
	SO 2.3: Differentiate between heartwood and sapwood.		**CI 2.3**: Explain the differences between heartwood and sapwood and their roles in plants.	**SLT 2.3**: Investigate how heartwood and sapwood contribute to the overall strength and durability of trees.

	SO 2.4: Recognize anomalous structures in plant growth.		**CI 2.4**: Describe anomalous structures and their impact on plant morphology.	**SLT 2.4**: Study a case of anomalous growth in a specific plant species and present findings.
	SO 2.5: Understand the adaptive and protective systems in plants.		**CI 2.5**: Discuss the structure and function of adaptive systems like the epidermis and cuticle.	**SLT 2.5**: Analyze how different protective systems help plants adapt to various environmental conditions.
	SO 2.6: Explore adaptations in xerophytes and hydrophytes.		**CI 2.6**: Explain the specific adaptations of xerophytes and hydrophytes to their environments.	
	SO 2.7: Understand the principles of dendrochronology. Explore the process of cambial activity in relation to wood formation		**CI 2.7**: Describe dendrochronology and its applications in ecological and historical studies. : Discuss the relationship between cambial activity and wood formation.	
	SO 2.8: Analyze the protective adaptations in plants.		**CI 2.8**: Explain the role of protective adaptations in plant survival.	
	SO 2.9: Discuss the impact of secondary metabolites in plant protection. : Examine the role of lignin in plant structure and protection.		**CI 2.9**: Describe the role of secondary metabolites in plant protection. Explain the role of lignin in plant structure and protection.	
	SO 2.10: Analyze the effects of environmental stress on secondary growth and adaptive mechanisms.		**CI 2.10**: Discuss the impact of environmental stress on secondary growth and plant adaptation.	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Describe and define the secondary growth.
	SW2.2 Mini Project	Explain the role of lignin in plant structure .
	SW2.3 Other Activities (Specify)	Study one review article on plant protection.

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	9	4	1	2	16

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO3: Students will understand the history, importance and types of embryology.			**Unit-3**	
	SO 3.1: Understand the history and importance of embryology in plant biology.	LI 3.1: Investigate the anatomy and function of flowers, focusing on anther and pollen development.	CI 3.1: Discuss the key milestones in the history of plant embryology and its relevance today.	SLT 3.1: Research the contributions of early botanists to the field of plant embryology and present findings.
	SO 3.2: Analyze the structure of flowers, anthers, and pollen.	LI 3.2: explore the stage and significance of microsporogenesis and megasporogenesis.	CI 3.2: Explain the structure of flowers, anthers, and pollen with diagrams.	SLT 3.2: Dissect a flower to observe its structure and create a detailed sketch of its reproductive organs.
	SO 3.3: Explore the processes of microsporogenesis and megasporogenesis. Understand the structure and types of ovules.		CI 3.3: Describe the stages and significance of microsporogenesis and megasporogenesis. Discuss the structure and types of ovules, highlighting their roles in plant reproduction.	
	SO 3.4: Explore the types of embryo sacs and their		CI 3.4: Explain the organization and types of embryo sacs in plants.	

	organization.			
	SO 3.5: Examine the ultrastructure of the mature embryo sac. Understand the process of double fertilization in angiosperms.		CI 3.5: Describe the ultrastructure of the mature embryo sac and its role in fertilization. : Explain the process of double fertilization and its role in seed development.	
	SO 3.6: Explore the factors influencing embryo development and seed formation.		CI 3.6: Discuss the stages of embryo development and factors influencing seed formation.	
	SO 3.7: Analyze the significance of seed dispersal mechanisms in plant reproduction.		CI 3.7: Explain different seed dispersal mechanisms and their advantages for plant species.	
	SO 3.8: Understand the role of endosperm in supporting embryo development. Explore the concept of apomixis and its significance in plant reproduction.		CI 3.8: Describe the structure and function of endosperm in seed development. Explain apomixis and its role in plant reproduction, highlighting examples of apomictic species.	
	SO 3.9: Examine the practical applications of embryology in agriculture and horticulture.		CI 3.9: Highlight the applications of plant embryology in modern agriculture and horticulture.	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Describe the endosperm in seed development.
	SW3.2 Mini Project	Detailed study plant biology .
	SW3.3 Other Activities (Specify)	Importance of embryology in plant biology

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	8	2	1	4	15

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO4: Students will understand the dynamic mechanism of plant pollination, fertilization and development.			**Unit-4**	
	SO 4.1: Identify different types of anthers and pollen. Understand pollination mechanisms and adaptations.	LI 4.1: Explore the morphological diversity of anthers and pollen grains across plant species.	CI 4.1: Describe the structure and types of anthers and pollen, emphasizing their roles in reproduction.	**SL4.1** Search various reference books and other study material to start the learning about Pollen grains..
	SO 4.2: Explore pollen-pistil interactions during fertilization.		CI 4.2: Explain the molecular and cellular mechanisms of pollen-pistil interaction.	**SL4.2** Pollination mechanisms and adaptations
	SO 4.3: Understand the process and significance of double fertilization. Analyze post-fertilization changes in ovules and seeds.		CI 4.3: Describe the process of double fertilization and its outcomes in seed development. Discuss the post-fertilization changes and the formation of seed structures.	**SL4.3** To Understand the significance of double fertilization.
	SO 4.4: Examine seed structure, appendages, and dispersal mechanisms.		CI 4.4: Describe seed structure and the role of appendages in seed dispersal. Discuss the significance of	**SL4.4** To independently explore the brief in detail

	Understand the field of palynology and its scope.		palynology and its applications in scientific research.	Equitable Benefit Sharing of Plant biology.
	SO 4.5: Investigate the role of environmental factors in pollination success.		CI 4.5: Explain the impact of environmental conditions on pollination and seed set.	
	SO 4.6: Analyze the genetic and evolutionary implications of self-pollination and cross-pollination.		CI 4.6: Discuss the genetic outcomes and evolutionary significance of different pollination strategies.	
	SO 4.7: Understand the role of pollinators in maintaining biodiversity. Explore the co-evolution of plants and pollinators.		CI 4.7: Describe the ecological importance of pollinators in maintaining plant biodiversity. Explain the concept of co-evolution and provide examples of plant-pollinator interactions.	
	SO 4.8: Examine the impact of human activities on pollination processes.		CI 4.8: Analyze the effects of human activities on pollination and propose solutions to mitigate negative impacts.	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Describe the introduction of Pollination.
	SW4.2 Mini Project	Explain in detail future challenges and opportunities of Plant biology
	SW4.3 Other Activities (Specify)	Write a one review article on educational role of Plant anatomy and embryology.

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	10	2	1	3	16

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO5: They will have hands on training on section cutting, preparation of slides, study of pollen and ovules.			**Unit-5**	
	SO 5.1: Identify the types, structure, and functions of endosperm in plants.	LI 5.1: Explore different types of endosperm and their roles in seed development.	CI 5.1: Discuss the structure and functions of endosperm types such as nuclear, cellular, and helobial types	SLT 5.1: Create a comparative analysis of endosperm types and their contributions to seed nutrition.
	SO 5.2: Compare dicot and monocot embryos in terms of structure and development. Analyze the embryo-endosperm relationship in seed development.		CI 5.2: Explain the structure and development of dicot and monocot embryos. Describe the embryo-endosperm relationship and its significance in seed development.	SLT 5.2: Prepare a detailed diagram comparing the stages of development in dicot and monocot embryos.
	SO 5.3: Understand the nutrition of the embryo and its sources.		CI 5.3: Explain the nutrition of the embryo and the role of nutrient sources like endosperm and cotyledons.	SLT 5.3: Study the impact of endosperm nutrition on the growth and viability of seeds in different plant species.
	SO 5.4: Examine unusual features in embryo and endosperm development. Explore the concepts of apomixis and polyembryony in plants.		CI 5.4: Discuss examples of unusual features in embryo and endosperm development and their implications. Explain apomixis and polyembryony, their types, and applications in plant breeding.	
	SO 5.5: Understand the principles and applications of in-vitro fertilization in plant breeding.		CI 5.5: Describe the process of in-vitro fertilization and its significance in modern agriculture.	
	SO 5.6: Analyze the ecological role of seeds in plant life cycles.		CI 5.6: Discuss the ecological importance of seeds in plant life cycles and ecosystems.	
	SO 5.7: Explore the genetic regulation of seed development and		CI 5.7: Explain the genetic regulation of seed development and	

	maturation.		its impact on plant breeding.	
	SO 5.8: Understand the mechanisms of seed dormancy and germination.		CI 5.8: Discuss the mechanisms of seed dormancy and germination, emphasizing environmental triggers.	
	SO 5.9: Examine the role of seed banks in conservation and agriculture.		CI 5.9: Describe the role of seed banks in conservation and agriculture, highlighting key examples. in various ecosystems.	
	SO 5.10 Explore the impact of climate change on seed development and germination.		5.10 Analyse the impact of climate change on seed development and germination	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Explain in detail about medicinal plant.
	SW5.2 Mini Project	Describe in the detail different types of diseases.
	SW5.3 Other Activities (Specify)	One case research study on heart diseases.

Course duration (in hours) to attain Course Outcomes:

Course Title: Plant Anatomy and Embryology **Course Code:** 03BO321

Course Outcomes (COs)	**Class lecture (CI)**	**Laboratory Instruction (LI)**	**Self-Learning (SL)**	**Sessional work (SW)**	**Total Hours (Li+CI+SL+SW)**
CO1: Students will learn the internal structure of plants.	8	4	5	1	18
CO2: It will enhance the basic understanding of organization of plant body by cells and tissues.	10	4	5	1	20
CO3: Students will understand the history, importance	9	4	2	1	16

and types of embryology.					
CO4: Students will understand the dynamic mechanism of plant pollination, fertilization and development.	8	2	4	1	15
CO5:They will have hands on training on section cutting, preparation of slides, study of pollen and ovules.	10	2	3	1	16
Total Hours	45	16	19	05	85

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcomes:

Course Title: Plant Anatomy and Embryology **Course Code;** 03BO321

Course Outcomes	**Marks Distribution**				**Total Marks**
	R	**U**	**A**	**A**	
CO1: Students will learn the internal structure of plants.	2	2	3	2	9
CO2: It will enhance the basic understanding of organization of plant body by cells and tissues.	2	3	3	2	10
CO3: Students will understand the history, importance and types of embryology.	2	2	3	4	11
CO4: Students will understand the dynamic mechanism of plant pollination, fertilization and development.	2	2	3	3	10
CO5:They will have hands on training on section cutting, preparation of slides, study of pollen and ovules.	2	2	2	4	10
Total Marks	**10**	**11**	**14**	**15**	**50**

***Legend*:R,** Remember; **U,** Understand; **A,** Apply; **A,** Analyze

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1.	.Bhojwani,S.S & bhatnagar , S.P. (2011) Embriology of Angiosperm. Vikash Publication
2.	Dickison, W.C. (2000). Integrative plant anatomy .
3.	Fahn,A.(1974). Plant Anatomy
4.	Mauseth J.D. (1988) Plant Anatomy
5.	Evert , R.F. (2006) Esau's Plant Anatomy

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Visit to animal biotechnology lab and stem cells biology lab
7. Demonstration
8. ICT Based teaching Learning
9. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Sc. BOTANY

Semester: 3rd semester

Course Title: Plant Anatomy and Embryology

Course Code: 03BO321

Course Outcome (Cos)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1: Students will learn the internal structure of plants.	3	1	1	-	-	1	1	1	1	-	2	1	2	2	2
CO2: It will enhance the basic understanding of organization of plant body by cells and tissues.	3	2	1	2	1	-	-	1	1	-	2	1	2	3	3
CO3: Students will understand the history, importance and types of embryology.	2	1	1	-	-	2	-	2	1	-	1	1	3	2	1
CO4: Students will understand the dynamic mechanism of plant pollination, fertilization and development.	2	3	1	1	-	1	-	1	1	1	2	1	2	2	2
CO5:They will have hands on training on section cutting, preparation of slides, study of pollen and ovules.	2	3	-	1	2	2	1	2	1	2	1	2	2	2	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO1**: Students will learn the internal structure of plants.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8	LI 1 LI 2	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8	1SL-1,2,3,4,5
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO2**: It will enhance the basic understanding of organization of plant body by cells and tissues.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9 SO2.10	LI 1 LI 2	2.1,2.2,2.3,2.4,2.5, 2.6,2.7,2.8,2.9,2.1 0	2SL-1,2,3,4,5
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO3**: Students will understand the history, importance and types of embryology.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9	LI 1 LI 2	3.1,3.2,3.3,3.4,3.5, 3.6,3.7,3.8,3.9	3SL-1,2
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO4**: Students will understand the dynamic mechanism of plant pollination, fertilization and development.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8	LI 1	4.1,4.2,4.3,4.4,4.5, 4.6,4.7,4.8	4SL-1,2,3,4
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO5**:They will have hands on training on section cutting, preparation of slides, study of pollen and ovules.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9 SO5.10	LI 1	5.1,5.2,5.3,5.4,5.5, 5.6,5.7,5.8,5.9,5.1 0	5SL-1,2,3

Program Name	**Bachelor of Science (B.Sc.)- Biology**	
Semester	III	
Course Code:	03ZO322	
Course title:	Diversity of Chordates and Comparative Anatomy: Non chordate	**Curriculum Developer**: Mr. AMIT BAGRI
Pre-requisite:	Student should have basic knowledge of Diversity of Chordates and Comparative Anatomy: Non chordate animals.	
Rationale:	This core course will cover the essential aspects of taxonomic position, characteristic features and distribution of different orders of the chordates and non-chordate animals. This course will help to obtain comprehensive knowledge of comparative anatomy of chordates and to recognize their evolutionary trends and evidences, theories and mechanisms of evolution.	
Course Outcomes (COs):	03ZO322**.1** Understand chordate diversity of animals and their taxonomic position**.** 03ZO322**.2.** Identify the morphological and anatomical features and basis of chordate classification 03ZO322. **3.** To recognize economic importance and present status that will develop positive attitude toward conservation of biodiversity. 03ZO322**.4.** Differentiate the organism belonging to different taxa by studying comparative anatomy. 03ZO322 **.5.** Describe structural anatomy and organ systems of different groups of animals.	

Scheme of Studies:

Board of Study	**Course Code**	**Course Title**	**Scheme of studies (Hours/Week)**					**Total Credits(C) (L:T:P=3:0:1)**
			Cl	LI	SW	SL	**Total Study Hours(CI+LI+SW+SL)**	
Generic Elective	03ZO322	Diversity of Chordates and Comparative Anatomy: Non chordate	3	1	1	1	6	3+1= 4

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)		
Generic Elective	03ZO322	Diversity of Chordates and Comparative Anatomy: Non chordate	**15**	**20**	**10**	**5**	**50**	**50**	**100**

Scheme of Assessment: Practical

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)		
Generic Elective	03ZO322	Diversity of Chordates and Comparative Anatomy: Non chordate	35	5	5	5	50	50	50

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	10	04	01	06	21

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
03ZO322 **.1.** understand chordate diversity of animals and their taxonomic position.	**SO1.1** Study of traditional knowledge on animal science in ancient Indian civilization	1.1. Study of museum specimens and slides.	**Unit-1 introduction of chordates , protochordate, Agnetha** **1.1** traditional knowledge on animal science in ancient Indian civilization classification of phylum chordate	1.1. define traditional knowledge on animal science in ancient Indian civilization
	SO1.2 define about Origin of chordates general characteristics and outline classification of phylum chordate	1.2 protochordate hard mania, Amphioxus	**1.2** Origin of chordates general characteristics and outline	1.2. define Origin of chordates general characteristics and outline classification of phylum chordate
	SO1.3 Define general characteristics and classification of sub phylum Urochordata and cephalochordate		**1.3** general characteristics and classification of sub phylum Urochordata and cephalochordate	1.3. learn about general characteristics and classification of sub phylum Urochordata and cephalochordate
	SO1.4 type study of herd mania and retrogressive metamorphosis in ascidian tadpole		**1.4** type study of herd mania and retrogressive metamorphosis in ascidian tadpole	1.4. Learn about type study of herd mania and retrogressive metamorphosis in ascidian tadpole
	SO1.5 type study of amphioxus and its affinities		**1.5** type study of amphioxus and its affinities	1.5. type study of amphioxus and its affinities
	SO1.6 define about comparison of Petromyzon and myxine		**1.6** comparison of Petromyzon and myxine	1.6. comparison of Petromyzon and myxine
	SO1.7 Amphioxus described as a simple organism?		1.7 Why is Amphioxus described as a simple organism?	
	SO1.8 explain positive benefit of having vertebrae for Chordates.		1.8 Name one positive benefit of having vertebrae for Chordates.	
	SO1.9 advantages do animals with jaws have?		1.9 What advantages do animals with jaws have?	
	SO1.10 described protects the brains of fish?		1.10 What protects the brains of fish?	

Suggested Sessional Work (SW):*anyone*	**SW1.1** Assignments	Write about the history traditional knowledge on animal science in ancient Indian civilization
	SW1.2 Mini Project	Write about type study of herd mania and retrogressive metamorphosis in ascidian tadpole
	SW1.3 Other Activities (Specify)	type study of amphioxus and its affinities.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	08	04	01	07	20

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
03ZO322 **.2.** To identify the morphological and anatomical features and basis of chordate classification	**SO2.1** study of General characteristics.	2.1. Study of museum specimens a. fishes: scolidon, stegostoma , torpedo, labeo, eal, flat fish	**Unit-2 Pisces, amphibia and Reptilia** **2.1** General characteristics and classification of Pisces	2.1. study of General characteristics and classification of Pisces
	SO2.2 define accessory respiratory organ.	2.2. Amphibia: chelone, trimix, Varanus, chameleon, draco	**2.2** accessory respiratory organ, parental care in fishes	2.2. learn about accessory respiratory organ, parental care in fishes
	SO2.3 define General characteristics		**2.3** General characteristics and classification of amphibia	2.3. learn about General characteristics and classification of amphibia
	SO2.4 study of parental care in amphibia		**2.4** parental care in amphibia and pedomorphosis	2.4. Know about the parental care in amphibia and pedomorphosis
	SO2.5 Study of General characteristics		**2.5** General characteristics and classification of Reptilia	2.5. learn about General characteristics and classification of Reptilia.
	SO2.6 study of difference between poisonous and non-poisonous snakes		**2.6** difference between poisonous and non-poisonous snakes, venom and antivenom	2.6. learn about difference between poisonous and non-poisonous snakes, venom and antivenom
	SO2.7 poison apparatus and biting mechanism in snake?		2.7 poison apparatus and biting mechanism in snake	2.7. study of poison apparatus and biting mechanism in snake.
	SO2.8 explain parental care in fishes		**2.8** study of parental care in fishes	

Suggested Sessional Work (SW):*anyone*	**SW2.1** Assignments	Write about General characteristics and classification of pisces.
	SW2.2 Mini Project	Write about the parental care in ambhibia and paedomorphosis.
	SW2.3 Other Activities (Specify)	write the poison apparatus and biting mechanism in snake.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	04	01	07	21

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
03ZO322 **.3.** To know economic importance and present status that will develop positive attitude towards conservation of biodiversity	**SO3.1** Study of Brief introduction of birdman of india – Dr. Salim Ali	3.1. Study of museum specimens	**Unit-3 Aves, Mammalia** **3.1** Brief introduction of birdman of india – Dr. Salim Ali	3.1. Know about the birdman of India – Dr. Salim Ali
	SO3.2 define the General characteristics	3.2. Study of limb bones	**3.2** General characteristics and classification of Aves	3.2. learn about General characteristics and classification of Aves
	SO3.3 Explain the Migration of birds,		**3.3** Migration of birds, principles and aerodynamics of flight.	3.3. Know about the Migration of birds, principles and aerodynamics of flight.
	SO3.4 Explain the flights adaptation In birds.		**3.4** flights adaptation In birds.	3.4. learn about flights adaptation In birds
	SO3.5 Explain the General characteristics and	.	**3.5** General characteristics and classification of mammals.	3.5. Know about the General characteristics and classification of mammals.
	SO3.6 define adaptive radiation in mammals?		**3.6** adaptive radiation in mammals with reference to locomotory appendages.	3.6. study of adaptive radiation in mammals with reference to locomotory appendages.
	SO3.7 explain classification of Aves?		**3.7** classification of Aves?	3.7. learn about introduction of ZSI
	SO3.8 described principles and aerodynamics of flight.?		**3.8** principles and aerodynamics of flight.?	
	SO3.9 explain classification of mammals.		**3.9** classification of mammals.	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Study of Brief introduction of birdman of India – Dr. Salim Ali
	SW3.2 Mini Project	Explain the General characteristics and classification of mammals.
	SW3.3 Other Activities (Specify)	Explain the flights adaptation in birds.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	04	01	06	20

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
03ZO322 **.4.** Differentiate the organism belonging to different taxa by studying comparative anatomy.	**SO4.1** study of Comparative study of integument	4.1. Comparative study of heart and brain of vertebrates.	**Unit-4** **Comparative Anatomy of vertebrates** **4.1** Comparative study of integument and its derivatives of vertebrates.	4.1. Read the Comparative study of integument and its derivatives of vertebrates.
	SO4.2 study of Comparative study of appendicular skeleton of vertebrates.	4.2. Study of limb bones and girdles of vertebrates.	**4.2** Comparative study of appendicular skeleton of vertebrates.	4.2. study of Comparative study of appendicular skeleton of vertebrates.
	SO4.3 comparative study of digestive system of vertebrates		**4.3** comparative study of digestive system of vertebrates	4.3. comparative study of digestive system of vertebrates
	SO4.4 comparative study of respiratory system of vertebrates.		**4.4** comparative study of respiratory system of vertebrates.	4.4. learn about comparative study of respiratory system of vertebrates.
	SO4.5 study of its derivatives of vertebrates.		4.5 study of its derivatives of vertebrates.	4.5. external system of vertebrates
	SO4.6 Explain internal respiratory system of vertebrates?		4.6 internal respiratory system of vertebrates	4.6. berating process of vertebrates
	SO4.7 explain external system of vertebrates		4.7 external system of vertebrates	
	SO4.8 described modification of mammals?		4.8 modification of mammals	
	SO4.9 explain function of digestion in vertebrates.		4.9 function of digestion in vertebrates	

Suggested Sessional Work (SW): *anyone*		
	SW4.1 Assignments	Write about of Comparative study of integument and its derivatives of vertebrates.
	SW4.2 Mini Project	Write about the comparative study of digestive system of vertebrates.
	SW4.3 Other Activities (Specify)	write the respiratory system of vertebrates

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	02	01	06	16

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Classroom Instruction(CI)	Self-Learning(SL)
03ZO322 **.5.** the project, assignment will give them a flavor of research in studying biodiversity, taxonomy beside improving their writing skills and lay foundation of career in zoology.	**SO5.1** Explain the comparative study of aortic arches	5.1. Study of limb bones and girdles of vertebrates	**Unit-5 Comparative Anatomy of vertebrates** **5.1** comparative study of aortic arches and hearts of vertebrates.	5.1. learn about comparative study of aortic arches and hearts of vertebrate
	SO5.2 study about comparative study of brain of vertebrates		**5.2** comparative study of brain of vertebrates	5.2. learn about about comparative study of brain of vertebrates
	SO5.3 comparative study of Urinogenital system of vertebrates		**5.3** comparative study of Urinogenital system of vertebrates	5.3. learn about comparative study of Urinogenital system of vertebrates
	SO5.4 study of eye of mammals.		**5.4** study of eye and ear of mammals.	5.4. study of eye and ear of mammals.
	SO5.5 study of hearts of vertebrates		SO5.5 study of hearts of vertebrates	5.5. study of hearts of vertebrates
	SO5.6 study of ear of mammals.		SO5.6 study of ear of mammals.	5.6. study of digestive system?
	SO5.7 What is the world's largest and smallest fish in the world?		SO5.7 What is the world's largest and smallest fish in the world?	
	SO5.8 study of internal character of mammals		SO5.8 study of internal character of mammals	
	SO5.9 study of external character of vertebrates?		SO5.9 study of external character of vertebrates?	

Suggested Sessional Work (SW): *anyone*		
	SW5.1 Assignments	Write study about comparative study of brain of vertebrates
	SW5.2 Mini Project	Write about the comparative study of Urinogenital system of vertebrates
	SW5.3 Other Activities (Specify)	Write the study of eye and ear of mammals.

Course duration (in hours) to attain Course Outcomes:

Course Title: Diversity of Chordates and Comparative Anatomy: Non chordate **Course Code:** 02ZO312

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction(LI)	Sessional work (SW)	Self-Learning (SL)	Total Hours (Li+CI+SL+SW)
03ZO322 **.1** Understand chordate diversity of animals and their taxonomic position**.**	10	04	1	6	21
03ZO322 **.2.** Identify the morphological and anatomical features and basis of chordate classification	08	04	1	7	20
03ZO322 **.3.** To recognize economic importance and present status that will develop positive attitude toward conservation of biodiversity.	09	04	1	7	21
03ZO322 **.4.** Differentiate the organism belonging to different taxa by studying comparative anatomy.	09	04	1	6	20
03ZO322 **.5.** Describe structural anatomy and organ systems of different groups of animals.	09	02	1	6	16
Total Hours	45	18	5	32	78

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Diversity of Chordates and Comparative Anatomy: Non chordate **Course Code:** 03ZO322

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
03ZO322 **.1** Understand chordate diversity of animals and their taxonomic position**.**	2	2	3	2	9
03ZO322 **.2.** Identify the morphological and anatomical features and basis of chordate classification	3	4	2	2	11
03ZO322 **.3.** To recognize economic importance and present status that will develop positive attitude toward conservation of biodiversity.	2	3	3	2	10
03ZO322 **.4.** Differentiate the organism belonging to different taxa by studying comparative anatomy.	3	3	2	2	10
03ZO322 **.5.** Describe structural anatomy and organ systems of different groups of animals.	3	4	1	2	10
Total Marks	**13**	**16**	**11**	**10**	**50**

***Legend*: A,** Apply; **An,** Analyze**,** Evaluate**,** Create

Suggested learning Resources:

(a)

S. No.	Title/Author/Publisher details
1	The Life of Vertebrates, J.Z. Young Oxford University Press III& 2004
2	Comparative Anatomy of Vertebrates , C.G. Kent & R.K. Kart McGraw Hill,Bostan,USA 9 & 2015
3	Morden Textbook of Zoology -Vertebrate R.L Kotpal Rastogi Publication ,Meerut 2000
4	Chordate and Comparative anatomy R.L Kotpal Rastogi Publication 2017
5	

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Demonstration
7. ICT Based teaching Learning
8. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Sc. Biology
Semester: 3rd Semester
Course Title: Diversity of Chordates and Comparative Anatomy: Non chordate
Course Code: 03ZO322

CO/PO/PSO Mapping								
Course Outcome (Cos)	**Program Outcomes (POs)**					**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**
02ZO312 **.1** Understand chordate diversity of animals and their taxonomic position**.**	2	1	2	2	2	2	3	3
02ZO312 **.2.** Identify the morphological and anatomical features and basis of chordate classification	1	1	2	2	1	2	3	3
02ZO312 **.3.** To recognize economic importance and present status that will develop positive attitude toward conservation of biodiversity.	2	1	3	3	1	1	1	3
02ZO312 **.4.** Differentiate the organism belonging to different taxa by studying comparative anatomy.	1	1	3	2	3	1	2	3
02ZO312 **.5.** Describe structural anatomy and organ systems of different groups of animals.	2	2	3	3	2	1	1	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5 PSO 1,2,3	03ZO322 **.1** Understand chordate diversity of animals and their taxonomic position**.**	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9 SO5.10	1.1,1.2	1.1, 1.2, 1.3, 1.4, 1.5 1.6, 1.7, 1.8, 1.9, 1.10	1SL-1,2,3,4,5,6
PO 1,2,3,4,5 PSO 1,2,3	03ZO322 **.2.** Identify the morphological and anatomical features and basis of chordate classification	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8	2.1, 2.2	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8	2SL-1,2,3,4,5,6,7
PO 1,2,3,4,5 PSO 1,2,3	03ZO322 **.3.** To recognize economic importance and present status that will develop positive attitude toward conservation of biodiversity.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9	3.1,3.2	3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9	3SL-1,2,3,4,5,6,7
PO 1,2,3,4,5 PSO 1,2,3	03ZO322 **.4.** Differentiate the organism belonging to different taxa by studying comparative anatomy.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9	4.1,4.2	4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9	4SL-1,2,3,4,5,6
PO 1,2,3,4,5 PSO 1,2,3	03ZO322 **.5.** Describe structural anatomy and organ systems of different groups of animals.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9	5.1	5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9	5SL-1,2,3,4,5,6

B.Sc. IIIrd Semester

Course Code	Course Title	L	T	P	Total Credits
03CH323	**Reaction, Reagents and Mechanism in organic Chemistry**	3	1	2	6

Pre-requisite: **Students must have fundamental knowledge of mathematics, valence shell electron pair repulsion theory, and different concentration terms to understand the concept of analytical chemistry.**

Rationale: **The students studying analytical chemistry should possess foundational understanding about basic mathematics, valence shell electron pair repulsion theory, and different concentration terms to understand the basic principle of chromatography and spectroscopic analysis.**

Course Outcomes:

After the completion of this course, the learner will able to

003CH323.1: Explain Nucleophilic substitution , Electrophilic Substitution,Benzyne,SN1, SN2, SNi,SNAr.

003CH323.2:Describe the Additionreaction,Eliminationreactions,chemo-selectivity,orientation and reactivity, Markownikov and Anti markonikov s addition, Saytzeff and Hafmann rule.

003CH323.3: Explain Regent and catalyst, Grignard reagent, N- bromo Succinamide Rearrangement, pinacol pinacolone Benzilic acid and Wagner –meerwein.

003CH323.4: **d**iscuss principle of oxidation reactions, Reduction reactions . Oppenauer oxidation

003CH323.5: discuss basic concept of photo- chemical reaction and Paricyclic Reactions ,Norrish type-I and II reactions and cis- trans isomerisations pericyclic reaction and their classification 2 + 2 and 4 + 2 cycloaadition ,

Reaction,Reagents and Mechanism in organic Chemistry (Paper III)

CLO: - By the end of this course students must have had the subject chemistry in class or equivalent

1. Basic concepts of Nucleophilic substitution , Electrophilic Substitution,Benzyne,SN1, SN2, SNi,SNAr.
2. Addition reaction, Elimination reactions,
3. Regent and catalyst, Grignard reagent, N- bromo Succinamide Rearrangement, pinacol pinacolone Benzilic acid and Wagner –meerwein.
4. oxidation reactions, Reduction reactions
5. Photo-chemical Reactions, Paricyclic Reactions,) 2 + 2 and 4 + 2 cycloaadition

Unit-1 (03CH323.1): (A) Aliphatic nucleophilic substitution: Introduction, the SN1 SN2 and SNi mechanism , Neighbouring group participation, effect of substrate, nucleophilie, leaving group and reaction medium.

(B) Aliphatic Electrophilic Substitution: Elementary treatment.

(C) Aromatic Nucleophilic Substitution: the SNAr,SN1 and benzyne mechanisms, effect of substrate, nucleophile, leaving group and reaction medium.

(D) Aromatic Electrophilic Substitution,: arenium ion mechanism, orientation/directive influence (electronic explanation only) and reactivity, diazonium coupling,vilsmeier reaction.

Keywords/Tags:- Nucleophilic substitution , Electrophilic Substitution,Benzyne,SN1, SN2, SNi,SNAr.

Unit-2 (03CH323.2): -(A)Addition reaction : Introduction, reactions involving addition of nucleophile, electrophile and free radicals regio-selectivity and chemo-selectivity ,orientation and reactivity, Markownikov and Anti markonikov s addition.

(B) Elimination reactions: introduction E1,E2 ,E1cb mechanism,effect of substate attacking species leaving group and reaction medium orientation Saytzeff and Hafmann rule.

Keywords/Tags:-Additionreaction,Eliminationreactions,chemo-selectivity,orientation and reactivity, Markownikov and Anti markonikov s addition, Saytzeff and Hafmann rule.

Unit-3 (03CH323.3): Regent and catalyst: preparation properties and applications of important regents and catalyst in organic synthesis with mechanistic details : Grignard reagent and N- bromo Succinamide (NBS) diazomethane, anhydrous aluminium chloride(AlCl3) sodamide (NaNH2) ziegler natta catalyst.

Rearrangement (Reactions,Mechanism and applications): introduction types of rearrangement , Rearrangement to electron deficient carbon (pinacol pinacolone Benzilic acid and Wagner -meerwein) , rearrangement to electron deficiency nitrogen halfman lotion tests and backman rearrangement to electron deficient oxygen where villager and Deccan to electron rich carboniting aromatic rearrangement freez and clezen,

Keywords/Tags:- Regent and catalyst, Grignard reagent, N- bromo Succinamide Rearrangement, pinacol pinacolone Benzilic acid and Wagner –meerwein.

Unit-4 (03CH323.4): oxidation reactions: Introduction metal based oxidation and nonmetal base oxidation oxidation of electron to carbonil carbonium manganese and silver base regions alkys to apoxide peroxide alkene to die manganese and awesome based to carbonyl with bond cleavage manganese and lead based. Oppenauer oxidation

Oxidation of amino groups to nitro groups : oxidation by alkaline KMno4 oxidation of aliphatic and aromatic Amines by peracids ,oxidation of primary and secondary amines to hydroxylamine by hydrogen peroxide.

Reduction reactions: introduction reduction of carbon - carbon multiple bonds carbonyl group and nitro compounds catalytic hydrogenation : heterogeneous (palladium carbon and raney nickel) homogeneous(wilkinsons catalyst) hydride transfer reagents: sodium borohydride and lithium aluminium hydride, metal based reductions: Birch reduction clemmensen reduction, Reduction of nitro compounds by catalytic hydrogenation and metals (with mechanism).

Keywords/Tags:-. oxidation reactions, Reduction reactions, catalytic hydrogenation and metals

Unit-5 (03CH323.5): Photo-chemical Reactions: Introduction of photo- chemistry ,Electronic excitations Jablonski diagram, Norrish type-I and II reactions and cis- trans isomerisations.

Paricyclic Reactions: Introduction of pericyclic reaction and their classification ,(electrocyclic, Sigmatropic rearrangement and cycloaadition) 2 + 2 and 4 + 2 cycloaadition claisen and cope rearrangement.

Keywords/Tags:- Photo-chemical Reactions, Paricyclic Reactions,) 2 + 2 and 4 + 2 cycloaadition ,

Learning Resources

1. https://nptel.ac.in/course.html
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
3. https://swayam.gov.in/explorer?category=Chemistry

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)						Total CreditsI
			CI	T	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	**03CH323**	**Reaction, Reagents and Mechanism in organic Chemistry**	4	0	2	1	1	8	6

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),

LI: Laboratory Instruction (Includes Practical performances in laboratory workshop,field or other locations using different instructional strategies)

SW: Sessional Work (includes assignment, seminar, mini project etc.),

SL: Self Learning

C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback ofteacher to ensure outcome of Learning.

Scheme of Assessment: Theory

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (RA)					End Semester Assessment (ESA)	Total Marks (PRA+ESA)
			Class/Home Assignment 5 number markseach	Class Test2 (2 best out of 3) 10 markseach	Seminar one	Class	Total Marks (CA+CT+SA		
PCC	**03CH323**	**Reaction, Reagents and Mechanism in organic Chemistry**	15	20	10	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (Sos), culminating in the overall achievement of Course Outcomes (Cos) upon the course's conclusion.

Unit-1 (03CH323.1): (A) Aliphatic nucleophilic substitution: Introduction, the SN1 SN2 and SNi mechanism , Neighbouring group participation, effect of substrate, nucleophilie, leaving group and reaction medium.

(B) Aliphatic Electrophilic Substitution: Elementary treatment.

(C) Aromatic Nucleophilic Substitution: the SNAr,SN1 and benzyne mechanisms, effect of substrate, nucleophile, leaving group and reaction medium.

(D) Aromatic Electrophilic Substitution,: arenium ion mechanism, orientation/directive influence (electronic explanation only) and reactivity, diazonium coupling,vilsmeier reaction.

Activity	Appx Hrs
Cl	12
LI	6
SW	2
SL	1
Total	21

Session Outcomes (SOs)	LI	CI	SL
After the completion of topics: students will be able to SO1.1 Discuss the concept of Aliphatic nucleophilic substitution SO1.2 Explain SN1 SN2 and SNi mechanism SO1.3 discuss differentiation of important Electrophilic Substitution and Nucleophilic Substitution reaction. SO1.4 discuss arenium ion mechanism SO1.5 discusses diazonium coupling,and vilsmeier reaction.		**Unit-1 (03CH323.1):** **1.1 (A) Aliphatic nucleophilic substitution**: Introduction, **1.2** SN1 SN2 and SNi mechanism , **1.3** Neighbouring group participation, effect of substrate, **1.4** nucleophilie, leaving group and reaction medium. **1.5 (B) Aliphatic Electrophilic Substitution**: **1.6** Elementary treatment. **1.7 (C) Aromatic Nucleophilic Substitution**: the SNAr,SN1 **1.8** benzyne mechanisms, effect of substrate, **1.9** nucleophile, leaving group and reaction medium. **1.10 (D) Aromatic Electrophilic Substitution**,: **1.11** arenium ion mechanism, **1.12** orientation/directive influence (electronic explanation only) reactivity, **1.13** diazonium coupling, **1.14** vilsmeier reaction.	• Introduction to nucleophilic substitution • And electrophilic substitution reaction diazonium coupling, • vilsmeier reaction •

SW-1 Suggested Sessional Work (SW):

Assignments: SN1 SN2 and SNi mechanism

Mini Project: Software's for drawing structures and molecular formulae.

Other Activities (Specify): Introduction to graph and its types in different ways to represent data

Unit-2 (03CH323.2): -(A)Addition reaction : Introduction, reactions involving addition of nucleophile, electrophile and free radicals regio-selectivity and chemo-selectivity ,orientation and reactivity, Markownikov and Anti markonikov s addition.

(B) Elimination reactions: introduction E1,E2 ,E1cb mechanism,effect of substate attacking species leaving group and reaction medium orientation Saytzeff and Hafmann rule.

Activity	AppX Hrs
Cl	13
LI	6
SW	2
SL	1
Total	22

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
After the completion of topics students will be able to **SO2.1** explain Addition reaction **SO2.2** explain Elimination reactions **SO2.3** discuss Markownikov and Anti markonikov s addition **SO2.4** discuss E1,E2 ,E1cb mechanism,effect of substate **SO2.5** Estimate Saytzeff and Hafmann rule.	•	**Unit-2 (2CH101.2): -** **(A)Addition reaction** : Introduction, reactions involving addition of nucleophile, electrophile and free radicals regio-selectivity and chemo-selectivity ,orientation and reactivity, Markownikov and Anti markonikov s addition. **(B) Elimination reactions**: introduction E1,E2 ,E1cb mechanism,effect of substate attacking species leaving group and reaction medium orientation Saytzeff and Hafmann rule.	• Addition reaction • Elimination reactions • nucleophile, electrophile and free radicals • Saytzeff and Hafmann rule.

SW-2 Suggested Sessional Work (SW):

Assignments: effect of substate attacking species leaving group and reaction

Mini Project: nucleophile, electrophile and free radicals mechanism

Other Activities (Specify): Saytzeff and Hafmann rule.

Unit-3 (03CH323.3): Regent and catalyst: preparation properties and applications of important regents and catalyst in organic synthesis with mechanistic details : Grignard reagent and N- bromo Succinamide (NBS) diazomethane, anhydrous aluminium chloride(AlCl3) sodamide (NaNH2) ziegler natta catalyst.

Rearrangement (Reactions,Mechanism and applications): introduction types of rearrangement , Rearrangement to electron deficient carbon (pinacol pinacolone Benzilic acid and Wagner -meerwein) , rearrangement to electron deficiency nitrogen halfman lotion tests and backman rearrangement to electron deficient oxygen where villager and Deccan to electron rich carboniting aromatic rearrangement freez and clezen,

Activity	AppX Hrs
Cl	11
LI	4
SW	2
SL	1
Total	18

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
After the completion of topics students will be able to **SO3.1** explain preparation properties and applications of important regents and catalyst Grignard reagent. **SO3.2** discuss concept of anhydrous aluminium chloride(AlCl3) and NBS diazomethane. **SO3.3** describe sodamide (NaNH2) ziegler natta catalyst. **SO3.4** explain Rearrangement to electron deficient carbon. **SO3.5** describe rearrangement to electron deficiency nitrogen	• To study the Determination of free alkali present in different soaps/detergents.	• **Unit-3 (2CH101.3): Regent and catalyst**:3.1 preparation properties and applications of important regents and catalyst in organic synthesis with mechanistic details : 3.1 Grignard reagent and N- bromo 3.2 Succinamide (NBS) diazomethane, 3.3 anhydrous aluminium chloride(AlCl3) 3.4 sodamide (NaNH2) ziegler natta catalyst. **Rearrangement (Reactions,Mechanism and applications)**: introduction types of rearrangement , **3.5** Rearrangement to electron deficient carbon	•

halfman lotion tests and backman rearrangement to electron deficient oxygen		**3.6** (pinacol pinacolone Benzilic acid and Wagner -meerwein) , 3.7 rearrangement to electron deficiency nitrogen halfman lotion tests and backman rearrangement to electron deficient oxygen 3.9 villager and Deccan to electron rich carboniting aromatic rearrangement freez and clezen,	

SW-3 Suggested Sessional Work (SW):

Assignments: Concept of chemical potential

Mini Project:

Other Activities (Specify):

Unit-4 (03CH323.4): oxidation reactions: Introduction metal based oxidation and nonmetal base oxidation oxidation of electron to carbonil carbonium manganese and silver base regions alkys to apoxide peroxide alkene to die manganese and awesome based to carbonyl with bond cleavage manganese and lead based. Oppenauer oxidation

Oxidation of amino groups to nitro groups : oxidation by alkaline KMno4 oxidation of aliphatic and aromatic Amines by peracids ,oxidation of primary and secondary amines to hydroxylamine by hydrogen peroxide.

Reduction reactions: introduction reduction of carbon - carbon multiple bonds carbonyl group and nitro compounds catalytic hydrogenation : heterogeneous (palladium carbon and raney nickel) homogeneous(wilkinsons catalyst) hydride transfer reagents: sodium borohydride and lithium aluminium hydride, metal based reductions: Birch reduction clemmensen reduction, Reduction of nitro compounds by catalytic hydrogenation and metals (with mechanism).

Activity	AppX Hrs
Cl	13
LI	6
SW	2
SL	1
Total	21

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
After the completion of topics students will be able to	Qualitative Analysis • Identification by determination of the	**Unit-4 (2CH101.4): oxidation reactions**: Introduction metal based oxidation and nonmetal	To understand the chromatographic

SO4.1 Discuss metal based oxidation and nonmetal base oxidation oxidation of electron to carbonil carbonium manganese. **SO4.2** discuss the Oppenauer oxidation. **SO4.3** discusses oxidation by alkaline KMno4 oxidation of aliphatic and aromatic Amines by peracids **SO4.4** explain column chromatography (CC) and gas chromatography (GC) **SO4.5** discuss the reduction of carbon - carbon multiple bonds carbonyl group and nitro compounds catalytic hydrogenation. **SO4.6** explain Birch reduction clemmensen reduction, Reduction of nitro compounds by catalytic hydrogenation and metals	Rf values of the given organic / inorganic compounds by paper/ thin layer chromatography. • Systematic identification of organic compound by qualitative analysis	base oxidation oxidation of electron to carbonil carbonium manganese and silver base regions alkys to apoxide peroxide alkene to die manganese and awesome based to carbonyl with bond cleavage manganese and lead based. Oppenauer oxidation Oxidation of amino groups to nitro groups : oxidation by alkaline KMno4 oxidation of aliphatic and aromatic Amines by peracids ,oxidation of primary and secondary amines to hydroxylamine by hydrogen peroxide. **Reduction reactions**: introduction reduction of carbon - carbon multiple bonds carbonyl group and nitro compounds catalytic hydrogenation : heterogeneous (palladium carbon and raney nickel) homogeneous(wilkinsons catalyst) hydride transfer reagents: sodium borohydride and lithium aluminium hydride, metal based reductions: Birch reduction clemmensen reduction, Reduction of nitro compounds by catalytic hydrogenation and metals (with mechanism).	principle students must read about • Nature of compound (polar/non-polar)

SW-4 Suggested Sessional Work (SW)

Assignment: Chromatography (HPLC) types of column and column selection

Mini Project:

Other Activities (Specify): Mechanism of separation of components in a mixture: adsorption, partition and ion-exchange

Unit-5 (03CH323.5): Photo-chemical Reactions: Introduction of photo- chemistry ,Electronic Excitations Jablonski diagram, Norrish type-I and II reactions and cis- trans isomerisations.

Paricyclic Reactions: Introduction of pericyclic reaction and their classification ,(electrocyclic, Sigmatropic rearrangement and cycloaadition) 2 + 2 and 4 + 2 cycloaadition claisen and cope rearrangement.

Activity	AppX Hrs
Cl	11
LI	6
SW	2
SL	1
Total	20

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
After the completion of topics. students will be able to **SO5.**1 understand Basics of **Photo-chemical Reactions** **SO5.2** discuss the principle of excitations Jablonski diagram **SO5.3** Norrish type-I and II reactions and cis- trans isomerisations. **SO5.**4 describes pericyclic reaction and their classification. **SO5.5** Explain electrocyclic, Sigmatropic rearrangement and cycloaadition . **SO5.6** Explain 2 + 2 and 4 + 2 cycloaadition claisen and cope rearrangement.	Quantitative Analysis.	**Unit-5 (03CH323.5):** **Photo-chemical Reactions**: Introduction of photo- chemistry ,Electronic excitations Jablonski diagram, Norrish type-I and II reactions and cis- trans isomerisations. **Paricyclic Reactions**: Introduction of pericyclic reaction and their classification ,(electrocyclic, Sigmatropic rearrangement and cycloaadition) 2 + 2 and 4 + 2 cycloaadition claisen and cope rearrangement.	cis- trans isomerisations. • pericyclic reaction and their classification

SW-5 Suggested Sessional Work (SW):

Assignments:.

Mini Project:

Other Activities (Specify):

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Laboratory Instruction (LI)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
03CH323.1: Explain Nucleophilic substitution , Electrophilic Substitution,Benzyne,SN1, SN2, SNi,SNAr.	12	6	02	01	21
03CH323.2: Describe the Additionreaction,Eliminationreactions,chemo-selectivity,orientation and reactivity, Markownikov and Anti markonikov s addition, Saytzeff and Hafmann rule.	13	6	02	01	22
03CH323.3: Explain Regent and catalyst, Grignard reagent, N- bromo Succinamide Rearrangement, pinacol pinacolone Benzilic acid and Wagner – meerwein	11	6	02	01	18
03CH323.4: **d**iscuss principle of oxidation reactions, Reduction reactions . Oppenauer oxidation	13	6	02	01	22
03CH323.5:. discuss basic concept of photo-chemical reaction and Paricyclic Reactions ,Norrish type-I and II reactions and cis- trans isomerisations pericyclic reaction and their classification 2 + 2 and 4 + 2 cycloaadition ,	11	6	02	01	20
Total Hours	60	30	10	05	103

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Aliphatic nucleophilic substitution, Aliphatic Electrophilic Substitution, Aromatic Nucleophilic Substitution, Aromatic Electrophilic Substitution	03	01	01	05
CO-2	Addition reaction, Elimination reactions	02	06	02	10
CO-3	Regent and catalyst, Rearrangement (Reactions,Mechanism and applications	03	04	03	10
CO-4	oxidation reactions and Reduction reactions	-02	08	05	15
CO-5	Photo-chemical Reactions, Paricyclic Reactions	03	02	05	10
Total		13	21	16	50

Legend: **R: Remember, U: Understand, A: Apply**

The written examination of 50 marks will be held at the end of semester for Inorganic Chemistry

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to NCL, CSIR laboratories
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT,Blog, Facebook,Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher
1	Organic Chemistry	Clayden,J.,Greeves,N.and Warren,S.,"Organic Chemistry" Oxford University press, India, 2012, 2nd Edition.	Sultan Chand and Sons, . Delhi
2	Chemistry	Srivastava, S. S. Gehlot. A.S.	Ratan Prakashan Temple. Indore.
3	Inorganic Chemicals	Sing, DR, Saxena, G, Singh, B.	Shivlal Aggarwal & Company, Agra
4	Bioinorganic Chemistry	AK Das	Prentice -Hall
5	Inorganic chemistry	Gary L. Miessler	Pearson
6	Inorganic chemistry	VK Jaiswal	Shri Balaji
7	Elementary Organic Spectroscopy	Sharma Y.R.	S Chand, 2013
8	Analytical Chemistr	Gupta Alka L	Pragiti Prakashan 2020
9	Analytical Chemistry	Kaur H,	Pragatic Prakashan 2008
10	Advanced Organic Chemistry	Bahl. A. & Bahal. B.S.	S. Chand. 2010
11	Chromatography	Sharma B.K.	Krishna Prakashan, 2019

Suggested Web Sources:

1. https://celqusb.files.wordpress.com/2017/12/inorganic-chemistry-g-l-miessler-2014.pdf
2. https://www.slideshare.net/MANISHSAHU106/inert-and-labile-complexes
3. https://swayam.gov.in/explorer?category=Chemistry

Mode of Delivery: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point;

LMS/ICT Tools: Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Cos, Pos and PSOs Mapping

Course Title: Reaction,Reagents and Mechanism in organic Chemistry Course Code: 3CH101

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2	PS O 1	PS O 2	PS O 3	PS O 4
	Knowledge	Research Aptitude	Communication	Problem Solving	Individual and Team Work	Investigation of Problems	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and sustainability	The detailed functional knowledge of theoretical concepts and experimental	To integrate the gained knowledge with various contemporary and	understand, analyze, plan and implement qualitative as well as	Provide opportunities to excel in academics, research or Industry by
CO1: Explain Nucleophilic substitution , Electrophilic Substitution,Benzyne,SN1, SN2, SNi,SNAr.	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1

CO2: Describe the Additionreaction,Eliminationreactions,chemo-selectivity,orientation and reactivity, Markownikov and Anti markonikov s addition, Saytzeff and Hafmann rule.	**2**	**1**	**2**	**2**	**1**	**2**	**3**	**2**	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**1**
CO3: Explain Regent and catalyst, Grignard reagent, N-bromo Succinamide Rearrangement, pinacol pinacolone Benzilic acid and Wagner –meerwein	**2**	**2**	**1**	**1**	**1**	**2**	**2**	**2**	**1**	**2**	**1**	**2**	**1**	**1**	**2**	**2**
CO4: discuss principle of oxidation reactions, Reduction reactions . Oppenauer oxidation	**2**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**2**	**3**	**3**	**3**	**3**	**2**
CO5: discuss basic concept of photo-chemical reaction and Paricyclic Reactions ,Norrish type-I and II reactions and cis-trans isomerisations pericyclic reaction and their classification 2 + 2 and 4 + 2 cycloaadition ,	**2**	**-**	**-**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**3**	**1**	**3**

Legend: 1–Low, 2–Medium, 3–High

Course Curriculum Map:

POs &PSOsNo.	COs No. & Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	**CO1:** Explain Nucleophilic substitution , Electrophilic Substitution,Benzyne,SN1, SN2, SNi,SNAr.	SO1.1SO1.2SO1.3SO1.4 SO1.5		Unit-1. 1.1,1.2 ,1.3,1.4,1.5,1.6,1.7	• Significance of differentiation and integration • Introduction to window
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	**CO2:** Describe the Additionreaction,Elimination reactions,chemo-selectivity,orientation and reactivity, Markownikov and Anti markonikov s addition, Saytzeff and Hafmann rule.	SO2.1SO2.2SO2.3 SO2.4 SO2.5		Unit-2 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9	• Some Important units of measurements: SI Unit • distinction between mass and weight • mole, mill mole and numerical problems
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	**CO3:** Explain Regent and catalyst, Grignard reagent, N-bromo Succinamide Rearrangement, pinacol pinacolone Benzilic acid and Wagner – meerwein	SO3.1SO3.2 SO3.3 SO3.4 SO3.5		Unit-3 : Chemical Equilibrium 3.1, 3.2,3.3,3.4,3.5,3.6,3.7	• Gibbs free energy • Van't Hoff factors
PO1,2,3,4,5,6 7,8,9,10,11,12	**CO4: d**iscuss principle of oxidation reactions, Reduction reactions . Oppenauer oxidation	SO4.1SO4.2SO4.3SO4.4 SO4.5		Unit-4: 4.1, 4.2,4.3,4.4,4.5,4.6, 4.7	To understand the chromatographic

PSO 1,2, 3, 4					principle students must read about • Nature of compound (polar/non-polar)
PO1,2, 3,4,5,6 7,8,9,1 0,11,1 2 PSO 1,2, 3, 4	**CO5:** discuss basic concept of photo- chemical reaction and Paricyclic Reactions ,Norrish type-I and II reactions and cis- trans isomerisations pericyclic reaction and their classification 2 + 2 and 4 + 2 cycloaadition ,	SO5.1SO5. 2SO5.3SO 5.4 SO5.5		Unit 5: 5.1,5.2,5.3,5 .4,5.5,5.6,5. 7	Basics of absorption spectroscopy : • Electro magneti c radiation , • Spectral range • Absorba nce Absorpti vity, Molar Absorpti vity

Curriculum Development Team:

1. Dr. Shailendra Yadav, HoD, Department of Chemistry, AKS University, Satna (M.P.).
2. Dr. Dinesh Kumar Mishra, Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
3. Dr. Samit Kumar,Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
4. Dr. Sushma Singh, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
5. Dr. Manoj Kumar Sharma, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
6. Mr. Kanha Singh Tiwari,Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
7. Mrs. Nahid Usamani, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).

Program Name	**Bachelor of Science B.Sc. (Biology)**	
Semester	III	
Course Code:	0MT001	
Course title:	Principal of management	**Curriculum Developer**: Mr. Dhirendra Mishra,
Pre-requisite:	Students should have basic knowledge of Principle of management	
Rationale:	It involves planning, organizing, leading, and controlling resources to achieve specific goals and objectives. Managers play a vital role in guiding individuals and teams, making informed decisions, and ensuring the efficient and effective functioning of organizations	
Course Outcomes (COs):	**CO1-** Identify and apply appropriate management techniques for managing business **CO2-** Have a conceptual knowledge about the planning, Organization and decision making **CO3-** Apply the concept of Directing and coordination for the effective functioning of a management **CO4-** Evaluate leadership style to anticipate the consequences of each leadership style **CO5-** Demonstrate the techniques for controlling and coordination	

Scheme of Studies:

Board ofStudy	**Course Code**	**Course Title**	**Scheme of studies (Hours/Week)**					**Total Credits(C) (L:T:P=3:0:0)**
			Cl	LI	SW	SL	**Total Study Hours(CI+LI+SW+SL)**	

Program Common(PC)	0MT001	Principal of management	3	0	1	3	7	3

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment:Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)		
PC	0MT001	Principle of management	**15**	**20**	**10**	**5**	**50**	**50**	**100**

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

ApproximateHours

Item	Cl	LI	SW	SL	Total
Approx.Hrs	13	00	01	04	18

Course outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction(CI)	Self-Learning(SL)
CO1-98EN305.1: CO1. Students would gain a thorough grounding in the fundamentals knowledge of management	**SO1.1** concept and definition of Management		**Unit 1** **Management** **CI1.1** Concept /Definition	**SL1.1** Visit various reference books and study material to start the learning of management..
	SOI.2 Students understand Nature Functions of management		**CI 1.2** Nature Functions of management	**SL1.2** Read books to know natures and functions of management
	SOI.3 Know The process of Management		**CI 1.3** process of Management	**SL1.3** Learn about process of management
	SOI.4 Understand scope and importance of management **SOI.5** Understand role of Vedic values and ethics in management		**CI 1.4** scope and importance of management **CI 1.5** role of Vedic values and ethics in management	**SL1.4** Learn role of Vedic values and ethics in management
	SOI.6 Know the Difference between management and administration		**CI1.6** Difference between management and administration	
	SOI. 7 Students understand Evolution of management through early contribution		**CI1.7** Evolution of management through early contribution	
	SO1.8		**CI1.8**	

	Know the Taylor and scientific management		Taylor and scientific management	
	SO1.9 Know the Fayol's administrative management		**CI1.9** Fayol's administrative management	
	SO1.10 Students understand Bureaucracy		**CI1.10** Bureaucracy	
	SO1.11 Students understand Human relations		**CI1.11** Human relations	
	SO1.12 Students should know the Modern approach		**CI1.12** Modern approach	
	SO1.13 Understands Managerial ethics		**CI1.13** Managerial ethics	

Suggested Sessional Work (SW):*anyone*	**SW1.1** Assignments	Write the concept of management .
	SW1.2 Mini Project	Managerial ethics
	SW1.3 Other Activities (Specify)	**Case study –N.R. Narayana Murthy**

Item	Cl	LI	SW	SL	Total
Approx.Hrs	15	00	001	003	019

Course Outcome (CO)	SessionOutcomes (SOs)	Laboratory Instruction (LI)	ClassroomInstruction (CI)	Self Learning (SL)
CO2-98EN305.2: Have a conceptual knowledge about the planning, Organization and decision making.	**SO2.1** To understand Meaning of planning.		**Unit-II Planning** **CI2.1** Meaning of planning	**SL2.1** Read about Planning.
	SO2.2 To describe Nature of planning		**CI2.2** Nature of planning .	**SL2.2** Learn various steps of Selection of the product. .
	SO2.3 To explain Scope, Objective of Planning.		**CI2.3** Scope, Objective.	
	SO2.4 Describe about various Functions and significance of planning. .		**CI2.4** Functions and significance of planning.	
	SO2.5 Understand the Elements and steps of planning		**CI2.5** Elements and steps of planning	
	SO2.6 Know the Strategies and policies of planning.		**CI2.6** Strategies and policies	
	SO2.7 Understand the meaning and Definition of organization		**CI2.7** **Organization** Meaning, Definition	
	SO2.8 Discuss Types ,Scope and Principles		**CI2.8** Types ,Scope and Principles	
	SO2.9 Understand Line and staff relationship of organization		**CI2.9** Line and staff relationship	
	SO2.10		**CI2.10**	

	. Understand the meaning and definition of Decision.		**Decision** Meaning, Definition	
	SO2.11 Know the Types and scope of Decision.		**CI2.11** Types and scope	
	SO2.14 Describe the principles of Decision		**CI2.14** Principles	
	SO2.15 Know about Decision making.		**CI2.15** Decision making	

Suggested Sessional Work (SW):*anyone*	**SW2.1** Assignments	Suppose you propose two-three enterprise like travel agency in a tourist place like Nainital. Elaborate which form of ownership you will chose and why?
	SW2.2 Mini Project	Write decision Making steps
	SW2.3 Other Activities (Specify)	Visit industry to know the Strategies and policies of planning.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	10	00	01	02	13

Course Outcome (CO)	**Session Outcomes(SOs)**	**Laboratory Instruction(LI)**	**Class room Instruction (CI)**	**Self-Learning(SL)**
CO3-98EN3053: Apply the concept of Directing and coordination for the effective functioning of a management.	**SO3.1** Explain the Meaning and Definition of Direction		**Unit-III** **CI3.1 Direction and coordination** Meaning and Definition of Direction	**SL3.1** Read Topic Direction and coordination.
	SO3.2 Define and describe Impotence and principles of Direction		**CI3.2** Impotence and principles of Direction.	**SL3.2** Capital structure is composition of long-term and short-term loans.
	SO3.3 Describe the Techniques of Direction		**CI3.3** Techniques of Direction	
	SO3.4 Describe the Meaning of Supervision		**CI3.4** Meaning of Supervision.	

	SO3.5 Explain Meaning of Coordination		**CI3.5** Meaning of Coordination.	
	SO3.6 Explain in detail Elements and features of coordination.		**CI3.6** Elements and features of coordination.	
	SO3.7 Understand Importance of coordination		**CI3.7** Importance of coordination	
	SO3.8 Know about Cooperation and coordination		**CI3.8** Cooperation and coordination	
	SO3.9 Discuss the Steps for effective coordination		**CI3.9** Steps for effective coordination	
	SO3.10 Know the Management of conflicts		**CI3.10** Management of conflicts	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Write the Elements and features of coordination.
	SW3.2 Mini Project	Visit to an enterprise and find out Management of conflicts .
	SW3.3 Other Activities (Specify)	Find out some you tube videos based on Direction and coordination

Item	Cl	LI	SW	SL	Total
Approx.Hrs	10	00	01	02	13

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Classroom Instruction(CI)	Self-Learning(SL)
CO4-98EN305.4: Evaluate Motivation and leadership style to anticipate the consequences of each leadership style.	**SO4.1** Describe the Concept of motivation.		**Unit-IV** **CI4.1** **Motivation** Concept	**SL4.1** Learn about the Concept of motivation
	SO4.2 Explain the Forms of employee motivation		**CI4.2** Forms of employee motivation	**SL4.2** Discuss Forms of employee motivation
	SO4.3 Evaluate the Need for motivation		**CI4.3** Need for motivation	**SL4.3** Learn about Need for motivation
	SO4.4 Define and describe the Theories of motivation .		**CI4.4** Theories of motivation	
	SO4.5 Define the Meaning and functions of a leader		**CI4.5** Meaning and functions of a leader .	
	SO4.6 Describe the Characteristics of effective leadership .		**CI4.6** Characteristics of effective leadership .	
	SO4.7 Discuss Types and theories of leadership and leadership styles.		**CI4.7** Types and theories of leadership and leadership styles.	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Explain Theories of motivation
	SW4.2 Mini Project	Meet an entrepreneur running a manufacturing enterprise. Ask him how he/she took decision on effective leadership ..
	SW4.3 Other Activities (Specify)	Find out some you tube videos based on Theories of motivation..

Item	Cl	LI	SW	SL	Total
Approx.Hrs	8	00	01	03	12

Course Outcome (CO)	**SessionOutcomes(SOs)**	**LaboratoryInstruction(LI)**	**ClassroomInstruction(CI)**	**Self-Learning(SL)**
CO5-98EN305.5: To compare various Control techniques in organization. .	**SO5.1** Explain the Definition, Meaning of Controlling ,		**Unit-V** **Controlling** **CI5.1** Definition, Meaning of Controlling,	**SL5.1** Find out the role of controlling in management
	SO5.2 Express the view of Elements ,Importance of controlling.		**CI5.2** Elements ,Importance	**SL5.2** Explore the various kinds Elements of controlling .
	SO5.3 Know about Controlling procedure .		**CI5.3** Controlling procedure	**SL5.3** Read the topic controlling procedure
	SO5.4		**CI5.4**	

	Evaluate Types of controlling.		Types of controlling	
	SO5.5 Describe the Control techniques.		**CI5.5** Control techniques	
	SO5.6 Describe about Requirements of good control system		**CI5.6** Requirements of good control system	
	SO5.7 Understand Responsibility accounting PERT and CPM		**CI5.7** Responsibility accounting PERT and CPM	
	SO5.8 Know the Use of computer and IT in management control		**CI5.8** Use of computer and IT in management control	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Write about Use of computer and IT in management control
	SW5.2 Mini Project	Make a list of Elements ,Importance of controlling.
	SW5.3 Other Activities (Specify)	Find out some you tube videos based on Controlling

Course duration (in hours)to attain Course Outcomes:

Course Title: Principle of Management **Course Code:** 0MT001

Course Outcomes(COs)	Class lecture (CI)	Laboratory Instruction(LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1-98EN305.1:Understand basic aspects of establishing a business in a competitive environment.	13		4	1	18
CO2-98EN3055.2: Apply the basic understanding to examine the existing business ventures.	15	0	3	1	19
CO3-98EN305.3: Examine various business considerations such as marketing, financial and teaming etc.	10	0	2	1	13

CO4-98EN305.4: Assessing strategies for planning a business venture	10	0	2	1	13
CO5-98EN305.5: Create business ideas that can drive the innovative society	8	0	2	2	11
Total Hours	56	00	13	06	75

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Principle of Management **Course Code:** 0MT001

Course Outcomes	**Marks Distribution**				**Total Marks**
	A	**An**	**E**	**C**	
CO1-.1: Understand basic aspects of establishing a business in a competitive environment.	2	1	1	1	5
CO2-.2: Apply the basic understanding to examine the existing business ventures.	2	4	2	2	10
CO3-.3: Examine various business considerations such as marketing, financial and teaming etc. .	3	5	5	2	15
CO4-.4: Assessing strategies for planning a business venture	2	3	3	2	10
CO5-.5: Create business ideas that can drive the innovative society	5	4	1	0	10
Total Marks	**14**	**17**	**12**	**07**	**50**

***Legend*: A,** Apply; **An,** Analyze; **E,** Evaluate; **C,** Create

Suggested learning Resources:

(a) Books:

(b)

S.No.	**Title/Author/Publisher details**
1	Essentials of management,koontz Harold&weihrich,Tata McGraw Hill New
2	Principles of management,Ramasamy,T.Himalaya Publicshing House Pvt.L.t.d Nagpur
3	Principles of Management,Text and Cases,Durai,P,Pearson Education New Delhi

(c) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Industrial Visit.
7. Demonstration
8. ICT Based teaching Learning
9. Brainstorming

CO, PO and PSO Mapping

Program Name: Bachelor of Science B.Sc. (Biology)
Semester:III Semester
Course Title: Principle of Management
Course Code: 0MT001

CO/PO/PSO Mapping								
Course Outcome (Cos)	**Program Outcomes (POs)**					**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**
CO1- Identify and apply appropriate management techniques for managing business coordination	2	-	-	1	2	2	2	1
CO2- Have a conceptual knowledge about the planning, Organization and decision making	-	-	-	-	-	1	1	2
CO3-Apply the concept of Directing and coordination for the effective functioning of a management	-	1	1	1	-	1	1	1
CO4- Evaluate leadership style to anticipate the consequences of each leadership style	-	1	1	-	2	1	1	3
CO5- Demonstrate the techniques for controlling and	1	1	1	-	-	1	3	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5 PSO 1,2,3	**CO1-** Identify and apply appropriate management techniques for managing business coordination	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12 SO1.13		1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9,1.10 1.11,1.12,1.13,	**1SL-1,2,3,4**
PO 1,2,3,4,5 PSO 1,2,3	**CO2-** Have a conceptual knowledge about the planning, Organization and decision making	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9 SO2.10 SO2.11SO2.12SO2.13 SO2.14 SO2.15		2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.10, 2.11, 2.12, 2.13, 2.14, 2.15,	**2SL-1,2,3**
PO 1,2,3,4,5 PSO 1,2,3	**CO3-**Apply the concept of Directing and coordination for the effective functioning of a management	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9 SO3.10		3.1,3.2,3.3,3.4,3.5 3.6,3.7,3.8,3.9,3.10	**3SL-1,2**
PO 1,2,3,4,5 PSO 1,2,3	**CO4-** Evaluate leadership style to anticipate the consequences of each leadership style	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8 SO4.9 SO4.10		4.1,4.2,4.3,4.4,4.5, 4.6,4.7,4.8,4.9,4.10	**4SL-1,2**
PO 1,2,3,4,5 PSO 1,2,3	**CO5-** Demonstrate the techniques for controlling and	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8		5.1,5.2,5.3,5.4,5.5 5.6,5.7,5.8	**5SL-1,2**

Program Name	**BSc. Biology**	
Semester	3rd	
Course Code:	**0FC001**	
Course title:	Fundamentals of computer & programming	**Curriculum Developer**: Er. Vinay Shrivastava, Assistant Professor
Pre-requisite:	Students should have basic knowledge of computer engineering & programming.	
Rationale:	Fundamental of computer & programming covers basic knowledge of Multimedia technique, image , coloring, and digital transmission & basic computing and programming . It has diverse scope of how to use internet and multimedia. The subject computing allows you to reach your coding work. .It includes strategies that allow you to target your exact audience online — allowing you to make good work for programming and multi media. Configuration and customization is key to achieving desired outcomes	
Course Outcomes (COs):	**CO1- 0FC001.1.** Illustrate the terminologies associated with computing and its devices. **CO2- 0FC001.2.** Explain the importance of C programming and characteristics of programming language. **CO3- 0FC001.3.** Explain the importance of conditional statements and arithmetic programming in C language. **CO4- 0FC001.4.** Explain the importance of C array and functions of programming in C language. **CO5- 0FC001.5** Acquire the basic and advances knowledge of ms-word, ms-excel, ms-powerpoint.	

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits(C) (L:T:P=3:0:1)
			Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
Program Common(PC)	0FC001	Fundamentals of computer & programming	**3**	**-**	**1**	**1**	**5**	**3**

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title		Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity (CAT)	Class Attendance (AT)	Total Marks (CA+CT+CAT+SA+AT)		
PC	0FC001	Fundamentals of computer & programming	**15**	**20**	**5**	**5**	**5**	**50**	**50**	**100**

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.	**Approximate Hours** **Item** | Cl | LI | SW | SL | Total **Approx.Hrs** | 08 | 00 | 01 | 01 | 10

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1- 0FC001.1. Illustrate the terminologies associated with computing and its devices.	**SO1.1** Understanding fundamentals of computer		**CI1.1** introduction to computer	**SL1.1**Learning computer and internet
	SO1.2 study different characteristics of computer		**CI1.2** characteristics of computer	
	SO1.3 learning high level language		**CI1.3** memory	
	SO1.4 Using internal commands		**CI1.4** types of programming language	
	SO1.5 understanding external commands		**CI1.5** machine languages	
			CI1.56assembly language	
			CI1.7 high level language	
			CI1.8 basic dos commands	

Suggested Sessional Work (SW):*anyone*	**SW1.1** Assignments	Describe in detail "Applications of computer in various Sectors"

This course syllabus illustrates the expected learning achievements, both at the	**ApproximateHours**

course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.	

Item	Cl	LI	SW	SL	Total
Approx.Hrs	08	00	01	01	10

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO2- 0FC001.2. Explain the importance of C programming and characteristics of programming language.	**SO2.1** Understanding fundamentals of C Language		**CI2.1** what is c: historical development of c	**SL2.1**Learning coding in C
	SO2.2 study different keywords		**CI2.2** where c stands, getting started with c	
	SO2.3 study different operator		**CI2.3** the c character set ,types of c constants	
	SO2.4 learning printf function		**CI2.4** types of c variables, c keywords	
	SO2.5 Using scanf function		**CI2.5** identifiers and literals	
			CI2.6 basic input and output function-printf and scanf	
			CI2.7 operator: arithmetic operator, relational operator, assignment operator, logical operator	
			CI2.8 increment and decrement operator and conditional operator	

Suggested Sessional Work (SW):*anyone*	**SW2.1** Assignments	Describe C language Development

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.	**ApproximateHours** **Item** | Cl | LI | SW | SL | Total **Approx.Hrs** | 07 | 00 | 01 | 01 | 9

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO3- 0FC001.3 Explain the importance of conditional statements and arithmetic programming in C language.	**SO3.1** Understanding control structure		**CI3.1** decision control structure: control instruction in c, if, if else	**SL3.1.**Develop program for decision making
	SO3.2 study if,if else, nested structure		**CI3.2**if-else if, nested if if-else if, nested if	
	SO3.3 study different loops		**CI3.3**loop control structure: while loop	
	SO3.4 learning go to and exit in C language		**CI3.4**go to and exit statement	
	SO3.5 using case structure		**CI3.5**for loop, do-while loop.odd loop, nested loop,	
			CI3.6break ,continue break continue 1	
			CI3.7case control structure case control structure	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Describe conditional statements

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.	**ApproximateHours** **Item** | Cl | LI | SW | SL | Total **Approx.Hrs** | 07 | 00 | 01 | 01 | 09

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO4- 0FC001.4. Explain the importance of C array and functions of programming in C language.	**SO4.1** Understanding array		**CI4.1**array :what are arrays	**SL4.1**Learning array for easing the difficulty in searching
	SO4.2 study different ways of array initialization		**CI4.2**array initialization and 2d array	
	SO4.3 study function		**CI4.3**function: need of function	
	SO4.4 study different types of parameter in function		**CI4.4**initialization of 1d and 2d arrays	
	SO4.5 learning 2D array in C language		**CI4.5**declaring function, defining, calling function	
			CI4.6types of function	
			CI4.7passing parameters in function	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Coding array and function.

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.	**ApproximateHours** **Item** | Cl | LI | SW | SL | Total **Approx.Hrs** | 09 | 00 | 01 | 01 | 11

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO5- 0FC001.5 Acquire the basic and advances knowledge of ms-word, ms-excel, ms-powerpoint.	**SO5.1** Understanding fundamentals of ms-office		**CI5.1**ms office : introduction and features	**SL5.1**Learning documentation in ms-office
	SO5.2 Understanding ms word in computer		**CI5.2**ms word and introduction	
	SO5.3 Understanding ms excel in computer		**CI5.3**features and application,	
	SO5.4 Understanding powerpoint in computer		**CI5.4**working with ms word: menus and commands	
	SO5.5 Understanding fundamentals of computer network, cyberspace		**CI5.5**toolbars and buttons	
			CI5.6creating a new documents, word in table	
			CI5.7arithmatic operation, with excel sheet	
			CI5.8networking:definition,types of network, protocol, e-mail, creating an e mail account, cyber law, security ,hacking and cracking	
			CI5.9creating a power point presentation	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Internet and its applications

Course duration (in hours)to attain Course Outcomes:

Course Title: Fundamentals of computer & programming **Course Code: 0FC001**

Course Outcomes(COs)	Class lecture (CI)	(LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1- 0FC001.1. Illustrate the terminologies associated with computing and its devices.	8	-	1	1	10
CO2- 0FC001.2. Explain the importance of C programming and characteristics of programming language.	8	-	1	1	10
CO3- 0FC001.3. Explain the importance of conditional statements and arithmetic programming in C language.	7	-	1	1	9
CO4- 0FC001.4. Explain the importance of C array and functions of programming in C language.	7	-	1	1	9
CO5- 0FC001.5 Acquire the basic and advances knowledge of ms-word, ms-excel, ms-powerpoint.	9	-	1	1	11
Total Hours	39	00	05	05	49

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Fundamentals of computer & programming **Course Code: 0FC001**

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
CO1- 0FC001.1. Illustrate the terminologies associated with computing and its devices.	1	2	1	1	5
CO2- 0FC001.2. Explain the importance of C programming and characteristics of programming language.	1	5	4	2	12
CO3- 0FC001.3. Explain the importance of conditional statements and arithmetic programming in C language.	1	5	5	3	14
CO4- 0FC001.4. Explain the importance of C array and functions of programming in C language.	1	5	3	2	11
CO5- 0FC001.5 Acquire the basic and advances knowledge of ms-word, ms-excel, ms-powerpoint.	1	1	4	2	08
Total Marks	**05**	**18**	**17**	**10**	**50**

***Legend*:A,** Apply;**An,** Analyze;**E,** Evaluate;**C,** Create

Suggested learning Resources:

(a) Books:

(b)

S.No.	Title/Author/Publisher details
1	fundamentals of computers by E Balagurusamy
2	fundamentals of computers by Pk Sinha
3	fundamentals of computers by Rajaraman
4	Let us c by Yashwant Kanitkar

(c) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Visit to Beverage producing plants & Distillery/Fermenter units
7. Demonstration
8. ICT Based teaching Learning
9. Brainstorming

CO, PO and PSO Mapping

Program Name: BSc Biology
Semester:II Semester
Course Title: Fundamentals of computer & programming
Course Code: 0FC001

CO/PO/PSO Mapping									
Course Outcome (Cos)	**Program Outcomes (POs)**						**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**
CO1- 0FC001.1. Illustrate the terminologies associated with computing and its devices.	1	1	1	2	2	1	1	1	2
CO2- 0FC001.2. Explain the importance of C programming and characteristics of programming language.	2	1	1	1	1	1	2	2	1
CO3- 0FC001.3. Explain the importance of conditional statements and arithmetic programming in C language.	2	1	2	1	1	1	1	1	1
CO4- 0FC001.4. Explain the importance of C array and functions of programming in C language.	2	1	2	1	2	1	3	2	1
CO5- 0FC001.5 Acquire the basic and advances knowledge of ms-word, ms-excel, ms-powerpoint.	1	2	1	1	1	1	2	3	3

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	(LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6 PSO 1,2, 3	**CO1- 0FC001.1.** Illustrate the terminologies associated with computing and its devices.	SO1.1 SO1.2 SO1.3 SO1.4 , SO1.5		1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8	**SL1.1**
PO 1,2,3,4,5,6 PSO 1,2, 3	**CO2- 0FC001.2.** Explain the importance of C programming and characteristics of programming language.	SO2.1 SO2.2 SO2.3 SO2.4, SO2.5		2.1, 2.2, 2.3, 2.4,2.5,2.6,2.7,2.8	**SL2.1**
PO 1,2,3,4,5,6 PSO 1,2, 3	**CO3- 0FC001.3.** Explain the importance of conditional statements and arithmetic programming in C language.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5		3.1,3.2,3.3,3.4,3.5,3.6,3.7	**SL3.1**
PO 1,2,3,4,5,6 PSO 1,2, 3	**CO4- 0FC001.4.** Explain the importance of C array and functions of programming in C language.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5		4.1,4.2,4.3,4.4, 4.5,4.6,4.7	**SL4.1**
PO 1,2,3,4,5,6 PSO 1,2, 3	**CO5- 0FC001.5** Acquire the basic and advances knowledge of ms-word, ms-excel, ms-powerpoint.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5		5.1,5.2,5.3,5.4,5.5, 5.6,5.7,5.8,5.9	**SL5.1**

Program name	**Bachelor of Science (B.Sc.)- Biology**	
Semester	**4th**	
CourseCode:	**01BO401**	
Coursetitle:	**Industrial Botany**	Developer: **Paras Koshe**
Pre-requisite:	Student should have basic knowledge biology, botany economic and ethanobotany.	
Rationale:	Industrial botany is the commercial exploitation of plants by people; it contributes significantly to anthropology, biology, conservation, botany, and other fields of science. Economic plants are defined as being useful either directly, as in food, or indirectly, as products we use or that enhance the environment. This course will provide knowledge on plants and their parts in various industries. Students will get an idea to establish plant based natural product industry. This course will make the students self-reliant.	
CourseOutcomes (COs):	CO 1: Students should able to gain Comprehensive information on the use of plants in timber industry. CO 2: Understand and apply the concepts of economic botany and provide knowledge about leaf based industries. CO 3: Interpretate and learn the use of flowers in flower based industries. CO 4: Explain the industrial utility of fruits and seeds of various plants in fruits and seed based industries. CO 5: Acquire knowledge about the use of other parts of plants and to explain their significance in industries.	

Scheme of Studies:

Board ofStudy	**CourseCode**	**CourseTitle**	**Scheme ofstudies (Hours/Week)**					**Total Credits(C) (L:T:P=4:0:2)**
			Cl	**LI**	**SW**	**SL**	**Total Study Hours(CI+LI+SW+SL)**	
Major	**01BO401**	**Industrial Botany**	4	2	1	2	9	4+2=6

*Legends:*CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial(T) and others);
LI: Laboratory Instruction(Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
Major	01BO401	Industrial Botany	15	20	5	5	5	50	50	100

Unit I:	
Course-Curriculum: This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.	**ApproximateHours** **Item** | **Cl** | **LI** | **SW** | **SL** | **Total** **Approx.Hrs** | **12** | **04** | **01** | **02** | **19**

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO 1: Students should able to gain Comprehensive information on the use of plants in timber industry.	**SO1.**1 Explain the use of various plants in Timber Industry.	**LI1.1**: Preparation of Holi color's from locally available flowers.	**CI 1.1:** Plants in Timber Industry:	**SL 1.1:** learn the names of timber industries with place in your state.
	SO1.2 Describe various timber yielding trees of India	**LI1.2**: Preparation of food colors from locally available flowers.	**CI1.2:** timber yielding trees of India	**SL1.2:** Learn more about kattha and its use as well as medicinal importance.
	SO1.3: Illustrate timber yielding trees of India and their products		**CI1.3:** Timber yielding trees of India and their products	
	SO1.4: Understand about timber yielding tree i.e. Shisham		**CI1.4:** Timber yielding trees of India and their products (Shisham)	
	SO1.5: Students will be able to brief the use of Sal in textile industries.		**CI1.5:** Timber yielding trees of India and their products (Sal)	
	SO1.6: Discuss various strategies of obtaining Timber yielding trees of India and their products (Teak)		**CI1.6:** Timber yielding trees of India and their products (Teak)	
	SO1.7: Describe the use of Deodar tree in timber industry,		**CI1.7:** Timber yielding trees of India and their products (Deodar)	
	SO1.8: Understand how babool plant can be processed and utilised in timber industry.		CI1.8: Timber yielding trees of India and their products (Babool)	
	SO1.9 Elucidate about the processing of bamboo and their products in Bamboo industry.		**CI1.9** Bamboo Industry	
	SO1.10 Describe the use of sugarcane and other materials in cane industry.		**CI1.10** Cane Industry	
	SO1.11 Explain about the raw materials used in Kattha Industry		**CI1.11** Kattha Industry	
	SO1.12 Explain about the products of Kattha Industry		**CI1.12** Kattha Industry	

Suggested Sessional Work (SW): *anyone*	Assignments:	Discuss how timber yielding trees are useful to mankind.
	Mini Project:	Make a chart showing timber yielding plants and their products.
	Other Activities (Specify):	Write an article on status timber yielding industries in India.

Unit-II:

Course-Curriculum:
This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

ApproximateHours

Item	Cl	LI	SW	SL	Total
Approx.Hrs	12	04	01	02	19

Course outcome (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO 2:: Understand and apply the concepts of economic botany and provide knowledge about leaf based industries.	**SO2.1** Define and describe about Leaf based Industries	**LI2.1**. Perfume extraction process by distillation method	**CI2.1** Leaf based Industries	**SL2.1:** Learn about the leaves of some other plant which are used in leaf industry. (not mentioned in your syllabus)
	SO2.2: Understand utility products of leaf of Palash.	**LI2.2:** Preparation and preservation techniques of jams, jellies and prickles.	**CI2.2:** Utility products of leaf (Palash)	**SL2.2:** Enhance your knowledge about the Tea industry and other beverage production.
	SO2.3 Explain about the utility products of leaf of Banana		**CI2.3** Utility products of leaf (Banana).	
	SO2.4: Illustrate the mechanism and processing of leaves to make tea in Tea Industry		**CI2.4:** Tea Industry	
	SO2.5 Gaining knowledge about the : production of various types of teas.		**CI2.5:** Production of various types of teas	
	SO2.6: Over viewing the process and steps in Leaf oil Industry in making mint and camphor.		**CI2.6:** Leaf oil Industry (Mint, Camphor).	
	SO2.7: Understand how Neem and Tulsi is processed to make oil from leaf in leaf oil industry.		**CI2.7:** Leaf oil Industry (Neem, Tulsi)	
	SO2.8: To learn about different methods of making oil from leaves of eucalyptus and lemon grass.		**CI2.8:** Leaf oil Industry (Eucalyptus and Lemon grass).	
	SO2.9. Analyze the importance of Kasoori Methi leaves and their use as spices.		**CI2.9:** Leaves used as spices (Kasoori Methi)	
	SO2.10.Dicuss about curry patta and their use as spices.		**CI2.10:** Leaves used as spices (Curry patta).	
	SO2.11 Describe the uses of onion leave as spices.		**CI2.11:** Leaves used as spices (Onion)	
	SO2.12 Explain about Tejpatta and its use as spices.		**CI2.12:** Leaves used as spices (Tejpatta).	

Suggested Sessional Work (SW): Anyone	**Assignments:**	Describe the various products of leaf oil industry.
	Mini Project:	Make a chart showing leaf based industry in your area. Also focus on tendu patta.
	Other Activities (Specify):	Compare between tea and coffee and good and ill effects of tea on human health.

Unit-III:	
Course-Curriculum: This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.	**ApproximateHours** **Item** | **Cl** | **LI** | **SW** | **SL** | **Total** **Approx.Hrs** | **12** | **04** | **01** | **03** | **20**

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO 3: Interpretate and learn the use of flowers in flower based industries	**SO 3.1:** Students should able to understand introduction and history of Flower based Industries.	**LI 3.1:** Extraction and preservation of juices (lemon and orange etc.)	**CI 3.1:** Flower based Industries	**SL 3.1:** Read the machine for : Flower based Industries
	SO 3.2: Learn how gulab (Rose) is used to make perfume products.	**LI 3.2:** Preparation of different types of teas (Tulsi tea, lemon tea etc.)	**CI 3.2:** Perfume products of Gulab	**SL 3.2:** learn more about various flowers used in making perfumes.
	SO 3.3 Understand the process and steps of perfume production by using Jasmine.		**CI 3.3** Perfume products of Jasmine.	**SL 3.3:** Read how plants produced colours are different from synthetic colours.
	SO 3.4 Describe the perfume products of Henna.		**CI 3.4** Perfume products of Henna.	
	SO 3.5 learn the advancement of Color industry in India,		**CI 3.5** Color industry	
	SO 3.6 Understand the importance of Food colors and their production and raw materials in color industry.		**CI 3.6** Color industry (Food colors).	
	SO 3.7 Learn about the holi colors and plant materials used to make holi colors in color industry.		**CI 3.7** Color industry (Holi colors).	
	SO 3.8 Understand the Fermentation process and its role in industrial botany.		**CI 3.8** Fermentation	
	SO 3.9 Describe the types of fermentation.		**CI 3.9** Types of fermentation	
	SO 3.10 Gain more insight on raw material for Fermentation in industry.		**CI 3.10** Raw material for Fermentation	
	SO 3.11 Explain various raw material used in fermentation industry with emphasis on mahua.		**CI 3.11** Raw material for Fermentation (Mahua).	
	SO 3.12 Apply the use of Mahua in alcohol production and its product recovery.		**CI 3.12** Use of Mahua in alcohol production and its product recovery.	

Suggested Sessional Work (SW): Anyone	**Assignments:**	Describe about the different types of perfume products and row materials used in making perfumes.
	Mini Project:	Try to extract oil from rose jasmine and mint in your laboratory by using Soxhlet extractor
	Other Activities (Specify):	Literature and presentation; on fermentation and flower based industry.

Unit-IV:

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

ApproximateHours

Item	Cl	LI	SW	SL	Total
Approx.Hrs	12	04	01	02	19

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO 4: Explain the industrial utility of fruits and seeds of various plants in fruits and seed based industries.	**SO4.1:** Students should able to understand introduction and history of Fruits and Seeds based Industries.	**LI4.1:** Identification, collection and extraction of oil yielding leaves	**CI4.1:**Introduction to Fruits and Seeds based Industries	**SL 4.1:** Learn basics of ethanobotany
	SO4.2: Describe the methods of making jams and jellies,	**LI4.2:** Identification, collection and specimen preparation of leafy spices.	**CI4.2:** Jams and Jellies	**SL4.2:** Learn about the fruits and their scientific names found in your locality.
	SO 4.3 Understand the process and steps of producing Juice and Sauce.		**CI 4.3:** Juice and Sauce	
	SO4.4: Learn new technology of preparing Pickles.		**CI4.4:** Pickles.	
	SO 4.5 Brief sbout poha industry.		**CI 4.5** Poha Industry	
	SO4.6: Gain knowledge about Daal Industry.		**CI4.6:** Daal Industry	
	SO4.7: Learn how to raw materials are processed in Edible Oil Industry.		**CI4.7:** Edible Oil Industry	
	SO4.8: Understand how groundnuts are processed to extract oil in Edible Oil Industry.		**CI4.8** Edible Oil Industry (Groundnut)	
	SO4.9: Explain the use of soya bean in Edible Oil Industry		**CI4.9**: Edible Oil Industry (Soybean)	
	SO4.10: Analyze the raw materials and processing in Starch Industry.		**CI4.10**: Starch Industry	
	SO4.11: Describe the raw materials used in Glucose, and Dextrose Industry.		**CI4.11:** Glucose, and Dextrose Industry	
	SO4.12: Explain the products of Glucose and Dextrose Industry.		**CI4.12**: Glucose, and Dextrose Industry	

Suggested Sessional Work (SW): ***anyone***	**SW1.1 Assignments**	Explain importance of Fruits and Seeds based Industries
	SW1.2 Mini Project	Make a chart showing comparison between refined and non refined oil.
	SW1.3 Other Activities (Specify)	Try to make jams and jellies from different fruits in your lab or at home.

Unit-V:

Course-Curriculum:
This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

ApproximateHours

Item	Cl	LI	SW	SL	Total
Approx.Hrs	12	06	01	02	21

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO 5: Acquire knowledge about the use of other parts of plants and to explain their significance in industries.	**SO5.1:** Analyze the functioning of other parts of plants based Industries	**LI5.1**: Hands on training for preparation of "Douna and Pattal" using Palash and Banana leaves.	**CI5.1**: other parts of plants based Industries	**SL5.1**: Study in details about **:** Sugar and Jaggery Industries
	SO5.2: Learn how materials are processed in Sugar and Jaggery Industries	**LI5.2:** Visit to any plant based industry.	**CI5.2:** Sugar and Jaggery Industries	**SL5.2**: Study different funding agencies in your subject for a project
	SO 5.3 Students should able to gain knowledge about the products of Sugar and Jaggery Industries.	**LI5.3**: Herbarium preparation of different parts of plants used in various industries.	**CI 5.3** Sugar and Jaggery Industries	
	SO 5.4 Explain the working and processing of jute in Jute industry.		**CI 5.4** Jute industry	
	SO5.5: Describe various products of jute industry.		**CI5.5**: Jute industry	
	SO 5.6 Understand the making and producing agarbatti in Agarbatti stick making industry.		**CI 5.6** Agarbatti stick making industry	
	SO5.7: Learn about the different products of agarbatti stick making industry.		**CI5.7:** Agarbatti stick making industry	
	SO5.8: Define and describe project proposal preparation for establishment of an industry.		**CI5.8:** Project proposal preparation for establishment of an industry.	
	SO5.9 Explain various aspects of writing project proposal and give idea about recent research topics.		**CI5.9:** Project proposal preparation for establishment of an industry	
	SO5.10: Describe about grants and funding provider organizations of India		**CI5.10** Grants and funding provider organizations of India	
	SO5.11: Define the procedure or proposal for applying grants in funding provider organizations of India.		**CI5.11:** Grants and funding provider organizations of India	
	SO5.12: To know about the different funding agencies in life science.		**CI5.12** DBT, ICMR, CSIR. MPCOST,DST	

Suggested Sessional Work (SW): ***anyone***	**SW1.1 Assignments**	Explain project proposal preparation for establishment of an industry and also mention funding provider in life sciences.
	SW1.2 Mini Project	Try to make agarbatti or stick in lab or at home.
	SW1.3 Other Activities (Specify)	Visit nearby village and learn the raw process of jiggery production from sugarcane juice.

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome: **Course title: Industrial Botany** **(Course code :) 01BO401**					
Course Outcomes	**Marks Distribution**				**Total Marks**
	A	**An**	**E**	**C**	
CO 1: Students should able to gain Comprehensive information on the use of plants in timber industry.	2	1	1	1	5
CO 2: Understand and apply the concepts of economic botany and provide knowledge about leaf based industries.	2	4	2	2	10
CO 3: Interpretate and learn the use of flowers in flower based industries.	3	5	5	2	15
CO 4: Explain the industrial utility of fruits and seeds of various plants in fruits and seed based industries.	2	3	3	2	10
CO 5: Acquire knowledge about the use of other parts of plants and to explain their significance in industries	5	4	1	0	10
Total Marks	**14**	**17**	**12**	**07**	**50**
Legend**: A**-Apply, **An-** Analyze, **E**- Evaluate, **C**- Create					

Course duration (in hours) to attain Course Outcomes **(Course title: Industrial Botany** **(Course code :) 01BO401**					
Course Outcomes(COs)	**Class lecture(CI)**	**LaboratoryInstruction (LI)**	**Self-Learning (SL)**	**Sessional work (SW)**	**Total Hours (Li+CI+SL+SW)**
CO 1: Students should able to gain Comprehensive information on the use of plants in timber industry.	12	4	2	1	19
CO 2: Understand and apply the concepts of economic botany and provide knowledge about leaf based industries.	12	4	2	1	19
CO 3: Interpretate and learn the use of flowers in flower based industries.	12	4	3	1	20
CO 4: Explain the industrial utility of fruits and seeds of various plants in fruits and seed based industries.	12	4	2	1	19
CO 5: Acquire knowledge about the use of other parts of plants and to explain their significance in industries	12	6	2	1	21
Total Hours	60	22	11	05	98

Suggested learning Resources:

S.no.	Title	Author	Publisher	Edition & Year
1	Economic Botany, principles and Practice	Gerald E Wickens	Kluver Academic Publishers	1 & 2001
2	Economic Botany	Koochar S.L.	Cambridge University Press, UK	2 & 2016
3	Economic Botany	. Simpson, B.B. and Ogorzaly, M.C	Tata Macgray Hill Publisher	1 & 1986

Suggested online material:

1. https://krishi.icar.gov.in/jspui/bitstream/123456789/19815/1/Timber.pdf

2. file:///C:/Users/CSP/Downloads/7B.pdf

3. https://swsu.ru/sbornik-statey/pdf/11 chapter%202.pdf

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Visit to Cement Plant
7. Demonstration
8. ICT Based teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, WhatsApp, Mobile, Online sources)
9. Brainstorming

Program Title: B. Sc. Biology
Course Code: 01BO401
Course Title: Industrial Botany

CO, PO and PSO Mapping

CO/PO Mapping															
Course Outcome	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1: Students should able to gain Comprehensive information on the use of plants in timber industry	**3**	**1**	**3**	**2**	**1**	**1**	**2**	**-**	**2**	**-**	**1**	**-**	**2**	**1**	**3**
CO 2: Understand and apply the concepts of economic botany and provide knowledge about leaf based industries	**3**	**-**	**2**	**1**	**-**	**1**	**1**	**1**	**-**	**3**	**1**	**2**	**2**	**1**	**3**
CO 3: Interpretate and learn the use of flowers in flower based industries.	**2**	**2**	**2**	**2**	**2**	**1**	**-**	**2**	**3**	**1**	**1**	**2**	**1**	**2**	**3**
CO 4: Explain the industrial utility of fruits and seeds of various plants in fruits and seed based industries	**2**	**3**	**2**	**2**	**3**	**-**	**3**	**1**	**1**	**2**	**1**	**-**	**2**	**2**	**3**
CO 5: Acquire knowledge about the use of other parts of plants and to explain their significance in industries.	**1**	**2**	**1**	**-**	**3**	**3**	**1**	**2**	**2**	**3**	**1**	**2**	**1**	**3**	**1**
Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3															

Program Title: B. Sc. Biology, 4th **Sem**
Course Code: **01BO401**
Course Title: Industrial Botany

Course Curriculum Map:

POs & PSOs No.	**COs No**	**SOs No.**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO 1:** Students should able to gain Comprehensive information on the use of plants in timber industry.	1.1, 1.2, 1.3, 1.4, 1.5, 1.5, 1.7, 1.8,1.9,1.10,1.11,1.12	LI 1 LI 2	1.1, 1.2, 1.3, 1.4, 1.5, 1.5, 1.7, 1.8,1.9,1.10,1.11,1.12	1 SL-1,2
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO 2:** Understand and apply the concepts of economic botany and provide knowledge about leaf based industries.	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7,2.8,2.9,2.10,2.11,2.12	LI 1 LI 2	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7,2.8,2.9,2.10,2.11,2.12	2 SL-1,2
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO 3:** Interpretate and learn the use of flowers in flower based industries.	3.1, 3.2, 3.3, 3.4 3.5,3.6, 3.7, 3.8, 3.9, 3.10, 3.11,3.12	LI 1 LI 2	3.1, 3.2, 3.3, 3.4 3.5,3.6, 3.7, 3.8, 3.9, 3.10, 3.11,3.12	3 SL-1,2,3
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO 4:** Explain the industrial utility of fruits and seeds of various plants in fruits and seed based industries.	4.1,4.2, 4.3, 4.4, 4.5, 4.6, 4.7,4.8,4.9,4.10,4.11,4.12	LI 1 LI 2	4.1,4.2, 4.3, 4.4, 4.5, 4.6, 4.7,4.8,4.9,4.10,4.11,4.12	4 SL-1,2
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO5:** Acquire knowledge about the use of other parts of plants and to explain their significance in industries.	5.1, 5.2, 5.3,5.4, 5.5, 5.6, 5.7,5.8,5.9,5.10,5.11,5.12	LI 1 LI 2	5.1, 5.2, 5.3,5.4, 5.5, 5.6, 5.7,5.8,5.9,5.10,5.11,5.12	5 SL-1,2

Program Name	**Bachelor of Science (B.Sc.)- Biology**	
Semester	4th	
Course Code:	01ZO402	
Course title:	Physiology and bio chemistry	**Curriculum Developer**: Mr. AMIT BAGRI
Pre-requisite:	Student must have had the subject zoology in class B.Sc. I year.	
Rationale:	The present core course has been designed for the students studying in the subject of zoology at university level as per the UGC approved curriculum. The core course will cover the essential aspects of physiology and biochemistry comprising of introductory background of scope and history of physiology as well as biochemistry. Physiology is the branch of biology that deals with the normal functions of living organisms and their parts. Biochemistry is the branch of science which is concerned with the chemical and physicochemical processes that occur within living organisms. Physiology and biochemistry both are the very important branches of science which have their own significance in various fields including medical, paramedical, toxicology, pharmacy, cardiology and many more. Physiology itself contains vast number of branches such as blood physiology, renal physiology, reproductive physiology, neural physiology, muscle physiology etc., and these all branches specially focuses on how these organs work in coordination with each other and they also show division of labor. It helps us in understanding the functions of various organ systems of our body which is unavoidable if one wants to lead a healthy, disease-free life.	
CourseOutcomes (COs):	01ZO402 **.1.** Develop deeper understanding of how organ function at different level i.e. from cellular to system level. 01ZO402 **.2.** Understand functions of biomolecules and their role in metabolism by studying biochemistry 01ZO402 **3.**Examine internal harmony of different body system by learning inherent disorder and deficiencies which is needed to maintain good health. 01ZO402 **.4.** Analysis about neuromuscular coordination and impulse conduction physiology. 01ZO402 **.5.** Understand about hormonal balance and the effects of their responses on the body.	

Scheme of Studies:

Board of Study	**Course Code**	**Course Title**	**Scheme of studies (Hours/Week)**					**Total Credits(C) (L:T:P=3:0:1)**
			Cl	LI	SW	SL	**Total Study Hours(CI+LI+SW+SL)**	
MAJOR	01ZO402	Physiology and bio chemistry	4	4	1	1	10	4+2= 6

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)		
MAJOR	01ZO402	Physiology and bio chemistry	**15**	**20**	**10**	**5**	**50**	**50**	**100**

Scheme of Assessment: Practical

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)		
Major	01ZO202	Physiology and bio chemistry	35	5	5	5	50	50	50

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	05	24

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction(CI)	Self-Learning (SL)
01ZO402 **.1.** Develop deeper understanding of how organ function at different level i.e. from cellular to system level.	**SO1.1** Explain the Contribution of charak	1.1 study of enzymatic activity of trypsin and lipase	**Unit-1 introduction and historical background of physiology and biochemistry** **1.1** Study of Contribution of charak	1.1. Explain the Contribution of charak
	SO1.2 Explain the Contribution of sushrut	1.2 Qualitative estimations protein, carbohydrates and lipids.	**1.2** Study of Contribution of sushrut	1.2. Explain the Contribution of sushrut
	SO1.3 define of Micro and macro molecules		**1.3** Study of Micro and macro molecules	1.3. learn about Micro and macro molecules
	SO1.4 Study about Water and buffer system	1.3. Study of Water and buffer system	**1.4** Study of Water and buffer system	1.4. Learn about of Water and buffer system
	SO1.5 Study about definition and general properties of enzyme		**1.5** definition and general properties of enzyme?	1.5. Learn Study about definition and general properties of enzyme
	SO1.6 Study of Nomenclature and classification and function		**1.6** Nomenclature and classification and function?	
	SO1.7 study of Mechanism and regulation of enzyme action		**1.7** Mechanism and regulation of enzyme action?	
	SO1.8 study of Co- enzyme		**1.8** Study of Co- enzyme?	
	SO1.9 types and source of vitamins **SO1.10** study of Biological importance **SO1.11** explain about Deficiencies		**1.9** types and source of vitamins? **1.10** Biological importance? **1.11 study of** Deficiencies?	
	SO1.12 Explain about disorders?		**1.12** Study of disorders?	

Suggested Sessional Work (SW):*anyone*	**SW1.1** Assignments	Write Study about definition and general properties of enzyme
	SW1.2 Mini Project	Write Study of Nomenclature and classification and function
	SW1.3 Other Activities (Specify)	Write the study of Biological importance.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	05	24

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
01ZO402 **2.** Understand functions of biomolecules and their role in metabolism by studying in biochemistry.	**SO2.1** define Structure Nomenclature, classification and biological importance of protein acids and ornithine cycle.	2.1 Qualitative estimations protein, carbohydrates and lipids.	**Unit-2 Metabolism, physiology and regulation** **2.1** Structure Nomenclature, classification and biological importance of protein.	2.1. Know about the Structure Nomenclature, classification and biological importance of protein.
	SO2.2 study of Metabolism: deamination, decarboxylation, transamination of amino	**2.2** Metabolism: glycogenesis, gluconeogenesis, glycolysis.	**2.2** Metabolism: deamination, decarboxylation, transamination of amino acids and ornithine cycle.	2.2. learn about the Metabolism: deamination, decarboxylation, transamination of amino acids and ornithine cycle.
	SO2.3 define Structure Nomenclature, classification and biological importance of carbohydrates	2.3 Structure Nomenclature, classification and biological importance of carbohydrates	**2.3** Structure Nomenclature, classification and biological importance of carbohydrates	2.3. learn about Structure Nomenclature, classification and biological importance of carbohydrates
	SO2.4 define Metabolism: glycogenesis, gluconeogenesis, glycolysis.		**2.4** Metabolism: glycogenesis.	2.4. Know about the Metabolism: glycogenesis, gluconeogenesis, glycolysis.
	SO2.5 Study of Structure Nomenclature, classification and biological importance of lipids.		**2.5** Structure Nomenclature, classification and biological importance of lipids	2.5. learn about the Structure Nomenclature, classification and biological importance of lipids
	SO2.6 study of Metabolism: beta oxidation of fatty acids.		**2.6** Metabolism: beta oxidation of fatty acids.	
	SO2.7 study of physiology of digestion**,** regulation and disorder **SO2.8** explain the BMR		**2.7** physiology of digestion? **2.8** study of BMR	
	SO2.9 explain about **thermoregulation**?		**2.9 study of** thermoregulation?	
	SO2.10 explain regulation and disorder?		**2.10** regulation and disorder?	
	SO2.11 explain about Metabolism: gluconeogenesis?		**2.11** Metabolism: gluconeogenesis	
	SO2.12 described Metabolism: glycolysis.?		**2.12** Metabolism: glycolysis.	

Suggested Sessional Work (SW):*anyone*	**SW2.1** Assignments	Write about the Structure Nomenclature, classification and biological importance of protein.
	SW2.2 Mini Project	Write about the Study of Structure Nomenclature, classification and biological importance of lipids
	SW2.3 Other Activities (Specify)	write the explain the BMR.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	08	01	07	28

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self-Learning(SL)
01ZO402 **.3.**Examine internal harmony of different body system by learning inherent disorder and deficiencies which is needed to maintain good health.	**SO3.1** Explain the mechanism – inspiration and expiration	3.1. Detection of ammonia, urea and uric acid.	**Unit-3 Respiration, Excretion and immune system** **3.1** mechanism – inspiration and expiration	3.1. Know about the mechanism – inspiration and expiration
	SO3.2 define the physiology- exchange and transport of gases	3.2. Estimation of haemoglobin using heam-ometer	**3.2** physiology- exchange and transport of gases	3.2. learn about physiology- exchange and transport of gases
	SO3.3 Explain the disorders- apnoea, hypoxia, asthma	3.3 physiology- urea, urine formation, and counter current mechanism	**3.3 study of** disorders- apnoea	3.3. Know about the disorders- apnoea, hypoxia, asthma
	SO3.4 Explain the physiology- urea , urine formation, and counter current mechanism	3.4 innate and acquired immunity	**3.4** physiology- urea , urine formation, and counter current mechanism	3.4. learn about the physiology- urea , urine formation, and counter current mechanism
	SO3.5 Explain the Osmoregulation		**3.5** Osmoregulation	3.5. Know about the Osmoregulation
	SO3.6 study of Innate and acquired immunity		**3.6** Innate and acquired immunity	3.6. learn about Innate and acquired immunity
	SO3.7 study of disorders-, hypoxia.		**3.7** study of disorders- ,hypoxia.	
	SO3.8 study of disorders- asthma		**3.8 study of** disorders- asthma	
	SO3.9 study of Antigen response		**3.9** study of Antigen response	3.7. study of Antigen response
	SO3.10 study of immune cells?		**3.10** study of immune cells?	
	SO3.11 explain about innate?		**3.11** study of innate?	
	SO3.12 explain immune globulins.		3.12 study of immune globulins.	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Write about Explain the disorders- apnea, hypoxia, asthma
	SW3.2 Mini Project	Write about the the physiology- exchange and transport of gases.
	SW3.3 Other Activities (Specify)	write the study of Antigen response.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	12	10	01	06	29

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Classroom Instruction(CI)	Self-Learning(SL)
01ZO402 **.4.** Analysis about neuromuscular coordination and impulse conduction physiology.	**SO4.1** study of structure and types of Neurons	4.1. study of types of Neurons	**Unit-4 Neuromuscular co-ordination** **4.1** structure of Neurons	1. Read the structure and types of Neurons
	SO4.2 study of physiology of nerve impulse condition	4.2. study of Neuromuscular disorder- Alzheimer	**4.2** study of physiology of nerve impulse condition	2. study of physiology of nerve impulse condition
	SO4.3 Study of Neuromuscular disorder- epilepsy, Alzheimer	4.3. physiology of muscles contraction	**4.3** study of Neuromuscular disorder- epilepsy.	3. Understand the Neuromuscular disorder- epilepsy, Alzheimer
	SO4.4 explains types of Neurons	4.4. muscles contraction and its bio chemistry	**4.4** study of types of Neurons	4. learn about structure and types of muscles
	SO4.5 described Neuromuscular disorder- Alzheimer	4.5 structure of muscles	**4.5** study of Neuromuscular disorder- Alzheimer	5. Know about the physiology of muscles contraction and its bio chemistry
	SO4.6 explains Neuromuscular disorder- Parkinson disease.		**4.6** study of Neuromuscular disorder- Parkinson disease.	6. study of Muscular disorder – fatigue
	SO4.7 explains physiology of muscles contraction?		**4.7** physiology of muscles contraction?	
	SO4.8 explains structure of muscles?		**4.8** structure of muscles	
	SO4.9 Explains neurons?		**4.9** Explains neurons?	
	SO4.10 Understand the structure and types of muscles		**4.10** types of muscles	
	SO4.11 Explain the physiology of muscles contraction and its bio chemistry		**4.11** muscles contraction and its bio chemistry	
	SO4.12 Study of Muscular disorder – fatigue		4.12 Muscular disorder – fatigue	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Write about study of Study of Neuromuscular disorder- epilepsy, Alzheimer.
	SW4.2 Mini Project	Explain the Explain the physiology of muscles contraction and its bio chemistry.
	SW4.3 Other Activities (Specify)	write the Study of Muscular disorder – fatigue.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	12	00	01	08	21

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Classroom Instruction(CI)	Self-Learning(SL)
01ZO402 **.5.** Understand about hormonal balance and the effects of their responses on the body.	**SO5.1** Explain the structure of Definition and classification of Hormones.		**Unit-5 Hormones, endocrine system, and reproductive biology** **5.1** Definition and classification of Hormones.	1. Read the structure of Definition and classification of Hormones.
	SO5.2 study about mechanism of hormones action.		**5.2** mechanism of hormones action.	2. learn about about mechanism of hormones action.
	SO5.3 Identify Structure, function and disorder of pituitary gland.		**5.3** Structure, of pituitary gland.	3. learn about Structure, function and disorder of pituitary gland.
	SO5.4 Explain the Structure, function and disorder of thyroid and parathyroid gland.		**5.4** Structure, of thyroid and parathyroid gland.	4. Read the Structure, function and disorder of thyroid and parathyroid gland.
	SO5.5 study of Structure, function and disorder of adrenal gland.		**5.5** Structure, function and disorder of adrenal gland.	5. learn about Structure, function and disorder of adrenal gland.
	SO5.6 study of Structure, function and disorder of thymus gland		**5.6** Structure, function and disorder of thymus gland	6. study of Structure, function and disorder of thymus gland
	SO5.7 explains physiology of reproduction?		**5.7** physiology of reproduction	7. read the physiology of reproduction
	SO5.8 explains Sex hormones?		**5.8** Sex hormones	8. learn about Sex hormones
	SO5.9 described function of pituitary gland?		**5.9** function of pituitary gland.	
	SO5.10 described disorder of pituitary gland.		**5.10** disorder of pituitary gland.	
	SO5.11 described function of thyroid and parathyroid gland.		**5.11** function of thyroid and parathyroid gland.	
	SO5.12 described disorder of thyroid and parathyroid gland.		**5.12** disorder of thyroid and parathyroid gland.	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Explain the structure of Definition and classification of Hormones
	SW5.2 Mini Project	Explain the physiology of reproduction
	SW5.3 Other Activities (Specify)	Identify Sex hormones

Course duration (in hours) to attain Course Outcomes:

Course Title: Physiology and bio chemistry **Course Code:** 01ZO402

Course Outcomes(COs)	Class lecture (CI)	Laboratory Instruction(LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
01ZO402 **.1.** Develop deeper understanding of how organ function at different level i.e. from cellular to system level.	12	06	5	1	24
01ZO402 **.2.** Understand functions of biomolecules and their role in metabolism by studying biochemistry	12	06	5	1	24
01ZO402 **.3.**Examine internal harmony of different body system by learning inherent disorder and deficiencies which is needed to maintain good health.	12	08	7	1	26
01ZO402 **.4.** Analysis about neuromuscular coordination and impulse conduction physiology.	12	10	6	1	27
01ZO402 **.5.** Understand about hormonal balance and the effects of their responses on the body.	12	0	8	1	21
Total Hours	60	30	31	5	122

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Physiology and bio chemistry **Course Code:** 01ZO402

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
01ZO402 **.1.** Develop deeper understanding of how organ function at different level i.e. from cellular to system level.	3	3	2	1	9
01ZO402 **.2.** Understand functions of biomolecules and their role in metabolism by studying biochemistry	4	4	2	1	11
01ZO402 **.3.**Examine internal harmony of different body system by learning inherent disorder and deficiencies which is needed to maintain good health.	2	3	3	2	10
01ZO402 **.4.** Analysis about neuromuscular coordination and impulse conduction physiology.	3	5	1	1	10
01ZO402 **.5.** Understand about hormonal balance and the effects of their responses on the body.	5	4	1	0	10
Total Marks	**17**	**19**	**9**	**05**	**50**

***Legend*:A,** Apply;**An,** Analyze;**E,** Evaluate;**C,** Create

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1	Principles of Biochemistry A.L. Leininger & others Edition W.H. Freeman and Co. new York 2008
2	Textbook of Animal Physiology and Biochemistry H.R. Singh Vishal Publishing Co. 9th 2014
3	Immunology T.J. Kindt and Others Edition W.H. Freeman and Co. new York VIth 2006
4	A Textbook of Animal Physiology A.K. Berry Emkey Publication, Delhi 1991

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Demonstration
7. ICT Based teaching Learning
8. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Sc. Biology
Semester: 4th Semester
Course Title: Physiology and bio chemistry
Course Code: 01ZO402

CO/PO/PSO Mapping								
Course Outcome (Cos)	**Program Outcomes (POs)**					**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**
01ZO402 **.1.** Develop deeper understanding of how organ function at different level i.e. from cellular to system level.	1	2	3	2	1	2	2	3
01ZO402 **.2.** Understand functions of biomolecules and their role in metabolism by studying biochemistry	3	3	1	2	2	2	1	3
01ZO402 **.3.**Examine internal harmony of different body system by learning inherent disorder and deficiencies which is needed to maintain good health.	1	2	2	3	1	1	2	3
01ZO402 **.4.** Analysis about neuromuscular coordination and impulse conduction physiology.	3	1	1	3	2	1	2	3
01ZO402 **.5.** Understand about hormonal balance and the effects of their responses on the body.	2	2	1	3	3	1	1	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5 PSO 1,2,3	01ZO402 **.1.** Develop deeper understanding of how organ function at different level i.e. from cellular to system level.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	1.1,1.2,1.3	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9,1.10,1.11,1.12	1SL-1,2,3,4,5
PO 1,2,3,4,5 PSO 1,2,3	01ZO402 **.2.** Understand functions of biomolecules and their role in metabolism by studying biochemistry	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9 SO2.10 SO2.11 SO2.12	2.1, 2.2, 2.3	2.1,2.2,2.3,2.4,2.5, 2.6,2.7,2.8,2.9,2.10,2.11,2.12	2SL-1,2,3,4,5
PO 1,2,3,4,5 PSO 1,2,3	01ZO402 **.3.**Examine internal harmony of different body system by learning inherent disorder and deficiencies which is needed to maintain good health.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9 SO3.10 SO3.11 SO3.12	3.1,3.2,3.3,3	3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9,3.10,3.11,3.12	3SL-1,2,3,4,5,6,7
PO 1,2,3,4,5 PSO 1,2,3	01ZO402 **.4.** Analysis about neuromuscular coordination and impulse conduction physiology.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8 SO4.9 SO4.10 SO4.11 SO4.12	4.1,4.2,4.3,4.4,	4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9,4.10,4.11,4.12	4SL-1,2,3,4,5,6
PO 1,2,3,4,5 PSO 1,2,3	01ZO402 **.5.** Understand about hormonal balance and the effects of their responses on the body.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9 SO5.10 SO5.11 SO5.12		5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,5.9,5.10,5.11,5.12	5SL-1,2,3,4,5,6,7,8

B.Sc. IVth Semester

COURSE NAME: Transition elements, Chemi – energetic,Phase Equilibria
COURSE CODE: 01CH403

Course Code	Course Title	L	T	P	Total Credits
01CH403	**Transition elements, Chemi – energetic,Phase Equilibria**	3	1	2	6

Pre-requisite: Students must have fundamental knowledge of mathematics, valence shell electron pair repulsion theory and basic concepts of periodic table

Rationale: The students studying analytical chemistry should possess foundational understanding about basic mathematics, valence shell electron pair repulsion theory, and different concentration terms to understand the basic principle of chromatography and spectroscopic analysis.

Course Outcomes:

After the completion of this course, the learner willable to

01CH403.1: Explain the electronic configuration, oxidation states and magnetic behavior of d and f-block elements

01CH403.2: Describe the metal ligand bonding on the basis of VBT,CFTand LFT

01CH403.3:Discuss about the first, second and third law of thermodynamics and their applications

01CH403.4:Describe the various types of reference electrodes, electrochemical series, electrode potential and Nernst equation

01CH403.5: Apply their knowledge to explain the phase diagram of one and two component Systems

Transition elements, Chemi – energetic, Phase Equilibria

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(Paper-2)

CLO: - By the end of this course students must have had the subject chemistry in class =@ or equivalent

1. Chemistry of d & f-block Elements, Basic Concepts of Coordination Chemistry
2. Siereochemistry of Transition Metal Complexes.
3. Laws of Thermodynamics..
4. Concept of Phase Equilibrium with reference to Solid Solution, Liquid-Liquid Mixtures, Partially Miscible Liquids.
5. Basic Concepts of Electrochemistry.

UNIT-1

Chemistry of d-&f-block elements

Chemistry of Transition elements: First, Second andThirdTransitionseries.Generalgrouptrendswithspecialreferenceto-ElectronicConfiguration,CoordinationGeometry,Colour,VariableValency,Spectral,MagneticandCatalyticProperties,AbilitytoformComplexes.

ChemistryofInnerTransitionelements: LanthanidesandActinides,GeneralgrouptrendswithspecialreferencetoElectronicConfiguration,OxidationStates,Colour,SpectralandMagneticProperties.LanthanideContraction.SeparationofLanthanides(Ion-exchangemethodonly).Transuranicelements:GeneralIntroduction.

UNIT-2

Coordination. Chemistry „-,

Metal Ligand Bonding in Transition Metal Complexes

TypesofligandsCoordinationnumberOxidationstate,EAN,ValenceBondTheory(VBT).PostulatesandapplicationsforTetrahedral,SquareplanarandOctahedrahedralcomplexes.LimitationsofVBT.CrystalFieldTheory(CFT),PostulatesandapplicationofCrystalfieldtheory,splittingofd-orbitals:..Crystalfieldstabilisationenergy(CFSE),Factors'affectingthecrystalfieldparameters..Jahn-Tellertheorem.LigandfieldandMolecularOrbital(MO)Theory

Isomerism in coordination compounds:

Structuralisomerism-Ionization,Linkage,Coordination-LigandIsomerism.

Stereoisomerism:

Geometrical isomerism and Optical isomerism:

UNIT-3

Thermodynamics

First law of Thermodynamics.

Conceptofheat(Q),work(W),internalenergy(U),Statementoffirstlaw,Enthalpy(H),Relationbetweenheatcapacities.CalculationsofQ,W,internalenergychangeandenthalpychangeunderisothermalandadiabaticconditionsforReversible,IrreversibleandFree(idealandvanderWaals)expansionsofgases.JouleThomsoneffectanditstheory,Inversiontemperature.

Second Law of Thermodynamics.

Carnotcycle,Statementofthesecondlawofthermodynamics.'ConceptofEntropy,Calculationofentropychangefor,Reversibleandirreversibleprocesses,Conceptofresidualentropy,FreeEnergyFunctions:GibbsandHelmholtzeneizy..VariOonofentropy (S),Gibbsfreeenergy(G),workfunction(A)With'temperature(T)volume(V)&pressure(P).Freeenergychangeandspontaneity,Gibbs-Helmholtzequation.

Third Law of Thermodynamics : Statement of third law,Calculation of absolute entropy of substance

UNIT-4

Electrochemistry

Electrical Conduction in metals and in electrolyte solutions. Specific equivalent, and molar conductivity. Measurement of equivalent conductance Effect of dilution on conductivity. KohlialiSchlaw and its applications. Wea-kand 'Strong electrolytes: Theory of strong electrolytes, DebyeHuckel On Sager (DHO) theory and equation. Transport numbers 'Determination of transport numbers by Hitter Method and Moving boundary method. 'Nernst equation, Derivation and application of Nernst equation, Electrode

Reference electrodes

Standard hydrogen electrode,Quinhydrone electrode, Glass electrode, Calomel electrode.

Electrochemical series and its applications, Electrochemical cells

UNIT-5

Phase equilibrium

Concept of phases. Components and degrees of freedom. Thermodynamic derivation of Gibbs Phase Rule for reactive and non reactive systems. Clausius-Clapeyron equation and its applications to Solid- Liquid, Liquid-Vapourand Solid-Vapour equilibria. Phase diagram for one component systems with applications-Water and Sulphur.

Phase diagrams for systems of solid-liquid equilibria in volving-Eutectic, Congruent and In congruentmelting points.WaterandSulfursystem,Ag-PbandMg-Znsystem,NaC1-H20system.

Bi**nary solutions:** Raoult'sLaw, Ideal and Non-ideal or Azeotropic mixtures, Immiscible liquids, Steamdistillation.

SUGGESTEDWEBSOURCES:

1. https://nptel.ac.in/course.html
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
3. https://swayam.gov.in/explorer?category=Chemistry

MODEOFTRANSACTION:Lecture,demonstration,E-tutoring,discussion,assignments,quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite,MSPower-Point, Online Resources

Scheme of Studies:

Board ofStudy	CourseCode	Course Title	Scheme of studies (Hours/Week)						Total CreditsI
			Cl	T	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
Program Core(PCC)	**01CH403**	**Transition elements, Chemi – energetic,Phase Equilibria**	4	0	2	1	1	8	6

Legend: CI: ClassroomInstruction(Includesdifferentinstructionalstrategiesi.e.Lecture(L)andTutorial (T)andothers),

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LI: LaboratoryInstruction(IncludesPracticalperformancesinlaboratoryworkshop,fieldorotherlocationsusingdifferentinstructionalstrategies)
SW: SessionalWork(includesassignment,seminar,miniprojectetc.),
SL: SelfLearning
C: Credits.

Note:SW&SLhastobeplannedandperformedunderthecontinuousguidanceandfeedbackofteacherto ensure outcome of Learning.

Scheme of Assessment: Theory

Board of Study	Course Code	Course Title	**Scheme of Assessment(Marks)**						
			ProgressiveAssessment(RA)					**EndSemesterAssessment (ESA)**	**TotalMarks** (PRA+ESA)
			Class/HomeAssignment5number markseach	Class Test2 (2bestoutof3) 10	Seminarone + Class activity	ClassAttendance (AT)	TotalMarks (CA+CT+SA +AT)		
DCC	01CH403	**Transition elements, Chemi – energetic,Phase Equilibria**	15	20	10	5	50	50	100

Course-Curriculum Detailing:
This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (Sos), culminating in the overall achievement of Course Outcomes (Cos) upon the course's conclusion.

Unit-1 (01CH403.1):

Chemistry of d-&f-block elements

Chemistry of Transition elements: First, Second and Third Transition series. General group trendswithspecialreferenceto-

ElectronicConfiguration,CoordinationGeometry,Colour,VariableValency,Spectral,MagneticandCatalyticProperties,AbilitytoformComplexes.

ChemistryofInnerTransitionelements: LanthanidesandActinides,GeneralgrouptrendswithspecialreferencetoElectronicConfiguration,OxidationStates,Colour,SpectralandMagneticProperties.LanthanideContraction.SeparationofLanthanides(Ion-exchangemethodonly).Transuranicelements:GeneralIntroduction.

formulae.

Activity	Appx Hrs
Cl	12
LI	6
SW	2
SL	1
Total	21

Session Outcomes (SOs)	LI	CI	SL
After the completion of topics students will be able to SO1.1 understand the concept of d block elements SO1.2 Restate the concept of f-block elements SO1.3 Overview of Oxidation States and magnetic properties SO1.4 Discuss about the Lanthanide and Actinide contraction	Synthesis of inorganic complexes • Preparation of potassium tri oxalate ferrate(III) • Preparation of tetra ammine copper (II) sulphate • Preparation of tetraammine carbonate Cobalt(III)nitrate	**Unit-1:Chemistry of d- & f-block elements** 1.1Chemistry of Transition elements: 1.2First, Second and Third Transition series. 1.3General group trends with special reference to- Electronic Configuration Coordination Geometry, 1.4Colour, Variable Valency, 1.5Spectral, Magnetic and Catalytic Properties, 1.6Ability to form Complexes. 1,7Chemistry of Inner Transition elements: 1.8Lanthanides and Actinides, 1.9General group trends with special reference to Electronic Configuration,	• Basic idea about d-block elements • Properties of f-block elements

SO1.5 Explain complex formation by metal-ligand bonding		1.10 Oxidation States, Colour, Spectral and Magnetic Properties. 1.11Lanthanide Contraction. Separation of Lanthanides (Ion-exchange method only). 1.12Transuranic elements: General Introduction	

SW-1SuggestedSessionalWork(SW):
Assignments: properties of 4d and 5d Transition metals
Mini Project: Software's for drawing structures and molecular formulae.
Other Activities (Specify):Basic idea about periodic table
Unit-2(01CH403.2):

CoordinationChemistry ,,-,

MetalLigandBondinginTransitionMetalComplexes

TypesofligandsCoordinationnumberOxidationstate,EAN,ValenceBondTheory(VBT).PostulatesandapplicationsforTetrahedral,SquareplanarandOctahedrahedralcomplexes.LimitationsofVBT.CrystalFieldTheory(CFT),PostulatesandapplicationofCrystalfieldtheory,splittingofd-orbitals:..Crystalfieldstabilisationenergy(CFSE),Factors'affectingthecrystalfieldparameters..Jahn-Tellertheorem.LigandfieldandMolecularOrbital(MO)Theory

Isomerism in coordination compounds:

Structuralisomerism-Ionization,Linkage,Coordination-LigandIsomerism.

Stereoisomerism:

Geometrical isomerism and Optical isomerism:

Activity	AppX Hrs
Cl	13
LI	6
SW	2
SL	1
Total	22

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)

After the completion of topics students will be able to **SO2.1**Restate the concept of ligand and types of ligand **SO2.2**Explain the Postulates of valence bond theory **SO2.3 Di**scuss splitting of d-orbitals **SO2.4**Discuss CFSE and pairing energy **SO2.5O**verview of ligand field theory	Synthesis of inorganic complexes • Preparation of Nickel(II)dmg • Preparation of copper (II)acetylacetonate • Preparation of Iron(III) acetylacetonate • • Determination of carbonate and hydroxide present in mixtur • Determination of carbonate and bicarbonate present in a mixture.	**UNIT- 2** **Coordination Chemistry** „- , ' , ' ' 2.1Metal Ligand Bonding in Transition Metal Complexes 2.2Types of ligands 2.3Coordination numberOxidation state, 2.4 EAN(Effective atomic number) 2.5Valence Bond Theory (VBT): Postulates and applications 2.6Limitations of VBT. 2.7Crystal Field Theory (CFT) 2.8 Postulates and application of Crystal field theory, 2.9splitting of d-orbitals:.. Crystal field stabilisation energy (CFSE) 2.10 Factors 'affecting the crystal field parameters.. 2.11 Jahn-Teller theorem. Ligand field and Molecular Orbital (MO) Theory **2.12**Isomerism in coordination compounds:	• Factors affecting CFSE • Isomerism in co-ordination compounds

SW-2 Suggested Sessional Work (SW):

Assignments: Presentation of experimental data and results, from the point of view of Metal-Ligand bonding

Mini Project: Synthesis of inorganic complexes and their applications

Other Activities (Specify): Determination of hybridization and geometry of some metal complexes

Unit-3 (01CH403.3):

Thermodynamics

First law of Thermodynamics.

Conceptofheat(Q),work(W),internalenergy(U),Statementoffirstlaw,Enthalpy(H),Relationbetweenheatcapacities.CalculationsofQ,W,internalenergychangeandenthalpychangeunderisothermalandadiabaticconditionsforReversible,IrreversibleandFree(idealandvanderWaals)expansionsofgases.JouleThomsoneffectanditstheory,Inversiontemperature.

SecondLawofThermodynamics.

Carnotcycle,Statementofthesecondlawofthermodynamics.'ConceptofEntropy,Calculationofentropychangefor,Reversibleandirreversibleprocesses,Conceptofresidualentropy,FreeEnergyFunctions:GibbsandHelmholtzeneizy..VariOonofentropy(S),Gibbsfreeenergy(G),workfunction(A)With'temperature(T)volume(V)&pressure(P).Freeenergychangeandspontaneity,Gibbs-Helmholtzequation.

ThirdLawofThermodynamics: Statementofthirdlaw,Calculationofabsoluteentropyofsubstance

Activity	AppX Hrs
Cl	11
LI	4
SW	2
SL	1
Total	18

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)

After the completion of topics students will be able to **SO3.1** Overview of enthalpy. Entropy and free energy **SO3.2**Discuss basic concept of thermodynamics **SO3.3**Explain Laws of Thermodynamics **SO3.4** **E**xplain conceptually the state function and path function **SO3.5**Describe Carnot cycle and efficiency of engine	Determination of enthalpy of following: • Determination of free alkali present in different soaps/detergents • Neutralization of hydrochloric acid with sodium hydroxide • Ionization of ethnic acid • Hydration of salts • Determination of enthalpy (endothermic and exothermic)of aqueous solution of salts	**UNIT-3Thermodynamics** 1.1First law of Thermodynamics. 1.2Concept of heat (Q), work (W), internal energy (U), 1.3Statement of first law, Enthalpy (H), Relation between heat capacities. 1.4Calculationsof Q, W, internal energy change and enthalpy change under isothermal and adiabaticconditions 1.5 for Reversible, Irreversible and Free (ideal and van der Waals) expansions of gases 1.6.Joule Thomson effect and its theory, Inversion temperature. 1.7Second Law of Thermodynamics. 1.8Carnot cycle, Statement of the second law of thermodynamics. 1.9'Concept of Entropy, Calculation of entropy change for ,Reversible and irreversible processes, 1.10Gibbs and Helmholtz energy..VariOon of entropy (S), Gibbs free energy (G), work function (A) With' temperature (T)volume (V) & pressure (P). Free energy changeand spontaneity, 1.11 Gibbs-Helmholtz equation. 1.12Third Law of Thermodynamics	• Gibbs free energy • Van't Hoff factors

SW-3 Suggested Sessional Work (SW):

Assignments: Concept of enthalpy,entropy and free energy

Mini Project:Thermodynamics of Ramjet

Other Activities (Specify): Numerical Problems on thermodynamics

Unit-4 (01CH403.4): Electrochemistry

Electrical Conduction in metals and in electrolyte solutions. Specifie equivalent, and molar conductivity. Measurement of equivalent conductance Effect of dilution on conductivity. KohlialiSchlaw and its applications. Wea-kand 'Strongelectrolytes: Theory of strong electrolytes, Debye Huckel On Sager (DHO) theory and equation. Transport numbers 'Determination of transport numbers by Hitter Method and Moving boundary method. 'Nernst equation, Derivation and application of Nernst equation, Electrode

Reference electrodes

Standard hydrogen electrode, Qu in hydrone electrode,Glass electrode, Calomelel ectrode.

Electro chemical series and its applications, Electrochemical cells

Activity	AppX Hrs
Cl	13
LI	6
SW	2
SL	1
Total	21

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
After the completion of topics students will be able to **SO4.1**understand basics of Electrochemistry **SO4.2**Overview of strong ,weak electrolyte and cell notation **SO4.3** Disuss effect of dilution on conductivity **SO4.4**Explain the concept of reference electrodes **SO4.5 Di**scuss the concept of various cell	Qualitative Analysis • Identification by determination of the Rf values of the given organic / inorganic compounds by paper/ thin layer chromatography. • Systematic identification of organic compound by qualitative analysis	**Unit-4 (2CH101.4):** **Electrochemistry** 4.1 Electrical Conduction in metals and in electrolyte solutions. 4.2Specifie,,equivalent, and molar conductivity. Measurement of equivalent conductance 4.3 Effect of dilution on conductivity. 4.4KohlialiSch law and its applications .4.5Wea¯k and 'Strong electrolytes, Debye Huckel On Sager (DHO) theory and equation. 4.6Transport numbers' Determination of transport numbers by Hittorf Method and Moving boundary method. 4.7'Nernst equation, Derivation and 4.8application of Nernst equation 4.9**Referenceelectrodes**Standardhydrogenelectrode, 4.10Quinhydrone electrode, Glass electrode, Calomel electrode. 4.11Electrochemical series and its applications, 4.12Electrochemical cells	DebyeHuckelOnSager(DHO)theoryandequation. measurementofequivalentconductance

SW-4 Suggested Sessional Work (SW)

Assignment: Application of electrochemical series

Mini Project: Synthesis of green corrosion inhibitors
Other Activities (Specify): Mechanism of Rusting

Unit-5 (01CH403.5):
Phase equilibrium

Concept of phases. Components and degrees of freedom. Thermodynamic derivation of Gibbs Phase Rule for reactive and non reactive systems. Clausius-Clapeyron equation and its applications to Solid- Liquid, Liquid-Vapourand Solid-Vapour equilibria. Phase diagram for one component systems with applications-Water and Sulphur.

Phase diagrams for systems of solid-liquid equilibria in volving-Eutectic, Congruent and In congruentmelting points.WaterandSulfursystem,Ag-PbandMg-Znsystem,NaC1-H20system.

Bi**nary solutions:** Raoult'sLaw, Ideal and Non-ideal or Azeotropic mixtures, Immiscible liquids, Steamdistillation.

Activity	AppX Hrs
Cl	11
LI	6
SW	2
SL	1
Total	20

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
After the completion of topics students will be able to **SO5.**1 Understand Basics of water and Sulphur systems **SO5.2**Overview of vaporization and Sublimation curve	Phase equilibria: • Verification of Lambert-Beer Law • Determination of concentration of colored compounds (e.g. CuSO4, KMnO4) a)Construction of the phase diagram using cooling curves or ignition tube method: 1)Simple eutectic and 2)Congruently melting systems	**Unit-5Phase equilibrium** 5.1 Concept ofphasesComponents and degrees of freedom freedom.. 5.2Thermodynamic derivation of Gibbs Phase Rule for reactive and nonreactive systems. 5.3 Clausius-Clapeyronequation andits applicationsto Solid-	• Applications of one component systems • Positive and negative deviation

SO5.3 Apply the concept of Phase to evaluate the degree of freedom and triple point **SO5.**4 Idea about ideal and non ideal solution **SO5.5** Explain about the esthetic and congruent point	b)Distribution of acetic/benzoic acid between water and cyclohexane c)Purification/Separation of compounds by fractional distillation/Steam distillation	Liquid, Liquid-Vapour and Solid-Vapour equilibria. 5.4Phase diagram for one component systems 5.5 Water and Sulfur system, 5.6Ag-Pb and 5.7 Mg-Zn system, 5.8 NaC1-H_2O system. 5.9Binary solutions: Raoult's Law, 5.10Ideal and Non-ideal solutions .11Azeotropic mixtures, 5.12Immiscible liquids, Steam distillation.	

SW-5 Suggested Sessional Work (SW):
Assignments: Applications of two component Systems
Mini Project: Application of Phase diagrams in metallurgy and ceramics
Other Activities (Specify): Numerical Problems on Raoult's Law

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Laboratory Instruction (LI)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
01CH403.1: Explainthe electronic configuration,oxidation states and magnetic behavior of d and f-block elements	12	3	01	02	21
01CH403.2: Describe the metal ligand bonding on the basis of VBT,CFTand LFT	12		02	01	22
01CH403.3:Discuss aboutthefirst,secondandthirdlawofthermodynamics and their applications	11	4	02	01	18

01CH403.4:Describe the various types of reference electrodes,electrochemical series,electrode potential and Nernst equation	13	6	02	01	22
01CH403.5: Apply their knowledge to explain the phase diagram of one and two component Systems.	11	6	02	01	20
Total Hours	60	28	10	05	103

Suggestion for End Semester Assessment

SuggestedSpecificationTable(ForESA)

CO	UnitTitles	Marks Distribution			Total Marks
		R	U	A	
CO-1	**Chemistry of d-&f-blockelements**	03	01	01	05
CO-2	**Coordination Chemistry**	02	06	02	10
CO-3	**Thermodynamics**	03	04	03	10
CO-4	**Electrochemistry**	-02	08	05	15
CO-5	**Phaseequilibrium**	03	02	05	10
Total		13	21	16	50

Legend: R:Remember, U:Understand, A:Apply

The written examination of 50 marks will be held at theendof semesterfor Inorganic Chemistry

Note.DetailedAssessmentrubricneedtobepreparedbythecoursewiseteachersforabovetasks. Teacherscanalsodesigndifferenttasksasperrequirement,forendsemesterassessment.

SuggestedInstructional/ImplementationStrategies:

1. ImprovedLecture
2. Tutorial
3. CaseMethod
4. GroupDiscussion
5. RolePlay
6. Visitto NCL, CSIR laboratories
7. Demonstration

8. ICTBasedTeachingLearning(VideoDemonstration/TutorialsCBT ,Blog,Facebook,Twitter,Whatsapp,Mobile,Onlinesources)
9. Brainstorming

SuggestedLearningResources:

(a) Books:

S. No.	Title	Author	Publisher
1	Organic Chemistry, Sultan Chand and Sons. Delhi.	Soni PL,	Sultan Chand and Sons, . Delhi
2	Chemistry	Srivastava, S. S. Gehlot. A.S.	Ratan Prakashan Temple. Indore.
3	Inorganic Chemicals	Sing, DR, Saxena, G, Singh, B.	Shivlal Aggarwal & Company, Agra
4	Bioinorganic Chemistry	AK Das	Prentice-Hall
5	Inorganic chemistry	Gary L. Miessler	Pearson
6	Inorganic chemistry	VK Jaiswal	Shri Balaji
7	Elementary Organic Spectroscopy	Sharma Y.R.	S Chand, 2013
8	Elements Physical Chemistry	Peter Atkins	7Th Edition 2017
9	Textbook of Physical Chemistry	Glasstone, S	Macmillan, 1951.
10	Advanced Physical Chemistry	Bahl. A. & Bahal. B.S.	S. Chand. 2010

Suggested Web Sources:

1. https://celqusb.files.wordpress.com/2017/12/inorganic-chemistry-g-l-miessler-2014.pdf
2. https://www.slideshare.net/MANISHSAHU106/inert-and-labile-complexes
3. https://swayam.gov.in/explorer?category=Chemistry

Mode of Delivery: Lecture,demonstration,E-tutoring,discussion,assignments,quizzes, case study, power point;

LMS/ICT Tools: Digital Classrooms, DLMS, ZOOM, G-Suite,MSPower-Point, Online Resources.

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Course Title: Transition elements, Chemi – energetic,Phase Equilibria **Course Code: 01CH403**

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Knowledge	Research Aptitude	Communication	Problem Solving	Individual and Team	Investigation of	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and	The detailed	To integrate	understand, analyze,	Provide opportunitie
CO1: Explainthe electronic configuration,oxidation states and magnetic behavior of d and f-block elements.	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO2: Describe the metal ligand bonding on the basis of VBT,CFTand LFT	2	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3: Discuss aboutthefirst,secondandthirdlawofthermodynamics and their applications.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO4: Describe the various types of reference electrodes,electrochemical series,electrode potential and Nernst equation	2	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2

CO5: Apply their knowledge to explain the phase diagram of one and two component Systems	**2**	**-**	**-**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**3**	**1**	**3**

Legend: **1–Low,** **2–Medium,** **3–High**

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C0urse Curriculum Map:

POs &PSOsNo.	COs No. &	SOs No.	Laboratory Ins	Classroom Instru	Self Learnin
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1:explain basic structure of different	SO1.1SO1. SO1.5		Unit-1. **Chemistryof** 1.1,1.2,1.3,1.	• Basic idea • Properties
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO2:describe the pr sampling, precision,	SO2.1SO2. SO2.4 SO2.5		Unit-2 **Coordination** 2.1,2.2,2.3,2.4,2.5,2.	• Factors affe • Isomerism i
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3:explain thermo	SO3.1SO3. SO3.3 SO3.4 SO3.5		Unit-3 : **Thermodyn** 3.1, 3.2,3.3,3.4,3.5,3	• Gibbs fr • Van't Ho
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO4:**d**iscuss princip	SO4.1SO4. SO4.5		Unit-4 : **Electrochen** 4.1, 4.2,4.3,4.4,4.5,4	Debye HuckelC measurementof
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO5:discuss basic c on the basis of their	SO5.1SO5. SO5.5		Unit 5: **Phaseequilib** 5.1,5.2,5.3,5.4,5.5,	• Applicatio • Positive an

Curriculum Development Team:

1. Dr. Shailendra Yadav, HoD, Department of Chemistry, AKS University, Satna (M.P.).
2. Dr. Dinesh Kumar Mishra, Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
3. Dr. Samit Kumar,Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
4. Dr. Sushma Singh, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
5. Dr. Manoj Kumar Sharma, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).

6. Mr. Kanha Singh Tiwari,Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
7. Mrs. Nahid Usamani, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).

Program name	**Bachelor of Science (B.Sc.)- Biology**	
Semester	**4th**	
CourseCode:	**02BO411**	
Coursetitle:	**Industrial Botany**	Developer: **Paras Koshe**
Pre-requisite:	Student should have basic knowledge biology, botany economic and ethanobotany.	
Rationale:	Industrial botany is the commercial exploitation of plants by people; it contributes significantly to anthropology, biology, conservation, botany, and other fields of science. Economic plants are defined as being useful either directly, as in food, or indirectly, as products we use or that enhance the environment. This course will provide knowledge on plants and their parts in various industries. Students will get an idea to establish plant based natural product industry. This course will make the students self-reliant.	
CourseOutcomes (COs):	CO 1: Students should able to gain Comprehensive information on the use of plants in timber industry. CO 2: Understand and apply the concepts of economic botany and provide knowledge about leaf based industries. CO 3: Interpretate and learn the use of flowers in flower based industries. CO 4: Explain the industrial utility of fruits and seeds of various plants in fruits and seed based industries. CO 5: Acquire knowledge about the use of other parts of plants and to explain their significance in industries.	

Scheme of Studies:

Board ofStudy	**CourseCode**	**CourseTitle**	**Scheme ofstudies (Hours/Week)**					**Total Credits(C) (L:T:P=4:0:2)**
			Cl	**LI**	**SW**	**SL**	**Total Study Hours(CI+LI+SW+SL)**	
Minor	**02BO411**	**Industrial Botany**	4	2	1	2	9	4+2=6

*Legends:*CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial(T) and others);
LI: Laboratory Instruction(Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
Minor	02BO411	Industrial Botany	15	20	5	5	5	50	50	100

Unit I:	
Course-Curriculum: This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.	**ApproximateHours** **Item** | **Cl** | **LI** | **SW** | **SL** | **Total** **Approx.Hrs** | **12** | **04** | **01** | **02** | **19**

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO 1: Students should able to gain Comprehensive information on the use of plants in timber industry.	**SO1.**1 Explain the use of various plants in Timber Industry.	**LI1.1**: Preparation of Holi color's from locally available flowers.	**CI 1.1:** Plants in Timber Industry:	**SL 1.1:** learn the names of timber industries with place in your state.
	SO1.2 Describe various timber yielding trees of India	**LI1.2**: Preparation of food colors from locally available flowers.	**CI1.2:** timber yielding trees of India	**SL1.2:** Learn more about kattha and its use as well as medicinal importance.
	SO1.3: Illustrate timber yielding trees of India and their products		**CI1.3:** Timber yielding trees of India and their products	
	SO1.4: Understand about timber yielding tree i.e. Shisham		**CI1.4:** Timber yielding trees of India and their products (Shisham)	
	SO1.5: Students will be able to brief the use of Sal in textile industries.		**CI1.5:** Timber yielding trees of India and their products (Sal)	
	SO1.6: Discuss various strategies of obtaining Timber yielding trees of India and their products (Teak)		**CI1.6:** Timber yielding trees of India and their products (Teak)	
	SO1.7: Describe the use of Deodar tree in timber industry,		**CI1.7:** Timber yielding trees of India and their products (Deodar)	
	SO1.8: Understand how babool plant can be processed and utilised in timber industry.		CI1.8: Timber yielding trees of India and their products (Babool)	
	SO1.9 Elucidate about the processing of bamboo and their products in Bamboo industry.		**CI1.9** Bamboo Industry	
	SO1.10 Describe the use of sugarcane and other materials in cane industry.		**CI1.10** Cane Industry	
	SO1.11 Explain about the raw materials used in Kattha Industry		**CI1.11** Kattha Industry	
	SO1.12 Explain about the products of Kattha Industry		**CI1.12** Kattha Industry	

Suggested Sessional Work (SW): *anyone*	Assignments:	Discuss how timber yielding trees are useful to mankind.
	Mini Project:	Make a chart showing timber yielding plants and their products.
	Other Activities (Specify):	Write an article on status timber yielding industries in India.

Unit-II:

Course-Curriculum:
This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

ApproximateHours

Item	Cl	LI	SW	SL	Total
Approx.Hrs	12	04	01	02	19

Course outcome (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO 2:: Understand and apply the concepts of economic botany and provide knowledge about leaf based industries.	**SO2.1** Define and describe about Leaf based Industries	**LI2.1**. Perfume extraction process by distillation method	**CI2.1** Leaf based Industries	**SL2.1:** Learn about the leaves of some other plant which are used in leaf industry. (not mentioned in your syllabus)
	SO2.2: Understand utility products of leaf of Palash.	**LI2.2:** Preparation and preservation techniques of jams, jellies and prickles.	**CI2.2:** Utility products of leaf (Palash)	**SL2.2:** Enhance your knowledge about the Tea industry and other beverage production.
	SO2.3 Explain about the utility products of leaf of Banana		**CI2.3** Utility products of leaf (Banana).	
	SO2.4: Illustrate the mechanism and processing of leaves to make tea in Tea Industry		**CI2.4:** Tea Industry	
	SO2.5 Gaining knowledge about the : production of various types of teas.		**CI2.5:** Production of various types of teas	
	SO2.6: Over viewing the process and steps in Leaf oil Industry in making mint and camphor.		**CI2.6:** Leaf oil Industry (Mint, Camphor).	
	SO2.7: Understand how Neem and Tulsi is processed to make oil from leaf in leaf oil industry.		**CI2.7:** Leaf oil Industry (Neem, Tulsi)	
	SO2.8: To learn about different methods of making oil from leaves of eucalyptus and lemon grass.		**CI2.8:** Leaf oil Industry (Eucalyptus and Lemon grass).	
	SO2.9. Analyze the importance of Kasoori Methi leaves and their use as spices.		**CI2.9:** Leaves used as spices (Kasoori Methi)	
	SO2.10.Dicuss about curry patta and their use as spices.		**CI2.10:** Leaves used as spices (Curry patta).	
	SO2.11 Describe the uses of onion leave as spices.		**CI2.11:** Leaves used as spices (Onion)	
	SO2.12 Explain about Tejpatta and its use as spices.		**CI2.12:** Leaves used as spices (Tejpatta).	

Suggested Sessional Work (SW): Anyone	**Assignments:**	Describe the various products of leaf oil industry.
	Mini Project:	Make a chart showing leaf based industry in your area. Also focus on tendu patta.
	Other Activities (Specify):	Compare between tea and coffee and good and ill effects of tea on human health.

Unit-III:	
Course-Curriculum: This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.	**ApproximateHours** **Item** | **Cl** | **LI** | **SW** | **SL** | **Total** **Approx.Hrs** | **12** | **04** | **01** | **03** | **20**

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO 3: Interpretate and learn the use of flowers in flower based industries	**SO 3.1:** Students should able to understand introduction and history of Flower based Industries.	**LI 3.1:** Extraction and preservation of juices (lemon and orange etc.)	**CI 3.1:** Flower based Industries	**SL 3.1:** Read the machine for : Flower based Industries
	SO 3.2: Learn how gulab (Rose) is used to make perfume products.	**LI 3.2:** Preparation of different types of teas (Tulsi tea, lemon tea etc.)	**CI 3.2:** Perfume products of Gulab	**SL 3.2:** learn more about various flowers used in making perfumes.
	SO 3.3 Understand the process and steps of perfume production by using Jasmine.		**CI 3.3** Perfume products of Jasmine.	**SL 3.3:** Read how plants produced colours are different from synthetic colours.
	SO 3.4 Describe the perfume products of Henna.		**CI 3.4** Perfume products of Henna.	
	SO 3.5 learn the advancement of Color industry in India,		**CI 3.5** Color industry	
	SO 3.6 Understand the importance of Food colors and their production and raw materials in color industry.		**CI 3.6** Color industry (Food colors).	
	SO 3.7 Learn about the holi colors and plant materials used to make holi colors in color industry.		**CI 3.7** Color industry (Holi colors).	
	SO 3.8 Understand the Fermentation process and its role in industrial botany.		**CI 3.8** Fermentation	
	SO 3.9 Describe the types of fermentation.		**CI 3.9** Types of fermentation	
	SO 3.10 Gain more insight on raw material for Fermentation in industry.		**CI 3.10** Raw material for Fermentation	
	SO 3.11 Explain various raw material used in fermentation industry with emphasis on mahua.		**CI 3.11** Raw material for Fermentation (Mahua).	
	SO 3.12 Apply the use of Mahua in alcohol production and its product recovery.		**CI 3.12** Use of Mahua in alcohol production and its product recovery.	

Suggested Sessional Work (SW): Anyone	**Assignments:**	Describe about the different types of perfume products and row materials used in making perfumes.
	Mini Project:	Try to extract oil from rose jasmine and mint in your laboratory by using Soxhlet extractor
	Other Activities (Specify):	Literature and presentation; on fermentation and flower based industry.

Unit-IV:

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

ApproximateHours

Item	Cl	LI	SW	SL	Total
Approx.Hrs	12	04	01	02	19

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO 4: Explain the industrial utility of fruits and seeds of various plants in fruits and seed based industries.	**SO4.1:** Students should able to understand introduction and history of Fruits and Seeds based Industries.	**LI4.1:** Identification, collection and extraction of oil yielding leaves	**CI4.1:**Introduction to Fruits and Seeds based Industries	**SL 4.1:** Learn basics of ethanobotany
	SO4.2: Describe the methods of making jams and jellies,	**LI4.2:** Identification, collection and specimen preparation of leafy spices.	**CI4.2:** Jams and Jellies	**SL4.2:** Learn about the fruits and their scientific names found in your locality.
	SO 4.3 Understand the process and steps of producing Juice and Sauce.		**CI 4.3:** Juice and Sauce	
	SO4.4: Learn new technology of preparing Pickles.		**CI4.4:** Pickles.	
	SO 4.5 Brief sbout poha industry.		**CI 4.5** Poha Industry	
	SO4.6: Gain knowledge about Daal Industry.		**CI4.6:** Daal Industry	
	SO4.7: Learn how to raw materials are processed in Edible Oil Industry.		**CI4.7:** Edible Oil Industry	
	SO4.8: Understand how groundnuts are processed to extract oil in Edible Oil Industry.		**CI4.8** Edible Oil Industry (Groundnut)	
	SO4.9: Explain the use of soya bean in Edible Oil Industry		**CI4.9**: Edible Oil Industry (Soybean)	
	SO4.10: Analyze the raw materials and processing in Starch Industry.		**CI4.10**: Starch Industry	
	SO4.11: Describe the raw materials used in Glucose, and Dextrose Industry.		**CI4.11:** Glucose, and Dextrose Industry	
	SO4.12: Explain the products of Glucose and Dextrose Industry.		**CI4.12**: Glucose, and Dextrose Industry	

Suggested Sessional Work (SW): ***anyone***	**SW1.1 Assignments**	Explain importance of Fruits and Seeds based Industries
	SW1.2 Mini Project	Make a chart showing comparison between refined and non refined oil.
	SW1.3 Other Activities (Specify)	Try to make jams and jellies from different fruits in your lab or at home.

Unit-V:

Course-Curriculum:
This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

ApproximateHours

Item	Cl	LI	SW	SL	Total
Approx.Hrs	12	06	01	02	21

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO 5: Acquire knowledge about the use of other parts of plants and to explain their significance in industries.	**SO5.1:** Analyze the functioning of other parts of plants based Industries	**LI5.1**: Hands on training for preparation of "Douna and Pattal" using Palash and Banana leaves.	**CI5.1**: other parts of plants based Industries	**SL5.1**: Study in details about **:** Sugar and Jaggery Industries
	SO5.2: Learn how materials are processed in Sugar and Jaggery Industries	**LI5.2:** Visit to any plant based industry.	**CI5.2:** Sugar and Jaggery Industries	**SL5.2**: Study different funding agencies in your subject for a project
	SO 5.3 Students should able to gain knowledge about the products of Sugar and Jaggery Industries.	**LI5.3**: Herbarium preparation of different parts of plants used in various industries.	**CI 5.3** Sugar and Jaggery Industries	
	SO 5.4 Explain the working and processing of jute in Jute industry.		**CI 5.4** Jute industry	
	SO5.5: Describe various products of jute industry.		**CI5.5**: Jute industry	
	SO 5.6 Understand the making and producing agarbatti in Agarbatti stick making industry.		**CI 5.6** Agarbatti stick making industry	
	SO5.7: Learn about the different products of agarbatti stick making industry.		**CI5.7:** Agarbatti stick making industry	
	SO5.8: Define and describe project proposal preparation for establishment of an industry.		**CI5.8:** Project proposal preparation for establishment of an industry.	
	SO5.9 Explain various aspects of writing project proposal and give idea about recent research topics.		**CI5.9:** Project proposal preparation for establishment of an industry	
	SO5.10: Describe about grants and funding provider organizations of India		**CI5.10** Grants and funding provider organizations of India	
	SO5.11: Define the procedure or proposal for applying grants in funding provider organizations of India.		**CI5.11:** Grants and funding provider organizations of India	
	SO5.12: To know about the different funding agencies in life science.		**CI5.12** DBT, ICMR, CSIR. MPCOST,DST	

Suggested Sessional Work (SW): ***anyone***	**SW1.1 Assignments**	Explain project proposal preparation for establishment of an industry and also mention funding provider in life sciences.
	SW1.2 Mini Project	Try to make agarbatti or stick in lab or at home.
	SW1.3 Other Activities (Specify)	Visit nearby village and learn the raw process of jiggery production from sugarcane juice.

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome: **Course title: Industrial Botany** **(Course code :) 02BO411**					
Course Outcomes	**Marks Distribution**				**Total Marks**
	A	**An**	**E**	**C**	
CO 1: Students should able to gain Comprehensive information on the use of plants in timber industry.	2	1	1	1	5
CO 2: Understand and apply the concepts of economic botany and provide knowledge about leaf based industries.	2	4	2	2	10
CO 3: Interpretate and learn the use of flowers in flower based industries.	3	5	5	2	15
CO 4: Explain the industrial utility of fruits and seeds of various plants in fruits and seed based industries.	2	3	3	2	10
CO 5: Acquire knowledge about the use of other parts of plants and to explain their significance in industries	5	4	1	0	10
Total Marks	**14**	**17**	**12**	**07**	**50**
Legend**: A**-Apply, **An-** Analyze, **E**- Evaluate, **C**- Create					

Course duration (in hours) to attain Course Outcomes **(Course title: Industrial Botany** **(Course code :) 02BO411**					
Course Outcomes(COs)	**Class lecture(CI)**	**LaboratoryInstruction (LI)**	**Self-Learning (SL)**	**Sessional work (SW)**	**Total Hours (Li+CI+SL+SW)**
CO 1: Students should able to gain Comprehensive information on the use of plants in timber industry.	12	4	2	1	19
CO 2: Understand and apply the concepts of economic botany and provide knowledge about leaf based industries.	12	4	2	1	19
CO 3: Interpretate and learn the use of flowers in flower based industries.	12	4	3	1	20
CO 4: Explain the industrial utility of fruits and seeds of various plants in fruits and seed based industries.	12	4	2	1	19
CO 5: Acquire knowledge about the use of other parts of plants and to explain their significance in industries	12	6	2	1	21
Total Hours	60	22	11	05	98

Suggested learning Resources:

S.no.	Title	Author	Publisher	Edition & Year
1	Economic Botany, principles and Practice	Gerald E Wickens	Kluver Academic Publishers	1 & 2001
2	Economic Botany	Koochar S.L.	Cambridge University Press, UK	2 & 2016
3	Economic Botany	. Simpson, B.B. and Ogorzaly, M.C	Tata Macgray Hill Publisher	1 & 1986

Suggested online material:

1. https://krishi.icar.gov.in/jspui/bitstream/123456789/19815/1/Timber.pdf

2. file:///C:/Users/CSP/Downloads/7B.pdf

3. https://swsu.ru/sbornik-statey/pdf/11 chapter%202.pdf

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Visit to Cement Plant
7. Demonstration
8. ICT Based teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, WhatsApp, Mobile, Online sources)
9. Brainstorming

Program Title: B. Sc. Biology
Course Code: 02BO411
Course Title: Industrial Botany

CO, PO and PSO Mapping

CO/PO Mapping															
Course Outcome	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1: Students should able to gain Comprehensive information on the use of plants in timber industry	**3**	**1**	**3**	**2**	**1**	**1**	**2**	**-**	**2**	**-**	**1**	**-**	**2**	**1**	**3**
CO 2: Understand and apply the concepts of economic botany and provide knowledge about leaf based industries	**3**	**-**	**2**	**1**	**-**	**1**	**1**	**1**	**-**	**3**	**1**	**2**	**2**	**1**	**3**
CO 3: Interpretate and learn the use of flowers in flower based industries.	**2**	**2**	**2**	**2**	**2**	**1**	**-**	**2**	**3**	**1**	**1**	**2**	**1**	**2**	**3**
CO 4: Explain the industrial utility of fruits and seeds of various plants in fruits and seed based industries	**2**	**3**	**2**	**2**	**3**	**-**	**3**	**1**	**1**	**2**	**1**	**-**	**2**	**2**	**3**
CO 5: Acquire knowledge about the use of other parts of plants and to explain their significance in industries.	**1**	**2**	**1**	**-**	**3**	**3**	**1**	**2**	**2**	**3**	**1**	**2**	**1**	**3**	**1**
Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3															

Program Title: B. Sc. Biology, 4th **Sem**
Course Code: **02BO411**
Course Title: Industrial Botany

Course Curriculum Map:

POs & PSOs No.	**COs No**	**SOs No.**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO 1:** Students should able to gain Comprehensive information on the use of plants in timber industry.	1.1, 1.2, 1.3, 1.4, 1.5, 1.5, 1.7, 1.8,1.9,1.10,1.11,1.12	LI 1 LI 2	1.1, 1.2, 1.3, 1.4, 1.5, 1.5, 1.7, 1.8,1.9,1.10,1.11,1.12	1 SL-1,2
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO 2:** Understand and apply the concepts of economic botany and provide knowledge about leaf based industries.	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7,2.8,2.9,2.10,2.11,2.12	LI 1 LI 2	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7,2.8,2.9,2.10,2.11,2.12	2 SL-1,2
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO 3:** Interpretate and learn the use of flowers in flower based industries.	3.1, 3.2, 3.3, 3.4 3.5,3.6, 3.7, 3.8, 3.9, 3.10, 3.11,3.12	LI 1 LI 2	3.1, 3.2, 3.3, 3.4 3.5,3.6, 3.7, 3.8, 3.9, 3.10, 3.11,3.12	3 SL-1,2,3
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO 4:** Explain the industrial utility of fruits and seeds of various plants in fruits and seed based industries.	4.1,4.2, 4.3, 4.4, 4.5, 4.6, 4.7,4.8,4.9,4.10,4.11,4.12	LI 1 LI 2	4.1,4.2, 4.3, 4.4, 4.5, 4.6, 4.7,4.8,4.9,4.10,4.11,4.12	4 SL-1,2
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO5:** Acquire knowledge about the use of other parts of plants and to explain their significance in industries.	5.1, 5.2, 5.3,5.4, 5.5, 5.6, 5.7,5.8,5.9,5.10,5.11,5.12	LI 1 LI 2	5.1, 5.2, 5.3,5.4, 5.5, 5.6, 5.7,5.8,5.9,5.10,5.11,5.12	5 SL-1,2

Program Name	**Bachelor of Science (B.Sc.)- Biology**	
Semester	4th	
Course Code:	02ZO412	
Course title:	Physiology and bio chemistry	**Curriculum Developer**: Mr. AMIT BAGRI
Pre-requisite:	Student must have had the subject zoology in class B.Sc. I year.	
Rationale:	The present core course has been designed for the students studying in the subject of zoology at university level as per the UGC approved curriculum. The core course will cover the essential aspects of physiology and biochemistry comprising of introductory background of scope and history of physiology as well as biochemistry. Physiology is the branch of biology that deals with the normal functions of living organisms and their parts. Biochemistry is the branch of science which is concerned with the chemical and physicochemical processes that occur within living organisms. Physiology and biochemistry both are the very important branches of science which have their own significance in various fields including medical, paramedical, toxicology, pharmacy, cardiology and many more. Physiology itself contains vast number of branches such as blood physiology, renal physiology, reproductive physiology, neural physiology, muscle physiology etc., and these all branches specially focuses on how these organs work in coordination with each other and they also show division of labor. It helps us in understanding the functions of various organ systems of our body which is unavoidable if one wants to lead a healthy, disease-free life.	
Course Outcomes (COs):	02ZO412 **.1.** Develop deeper understanding of how organ function at different level i.e. from cellular to system level. 02ZO412 **.2.** Understand functions of biomolecules and their role in metabolism by studying biochemistry 02ZO412 **3.**Examine internal harmony of different body system by learning inherent disorder and deficiencies which is needed to maintain good health. 02ZO412 **.4.** Analysis about neuromuscular coordination and impulse conduction physiology. 02ZO412 **.5.** Understand about hormonal balance and the effects of their responses on the body.	

Scheme of Studies:

Board of Study	**Course Code**	**Course Title**	**Scheme of studies (Hours/Week)**					**Total Credits(C) (L:T:P=3:0:1)**
			Cl	LI	SW	SL	**Total Study Hours(CI+LI+SW+SL)**	
Minor	02ZO412	Physiology and bio chemistry	4	4	1	1	10	4+2= 6

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)		
Minor	02ZO412	Physiology and bio chemistry	**15**	**20**	**10**	**5**	**50**	**50**	**100**

Scheme of Assessment: Practical

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)		
Minor	02ZO412	Physiology and bio chemistry	35	5	5	5	50	50	50

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	05	24

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction(CI)	Self-Learning (SL)
02ZO412 **.1.** Develop deeper understanding of how organ function at different level i.e. from cellular to system level.	**SO1.1** Explain the Contribution of charak	1.1 study of enzymatic activity of trypsin and lipase	**Unit-1 introduction and historical background of physiology and biochemistry** **1.1** Study of Contribution of charak	1.1. Explain the Contribution of charak
	SO1.2 Explain the Contribution of sushrut	1.2 Qualitative estimations protein, carbohydrates and lipids.	**1.2** Study of Contribution of sushrut	1.2. Explain the Contribution of sushrut
	SO1.3 define of Micro and macro molecules		**1.3** Study of Micro and macro molecules	1.3. learn about Micro and macro molecules
	SO1.4 Study about Water and buffer system	1.3. Study of Water and buffer system	**1.4** Study of Water and buffer system	1.4. Learn about of Water and buffer system
	SO1.5 Study about definition and general properties of enzyme		**1.5** definition and general properties of enzyme?	1.5. Learn Study about definition and general properties of enzyme
	SO1.6 Study of Nomenclature and classification and function		**1.6** Nomenclature and classification and function?	
	SO1.7 study of Mechanism and regulation of enzyme action		**1.7** Mechanism and regulation of enzyme action?	
	SO1.8 study of Co- enzyme		**1.8** Study of Co- enzyme?	
	SO1.9 types and source of vitamins **SO1.10** study of Biological importance **SO1.11** explain about Deficiencies		**1.9** types and source of vitamins? **1.10** Biological importance? **1.11 study of** Deficiencies?	
	SO1.12 Explain about disorders?		**1.12** Study of disorders?	

Suggested Sessional Work (SW):*anyone*	**SW1.1** Assignments	Write Study about definition and general properties of enzyme
	SW1.2 Mini Project	Write Study of Nomenclature and classification and function
	SW1.3 Other Activities (Specify)	Write the study of Biological importance.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	05	24

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
02ZO412 **2.** Understand functions of biomolecules and their role in metabolism by studying in biochemistry.	**SO2.1** define Structure Nomenclature, classification and biological importance of protein acids and ornithine cycle.	2.1 Qualitative estimations protein, carbohydrates and lipids.	**Unit-2 Metabolism, physiology and regulation** **2.1** Structure Nomenclature, classification and biological importance of protein.	2.1. Know about the Structure Nomenclature, classification and biological importance of protein.
	SO2.2 study of Metabolism: deamination, decarboxylation, transamination of amino	**2.2** Metabolism: glycogenesis, gluconeogenesis, glycolysis.	**2.2** Metabolism: deamination, decarboxylation, transamination of amino acids and ornithine cycle.	2.2. learn about the Metabolism: deamination, decarboxylation, transamination of amino acids and ornithine cycle.
	SO2.3 define Structure Nomenclature, classification and biological importance of carbohydrates	2.3 Structure Nomenclature, classification and biological importance of carbohydrates	**2.3** Structure Nomenclature, classification and biological importance of carbohydrates	2.3. learn about Structure Nomenclature, classification and biological importance of carbohydrates
	SO2.4 define Metabolism: glycogenesis, gluconeogenesis, glycolysis.		**2.4** Metabolism: glycogenesis.	2.4. Know about the Metabolism: glycogenesis, gluconeogenesis, glycolysis.
	SO2.5 Study of Structure Nomenclature, classification and biological importance of lipids.		**2.5** Structure Nomenclature, classification and biological importance of lipids	2.5. learn about the Structure Nomenclature, classification and biological importance of lipids
	SO2.6 study of Metabolism: beta oxidation of fatty acids.		**2.6** Metabolism: beta oxidation of fatty acids.	
	SO2.7 study of physiology of digestion**,** regulation and disorder **SO2.8** explain the BMR		**2.7** physiology of digestion? **2.8** study of BMR	
	SO2.9 explain about **thermoregulation**?		**2.9 study of** thermoregulation?	
	SO2.10 explain regulation and disorder?		**2.10** regulation and disorder?	
	SO2.11 explain about Metabolism: gluconeogenesis?		**2.11** Metabolism: gluconeogenesis	
	SO2.12 described Metabolism: glycolysis.?		**2.12** Metabolism: glycolysis.	

Suggested Sessional Work (SW):*anyone*	**SW2.1** Assignments	Write about the Structure Nomenclature, classification and biological importance of protein.
	SW2.2 Mini Project	Write about the Study of Structure Nomenclature, classification and biological importance of lipids
	SW2.3 Other Activities (Specify)	write the explain the BMR.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	08	01	07	28

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self-Learning(SL)
02ZO412 **.3.**Examine internal harmony of different body system by learning inherent disorder and deficiencies which is needed to maintain good health.	**SO3.1** Explain the mechanism – inspiration and expiration	3.1. Detection of ammonia, urea and uric acid.	**Unit-3 Respiration, Excretion and immune system** **3.1** mechanism – inspiration and expiration	3.1. Know about the mechanism – inspiration and expiration
	SO3.2 define the physiology- exchange and transport of gases	3.2. Estimation of haemoglobin using heam-ometer	**3.2** physiology- exchange and transport of gases	3.2. learn about physiology- exchange and transport of gases
	SO3.3 Explain the disorders- apnoea, hypoxia, asthma	3.3 physiology- urea, urine formation, and counter current mechanism	**3.3 study of** disorders- apnoea	3.3. Know about the disorders- apnoea, hypoxia, asthma
	SO3.4 Explain the physiology- urea , urine formation, and counter current mechanism	3.4 innate and acquired immunity	**3.4** physiology- urea , urine formation, and counter current mechanism	3.4. learn about the physiology- urea , urine formation, and counter current mechanism
	SO3.5 Explain the Osmoregulation		**3.5** Osmoregulation	3.5. Know about the Osmoregulation
	SO3.6 study of Innate and acquired immunity		**3.6** Innate and acquired immunity	3.6. learn about Innate and acquired immunity
	SO3.7 study of disorders-, hypoxia.		**3.7** study of disorders- ,hypoxia.	
	SO3.8 study of disorders- asthma		**3.8 study of** disorders- asthma	
	SO3.9 study of Antigen response		**3.9** study of Antigen response	3.7. study of Antigen response
	SO3.10 study of immune cells?		**3.10** study of immune cells?	
	SO3.11 explain about innate?		**3.11** study of innate?	
	SO3.12 explain immune globulins.		3.12 study of immune globulins.	

Suggested Sessional Work (SW): *anyone*		
	SW3.1 Assignments	Write about Explain the disorders- apnea, hypoxia, asthma
	SW3.2 Mini Project	Write about the the physiology- exchange and transport of gases.
	SW3.3 Other Activities (Specify)	write the study of Antigen response.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	12	10	01	06	29

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Classroom Instruction(CI)	Self-Learning(SL)
02ZO412 **.4.** Analysis about neuromuscular coordination and impulse conduction physiology.	**SO4.1** study of structure and types of Neurons	4.1. study of types of Neurons	**Unit-4 Neuromuscular co-ordination** **4.1** structure of Neurons	1. Read the structure and types of Neurons
	SO4.2 study of physiology of nerve impulse condition	4.2. study of Neuromuscular disorder- Alzheimer	**4.2** study of physiology of nerve impulse condition	2. study of physiology of nerve impulse condition
	SO4.3 Study of Neuromuscular disorder- epilepsy, Alzheimer	4.3. physiology of muscles contraction	**4.3** study of Neuromuscular disorder- epilepsy.	3. Understand the Neuromuscular disorder- epilepsy, Alzheimer
	SO4.4 explains types of Neurons	4.4. muscles contraction and its bio chemistry	**4.4** study of types of Neurons	4. learn about structure and types of muscles
	SO4.5 described Neuromuscular disorder- Alzheimer	4.5 structure of muscles	**4.5** study of Neuromuscular disorder- Alzheimer	5. Know about the physiology of muscles contraction and its bio chemistry
	SO4.6 explains Neuromuscular disorder- Parkinson disease.		**4.6** study of Neuromuscular disorder- Parkinson disease.	6. study of Muscular disorder – fatigue
	SO4.7 explains physiology of muscles contraction?		**4.7** physiology of muscles contraction?	
	SO4.8 explains structure of muscles?		**4.8** structure of muscles	
	SO4.9 Explains neurons?		**4.9** Explains neurons?	
	SO4.10 Understand the structure and types of muscles		**4.10** types of muscles	
	SO4.11 Explain the physiology of muscles contraction and its bio chemistry		**4.11** muscles contraction and its bio chemistry	
	SO4.12 Study of Muscular disorder – fatigue		4.12 Muscular disorder – fatigue	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Write about study of Study of Neuromuscular disorder- epilepsy, Alzheimer.
	SW4.2 Mini Project	Explain the Explain the physiology of muscles contraction and its bio chemistry.
	SW4.3 Other Activities (Specify)	write the Study of Muscular disorder – fatigue.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	12	00	01	08	21

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Classroom Instruction(CI)	Self-Learning(SL)
02ZO412 **.5.** Understand about hormonal balance and the effects of their responses on the body.	**SO5.1** Explain the structure of Definition and classification of Hormones.		**Unit-5 Hormones, endocrine system, and reproductive biology** **5.1** Definition and classification of Hormones.	1. Read the structure of Definition and classification of Hormones.
	SO5.2 study about mechanism of hormones action.		**5.2** mechanism of hormones action.	2. learn about about mechanism of hormones action.
	SO5.3 Identify Structure, function and disorder of pituitary gland.		**5.3** Structure, of pituitary gland.	3. learn about Structure, function and disorder of pituitary gland.
	SO5.4 Explain the Structure, function and disorder of thyroid and parathyroid gland.		**5.4** Structure, of thyroid and parathyroid gland.	4. Read the Structure, function and disorder of thyroid and parathyroid gland.
	SO5.5 study of Structure, function and disorder of adrenal gland.		**5.5** Structure, function and disorder of adrenal gland.	5. learn about Structure, function and disorder of adrenal gland.
	SO5.6 study of Structure, function and disorder of thymus gland		**5.6** Structure, function and disorder of thymus gland	6. study of Structure, function and disorder of thymus gland
	SO5.7 explains physiology of reproduction?		**5.7** physiology of reproduction	7. read the physiology of reproduction
	SO5.8 explains Sex hormones?		**5.8** Sex hormones	8. learn about Sex hormones
	SO5.9 described function of pituitary gland?		**5.9** function of pituitary gland.	
	SO5.10 described disorder of pituitary gland.		**5.10** disorder of pituitary gland.	
	SO5.11 described function of thyroid and parathyroid gland.		**5.11** function of thyroid and parathyroid gland.	
	SO5.12 described disorder of thyroid and parathyroid gland.		**5.12** disorder of thyroid and parathyroid gland.	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Explain the structure of Definition and classification of Hormones
	SW5.2 Mini Project	Explain the physiology of reproduction
	SW5.3 Other Activities (Specify)	Identify Sex hormones

Course duration (in hours) to attain Course Outcomes:

Course Title: Physiology and bio chemistry **Course Code:** 02ZO412

Course Outcomes(COs)	Class lecture (CI)	Laboratory Instruction(LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
02ZO412 **.1.** Develop deeper understanding of how organ function at different level i.e. from cellular to system level.	12	06	5	1	24
02ZO412 **.2.** Understand functions of biomolecules and their role in metabolism by studying biochemistry	12	06	5	1	24
02ZO412 **.3.**Examine internal harmony of different body system by learning inherent disorder and deficiencies which is needed to maintain good health.	12	08	7	1	26
02ZO412 **.4.** Analysis about neuromuscular coordination and impulse conduction physiology.	12	10	6	1	27
02ZO412 **.5.** Understand about hormonal balance and the effects of their responses on the body.	12	0	8	1	21
Total Hours	60	30	31	5	122

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Physiology and bio chemistry **Course Code:** 02ZO412

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
02ZO412 **.1.** Develop deeper understanding of how organ function at different level i.e. from cellular to system level.	3	3	2	1	9
02ZO412 **.2.** Understand functions of biomolecules and their role in metabolism by studying biochemistry	4	4	2	1	11
02ZO412 **.3.**Examine internal harmony of different body system by learning inherent disorder and deficiencies which is needed to maintain good health.	2	3	3	2	10
02ZO412 **.4.** Analysis about neuromuscular coordination and impulse conduction physiology.	3	5	1	1	10
02ZO412 **.5.** Understand about hormonal balance and the effects of their responses on the body.	5	4	1	0	10
Total Marks	**17**	**19**	**9**	**05**	**50**

***Legend*:A,** Apply;**An,** Analyze;**E,** Evaluate;**C,** Create

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1	Principles of Biochemistry A.L. Leininger & others Edition W.H. Freeman and Co. new York 2008
2	Textbook of Animal Physiology and Biochemistry H.R. Singh Vishal Publishing Co. 9th 2014
3	Immunology T.J. Kindt and Others Edition W.H. Freeman and Co. new York VIth 2006
4	A Textbook of Animal Physiology A.K. Berry Emkey Publication, Delhi 1991

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Demonstration
7. ICT Based teaching Learning
8. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Sc. Biology
Semester: 4th Semester
Course Title: Physiology and bio chemistry
Course Code: 02ZO412

CO/PO/PSO Mapping								
Course Outcome (Cos)	**Program Outcomes (POs)**					**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**
02ZO412 **.1.** Develop deeper understanding of how organ function at different level i.e. from cellular to system level.	1	2	3	2	1	2	2	3
02ZO412 **.2.** Understand functions of biomolecules and their role in metabolism by studying biochemistry	3	3	1	2	2	2	1	3
02ZO412 **.3.**Examine internal harmony of different body system by learning inherent disorder and deficiencies which is needed to maintain good health.	1	2	2	3	1	1	2	3
02ZO412 **.4.** Analysis about neuromuscular coordination and impulse conduction physiology.	3	1	1	3	2	1	2	3
02ZO412 **.5.** Understand about hormonal balance and the effects of their responses on the body.	2	2	1	3	3	1	1	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5 PSO 1,2,3	02ZO412 **.1.** Develop deeper understanding of how organ function at different level i.e. from cellular to system level.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	1.1,1.2,1.3	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9,1.10,1.11,1.12	1SL-1,2,3,4,5
PO 1,2,3,4,5 PSO 1,2,3	02ZO412 **.2.** Understand functions of biomolecules and their role in metabolism by studying biochemistry	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9 SO2.10 SO2.11 SO2.12	2.1, 2.2, 2.3	2.1,2.2,2.3,2.4,2.5, 2.6,2.7,2.8,2.9,2.10,2.11,2.12	2SL-1,2,3,4,5
PO 1,2,3,4,5 PSO 1,2,3	02ZO412 **.3.**Examine internal harmony of different body system by learning inherent disorder and deficiencies which is needed to maintain good health.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9 SO3.10 SO3.11 SO3.12	3.1,3.2,3.3,3	3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9,3.10,3.11,3.12	3SL-1,2,3,4,5,6,7
PO 1,2,3,4,5 PSO 1,2,3	02ZO412 **.4.** Analysis about neuromuscular coordination and impulse conduction physiology.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8 SO4.9 SO4.10 SO4.11 SO4.12	4.1,4.2,4.3,4.4,	4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9,4.10,4.11,4.12	4SL-1,2,3,4,5,6
PO 1,2,3,4,5 PSO 1,2,3	02ZO412 **.5.** Understand about hormonal balance and the effects of their responses on the body.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9 SO5.10 SO5.11 SO5.12		5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,5.9,5.10,5.11,5.12	5SL-1,2,3,4,5,6,7,8

B.Sc. IVth Semester

COURSE NAME: Transition elements, Chemi – energetic,Phase Equilibria
COURSE CODE: 02CH413

Course Code	Course Title	L	T	P	Total Credits
02CH413	**Transition elements, Chemi – energetic,Phase Equilibria**	3	1	2	6

Pre-requisite: Students must have fundamental knowledge of mathematics, valence shell electron pair repulsion theory and basic concepts of periodic table

Rationale: The students studying analytical chemistry should possess foundational understanding about basic mathematics, valence shell electron pair repulsion theory, and different concentration terms to understand the basic principle of chromatography and spectroscopic analysis.

Course Outcomes:

After the completion of this course, the learner willable to

02CH413.1: Explain the electronic configuration, oxidation states and magnetic behavior of d and f-block elements

02CH413.2: Describe the metal ligand bonding on the basis of VBT,CFTand LFT

02CH413.3:Discuss about the first, second and third law of thermodynamics and their applications

02CH413.4:Describe the various types of reference electrodes, electrochemical series, electrode potential and Nernst equation

02CH413.5: Apply their knowledge to explain the phase diagram of one and two component Systems

Transition elements, Chemi – energetic, Phase Equilibria

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(Paper-2)

CLO: - By the end of this course students must have had the subject chemistry in class =@ or equivalent

1. Chemistry of d & f-block Elements, Basic Concepts of Coordination Chemistry
2. Siereochemistry of Transition Metal Complexes.
3. Laws of Thermodynamics..
4. Concept of Phase Equilibrium with reference to Solid Solution, Liquid-Liquid Mixtures, Partially Miscible Liquids.
5. Basic Concepts of Electrochemistry.

UNIT-1

Chemistry of d-&f-block elements

Chemistry of Transition elements: First, Second andThirdTransitionseries.Generalgrouptrendswithspecialreferenceto-ElectronicConfiguration,CoordinationGeometry,Colour,VariableValency,Spectral,MagneticandCatalyticProperties,AbilitytoformComplexes.

ChemistryofInnerTransitionelements: LanthanidesandActinides,GeneralgrouptrendswithspecialreferencetoElectronicConfiguration,OxidationStates,Colour,SpectralandMagneticProperties.LanthanideContraction.SeparationofLanthanides(Ion-exchangemethodonly).Transuranicelements:GeneralIntroduction.

UNIT-2

Coordination. Chemistry „-,

Metal Ligand Bonding in Transition Metal Complexes

TypesofligandsCoordinationnumberOxidationstate,EAN,ValenceBondTheory(VBT).PostulatesandapplicationsforTetrahedral,SquareplanarandOctahedrahedralcomplexes.LimitationsofVBT.CrystalFieldTheory(CFT),PostulatesandapplicationofCrystalfieldtheory,splittingofd-orbitals:..Crystalfieldstabilisationenergy(CFSE),Factors'affectingthecrystalfieldparameters..Jahn-Tellertheorem.LigandfieldandMolecularOrbital(MO)Theory

Isomerism in coordination compounds:

Structuralisomerism-Ionization,Linkage,Coordination-LigandIsomerism.

Stereoisomerism:

Geometrical isomerism and Optical isomerism:

UNIT-3

Thermodynamics

First law of Thermodynamics.

Conceptofheat(Q),work(W),internalenergy(U),Statementoffirstlaw,Enthalpy(H),Relationbetweenheatcapacities.CalculationsofQ,W,internalenergychangeandenthalpychangeunderisothermalandadiabaticconditionsforReversible,IrreversibleandFree(idealandvanderWaals)expansionsofgases.JouleThomsoneffectanditstheory,Inversiontemperature.

Second Law of Thermodynamics.

Carnotcycle,Statementofthesecondlawofthermodynamics.'ConceptofEntropy,Calculationofentropychangefor,Reversibleandirreversibleprocesses,Conceptofresidualentropy,FreeEnergyFunctions:GibbsandHelmholtzeneizy..VariOonofentropy (S),Gibbsfreeenergy(G),workfunction(A)With'temperature(T)volume(V)&pressure(P).Freeenergychangeandspontaneity,Gibbs-Helmholtzequation.

Third Law of Thermodynamics : Statement of third law,Calculation of absolute entropy of substance

UNIT-4

Electrochemistry

Electrical Conduction in metals and in electrolyte solutions. Specific equivalent, and molar conductivity. Measurement of equivalent conductance Effect of dilution on conductivity. KohlialiSchlaw and its applications. Wea-kand 'Strong electrolytes: Theory of strong electrolytes, DebyeHuckel On Sager (DHO) theory and equation. Transport numbers 'Determination of transport numbers by Hitter Method and Moving boundary method. 'Nernst equation, Derivation and application of Nernst equation, Electrode

Reference electrodes

Standard hydrogen electrode,Quinhydrone electrode, Glass electrode, Calomel electrode.

Electrochemical series and its applications, Electrochemical cells

UNIT-5

Phase equilibrium

Concept of phases. Components and degrees of freedom. Thermodynamic derivation of Gibbs Phase Rule for reactive and non reactive systems. Clausius-Clapeyron equation and its applications to Solid- Liquid, Liquid-Vapourand Solid-Vapour equilibria. Phase diagram for one component systems with applications-Water and Sulphur.

Phase diagrams for systems of solid-liquid equilibria in volving-Eutectic, Congruent and In congruentmelting points.WaterandSulfursystem,Ag-PbandMg-Znsystem,NaC1-H20system.

Bi**nary solutions:** Raoult'sLaw, Ideal and Non-ideal or Azeotropic mixtures, Immiscible liquids, Steamdistillation.

SUGGESTEDWEBSOURCES:

1. https://nptel.ac.in/course.html
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
3. https://swayam.gov.in/explorer?category=Chemistry

MODEOFTRANSACTION:Lecture,demonstration,E-tutoring,discussion,assignments,quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite,MSPower-Point, Online Resources

Scheme of Studies:

Board ofStudy	CourseCode	Course Title	Scheme of studies (Hours/Week)						Total CreditsI
			Cl	T	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
Program Core(PCC)	**02CH413**	**Transition elements, Chemi – energetic,Phase Equilibria**	4	0	2	1	1	8	6

Legend: CI: ClassroomInstruction(Includesdifferentinstructionalstrategiesi.e.Lecture(L)andTutorial (T)andothers),

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LI: LaboratoryInstruction(IncludesPracticalperformancesinlaboratoryworkshop,fieldorotherlocationsusingdifferentinstructionalstrategies)
SW: SessionalWork(includesassignment,seminar,miniprojectetc.),
SL: SelfLearning
C: Credits.

Note:SW&SLhastobeplannedandperformedunderthecontinuousguidanceandfeedbackofteacherto ensure outcome of Learning.

Scheme of Assessment: Theory

Board of Study	Course Code	Course Title	**Scheme of Assessment(Marks)**						
			ProgressiveAssessment(RA)					**EndSemesterAssessment (ESA)**	**TotalMarks** (PRA+ESA)
			Class/HomeAssignment5number marksseach	Class Test2 (2bestoutof3) 10	Seminarone + Class activity	ClassAttendance (AT)	TotalMarks (CA+CT+SA+AT)		
DCC	02CH413	**Transition elements, Chemi – energetic,Phase Equilibria**	15	20	10	5	50	50	100

Course-Curriculum Detailing:
This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (Sos), culminating in the overall achievement of Course Outcomes (Cos) upon the course's conclusion.

Unit-1 (02CH413.1):

Chemistry of d-&f-block elements

Chemistry of Transition elements: First, Second and Third Transition series. General group trendswithspecialreferenceto-

ElectronicConfiguration,CoordinationGeometry,Colour,VariableValency,Spectral,MagneticandCatalyticProperties,AbilitytoformComplexes.

ChemistryofInnerTransitionelements: LanthanidesandActinides,GeneralgrouptrendswithspecialreferencetoElectronicConfiguration,OxidationStates,Colour,SpectralandMagneticProperties.LanthanideContraction.SeparationofLanthanides(Ion-exchangemethodonly).Transuranicelements:GeneralIntroduction.

formulae.

Activity	Appx Hrs
Cl	12
LI	6
SW	2
SL	1
Total	21

Session Outcomes (SOs)	LI	CI	SL
After the completion of topics students will be able to SO1.1 understand the concept of d block elements SO1.2 Restate the concept of f-block elements SO1.3 Overview of Oxidation States and magnetic properties SO1.4 Discuss about the Lanthanide and Actinide contraction	Synthesis of inorganic complexes • Preparation of potassium tri oxalate ferrate(III) • Preparation of tetra ammine copper (II) sulphate • Preparation of tetraammine carbonate Cobalt(III)nitrate	**Unit-1:Chemistry of d- & f-block elements** 1.1Chemistry of Transition elements: 1.2First, Second and Third Transition series. 1.3General group trends with special reference to- Electronic Configuration Coordination Geometry, 1.4Colour, Variable Valency, 1.5Spectral, Magnetic and Catalytic Properties, 1.6Ability to form Complexes. 1,7Chemistry of Inner Transition elements: 1.8Lanthanides and Actinides, 1.9General group trends with special reference to Electronic Configuration,	• Basic idea about d-block elements • Properties of f-block elements

SO1.5 Explain complex formation by metal-ligand bonding		1.10 Oxidation States, Colour, Spectral and Magnetic Properties. 1.11Lanthanide Contraction. Separation of Lanthanides (Ion-exchange method only). 1.12Transuranic elements: General Introduction	

SW-1SuggestedSessionalWork(SW):
Assignments: properties of 4d and 5d Transition metals
Mini Project: Software's for drawing structures and molecular formulae.
Other Activities (Specify):Basic idea about periodic table
Unit-2(02CH413.2):

CoordinationChemistry ,,-,

MetalLigandBondinginTransitionMetalComplexes

TypesofligandsCoordinationnumberOxidationstate,EAN,ValenceBondTheory(VBT):PostulatesandapplicationsforTetrahedral,SquareplanarandOctahedrahedralcomplexes.LimitationsofVBT.CrystalFieldTheory(CFT),PostulatesandapplicationofCrystalfieldtheory,splittingofd-orbitals:..Crystalfieldstabilisationenergy(CFSE),Factors'affectingthecrystalfieldparameters..Jahn-Tellertheorem.LigandfieldandMolecularOrbital(MO)Theory

Isomerism in coordination compounds:

Structuralisomerism-Ionization,Linkage,Coordination-LigandIsomerism.

Stereoisomerism:

Geometrical isomerism and Optical isomerism:

Activity	AppX Hrs
Cl	13
LI	6
SW	2
SL	1
Total	22

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)

After the completion of topics students will be able to **SO2.1**Restate the concept of ligand and types of ligand **SO2.2**Explain the Postulates of valence bond theory **SO2.3 Di**scuss splitting of d-orbitals **SO2.4**Discuss CFSE and pairing energy **SO2.5O**verview of ligand field theory	Synthesis of inorganic complexes • Preparation of Nickel(II)dmg • Preparation of copper (II)acetylacetonate • Preparation of Iron(III) acetylacetonate • • Determination of carbonate and hydroxide present in mixtur • Determination of carbonate and bicarbonate present in a mixture.	**UNIT- 2** **Coordination Chemistry** „- , ' , ' ' 2.1Metal Ligand Bonding in Transition Metal Complexes 2.2Types of ligands 2.3Coordination numberOxidation state, 2.4 EAN(Effective atomic number) 2.5Valence Bond Theory (VBT): Postulates and applications 2.6Limitations of VBT. 2.7Crystal Field Theory (CFT) 2.8 Postulates and application of Crystal field theory, 2.9splitting of d-orbitals:.. Crystal field stabilisation energy (CFSE) 2.10 Factors 'affecting the crystal field parameters.. 2.11 Jahn-Teller theorem. Ligand field and Molecular Orbital (MO) Theory **2.12**Isomerism in coordination compounds:	• Factors affecting CFSE • Isomerism in co-ordination compounds

SW-2 Suggested Sessional Work (SW):

Assignments: Presentation of experimental data and results, from the point of view of Metal-Ligand bonding

Mini Project: Synthesis of inorganic complexes and their applications

Other Activities (Specify): Determination of hybridization and geometry of some metal complexes

Unit-3 (02CH413.3):

Thermodynamics

First law of Thermodynamics.

Conceptofheat(Q),work(W),internalenergy(U),Statementoffirstlaw,Enthalpy(H),Relationbetweenheatcapacities.CalculationsofQ,W,internalenergychangeandenthalpychangeunderisothermalandadiabaticconditionsforReversible,IrreversibleandFree(idealandvanderWaals)expansionsofgases.JouleThomsoneffectanditstheory,Inversiontemperature.

SecondLawofThermodynamics.

Carnotcycle,Statementofthesecondlawofthermodynamics.'ConceptofEntropy,Calculationofentropychangefor,Reversibleandirreversibleprocesses,Conceptofresidualentropy,FreeEnergyFunctions:GibbsandHelmholtzeneizy..VariOonofentropy(S),Gibbsfreeenergy(G),workfunction(A)With'temperature(T)volume(V)&pressure(P).Freeenergychangeandspontaneity,Gibbs-Helmholtzequation.

ThirdLawofThermodynamics: Statementofthirdlaw,Calculationofabsoluteentropyofsubstance

Activity	AppX Hrs
Cl	11
LI	4
SW	2
SL	1
Total	18

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)

After the completion of topics students will be able to **SO3.1** Overview of enthalpy. Entropy and free energy **SO3.2**Discuss basic concept of thermodynamics **SO3.3**Explain Laws of Thermodynamics **SO3.4** **E**xplain conceptually the state function and path function **SO3.5**Describe Carnot cycle and efficiency of engine	Determination of enthalpy of following: • Determination of free alkali present in different soaps/detergents • Neutralization of hydrochloric acid with sodium hydroxide • Ionization of ethnic acid • Hydration of salts • Determination of enthalpy (endothermic and exothermic)of aqueous solution of salts	**UNIT-3Thermodynamics** 1.1First law of Thermodynamics. 1.2Concept of heat (Q), work (W), internal energy (U), 1.3Statement of first law, Enthalpy (H), Relation between heat capacities. 1.4Calculationsof Q, W, internal energy change and enthalpy change under isothermal and adiabaticconditions 1.5 for Reversible, Irreversible and Free (ideal and van der Waals) expansions of gases 1.6.Joule Thomson effect and its theory, Inversion temperature. 1.7Second Law of Thermodynamics. 1.8Carnot cycle, Statement of the second law of thermodynamics. 1.9'Concept of Entropy, Calculation of entropy change for ,Reversible and irreversible processes, 1.10Gibbs and Helmholtz energy..VariOon of entropy (S), Gibbs free energy (G), work function (A) With' temperature (T)volume (V) & pressure (P). Free energy changeand spontaneity, 1.11 Gibbs-Helmholtz equation. 1.12Third Law of Thermodynamics	• Gibbs free energy • Van't Hoff factors

SW-3 Suggested Sessional Work (SW):

Assignments: Concept of enthalpy,entropy and free energy

Mini Project:Thermodynamics of Ramjet

Other Activities (Specify): Numerical Problems on thermodynamics

Unit-4 (02CH413.4): Electrochemistry

Electrical Conduction in metals and in electrolyte solutions. Specifie equivalent, and molar conductivity. Measurement of equivalent conductance Effect of dilution on conductivity. KohlialiSchlaw and its applications. Wea kand 'Strongelectrolytes: Theory of strong electrolytes, Debye Huckel On Sager (DHO) theory and equation. Transport numbers 'Determination of transport numbers by Hitter Method and Moving boundary method. 'Nernst equation, Derivation and application of Nernst equation, Electrode

Reference electrodes

Standard hydrogen electrode, Qu in hydrone electrode,Glass electrode, Calomelel ectrode.

Electro chemical series and its applications, Electrochemical cells

Activity	AppX Hrs
Cl	13
LI	6
SW	2
SL	1
Total	21

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
After the completion of topics students will be able to **SO4.1**understand basics of Electrochemistry **SO4.2**Overview of strong ,weak electrolyte and cell notation **SO4.3** Disuss effect of dilution on conductivity **SO4.4**Explain the concept of reference electrodes **SO4.5 Di**scuss the concept of various cell	Qualitative Analysis • Identification by determination of the Rf values of the given organic / inorganic compounds by paper/ thin layer chromatography. • Systematic identification of organic compound by qualitative analysis	**Unit-4 (2CH101.4):** **Electrochemistry** 4.1 Electrical Conduction in metals and in electrolyte solutions. 4.2Specifie,,equivalent, and molar conductivity. Measurement of equivalent conductance 4.3 Effect of dilution on conductivity. 4.4KohlialiSch law and its applications .4.5Wea¯k and 'Strong electrolytes, Debye Huckel On Sager (DHO) theory and equation. 4.6Transport numbers' Determination of transport numbers by Hittorf Method and Moving boundary method. 4.7'Nernst equation, Derivation and 4.8application of Nernst equation 4.9**Referenceelectrodes**Standardhydrogenelectrode, 4.10Quinhydrone electrode, Glass electrode, Calomel electrode. 4.11Electrochemical series and its applications, 4.12Electrochemical cells	DebyeHuckelOnSager(DHO)theoryandequation. measurementofequivalentconductance

SW-4 Suggested Sessional Work (SW)

Assignment: Application of electrochemical series

Mini Project: Synthesis of green corrosion inhibitors
Other Activities (Specify): Mechanism of Rusting

Unit-5 (02CH413.5):
Phase equilibrium

Concept of phases. Components and degrees of freedom. Thermodynamic derivation of Gibbs Phase Rule for reactive and non reactive systems. Clausius-Clapeyron equation and its applications to Solid- Liquid, Liquid-Vapourand Solid-Vapour equilibria. Phase diagram for one component systems with applications-Water and Sulphur.

Phase diagrams for systems of solid-liquid equilibria in volving-Eutectic, Congruent and In congruentmelting points.WaterandSulfursystem,Ag-PbandMg-Znsystem,NaC1-H20system.

Bi**nary solutions:** Raoult'sLaw, Ideal and Non-ideal or Azeotropic mixtures, Immiscible liquids, Steamdistillation.

Activity	AppX Hrs
Cl	11
LI	6
SW	2
SL	1
Total	20

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
After the completion of topics students will be able to **SO5.**1 Understand Basics of water and Sulphur systems **SO5.2**Overview of vaporization and Sublimation curve	Phase equilibria: • Verification of Lambert-Beer Law • Determination of concentration of colored compounds (e.g. CuSO4, KMnO4) a)Construction of the phase diagram using cooling curves or ignition tube method: 1)Simple eutectic and 2)Congruently melting systems	**Unit-5Phase equilibrium** 5.1 Concept ofphasesComponents and degrees of freedom freedom.. 5.2Thermodynamic derivation of Gibbs Phase Rule for reactive and nonreactive systems. 5.3 Clausius-Clapeyronequation andits applicationsto Solid-	• Applications of one component systems • Positive and negative deviation

SO5.3 Apply the concept of Phase to evaluate the degree of freedom and triple point **SO5.**4 Idea about ideal and non ideal solution **SO5.5** Explain about the esthetic and congruent point	b)Distribution of acetic/benzoic acid between water and cyclohexane c)Purification/Separation of compounds by fractional distillation/Steam distillation	Liquid, Liquid-Vapour and Solid-Vapour equilibria. 5.4Phase diagram for one component systems 5.5 Water and Sulfur system, 5.6Ag-Pb and 5.7 Mg-Zn system, 5.8 NaC1-H_2O system. 5.9Binary solutions: Raoult's Law, 5.10Ideal and Non-ideal solutions .11Azeotropic mixtures, 5.12Immiscible liquids, Steam distillation.	

SW-5 Suggested Sessional Work (SW):
Assignments: Applications of two component Systems
Mini Project: Application of Phase diagrams in metallurgy and ceramics
Other Activities (Specify): Numerical Problems on Raoult's Law

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Laboratory Instruction (LI)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
02CH413.1: Explainthe electronic configuration,oxidation states and magnetic behavior of d and f-block elements	12	3	01	02	21
02CH413.2: Describe the metal ligand bonding on the basis of VBT,CFTand LFT	12		02	01	22
02CH413.3:Discuss aboutthefirst,secondandthirdlawofthermodynamics and their applications	11	4	02	01	18

02CH413.4:Describe the various types of reference electrodes,electrochemical series,electrode potential and Nernst equation	13	6	02	01	22
02CH413.5: Apply their knowledge to explain the phase diagram of one and two component Systems.	11	6	02	01	20
Total Hours	60	28	10	05	103

Suggestion for End Semester Assessment

SuggestedSpecificationTable(ForESA)

CO	UnitTitles	Marks Distribution			Total Marks
		R	U	A	
CO-1	**Chemistry of d-&f-blockelements**	03	01	01	05
CO-2	**Coordination Chemistry**	02	06	02	10
CO-3	**Thermodynamics**	03	04	03	10
CO-4	**Electrochemistry**	-02	08	05	15
CO-5	**Phaseequilibrium**	03	02	05	10
Total		13	21	16	50

Legend: R:Remember, U:Understand, A:Apply

The written examination of 50 marks will be held at theendof semesterfor Inorganic Chemistry

Note.DetailedAssessmentrubricneedtobepreparedbythecoursewiseteachersforabovetasks. Teacherscanalsodesigndifferenttasksasperrequirement,forendsemesterassessment.

SuggestedInstructional/ImplementationStrategies:

1. ImprovedLecture
2. Tutorial
3. CaseMethod
4. GroupDiscussion
5. RolePlay
6. Visitto NCL, CSIR laboratories
7. Demonstration

8. ICTBasedTeachingLearning(VideoDemonstration/TutorialsCBT ,Blog,Facebook,Twitter,Whatsapp,Mobile,Onlinesources)
9. Brainstorming

SuggestedLearningResources:

(a) Books:

S. No.	Title	Author	Publisher
1	Organic Chemistry, Sultan Chand and Sons. Delhi.	Soni PL,	Sultan Chand and Sons, . Delhi
2	Chemistry	Srivastava, S. S. Gehlot. A.S.	Ratan Prakashan Temple. Indore.
3	Inorganic Chemicals	Sing, DR, Saxena, G, Singh, B.	Shivlal Aggarwal & Company, Agra
4	Bioinorganic Chemistry	AK Das	Prentice-Hall
5	Inorganic chemistry	Gary L. Miessler	Pearson
6	Inorganic chemistry	VK Jaiswal	Shri Balaji
7	Elementary Organic Spectroscopy	Sharma Y.R.	S Chand, 2013
8	Elements Physical Chemistry	Peter Atkins	7Th Edition 2017
9	Textbook of Physical Chemistry	Glasstone, S	Macmillan, 1951.
10	Advanced Physical Chemistry	Bahl. A. & Bahal. B.S.	S. Chand. 2010

Suggested Web Sources:

1. https://celqusb.files.wordpress.com/2017/12/inorganic-chemistry-g-l-miessler-2014.pdf
2. https://www.slideshare.net/MANISHSAHU106/inert-and-labile-complexes
3. https://swayam.gov.in/explorer?category=Chemistry

Mode of Delivery: Lecture,demonstration,E-tutoring,discussion,assignments,quizzes, case study, power point;

LMS/ICT Tools: Digital Classrooms, DLMS, ZOOM, G-Suite,MSPower-Point, Online Resources.

AKS University

Faculty of Basic Science

Curriculum of B. Sc. (Honours / By Research) Program

(Revised as on 01 August 2023)

Course Title: Transition elements, Chemi – energetic,Phase Equilibria **Course Code: 02CH413**

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Knowledge	Research Aptitude	Communication	Problem Solving	Individual and Team	Investigation of	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and	The detailed	To integrate	understand, analyze,	Provide opportunitie
CO1: Explainthe electronic configuration,oxidation states and magnetic behavior of d and f-block elements.	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO2: Describe the metal ligand bonding on the basis of VBT,CFTand LFT	2	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3: Discuss aboutthefirst,secondandthirdlawofthermodynamics and their applications.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO4: Describe the various types of reference electrodes,electrochemical series,electrode potential and Nernst equation	2	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2

CO5: Apply their knowledge to explain the phase diagram of one and two component Systems	**2**	**-**	**-**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**3**	**1**	**3**

Legend: **1–Low,** **2–Medium,** **3–High**

AKS University

Faculty of Basic Science

Curriculum of B. Sc. (Honours / By Research) Program

(Revised as on 01 August 2023)

C0urse Curriculum Map:

POs &PSOsNo.	COs No. &	SOs No.	Laboratory Ins	Classroom Instru	Self Learnin
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1:explain basic structure of different	SO1.1SO1. SO1.5		Unit-1. **Chemistryof** 1.1,1.2,1.3,1.	• Basic idea • Properties
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO2:describe the pr sampling, precision,	SO2.1SO2. SO2.4 SO2.5		Unit-2 **Coordination** 2.1,2.2,2.3,2.4,2.5,2.	• Factors affe • Isomerism i
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3:explain thermo	SO3.1SO3. SO3.3 SO3.4 SO3.5		Unit-3 : **Thermodyn** 3.1, 3.2,3.3,3.4,3.5,3	• Gibbs fre • Van't Ho
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO4:**d**iscuss princip	SO4.1SO4. SO4.5		Unit-4 : **Electrochen** 4.1, 4.2,4.3,4.4,4.5,4	Debye HuckelC measurementof
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO5:discuss basic c on the basis of their	SO5.1SO5. SO5.5		Unit 5: **Phaseequilib** 5.1,5.2,5.3,5.4,5.5,	• Applicatio • Positive an

Curriculum Development Team:

1. Dr. Shailendra Yadav, HoD, Department of Chemistry, AKS University, Satna (M.P.).
2. Dr. Dinesh Kumar Mishra, Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
3. Dr. Samit Kumar,Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
4. Dr. Sushma Singh, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
5. Dr. Manoj Kumar Sharma, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).

6. Mr. Kanha Singh Tiwari,Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
7. Mrs. Nahid Usamani, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).

Program name	**Bachelor of Science (B.Sc.)- Biology**	
Semester	**4th**	
CourseCode:	**03BO421**	
Coursetitle:	**Industrial Botany**	Developer: **Paras Koshe**
Pre-requisite:	Student should have basic knowledge biology, botany economic and ethanobotany.	
Rationale:	Industrial botany is the commercial exploitation of plants by people; it contributes significantly to anthropology, biology, conservation, botany, and other fields of science. Economic plants are defined as being useful either directly, as in food, or indirectly, as products we use or that enhance the environment. This course will provide knowledge on plants and their parts in various industries. Students will get an idea to establish plant based natural product industry. This course will make the students self-reliant.	
CourseOutcomes (COs):	CO 1: Students should able to gain Comprehensive information on the use of plants in timber industry. CO 2: Understand and apply the concepts of economic botany and provide knowledge about leaf based industries. CO 3: Interpretate and learn the use of flowers in flower based industries. CO 4: Explain the industrial utility of fruits and seeds of various plants in fruits and seed based industries. CO 5: Acquire knowledge about the use of other parts of plants and to explain their significance in industries.	

Scheme of Studies:

Board ofStudy	CourseCode	CourseTitle	Scheme ofstudies (Hours/Week)					Total Credits(C) (L:T:P=3:0:1)
			Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
Generic Elective	**03BO421**	**Industrial Botany**	3	1	1	1	6	3+1=4

*Legends:*CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial(T) and others);
LI: Laboratory Instruction(Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
Generic Elective	**03BO421**	**Industrial Botany**	**15**	**20**	**5**	**5**	**5**	**50**	**50**	**100**

Unit I:	
Course-Curriculum: This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.	**ApproximateHours** **Item** | **Cl** | **LI** | **SW** | **SL** | **Total** **Approx.Hrs** | **9** | **04** | **01** | **02** | **16**

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO 1: Students should able to gain Comprehensive information on the use of plants in timber industry.	**SO1.**1 Explain the use of various plants in Timber Industry.	**LI1.1**: Preparation of Holi color's from locally available flowers.	**CI 1.1:** Plants in Timber Industry:	**SL 1.1:** learn the names of timber industries with place in your state.
	SO1.2 Describe various timber yielding trees of India	**LI1.2**: Preparation of food colors from locally available flowers.	**CI1.2:** timber yielding trees of India	**SL1.2:** Learn more about kattha and its use as well as medicinal importance.
	SO1.3: Illustrate timber yielding trees of India and their products		**CI1.3:** Timber yielding trees of India and their products	
	SO1.4: Understand about timber yielding tree i.e. Shisham		**CI1.4:** Timber yielding trees of India and their products (Shisham)	
	SO1.5: Students will be able to brief the use of Sal in textile industries.		**CI1.5:** Timber yielding trees of India and their products (Sal)	
	SO1.6: Discuss various strategies of obtaining Timber yielding trees of India and their products (Teak)		**CI1.6:** Timber yielding trees of India and their products (Teak)	
	SO1.7: Describe the use of Deodar tree in timber industry,		**CI1.7:** Timber yielding trees of India and their products (Deodar)	
	SO1.8: Understand how babool plant can be processed and utilised in timber industry.		CI1.8: Timber yielding trees of India and their products (Babool)	
	SO1.9 Elucidate about the processing of bamboo, Cane and Kattha in industry.		**CI1.9** Bamboo,Cane and Kattha Industry	

Suggested Sessional Work (SW): *anyone*	Assignments:	Discuss how timber yielding trees are useful to mankind.
	Mini Project:	Make a chart showing timber yielding plants and their products.
	Other Activities (Specify):	Write an article on status timber yielding industries in India.

Unit-II:

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

ApproximateHours

Item	Cl	LI	SW	SL	Total
Approx.Hrs	9	04	01	02	16

Course outcome (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO 2:: Understand and apply the concepts of economic botany and provide knowledge about leaf based industries.	**SO2.1** Define and describe about Leaf based Industries	**LI2.1**. Perfume extraction process by distillation method	**CI2.1** Leaf based Industries	**SL2.1:** Learn about the leaves of some other plant which are used in leaf industry. (not mentioned in your syllabus)
	SO2.2: Understand utility products of leaf of Palash.	**LI2.2:** Preparation and preservation techniques of jams, jellies and prickles.	**CI2.2:** Utility products of leaf (Palash)	**SL2.2:** Enhance your knowledge about the Tea industry and other beverage production.
	SO2.3 Explain about the utility products of leaf of Banana		**CI2.3** Utility products of leaf (Banana).	
	SO2.4: Illustrate the mechanism and processing of leaves to make tea in Tea Industry		**CI2.4:** Tea Industry	
	SO2.5 Gaining knowledge about the : production of various types of teas.		**CI2.5:** Production of various types of teas	
	SO2.6: Over viewing the process and steps in Leaf oil Industry in making mint and camphor.		**CI2.6:** Leaf oil Industry (Mint, Camphor).	
	SO2.7: Understand how Neem and Tulsi is processed to make oil from leaf in leaf oil industry.		**CI2.7:** Leaf oil Industry (Neem, Tulsi)	
	SO2.8: To learn about different methods of making oil from leaves of eucalyptus and lemon grass.		**CI2.8:** Leaf oil Industry (Eucalyptus and Lemon grass).	
	SO2.9. Analyze the importance of Kasoori Methi curry patta onion and Tejpatta leaves and their use as spices.		**CI2.9:** Leaves used as spices (Kasoori ,Meth,Curry patta Onion and Tejpatta)	

Suggested Sessional Work (SW): Anyone	**Assignments:**	Describe the various products of leaf oil industry.
	Mini Project:	Make a chart showing leaf based industry in your area. Also focus on tendu patta.
	Other Activities (Specify):	Compare between tea and coffee and good and ill effects of tea on human health.

Unit-III:	
Course-Curriculum: This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.	**ApproximateHours** **Item** | **Cl** | **LI** | **SW** | **SL** | **Total** **Approx.Hrs** | **9** | **04** | **01** | **03** | **17**

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO 3: Interpretate and learn the use of flowers in flower based industries	**SO 3.1:** Students should able to understand introduction and history of Flower based Industries.	**LI 3.1:** Extraction and preservation of juices (lemon and orange etc.)	**CI 3.1:** Flower based Industries	**SL 3.1:** Read the machine for : Flower based Industries
	SO 3.2: Learn how gulab (Rose) is used to make perfume products.	**LI 3.2:** Preparation of different types of teas (Tulsi tea, lemon tea etc.)	**CI 3.2:** Perfume products of Gulab	**SL 3.2:** learn more about various flowers used in making perfumes.
	SO 3.3 Understand the process and steps of perfume production by using Jasmine.		**CI 3.3** Perfume products of Jasmine.	**SL 3.3:** Read how plants produced colours are different from synthetic colours.
	SO 3.4 Describe the perfume products of Henna.		**CI 3.4** Perfume products of Henna.	
	SO 3.5 learn the advancement of Color industry in India,		**CI 3.5** Color industry	
	SO 3.6 Understand the importance of Food colors and their production and raw materials in color industry.		**CI 3.6** Color industry (Food colors).	
	SO 3.7 Learn about the holi colors and plant materials used to make holi colors in color industry.		**CI 3.7** Color industry (Holi colors).	
	SO 3.8 Understand the Fermentation process and its role in industrial botany.		**CI 3.8** Fermentation	
	SO 3.9 Explain various raw material used in fermentation industry with emphasis on mahua.		**CI 3.9** Raw material for Fermentation (Mahua).	

Suggested Sessional Work (SW): Anyone	**Assignments:**	Describe about the different types of perfume products and row materials used in making perfumes.
	Mini Project:	Try to extract oil from rose jasmine and mint in your laboratory by using Soxhlet extractor
	Other Activities (Specify):	Literature and presentation; on fermentation and flower based industry.

Unit-IV:

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx.Hrs	09	04	01	02	16

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO 4: Explain the industrial utility of fruits and seeds of various plants in fruits and seed based industries.	**SO4.1:** Students should able to understand introduction and history of Fruits and Seeds based Industries.	**LI4.1:** Identification, collection and extraction of oil yielding leaves	**CI4.1:**Introduction to Fruits and Seeds based Industries	**SL 4.1:** Learn basics of ethanobotany
	SO4.2: Describe the methods of making jams and jellies,	**LI4.2:** Identification, collection and specimen preparation of leafy spices.	**CI4.2:** Jams and Jellies	**SL4.2:** Learn about the fruits and their scientific names found in your locality.
	SO 4.3 Understand the process and steps of producing Juice , Sauce. and Pickles		**CI 4.3:** Juice, Sauce and Pickles.	
	SO 4.4 Brief sbout poha and Daal industry.		**CI 4.5** Poha and Daal Industry	
	SO4.5: Gain knowledge about Daal Industry.		**CI4.6:** Daal Industry	
	SO4.6: Understand how groundnuts are processed to extract oil in Edible Oil Industry.		**CI4.8** Edible Oil Industry (Groundnut)	
	SO4.9: Explain the use of soya bean in Edible Oil Industry		**CI4.9**: Edible Oil Industry (Soybean)	
	SO4.7: Analyze the raw materials and processing in Starch Industry.		**CI4.10**: Starch Industry	
	SO4.8: Describe the raw materials used in Glucose, and Dextrose Industry.		**CI4.11:** Glucose, and Dextrose Industry	
	SO4.9: Explain the products of Glucose and Dextrose Industry.		**CI4.12**: Glucose, and Dextrose Industry	

Suggested Sessional Work (SW): ***anyone***	**SW1.1 Assignments**	Explain importance of Fruits and Seeds based Industries
	SW1.2 Mini Project	Make a chart showing comparison between refined and non refined oil.
	SW1.3 Other Activities (Specify)	Try to make jams and jellies from different fruits in your lab or at home.

Unit-V:	
Course-Curriculum: This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.	**Approximate Hours** **Item** | **Cl** | **LI** | **SW** | **SL** | **Total** **Approx.Hrs** | **9** | **00** | **01** | **02** | **12**

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO 5: Acquire knowledge about the use of other parts of plants and to explain their significance in industries.	**SO5.1:** Analyze the functioning of other parts of plants based Industries		**CI5.1**: other parts of plants based Industries	**SL5.1**: Study in details about **:** Sugar and Jaggery Industries
	SO5.2: Learn how materials are processed in Sugar and Jaggery Industries		**CI5.2:** Sugar and Jaggery Industries	**SL5.2**: Study different funding agencies in your subject for a project
	SO 5.3 Students should able to gain knowledge about the products of Sugar and Jaggery Industries.		**CI 5.3** Sugar and Jaggery Industries	
	SO 5.4 Explain the working and processing of jute in Jute industry.		**CI 5.4** Jute industry	
	SO5.5: Describe various products of jute industry.		**CI5.5**: Jute industry	
	SO 5.6 Understand the making and producing agarbatti in Agarbatti stick making industry.		**CI 5.6** Agarbatti stick making industry	
	SO5.7: Define and describe project proposal preparation for establishment of an industry.		**CI5.8:** Project proposal preparation for establishment of an industry.	
	SO5.8 Explain various aspects of writing project proposal and give idea about recent research topics.		**CI5.9:** Project proposal preparation for establishment of an industry	
	SO5.9: Describe about grants and funding provider organizations of India		**CI5.10** Grants and funding provider organizations of India	

Suggested Sessional Work (SW): ***anyone***	**SW1.1 Assignments**	Explain project proposal preparation for establishment of an industry and also mention funding provider in life sciences.
	SW1.2 Mini Project	Try to make agarbatti or stick in lab or at home.
	SW1.3 Other Activities (Specify)	Visit nearby village and learn the raw process of jiggery production from sugarcane juice.

Course duration (in hours) to attain Course Outcomes
(Course title: Industrial Botany
(Course code :) 03BO421

Course Outcomes(COs)	Class lecture(CI)	LaboratoryInstruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO 1: Students should able to gain Comprehensive information on the use of plants in timber industry.	9	4	2	1	16
CO 2: Understand and apply the concepts of economic botany and provide knowledge about leaf based industries.	9	4	2	1	16
CO 3: Interpretate and learn the use of flowers in flower based industries.	9	4	3	1	17
CO 4: Explain the industrial utility of fruits and seeds of various plants in fruits and seed based industries.	9	4	2	1	16
CO 5: Acquire knowledge about the use of other parts of plants and to explain their significance in industries	9	0	2	1	12
Total Hours	45	16	11	05	77

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:
Course title: Industrial Botany
(Course code :) 03BO421

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
CO 1: Students should able to gain Comprehensive information on the use of plants in timber industry.	2	1	1	1	5
CO 2: Understand and apply the concepts of economic botany and provide knowledge about leaf based industries.	2	4	2	2	10
CO 3: Interpretate and learn the use of flowers in flower based industries.	3	5	5	2	15
CO 4: Explain the industrial utility of fruits and seeds of various plants in fruits and seed based industries.	2	3	3	2	10
CO 5: Acquire knowledge about the use of other parts of plants and to explain their significance in industries	5	4	1	0	10
Total Marks	**14**	**17**	**12**	**07**	**50**

Legend**: A**-Apply, **An-** Analyze, **E**- Evaluate, **C**- Create

Suggested learning Resources:

S.no.	Title	Author	Publisher	Edition & Year
1	Economic Botany, principles and Practice	Gerald E Wickens	Kluver Academic Publishers	1 & 2001
2	Economic Botany	Koochar S.L.	Cambridge University Press, UK	2 & 2016
3	Economic Botany	. Simpson, B.B. and Ogorzaly, M.C	Tata Macgray Hill Publisher	1 & 1986

Suggested online material:

1. https://krishi.icar.gov.in/jspui/bitstream/123456789/19815/1/Timber.pdf

2. file:///C:/Users/CSP/Downloads/7B.pdf

3. https://swsu.ru/sbornik-statey/pdf/11 chapter%202.pdf

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Visit to Cement Plant
7. Demonstration
8. ICT Based teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, WhatsApp, Mobile, Online sources)
9. Brainstorming

Program Title: B. Sc. Biology,4th SEM
Course Code**: 03BO421**
Course Title: **Industrial Botany**

CO/PO Mapping															
Course Outcome	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1: Students should able to gain Comprehensive information on the use of plants in timber industry	**3**	**1**	**3**	**2**	**1**	**1**	**2**	**-**	**2**	**-**	**1**	**-**	**2**	**1**	**3**
CO 2: Understand and apply the concepts of economic botany and provide knowledge about leaf based industries	**3**	**-**	**2**	**1**	**-**	**1**	**1**	**1**	**-**	**3**	**1**	**2**	**2**	**1**	**3**
CO 3: Interpretate and learn the use of flowers in flower based industries.	**2**	**2**	**2**	**2**	**2**	**1**	**-**	**2**	**3**	**1**	**1**	**2**	**1**	**2**	**3**
CO 4: Explain the industrial utility of fruits and seeds of various plants in fruits and seed based industries	**2**	**3**	**2**	**2**	**3**	**-**	**3**	**1**	**1**	**2**	**1**	**-**	**2**	**2**	**3**
CO 5: Acquire knowledge about the use of other parts of plants and to explain their significance in industries.	**1**	**2**	**1**	**-**	**3**	**3**	**1**	**2**	**2**	**3**	**1**	**2**	**1**	**3**	**1**
Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3															

Program Title: B. Sc. Biology, 4th Sem
Course Code: **03BO421**
Course Title: Industrial Botany

Course Curriculum Map:					
POs & PSOs No.	**COs No**	**SOs No.**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO 1:** Students should able to gain Comprehensive information on the use of plants in timber industry.	1.1, 1.2, 1.3, 1.4, 1.5, 1.5, 1.7, 1.8,1.9,	LI 1 LI 2	1.1, 1.2, 1.3, 1.4, 1.5, 1.5, 1.7, 1.8,1.9	1 SL-1,2
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO 2:** Understand and apply the concepts of economic botany and provide knowledge about leaf based industries.	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7,2.8,2.9,	LI 1 LI 2	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7,2.8,2.9	2 SL-1,2
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO 3:** Interpretate and learn the use of flowers in flower based industries.	3.1, 3.2, 3.3, 3.4 3.5,3.6, 3.7, 3.8, 3.9	LI 1 LI 2	3.1, 3.2, 3.3, 3.4 3.5,3.6, 3.7, 3.8, 3.9	3 SL-1,2,3
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO 4:** Explain the industrial utility of fruits and seeds of various plants in fruits and seed based industries.	4.1,4.2, 4.3, 4.4, 4.5, 4.6, 4.7,4.8,4.9,	LI 1 LI 2	4.1,4.2, 4.3, 4.4, 4.5, 4.6, 4.7,4.8,4.9	4 SL-1,2
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO5:** Acquire knowledge about the use of other parts of plants and to explain their significance in industries.	5.1, 5.2, 5.3,5.4, 5.5, 5.6, 5.7,5.8,5.9		5.1, 5.2, 5.3,5.4, 5.5, 5.6, 5.7,5.8,5.9	5 SL-1,2

Program Name	**Bachelor of Science (B.Sc.)- Biology**	
Semester	4th	
Course Code:	03ZO422	
Course title:	Physiology and bio chemistry	**Curriculum Developer**: Mr. AMIT BAGRI
Pre-requisite:	Student must have had the subject zoology in class B.Sc. I year.	
Rationale:	The present core course has been designed for the students studying in the subject of zoology at university level as per the UGC approved curriculum. The core course will cover the essential aspects of physiology and biochemistry comprising of introductory background of scope and history of physiology as well as biochemistry. Physiology is the branch of biology that deals with the normal functions of living organisms and their parts. Biochemistry is the branch of science which is concerned with the chemical and physicochemical processes that occur within living organisms. Physiology and biochemistry both are the very important branches of science which have their own significance in various fields including medical, paramedical, toxicology, pharmacy, cardiology and many more. Physiology itself contains vast number of branches such as blood physiology, renal physiology, reproductive physiology, neural physiology, muscle physiology etc., and these all branches specially focuses on how these organs work in coordination with each other and they also show division of labor. It helps us in understanding the functions of various organ systems of our body which is unavoidable if one wants to lead a healthy, disease-free life.	
Course Outcomes (COs):	03ZO422 **.1.** Develop deeper understanding of how organ function at different level i.e. from cellular to system level. 03ZO422 **.2.** Understand functions of biomolecules and their role in metabolism by studying biochemistry 03ZO422 **3.** Examine internal harmony of different body system by learning inherent disorder and deficiencies which is needed to maintain good health. 03ZO422 **.4.** Analysis about neuromuscular coordination and impulse conduction physiology. 03ZO422 **.5.** Understand about hormonal balance and the effects of their responses on the body.	

Scheme of Studies:

Board of Study	**Course Code**	**Course Title**	**Scheme of studies (Hours/Week)**					**Total Credits(C) (L:T:P=3:0:1)**
			Cl	LI	SW	SL	**Total Study Hours(CI+LI+SW+SL)**	
Generic Elective	03ZO422	Physiology and bio chemistry	4	4	1	1	10	3+1= 4

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)		
Generic Elective	03ZO422	Physiology and bio chemistry	**15**	**20**	**10**	**5**	**50**	**50**	**100**

Scheme of Assessment: Practical

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)		
Generic Elective	03ZO422	Physiology and bio chemistry	35	5	5	5	50	50	50

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	04	01	04	18

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction(CI)	Self-Learning (SL)
03ZO422 **.1.** Develop deeper understanding of how organ function at different level i.e. from cellular to system level.	**SO1.1** Explain the Contribution of charak	1.1 study of enzymatic activity of trypsin and lipase	**Unit-1 introduction and historical background of physiology and biochemistry** **1.1** Study of Contribution of charak	1. Explain the Contribution of charak
	SO1.2 Explain the Contribution of sushrut	1.2 Qualitative estimations protein, carbohydrates and lipids.	**1.2** Study of Contribution of sushrut	2. Explain the Contribution of sushrut
	SO1.3 define of Micro and macro molecules		**1.3** Study of Micro and macro molecules	3. learn about Micro and macro molecules
	SO1.4 Study about Water and buffer system		**1.4** Study of Water and buffer system	4. Learn about of Water and buffer system
	SO1.5 Study about definition and general properties of enzyme		**1.5** definition and general properties of enzyme?	
	SO1.6 Study of Nomenclature and classification and function		**1.6** Nomenclature and classification and function ?	
	SO1.7 study of Mechanism and regulation of enzyme action		**1.7** Mechanism and regulation of enzyme action?	
	SO1.8 study of Co- enzyme		**1.8** Study of Co- enzyme?	
	SO1.9 types and source of vitamins		**1.9** types and source of vitamins?	

Suggested Sessional Work (SW):*anyone*	**SW1.1** Assignments	Write Study about definition and general properties of enzyme
	SW1.2 Mini Project	Write Study of Nomenclature and classification and function
	SW1.3 Other Activities (Specify)	Write the study of Biological importance.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	04	01	04	18

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
03ZO422 **2.** Understand functions of biomolecules and their role in metabolism by studying in biochemistry.	**SO2.1** define Structure Nomenclature, classification and biological importance of protein acids and ornithine cycle.	2.1 Qualitative estimations protein, carbohydrates and lipids.	**Unit-2 Metabolism, physiology and regulation** **2.1** Structure Nomenclature, classification and biological importance of protein. .	1. Know about the Structure Nomenclature, classification and biological importance of protein.
	SO2.2 study of Metabolism: deamination, decarboxylation, transamination of amino	**2.2** Metabolism: glycogenesis, gluconeogenesis, glycolysis.	**2.2** Metabolism: deamination, decarboxylation, transamination of amino acids and ornithine cycle.	2. learn about the Metabolism: deamination, decarboxylation, transamination of amino acids and ornithine cycle.
	SO2.3 define Structure Nomenclature, classification and biological importance of carbohydrates		**2.3** Structure Nomenclature, classification and biological importance of carbohydrates	3. learn about Structure Nomenclature, classification and biological importance of carbohydrates
	SO2.4 define Metabolism: glycogenesis, gluconeogenesis, glycolysis.		**2.4** Metabolism: glycogenesis.	4. Know about the Metabolism: glycogenesis, gluconeogenesis, glycolysis.
	SO2.5 Study of Structure Nomenclature, classification and biological importance of lipids.		**2.5** Structure Nomenclature, classification and biological importance of lipids	
	SO2.6 study of Metabolism: beta oxidation of fatty acids.		**2.6** Metabolism: beta oxidation of fatty acids.	
	SO2.7 study of physiology of digestion**,** regulation and disorder **SO2.8** explain the BMR		**2.7** physiology of digestion? **2.8** study of BMR	
	SO2.9 explain about **thermoregulation**?		**2.9 study of** thermoregulation?	

Suggested Sessional Work (SW):*anyone*	**SW2.1** Assignments	Write about the Structure Nomenclature, classification and biological importance of protein.
	SW2.2 Mini Project	Write about the Study of Structure Nomenclature, classification and biological importance of lipids
	SW2.3 Other Activities (Specify)	write the explain the BMR.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	02	01	05	17

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self-Learning (SL)
03ZO422**.3.**Examine internal harmony of different body system by learning inherent disorder and deficiencies which is needed to maintain good health.	**SO3.1** Explain the mechanism – inspiration and expiration	3.1. Detection of ammonia, urea and uric acid.	**Unit-3 Respiration, Excretion and immune system** **3.1** mechanism – inspiration and expiration	1. Know about the mechanism – inspiration and expiration
	SO3.2 define the physiology- exchange and transport of gases		**3.2** physiology- exchange and transport of gases	2. learn about physiology- exchange and transport of gases
	SO3.3 Explain the disorders- apnea, hypoxia, asthma		**3.3 study of** disorders- apnea	3. Know about the disorders- apnea, hypoxia, asthma
	SO3.4 Expalin the physiology- urea , urine formation, and counter current mechanism		**3.4** physiology- urea , urine formation, and counter current mechanism	4. learn about the physiology- urea , urine formation, and counter current mechanism
	SO3.5 Explain the Osmoregulation		**3.5** Osmoregulation	5. Know about the Osmoregulation
	SO3.6 study of Innate and acquired immunity		**3.6** Innate and acquired immunity	
	SO3.7 study of disorders-, hypoxia.		**3.7** study of disorders- ,hypoxia.	
	SO3.8 study of disorders- asthma		**3.8 study of** disorders- asthma	
	SO3.9 study of Antigen response		**3.9** study of Antigen response	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Write about Explain the disorders- apnea, hypoxia, asthma
	SW3.2 Mini Project	Write about the the physiology- exchange and transport of gases.
	SW3.3 Other Activities (Specify)	write the study of Antigen response.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	09	06	01	06	22

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Classroom Instruction(CI)	Self-Learning(SL)
03ZO422 **.4.** Analysis about neuromuscular coordination and impulse conduction physiology.	**SO4.1** study of structure and types of Neurons	4.1. study of types of Neurons	**Unit-4 Neuromuscular co-ordination** **4.1** structure of Neurons	1. Read the structure and types of Neurons
	SO4.2 study of physiology of nerve impulse condition	4.2. study of Neuromuscular disorder- Alzheimer	**4.2** study of physiology of nerve impulse condition	2. study of physiology of nerve impulse condition
	SO4.3 Study of Neuromuscular disorder- epilepsy, Alzheimer	4.3. physiology of muscles contraction	**4.3** study of Neuromuscular disorder- epilepsy.	3. Understand the Neuromuscular disorder- epilepsy, Alzheimer
	SO4.4 explains types of Neurons		**4.4** study of types of Neurons	
	SO4.5 described Neuromuscular disorder- Alzheimer		**4.5** study of Neuromuscular disorder- Alzheimer	
	SO4.6 explains Neuromuscular disorder- Parkinson disease.		**4.6** study of Neuromuscular disorder- Parkinson disease.	
	SO4.7 explains physiology of muscles contraction?		**4.7** physiology of muscles contraction?	
	SO4.8 explains structure of muscles?		**4.8** structure of muscles	
	SO4.9 Explains neurons?		**4.9** Explains neurons?	
	SO4.10 Understand the structure and types of muscles		**4.10** types of muscles	4. learn about structure and types of muscles

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Write about study of Study of Neuromuscular disorder- epilepsy, Alzheimer.
	SW4.2 Mini Project	Explain the Explain the physiology of muscles contraction and its bio chemistry.
	SW4.3 Other Activities (Specify)	write the Study of Muscular disorder – fatigue.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	09	00	01	08	18

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Classroom Instruction(CI)	Self-Learning(SL)
03ZO422 **.5.** Understand about hormonal balance and the effects of their responses on the body.	**SO5.1** Explain the structure of Definition and classification of Hormones.		**Unit-5 Hormones, endocrine system, and reproductive biology** **5.1** Definition and classification of Hormones.	5.1. Read the structure of Definition and classification of Hormones.
	SO5.2 study about mechanism of hormones action.		**5.2** mechanism of hormones action.	5.2. learn about about mechanism of hormones action.
	SO5.3 Identify Structure, function and disorder of pituitary gland.		**5.3** Structure, of pituitary gland.	5.3. learn about Structure, function and disorder of pituitary gland.
	SO5.4 Explain the Structure, function and disorder of thyroid and parathyroid gland.		**5.4** Structure, of thyroid and parathyroid gland.	5.4. Read the Structure, function and disorder of thyroid and parathyroid gland.
	SO5.5 study of Structure, function and disorder of adrenal gland.		**5.5** Structure, function and disorder of adrenal gland.	5.5. learn about Structure, function and disorder of adrenal gland.
	SO5.6 study of Structure, function and disorder of thymus gland		**5.6** Structure, function and disorder of thymus gland	5.6. study of Structure, function and disorder of thymus gland
	SO5.7 explains physiology of reproduction?		**5.7** physiology of reproduction	7. read the physiology of reproduction
	SO5.8 explains Sex hormones?		**5.8** Sex hormones	8. learn about Sex hormones
	SO5.9 described function of pituitary gland?		**5.9** function of pituitary gland.	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Explain the structure of Definition and classification of Hormones
	SW5.2 Mini Project	Explain the physiology of reproduction
	SW5.3 Other Activities (Specify)	Identify Sex hormones

Course duration (in hours) to attain Course Outcomes:

Course Title: Physiology and bio chemistry **Course Code:** 03ZO422

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction(LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
03ZO422 **.1.** Develop deeper understanding of how organ function at different level i.e. from cellular to system level.	09	04	4	1	18
03ZO422 **.2.** Understand functions of biomolecules and their role in metabolism by studying biochemistry	09	04	4	1	18
03ZO422**.3.** Examine internal harmony of different body system by learning inherent disorder and deficiencies which is needed to maintain good health.	09	02	5	1	17
03ZO422 **.4.** Analysis about neuromuscular coordination and impulse conduction physiology.	09	06	6	1	22
03ZO422 **.5.** Understand about hormonal balance and the effects of their responses on the body.	09	0	8	1	18
Total Hours	45	16	27	5	93

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Physiology and bio chemistry **Course Code:** 03ZO422

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
03ZO422 **.1.** Develop deeper understanding of how organ function at different level i.e. from cellular to system level.	3	3	2	1	9
03ZO422**.2.** Understand functions of biomolecules and their role in metabolism by studying biochemistry	4	4	2	1	11
03ZO422 **.3.**Examine internal harmony of different body system by learning inherent disorder and deficiencies which is needed to maintain good health.	2	3	3	2	10
03ZO422 **.4.** Analysis about neuromuscular coordination and impulse conduction physiology.	3	5	1	1	10
03ZO422 **.5.** Understand about hormonal balance and the effects of their responses on the body.	5	4	1	0	10
Total Marks	**17**	**19**	**9**	**05**	**50**

***Legend*:A,** Apply;**An,** Analyze;**E,** Evaluate;**C,** Create

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1	Principles of Biochemistry A.L. Leininger & others Edition W.H. Freeman and Co. new York 2008
2	Textbook of Animal Physiology and Biochemistry H.R. Singh Vishal Publishing Co. 9th 2014
3	Immunology T.J. Kindt and Others Edition W.H. Freeman and Co. new York VIth 2006
4	A Textbook of Animal Physiology A.K. Berry Emkey Publication, Delhi 1991

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Demonstration
7. ICT Based teaching Learning
8. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Sc. Biology
Semester: 4th Semester
Course Title: Physiology and bio chemistry
Course Code: 03ZO422

CO/PO/PSO Mapping								
Course Outcome (Cos)	**Program Outcomes (POs)**					**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**
03ZO422 **.1.** Develop deeper understanding of how organ function at different level i.e. from cellular to system level.	1	2	3	2	1	2	2	3
03ZO422 **.2.** Understand functions of biomolecules and their role in metabolism by studying biochemistry	3	3	1	2	2	2	1	3
03ZO422 **.3.**Examine internal harmony of different body system by learning inherent disorder and deficiencies which is needed to maintain good health.	1	2	2	3	1	1	2	3
03ZO422 **.4.** Analysis about neuromuscular coordination and impulse conduction physiology.	3	1	1	3	2	1	2	3
03ZO422 **.5.** Understand about hormonal balance and the effects of their responses on the body.	2	2	1	3	3	1	1	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5 PSO 1,2,3	03ZO422 **.1.** Develop deeper understanding of how organ function at different level i.e. from cellular to system level.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9	1.1,1.2	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9	1SL-1,2,3,4
PO 1,2,3,4,5 PSO 1,2,3	03ZO422 **.2.** Understand functions of biomolecules and their role in metabolism by studying biochemistry	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9	2.1, 2.2	2.1,2.2,2.3,2.4,2.5, 2.6,2.7,2.8,2.9	2SL-1,2,3,4
PO 1,2,3,4,5 PSO 1,2,3	03ZO422 **.3.**Examine internal harmony of different body system by learning inherent disorder and deficiencies which is needed to maintain good health.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9	3.1,	3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9	3SL-1,2,3,4,5
PO 1,2,3,4,5 PSO 1,2,3	03ZO422 **.4.** Analysis about neuromuscular coordination and impulse conduction physiology.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8 SO4.9	4.1,4.2,4.3	4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9	4SL-1,2,3,4,5,6
PO 1,2,3,4,5 PSO 1,2,3	03ZO422 **.5.** Understand about hormonal balance and the effects of their responses on the body.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9		5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,5.9,5.10,5.11,5.12	5SL-1,2,3,4,5,6,7,8

AKS University

Faculty of Basic Science

Curriculum of B. Sc. (Honours / By Research) Program

(Revised as on 01 August 2023)

B.Sc. IVth Semester

COURSE NAME: Transition elements, Chemi – energetic,Phase Equilibria
COURSE CODE: 03CH423

Course Code	Course Title	L	T	P	Total Credits
03CH423	**Transition elements, Chemi – energetic, Phase Equilibria**	3	1	2	6

Pre-requisite: Students must have fundamental knowledge of mathematics, valence shell electron pair repulsion theory and basic concepts of periodic table

Rationale: The students studying analytical chemistry should possess foundational understanding about basic mathematics, valence shell electron pair repulsion theory, and different concentration terms to understand the basic principle of chromatography and spectroscopic analysis.

Course Outcomes:

After the completion of this course, the learner willable to

03CH423.1: Explain the electronic configuration, oxidation states and magnetic behavior of d and f-block elements

03CH423.2: Describe the metal ligand bonding on the basis of VBT,CFTand LFT

03CH423.3:Discuss about the first, second and third law of thermodynamics and their applications

03CH423.4:Describe the various types of reference electrodes, electrochemical series, electrode potential and Nernst equation

03CH423.5: Apply their knowledge to explain the phase diagram of one and two component Systems

Transition elements, Chemi – energetic, Phase Equilibria

AKS University

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Curriculum of B. Sc. (Honours / By Research) Program

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(Paper-2)

CLO: - By the end of this course students must have had the subject chemistry in class =@ or equivalent

1. Chemistry of d & f-block Elements, Basic Concepts of Coordination Chemistry
2. Siereochemistry of Transition Metal Complexes.
3. Laws of Thermodynamics..
4. Concept of Phase Equilibrium with reference to Solid Solution, Liquid-Liquid Mixtures, Partially Miscible Liquids.
5. Basic Concepts of Electrochemistry.

UNIT-1

Chemistry of d-&f-block elements

Chemistry of Transition elements: First, Second andThirdTransitionseries.Generalgrouptrendswithspecialreferenceto-ElectronicConfiguration,CoordinationGeometry,Colour,VariableValency,Spectral,MagneticandCatalyticProperties,AbilitytoformComplexes.

ChemistryofInnerTransitionelements: LanthanidesandActinides,GeneralgrouptrendswithspecialreferencetoElectronicConfiguration,OxidationStates,Colour,SpectralandMagneticProperties.LanthanideContraction.SeparationofLanthanides(Ion-exchangemethodonly).Transuranicelements:GeneralIntroduction.

UNIT-2

Coordination. Chemistry „-,

Metal Ligand Bonding in Transition Metal Complexes

TypesofligandsCoordinationnumberOxidationstate,EAN,ValenceBondTheory(VBT).PostulatesandapplicationsforTetrahedral,SquareplanarandOctahedrahedralcomplexes.LimitationsofVBT.CrystalFieldTheory(CFT),PostulatesandapplicationofCrystalfieldtheory,splittingofd-orbitals:..Crystalfieldstabilisationenergy(CFSE),Factors'affectingthecrystalfieldparameters..Jahn-Tellertheorem.LigandfieldandMolecularOrbital(MO)Theory

Isomerism in coordination compounds:

Structuralisomerism-Ionization,Linkage,Coordination-LigandIsomerism.

Stereoisomerism:

Geometrical isomerism and Optical isomerism:

UNIT-3

Thermodynamics

First law of Thermodynamics.

Conceptofheat(Q),work(W),internalenergy(U),Statementoffirstlaw,Enthalpy(H),Relationbetweenheatcapacities.CalculationsofQ,W,internalenergychangeandenthalpychangeunderisothermalandadiabaticconditionsforReversible,IrreversibleandFree(idealandvanderWaals)expansionsofgases.JouleThomsoneffectanditstheory,Inversiontemperature.

Second Law of Thermodynamics.

Carnotcycle,Statementofthesecondlawofthermodynamics.'ConceptofEntropy,Calculationofentropychangefor,Reversibleandirreversibleprocesses,Conceptofresidualentropy,FreeEnergyFunctions:GibbsandHelmholtzeneizy..VariOonofentropy (S),Gibbsfreeenergy(G),workfunction(A)With'temperature(T)volume(V)&pressure(P).Freeenergychangeandspontaneity,Gibbs-Helmholtzequation.

Third Law of Thermodynamics : Statement of third law,Calculation of absolute entropy of substance

UNIT-4

Electrochemistry

Electrical Conduction in metals and in electrolyte solutions. Specific equivalent, and molar conductivity. Measurement of equivalent conductance Effect of dilution on conductivity. KohlialiSchlaw and its applications. Wea-kand 'Strong electrolytes: Theory of strong electrolytes, DebyeHuckel On Sager (DHO) theory and equation. Transport numbers 'Determination of transport numbers by Hitter Method and Moving boundary method. 'Nernst equation, Derivation and application of Nernst equation, Electrode

Reference electrodes

Standard hydrogen electrode,Quinhydrone electrode, Glass electrode, Calomel electrode.

Electrochemical series and its applications, Electrochemical cells

UNIT-5

Phase equilibrium

Concept of phases. Components and degrees of freedom. Thermodynamic derivation of Gibbs Phase Rule for reactive and non reactive systems. Clausius-Clapeyron equation and its applications to Solid- Liquid, Liquid-Vapourand Solid-Vapour equilibria. Phase diagram for one component systems with applications-Water and Sulphur.

Phase diagrams for systems of solid-liquid equilibria in volving-Eutectic, Congruent and In congruentmelting points.WaterandSulfursystem,Ag-PbandMg-Znsystem,NaC1-H20system.

Bi**nary solutions:** Raoult'sLaw, Ideal and Non-ideal or Azeotropic mixtures, Immiscible liquids, Steamdistillation.

SUGGESTEDWEBSOURCES:

1. https://nptel.ac.in/course.html
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
3. https://swayam.gov.in/explorer?category=Chemistry

MODEOFTRANSACTION:Lecture,demonstration,E-tutoring,discussion,assignments,quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite,MSPower-Point, Online Resources

Scheme of Studies:

Board ofStudy	CourseCode	Course Title	Scheme of studies (Hours/Week)						Total CreditsI
			Cl	T	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
Program Core(PCC)	**03CH423**	**Transition elements, Chemi – energetic,Phase Equilibria**	4	0	2	1	1	8	6

Legend: CI: ClassroomInstruction(Includesdifferentinstructionalstrategiesi.e.Lecture(L)andTutorial (T)andothers),

LI: LaboratoryInstruction(IncludesPracticalperformancesinlaboratoryworkshop,fieldorotherlocationsusingdifferentinstructionalstrategies)
SW: SessionalWork(includesassignment,seminar,miniprojectetc.),
SL: SelfLearning
C: Credits.

Note:SW&SLhastobeplannedandperformedunderthecontinuousguidanceandfeedbackofteacherto ensure outcome of Learning.

Scheme of Assessment: Theory

Board of Study	Course Code	Course Title	**Scheme of Assessment(Marks)**						
			ProgressiveAssessment(RA)					**EndSemesterAssessment (ESA)**	**TotalMarks** (PRA+ESA)
			Class/HomeAssignment5number marksseach	Class Test2 (2bestoutof3) 10	Seminarone + Class activity	ClassAttendance (AT)	TotalMarks (CA+CT+SA +AT)		
DCC	03CH423	**Transition elements, Chemi – energetic,Phase Equilibria**	15	20	10	5	50	50	100

Course-Curriculum Detailing:
This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (Sos), culminating in the overall achievement of Course Outcomes (Cos) upon the course's conclusion.

Unit-1 (03CH423.1):

Chemistry of d-&f-block elements

Chemistry of Transition elements: First, Second and Third Transition series. General group trendswithspecialreferenceto-

ElectronicConfiguration,CoordinationGeometry,Colour,VariableValency,Spectral,MagneticandCatalyticProperties,AbilitytoformComplexes.

ChemistryofInnerTransitionelements: LanthanidesandActinides,GeneralgrouptrendswithspecialreferencetoElectronicConfiguration,OxidationStates,Colour,SpectralandMagneticProperties.LanthanideContraction.SeparationofLanthanides(Ion-exchangemethodonly).Transuranicelements:GeneralIntroduction.

formulae.

Activity	Appx Hrs
Cl	12
LI	6
SW	2
SL	1
Total	21

Session Outcomes (SOs)	LI	CI	SL
After the completion of topics students will be able to SO1.1 understand the concept of d block elements SO1.2 Restate the concept of f-block elements SO1.3 Overview of Oxidation States and magnetic properties SO1.4 Discuss about the Lanthanide and Actinide contraction	Synthesis of inorganic complexes • Preparation of potassium tri oxalate ferrate(III) • Preparation of tetra ammine copper (II) sulphate • Preparation of tetraammine carbonate Cobalt(III)nitrate	**Unit-1:Chemistry of d- & f-block elements** 1.1Chemistry of Transition elements: 1.2First, Second and Third Transition series. 1.3General group trends with special reference to- Electronic Configuration Coordination Geometry, 1.4Colour, Variable Valency, 1.5Spectral, Magnetic and Catalytic Properties, 1.6Ability to form Complexes. 1,7Chemistry of Inner Transition elements: 1.8Lanthanides and Actinides, 1.9General group trends with special reference to Electronic Configuration,	• Basic idea about d-block elements • Properties of f-block elements

SO1.5 Explain complex formation by metal-ligand bonding		1.10 Oxidation States, Colour, Spectral and Magnetic Properties. 1.11Lanthanide Contraction. Separation of Lanthanides (Ion-exchange method only). 1.12Transuranic elements: General Introduction	

SW-1SuggestedSessionalWork(SW):
Assignments: properties of 4d and 5d Transition metals
Mini Project: Software's for drawing structures and molecular formulae.
Other Activities (Specify):Basic idea about periodic table
Unit-2(03CH423.2):

CoordinationChemistry ,,-,

MetalLigandBondinginTransitionMetalComplexes

TypesofligandsCoordinationnumberOxidationstate,EAN,ValenceBondTheory(VBT).PostulatesandapplicationsforTetrahedral,SquareplanarandOctahedrahedralcomplexes.LimitationsofVBT.CrystalFieldTheory(CFT),PostulatesandapplicationofCrystalfieldtheory,splittingofd-orbitals:..Crystalfieldstabilisationenergy(CFSE),Factors'affectingthecrystalfieldparameters..Jahn-Tellertheorem.LigandfieldandMolecularOrbital(MO)Theory

Isomerism in coordination compounds:

Structuralisomerism-Ionization,Linkage,Coordination-LigandIsomerism.

Stereoisomerism:

Geometrical isomerism and Optical isomerism:

Activity	AppX Hrs
Cl	13
LI	6
SW	2
SL	1
Total	22

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)

After the completion of topics students will be able to **SO2.1**Restate the concept of ligand and types of ligand **SO2.2**Explain the Postulates of valence bond theory **SO2.3 Di**scuss splitting of d-orbitals **SO2.4**Discuss CFSE and pairing energy **SO2.5O**verview of ligand field theory	Synthesis of inorganic complexes • Preparation of Nickel(II)dmg • Preparation of copper (II)acetylacetonate • Preparation of Iron(III) acetylacetonate • • Determination of carbonate and hydroxide present in mixtur • Determination of carbonate and bicarbonate present in a mixture.	**UNIT- 2** **Coordination Chemistry** „- , ' , ' ' 2.1Metal Ligand Bonding in Transition Metal Complexes 2.2Types of ligands 2.3Coordination numberOxidation state, 2.4 EAN(Effective atomic number) 2.5Valence Bond Theory (VBT): Postulates and applications 2.6Limitations of VBT. 2.7Crystal Field Theory (CFT) 2.8 Postulates and application of Crystal field theory, 2.9splitting of d-orbitals:.. Crystal field stabilisation energy (CFSE) 2.10 Factors 'affecting the crystal field parameters.. 2.11 Jahn-Teller theorem. Ligand field and Molecular Orbital (MO) Theory **2.12**Isomerism in coordination compounds:	• Factors affecting CFSE • Isomerism in co-ordination compounds

SW-2 Suggested Sessional Work (SW):

Assignments: Presentation of experimental data and results, from the point of view of Metal-Ligand bonding

Mini Project: Synthesis of inorganic complexes and their applications

Other Activities (Specify): Determination of hybridization and geometry of some metal complexes

Unit-3 (03CH423.3):

Thermodynamics

First law of Thermodynamics.

Conceptofheat(Q),work(W),internalenergy(U),Statementoffirstlaw,Enthalpy(H),Relationbetweenheatcapacities.CalculationsofQ,W,internalenergychangeandenthalpychangeunderisothermalandadiabaticconditionsforReversible,IrreversibleandFree(idealandvanderWaals)expansionsofgases.JouleThomsoneffectanditstheory,Inversiontemperature.

SecondLawofThermodynamics.

Carnotcycle,Statementofthesecondlawofthermodynamics.'ConceptofEntropy,Calculationofentropychangefor,Reversibleandirreversibleprocesses,Conceptofresidualentropy,FreeEnergyFunctions:GibbsandHelmholtzeneizy..VariOonofentropy(S),Gibbsfreeenergy(G),workfunction(A)With'temperature(T)volume(V)&pressure(P).Freeenergychangeandspontaneity,Gibbs-Helmholtzequation.

ThirdLawofThermodynamics: Statementofthirdlaw,Calculationofabsoluteentropyofsubstance

Activity	AppX Hrs
Cl	11
LI	4
SW	2
SL	1
Total	18

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)

After the completion of topics students will be able to **SO3.1** Overview of enthalpy. Entropy and free energy **SO3.2**Discuss basic concept of thermodynamics **SO3.3**Explain Laws of Thermodynamics **SO3.4** **E**xplain conceptually the state function and path function **SO3.5**Describe Carnot cycle and efficiency of engine	Determination of enthalpy of following: • Determination of free alkali present in different soaps/detergents • Neutralization of hydrochloric acid with sodium hydroxide • Ionization of ethnic acid • Hydration of salts • Determination of enthalpy (endothermic and exothermic)of aqueous solution of salts	**UNIT-3Thermodynamics** 1.1First law of Thermodynamics. 1.2Concept of heat (Q), work (W), internal energy (U), 1.3Statement of first law, Enthalpy (H), Relation between heat capacities. 1.4Calculationsof Q, W, internal energy change and enthalpy change under isothermal and adiabaticconditions 1.5 for Reversible, Irreversible and Free (ideal and van der Waals) expansions of gases 1.6.Joule Thomson effect and its theory, Inversion temperature. 1.7Second Law of Thermodynamics. 1.8Carnot cycle, Statement of the second law of thermodynamics. 1.9'Concept of Entropy, Calculation of entropy change for ,Reversible and irreversible processes, 1.10Gibbs and Helmholtz energy..VariOon of entropy (S), Gibbs free energy (G), work function (A) With' temperature (T)volume (V) & pressure (P). Free energy changeand spontaneity, 1.11 Gibbs-Helmholtz equation. 1.12Third Law of Thermodynamics	• Gibbs free energy • Van't Hoff factors

SW-3 Suggested Sessional Work (SW):

Assignments: Concept of enthalpy,entropy and free energy

Mini Project:Thermodynamics of Ramjet

Other Activities (Specify): Numerical Problems on thermodynamics

Unit-4 (03CH423.4): Electrochemistry

Electrical Conduction in metals and in electrolyte solutions. Specifie equivalent, and molar conductivity. Measurement of equivalent conductance Effect of dilution on conductivity. KohlialiSchlaw and its applications. Wea-kand 'Strongelectrolytes: Theory of strong electrolytes, Debye Huckel On Sager (DHO) theory and equation. Transport numbers 'Determination of transport numbers by Hitter Method and Moving boundary method. 'Nernst equation, Derivation and application of Nernst equation, Electrode

Reference electrodes

Standard hydrogen electrode, Qu in hydrone electrode,Glass electrode, Calomelel ectrode.

Electro chemical series and its applications, Electrochemical cells

Activity	AppX Hrs
Cl	13
LI	6
SW	2
SL	1
Total	21

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
After the completion of topics students will be able to **SO4.1**understand basics of Electrochemistry **SO4.2**Overview of strong ,weak electrolyte and cell notation **SO4.3** Disuss effect of dilution on conductivity **SO4.4**Explain the concept of reference electrodes **SO4.5 Di**scuss the concept of various cell	Qualitative Analysis • Identification by determination of the Rf values of the given organic / inorganic compounds by paper/ thin layer chromatography. • Systematic identification of organic compound by qualitative analysis	**Unit-4 (2CH101.4):** **Electrochemistry** 4.1 Electrical Conduction in metals and in electrolyte solutions. 4.2Specifie,,equivalent, and molar conductivity. Measurement of equivalent conductance 4.3 Effect of dilution on conductivity. 4.4KohlialiSch law and its applications .4.5Wea¯k and 'Strong electrolytes, Debye Huckel On Sager (DHO) theory and equation. 4.6Transport numbers' Determination of transport numbers by Hittorf Method and Moving boundary method. 4.7'Nernst equation, Derivation and 4.8application of Nernst equation 4.9**Referenceelectrodes**Standardhydrogenelectrode, 4.10Quinhydrone electrode, Glass electrode, Calomel electrode. 4.11Electrochemical series and its applications, 4.12Electrochemical cells	DebyeHuckelOnSager(DHO)theoryandequation. measurementofequivalentconductance

SW-4 Suggested Sessional Work (SW)

Assignment: Application of electrochemical series

Mini Project: Synthesis of green corrosion inhibitors
Other Activities (Specify): Mechanism of Rusting

Unit-5 (03CH423.5):
Phase equilibrium

Concept of phases. Components and degrees of freedom. Thermodynamic derivation of Gibbs Phase Rule for reactive and non reactive systems. Clausius-Clapeyron equation and its applications to Solid- Liquid, Liquid-Vapourand Solid-Vapour equilibria. Phase diagram for one component systems with applications-Water and Sulphur.

Phase diagrams for systems of solid-liquid equilibria in volving-Eutectic, Congruent and In congruentmelting points.WaterandSulfursystem,Ag-PbandMg-Znsystem,NaC1-H20system.

Bi**nary solutions:** Raoult'sLaw, Ideal and Non-ideal or Azeotropic mixtures, Immiscible liquids, Steamdistillation.

Activity	AppX Hrs
Cl	11
LI	6
SW	2
SL	1
Total	20

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
After the completion of topics students will be able to **SO5.**1 Understand Basics of water and Sulphur systems **SO5.2**Overview of vaporization and Sublimation curve	Phase equilibria: • Verification of Lambert-Beer Law • Determination of concentration of colored compounds (e.g. CuSO4, KMnO4) a)Construction of the phase diagram using cooling curves or ignition tube method: 1)Simple eutectic and 2)Congruently melting systems	**Unit-5Phase equilibrium** 5.1 Concept ofphasesComponents and degrees of freedom freedom.. 5.2Thermodynamic derivation of Gibbs Phase Rule for reactive and nonreactive systems. 5.3 Clausius-Clapeyronequation andits applicationsto Solid-	• Applications of one component systems • Positive and negative deviation

SO5.3 Apply the concept of Phase to evaluate the degree of freedom and triple point **SO5.**4 Idea about ideal and non ideal solution **SO5.5** Explain about the esthetic and congruent point	b)Distribution of acetic/benzoic acid between water and cyclohexane c)Purification/Separation of compounds by fractional distillation/Steam distillation	Liquid, Liquid-Vapour and Solid-Vapour equilibria. 5.4Phase diagram for one component systems 5.5 Water and Sulfur system, 5.6Ag-Pb and 5.7 Mg-Zn system, 5.8 NaC1-H_2O system. 5.9Binary solutions: Raoult's Law, 5.10Ideal and Non-ideal solutions .11Azeotropic mixtures, 5.12Immiscible liquids, Steam distillation.	

SW-5 Suggested Sessional Work (SW):
Assignments: Applications of two component Systems
Mini Project: Application of Phase diagrams in metallurgy and ceramics
Other Activities (Specify): Numerical Problems on Raoult's Law

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Laboratory Instruction (LI)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
03CH423.1: Explainthe electronic configuration,oxidation states and magnetic behavior of d and f-block elements	12	3	01	02	21
03CH423.2: Describe the metal ligand bonding on the basis of VBT,CFTand LFT	12		02	01	22
03CH423.3:Discuss aboutthefirst,secondandthirdlawofthermodynamics and their applications	11	4	02	01	18

03CH423.4:Describe the various types of reference electrodes,electrochemical series,electrode potential and Nernst equation	13	6	02	01	22
03CH423.5: Apply their knowledge to explain the phase diagram of one and two component Systems.	11	6	02	01	20
Total Hours	60	28	10	05	103

Suggestion for End Semester Assessment

SuggestedSpecificationTable(ForESA)

CO	UnitTitles	Marks Distribution			Total Marks
		R	U	A	
CO-1	**Chemistry of d-&f-blockelements**	03	01	01	05
CO-2	**Coordination Chemistry**	02	06	02	10
CO-3	**Thermodynamics**	03	04	03	10
CO-4	**Electrochemistry**	-02	08	05	15
CO-5	**Phaseequilibrium**	03	02	05	10
Total		13	21	16	50

Legend: R:Remember, U:Understand, A:Apply

The written examination of 50 marks will be held at theendof semesterfor Inorganic Chemistry

Note.DetailedAssessmentrubricneedtobepreparedbythecoursewiseteachersforabovetasks. Teacherscanalsodesigndifferenttasksasperrequirement,forendsemesterassessment.

SuggestedInstructional/ImplementationStrategies:

1. ImprovedLecture
2. Tutorial
3. CaseMethod
4. GroupDiscussion
5. RolePlay
6. Visitto NCL, CSIR laboratories
7. Demonstration

8. ICTBasedTeachingLearning(VideoDemonstration/TutorialsCBT ,Blog,Facebook,Twitter,Whatsapp,Mobile,Onlinesources)
9. Brainstorming

SuggestedLearningResources:

(a) Books:

S. No.	Title	Author	Publisher
1	Organic Chemistry, Sultan Chand and Sons. Delhi.	Soni PL,	Sultan Chand and Sons, . Delhi
2	Chemistry	Srivastava, S. S. Gehlot. A.S.	Ratan Prakashan Temple. Indore.
3	Inorganic Chemicals	Sing, DR, Saxena, G, Singh, B.	Shivlal Aggarwal & Company, Agra
4	Bioinorganic Chemistry	AK Das	Prentice-Hall
5	Inorganic chemistry	Gary L. Miessler	Pearson
6	Inorganic chemistry	VK Jaiswal	Shri Balaji
7	Elementary Organic Spectroscopy	Sharma Y.R.	S Chand, 2013
8	Elements Physical Chemistry	Peter Atkins	7Th Edition 2017
9	Textbook of Physical Chemistry	Glasstone, S	Macmillan, 1951.
10	Advanced Physical Chemistry	Bahl. A. & Bahal. B.S.	S. Chand. 2010

Suggested Web Sources:

1. https://celqusb.files.wordpress.com/2017/12/inorganic-chemistry-g-l-miessler-2014.pdf
2. https://www.slideshare.net/MANISHSAHU106/inert-and-labile-complexes
3. https://swayam.gov.in/explorer?category=Chemistry

Mode of Delivery: Lecture,demonstration,E-tutoring,discussion,assignments,quizzes, case study, power point;

LMS/ICT Tools: Digital Classrooms, DLMS, ZOOM, G-Suite,MSPower-Point, Online Resources.

AKS University

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Curriculum of B. Sc. (Honours / By Research) Program

(Revised as on 01 August 2023)

Course Title: Transition elements, Chemi – energetic,Phase Equilibria **Course Code: 03CH423**

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Knowledge	Research Aptitude	Communication	Problem Solving	Individual and Team	Investigation of	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and	The detailed	To integrate	understand, analyze,	Provide opportunitie
CO1: Explainthe electronic configuration,oxidation states and magnetic behavior of d and f-block elements.	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO2: Describe the metal ligand bonding on the basis of VBT,CFTand LFT	2	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3: Discuss aboutthefirst,secondandthirdlawofthermodynamics and their applications.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO4: Describe the various types of reference electrodes,electrochemical series,electrode potential and Nernst equation	2	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2

CO5: Apply their knowledge to explain the phase diagram of one and two component Systems	**2**	**-**	**-**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**3**	**1**	**3**

Legend: **1–Low,** **2–Medium,** **3–High**

AKS University

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C0urse Curriculum Map:

POs &PSOsNo.	COs No. &	SOs No.	Laboratory Ins	Classroom Instru	Self Learnin
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1:explain basic structure of different	SO1.1SO1. SO1.5		Unit-1. **Chemistryof** 1.1,1.2,1.3,1.	• Basic idea • Properties
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO2:describe the pr sampling, precision,	SO2.1SO2. SO2.4 SO2.5		Unit-2 **Coordination** 2.1,2.2,2.3,2.4,2.5,2.	• Factors affe • Isomerism i
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3:explain thermo	SO3.1SO3. SO3.3 SO3.4 SO3.5		Unit-3 : **Thermodyn** 3.1, 3.2,3.3,3.4,3.5,3	• Gibbs fre • Van't Ho
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO4:**d**iscuss princip	SO4.1SO4. SO4.5		Unit-4 : **Electrochen** 4.1, 4.2,4.3,4.4,4.5,4	Debye HuckelC measurementof
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO5:discuss basic c on the basis of their	SO5.1SO5. SO5.5		Unit 5: **Phaseequilib** 5.1,5.2,5.3,5.4,5.5,	• Applicatio • Positive an

Curriculum Development Team:

1. Dr. Shailendra Yadav, HoD, Department of Chemistry, AKS University, Satna (M.P.).
2. Dr. Dinesh Kumar Mishra, Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
3. Dr. Samit Kumar,Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
4. Dr. Sushma Singh, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
5. Dr. Manoj Kumar Sharma, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).

6. Mr. Kanha Singh Tiwari,Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
7. Mrs. Nahid Usamani, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).

Program Name	**Bachelor of Science (B.Sc.) -Biology**	
Semester	IV	
Course Code:	**0EN401**	
Course title:	Entrepreneurship Development	**Curriculum Developer**: Mr. Dhirendra Mishra, Teaching Associate
Pre-requisite:	Students should have basic knowledge of Entrepreneurship Development	
Rationale:	Entrepreneurs perform a vital function in economic development. They have been referred to as the human agents needed "to mobilize capital, to exploit natural resources, to create markets and to carry on trade". It might well be said that the entrepreneurial input spells the difference between prosperity and poverty among nations. Many economic theories emphasize the significant roles played by individual entrepreneurs as they combine talents, abilities, and drive to transform resources into profitable undertakings. Joseph Schumpeter, the first major writer to highlight the human agent in the process of economic development, believed that the economy was propelled by the activities of persons. Who wanted to promote new goods and new methods of production, or to exploit a new source of materials or new market not merely for profit but also to the purpose of creating.	
CourseOutcomes (COs):	**CO1-0EN401.1:** Basic aspects of establishing a business in a competitive environment **CO2-0EN401.2:** Apply the basic understanding to examine the existing business ventures **CO3-0EN401.3:** Examine various business considerations such as marketing, financial and teaming etc. **CO4-0EN401.4:** Assessing strategies for planning a business venture **CO5-0EN401.5:** Create business ideas that can drive the innovative society	

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits(C) (L:T:P=2:0:0)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Skill Enhancement Course	**0EN401**	Entrepreneurship Development	2	0	1	3	7	2+0=2

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)		
Skill Enhancement Course	**0EN401**	Entrepreneurship Development	15	20	10	5	50	50	100

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.	**Approximate Hours** **Item** Cl LI SW SL Total **Approx. Hrs** 05 00 01 04 10

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction(CI)**	**Self-Learning (SL)**
CO1-0EN401.1: Basic aspects of establishing a business in a competitive environment	**SO1.1** Aims and objectives of entrepreneurship		**Unit 1 Meaning of Entrepreneurship Development** **CI1.1** Needs and Importance of Entrepreneurship	**SL1.1** Visit various reference books and study material to start the learning of Entrepreneurship.
	SOI.2 Concept of Needs and Importance of Entrepreneurship		**CI1.2** Factors influencing entrepreneurship	**SL1.2** Promotion of entrepreneurship
	SOI.3 Know The process of Promotion of entrepreneurship		**CI1.3** Promotion of entrepreneurship	**SL1.3** Learn about Factors influencing entrepreneurship
	SOI.4 Understand Factors influencing entrepreneurship		**CI1.4** Factors influence entrepreneurship	**SL1.4** Establishing a business in a competitive environment
	SOI.5 Understand Features of a successful Entrepreneurship		**CI1.5** Features of a successful Entrepreneurship.	

Suggested Sessional Work (SW):*anyone*	**SW1.1** Assignments	Interview one successful and one unsuccessful entrepreneur in your place/location. Identify five major characteristics of both
	SW1.2 Mini Project	Meet one or two Government officials involved in the promotion of small enterprise. Ask them about the specific facilities the government offers to entrepreneurs to establish small-scale facilities. Also try to know the extent of use of these facilities by the entrepreneurs and major problems faced by them in this regard.
	SW1.3 Other Activities (Specify)	**Case study –N.R. Narayana Murthy**

Item	Cl	LI	SW	SL	Total
Approx. Hrs	05	00	01	02	08

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
CO2-0EN401.2: Apply the basic understanding to examine the existing business ventures .	**SO2.1** To understand aims and objective of enterprise.		**Unit-II** **CI2.1** Forms of Business Organization.	**SL2.1** Read the Process of Project Identification
	SO2.2 To describe various forms of business organization.		**CI2.2** Project Identification.	**SL2.2** Learn various steps of Selection of the product.
	SO2.3 To explain project identification.		**CI2.3** Selection of project.	
	SO2.4 To elaborate selection of product		**CI2.4** Project formulation.	
	SO2.5 Describe about various methods and techniques used for project feasibility		**CI2.5** Assessment of project feasibility.	

Suggested Sessional Work (SW):*anyone*	**SW2.1** Assignments	Suppose you propose two-three enterprise like travel agency in a tourist place like neonatal. Elaborate form of ownership you will chose and why?
	SW2.2 Mini Project	Selection of the product.
	SW2.3 Other Activities (Specify)	How an entrepreneurs do assessment of project feasibility

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	00	01	02	09

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO3-0EN401.3: Examine various business considerations such as marketing, financial and teaming etc.	**SO3.1** Explain the importance of finance.		**Unit-III** **CI3.1** Finance the enterprise Importance of finance.	**SL3.1** On the basis of extent of performance, financial needs are classified into fixed capital and working capital.
	SO3.2 Define and describe loan and repayment.		**CI3.2** General idea about loan and repayment.	**SL3.2** Capital structure is composition of long-term and short-term loans.
	SO3.3 Describe the characteristics of business finance.		**CI3.3** Characteristics of business finance.	
	SO3.4 Describe the fixes capital management.		**CI3.4** Fixed capital management.	
	SO3.5 Explain role of working capital in business.		**CI3.5** Working capital management.	
	SO3.6 Explain in detail Of inventory Define direct and indirect inventory.		**CI3.6** Inventory management.	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Issue of debenture is source of short term loans.
	SW3.2 Mini Project	Visit to an enterprise and find out its financial position whether it is over-capitalized or under – capitalized. Give your suggestion to correct the situation whatever be the case.
	SW3.3 Other Activities (Specify)	Find out some you tube videos based on financing the enterprise.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	08	00	01	03	12

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO4-0EN401.4: Assessing strategies for planning a business venture	**SO4.1** Describe the Marketing management.		**Unit-IV** **CI4.1** Marketing Management, Marketing mix	**SL4.1** Learn about marketing management.
	SO4.2 Explain the Marketing mix.		**CI4.2** Product management	**SL4.2** Discuss various steps of marketing mix based on self-study
	SO4.3 Evaluate the product line		**CI4.3** Product mix	**SL4.3** Learn about various types of distribution channel involves in Marketing management.
	SO4.4 Define and describe the product mix.		**CI4.4** Product line	
	SO4.5 Define the marketing research.		**CI4.5** Stages of Life cycle.	
	SO4.6 Describe the marketing research.		**CI4.6** Marketing research and importance of survey.	
	SO4.7 Stock management.		**CI4.7** Physical distribution	
	SO4.8 Stock management.		**CI4.8** stock management.	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Explain life cycle of product.
	SW4.2 Mini Project	Meet an entrepreneur running a manufacturing enterprise. Ask him how he/she took decision on marketing mix and prepare systematic report on the same.
	SW4.3 Other Activities (Specify)	Find out some you tube videos based on Marketing Management.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	00	01	03	10

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO5-0EN401.5: Create business ideas that can drive the innovative society	**SO5.1** Explain the Meaning of international business.		**Unit-V** **CI5.1** Meaning of international business,	**SL5.1** Find out the role of International market in terms of business.
	SO5.2 Express the view of selection of product for international business.		**CI5.2** Selection of product in for international business .	**SL5.2** Explore the various kinds of selection method for product selection in international market.
	SO5.3 Able to execute to perform the cultivation of fungi.		**CI5.3** Selection of product for international business	**SL5.3** Read research on advancement in fungi
	SO5.4 Evaluate the various selection methods of product selection for		**CI5.4** Selection of market for international business international business.	
	SO5.5 Describe the export fiancé process.		**CI5.5** Export financing,	
	SO5.6 Describe about institutions support for export.		**SL5.6** Institutional support for international business.	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Write about Institutional support for exports for international business.
	SW5.2 Mini Project	Make a list of financial institute those support for export and also write about their polices for export
	SW5.3 Other Activities (Specify)	Find out some you tube videos based on International business.

Course duration (in hours) to attain Course Outcomes:

Course Title: Entrepreneurship Development **Course Code: 0EN401**

Course Outcomes(COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1-0EN401.1: Basic aspects of establishing a business in a competitive environment	5	0	4	1	10
CO2-0EN401.2: Apply the basic understanding to examine the existing business ventures	5	0	2	1	8
CO3-0EN401.3: Examine various business considerations such as marketing, financial and teaming etc.	6	0	2	1	9
CO4-0EN401.4: Assessing strategies for planning a business venture	8	0	3	1	12
CO5-0EN401.5: Create business ideas that can drive the innovative society	6	0	3	1	10
Total Hours	30	00	14	05	49

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Entrepreneurship Development **Course Code: 0EN401**

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
CO1-0EN4015.1: Understand basic aspects of establishing a business in a competitive environment.	2	1	1	1	5
CO2-0EN401.2: Apply the basic understanding to examine the existing business ventures.	2	4	2	2	10
CO3-0EN4015.3: Examine various business considerations such as marketing, financial and teaming etc.	3	5	5	2	15
CO4-0EN401.4: Assessing strategies for planning a business venture	2	3	3	2	10
CO5-0EN401.5: Create business ideas that can drive the innovative society	5	4	1	0	10
Total Marks	**14**	**17**	**12**	**07**	**50**

***Legend*: A,** Apply; **An,** Analyze; **E,** Evaluate; **C,** Create

Suggested learning Resources:

(a) Books:

(b)

S.No.	Title/Author/Publisher details
1	Holt DH. Entrepreneurship: New Venture Creation
2	Kaplan JM Patterns of Entrepreneurship.
3	Gupta CB, Khanka SS. Entrepreneurship and Small Business Management, Sultan Chand & Sons

(c) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Industrial Visit.
7. Demonstration
8. ICT Based teaching Learning
9. Brainstorming

CO, PO and PSO Mapping

Program Name: Bachelor of Science B.Sc. Biology
Semester: IV Semester
Course Title: Entrepreneurship Development
Course Code: 0EN401

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

CO/PO Mapping															
Course Outcome	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1-0EN4015.1: Understand basic aspects of establishing a business in a competitive environment.	3	3	1	1	-	-	2	1	1	3	3	2	2	2	2
CO2-0EN401.2: Apply the basic understanding to examine the existing business ventures.	1	1	2	2	2	-	1	1	-	2	3	2	2	2	1
CO3-0EN401.3: Examine various business considerations such as marketing, financial and teaming etc.	1	3	2	3	2	-	-	2	3	1	1	2	3	3	1
CO4-0EN401.4: Assessing strategies for planning a business venture.	2	3	3	2	2	2	-	1	1	2	1	-	1	1	3
CO5-0EN401.5: Create business ideas that can drive the innovative society.	2	-	2	-	1	3	2	2	1	3	2	2	3	2	3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO1-0EN401.1:** Understand basic aspects of establishing a business in a competitive environment	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5		1.1,1.2,1.3,1.4,1.5	**1SL-1,2,3,4**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO2-0EN401.2:** Apply the basic understanding to examine the existing business ventures	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5		2.1, 2.2, 2.3, 2.4, 2.5,	**2SL-1,2**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO3-0EN401.3:** Examine various business considerations such as marketing, financial and teaming etc.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6		3.1,3.2,3.3,3.4,3.5 3.6	**3SL-1,2**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO4-0EN401.4:** Assessing strategies for planning a business venture.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8		4.1,4.2,4.3,4.4,4.5, 4.6,4.7, 4.8	**4SL-1,2,3**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO5-0EN401.5:** Create business ideas that can drive the innovative society.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6		5.1,5.2,5.3,5.4,5.5 5.6	**5SL-1,2,3**

Program Name	**Bachelor of Science (B.Sc.) Biology**	
Semester	IV	
Course Code:	0FS402	
Course title:	Basics of forensic science	**Curriculum Developer**: Chahana Desai, Teaching Associate
Pre-requisite:	Students should have basic knowledge and understanding about forensic biology and concept of forensic science.	
Rationale:	• Students will develop an understanding of the scientific principles of crime scene investigation and reconstruction, including evidence collection and preservation. • Students will receive intensive hands-on training in forensic laboratory methodologies with respect to the analysis of evidence. • Additionally, students will develop an understanding of the importance of the interaction between law enforcement, scientists and the legal profession.	
Course Outcomes (COs):	**CO1-0FS402.1:-** Elucidate the overview of forensic science. **CO2-0FS402.2:-** Acquire knowledge regarding causes of crime and types of injuries **CO3-0FS402.3:-** Applied knowledge about ballistics and handwriting examination. **CO4-0FS402.4:-** To gain the knowledge about toxicology and fingerprinting analysis. **CO5-0FS402.5:-** Elucidate the detailing of DNA profiling and cyber security.	

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme ofstudies (Hours/Week)					Total Credits(C) (L:T:P=2:0:0)
			Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
Skill enhancement course (SEC)	0FS402	Basics of forensic science	2	0	1	1	4	2+0=2

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies); SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+CAT+SA+AT)		
SEC	**0FS402**	**Basics of Forensic science**	**15**	**20**	**10**	**5**	**50**	**50**	**100**

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.	**Approximate Hours** **Item** | Cl | LI | SW | SL | Total **Approx. Hrs** | 06 | 00 | 01 | 01 | 08

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-0FS402.1: Elucidate the overview of forensic science.	**SO1.1** Explain the concept and principles of forensic science.		**Unit-1-Introduction to forensic science** **CI1.1** Introduction and principles of forensic science,	**SL1.1** Read some articles about forensic studies.
	SO1.2 Elucidate the functions and importance of forensic science laboratory		**CI1.2** forensic science laboratory	
	SO1.3 Elaborate the role of FSL and its organization and service.		**CI1.3** FSL and its organization and service,	
	SO1.4 Elucidate the various tools and techniques used in forensic science.		**CI1.4** tools and techniques in forensic science,	
	SO1.5 Elaborate the different branches of forensic science and its involvement.		**CI1.5** branches of forensic science.	
	SO1.6 Elaborate the different branches of forensic science and its involvement.		**CI1.6** branches of forensic science.	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Describe various principles of forensic science.
	SW1.2 Mini Project	Elaborate different branches of forensic science with its role.
	SW1.3 Other Activities (Specify)	Make a power point presentation on forensic science laboratory and its service.

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.	**Approximate Hours** **Item** | Cl | LI | SW | SL | Total **Approx. Hrs** | 06 | 00 | 01 | 01 | 08

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO2-0FS402.2: Acquire knowledge regarding causes of crime and types of injuries	**SO2.1** Explain the different types of causes which leads to crime.		**Unit-2 types of injuries and deaths.** **CI2.1** Causes of crime	**SL2.1** Note down the reasons which can lead to crime.
	SO2.2 Elucidate the Role of modus operandi in criminal investigation.		**CI2.2** Role of modus operandi in criminal investigation.	
	SO2.3 Elaborate the classification of injuries.		**CI2.3** Classification of injuries	
	SO2.4 Elucidate the medico-legal aspects of injuries.		**CI2.4** Medico-legal aspects of injuries.	
	SO2.5 Explanation about the method of assessing various types of deaths.		**CI2.5** method of assessing various types of deaths.	
	SO2.5 Explanation about the method of assessing various types of deaths.		**CI2.5** method of assessing various types of deaths.	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Describe the Role of modus operandi in criminal investigation.
	SW2.2 Mini Project	Make a chart on classification of injuries.
	SW2.3 Other Activities (Specify)	Make Power point presentation on method of assessing various types of deaths

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.	**Approximate Hours** **Item** | Cl | LI | SW | SL | Total **Approx. Hrs** | 06 | 00 | 01 | 01 | 08

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO3-0FS402.3: Applied knowledge about ballistics and handwriting examination.	**SO3.1** Elucidate the classification of fire arms and explosives.		**Unit-3 Application of ballistics and handwriting examination:** **CI3.1** Classification of fire arms and explosives	**SL3.1** Read about various examples of handwriting examination
	SO3.2 Explain about the internal, external and terminal ballistics.		**CI3.2** introduction to internal, external and terminal ballistics.	
	SO3.3 Elaborate the chemical evidence for explosives.		**CI3.3** Chemical evidence for explosives.	
	SO3.4 To learn the general and individual characteristics of handwriting.		**CI3.4** General and individual characteristics of handwriting,	
	SO3.5 Explanation about the examination of handwritings and analysis of ink various samples.		**CI3.5** examination of handwritings and analysis of ink various samples.	
	SO3.6 Explanation about the comparison of handwritings and analysis of ink various samples		**CI3.6 c**omparison of handwritings and analysis of ink various samples.	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Flow chart on fire arms and explosives
	SW3.2 Mini Project	Describe the different characteristics of handwriting.
	SW3.3 Other Activities (Specify)	Prepare one Power point presentation on analysis of ink in handwriting analysis.

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.	**Approximate Hours** **Item** | Cl | LI | SW | SL | Total **Approx. Hrs** | 06 | 00 | 01 | 01 | 08

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO4-0FS402.4: To gain the knowledge about toxicology and fingerprinting analysis.	**SO4.1** Elucidate about the role of toxicologist		**Unit-4overview about toxicology and fingerprinting analysis** **CI4.1** Role of the toxicologist,	**SL4.1** Read about the functions of toxicological studies.
	SO4.2 Elaborate about the significance of toxicological findings		**CI4.2** significance of toxicological findings,	
	SO4.3 Explanation about the fundamental principles of fingerprinting.		**CI4.3** Fundamental principles of fingerprinting,	
	SO4.4 To learn about the detailed classification of fingerprints		**CI4.4** classification of fingerprints,	
	SO4.5 Explanation about the development of finger print		**CI4.5** development of finger print,	
	SO4.6 Explanation about science for personal identification		**CI4.6** science for personal identification,	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Determine the various applications and importance of toxicological analysis
	SW4.2 Mini Project	Flow chart on classification of fingerprints.
	SW4.3 Other Activities (Specify)	Make a Power point presentation on how the fingerprint development happens for personal identification.

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.	**Approximate Hours** **Item** | Cl | LI | SW | SL | Total **Approx. Hrs** | 06 | 00 | 01 | 01 | 08

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO5-0FS402.5: Elucidate the detailing of DNA profiling and cyber security	**SO5.1** Elucidate the principle of DNA fingerprinting.		**Unit-5 DNA fingerprinting and cyber security:** **CI5.1** Principle of DNA fingerprinting,	**SL5.1** Basic knowledge about the hybridization techniques.
	SO5.2 Elaborate the application of DNA profiling in forensic medicine.		**CI5.2** application of DNA profiling in forensic medicine,	
	SO5.3 Describe the investigating tools used in forensic studies, eDiscovery.		**CI5.3** Investigation Tools, eDiscovery,,	
	SO5.4 Elucidate about the how Evidence Preservation can be done?		**CI5.4** Evidence Preservation	
	SO5.5 Explanation about the Search and Seizure of Computers,		**CI5.5** Search and Seizure of Computers,	
	SO5.6 Elaborate about the basic concept of Cyber security.		**CI5.6** Introduction to Cyber security	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Principle and steps of DNA profiling.
	SW5.2 Mini Project	Explanation about the search and seizure of computers.
	SW5.3 Other Activities (Specify)	Prepare power point presentation on cyber security.

Course duration (in hours)to attain Course Outcomes:

Course Title: Basics of forensic science **Course Code: 0FS402**

Course Outcomes(COs)	Class lecture (CI)	Laboratory Instruction(LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1-0FS402.1: Elucidate theoverview of forensic science.	6	0	1	1	08
CO2-0FS402.2: Acquire knowledge regarding causes of crime and types of injuries.	6	0	1	1	08
CO3-0FS402.3: Applied knowledge about ballistics and handwriting examination.	6	0	1	1	08
CO4-0FS402.4: To gain the knowledge about toxicology and fingerprinting analysis.	6	0	1	1	08
CO5-0FS402.5: Elucidate the detailing of DNA fingerprinting and cyber security	6	0	1	1	08
Total Hours	30	00	05	05	40

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Basics of forensic science **Course Code: 04B402**

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
CO1-0FS402.1: Elucidate theoverview of forensic science.	2	1	1	1	5
CO2-0FS402.2: Acquire knowledge regarding causes of crime and types of injuries.	2	4	5	1	12
CO3-0FS402.3: Applied knowledge about ballistics and handwriting examination.	3	5	5	1	14
CO4-0FS402.4: To gain the knowledge about toxicology and fingerprinting analysis.	2	3	5	1	11
CO5-0FS402.5: Elucidate the detailing of DNA fingerprinting and cyber security.	2	4	1	1	10
Total Marks	**11**	**17**	**17**	**05**	**50**

***Legend*:A,** Apply; **An,** Analyze; **E,** Evaluate; **C,** Create

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1	Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
2	B.B. Nanda and R.K. Tiwari, Forensic Science in India: A Vision for the Twenty First Century, Select Publishers, New Delhi (2501).
3	M.K. Bhasin and S. Nath, Role of Forensic Science in the New Millennium, University of Delhi, Delhi (2502).
4	S.H. James and J.J. Nordby, Forensic Science: An Introduction to Scientific and Investigative Techniques, 2nd Edition, CRC Press, Boca Raton (2505).
5	W.G. Eckert and R.K. Wright in Introduction to Forensic Sciences, 2nd Edition, W.G. Eckert (ED.), CRC Press, Boca Raton (1997).
6	R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey (2504).
7	W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's Techniques of Crime Scene Investigation, CRC Press, Boca Raton (2013).

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Group Discussion
4. Role play
5. Demonstration
6. ICT Based teaching Learning
7. Brainstorming

CO, PO and PSO Mapping

Program Name: B.Sc. (Hons.) Biotechnology
Semester: IV Semester
Course Title: Basics of forensic science.
Course Code: 0FS402

Course Outcome (Cos)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-0FS402.1: Elucidate the overview of forensic science.	1	2	-	1	2	1	2	1	2	-	1	2	2	2	1
CO2-0FS402.2: Acquire knowledge regarding causes of crime and types of injuries.	-	1	1	-	-	-	1	-	1	1	-	-	1	1	2
CO3-0FS402.3: Applied knowledge about ballistics and handwriting examination.	1	1	2	1	-	1	1	1	1	2	1	-	3	1	1
CO4-0FS402.4: To gain the knowledge about toxicology and fingerprinting analysis.	1	1	1	-	2	1	1	1	1	1	-	2	1	1	3
CO5-0FS402.5: Elucidate the detailing of DNA fingerprinting and cyber security.	2	1	1	-	-	2	1	2	1	1	-	-	1	3	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs	Cos	SOs No.	Laboratory	Classroom Instruction (CI)	Self-Learning (SL)

No.			Instruction (LI)		
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO1-0FS402.1:** Elucidate the overview of forensic science.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6		1.1,1.2,1.3,1.4,1.5,1.6,	**1SL-1**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO2-0FS402.2:** Acquire knowledge regarding causes of crime and types of injuries.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6		2.1, 2.2, 2.3,2.4,2.5,2.6,	**2SL-1**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO3-0FS402.3:** Applied knowledge about ballistics and handwriting examination.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6		3.1,3.2,3.3,3.4,3.5,3.6,	**3SL-1**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO4-0FS402.4:**To gain the knowledge about toxicology and fingerprinting analysis.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5SO4.6		4.1,4.2,4.3,4.4, 4.5, 4.6,	**4SL-1**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO5-0FS402.5:**Elucidate the detailing of DNA fingerprinting and cyber security.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6		5.1,5.2,5.3,5.4,5.5,5.6	**5SL-1**

Program Name	**Bachelor of Science (B.Sc.)- Botany**	
Semester	5th	
Course Code:	**01BO501**	
Course title:	**Plant Physiology and Metabolism**	**Curriculum Developer**: Dr. Keerti Samdariya, Assistant Professor
Pre-requisite:	Students should have basic knowledge of biomolecules, their physiology, chemistry, and the metabolic activity of biomolecules present in plants.	
Rationale:	The paper on Plant physiology and Metabolism in a BSc Botany program explores the role of biomolecules and their metabolic activity in plants' biological systems. The living systems synthesize four primary types of biomolecules within the body. This study enables Students to learn how biomolecules promote different biological processes necessary for life. They vary in structure and size. Metabolic metabolism is a complex process essential for the proper functioning of the body. Students need to understand the role of biomolecules and metabolism in maintaining the physiological properties of plants.	
Course Outcomes (COs):	**CO1:** Understand the Plant-Water Relationship and Transport of water and Organic Substances Structure, classification, and properties of Biomolecules.	
	CO2: Extend knowledge about Photosynthesis and Nitrogen Metabolism.	
	CO3: Understanding of Respiration, Bioenergetics and Lipid Metabolism.	
	CO4: To become familiar with enzyme activity and chemistry of Plant Hormones.	
	CO5: Apply the concept of Growth and Development of plant.	

Scheme of Studies:

Board of Study	CourseCode	Course Title	Scheme of studies (Hours/Week)					Total Credits(C) (L: T: P=4:0:2)
			Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
Major	01BO501	**Plant Physiology and Metabolism**	4	2	1	1	8	4+2=6

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title		Scheme of Assessment (Marks)		
				Progressive Assessment (PRA)	End Semester Assessment (ESA)	Total Marks

			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CAT+CT+SA+AT)		(PRA+ ESA)
Major	**01BO501**	**Plant Physiology and Metabolism**	**15**	**20**	**5**	**5**	**5**	**50**	**50**	**100**

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	04	01	02	19

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO1: Understand the Plant-Water Relationship and Transport of water and Organic Substances Structure, classification, and properties of Biomolecules.	**SO1.1** Explain Plant-Water Relationship.	**LI 1.1** Separation of Photosynthetic pigments by Paper Chromatography and determining the Rf value.	**CI 1.1** Explain Plant-Water Relationship.	**SL1.1** Determine the difference between Diffusion and Osmosis.
	SO1.2 Give the importance of water to plant life.	**LI 1.2** Determination of Rate of Photosynthesis in different wavelength of Light	**CI 1.2** Give the importance of water to plant life.	**SL1.2** Explain the Absorption, Transport of water, and transpiration.

	SO1.3 Explain the physical properties of water.		**CI 1.3** Explain the physical properties of water.	
	SO1.4 Determine the difference between Diffusion and Osmosis.		**CI 1.4** Determine the difference between Diffusion and Osmosis.	
	SO1.5 Explain the Transport of Organic Substances.		**CI 1.5** Explain the Transport of Organic Substances.	
	SO1.6 Explain the Absorption, Transport of water and transpiration.		**CI 1.6** Explain the Absorption, Transport of water, and transpiration.	
	SO1.7 Explain, the Physiology of Stomata.		**CI 1.7** Explain, the Physiology of Stomata.	
	SO1.8 Explain the Mechanism of phloem transport.		**CI 1.8** Explain the Mechanism of phloem transport. relationship.	
	SO1.9 Determines the source-sink relationship.		**CI 1.9** Determines the source sink.	

	SO1.10 Evaluate factors affecting solute translocation.		**CI 1.10** Evaluate factors affecting solute translocation.	

Suggested Sessional Work (SW): *anyone*		**SW3.1** Assignments	Differentiate between Diffusion and Osmosis.
		SW3.2 Mini Project	factors affecting solute translocation.
		SW3.3 Other Activities (Specify)	Find out some YouTube videos based on the Mechanism of phloem transport.

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	03	22

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO2: Extend knowledge about Photosynthesis and Nitrogen Metabolism	**SO2.1** Discuss the Significance of Photosynthesis.	**LI 2.1** Determination of rate of photosynthesis in different concentration of C02	**CI 2.1** Discuss the Significance of Photosynthesis.	**SL2.1** Discuss the concept of two pigment systems.
	SO2.2 Clarify the historical background Of Photosynthesis.	**LI 2.2** Estimation of Ascorbic acid content in Plant sample	**CI 2.2** Clarify the historical background Of Photosynthesis.	**SL2.2** Learn the pathway of light reaction**.**
	SO2.3 Elucidation structures of Chloroplast.	**LI 2.3** Study of Geotropism, Phototropism and Hydrotropism	**CI 2.3** Elucidation structures of Chloroplast.	**SL2.3** Discriminate structures of Chloroplast.
	SO2.4 Explain photosynthetic pigments.		**CI 2.4** Explain photosynthetic pigments.	
	SO2.5 Discuss the concept of two pigment systems.	.	**CI 2.5** Discuss the concept of two pigment systems.	
	SO2.6 Explains pathway of light reaction.		**CI 2.6** Explains pathway of light reaction.	
	SO2.7 Discuss Calvin cycle		**CI 2.7** Discuss Calvin cycle	
	SO2.8 Explain Hatch & Slack pathway.		**CI 2.8** Explain Hatch & Slack pathway.	

	SO2.9 Explaining CAM plants, Photorespiration.		**CI 2.9** Explaining CAM plants, Photorespiration.	
	SO2.10 Explain Biology of, symbiotic and asymbiotic Nitrogen fixation.		**CI 2.10** Explain Biology of, symbiotic and asymbiotic Nitrogen fixation.	
	SO2.11 Explain the Importance of nitrate reductase and its regulation.		**CI 2.11** Explain the Importance of nitrate reductase and its regulation.	
	SO2.12 Explain ammonium assimilation and nitrogen cycle.		**CI 2.12** Explain ammonium assimilation and nitrogen cycle.	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Differentiate between symbiotic and asymbiotic Nitrogen fixation.
	SW2.2 Mini Project	Draw ray diagram of the Importance of nitrate reductase and its regulation
	SW2.3 Other Activities (Specify)	Find out some YouTube videos based on Photorespiration.

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	13	04	01	03	21

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO3: Understanding of Respiration, Bioenergetics	**SO3.1** Illustrating Respiration and	**LI 3.1** Evolution of C02 during	**CI 3.1** Illustrating Respiration and	**SL3.1** Discuss aerobic and

and Lipid Metabolism.	Bioenergetics.	respiration	Bioenergetics.	anaerobic respiration.
	SO3.2 Explain aerobic and anaerobic respiration.	**LI 3.2** Evolution of 02 during Photosynthesis	**CI 3.2** Explain aerobic and anaerobic respiration.	**SL3.2** Read the Oxidative Phosphorylation and ATP synthesis.
	SO3.3 Explain Fermentation.		**CI 3.3** Explain Fermentation.	**SL3.3** Explain beta oxidation.
	SO3.4 Explaining pathway of Glycolysis.	.	**CI 3.4** Explaining pathway of Glycolysis.	.
	SO3.5 Explaining pathway of Krebs cycle.		**CI 3.5** Explaining pathway of Krebs cycle.	
	SO3.6 Explain Electron transport mechanism.		**SO3.6** Explain Electron transport mechanism.	
	SO3.7 Explain Oxidative Phosphorylation and ATP synthesis.		**CI 3.7** Explain Oxidative Phosphorylation and ATP synthesis.	
	SO3.8 Explain Pentose phosphate pathway.		**CI 3.8** Explain Pentose phosphate pathway.	
	SO3.9 Explain Structure and function of lipids.		**CI 3.9** Explain Structure and function of lipids.	
	SO3.10 Explain pathway of fatty acid biosynthesis.		**CI 3.10** Explain pathway of fatty acid biosynthesis.	
	SO3.11 Explain pathway beta oxidation of saturated fatty acid.		**CI 3.11** Explain beta oxidation of saturated fatty acids.	
	SO3.12 Explain beta oxidation of unsaturated fatty acids.		**CI 3.12** Explain beta oxidation of unsaturated fatty acids.	
	SO3.13 Explain storage		**CI 3.13** Explain storage and	

	and mobilization of fatty acids.		mobilization of fatty acids.	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Describe in detail on mobilization of fatty acids.
	SW3.2 Mini Project	Explain beta oxidation of saturated fatty acids.
	SW3.3 other activity	Find out some you tube Fermentation.

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	13	06	01	02	22

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO4: To become familiar with enzyme activity and chemistry of Plant Hormones.	**SO4.1** Explain Classification of Enzymes.	**LI 4.1** Moll 's half leaf experiment	**CI 4.1** Explain Classification of Enzymes.	**SL 4.1** Understand Holoenzyme, Apoenzyme, Coenzyme and Cofactors
	SO4.2 Explain the nomenclature of Enzymes.	**LI 4.2** Determination of rate of growth by using Arc auxanometer.	**CI 4.2** Explain the nomenclature of Enzymes.	**SL 4.2** Learn Discovery of Plant Hormones.
	SO4.3 Explain the characteristics of Enzymes.	**LI 4.3** Determination of	**CI 4.3** Explain the characteristics of	.

		osmotic potential of plant cell sap by plasmolytic method.	Enzymes.	
	SO4.4 Describe concepts of Holoenzyme, Apoenzyme, Coenzyme and Cofactors		**CI 4.4** Describe concepts of Holoenzyme, Apoenzyme, Coenzyme and Cofactors	
	SO4.5 Explain regulation of enzyme activity.		**CI 4.5** Explain regulation of enzyme activity.	
	SO4.6 Explain mechanism of action of enzymes.		**CI 4.6** Explain mechanism of action of enzymes.	
	SO4.7 Explain factors affecting enzyme activity.		**CI 4.7** Explain factors affecting enzyme activity.	
	SO4.8 Explain Discovery of Plant Hormones.		**CI 4.8** Explain Discovery of Plant Hormones.	
	SO4.9 Explain the structure, mode of action and physiological role of Auxins		**CI 4.9 Explain the** structure, mode of action and physiological role of Auxins	
	SO4.10 Explain the structure, mode of action and physiological role of Gibberellins.		**CI 4.10 Explain the** structure, mode of action and physiological role of Gibberellins.	
			CI 4.11 Explain the	

	SO4.11 Explain the structure, mode of action and physiological role of Abscisic acid.		structure, mode of action and physiological role of Abscisic acid.	
	SO4.12 Explain the structure, mode of action and physiological role of Ethylene.		**CI 4.12 Explain the** structure, mode of action and physiological role of Ethylene.	
	SO4.13 Explain the structure, mode of action and physiological role of Cytokinin.		**CI 4.13** Explain the structure, mode of action and physiological role of Cytokinin.	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Explain mechanism of action of enzymes.
	SW4.2 Mini Project	Describe the discovery of Plant Hormones.
	SW4.3 Other Activities (Specify)	Find out some you tube videos based on the activity of plant hormones.

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	02	21

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO5: Apply the concept of Growth and Development of plant.	**SO5.1** Elucidate Growth and Development.	**LI 5.1** Determination of water potential of given tissue (potato tuber) by weight method	**Unit-5** **CI5.1** Elucidate Growth and Development.	**SL5.1** Differentiate phases of growth and development.
	SO5.2 comments on General knowledge of vegetative and reproductive growth	**LI 5.2** To study the induction of amylase activity	**CI5.2** comments on General knowledge of vegetative and reproductive growth.	**SL5.2** compares Seed dormancy, Seed germination, and factors of their regulations.
	SO5.3 Differentiate phases of growth and development.	**LI 5.3** To study the effect of different concentrations of IAA on Avena coleoptile elongation	**CI5.3** Differentiate phases of growth and development.	
	SO5.4 Explain the kinetics of growth.		**CI5.4** Explain the kinetics of growth.	
	SO5.5 compares Seed dormancy, Seed germination, and factors of their regulations.		**CI5.5** compares Seed dormancy, Seed germination, and factors of their regulations.	
	SO5.6 Recognize Concepts of Photoperiodism and physiology of flowering.		**CI 5.6** Recognize Concepts of Photoperiodism and physiology of flowering.	
	SO5.7 Define Florigen concept.		**CI 5.7** Define Florigen concept.	
	SO5.8 what is the concept of biological clocks, the physiology of		**CI 5.8** what is the concept of biological clocks, the physiology of	

	Senescence?		Senescence?	
	SO5.9 Explain Photomorphogenesis.		**CI 5.9** Explain Photomorphogenesis.	
	SO5.10 Explain discovery of Phytochromes and Cryptochromes.		**CI 5.10** Explain discovery of Phytochromes and Cryptochromes.	
	SO5.11 Explain the physiological role of Phytochromes and Cryptochromes.		**CI 5.11** Explain the physiological role of Phytochromes and Cryptochromes.	
	SO5.12 Explain the mechanism of action of Phytochromes and Cryptochromes.		**CI 5.12** Explain the mechanism of action of Phytochromes and Cryptochromes.	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Write in detail note on the kinetics of growth.
	SW5.2 Mini Project	Explain the mechanism of action of Phytochromes and Cryptochromes.
	SW5.3 Other Activities (Specify)	Prepare one article explaining the biological clocks, the physiology of Senescence.

Course duration (in hours) to attain Course Outcomes:

Course Title: Plant Physiology and Metabolism **Course Code: 01BO501**

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1: Understand the Plant-Water Relationship and Transport of water and Organic Substances Structure, classification, and properties of Biomolecules.	12	4	2	1	19
CO2: Extend knowledge about Photosynthesis and Nitrogen Metabolism.	12	6	3	1	22
CO3: Understanding of Respiration, Bioenergetics and Lipid Metabolism.	13	4	3	1	21
CO4: To become familiar with enzyme activity and chemistry of Plant Hormones.	13	6	2	1	22
CO5: Apply the concept of Growth and Development of plant.	12	6	2	1	21
Total Hours	62	26	12	05	105

End-semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Plant Physiology and Metabolism **Course Code: 01BO501**

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
CO1: Understand the Plant-Water Relationship and Transport of water and Organic Substances Structure, classification, and properties of Biomolecules.	2	1	1	1	5
CO2: Extend knowledge about Photosynthesis and Nitrogen Metabolism.	2	4	2	2	10
CO3: Understanding of Respiration, Bioenergetics and Lipid Metabolism.	3	5	5	2	15
CO4: To become familiar with enzyme activity and chemistry of Plant Hormones.	2	3	3	2	10
CO5: Apply the concept of Growth and Development of plant.	5	4	1	0	10
Total Marks	**14**	**17**	**12**	**07**	**50**

***Legend*: A,** Apply; **An,** Analyze; **E,** Evaluate; **C,** Create

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1	Principles of biochemistry David L. Nelson, Michael Cox WH Freeman 7 & 2017
2	Fundamentals of biochemistry j.l.jain S.chand 6 & 2005
3	Gengulee, H.C. lhs, Data, C. and sen, S. 2007, College Botany vol. 1, New Central Book Agency (P) Ltd. Kolkata 700009.
4	Salisbury, F.B. and C.W. Ross 1986- Plant Physiology, CBS Publ.& distributors , New Delhi

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Visit to virology lab (BSL-3)
7. Demonstration
8. ICT Based teaching Learning
9. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Sc. Biology
Semester: 5th semester
Course Title: Plant Physiology and Metabolism **Course Code: 01BO501**

CO/PO/PSO Mapping								
Course Outcome (Cos)	**Program Outcomes (POs)**					**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**
CO1: Understand the Plant-Water Relationship and Transport of water and Organic Substances Structure, classification, and properties of Biomolecules.	1	2	2	3	1	2	2	1
CO2: Extend knowledge about Photosynthesis and Nitrogen Metabolism.	1	2	3	2	1	1	1	2
CO3: Understanding of Respiration, Bioenergetics and Lipid Metabolism.	1	2	3	2	1	1	1	1
CO4: To become familiar with enzyme activity and chemistry of Plant Hormones.	-	1	1	-	2	1	1	3
CO5: Apply the concept of Growth and Development of plant.	1	1	1	-	-	1	3	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5 PSO 1,2,3	**CO1:** Understand the Plant-Water Relationship and Transport of water and Organic Substances Structure, classification, and properties of Biomolecules.	SO1.1 SO1.2 SO1.3, SO1.4 SO1.5, SO1.6, SO1.7, SO1.8, SO1.9, SO1.10, SO1.11, SO1.12	LI 1, 2	1.1, 1.2, 1.3, 1.4, 1.5 1.6, 1.7, 1.8, 1.9, 1.10, 1.11, 1.12	1SL-1,2
PO 1,2,3,4,5 PSO 1,2,3	**CO2:** Extend knowledge about Photosynthesis and Nitrogen Metabolism.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5, SO2.6, SO2.7, SO2.8, SO2.9, SO2.10, SO2.11, SO2.12	LI 1, 2,3	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.10, 2.11, 2.12	2SL-1,2,3
PO 1,2,3,4,5 PSO 1,2,3	**CO3:** Understanding of Respiration, Bioenergetics and Lipid Metabolism.	SO3.1 SO3.2 SO3.3 SO3.4, SO3.5, SO3.6, SO3.7, SO3.8, SO3.9, SO3.10, SO3.11, SO3.12, SO3.13	LI 1, 2	3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 3.10, 3.11, 3.12, 1.13	3SL-1,2,3
PO 1,2,3,4,5 PSO 1,2,3	**CO4:** To become familiar with enzyme activity and chemistry of Plant Hormones.	SO4.1 SO4.2 SO4.3 SO4.4, SO4.5, SO4.6, SO4.7, SO4.8, SO4.9, SO4.10, SO4.11, SO4.12, SO4.13	LI 1, 2,3	4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12, 1.13	4SL-1,2
PO 1,2,3,4,5 PSO 1,2,3	**CO5:** Apply the concept of Growth and Development of plant.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5, SO5.6, SO5.7, SO5.8., SO5.9. SO5.10., SO5.11. SO5.12.	LI 1, 2,3	5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10, 5.11, 5.12	5SL-1,2

Program Name	**Bachelor of Science (B.Sc.)- Biology**	
Semester	5th	
Course Code:	01ZO502	
Course title:	Aquaculture	**Curriculum Developer**: MR. AMIT BAGRI
Pre-requisite:	To study this course a student must have had the subject zoology in diploma.	
Rationale:	In order to sustainably feed the world's growing population with a healthy, lean protein, aquaculture's role is of the utmost importance. The primary responsibility of aquaculture is to efficiently complement wild-caught fish options to increase the amount of seafood available worldwide.	
Course Outcomes (COs):	01ZO502 **.1.** Gain knowledge about importance of Aquaculture, history and traditional of aquaculture. 01ZO502 **.2.** To describe unique prawn culture history and methods. 01ZO502 **.3.** To recognize importance and uses of edible oyster and pearl culture. 01ZO502 **.4.** To critically analyze fresh water edible fishes, marine water edible fishes, and carp culture. 01ZO502 **.5.** To Learn about the types and importance of aquarium and polyculture.	

Scheme of Studies:

Board of Study	**Course Code**	**Course Title**	**Scheme of studies (Hours/Week)**					**Total Credits(C) (L:T:P=4:0:2)**
			Cl	LI	SW	SL	**Total Study Hours (CI+LI+SW+SL)**	
Major	01ZO502	Aquaculture	4	4	1	1	10	4+2=6

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory/ Practical

Board of Study	Couse Code	Course Title	**Scheme of Assessment (Marks): Theory**						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)		
Major	01ZO502	Aquaculture	**15**	**20**	**10**	**5**	**50**	**50**	**100**

Board of Study	Course Code	Course Title	**Scheme of Assessment (Marks): Practical**						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)		
Major	01ZO502	Aquaculture	35	5	5	5	50	50	50

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	04	23

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
01ZO502 **.1.** Gain knowledge about importance of Aquaculture, history and traditional of aquaculture.	**SO1.1** Summarize concept of Aquaculture	1.1. Study of Aquaculture 1.2. locally available Aquaculture 1.3. problem of aquaculture.	**Unit-1 Aquaculture** **1.1** definition. history of aquaculture	1.1. define Aquaculture
	SO1.2 Planning higher aquaculture productivity		**1.2** definition and examples.	1.2. define Planning higher aquaculture productivity
	SO1.3 problem of aquaculture		**1.3** Definition and Examples	1.3. define problem of aquaculture
	SO1.4 Significance of aquaculture		**1.4** explain Significance of aquaculture	1.4. Learn about Significance of aquaculture
	SO1.5 aquaculture resource in India.		**1.5** explain aquaculture resource in India	
	SO1.6 Explain aquaculture, and how does it differ from traditional fishing?		**1.6** What is aquaculture, and how does it differ from traditional fishing?	
	SO1.7 describe the benefits and drawbacks of aquaculture?		**1.7** What are the benefits and drawbacks of aquaculture?	
	SO1.8 explain the most commonly farmed fish species in aquaculture?		**1.8** What are the most commonly farmed fish species in aquaculture?	
	SO1.9 describe the environmental impacts of large-scale fish farming operations?		**1.9** What are the environmental impacts of large-scale fish farming operations?	
	SO1.10 explain the primary species involved in shellfish aquaculture?		**1.10** What are the primary species involved in shellfish aquaculture?	
	SO1.11 describe the challenges faced by shellfish farmers?		**1.11** What are the challenges faced by shellfish farmers?	
	SO1.12 explain shellfish farming contribute to water quality and ecosystem health?		**1.12** How does shellfish farming contribute to water quality and ecosystem health?	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Write about the history of Aquaculture.
	SW1.2 Mini Project	Write about problem of aquaculture.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	12	01	06	31

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
01ZO502 **.2.** To describe unique prawn culture history and methods.	**SO2.1** History of Prawn culture	2.1. identify the study fresh and marine water economically importance fauna.	**Unit-2 Prawn culture** **2.1** study of History of Prawn culture.	2.1. Know about the history of prawn culture.
	SO2.2 Prawns of commercial value.	2.2. identify the water quality parameters by different experiments.	**2.2** Type study Prawns of commercial value.	2.2. learn Prawns of commercial value
	SO2.3 different stage of prawn life cycle	2.3. What are the common issues related to prawn feed and nutrition?	**2.3** study about different stage of prawn life cycle	2.3. learn about different stage of prawn life cycle
	SO2.4 define culture technology		**2.4** explain culture technology	2.4. Know about the culture technology
	SO2.5 Study methods of prawn fishing.		**2.5** Type Study methods of prawn fishing.	
	SO2.6 study of Preservation and processing of prawn.		**2.6** study of Preservation and processing of prawn	
	SO2.7 explain the advantages and disadvantages of extensive, semi-intensive, and intensive prawn farming?		**SO2.7** What are the advantages and disadvantages of extensive, semi-intensive, and intensive prawn farming?	
	SO2.8 describe integrate multi-trophic aquaculture (IMTA) benefit prawn farming?		**SO2.8** How does integrate multi-trophic aquaculture (IMTA) benefit prawn farming?	
	SO2.9 explain the most commonly farmed prawn species		**SO2.9** What are the most commonly farmed prawn species	
	SO2.10 explain the key considerations for broodstock management in prawn farming?		**SO2.1.10** What are the key considerations for broodstock management in prawn farming?	
	SO2.11 describe the dietary requirements for different stages of prawn growth?		**SO2.11** What are the dietary requirements for different stages of prawn growth?	
	SO2.12 describe formulations vary between different types of prawn farming systems?		**SO2.12** How do feed formulations vary between different types of prawn farming systems?	

Suggested Sessional Work (SW):*anyone*		
	SW2.1 Assignments	Write about different stage of prawn life cycle
	SW2.2 Mini Project	Write about Study methods of prawn fishing.
	SW2.3 Other Activities (Specify)	write the study Prawns of commercial value.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	05	24

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning(SL)
01ZO502 **.3.** To recognize importance and uses of edible oyster and pearl culture.	**SO3.1** culture species of oyster and their distribution	3.1. identify harmful aquatic insects of aquaculture.	**Unit-3 Edible oyster culture** **3.1** study of culture species of oyster and their distribution	3.1. Know about the culture species of oyster and their distribution
	SO3.2 define the biology the oyster	3.2. How has the global market for cultured pearls evolved in recent years	**3.2** define the biology the oyster	3.2. learn about define the biology the oyster
	SO3.3 Explain the oyster culture technique	3.3. What recent technological advancements have been made in pearl aquaculture?	**3.3** Explain the oyster culture technique	3.3. Know about the Explain the oyster culture technique
	SO3.4 Explain the preservation of oyster.		**3.4** Explain the preservation of oyster.	3.4. learn about the preservation of oyster.
	SO3.5 Explain the history of pearl culture and pearl producing site		**3.5** Explain the history of pearl culture and pearl producing site	3.5. Know about the Explain the history of pearl culture and pearl producing site
	SO3.6 define economic value and pearl industry in India		**3.6** define economic value and pearl industry in India	
	SO3.7 explain the main types of pearls produced through aquaculture?		**3.7** What are the main types of pearls produced through aquaculture?	
	SO3.8 explain the different species of oysters used in saltwater pearl farming?		**3.8** What are the different species of oysters used in saltwater pearl farming?	
	SO3.9 describe types of mussels are typically used in freshwater pearl farming?		**3.9** What types of mussels are typically used in freshwater pearl farming?	
	SO3.10 describe the challenges faced by freshwater pearl farmers?		**3.10** What are the challenges faced by freshwater pearl farmers?	
	SO3.11 explain sustainable practices are being implemented in pearl aquaculture		**3.11** What sustainable practices are being implemented in pearl aquaculture	
	SO3.12 explain the economic benefits of pearl farming for local communities?		**3.12** What are the economic benefits of pearl farming for local communities?	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Explain the oyster culture technique
	SW3.2 Mini Project	Explain the preservation of oyster.
	SW3.3 Other Activities (Specify)	define economic value and pearl industry in India.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	05	24

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
01ZO502 **.4.** To critically analyze fresh water edible fishes, marine water edible fishes, and carp culture.	**SO4.1** biology of major carp fishes , minor carp fishes and cat fishes , live fishes.	4.1. What are the main economic considerations for starting a carp aquaculture operation?	**Unit-4: fresh water edible fishes, marine water edible fishes, and carp culture** 4.1 study of biology of major carp fishes , minor carp fishes and cat fishes , live fishes.	4.1. biology of major carp fishes , minor carp fishes and cat fishes , live fishes.
	SO4.2 hilsa, eal, sardines, Bombay duck.	4.2. How does the market demand for different types of carp influence aquaculture practices?	**4.2** Type study of hilsa, eal, sardines, Bombay duck.	4.2. study of hilsa, eal, sardines, Bombay duck.
	SO4.3 Observing the history of carp culture.	4.3. What are the latest technological advancements in carp aquaculture?	**4.3** Observing the history of carp culture.	4.3. Understand the Observing the history of carp culture.
	SO4.4 resource the carp culture in India.		**4.4** resource the carp culture in India.	4.4. learn about resource the carp culture in India.
	SO4.5 procedure of carp culture.		**4.5** procedure of carp culture.	4.5. Know about the procedure of carp culture.
	SO4.6 study methods of catching of carps.		**4.6** Type study methods of catching of carps.	
	SO4.7 Explain the diseases, control, and carp fish health management of carp culture		**4.7** Explain the diseases, control, and carp fish health management of carp culture	
	SO4.8 explain the primary types of carp cultivated in aquaculture?		**4,8** What are the primary types of carp cultivated in aquaculture?	
	SO4.9 explain the common challenges faced in carp aquaculture?		**4.9** What are the common challenges faced in carp aquaculture?	
	SO4.10 describe the best practices for sustainable carp aquaculture?		**4.10** What are the best practices for sustainable carp aquaculture?	
	SO4.11 describe feeding strategies are most effective for optimizing growth in carp?		**4.11** What feeding strategies are most effective for optimizing growth in carp?	
	SO4.12 explain the key health management practices to prevent diseases in carp aquaculture?		**4.12** What are the key health management practices to prevent diseases in carp aquaculture?	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Study in details about the management of diseases
	SW4.2 Mini Project	Write about the Type study of hilsa, eal, sardines, Bombay duck.
	SW4.3 Other Activities (Specify)	write the resource the carp culture in India.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	06	25

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Classroom Instruction(CI)	Self-Learning(SL)
01ZO502 **.5.** To Learn about the types and importance of aquarium and polyculture.	**SO5.1** Explain the introduction and history of aquarium.	5.1. identify the learn the rearing Methods of aquarium.	**Unit-5 Aquarium , plankton, polyculture** **5.1** Explain the introduction and history of aquarium.	5.1. Explain the introduction and history of aquarium.
	SO5.2 study about types of aquariums.	5.2. What are the basic steps involved in maintaining a home aquarium?	**5.2** study about types of aquariums	5.2. study about types of aquariums
	SO5.3 types and significance of aquatic plants	5.3. Methods can be used to manage and reduce ammonia and nitrite levels in an aquarium?	**5.3** types and significance of aquatic plants	5.3. learn about types and significance of aquatic plants
	SO5.4 Explain the maintenance of aquarium.		**5.4** Explain the maintenance of aquarium.	5.4. Read the Explain the maintenance of aquarium.
	SO5.5 definition and history of plankton.		**5.5** definition and history of plankton.	5.5. Study about definition and history of plankton.
	SO 5.6 role of plankton in fisheries.		5.6 Structure and Significance role of plankton in fisheries.	5.6. learn about Structure and Significance role of plankton in fisheries.
	SO5.7 explain the basic steps involved in maintaining a home aquarium?		5.7 What are the basic steps involved in maintaining a home aquarium?	
	SO5.8 describe and define the test and adjust the pH level in an aquarium?		5.8 How can you test and adjust the pH level in an aquarium?	
	SO5.9 discuss the **methods** and reduce ammonia and nitrite levels in an aquarium?		5.9 What methods can be used to manage and reduce ammonia and nitrite levels in an aquarium?	
	SO5.10 explain filtration systems are commonly used in aquariums, and how do they work?		5.10 What types of filtration systems are commonly used in aquariums, and how do they work?	
	SO5.11 describe the role of an aquarium air pump, and how should it be maintained?		5.11 What is the role of an aquarium air pump, and how should it be maintained?	
	SO5.12 describe common diseases in aquarium fish, and how can they be treated or prevented?		5.12 What are some common diseases in aquarium fish, and how can they be treated or prevented?	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	study about types of aquariums
	SW5.2 Mini Project	definition and history of plankton.
	SW5.3 Other Activities (Specify)	Structure and Significance role of plankton in fisheries.

Course duration (in hours) to attain Course Outcomes:

Course Title: Aquaculture **Course Code:** 01ZO502

Course Outcomes(COs)	Class lecture (CI)	Laboratory Instruction(LI)	Sessional work (SW)	Self-Learning (SL)	Total Hours (Li+CI+SL+SW)
01ZO502 **.1.** Gain knowledge about importance of Aquaculture, history and traditional of aquaculture.	12	06	1	4	23
01ZO502 **.2.** To describe unique prawn culture history and methods.	12	06	1	4	23
01ZO502 **.3.** To recognize importance and uses of edible oyster and pearl culture.	12	06	1	5	24
01ZO502 **.4.** To critically analyze fresh water edible fishes, marine water edible fishes, and carp culture.	12	06	1	5	24
01ZO502 **.5.** To Learn about the types and importance of aquarium and polyculture.	12	06	1	6	25
Total Hours	60	30	05	24	119

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Aquaculture **Course Code:** 01ZO502

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
01ZO502 **.1.** Gain knowledge about importance of Aquaculture, history and traditional of aquaculture.	3	1	1	4	09
01ZO502 **.2.** To describe unique prawn culture history and methods.	4	4	1	2	11
01ZO502 **.3.** To recognize importance and uses of edible oyster and pearl culture.	2	3	3	2	10
01ZO502 **.4.** To critically analyze fresh water edible fishes, marine water edible fishes, and carp culture.	2	3	3	2	10
01ZO502 **.5.** To Learn about the types and importance of aquarium and polyculture.	2	3	3	2	10
Total Marks	**13**	**14**	**11**	**12**	**50**

***Legend*:A,** Apply ;**An,** Analyze; **E,** Evaluate;**C,** Create

Suggested learning Resources:

(a) Books:

(b)

S.No.	Title/Author/Publisher details
1	Pillay T.V.R. Aquaculture, principle and practice wiley Int.
2	Rath, RK “fresh water aquaculture” scientific publisher jodhpur 1993
3	Shukla, GS , Upadhyaya , VB Economic Zoology , Rastogi publication meerat 2014
4	Modem Textbook of Invertebrates R. Kotpal, Rastogi Publications ,Meerat, 2017
5	Books published by mp hindi granth academy Bhopal

(c) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Demonstration
7. ICT Based teaching Learning
8. Brainstorming

CO, PO and PSO Mapping

Program Name: B.Sc Biology
Semester: 5th Semester
Course Title: Aquaculture
Course Code: 01ZO502

CO/PO/PSO Mapping								
Course Outcome (Cos)	**Program Outcomes (POs)**					**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**
01ZO502 **.1.** Gain knowledge about importance of Aquaculture, history and traditional of aquaculture.	2	2	2	2	1	2	2	3
01ZO502 **.2.** To describe unique prawn culture history and methods.	1	1	2	2	2	1	2	3
01ZO502 **.3.** To recognize importance and uses of edible oyster and pearl culture.	2	1	2	3	2	2	1	3
01ZO502 **.4.** To critically analyze fresh water edible fishes, marine water edible fishes, and carp culture.	2	1	1	3	3	1	3	3
01ZO502 **.5.** To Learn about the types and importance of aquarium and polyculture.	1	1	3	2	2	1	2	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5 PSO 1,2,3	01ZO502 **.1.** Gain knowledge about importance of Aquaculture, history and traditional of aquaculture.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	1.1,1.2,1.3	1.1, 1.2, 1.3, 1.4, 1.5 1.6, 1.7, 1.8, 1.9, 1.10, 1.11, 1.12	1SL-1,2,3,4
PO 1,2,3,4,5 PSO 1,2,3	01ZO502 **A.2.** To describe unique prawn culture history and methods.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	2.1, 2.2, 2.3	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.10, 2.11, 2.12	2SL-1,2,3,4
PO 1,2,3,4,5 PSO 1,2,3	01ZO502 **.3.** To recognize importance and uses of edible oyster and pearl culture.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	3.1,3.2,3.3	3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 3.10, 3.11, 3.12	3SL-1,2,3,4,5
PO 1,2,3,4,5 PSO 1,2,3	01ZO502 **.4.** To critically analyze fresh water edible fishes, marine water edible fishes, and carp culture.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	4.1,4.2,4.3	4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12	4SL-1,2,3,4,5
PO 1,2,3,4,5 PSO 1,2,3	01ZO502 **.5.** To Learn about the types and importance of aquarium and polyculture.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	5.1,5.2,5.3	5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10, 5.11, 5.12	5SL-1,2,3,4,5,6

AKS University

Faculty of Basic Science

Curriculum of B. Sc. (Honours / By Research) Program

(Revised as on 01 August 2023)

B.Sc. Vth Semester

Course CODE: 01CH503

Course Titel: Green Chemistry

Pre-requisite: Students should have basic knowledge of chemistry

Rtional: After completion of course student will promote, develop and design environment benign chemical process and products.

COURSEOUTCOMES:

Afterthe completion of this course, the learner will

CO1 **01CH503.1**: Explain and apply concept and principle of green chemistry
CO2 **01CH503.2**: Design environment sustainable and economical route of a synthesis.
CO3 **01CH503.3**: Adopt renewable and alternate resources of energy in various processes
CO4 **01CH503.4**: Solve environmental issues by adopting the principle of green chemistry

UNIT I

PRINCIPLES & CONCEPT OF GREEN CHEMISTRY: Introduction, Concept and Principles, development of Green Chemistry, Atom economy reactions–rearrangement reactions, addition reactions, atom uneconomic-sublimation,elimination, Wittig reactions, toxicity measures, Need of Green Chemistry in our day-to-day life.

UNIT II

EMERGING GREEN TECHNOLOGY AND ALTERNATIVE ENERGY SOURCES :

Design for Energy efficiency, Photo-chemical reactions, Advantages & Challenge faced by photochemical process. Microwave technology on Chemistry, Microwave heating, Microwave assisted reactions, Sono chemistry and Green Chemistry, Electrochemical Synthesis, Examples of Electrochemical synthesis.

UNIT III

RENEWABLE RESOURCES: Biomass, Renewable energy, Fossil fuels, Energy from Biomass, SolarPower, Otherformsofrenewableenergy,FuelCells,Alternativeeconomics,Syngaseconomy,hydrogeneconomy, Some other natural chemical resources.

UNIT IV

INDUSTRIAL CASE STUDIES: Methyl Methacrylate (MMA), Greening of Acetic acid manufacture, Dyeing,

Application, Polyethylene, Ziegler-Natta Catalysis, Metallocene Catalysis, Eco friendly Pesticides-Insecticides.

AKS University

Faculty of Basic Science

Curriculum of B. Sc. (Honours / By Research) Program

(Revised as on 01 August 2023)

Scheme of Studies:

Board ofStudy	CourseCode	CourseTitle	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours(Cl+LI+SW+SL)	
ProgramCore(DCC)	01CH503	Green Chemistry	4	0	1	1	6	4

Legend: **CI:** Class room Instruction (Includes different in structional strategies i.e. Lecture (L) andTutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other location susing different in structional strategies)
SW: Sessional Work (includes assignment, seminar, mini-project etc.),
SL: Self Learning,

C: Credits.

Note: SW& SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme o fAssessment: Theory

Board of Study	Couse Code	Course Title	SchemeofAssessment(Marks)						
			ProgressiveAssessment(PRA)					EndSemesterAssessment	Total Marks
			Class/HomeAssignment5number 3 mark seac h (CA)	Class Test2 (2bestoutof3) 10 marks each(CT)	Seminar one (SA)	ClassAttendance (AT)	TotalMarks (CA+CT+SA+AT)	(ESA)	(PRA+ESA)
DCC	01CH503	Green Chemistry	15	20	10	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

01CH503.1: explain and apply concept and principle of green chemistry

Activity	AppX Hrs
Cl	10
LI	0
SW	2
SL	1
Total	09

Session Outcomes (SOs)	Laboratory Instruction(LI)	Class room Instruction(CI)	Self Learning (SL)
SO1.1 understand basics of green chemistry SO1.2 explain basic principles ofgreen chemistry SO1.3 understand rearrangements reactions SO1.4 Explain addition reactions,atom uneconomic- sublimation , elimination,witting reactions SO1.5 Understand need of green chemistry in our day to day life		Unit-1 1.1Introduction, Concept andPrinciples, 1.2DevelopmentofGreenChemistry, 1.3Atomeconomyreac tions–rearrangementreactio ns, 1.4Additionreactions,atomuneconomic-sublimation, elimination, Wittig reactions 1.5Toxicity measures, 1.6NeedofGreenChemi stryin our day-to- daylife. 1.8 applications	Understand need of green chemistry day today life.

SW-1SuggestedSessionalWork(SW):

a. Assignments: Discuss the principle of green chemistry and their synthesis
b. Mini Project:
chart on uses of green chemistry in day to day life
c. Other Activities (Specify):
Note on green synthesis reactions

01CH503: 2: design environment sustainable and economical route of a synthesis.

Activity	AppX Hrs
Cl	07
LI	0
SW	2
SL	1
Total	10

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 Understand greensynthesis techniques **SO2.2** Explain alternative energysources **SO2.3** Understand photochemical reactions and advantages and challenges facedby photochemical process **SO2.4** Explain Microwave technology , microwave heatingand microwave assisted reactions **SO2.5** Understand sono chemistry ,Green chemistry & Electrochemical synthesis		**Unit-2:** Design for Energy efficiency, Photochemical reactions, Advantages & Challenge faced byphotochemical process. 2.4Microwavetechnology onChemistry, 2.5Microwave heating, and Microwave assisted reactions, T-1SonochemistryandGreenChemistry,T-2 Electrochemical Synthesis, Examples of Electrochemical synthesis.	Studied different type of green synthesis techniques.

with example			

SW-2 Suggested Sessional Work (SW):

a. **Assignments:**
Apply different type of green synthesis techniques.

b. ***Mini Project:***

Prepare chart on green synthesis techniques.

c. ***Other Activities (Specify):***

Write an essay on sono chemistry and green chemistry

01CH503.3:Adoptrenewable andalternate resourcesof energy in various processes

Activity	AppX Hrs
Cl	10
LI	0
SW	2
SL	1
Total	10

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (Cl)	Self Learning (SL)

SO3.1 Describe basics of Renewable resources **SO3.2** Explain Biomass ,Renewable energy & Fossil fuels **SO3.3** Explain Solar power & other forms of renewable energy and fuels **SO3.4** Understand alternative economics ,syngas economy and hydrogen economy **SO3.5** Explain some other natural chemical resources		**Unit-3 3.1** Biomass, Renewable energy from Fossil fuels, Energy fromBiomass SolarPower, Otherformsofrenewableenergy,FuelCells, Alternativeeconomics, T-1Syngaseconomy,hydrogeneconomy, T-2 Someothernaturalchemical resources.	Learn some other natural chemical resources

SW-3 Suggested Sessional Work (SW):

a. **Assignments:** Discuss the renewable energy resources

b. **Mini Project:** Pictorial presentation of renewable energy

c. ***Other Activities (Specify):***

Explanatory note on importance of renewable resources

01CH503.4: Solve environmental issues which can be solved by adopting the principle of green chemistry

Activity	AppX Hrs
Cl	10
LI	0
SW	2
SL	1
Total	10

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning(SL)
SO4.1 Discuss basics of industrial case studies **SO4.2** Explain Methyl Methacrylate & greening of acetic acid **SO4.3** Explain and apply dyeing and its application **S04.4** Explain polyethylene , Ziegler Natta Catalysis ,Metallocene catalysis, Ecofriendly pesticides-insecticides		**Unit-4** 4.1Methyl Methacrylate (MMA), 4.2 Greening of Acetic acid manufacture, 4.3Dyeing, Application, Polyethylene, Ziegler-Natta Catalysis,T-1 Metallocene Catalysis,T-2 Eco friendlyPesticides-Insecticides.	Eco friendly pesticides &insecticides

SW-4 Suggested Sessional Work (SW):

a. **Assignments:**
Note on natural dyes

b. ***Mini Project:***

Prepare chart on Ziegler-Natta catalysis.

c. ***Other Activities (Specify):***

Importance and applications of greening of acetic acid manufacture.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
01CH503.1: Explain and apply concept and principle of green chemistry .	10	02	01	10
01CH503.2 Design Environment sustainable and economical routeof a synthesis	12	02	01	12

01CH503.3: Adopt renewable and alternate resources of energy in various processes	10	02	01	10
01CH503.4: Solve environmental issues which can be solved by adopting the principle of green chemistry	10	04	02	10
Total Hours	42	12	06	60

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Principle & Concept of Green Chemistry	03	01	01	05
CO-2	Emerging Green Technology and Alternative Energy sources	02	06	02	10
CO-3	Renewable resources	03	07	05	15
CO-4	Industrial case studies	-	10	05	15
Total		11	26	13	50

Legend:R:Remember, U:Understand, A:Apply

The end of semester assessment for Organic Chemistry I willbeheldwithwrittenexaminationof50 marks

Note.DetailedAssessmentrubricneedtobepreparedbythecoursewiseteachersforabovetasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

28. Improved Lecture

29. Tutorial
30. Case Method
31. Group Discussion
32. Role Play
33. Visit to NCL, CSIR laboratories
34. Demonstration
35. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, Whatsapp, Mobile, Online sources)
36. Brainst

Suggested Learning Resources:

(j) Books:

S. No.	Title	Author	Publisher	Edition& Year
1	GreenChemistryandIntroductorytext,	MikeLancaster,		IIEdition
2	P.T.AnastasandJ.C Warner,GreenChemistrytheoryandPractice	V Kumar	OxfordUniversitypress,Oxford	OxfordUniversitypress,Oxford(1988)
3	ATextBookofGreen Chemistry	Sankar P. Dey Nayim Sepay	ProttiD.Dondi*et.al.,* GreenChemistry	
4	Green Chemistry A Text Book	V.K. Abdullah		
5	An Introductory Text on Green Chemistry	Indu Tucker Sidhwani Rakesh K. Sharma	Wiley	Blaclwell ,London (2007)

SuggestedWebSources:

32. https://nptel.ac.in/course.html
33. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
34. https://swayam.gov.in/explorer?category=Chemistry

ModeofDelivery:Lecture,demonstration,E-tutoring,discussion,assignments,quizzes, case study, power point

LMS/ICT Tools: Digital Classrooms, DLMS, ZOOM, G-Suite,MS Power-Point, Online Resources

Cos, Pos and PSOs Mapping

Title: Green Chemistry **Course Code : 01CH503**

	Program Outcomes												Program Specific Outcome			
	PO1	PO 2	PO3	PO4	PO5	PO 6	PO7	PO8	PO9	PO1 0	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
Course Outcomes	Kno wl edge	Res e arc h Apt i tud e	Com mun ic atio n	Prob l em Solvi ng	Indi vi dual and Tea m Wor k	Inv e stig a tio n of Pro b lem s	Mod er n Tool usag e	Scie nce and Soci ety	Life- Long Lear ning	Ethi cs	Projec t Mana ge ment	Enviro n ment and sustai na bility	The detailed functional knowledg e of theoretica l concepts and experimen talaspects of chemistry	To integrate the gained knowledge with various contempor ary and evolving areas in chemical sciences like analytical, synthetic, pharmaceut ical etc.	understan d, analyze, planand implement qualitative aswell as quantitativ e analytical synthetic and phenomen on -based problems inchemical sciences.	Provide opportunit ie s to excel in academics , research or Industry by research based innovative knowledg e for sustainabl e developm entin chemical science

CO1 Explain and apply conceptand principle of green chemistry .	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO 2 Design environmentsustainable and economicalroute ofasynthesis	2	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3 Adopt renewable and alternate resources of energyin various process	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO 4: Solve environmental issues which can be solved by adopting the principle of green chemistry	2	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2

Legend:1–Low,2–Medium, 3–High

.

Curriculum Map:

POs &PSOsNo.	COsNo.&Titles	SOsNo.	Laboratory Instruction(LI)	Classroom Instruction(CI)	Self Learning(SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1Explain and apply concept and principle of green chemistry	SO1.1 SO 1.2 SO1.3 SO1.4 SO1.5		Unit-1.0 Principle & Concept of Green Chemistry 1.1,1.2,1.3,1.4,1.5, T-1,T-2	Understand need of green chemistry day to day life
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 2: Design environmentsustainablea ndeconomicalroute ofasynthesis	SO2.1 SO 2.2 SO2.3 SO2.4 SO2.5		Unit-2 Emerging Green Technology and Alternative Energy sources 2.1,2.2,2.3,2.4,2.5, T-1,T-2	. Studied different type of green synthesis techniques
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3 : Adopt renewable and alternate resources of energy in various process	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5		Unit3 Renewable resources 3 3.1, 3.2,3.3,3.4,3.5,T-1,T-2	Understand natural chemical resources
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4: : Solve environmental issues which can be solved by adopting the principle of green chemistry	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5		Unit-4 : Industrial case studies 4.1, 4.2,4.3,4.4,4.5,T-1,T-2	Eco friendly pesticides & insecticides

Curriculum Development Team:

AKS University

Faculty of Basic Science

Curriculum of B. Sc. (Honours / By Research) Program

(Revised as on 01 August 2023)

1. Dr. Shailendra Yadav, HoD, Department of Chemistry, AKS University, Satna (M.P.).
2. Dr. Dinesh Kumar Mishra, Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
3. Dr. Samit Kumar,Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
4. Dr. Sushma Singh, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
5. Dr. Manoj Kumar Sharma, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
6. Mr. Kanha Singh Tiwari,Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
7. Mrs. Nahid Usamani, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).

Program Name	**Bachler of Science (B.Sc.) BIOLOGY**	
Semester	5th	
Course Code:	05BO501	
Course title:	Ecology and Forestry	**Curriculum Developer**: Dr. Keerti Samdariya, Assistant Professor
Pre-requisite:	To study this course, a student must have had the subject botany in class Il year/ diploma	
Rationale:	The paper on Ecology and Forestry in B.Sc biology program explores the role of biomolecules and their metabolic activity in microbial systems. The living systems synthesize four primary types of biomolecules within the body. This study enables Students to learn how biomolecules promote different biological processes, which are necessary for life. They vary in structures and sizes. metabolism is a complex process that is essential for the body to function properly.	
Course Outcomes (COs):	**CO1:** Understand the basic concepts of Introductory Ecology.	
	CO2: Extend Ecological factor like soil, water, light, temperature etc.	
	CO3: Understanding Ecosystems and their types.	
	CO4: To become familiar with the Phytogeography.	
	CO5: Apply the ideas and concept of Forestry and Forest factors.	

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C) (L: T: P=3:0:1)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Discipline Specific Elective (DSE)	05BO501	Ecology and Forestry	3	1	1	1	6	3+1=4

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title		Scheme of Assessment (Marks)		
				Progressive Assessment (PRA)	End Semester Assessment	Total Marks

			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CAT+CT+SA+AT)	(ESA)	(PRA+ESA)
Discipline Specific Elective (DSE)	05BO501	Ecology and Forestry	**15**	**20**	**5**	**5**	**5**	**50**	**50**	**100**

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	9	04	01	03	17

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO1: Understand the basic concepts of Introductory Ecology.	**SO1.1** Explain the definition, branches and importance of Ecology. .	**LI 1.1** Identification of locally available plant species and listing with botanical name, family, and uses	**CI 1.1** Explain the definition, branches and importance of Ecology. .	**SL1.1** Explain analytical and synthetic characters of Synecology community.
	SO1.2 Explain Interrelationships between Life and environment.	**LI 1.2** To determine soil and water pH and conductivity	**CI 1.2** Explain Interrelationships between Life and environment.	**SL1.2** Explain the Characters, dynamics, and ecological speciation of population ecology.
	SO1.3 Define Synecology and types of community.		**CI 1.3** Define Synecology and types of community.	
	SO1.4 Explain analytical and synthetic characters of Synecology community		**CI 1.4** Explain analytical and synthetic characters of Synecology community	
	SO1.5. Explain Succession and their types and the process of Succession.		**CI 1.5**. Explain Succession and their types and the process of Succession.	
	SO1.6 Explain Population ecology.		**CI 1.6** Explain Population ecology.	

	SO1.7 Explain the Characters, dynamics, and ecological speciation of population ecology.		**CI 1.7** Explain the Characters, dynamics, and ecological speciation of population ecology.	
	SO1.8 Explain the following terms- Ecotone, Ecads.		**CI 1.8** Explain the following terms- Ecotone, Ecads.	
	SO1.9 Explain the following terms- Ecotype, Ecospecies, and Edge effect.		**CI 1.9** Explain the following terms- Ecotype, Ecospecies, and Edge effect.	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Differentiate between First and second law of thermodynamics.
	SW3.2 Mini Project	Explain following terms- Ecotone, Ecads, Ecotype, Ecospecies, and Edge effect.
	SW3.3 Other Activities (Specify)	Find out some you tube videos on Edge effect .

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	9	04	01	03	17

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO2: Extend Ecological factor like soil, water, light, temperature etc.	**SO2.1** Give an introduction about Ecological factos.	**LI 2.1** Study of frequency, density, and abundance of vegetation	**SO2.1** Give an introduction about Ecological factos.	**SL2.1** Understand the Distribution and precipitation types of Water. (Rain, fog, snow, hail, dew).

	SO2.2 Explain the Importance, origin, and formation of soil. Gives details on soil texture, soil profile, and components.	**LI 2.2** Soil testing (sulfate, carbonates, nitrates)	**SO2.2** Explain the Importance, origin, and formation of soil. Gives details on soil texture, soil profile, and components.	**SL2.2** Explain Types of radiation, variations, and adaptations in the plants.
	SO2.3 Understand the Distribution and precipitation types of Water. (Rain, fog, snow, hail, dew)		**SO2.3** Understand the Distribution and precipitation types of Water. (Rain, fog, snow, hail, dew)	
	SO2.4 Understand the hydrological cycle. and the effect of light on the plants.		**SO2.4** Understand the hydrological cycle. and the effect of light on the plants.	
	SO2.5 Explain Types of radiation, variations, and adaptations in the plants.		**SO2.5** Explain Types of radiation, variations, and adaptations in the plants.	
	SO2.6 Explaining the effect of Temperature. Explain the Types of plants according to temperature, variation.		**SO2.6 E**xplaining the effect of Temperature. Explain the Types of plants according to temperature, variation.	
	SO2.7 Explain the adaptations in the plants according to the temperature.		**SO2.7** Explain the adaptations in the plants according to the temperature.	

	SO2.8 Explain variation and adaptation in the plants by Fire.		**SO2.8** Explain variation and adaptation in the plants by Fire.	
	SO2.9 Explain the Biotic Factors.		**SO2.9** Explain the Biotic Factors.	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Explain the Types of plants according to temperature, variation.
	SW2.2 Mini Project	Draw ray diagram of Biotic Factors.
	SW2.3 Other Activities (Specify)	Find out some you tube videos based on soil profile.

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	9	04	01	03	17

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO3: Understanding Ecosystems and their types.	**SO3.1** Illustrating general introduction about Ecosystem. And their Structure components, and Trophic level.	**LI 3.1** Determination of water holding capacity of different soil samples	Unit-3 CI 3.1 Illustrating general introduction about Ecosystem. And their Structure components, and Trophic level.	**SL3.1** Discuss Oxygenic and an-oxygenic microorganisms, structure of chloroplast

	SO3.2 Explain about Concept of Energy flow and Energy flow models. Differentiate Food chain, and Food web.	**LI 3.2** Study of biotic interaction: Cuscuta (Stem Parasite), Orobanche (Root parasite) etc.	CI 3.2 Explain about Concept of Energy flow and Energy flow models. Differentiate Food chain, and Food web.	**SL3.2** Read Biosynthesis of lipids and fatty acids, triglycerol and phospholipids and their regulation.
	SO3.3 Explain Productivity and its types.		CI 3.3 Explain Productivity and its types.	
	SO3.4 Explain Autotrophy, and heterotrophy with examples.		CI 3.4 Explain Autotrophy, and heterotrophy with examples.	
	SO3.5 Explain symbiosis and commensalism and proto-cooperation.		CI 3.5 Explain symbiosis and commensalism and proto-cooperation.	
	SO3.6 Illustrate these terms Parasitism, amensalism, predation.		CI 3.6 Illustrate these terms Parasitism, amensalism, predation.	
	SO3.7 **Give the** Definition, concept Ecological pyramids.		CI 3.7 **Give the** Definition, concept Ecological pyramids.	
	SO3.8 Explain the Biogeochemical cycle: Carbon, nitrogen cycle.		CI 3.8 Explain the Biogeochemical cycle: Carbon, nitrogen cycle.	
	SO3.9 Explain the Biogeochemical cycle: sulfur, and phosphorus cycle.		CI 3.9 Explain the Biogeochemical cycle: sulphur, and phosphorus cycle.	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Describe in detail on Biogeochemical cycle: Carbon, nitrogen cycle.
	SW3.2 Mini Project	Describe Ecological pyramids.
	SW3.3 other activity	Find out some you tube videos based on Parasitism, amensalism, predation.

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	06	01	02	18

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO4: To become familiar with the Phytogeography.	**SO4.1** Illustrating general introduction about Phytogeography.	**LI 4.1** Field visit of pond, river, forest, and grassland ecosystem	**Unit-4** **CI 4.1** Illustrating general introduction about Phytogeography.	**SL4.1** Learn Phytogeographical divisions of India.
.	**SO4.2** Explaining Continental drift and endemism.	**LI 4.2** Study of Xerophytic adaptation (Cactus, Nerium leaf etc.)	**CI 4.2** Explaining Continental drift and endemism.	**SL4.2** Explain about Forest types of M.P.
	SO4.3 Explain about terrestrial biomes: Forest, Grassland, Desert.	**LI 4.3** Study of hydrophytic adaptation (Hydrill Trapa etc.)	**CI 4.3** Explain about terrestrial biomes: Forest, Grassland, Desert.	
	SO4.4 Explain about terrestrial biomes: Tai, Tundra.		**CI4.4** Explain about terrestrial biomes: Tai, Tundra.	

	SO4.5 Illustrate Phytogeographical divisions of India		**CI4.5** Illustrate Phytogeographical divisions of India	
	SO4.6 Explain in detail Forest types of M.P.		**CI4.6** Explain in detail Forest types of M.P.	
	SO4.7 Explain in detail vegetation of M. P.		**CI4.7** Explain in detail vegetation of M. P.	
	SO4.8 Explain in detail Grassland of M.P.		**CI4.8** Explain in detail Grassland of M.P.	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Illustrating terrestrial biomes: Tundra.
	SW4.2 Mini Project	Describe the Grassland of M.P.
	SW4.3 Other Activities (Specify)	Find out some you tube videos on terrestrial biomes: Desert.

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	06	01	03	19

Course outcome	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction**	**Self-Learning (SL)**

(CO)			(CI)	
CO5: Apply the ideas and concept of Forestry and Forest factors.	**SO5.1** Illustrating general introduction about Forestry.	**LI 4.1** The minimum size of the Quadrate required for Vegetation	**Unit-5** **CI5.1** Illustrating general introduction about Forestry.	**SL5.1** Explain types of Forest.
	SO5.2 Elucidate Definition, past and present distribution and status of forestry.	**LI 4.2** Minimum number of Quadrates required for the study a vegetation	**CI5.2** Elucidate Definition, past and present distribution and status of forestry.	**SL5.2** Describe Social Forestry and Agroforestry.
,	**SO5.3** Explain types and Importance of Forest.	**LI 4.3** Maximum and Minimum Thermometer Psychrometer	**CI5.3** Explain types and Importance of Forest.	
	SO5.4 Explain Deforestation, its Causes and consequences.		**CI5.4** Explain Deforestation, its Causes and consequences.	
	SO5.5 Define Afforestation. Explain practices.		**CI5.5** Define Afforestation. Explain practices.	
	SO5.6 Describe Social Forestry and Agroforestry.		**CI5.6** Describe Social Forestry and Agroforestry.	
	SO5.7 Explain Biotic Forest factors.		**CI5.7** Explain Biotic Forest factors.	
	SO5.8 Explain Abiotic Forest factors.		**CI5.8** Explain Abiotic Forest factors.	
	SO5.9 Explain Role of Remote sensing in forest management		**CI5.9**Explain Role of Remote sensing in forest management.	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Explain Deforestation, its Causes and consequences.

	SW5.2 Mini Project	Explain Role of Remote sensing in forest management.
	SW5.3 Other Activities (Specify)	Prepare one article explaining past and present distribution and status of forestry.

Course duration (in hours) to attain Course Outcomes:

Course Title: Ecology and Forestry **Course Code:** 05BO501

Course Outcomes (COs)	**Class lecture (CI)**	**Laboratory Instruction (LI)**	**Self-Learning (SL)**	**Sessional work (SW)**	**Total Hours (Li+CI+SL+SW)**
CO1: Understand the basic concepts of Introductory Ecology.	09	4	3	1	17
CO2: Extend Ecological factor like soil, water, light, temperature etc.	09	4	3	1	17
CO3: Understanding Ecosystems and their types.	09	4	3	1	17
CO4: To become familiar with the Phytogeography.	09	6	2	1	18
CO5: Apply the ideas and concept of Forestry and Forest factors.	09	6	3	1	19
Total Hours	45	24	14	05	88

End-semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Ecology and Forestry **Course Code:** 05BO501

Course Outcomes	**Marks Distribution**				**Total Marks**
	A	**An**	**E**	**C**	
CO1: Understand the basic concepts of Introductory Ecology.	2	1	1	1	5
CO2: Extend Ecological factor like soil, water, light, temperature etc.	2	4	2	2	10
CO3: Understanding Ecosystems and their types.	3	5	5	2	15
CO4: To become familiar with the Phytogeography.	2	3	3	2	10
CO5: Apply the ideas and concept of Forestry and Forest factors.	5	4	1	0	10
Total Marks	**14**	**17**	**12**	**07**	**50**

***Legend*: A,** Apply; **An,** Analyze; **E,** Evaluate; **C,** Create

Suggested learning Resources:

(a) Books:

S.No.	**Title/Author/Publisher details**
1	Odum, E.P. Cengage Fundamentals of ecology. Learning India Pvt. Ltd., New Delhi. 5th edition.
2	Singh, J.S., Singh, S.P., Gupta, S. Anamaya Ecology Environment and Resource Conservation Publications, New Delhi, India.
3	Sharma, P.D. Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
4	Kormondy, E.J Concepts of ecology PHI Learning Pvt. Ltd., Delhi, India. 4th edition. (1996).

Suggested instructions/Implementation strategies:

1. Improved lecture

2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Visit to virology lab (BSL-3)
7. Demonstration
8. ICT Based teaching Learning
9. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Sc. Biology
Semester: 5th Sem
Course Title: Ecology and Forestry **Course Code:** 05BO501

CO/PO/PSO Mapping								
Course Outcome (Cos)	**Program Outcomes (POs)**					**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**
CO1: Understand the basic concepts of Introductory Ecology.	1	2	2	3	1	2	2	1
CO2: Extend Ecological factor like soil, water, light, temperature etc.	1	2	3	2	1	1	1	2
CO3: Understanding Ecosystems and their types.	1	2	3	2	1	1	1	1
CO4: To become familiar with the Phytogeography.	-	1	1	-	2	1	1	3
CO5: Apply the ideas and concept of Forestry and Forest factors.	1	1	1	-	-	1	3	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5 PSO 1,2,3	**CO1:** Understand the basic concepts of Introductory Ecology.	SO1.1 SO1.2 SO1.3 SO1.4, SO1.5, SO1.6, SO1.7, SO1.8. SO1.9	**LI 1,2**	1.1, 1.2, 1.3, 1.4,1.5,1.6,1.7,1.8,1.9,	**1SL-1,2**
PO 1,2,3,4,5 PSO 1,2,3	**CO2:** Extend Ecological factor like soil, water, light, temperature etc.	SO2.1 SO2.2 SO2.3 SO2.4, SO2.5, SO2.6 SO2.7, SO2.8 SO2.9.	**LI 1,2**	2.1, 2.2, 2.3,2.4,2.5,2.6,2.7,2.,2.9,	**2SL-1,2**
PO 1,2,3,4,5 PSO 1,2,3	**CO3:** Understanding Ecosystems and their types.	SO3.1 SO3.2 SO3.3 SO3.4, SO3.5, SO3.6, SO3.7, SO3.8, SO3.9,	**LI 1,2,3**	3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9,	**3SL-1,2**
PO 1,2,3,4,5 PSO 1,2,3	**CO4:** To become familiar with the Phytogeography.	SO4.1 SO4.2 SO4.3 SO4.4, SO4.5,SO4.6, SO4.6, SO4.7, SO4.8, SO4.9	**LI 1,2,3**	4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9,	**4SL-1,2**
PO 1,2,3,4,5 PSO 1,2,3	**CO5:** Apply the ideas and concept of Forestry and Forest factors.	SO5.1 SO5.2 SO5.3, SO5.4, SO5.5, SO5.6, SO5.7, SO5.8, SO5.9.	**LI 1,2**	5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,5.9,	**5SL-1,2**

Program Name	**Bachelor of Science (B.Sc.)- Biology**	
Semester	5th	
CourseCode:	05ZO552	
Coursetitle:	Wild life Conservation and Management	**Curriculum Developer**: Mr. Amit Bagri
Pre-requisite:	To study this course a student must have had the subject zoology in diploma.	
Rationale:	In this course, we shall discuss the several facets of wildlife conservation, including its importance and the threats being faced, and also how they are being managed in the field. We shall explore how to capture wild animals, how to treat them when needed, how to manage their habitats and their populations, and so on. We'll use the case study approach with real-life examples from the field to get a better understanding of this field and its applications.	
Course Outcomes (COs):	05ZO552 **.1.** Gain knowledge about importance of Wildlife and Conservation. 05ZO552 **.2.** To describe Wild life protection Act, National Park, National and international Organizations. 05ZO552 **.3.** To recognize threatened and endangered Species. 05ZO552 **.4.** To critically analyze Population estimation. 05ZO552 **.5.** To Learn about the Management of habitat and Animal Health.	

Scheme of Studies:

Board of Study	**Course Code**	**CourseTitle**	**Scheme of studies (Hours/Week)**					**Total Credits(C) (L:T:P=3:0:1)**
			Cl	LI	SW	SL	**Total Study Hours(CI+LI+SW+SL)**	
MAJOR DSC	05ZO552	Wild life Conservation and Management	3	1	1	1`	6	3+1=4

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory/ Practical

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks): Theory						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)		
Major DSC	05ZO552	Wild life Conservation and Management	**15**	**20**	**10**	**5**	**50**	**50**	**100**

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks): Practical						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)		
Major DSC	05ZO552	Wild life Conservation and Management	35	5	5	5	50	50	50

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

ApproximateHours

Item	Cl	LI	SW	SL	Total
Approx.Hrs	09	04	01	04	18

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
05ZO552 **.1.** Gain knowledge abo importance of Wildlife and Conservation.	**SO1.1** Define and Describe concept of Historical background of wildlife.	**LI1.1** Study of endangered species of wild animals.	**Unit 1** **Wildlife and Conservation**. **CI1.1** Concept of Wild life Historical background.	**SL1.1** Learn about Wild life Historical background.
	SO1.2 Describe about Important wild Animal in India		**CI1.2** learn about important wild life animals in India.	**SL1.2** learn about important wild life animals in India.
	SO1.3 Explain about Principals and conservations of management.	**LI1.2** Study of valuable products of wild life?	**CI1.3** Explain about Principals of management.	**SL1.3** Learn about Principals and conservations of management.
	SO1.4 Describe Causes of extinction of forests and wild life.		**CI1.4** Describe Causes of extinction of forests and wild life.	**SL1.4** Describe Causes of extinction of forests and wild life.
	SO1.5 Explain about conservations of management.		**CI1.5** Explain about conservations of management.	
	SO1.6 Explain about values of wild life?		**CI1.6** Study of values of wild life?	
	SO1.7 Explain about valuable products of wild life?		**CI1.7** Study of valuable products of wild life?	
	SO1.8 Explain about conservation ethics?		**CI1.8** Study of conservation ethics?	
	SO1.9 Explain about world wild life conservation strategy.?		**CI1.9** Study of world wild life conservation strategy.?	

Suggested Sessional Work (SW):*anyone*	**SW1.1** Assignments	Describe in Concept of Wild life Historical background.
	SW1.2 Mini Project	Explain about Principals and conservations of management.
	SW1.3 Other Activities (Specify)	Describe Causes of extinction of forests and wild life.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	09	02	01	04	16

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
05ZO552 **.2.** To describe Wild life protection Act, National Park, National and international Organizations.	**SO2.1** Explain about Indian board of wild life and wild life protection act.	**LI2.1** Study of national parks, Kanha, Bandhavgarh pench.	**Unit-II** **Wild life conservation Measure in India** **CI2.1** Explain about Indian board of wild life?	**SL2.1** Learn about Indian board of wild life and wild life protection act.
	SO2.2 Explain about Indian forest laws and their amendment.		**CI2.2** Explain about Indian forest laws and their amendment.	**SL2.2** Learn about Indian forest laws and their amendment.
	SO2.3 Explain about international and National Organizations.		**CI2.3** Explain about international Organizations.	**SL2.3** Learn about international and National Organizations.
	SO2.4 Explain about National park, Sanctuaries, and Biospheres reserve of India.		**CI2.4** Explain about National Park of India.	**SL2.4** Learn about National Park, Sanctuaries, and Biospheres reserve of India.
	SO2.5 Describe the role of Flora and fauna in protects areas.		**CI2.5** Describe the role of Flora and fauna in protects areas.	
	SO2.6 Describe Management challenges in Tiger reserves.		**CI2.6** Describe Management challenges in Tiger reserves.	
	SO2.7 Explain about wild life protection act.?		**CI2.7** Explain about wild life protection act.?	
	SO2.8 Explain about National Organizations.?		**CI2.8** Explain about National Organizations.	
	SO2.9 Explain about, Sanctuaries of India.		**CI2.9** Explain about, Sanctuaries of India.	

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Suggested Sessional Work (SW) : *anyone*	**SW2.1** Assignments	Explain about international and National Organizations.
	SW2.2 Mini Project	Describe the role of Flora and fauna in protects areas.
	SW2.3 Other Activities (Specify)	Describe Management challenges in Tiger reserves.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	09	02	01	04	16

Course Outcome (CO)	**Session Outcomes(SOs)**	**Laboratory Instruction(LI)**	**Class room Instruction (CI)**	**Self-Learning(SL)**
05ZO552 **.3.** To recognize threatened and endangered Species.	**SO3.1** Explain the Major thread of wild life.	**LI3.1** Demonstration of use of tags, collars, radio tracking equipment's	**Unit-III threatened and endangered Species**. **CI3.1** Explain the Major thread of wild life.	**SL3.1** Learn about IUCN categories of threatened plant and Animals.
	SO3.2 Describe concept of threatened Species.		**CI3.2** Describe concept of threatened Species.	**SL3.2** Learn about about Musk deer project, crocodile project and elephant project
	SO3.3 Describe IUCN categories of threatened plant and Animals.		**CI3.3** Describe IUCN categories of threatened plant and Animals.	**SL3.3** LEARN ABOUT the Project tiger.
	SO3.4 describe the Project tiger and Gir lion Project.		**CI3.4** describe the Project tiger.	**SL3.4** learn about Musk deer project.
	SO3.5 Describe about Musk deer project, crocodile project and elephant project.		**CI3.5** Describe about Musk deer project,	
	SO3.6 describe the Gir lion Project.		**CI3.6** describe the Gir lion Project.	
	SO3.7 Describe about crocodile project?		**CI3.7** Describe about crocodile project?	
	SO3.8 Describe about elephant project?		**CI3.8** Describe about elephant project?	
	SO3.9 Describes endangered species?		**CI3.9** Describes endangered species?	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Explain the Major thread of wild life.
	SW3.2 Mini Project	Describe IUCN categories of threatened plant and Animals.
	SW3.3 Other Activities (Specify)	Describe about Musk deer project, crocodile project and elephant project

Item	Cl	LI	SW	SL	Total
Approx.Hrs	09	04	01	04	18

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Classroom Instruction(CI)	Self-Learning(SL)
05ZO552 **.4.** To critically analyze Population estimation.	**SO4.1** Describe the Estimation and computation of population density, Natality, birth rate.	**LI4.1** Faeceal Analysis	**Unit-IV Population estimation.** **CI4.1** Describe the Estimation and computation of population density?	**SL4.1** Learn about Estimation and computation of population density, Natality, birth rate.
	SO4.2 Describe the Census method for density estimation of wilds animals.	**LI4.2** Study of diversity of birds and mammals	**CI4.2** Describe the Census method for density estimation of wilds animals.	**SL4.2** Discuss Census method for density estimation of wilds animals.
	SO4.3 Explaining the direct count method, kings census.		**CI4.3** Explaining the direct count method, kings census.	**SL4.3** Learn about direct count method, kings census.
	SO4.4 Explaining the faecal analysis of Ungulates and carnivores.		**CI4.4** Explaining the faecal analysis of Ungulates and carnivores.	**SL4.4** Learn about Estimation and computation of population Natality.
	SO4.5 Evaluate role of Management planning of wild life in protect areas.		**CI4.5** Evaluate role of Management planning of wild life in protect areas.	
	SO4.6 Describe the Estimation and computation of population Natality.		**CI4.6** Describe the Estimation and computation of population Natality.	
	SO4.7 Describe the Estimation and computation of birth rate.		**CI4.7** Describe the Estimation and computation of birth rate.	
	SO4.8 Describe the Estimation and computation of sex ratio?		**CI4.8** Describe the Estimation and computation of sex ratio?	
	SO4.9 explain about in direct count methods?		**CI4.9** Study about in direct count methods?	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Describe the Estimation and computation of population density, Natality, birth rate.
	SW4.2 Mini Project	Explaining the direct count method, kings census.
	SW4.3 Other Activities (Specify)	Explaining the faecal analysis of Ungulates and carnivores.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	09	04	01	04	18

Course Outcome (CO)	SessionOutcomes(SOs)	LaboratoryInstruction(LI)	ClassroomInstruction(CI)	Self-Learning(SL)
05ZO552 **.5.** To Learn about the Management of habitat and Animal Health.	**SO5.1** Define the concept of common diseases of wilds animals.	**LI5.1** Study of handling and treatment of injured and diseased animals?	**Unit-V** **Management of habitat and Animal Health.** **CI5.1** Define the concept of common diseases?	**SL5.1** learn about basic concept of common diseases of wilds animals.
	SO5.2 Describe the importance of forests, their conservation measure and management.	**LI5.2** explain the remote sensing and GIS.	**CI5.2** Describe the importance of forests?	**SL5.2** Describe the importance of forests, their conservation measure and management.
	SO5.3 explain the remote sensing and GIS .		**CI5.3** explain the remote sensing and GIS.	**SL5.3**learn remote sensing and GIS.
	SO5.4 Evaluate the role of tribal community in management of forest areas.		**CI5.4** Evaluate the role of tribal community in management of forest areas.	
	SO5.5 Explain the opportunities of employment in reserves forest area.		**CI5.5** Explain the opportunities of employment in reserves forest area.	
	SO5.6 Define the concept of wilds animals?		**CI5.6** Define the concept of wilds animals?	
	SO5.7 Describe the conservation measure and management.?		**CI5.7** Describe the conservation measure and management.?	
	SO5.8 explain the GIS.?		**CI5.8** explain the GIS.?	
	SO5.9 Explain the injured and diseased animals?		**CI5.9** Study of injured and diseased animals?	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Define the concept of common diseases of wilds animals
	SW5.2 Mini Project	explain the remote sensing and GIS.
	SW5.3 Other Activities (Specify)	Explain the opportunities of employment in reserves forest area.

Course duration (in hours) to attain Course Outcomes:

Course Title: Wild life Conservation and Management **Course Code:** 05ZO552

Course Outcomes(COs)	Class lecture (CI)	Laboratory Instruction(LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
05ZO552 **.1.** Gain knowledge about importance of Wildlife and Conservation.	09	4	4	1	18
05ZO552 **.2.** To describe Wild life protection Act, National Park, National and international Organizations.	09	2	4	1	16
05ZO552 **.3.** To recognize threatened and endangered Species.	09	2	4	1	16
05ZO552 **.4.** To critically analyze Population estimation.	09	4	4	1	18
05ZO552 **.5.** To Learn about the Management of habitat and Animal Health.	09	4	3	1	17
Total Hours	45	16	19	05	85

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Wild life Conservation and Management **Course Code:** 05ZO552

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
05ZO552 **.1.** Gain knowledge about importance of Wildlife and Conservation.	2	1	1	1	5
05ZO552 **.2.** To describe Wild life protection Act, National Park, National and international Organizations.	2	4	2	2	10
05ZO552 **.3.** To recognize threatened and endangered Species.	3	5	5	2	15
05ZO552 **.4.** To critically analyze Population estimation.	2	3	3	2	10
05ZO552 **.5.** To Learn about the Management of habitat and Animal Health.	5	4	1	0	10
Total Marks	**14**	**17**	**12**	**07**	**50**

***Legend*:A,** Apply;**An,** Analyze;**E,** Evaluate;**C,** Create

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1	Kotwal, P.C. and gopal , rajesh radio telemetry and field observation on territoriality of tigers in kanha national parks Vol 22 Nb 04 oct-dec- 1995
2	Shukla C.p. raj publications 2016
3	Mathur R wild life conservations and management Rastogi publications 2018
4	Tiwari S.K wild life in central india 3 vols sarup and sons publications new delhi 2004
5	

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Demonstration
7. ICT Based teaching Learning
8. Brainstorming

CO, PO and PSO Mapping

Program Name: B.Sc Biology
Semester: 5th Semester
Course Title: Wild life Conservation and Management
Course Code: 05ZO552

CO/PO/PSO Mapping								
Course Outcome (Cos)	**Program Outcomes (POs)**					**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**
05ZO552 **.1.** Gain knowledge about importance of Wildlife and Conservation.	2	3	2	1	1	2	2	1
05ZO552 **.2.** To describe Wild life protection Act, National Park, National and international Organizations.	3	1	1	3	2	1	2	2
05ZO552 **.3.** To recognize threatened and endangered Species.	2	2	2	1	2	1	2	3
05ZO552 **.4.** To critically analyze Population estimation.	2	1	1	2	2	2	2	3
05ZO552 **.5.** To Learn about the Management of habitat and Animal Health.	3	3	3	1	2	2	3	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5 PSO 1,2,3	05ZO552 **.1.** Gain knowledge about importance of Wildlife and Conservation.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9	1.1,1.2	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9	1SL-1,2,3,4
PO 1,2,3,4,5 PSO 1,2,3	05ZO552 **.2.** To describe Wild life protection Act, National Park, National and international Organizations.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9	2.1,	2.1,2.2,2.3,2.4,2.5, 2.6,2.7,2.8,2.9	2SL-1,2,3,4
PO 1,2,3,4,5 PSO 1,2,3	05ZO552 **.3.** To recognize threatened and endangered Species.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9	3.1	3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9	3SL-1,2,3,4
PO 1,2,3,4,5 PSO 1,2,3	05ZO552 **.4.** To critically analyse Population estimation.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8 SO4.9	4.1,4.2	4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9	4SL-1,2,3,4
PO 1,2,3,4,5 PSO 1,2,3	05ZO552 **.5.** To Learn about the Management of habitat and Animal Health.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9	5.1,5.2	5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,5.9	5SL-1,2,3

B.Sc. Vth Semester

Code: 05CH503

Course Name: Instrumental Technique in Chemistry

Pre-requisite: Student should have basic knowledge of Role of analytical chemistry, Errors and Evalution, Origin of water pollutants and their effects, Fuel analysis.

Rationale: The Course will provide applicable knowledge about General survey of instrumental techniques for the analysis of heavy metals in aqueous systems. drug analysis

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

CO1: **05CH503** Explain and apply theoretical aspect of analytical chemistry.
CO2: **05CH503**Analyse water, soil and biological fluid sample
CO3: **05CH503**Explain and identify the errors occurred during chemical analysis.
CO4: **05CH503** Handle glass ware and reagent in scientific way
CO5: **05CH503**Expertise in laboratory saftey

Unit I

Introduction - Role of analytical chemistry. Classification of analytical methods–classical and instrumental. Types of instrumental analysis. Selecting an analytical method. Neatness and cleanliness. Laboratory operations and practices. Analytical balance. Techniques of weighing, errors. Volumetric glassware cleaning and calibration of glassware. Sample preparations-dissolution and decomposition.Gravimetric techniques. Selecting and handling of reagents. Laboratory notebooks. Safety in the analytical laboratory.

UNIT II

Errors and Evalution- Definition of terms in mean and median. Precision-standard deviation, relatives standard deviation. Accuracy-absolute error.Types of error in experimental data- determinate (systmatic), indeterminate (or random) and gross.

UNITIII

Analysis of water pollutionp- Origin of water pollutants and their effects. Sources of water pollution domestic, industrial, agricultural soil and radioactive wastes as sources of pollution objectives of analysis-parameter for analysis-colour, turbidity,total solids, conductvity, acidity, alkalinity, hardness, chloride,sulphate,fluoride,silica,phosphates and different forms of nitrogen.Heavy metal pollution-public health significance of cadmium,chromium,copper,lead,zinc,manganese,mercury and arsenic. General survey of

instrumental techniques for the analysis of heavy metals in aqueous systems. Measurements of DO,BOD&COD. Pesticides as water pollutants and analysis. Water pollution laws and standards.

UNIT IV

Analysis of Soil, Fuel, Body Fluids and Drugs- (a) Analysis of soil: moisture,pH, total nitrogen , phosphorus, silica, lime, magnesia, manganese, sulphur and alkali salts.

(a) **Fuel analysis**: solid, liquid and gas.Ultimate and proximate analysis-heating values- grading coal. Liquid fuels-flash point, aniline point, octane number and carbon residue. Gaseous fuels-producer gas and water gas –calorific values

UNIT V

Analysis of Soil, Fuel, Body Fluids and Drugs

(a) Clinical chemistry: Composition of blood collection and preservation of samples. Clinical analysis .Serum electrolytes , blood glucose , blood urea nitrogen, uric acid, albumin,globulins, barbiturates, acid and alkaline phosphateses. Immunoassay principles of ratio immunoassay (RIA) and applications.The blood gas analysis trace elements in the body.

(b) Drug analysis: Narcotics and dangerous grug.Classification of drugs.Screening by gas and thin-layar chromatography and spectrophotometric measurement.

Scheme of Studies:

Board ofStudy	CourseCode	CourseTitle	Scheme ofstudies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours(Cl+LI+SW+SL)	
ProgramCore(PCC)	05CH503	Analytical Chemistry	4	0	1	1	5	4

Legend: **CI:**Class room Instruction (Includes different instructiona lstrategies i.e.Lecture (L)and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances inlaboratory workshop ,field or other locations using different instructional strategies)
SW: Sessional Work (includesassignment,seminar,miniprojectetc.),
SL: Self Learning,

C: Credits.

Note: SW& SL has to be planned and performed under the continuous guidance and feed back of teacher to ensure outcome ofLearning.

SchemeofAssessment:

Theory

Board of Study	Couse Code	Course Title	SchemeofAssessment(Marks)						
			ProgressiveAssessment(PRA)					EndSemesterAssessment (ESA)	Total Marks (PRA+ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test2 (2bestout of3) 10 marks each(CT)	Seminarone (SA)	ClassAttendance (AT)	TotalMarks (CA+CT+SA+AT)		
PCC	05CH503	Analytical Chemistry	15	20	10	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). Asthe course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

05CH503**.1**: Explain and apply theoretical aspect of analytical chemistry

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1

Total	15

Session Outcomes(SOs)	Laboratory Instruction (LI)	Class room Instruction(CI)	Self Learning(SL)
SO1.1 Explain Role of analytical chemistry. Classification of analytical methods –classsical and instrumental		Unit-1.0 Role of analytical chemistry. 1.1Classification of analytical methods –classsical and instrumental	Techniques of weighing, errors.
SO1.2 Explain Types of instrumentalanalysis. Selecting an analytical method.Neatness and cleanliness.Laboratory operations and practices.Analytical balance. SO1.3 Explain Techniques of weighing,errors. Volumetric glassware cleaning and calibrationof glassware. SO1.4 Explain Sample preparations-dissolution and decomposition.Gravimetric techniques. SO1.5 Understand and explain Selecting and handling of reagents.Laboratory notebooks.Safety in the analytical laboratory.		Explain Types of instrumental analysis. Selecting an analyticalmethod. Neatness and cleanliness. Laboratory operations and practices. Analytical balance. Techniques ofweighing,errors. Volumetric glassware cleaning and calibration ofglassware. Sample preparations- dissolution and decomposition. Gravimetric techniques. Selecting and handling of reagents. Laboratory notebooks. Safety in the analyticallaboratory.	

SW-

1SuggestedSessionalWork(SW):

a.Assignments:

Discuss Techniques of weighing,errors. Volumetric glassware cleaning and calibration ofglassware.

b.Mini Project:

Sample preparations-dissolution and decomposition.Gravimetric techniques.

c.Other Activities (Specify):

Note on applications of selecting and handling of reagents.laboratory notebooks.safety in the analyticallaboratory.

05CH503.2: Analyse water, soil and biological fluid sampl

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes(SOs)	Laboratory Instruction (LI)	Class room Instruction(CI)	Self Learning(SL)
SO2.1 Understand Errors and Evalution-Definition of terms in mean and median.Precision-standard deviation. SO2.2 Explain relatives standard deviation. SO2.3Explain Accuracy-absolute error. SO2.4 Explain types of error in experimental data determinate(systmatic). SO2.5 Understand and apply indeterminate(or random)and gross.		Unit-2.0 Errors and Evalution-2.1Introduction of errors and evalution. Introduction of terms in mean and median.Precision. Properties of the terms in meanand median.Precision. Definition of terms in mean and median.Precision-standard deviation. Introduction of relatives standard deviation. Properties of the relatives standard deviation. Importance of relatives standard deviation. Introduction of accuracy-absolute error. Mechanism of the accuracy-absolute error. T1- Types of error in experimental datadeterminate(systmatic). T2- Indeterminate(or random)and gross. T3-Importance of Indeterminate(or random)and gross.	Properties and types of error in experimental data determinate.

SW-2 Suggested Sessional Work (SW):

a.Assignments:

Apply Errors and Evalution-Definition of terms in mean and median.Precision-standard deviation,

b.Mini Project:

Types of error in experimental data-determinate(systmatic)

c.Other Activities (Specify):

Write an eassy on relatives standard deviation.Accuracy-absolute error.
05CH503.3: Explain and identify the errors occurred during chemical analysis

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Understand and apply Origin of water pollutants and their effects. Sources of water pollution domestic, industrial, agricultural soil and radioactive wastes as sources of pollution. **SO3.2** Explain objectives of analysis-parameter for analysis-colour,turbidity,total solids,conductvity,acidity,alkalinity, hardness,chloride,sulphate,fluoride, silica,phosphates and different forms of nitrogen. **SO3.3** Explain Heavy metal pollution-public health significance of cadmium, chromium, copper, lead,zinc,manganese,mercury and arsenic. **SO3.4** Explain General survey of instrumental techniques for the analysis of heavy metals in aqueous systems. Measurements of DO,BOD&COD. **SO3.5** Explain Pesticides as water		Unit-3. **Analysis of water pollution** Origin of water pollutants and their effects. Sources of water pollution domestic, industrial, agricultural. soil and radioactive wastesas sources of pollution. objectives of analysis-parameter for analysis-colour,turbidity,total solids. objectives of analysis-conductvity,acidity. objectives of analysis-alkalinity,hardness,chloride,sulphate. objectives of analysis-fluoride,silica,phosphates and different forms of nitrogen. Introduction and propertiesof heavy mketals. Heavy metal pollution-public health significance of cadmium, chromium, copper, lead,zinc,manganese,mercury and arsenic. T1-General survey of	. General survey of instrumental techniques for the analysis of heavy metals in aqueous systems.

pollutants and analysis. Water		instrumental techniques for the	
pollution laws and standards.		analysis of heavy metals in aqueous systems. T2-Measurements of DO,BOD&COD. T3-Pesticides as water pollutants and analysis. Water pollution laws and standards.	

SW-3 Suggested Sessional Work (SW):

a.Assignments:

Origin of water pollutants and their effects. Sources of water pollution domestic, industrial, agricultural soil and radioactive wastes as sources of pollution.

b.Mini Project:

Explain Heavy metal pollution-public health significance of cadmium, chromium, copper,lead,zinc,manganese,mercury and arsenic.

c.Other Activities (Specify):

Explain Pesticides as water pollutants and analysis. Water pollution laws and standards.

05CH503.**4:** Handle glass ware and reagent in scientific way.

Activity	AppX Hrs
CI	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes(SOs)	**Laboratory Instruction (LI)**	**Class room Instruction(CI)**	**Self Learning (SL)**
SO4.1 Explain and apply The Analysis of soil: moisture,pH,total nitrogen , phosphorus, silica, lime, magnesia, manganese, sulphur and alkali salts. **SO4.2** Explainanalysis of Fuelanalysis: solid, liquid and gas. **SO4.3** Explain the Ultimate and proximate analysis- heating values- grading coal. SO4.4Explain and apply Liquid fuels-flash point, aniline point, octane number and carbon residue. SO4.5 Explain and apply Gaseous fuels-producer gasand water gas – calorific values. chemistry.		Unit-4.0 Drug design, Pharmacokinetics & Pharmacodynamics The Analysis of soil: moisture,pH, total nitrogen. The Analysis of soil: phosphorus, silica, lime, magnesia. The Analysis of soil: manganese, sulphur and alkali salts. Introduction of Fuel analysis. Properties of fuel analysis. Fuel analysis.solid. liquid and gas. The Ultimate and proximate analysis. heating values- grading coal. T1- Liquid fuels-flash point, anilinepoint, T2- octane number and carbonresidue. T3-Gaseous fuels-producer gas andwater gas –calorific values. chemistry.	The Analysis of soil: moisture,pH, total nitrogen , phosphorus.

SW-4 Suggested Sessional Work (SW):

a.Assignments:

Explain and apply The Analysis of soil: moisture,pH, total nitrogen , phosphorus, silica, lime, magnesia, manganese, sulphur and alkali salts.

b.Mini Project:

Explainanalysis of Fuel analysis: solid, liquid and gas.

c.Other Activities (Specify):

Explain and apply Liquid fuels-flash point, aniline point, octane number and carbon residue.

05CH503.**5**: Expertise in laboratory safety.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 Explain and apply the Clinical chemistry: Composition of blood collection and preservation of samples **SO5.2** Explain Clinical analysis .Serum electrolytes , blood glucose , blood urea nitrogen, uric acid,	.	**5. Clinical Chemistry:** Composition of blood collection and preservation of samples. Introduction of Clinical analysis . blood urea nitrogen.	Properties of Barbiturates, acid and alkaline phosphateses.

albumin,globulins. **SO5.3** Explain and apply effect of substrate structure, leaving group andattacking nucleophile in aromatic nucleophilic reactions. **SO5.4**Explain and apply The blood gas analysis trace elements in the body. **SO5.5** Explain and apply The **Drug analysis**: Narcotics and dangerous grug.Classification of drugs.Screening by gas and thin-layar chromatography and spectrophotometric measurement		barbiturates, acid and alkaline phosphateses. Immunoassay principles of ratio immunoassay (RIA) and applications. The blood gas analysis trace elements in the body. Drug analysis: Narcotics and dangerous grug. Clinical analysis uric acid, Screening by gas and thin-layar chromatography and spectrophotometric measurement T1- Clinical analysis .Serum electrolytes , blood glucose. T2- Classification of drugs. T3-Properties of chromatography.	

SW-5 Suggested Sessional Work (SW):

a.Assignments:

Explain and apply effect of substrate structure, leaving group andattacking nucleophile in aromatic nucleophilic reactions.

b.Mini Project:

Clinical chemistry: Composition of blood collection and preservation of samples.

c.Other Activities (Specify):

Drug analysis: Narcotics and dangerous grug.Classification of drugs.Screening by gas and thin-layarchromatography and spectrophotometric measurement.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture(Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
76CH303.1: Explain and apply theoretical aspect of analytical chemistry.	12	02	01	15
76CH303.2 Analyse water, soil and biological fluid sample	12	02	01	15
76CH303.3: Explain and identify the errors occurred during chemical analysis	12	02	01	15
76CH303.4:Handle glass ware and reagent in scientific way	12	02	01	15
76CH303.5:Expertise in laboratory saftey	12	02	01	15
Total Hours	60	15	05	75

Suggestion for End Semester Assessment

Suggested Specification Table(ForESA)

CO	UnitTitles	MarksDistribution			Total Marks
		R	U	A	
CO-1	Introduction of analytical chemistry	03	01	01	05
CO-2	Errors and Evalution	02	06	02	10
CO-3	Analysis of water pollution	03	07	05	15
CO-4	Analysis of Soil, Fuel, Body Fluids and Drugs –I	-	10	05	15
CO-5	Analysis of Soil, Fuel, Body Fluids and Drugs -II	03	02	-	05
Total		11	26	13	50

Legend: R: Remember, U:Understand, A:Apply

The end of semester assessment for Medicinal Chemistry and Natural Product I will be heldwith written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the coursewise teachers for above tasks. Teachers can also design different tasks as per requirement,for end semester assessment.

Suggested Instructional/ImplementationStrategies:

1. ImprovedLecture
2. Tutorial
3. CaseMethod
4. GroupDiscussion
5. RolePlay
6. Visitto NCL, CSIR laboratories
7. Demonstration
8. ICTBasedTeachingLearning(VideoDemonstration/ T utorialsCBT,Blog,Facebook,Twitter,Whatsapp,Mo b ile,Onlinesources)
9. Brainstorming

Suggested Learning Resources:

(i) **Books:**

S. No.	Title	Author	Publisher	Edition& Year
1	A Textbook of Quantitative Inorganic Analysis	A. I. Vogel	Longman,	Edition,1966
2	Fundamentals of Analytical Chemistry	Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch	Cengage Learning, 2021	Edition, 2021
3	Physical methods in chemistry.	Drago, Russell S. ,MNB	Ft. Worth : Saunders College Pub.	Edition,2021
4	Introduction to magnetic resonance with applications to chemistry and chemical physics	Carrington, Alan	New York : Harper & Row	Edition,2019
5	Instrumentalmethodsof Analysis	L. L.Merrit, R.H. Willard and J.A. Dean;VanNostrand-Reinhold.	D. Van Nostrand & Co.	Edition,2023

SuggestedWebSources:

26. https://nptel.ac.in/course.html
27. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
28. https://swayam.gov.in/explorer?category=Chemistry

ModeofDelivery:Lecture,demonstration,E-tutoring,discussion,assignments,quizzes, case study, power point;

LMS/ICT Tools: Digital Classrooms, DLMS, ZOOM, G-Suite,MSPower-Point, Online Resources.

AKS University

Faculty of Basic Science

Curriculum of B. Sc. (Honours / By Research) Program

(Revised as on 01 August 2023)

Title: Instrumental Technique in Chemistry

Course Code : 05CH503

	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO 6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3	PSO 4
Course Outcomes	Know ledge	Re se arc h Ap ti tud e	Com mun ic atio n	Pro bl em Solv ing	Indi vi dua l and Tea m Wo rk	Inv e stig a tio n of Pro b le ms	Mod er n Tool usag e	Scie nc e and Soci ety	Life- Lon g Lear ning	Ethi cs	Proje ct Mana ge ment	Envir on ment and sustai na bility	The detailed functiona l knowledg e of theoretic al concepts and experime ntal aspects of chemistry	To integrate the gained knowledge with various contempor ary and evolving areas in chemical sciences like analytical, synthetic, pharmace utical etc.	understa nd, analyze, planand impleme nt qualitativ e aswell as quantitati ve analytical synthetic and phenome non -based problem s in chemica l sciences	Provide opportun itie s to excel in academic s, research or Industry by research based innovativ e knowledg e for sustainab le develop mentin chemical science

															.	
CO1:Explain and apply theoretical aspect of analytical chemistry.	**3**	**1**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**3**	**2**	**2**	**3**	**3**	**1**
CO2:Analyse water, soil and biological fluid sample.	**2**	**1**	**2**	**2**	**1**	**2**	**3**	**2**	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**1**
CO3 Explain and identify the errors occurred during chemical analysis	**2**	**2**	**1**	**1**	**1**	**2**	**2**	**2**	**1**	**2**	**1**	**2**	**1**	**1**	**2**	**2**
CO4: Handle glass ware and reagent in scientific way	**2**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**2**	**3**	**3**	**3**	**3**	**2**
CO5: Expertise in laboratory saftey	**2**	**-**	**-**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**3**	**1**	**3**

Legend:1–Low,2–Medium, 3–High

Course Curriculum Mapping

POs &PSOsNo.	Cos No.&Titles	SOsNo.	LaboratoryInstruction(LI)	Classroom Instruction(CI)	Self Learning(SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO1: Explain and apply theoretical aspect of anytical chemistry.	SO 1.1 SO 1.2 SO 1.3 SO1.4 SO1.5		Unit-1: 1.1,1.2,1.3,1.4,1.5,1.6,1.7 , 1.8, 1.9 T1, T2,T3	Techniques of weighing, errors.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO2:Analyse water, soil and biological fluidsample	SO 2.1 SO 2.2 SO 2.3 SO2.4 SO2.5		Unit-2: 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9 T1, T2,T3	Properties and types of error in experimental data determinate.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3:Explain and identify the errors occurred during chemical analysis	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5		Unit-3 : 3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9T1, T2,T3	General survey of instrumental techniques forthe analysis of heavy metals in aqueous systems.
PO1,2,3,4,5,6 7,8,9,10,11,12	CO4: Handle glass ware and reagent in scientificway	SO 4.1 SO 4.2 SO 4.3 SO		Unit-4: Unit-4 : 4.1,4.2,4.3,4.4,4.5, 4.6,4.7,4.8,4.9 T1,T2,T3	The Analysis of soil: moisture,pH, total nitrogen, phosphorus.

PSO 1,2, 3, 4		4.4 SO4.5			
PO1,2,3,4,5,6 7,8,9,10,11, 12 PSO 1,2, 3, 4	CO5: Expertise in laboratory saftey	SO 5.1 SO 5.2 SO 5.3 SO5.4 SO5.5		Unit 5: 5.1,5.2,5.3,5.4,5.5,5.6,5.7, 5.8,5.9. T1,T2, T3	Properties of Barbiturates, acid and alkaline phosphatees.

Program name	**Bachelor of Science (B.Sc.) - Biology**	
Semester	5th	
Course Code:	04OF501	
Course title:	Organic farming & Agriculture Technology	Developer: Kamlesh Kumar Soni
Pre-requisite:	Student should have basic knowledge biology and biotechnology	
Rationale:	The inclusion of "Organic Farming & Agriculture Technology" in the B.Sc. program equips biology students with practical knowledge of sustainable agricultural practices. It integrates principles of biotechnology with organic farming techniques, emphasizing eco-friendly approaches to crop cultivation and soil management. This subject enhances students' understanding of biodiversity conservation, organic crop production methods, and the application of biotechnological tools in agriculture, preparing them for roles in the growing field of sustainable agriculture and environmental stewardship	
Course Outcomes (COs):	CO 1: Comprehensive information on govt. initiative and importance of organic forming CO 2: Understand and apply the concepts of organic forming to save the environments and society CO 3: Understand importance and history of agriculture technology CO 4: Advance the experimental acts and application of different biotechnology to the agricultural improvement. CO 5: Learn the tools used in modern Ag	

Scheme of Studies:

Board of Study	CourseCode	Course Title	Scheme of studies (Hours/Week)					Total Credits(C) (L:T:P=2:0:1)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
ProgramCommon (PC)	04OF501	Organic farming & Agriculture Technology	3	1	1	3	8	2+1=3

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
PC	04OF501	Organic farming & Agriculture Technology	15	20	5	5	5	50	50	100

Unit I:	
Course-Curriculum: This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.	Approximate Hours Item | Cl | LI | SW | SL | Total Approx. Hrs | 05 | 04 | 01 | 02 | 12

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO 1: Comprehensive information on govt. initiative and importance of organic forming	SO 1.1: Importance of Organic farming in India	LI 1.1: Visit to the field	CI 1.1: Organic farming- Introduction; Organic farming- Scope in India	SL 1.1: read why organic farming is important
	SO 1.2: Gain knowledge of various sources for organic farming	LI 1.2: discuss with expertise about the future of organic farming	CI 1.2: Organic farming- Natural sources to be used; Organic farming- Applications	SL 1.2: Gain more insight and its application
	SO 1.3: Discuss about various methods of organic farming		CI 1.3: Organic farming- Methods, Advantages & Limitations	
	SO 1.4: discussion about Govt. initiative		CI 1.4: Initiatives taken by Government (central/state)	
	SO 1.5: Learn what are the various NGOs working to enhance the skill of organic farming		CI 1.5: NGOs and other organizations for promotion of organic agriculture	

Suggested Sessional Work (SW): *anyone*	Assignments:	Discuss how organic farming came to picture and its advantages over conventional farming
	Mini Project:	Literature on current status of organic farming in India
	Other Activities (Specify):	Think and deliver a presentation; why organic farming to be practiced

Unit-II:	
Course-Curriculum: This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.	Approximate Hours Item | Cl | LI | SW | SL | Total Approx. Hrs | 06 | 04 | 01 | 02 | 13

Course outcome (COs)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO 2: Understand and apply the concepts of organic forming to save the environments and society	SO 2.1: Know how small amount of DNA is amplified with millions of copies.	LI 2.1: Demonstrate the difference in media of organic farming and chemical media	CI 2.1: Organic nutrient-Types; resources, fortification	SL 2.1: Deep knowledge on nutrient media
	SO 2.2: Learn what are the boundaries to use the nutrients for OF	LI 2.2: Demonstration of crop rotation effect	CI 2.2: Restrictions to nutrient use in organic farming	SL 2.2: Enhance your knowledge about the tools
	SO 2.3: Discuss about the crops to choose for OF		CI 2.3: Choice of crops and varieties in organic farming	
	SO 2.6		CI 2.4: Fundamentals of insect, pest, disease and weed management under organic mode of production	
	SO 2.7: Relate the fundamental differences between random and side directed mutagenesis		CI 2.5: Crop rotation: need and benefits;	
	SO 2.8: Building the concept of protein engineering and their application in welfare		CI 2.6: Land preparation - Tools and Technique	

Suggested Sessional Work (SW): Anyone	Assignments:	Prepare a report on nature of organic resources available for organic farming and their availability
	Mini Project:	Literature on the types of crop being practiced for organic farming and their yield and quality status.
	Other Activities (Specify):	Literature and presentation; Various tolls and techniques for land preparation

Unit-III:	
Course-Curriculum: This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.	Approximate Hours Item | Cl | LI | SW | SL | Total Approx. Hrs | 07 | 04 | 01 | 03 | 15

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO 3: Understand importance and history of agriculture technology	SO 3.1: Able to understand history of agriculture technology	LI 3.1: Visit green house	CI 3.1: Definition and importance of agricultural technology, Historical development and advancements, Role of technology in modern agriculture	SL 3.1: Read the machine for modern Ag technology
	SO 3.2: Learn why soil quality is important	LI 3.2: Growing of plants in hydroponics	CI 3.2: Soil properties and classifications; Soil fertility and nutrient managemen	SL 3.2: learn more about soil composition and their importance
	SO 3.3 How to conserve the soil		CI 3.3 Soil conservation techniques; Modern soil testing and analysis methods	SL 3.3: read how micro-irrigation is applied to the modern Ag.
	SO 3.4 Understand the importance of irrigation and conservation of water		CI 3.4 Importance of water in agriculture, Irrigation methods and technologies (drip, sprinkler, etc.),	
	SO 3.5 Understand the important of water conservation and management		CI 3.5 Water conservation and management practices, Role of technology in efficient water usage	
	SO 3.6 Gain more insight on genetic improvement of crops		ICI 3.6 Basics of crop production and management, Genetic improvement and hybrid varieties,	
	SO 3.7 Know the beauty of technologies for crop management system		CI 3.7 Precision farming and its components (GPS, GIS, etc.), Use of sensors and drones in crop monitoring	

Suggested Sessional Work (SW): Anyone	Assignments:	Prepare a report on recent sensor being applied Ag.
	Mini Project:	Explain how hybrids are different from Genetically modified plants, give some examples
	Other Activities (Specify):	Literature and presentation; Soil fertility and nutrient management

Unit-IV:	
Course-Curriculum: This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.	Approximate Hours Item | Cl | LI | SW | SL | Total Approx. Hrs | 05 | 02 | 01 | 02 | 10

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO 4: Advance the experimental acts and application of different biotechnology to the agricultural improvement.	SO 4.1: Understand value of Ag Biotechnology	LI 4.1: DNA isolation and digestion by restriction enzymes	CI 4.1: Introduction to agricultural biotechnology	SL 4.1: Know the fundamental of sterilization
	SO 4.2: Advance how genetic engineering play crucial role in crop improvement		CI 4.2: Introduction to Genetic engineering	SL 4.2: find the case study on application of micropropagation
	SO 4.3 Understand the why GM is future		CI 4.3 Genetically modified crops and advantages and. limitations	
	SO 4.4: Learn new technology of gene editing and its importance. In agriculture		CI 4.4: CRISPR and other gene-editing technologies; Applications of CRISPR technology	
	SO 4.6: Gain knowledge why ethical and safety is necessary here		CI 4.5: Ethical and safety considerations	

Suggested Sessional Work (SW): *anyone*	SW1.1 Assignments	Explain CRISPR technology in details and some case study
	SW1.2 Mini Project	What are the ethical issues, explain in details
	SW1.3 Other Activities (Specify)	Discus the various post-harvest technologies

Unit-V:	
Course-Curriculum: This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.	Approximate Hours Item | Cl | LI | SW | SL | Total Approx. Hrs | 07 | 02 | 01 | 02 | 12

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO 5: Learn the tools used in modern Ag	SO 5.1: How technology impact on modern technology	LI 5.1: Growing plants in hydroponics	CI 5.1: Basics of agricultural economics, Impact of technology on agricultural productivity and economics	SL 5.1: Study in details about socio-economic condition of Ag
	SO 5.2: Learn how climate change affect the crop productivity and how technologies can overcome these issues		CI 5.2: Impact of climate change on agriculture, Technologies for climate-smart agriculture,	SL 5.2: Study how soil and hydroponics are different and important tools
	SO 5.3 Learn the strategies of mitigation		CI 5.3 Adaptation and mitigation strategies	
	SO 5.4 Learn the concept of urban Ag.		CI 5.4: Concept and importance of urban agriculture	
\	SO 5.5 Understand the concept of vertical farming		CI 5.65Vertical farming techniques and technologies, Hydroponics, aquaponics, and aeroponics	
	SO 5.6: Know how advanced technology improving the Ag productivity.		CI 5.6: Emerging technologies in agriculture (e.g., artificial intelligence, blockchain)	
	SO 5.7: Read some best example and application of Ag technology.		CI 5.7: Case studies of successful technology adoption in agriculture	

Suggested Sessional Work (SW): *anyone*	SW1.1 Assignments	Explain vertical farming
	SW1.2 Mini Project	What are the hydroponics and its application
	SW1.3 Other Activities (Specify)	Discus the at least 3 case studies

Course duration (in hours) to attain Course Outcomes **(Course title:** Organic farming & Agriculture Technology **) (Course code:)**					
Course Outcomes (COs)	**Class lecture (CI)**	**Laboratory Instruction (LI)**	**Self-Learning (SL)**	**Sessional work (SW)**	**Total Hours (Li+CI+SL+SW)**
CO 1: Comprehensive information on govt. initiative and importance of organic forming	5	4	2	1	12
CO 2: Understand and apply the concepts of organic forming to save the environments and society	6	4	2	1	13
CO 3: Understand importance and history of agriculture technology	7	4	3	1	15
CO 4: Advance the experimental acts and application of different biotechnology to the agricultural improvement.	5	2	2	1	10
CO 5: Learn the tools used in modern Ag	7	2	2	1	12
Total Hours	30	16	11	05	62

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome: **Course title:** Tissue culture and organic farming**) (Course code:)**					
Course Outcomes	**Marks Distribution**				**Total Marks**
	A	**An**	**E**	**C**	
CO 1: Comprehensive information on govt. initiative and importance of organic forming	2	1	1	1	5
CO 2: Understand and apply the concepts of organic forming to save the environments and society	2	4	2	2	10
CO 3: Understand importance and history of agriculture technology	3	5	5	2	15
CO 4: Advance the experimental acts and application of different biotechnology to the agricultural improvement.	2	3	3	2	10
CO 5: Learn the tools used in modern Ag	5	4	1	0	10
Total Marks	**14**	**17**	**12**	**07**	**50**
Legend: A-Apply, A- Analyze, E- Evaluate, C- Create					

Suggested learning Resources:

S.no.	Title	Author	Publisher	Edition & Year
1	Fundamentals of Organic Farming	Waseem Akram Khan	AkiNik Publications	1 & 2014
2	Principles of Organic Farming (With Theory and Practical)	E Somasundaram, D Udhaya Nandhini, M Meyyappan	New India Publishing agency	1& 2015
3	Modern Agriculture Technology	Dr. Swain KC , Dr. Bhattacharya D , Dr. Saren BK , Dr. Mandal S	M/s AGROBIOS (INDIA)	1 & 2022

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Visit to Cement Plant
7. Demonstration
8. ICT Based teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, WhatsApp, Mobile, Online sources)
9. Brainstorming

CO, PO and PSO Mapping
Program Title: B. Sc. Biology, 5th Sem
Course Code: 04OF501
Course Title: Organic farming & Agriculture Technology

CO/PO Mapping															
Course Outcome	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1: Comprehensive information on govt. initiative and importance of organic forming	**3**	**1**	**3**	**3**	**1**	**1**	**2**	**1**	**-**	**3**	**3**	**2**	**3**	**1**	**3**
CO 2: Understand and apply the concepts of organic forming to save the environments and society	**3**	**-**	**2**	**1**	**-**	**1**	**1**	**1**	**-**	**3**	**1**	**2**	**2**	**-**	**3**
CO 3: Understand importance and history of agriculture technology	**3**	**2**	**2**	**2**	**2**	**1**	**-**	**2**	**3**	**1**	**1**	**2**	**2**	**3**	**3**
CO 4: Advance the experimental acts and application of different biotechnology to the agricultural improvement.	**2**	**3**	**2**	**2**	**3**	**-**	**3**	**1**	**1**	**2**	**1**	**-**	**2**	**2**	**1**
CO 5: Learn the tools used in modern Ag	**2**	**1**	**2**	**-**	**2**	**3**	**2**	**3**	**1**	**2**	**1**	**2**	**3**	**3**	**2**
Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3															

Program Title: B. Sc. Biology, 5th Sem
Course Code: 04OF501
Course Title: Organic farming & Agriculture Technology

Course Curriculum Map:					
POs & PSOs No.	COs No	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO 1:** Understand the history of Plant tissue culture & various beneficial applications	1.1, 1.2, 1.3, 1.4, 1.5, 1.5	LI 1 LI 2	1.1, 1.2, 1.3, 1.4, 1.5, 1.5	1 SL-1,2
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO 2:** Advance the experimental acts and application of different tissue culture techniques	2.1, 2.2, 2.3, 2.4, 2.5, 2.6	LI 1 LI 2	2.1, 2.2, 2.3, 2.4, 2.5, 2.6	2 SL-1,2
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO 3:** Transfer the knowledge to the benefit of society by applying the tissue culture techniques	3.1, 3.2, 3.3, 3.4 3.5,3.6, 3.7	LI 1 LI 2	3.1, 3.2, 3.3, 3.4 3.5,3.6, 3.7	3 SL-1,2,3
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO 4:** Comprehensive information on govt. initiative and importance of organic forming	4.1,4.2, 4.3, 4.4, 4.5	LI 1	4.1,4.2, 4.3, 4.4, 4.5	4 SL-1,2
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO 5:** Understand and apply the concepts of organic forming to save the environments and society	5.1, 5.2, 5.3,5.4, 5.5, 5.6, 5.7	LI 1	5.1, 5.2, 5.3,5.4, 5.5, 5.6, 5.7	5 SL-1,2

Program Name	**Bachelor of Science (B.Sc.) Biology**	
Semester	V	
Course Code:	04YS502	
Course title:	Yoga Science	**Curriculum Developer**: Dr. Dileep Kumar Tiwari, Assistant Professor
Pre-requisite:	Student should have basic knowledge of Applications of Yoga and Meditation and its concepts	
Rationale:	The Yoga Science course in a B.Sc. Hons. Biotechnology program serves a crucial role by providing students with a legal understanding of Yoga and its original text Yoga. At the same time, they should also have adequate knowledge of Yoga and Meditationin which they should have knowledge of its basic principles and elements.	
Course Outcomes (COs):	**CO1-04YS502.1:-** Elucidate the overview of Yoga Science **CO2-04YS502.2:-** Acquire knowledge regarding Yoga and Pranayam with practices of Bandha and Mudra **CO3-04YS502.3:-** Applied knowledge about yoga and Meditation	

Scheme of Studies:

Board of Study	**Course Code**	**Course Title**	**Scheme ofstudies (Hours/Week)**					**Total Credits(C) (L:T:P=0:0:2)**
			Cl	LI	SW	SL	**Total Study Hours(CI+LI+SW+SL)**	
Skill enhancement course (SEC)	04YS502	Yoga Science	0	4	1	1	4	0+1=1

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies); SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Practical

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)		
SEC	**04YS502**	**Yoga Science**	35	5	5	5	50	50	50

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.	**Approximate Hours** **Item** | Cl | LI | SW | SL | Total **Approx. Hrs** | 00 | 10 | 01 | 01 | 12

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-04YS502.1:- Elucidate the overview of Yoga Science	**SO1.1** Explain the concept and principles of yoga	**Unit-1.** Introduction to Yoga and Yogic Practices **LI 1.1** Yoga: Etymology, definitions, aim, objectives and misconceptions		**SL1.1** Read some articles about Yoga
	SO1.2 Elucidate the origin history of yoga	**LI 1.2** Yoga: Its Origin, history and development		
	SO1.3 Elaborate the rules of yoga	**LI 1.3**. Rules and regulations to be followed by Yoga ractitioners		
	SO1.4 Elucidate the various yoga practices	**LI 1.4** Introduction to Yoga practices		
	SO1.5 Elaborate the different steps of yoga sadhana	**LI 1.5** Shatkarma: meaning, purpose and their significance in Yoga Sadhana		
	SO1.6 Elaborate the different yogic loosening practices.	**LI 1.6**. Introduction to Yogic Loosening practices and Surya Namaskar		

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Describe various principles of yoga science.
	SW1.2 Mini Project	Elaborate different branches of yoga with its role.
	SW1.3 Other Activities (Specify)	Make a demonstration on yoga.

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.	**Approximate Hours** **Item** | Cl | LI | SW | SL | Total **Approx. Hrs** | 00 | 10 | 01 | 01 | 12

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO2-04YS502.2:- Acquire knowledge regarding Yoga and Pranayam with practices of Bandha and Mudra	**SO2.1** Explain the different types of yoga practices	**Unit-2.0:** Yogic Practices. Breathing Practices and Pranayama **LI 2.1**. Sectional Breathing (Abdominal, Thoracic and Clavicular)		**SL2.1** Note down the impact of yoga in life.
	SO2.2 Elucidate the Role of deep breathing in yoga	**LI 2.2**.Yogic Deep Breathing		
	SO2.3 Elaborate the concept of puraka, Rechaka and Kumbhaka	**LI 2.3**.Concept of Puraka, Rechaka and Kumbhaka		
	SO2.4 Elucidate the bandha and mudra	**LI 2.4**. Concept of Bandha and Mudra		
	SO2.5 Explanation about the anuloma viloma	**LI 2.5** .Anuloma Viloma/ Nadi Shodhana		
	SO2.5 Explanation about the shitali and bhamari .	**LI 2.6** Shitali. Bhramari		

Suggested Sessional Work (SW):*anyone*	**SW2.1** Assignments	Describe the Role of yoga mudra.
	SW2.2 Mini Project	Make a chart on classification of yoga practices
	SW2.3 Other Activities (Specify)	Describe methods of prranayam

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.	**Approximate Hours** **Item** | Cl | LI | SW | SL | Total **Approx. Hrs** | 00 | 10 | 01 | 01 | 12

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO3-04YS502.3:- Applied knowledge about yoga and Meditation	**SO3.1** Elucidate the meditation concept	**Unit-3** Practices leading to Meditation **LI 3.1**.Recitation of Pranava Mantra		**SL3.1** Read about various examples of meditation
	SO3.2 Explain about the prayers.	**LI 3.2**. Recitation of Hymns, in vocations and prayers		
	SO3.3 Elaborate the Anter Maun	**LI 3.3** Anter Maun		
	SO3.4 To learn the general about breath meditation	**LI 3.4** Breath Meditation		
	SO3.5 Explanation about om dhyana	**LI 3.5** 0m Dhyana		

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Flow chart on different types of meditation
	SW3.2 Mini Project	Describe the different characteristics of meditation
	SW3.3 Other Activities (Specify)	Demonstration on meditation

Course duration (in hours)to attain Course Outcomes:

Course Title: Yoga Science **Course Code: 04YS502**

Course Outcomes(COs)	Class lecture (CI)	Laboratory Instruction(LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1-04YS502.1:- Elucidate the overview of Yoga Science	0	10	1	1	12
CO2-04YS502.2:- Acquire knowledge regarding Yoga and Pranayam with practices of Bandha and Mudra.	0	10	1	1	12
CO3-04YS502.3:- Applied knowledge about yoga and Meditation	0	10	1	1	12
Total Hours	00	30	03	03	36

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Yoga Science **Course Code: 04B402**

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
CO1-04YS502.1:- Elucidate the overview of Yoga Science	3	8	7	2	20
CO2-04YS502.2:- Acquire knowledge regarding Yoga and Pranayam with practices of Bandha and Mudra.	3	4	5	2	14
CO3-04YS502.3:- Applied knowledge about yoga and Meditation	4	5	5	2	16
Total Marks	**10**	**17**	**17**	**06**	**50**

***Legend*:A,** Apply; **An,** Analyze; **E,** Evaluate; **C,** Create

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1	Singh S.P. & yogi Mukesh ,Foundation of yoga , standard publication , new Delhi ,2010
2	Swami dherendrabrhamchari , yogasanavigyaan , dherendra yoga prakshan , new Delhi 1966
3	Sarswati , swami satyananda , asan pranayama mudra bandha ,yogprakshan trust munger ,2013
4	H.R. nagendra , asan pranayama mudra bandha,swami Vivekananda yogprakshan ,banglore 2002
5	IshwerBhardwaj , saralyogashan , satyam publication house , new Delhi 2018
6	Shri ram chauhaan , mudra rahasya , bhartiyeyogsansthan , new delhi 2014
7	DrVishwanath Prasad sangha , dhyanyog,bhartiyeyogsansthan , new delhi 1987
8	ShriDeshraj ,Dhyansadhna ,bhartiyeyogsansthan , new delhi 2015
9	bhartiyeyogsansthan , new delhi 2014

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Group Discussion
4. Role play
5. Demonstration
6. ICT Based teaching Learning
7. Brainstorming

CO, PO and PSO Mapping

Program Name: B.Sc. Biology
Semester: IV Semester
Course Title: Yoga Science.
Course Code: 04YS502

Course Outcome (Cos)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-04YS502.1:- Elucidate the overview of Yoga Science	1	2	-	1	2	1	2	1	2	-	1	2	2	2	1
CO2-04YS502.2:- Acquire knowledge regarding Yoga and Pranayam with practices of Bandha and Mudra.	-	1	1	-	-	-	1	-	1	1	-	-	1	1	2
CO3-04YS502.3:- Applied knowledge about yoga and Meditation	1	1	2	1	-	1	1	1	1	2	1	-	3	1	1

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	Cos	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO1-04YS502.1:- Elucidate the overview of Yoga Science**	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6	1.1,1.2,1.3,1.4,1.5,1.6,		**1SL-1**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO2-04YS502.2:- Acquire knowledge regarding Yoga and Pranayam with practices of Bandha and Mudra**.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6	2.1, 2.2, 2.3,2.4,2.5,2.6,		**2SL-1**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO3-04YS502.3:- Applied knowledge about yoga and Meditation**	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5	3.1,3.2,3.3,3.4,3.5,		**3SL-1**

Program name	**Bachelor of Science (B.Sc.)- Biology**	
Semester	**6th**	
CourseCode:	**01BO601**	
Coursetitle:	**Cytology, Plant Breeding and Biotechnology**	Developer: **Paras Koshe**
Pre-requisite:	Student should have basic knowledge of cytology, plant breeding, and biotechnology	
Rationale:	1. Learn the basic principles of cytology, plant breeding, and biotechnology 2. Acquire the applicability of Biotechnology in relation to the welfare of society 3. Explain the importance of plant breeding 4. Differentiate between cell division types	
CourseOutcomes (COs):	CO 1: Students should able learn the basic principles of cytology and gain knowledge about cell structure and cell envelope. CO 2: Understand the detailed study of ultra structure and functions of different cell organelles. CO 3: Illustrate different types of chromosome structures and techniques involved in study of chromosomes. CO 4: Explain the principles, techniques and scopes of Plant breeding. CO 5: Acquire knowledge about the use of Biotechnology in crop improvement and tools and techniques of Recombinant DNA technology with emphasis on PCR and DNA fingerprinting.	

Scheme of Studies:

Board of Study	**CourseCode**	**CourseTitle**	**Scheme ofstudies (Hours/Week)**					**Total Credits(C) (L:T:P=4:0:2)**
			Cl	**LI**	**SW**	**SL**	**Total Study Hours(CI+LI+SW+SL)**	
Major	**01BO601**	**Cytology, Plant Breeding and Biotechnology**	4	2	1	2	9	4+2=6

*Legends:*CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial(T) and others);
LI: Laboratory Instruction(Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
Major	01BO601	Cytology, Plant Breeding and Biotechnology	15	20	5	5	5	50	50	100

Unit I:

Course-Curriculum:
This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

ApproximateHours

Item	Cl	LI	SW	SL	Total
Approx.Hrs	12	08	01	03	24

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO 1: Students should able learn the basic principles of cytology and gain knowledge about cell structure and cell envelope	**SO1.**1 Explain the history and principles of cytology.	**LI1.1**: Study of Plant cells by slide preparation (e.g. Onion leaf or Hydrilla leaf etc.)	**CI 1.1: Cytology:**	**SL 1.1:** learn the differences between prokaryotic cell and eukaryotic cell.
	SO1.2 Define cytology and its scopes in biology and other fields.	**LI1.2**: Electron micrograph study: Prokaryotic cell (Bacteria), Plant cell, Cyanobacteria and Virus	**CI1.2:** Definition and Scope	**SL1.2:** Study more about the structure of cell wall of bacteria.
	SO1.3: Illustrate timber yielding trees of India and their products	**LI1.3** Study of different cell organelles by specimen/ diagram and micrograph**.**	**CI1.3:** The cell theory	**SL1.3** Try to find more differences between plant cell and animal cell
	SO1.4: Understand about timber yielding tree i.e. Shisham	**LI1.4** Study of different models of Cell Membrane through charts/diagram	**CI1.4:**Postulates of cell theory	
	SO1.5: Students will be able to brief the use of Sal in textile industries.		**CI1.5:** Structure of prokaryotic cell.	
	SO1.6: Discuss various strategies of obtaining Timber yielding trees of India and their products (Teak)		**CI1.6:** Structure of Eukaryotic cell.	
	SO1.7: Describe the use of Deodar tree in timber industry,		**CI1.7:** Cell Envelops	
	SO1.8: Understand how baboolplant can be processed and utilised in timber industry.		CI1.8: Cell membrane: composition,	

	SO1.9 Elucidate about the processing of bamboo and their products in Bamboo industry.		**CI1.9** Models of cell membrane	
	SO1.10 Describe the use of sugarcane and other materials in cane industry.		**CI1.10** Functions of cell membrane	
	SO1.11 Explain about the raw materials used in Kattha Industry		**CI1.11** Plant cell wall structure	
	SO1.12 Explain about the products of Kattha Industry		**CI1.12** Plant cell wall function.	

Suggested Sessional Work (SW): *anyone*	Assignments:	Discuss how cell membrane and cell envelops helps in protection of cell.
	Mini Project:	Make a chart showing various models and structure of cell membrane.
	Other Activities (Specify):	Write an article on cell membrane structure of eukaryotes and prokaryotes.

Unit-II:

Course-Curriculum:
This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

ApproximateHours

Item	**Cl**	**LI**	**SW**	**SL**	**Total**
Approx.Hrs	**12**	**04**	**01**	**03**	**20**

Course outcome (COs)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO 2:: Understand the detailed study of ultra structure and functions of different cell organelles	**SO2.1** Define and describe various cell organelles present in eukaryotic cell.	**LI2.1**. study of different types of plastids.	**CI2.1** Cell organelles	**SL2.1:** Learn about the endomembrane system of eukaryotic cell.
	SO2.2: Understand the structure and functions of endoplasmic reticulum.	**LI2.2:** Study of different models of Cell Membrane through charts/diagram	**CI2.2:** Endoplasmic reticulum	**SL2.2:** Explain and identify different cell organelle
	SO2.3 Explain about the structure and functions of Golgi body.		**CI2.3** Golgi body.	**SL2.3:** Study biogenesis of mitochondria and chloroplast.
	SO2.4: Illustrate about the ultra structure and functions of mitochondria,		**CI2.4:** Mitochondria,	
	SO2.5 Gaining knowledge about the different types of plastids such as chromoplast leucoplast		**CI2.5:** Plastids- types	

	SO2.6: Over viewing the structure of chloroplast and its functions.		**CI2.6:** Chloroplast.	
	SO2.7: Understand nucleus is organized and study about its internal structures.		**CI2.7** Nucleus- nuclear membrane, nucleolus**,**	
	SO2.8: To learn about different components of nucleus such as**:** nuclear pore, nucleolus, chromatin material.		**CI2.8:** nuclear pore, nucleolus, chromatin material.	
	SO2.9. Analyze the importance and functions of Lysosomes.		**CI2.9:** Lysosomes,	
	SO2.10.Dicuss about occurrence and functions of peroxisomes, and vacuole		**CI2.10:** Peroxisomes, and vacuole	
	SO2.11 Describe structure and functions of cytoskeleton (microtubules and micro filaments)		**CI2.11** Cytoskeleton-microtubules and micro filaments	
	SO2.12 Explain about Ergastic substance (such as starch grains, crystals pums, resins and other compounds).and their role in plant life.		**CI2.12:** Ergastic substance (such as starch grains, crystals pums, resins and other compounds).	

Suggested Sessional Work (SW): Anyone	**Assignments:**	Describe the ultra structure of nucleus with emphasis on chromatin material.
	Mini Project:	Study more about chromoplast and isolate them and leucoplast from plant.
	Other Activities (Specify):	Compare between cilia and flagella and also write about intermediate filament and their role in muscle contraction.

Unit-III:

Course-Curriculum:
This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

ApproximateHours

Item	CI	LI	SW	SL	Total
Approx.Hrs	12	08	01	03	24

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO 3: Illustrate different types of chromosome structures and techniques involved in study of chromosomes.	**SO 3.1:** Students should able to understand Chromosomal organization.	**LI 3.1** Demonstration of the special chromosome of the Salivary gland/ Polytene and - Lamp brush chromosome through diagrams/ photographs..	**CI 3.1:**Chromosomal organization	**SL 3.1:** Read the Chromosomal organization in prokaryotes and eukaryotes separately.
	SO 3.2: Learn the structure of chromosomes.	**LI 3.2:** Isolation of DNA from banana or onion	**CI 3.2:** Structure of chromosomes	**SL 3.2:** learn more about various genetic diseases caused by Variations in chromosome structure and number
	SO 3. Define and elaborate different types of chromosomes.	**LI 3.3:** Study of Mitosis in the onion root tip.	**CI 3.3** Types of chromosomes.	**SL 3.3:** Read how diseases are caused by alterations in cell cycles. (cancer)
	SO 3.4 Describe various functions of chromosomes.	**LI 3.4:** Study of Meiosis in anthers.	**CI 3.4** Functions of chromosomes	
	SO 3.5 Explain the ultra structure of chromosomes.		**CI 3.5** ultra structure of chromosomes	

	SO 3.6 Understand the steps and uses of karyotyping.		**CI3.6** karyotype	
	SO 3.7 Learn about the steps and uses of Idiograms		**CI 3.7** Idiograms	
	SO 3.8 Explain the structure and organization of nucleosome model.		**CI 3.8** Nucleosome model.	
	SO 3.9 Describe the structure of Special types of chromosomes..		**CI 3.9** Special types of chromosomes.	
	SO 3.10 Gain more insight on Variations in chromosome structure: Structural change-deletion, translocation and inversion. duplication		**CI 3.10** 2. Variations in chromosome structure: Structural change-deletion, translocation and inversion. duplication	
	SO 3.11 Explain variation in chromosome number- euploidy. Aneuploidy.		**CI3.11** Variation in chromosome number-euploidy. Aneuploidy.	
	SO 3.12 Describe different types of cell division and its stages .		**CI3.12** Cell cycle and Cell division- Mitosis and Meiosis.	

Suggested Sessional Work (SW): Anyone	**Assignments:**	Describe about the ultrastructure and functions of chromosomes.
	Mini Project:	Illustrate the important facts and findings oh Human Genome project.
	Other Activities (Specify):	Write an article on inhibitors of cell division and cell cycles. study mutations that occurs in human genome

Unit-IV:

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

ApproximateHours

Item	Cl	LI	SW	SL	Total
Approx.Hrs	12	08	01	03	24

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO 4: Explain the principles, techniques and scopes of Plant breeding.	**SO4.1:**Students should able to understand introduction and history of Plant Breeding.	**LI4.1:** Perform the technique of Hybridization in a self-pollinated plant through selection, bagging, tagging up to pollination, and crossing,	**CI4.1:** Plant Breeding-	**SL 4.1:** Learn basics of Plant Breeding and plant tissue culture.

	SO4.2: Describe the goals and objectives of Plant Breeding.	**LI4.2:** Demonstration of different equipment used for plant tissue culture technique	**CI4.2:** Introduction and goals.	**SL4.2:** Learn about agricultural institutes and laboratories in your states.
	SO 4.3 Understand the principles and techniques of plant breeding.	**LI4.3:** Sterilization of explants in PTC	**CI 4.3:** Principles and techniques	**SL4.3:** Study about emasculation bagging anther dehiscence and artificial pollination and invitro fertilization.
	SO4.4: Learn the process of classical (conventional) – hybridization..	**LI4.4:**Preparation at Nutrient Medium for tissue culture experiment	**CI4.4:** classical (conventional) - hybridization..	
	SO 4.5 Brief about Hybrid vigor and heterosis.		**CI 4.5** Hybrid vigor and heterosis.	
	SO4.6: Gain knowledge about modern techniques production of genetic variation		**CI4.6:** Modern techniques production of genetic variation	
	SO4.7: Learn technique of genetic variation at plant level, cell /tissue		**CI4.7:** Technique at plant level, cell /tissue	
	SO4.8: Understand techniques production of genetic variation at DNA level.		**CI4.8** technique at DNA level.	
	SO4.9: Explain the significance and limitations of plant breeding		**CI4.9**: Significance and limitations of plant breeding.	
	SO4.10: Define and describe Plant Breeding programs in India		**CI4.10**: Plant Breeding programs in India-Rice, Wheat, Sugarcane and Cotton	
	SO4.11: Analyze and learn about. important National Institutes of plant breeding.		**CI4.11:** Important National Institutes	
	SO4.12: Brief about the Important International Institutes.		**CI4.12**: Important International Institutes	

Suggested Sessional Work (SW): ***anyone***	**SW1.1 Assignments**	Explain principles and techniques of plant breeding.
	SW1.2 Mini Project	Make a chart showing Plant Breeding programs in India**.**
	SW1.3 Other Activities (Specify)	Try to perform invitro fertilization of plants and write and article on GM seeds with emphasis on Golden rice,.

Unit-V:

Course-Curriculum:
This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

ApproximateHours

Item	Cl	LI	SW	SL	Total
Approx.Hrs	12	06	01	04	23

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO 5: Acquire knowledge about the use of Biotechnology in crop improvement and tools and techniques of Recombinant DNA technology with emphasis on PCR and DNA fingerprinting	**SO5.1:**Explain introduction and different branches of Biotechnology	**LI5.1**: Demonstrations of PCR through Models/charts	**CI5.1**: 1. Biotechnology	**SL5.1**: Study in details gene therapy
	SO5.2: Learn the history and definition of	**LI5.2:** Study of Cloning	**CI5.2:** History and definition	**SL5.2**: Study different

	biotechnology.	Vectors through Models/charts/Diagrams,		molecular markers used in genetic engineering
	SO 5.3 Students should able to gain knowledge about the scopes of biotechnology.	**LI5.3**: Study of Instruments used in Plant Tissue culture Lab	**CI 5.3** Scopes of biotechnology	**SL5.3** Learn the technique of micro propagation.
	SO 5.4 Explain basic aspects of plant tissue culture.		**CI 5.4** Basic aspects of plant tissue culture.	**SL5.4** Learn applications of RDT in medicine and human welfare
	SO5.5: Describe totipotency and its importance in plant tissue culture.		**CI5.5**: Totipotency.	
	SO 5.6 Define and describe important achievements in crop biotechnology.		**CI 5.6** Important achievements in crop biotechnology.	
	SO5.7: Explain introduction and different branches of **:** Genetic Engineering.		**CI5.7:** Genetic Engineering	
	SO5.8: : Learn about the tools and techniques of Recombinant DNA technology.		**CI5.8:** Tools and techniques of Recombinant DNA technology.	
	SO5.9 Explain strategies for construction of various types of cloning vectors and learn about DNA insert size of each vector.		**CI5.9:** Types of cloning vectors.	
	SO5.10: Describe about biology of Agrobacterium, and vector for gene delivery as marker gene.		**CI5.10** Biology of Agrobacterium, vector for gene delivery as marker gene.	
	SO5.11: Define Genomic and cDNA library and explain the steps of constructing libraries and their uses in genetic engineering,		**CI5.11:** Genomic and cDNA library	
	SO5.12: Students should able to know about the .important techniques of genetic engineering like PCR and DNA Fingerprinting.		**CI5.12** PCR and DNA Fingerprinting	

Suggested Sessional Work (SW): ***anyone***	**SW1.1 Assignments**	Explain role biotechnology and genetic engineering in crop improvement.
	SW1.2 Mini Project	Try to culture buds and other parts of plants in your Plant tissue culture laboratory..
	SW1.3 Other Activities (Specify)	Write an article on variants of PCR and its role in detection of genetic diseases.

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome: **Course title: Cytology, Plant Breeding and Biotechnology** **(Course code :) 01BO601**					
Course Outcomes	**Marks Distribution**				**Total Marks**
	A	**An**	**E**	**C**	
CO 1: Students should able learn the basic principles of cytology and gain knowledge about cell structure and cell envelope**.**	2	1	1	1	5
CO 2: Understand the detailed study of ultra structure and functions of different cell organelles.	2	4	2	2	10
CO 3: Illustrate different types of chromosome structures and techniques involved in study of chromosomes**.**	3	5	5	2	15
CO 4: Explain the principles, techniques and scopes of Plant breeding	2	3	3	2	10
CO 5 Acquire knowledge about the use of Biotechnology in crop improvement and tools and techniques of Recombinant DNA technology with emphasis on PCR and DNA fingerprinting.	5	4	1	0	10
Total Marks	**14**	**17**	**12**	**07**	**50**
Legend**: A**-Apply, **An-** Analyze, **E**- Evaluate, **C**- Create					

Suggested learning

Resources:

S.no.	**Title**	**Author**	**Publisher**	**Edition & Year**
1	Text book of Cell and Molecular biology,	P.K.Gupta	Rastogi Publication, Meerut, India	2 edition 1999
2	Molecular Biology of the Cell.	Alberts, B. Bray, D., Lesis, J., Ratf, M., Roberts, K., and Watson, J.D.	3. Garland PublishingInc., New York.	2 & 2001
3	Methods in Cell Wall Cytochemistry,	Krishanmurthy K. V.	CRC Press, Boca Raton, Florida, 13.SA	1and (2000)
4	Biotechnology	Singh B. D.	Kalyan Publishers, N. Delhi.	2 edition (2004)
5	Introductory Biotechnology,	Singh R.P.	Central Book Depot, Allahabad	(1992)
6	Biochemistry and Molecular Biology of Plants	Buchanan, R. Gruvem, W. and Jones, RL	American Society of Plant Physiologists, Maryland, USA	(2000)
7	Plant Biology,	Rost, T. et al.	Wadsworth Publishing Co., California, USA(	(1998)
8	Genetics	P.K.Gupta,	Rastogi Publication, Meerut, India	(1999)

Suggested equivalent online courses:-www.eshiksha.mp.gov.in

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Visit to Cement Plant
7. Demonstration
8. ICT Based teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, WhatsApp, Mobile, Online sources)
9. Brainstorming

CO, PO and PSO Mapping

Program Title: B. Sc. Biology, 6th SEM
Course Code**: 01BO601**
Course Title: **Cytology, Plant Breeding and Biotechnology**

CO/PO Mapping															
Course Outcome	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1: Students should able learn the basic principles of cytology and gain knowledge about cell structure and cell envelope**.**	**3**	**1**	**3**	**2**	**1**	**1**	**2**	**-**	**2**	**-**	**1**	**-**	**2**	**1**	**3**
CO 2: Understand the detailed study of ultra structure and functions of different cell organelles.	**3**	**-**	**2**	**1**	**-**	**1**	**1**	**1**	**-**	**3**	**1**	**2**	**2**	**1**	**3**
CO 3: Illustrate different types of chromosome structures and techniques involved in study of chromosomes**.**	**2**	**2**	**2**	**2**	**2**	**1**	**-**	**2**	**3**	**1**	**1**	**2**	**1**	**2**	**3**
CO 4: Explain the principles, techniques and scopes of Plant breeding	**2**	**3**	**2**	**2**	**3**	**-**	**3**	**1**	**1**	**2**	**1**	**-**	**2**	**2**	**3**
CO 5 Acquire knowledge about the use of Biotechnology in crop improvement and tools and techniques of Recombinant DNA technology with emphasis on PCR and DNA fingerprinting.	**1**	**2**	**1**	**-**	**3**	**3**	**1**	**2**	**2**	**3**	**1**	**2**	**1**	**3**	**1**
Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3															

Course duration (in hours) to attain Course Outcomes **(Course title: Cytology, Plant Breeding and Biotechnology** **(Course code :) 01BO601**					
Course Outcomes(COs)	**Class lecture(CI)**	**Laboratory Instruction (LI)**	**Self-Learning (SL)**	**Sessional work (SW)**	**Total Hours (Li+CI+SL+SW)**
CO 1: Students should able learn the basic principles of cytology and gain knowledge about cell structure and cell envelope**.**	12	08	03	1	24
CO 2: Understand the detailed study of ultra structure and functions of different cell organelles.	12	04	03	1	20
CO 3: Illustrate different types of chromosome structures and techniques involved in study of chromosomes**.**	12	08	03	1	24
CO 4: Explain the principles, techniques and scopes of Plant breeding	12	08	03	1	24
CO 5 Acquire knowledge about the use of Biotechnology in crop improvement and tools and techniques of Recombinant DNA technology with emphasis on PCR and DNA fingerprinting.	12	06	04	1	23
Total Hours	60	34	16	05	115

Program Title: B. Sc. Biology, 6th
Course Code: **01BO601**
Course Title: Cytology, Plant Breeding and Biotechnology

Course Curriculum Map:					
POs & PSOs No.	**COs No**	**SOs No.**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO 1:** Students should able learn the basic principles of cytology and gain knowledge about cell structure and cell envelope**.**	1.1, 1.2, 1.3, 1.4, 1.5, 1.5, 1.7, 1.8,1.9,1.10,1.11,1.12	LI 1 LI 2 LI 3 LI 4	1.1, 1.2, 1.3, 1.4, 1.5, 1.5, 1.7, 1.8,1.9,1.10,1.11,1.12	1 SL-1,2,3
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO 2:** Understand the detailed study of ultra structure and functions of different cell organelles.	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7,2.8,2.9,2.10,2.11,2.12	LI 1 LI 2	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7,2.8,2.9,2.10,2.11,2.12	2 SL-1,2,3
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO 3:** Illustrate different types of chromosome structures and techniques involved in study of chromosomes**.**	3.1, 3.2, 3.3, 3.4 3.5,3.6, 3.7, 3.8, 3.9, 3.10, 3.11,3.12	LI 1 LI 2 LI 3 LI 4	3.1, 3.2, 3.3, 3.4 3.5,3.6, 3.7, 3.8, 3.9, 3.10, 3.11,3.12	3 SL-1,2,3
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO 4:** Explain the principles, techniques and scopes of Plant breeding	4.1,4.2, 4.3, 4.4, 4.5, 4.6, 4.7,4.8,4.9,4.10,4.11,4.12	LI 1 LI 2 LI 3 LI 4	4.1,4.2, 4.3, 4.4, 4.5, 4.6, 4.7,4.8,4.9,4.10,4.11,4.12	4 SL-1,2,3
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO 5** Acquire knowledge about the use of Biotechnology in crop improvement and tools and techniques of Recombinant DNA technology with emphasis on PCR and DNA fingerprinting.	5.1, 5.2, 5.3,5.4, 5.5, 5.6, 5.7,5.8,5.9,5.10,5.11,5.12	LI 1 LI 2 LI 3	5.1, 5.2, 5.3,5.4, 5.5, 5.6, 5.7,5.8,5.9,5.10,5.11,5.12	5 SL-1,2,3,4

Program Name	**Bachelor of Science (B.Sc.)- Biology**	
Semester	6th	
CourseCode:	01ZO602	
Coursetitle:	Insect Taxonomy and applied entomology	**Curriculum Developer**: Mr. Amit Bagri
Pre-requisite:	To study this course a student must have had the subject zoology in diploma.	
Rationale:	The naming and ordering of objects into groups is probably the most fundamental step in the development of scientific principles. Insects are a very important group of animals because of their beneficial and adverse effects on the life of man. They have made a tremendous impact on the environment, on human activities and health. Medical, economic and agricultural Entomology are important branches of science.	
Course Outcomes (COs):	01ZO602 **.1.** Learn about the taxonomy, Morphology and anatomy of insects. 01ZO602 **.2.** Identify the importance of the insects as beneficial and harmful pests of different crop, forest, medical and veterinary field with their control measures. 01ZO602 **.3.** Get self-employment in the field of silk, honey and lac production. 01ZO602 **.4.** Identify the nutritive value of the insects. 01ZO602 **.5.** Identify the ecological service of the insects and its role in agriculture.	

Scheme of Studies:

Board of Study	**Course Code**	**CourseTitle**	**Scheme of studies (Hours/Week)**					**Total Credits(C) (L:T:P=3:0:1)**
			Cl	LI	SW	SL	**Total Study Hours(CI+LI+SW+SL)**	
Major	01ZO602	Insect Taxonomy and applied entomology	4	2	1	5	12	4+2=6

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)		
Major	01ZO602	Insect Taxonomy and applied entomology	**15**	**20**	**10**	**5**	**50**	**50**	**100**

Scheme of Assessment: Practical

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)		
Major	01ZO602	Insect Taxonomy and applied entomology	35	5	5	5	50	50	50

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

ApproximateHours

Item	Cl	LI	SW	SL	Total
Approx.Hrs	12	06	01	04	23

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction(CI)	Self-Learning(SL)
01ZO602 **.1.** Learn about the taxonomy, Morphology and anatomy of insects.	**SO1.1** Define and Describe concept of history of insect's biology, Characters and classification.	**LI1.1** Identification and comments on common insects of different order of class insect.	**Unit 1** **Introduction of insects**. **CI1.1** Concept of history of insect's biology, Characters and classification.	**SL1.1** Learn about history of insect's biology, Characters and classification/.
	SO1.2 Describe about general morphology of an insects.		**CI1.2** learn about general morphology of an insects.	**SL1.2** learn about general morphology of an insects.
	SO1.3 Explain about role of insects in agriculture.	**LI1.2** Demonstrations of morphological parts of insects, antennae, mouth parts, wings	**CI1.2** Explain about role of insects in agriculture.	**SL1.3** Learn about role of insects in agriculture.
	SO1.4 Describe ecological service in insects.	**LI1.3** Describe ecological service in insects.	**CI1.3** Describe ecological service in insects.	**SL1.4** Learn about ecological service in insects.
	SO1.5 explain Insect biology Characters.		**CI1.4** Insect biology Characters.	
	SO1.5 described Insect biology classification.		**CI1.5** Insect biology classification.	
	SO1.6 Explain diagnosis features of Isoptera		**CI1.6** Explain diagnosis features of Isoptera?	
	SO1.7 Explain diagnosis features of orthoptera?		**CI1.7** Explain diagnosis features of orthoptera?	
	SO1.8 Explain diagnosis features of Hemiptera?		**CI1.8** Explain diagnosis features of Hemiptera?	
	SO1.9 Explain diagnosis features of coleoptera?		**CI1.9** Explain diagnosis features of coleoptera?	
	SO1.10 Explain diagnosis features of lepidoptera?		**CI1.10** Explain diagnosis features of lepidoptera?	
	SO1.11 Explain diagnosis features of Diptera?		**CI1.11** Explain diagnosis features of Diptera?	
	SO1.12 explain insects' character's?		**CI1.12** explain insects' characters?	

Suggested Sessional Work (SW):*anyone*	**SW1.1** Assignments	Concept of history of insect's biology, Characters and classification.
	SW1.2 Mini Project	learn about general morphology of an insects.
	SW1.3 Other Activities (Specify)	Describe ecological service in insects.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	12	06	01	07	26

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
01ZO602 **.2.** Identify the importance of the insects as beneficial and harmful pests of different crop, forest, medical and veterinary field with their control measures.	**SO2.1** Explain about History of sericulture, Silk producing moths.	**LI2.1** Study the life cycle of bombyx mori. **LI2.2** Apis indica **LI2.3** Laccifer lacca	**Unit-II** **Beneficial insects** **CI2.1** Explain about History of sericulture, Silk producing moths.	**SL2.1** Learn about History of sericulture, Silk producing moths.
	SO2.2 Explain about mulberry silkworm, lifecycle of bombyx mori.		**CI2.2** Explain about mulberry silkworm, lifecycle of bombyx mori.	**SL2.2** Learn about mulberry silkworm, lifecycle of bombyx mori.
	SO2.3 Explain about sericulture and its management.		**CI2.3** Explain about sericulture.	**SL2.3** Learn about sericulture and its management.
	SO2.4 Explain about history of apiculture, classification and species of honey bee.		**CI2.4** Explain about history of apiculture, classification and species of honey bee.	**SL2.4** Learn about history of apiculture, classification and species of honey bee.
	SO2.5 Describe the role of bee keeping methods and equipment's.		**CI2.5** Describe the role of bee keeping methods and equipment's.	**SL2.5** Describe the role of Flora and fauna in protects areas.
	SO2.6 Describe life cycle of lac insects and host plants.		**CI2.6** Describe life cycle of lac insects	**SL2.6** learn about life cycle of lac insects and host plants.
	SO2.7 Explain cultivation of lac and enemies of lac insects.		**CI2.7** Explain cultivation of lac	
	SO2.8 Describe Use of lac and lac industry in India.		**CI2.8** Describe Use of lac and lac industry in India.	
	SO2.9 Describe history of lac culture systematic position.		**CI2.9** Describe history of lac culture systematic position.	**SL2.7** Learn history of lac culture systematic position.
	SO2.10 Explain enemies of lac insects		**CI2.10** Explain enemies of lac insects	
	SO2.11 Describe host plants.		**CI2.11** Describe host plants.	
	SO2.12 Explain sericulture management.		**CI2.12** Explain sericulture management.	

Suggested Sessional Work (SW) : *anyone*		
	SW2.1 Assignments	Explain about mulberry silkworm, lifecycle of bombyx mori.
	SW2.2 Mini Project	Explain about history of apiculture, classification and species of honey bee.
	SW2.3 Other Activities (Specify)	Describe Use of lac and lac industry in India.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	12	06	01	05	24

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
01ZO602 **.3.** Get self-employment in the field of silk, honey and lac production.	**SO3.1** Explain the Sugarcane pest – pyrilla perpusilla.	**LI3.1** Identification, characters and control measures of crop and forestry important pests	**Unit-III** **Important insect's pest of crop and forestry** **CI3.1** Explain the Sugarcane pest – pyrilla perpusilla.	**SL3.1** Learn about Sugarcane pest – pyrilla perpusilla. .
	SO3.2 Describe fruit pest-Amritodus Alkensoni	**LI3.2** Describe fruit pest-Amritodus Alkensoni	**CI3.2** Describe fruit pest-Amritodus Alkensoni	**SL3.2** Learn about about fruit pest-Amritodus Alkensoni
	SO3.3 Describe Polyphagus pest – Schistocerca gregaria.	**LI3.3** Describe Polyphagus pest – Schistocerca gregaria.	**CI3.3** Describe Polyphagus pest – Schistocerca gregaria.	**SL3.3** Learn about about Polyphagus pest – Schistocerca gregaria.
	SO3.4 describe the Sal borer – Hoplocerambyx Soinicornis.		**CI3.4** describe the Sal borer – Hoplocerambyx Soinicornis.	**SL3.4** Learn about about Sal borer – Hoplocerambyx Soinicornis.
	SO3.5 describe the Sal borer –		**CI3.5** describe the Sal borer –	**SL3.5** Learn about about Common forest beetle – Sinoxylon sps
	SO3.6 describe the bamboo borer?		**CI3.6** describe the bamboo borer?	
	SO3.7 Describe the insect interaction?		**CI3.7** describe the insect interaction?	
	SO3.8 Describe the plant interaction		**CI3.8** describe the plant interaction	
	SO3.9 Describe about Common Forest beetle – Sinoxylon sps.		**CI3.9** Describe about Common Forest beetle – Sinoxylon sps.	.
	SO3.10 explain destroys crops?		**CI3.10** Which insect destroys crops?	
	SO3.11 described the role of insects in the forest ecosystem?		**CI3.11** What is the role of insects in the forest ecosystem?	
	SO3.12 explain the beneficial insects in forestry?		**CI3.12** What are the beneficial insects in forestry?	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Explain the Sugarcane pest – pyrilla perpusilla.
	SW3.2 Mini Project	Describe Polyphagus pest – Schistocerca gregaria.
	SW3.3 Other Activities (Specify)	Describe about Common Forest beetle – Sinoxylon sps.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	12	06	01	04	23

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
01ZO602 **.4.** Identify the nutritive value of the insects.	**SO4.1** Describe the common vector insects, distribution, life cycle and their control.	**LI1.1** Identification, characters and disease and control of medical important pests.	**Unit-IV** **Pest of medical and veterinary Importance.** **CI4.1** Describe the common vector insects.	**SL4.1** Learn about common vector insects, distribution, life cycle and their control.
	SO4.2 Describe the distinguished Characters of Culex, Anopheles and Aides.	**LI4.2** Study of Application of collection.	**CI4.2** Describe the distinguished Characters of Culex,	**SL4.2** Discuss distinguished Characters of Culex, Anopheles and Aides.
	SO4.3 Explaining the insect's parasitism.	**LI4.3** Describe the distinguished Characters of Culex, Anopheles and Aides.	**CI4.3** Explaining the insect's parasitism.	**SL4.3** Learn about insects' parasitism.
	SO4.4 Explaining the horse fly and stable fly.		**CI4.4** Explaining the horse fly.	**SL4.4** learn the common vector insects their control
	SO4.5 Evaluate role of Cattle blood sucking louse.		**CI4.5** Evaluate role of Cattle blood sucking louse.	
	SO4.6 Describe the distribution?		**CI4.6** Describe the distribution,	
	SO4.7 Describe the common vector insects, life cycle?		**CI4.7** Describe the common vector insects, life cycle	
	SO4.8 Describe the common vector insects their control?		**CI4.8** Describe the common vector insects their control	
	SO4.9 Describe the distinguished Characters of Anopheles?		**CI4.9** Describe the distinguished Characters of Anopheles?	
	SO4.10 Describe the distinguished Characters of Aides.		**CI4.10** Describe the distinguished Characters of Aides.	
	SO4.11 Explaining the stable fly.		**CI4.11** Explaining the stable fly.	
	SO4.12 Describe cattle blood sucking louse?		**CI4.12** Describe cattle blood sucking louse.	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Describe the common vector insects, distribution, life cycle and their control.
	SW4.2 Mini Project	Describe the distinguished Characters of Culex, Anapheles and Aades..
	SW4.3 Other Activities (Specify)	Explaining the horse fly and stable fly.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	12	06	01	05	24

Course Outcome (CO)	SessionOutcomes(SOs)	LaboratoryInstruction(LI)	ClassroomInstruction(CI)	Self-Learning(SL)
01ZO602 **.5.** Identify the ecological service of the insects and its role in agriculture.	**SO5.1** Define the concept of Natural control.	**LI5.1** Explain the safety precautions by insecticides.	**Unit-V** **Insect pest control** **CI5.1** Define the concept of Natural control.	**SL5.1** learn about Natural control.
	SO5.2 Describe the artificial control.	**LI5.2** Evaluate the Integrated pest management.	**CI5.2** Describe the artificial control.	**SL5.2** Describe the artificial control.
	SO5.3 explain the biological control.	**LI5.3** First procedure for insecticide poisoning	**CI5.3** explain the Biological control.	**SL5.3** learn Biological control.
	SO5.4 Evaluate the Integrated pest management		**CI5.4** Evaluate the Integrated pest management.	**SL5.4** Learn the safety precautions by insecticides.
	SO5.5 Explain the safety precautions by insecticides.		**CI5.5** Explain the safety precautions by insecticides.	**SL5.5** learn most popular practice for IPM?
	SO5.6 Explain most popular practice for IPM?		**CI5.6** Explain most popular practice for IPM?	
	SO5.7 Explain Harmful impact of chemical control practices		**CI5.7** Explain Harmful impact of chemical control practices	
	SO5.8 Described First procedure for insecticide poisoning?		**CI5.8** First procedure for insecticide poisoning	
	SO5.9 example of biological control agent?		**CI5.9** Some example of biological control agent?	
	SO5.10 Classified the pesticides		**CI5.10** Classified the pesticides	
	SO5.11 described Brief history of mechanical control of pest?		**CI5.11** Brief history of mechanical control of pest?	
	SO5.12 Explain any one control practice which is eco-friendly in environment?		**CI5.12** Explain any one control practice which is eco friendly in environment?	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Define the concept of Natural control.
	SW5.2 Mini Project	explain the biological control.
	SW5.3 Other Activities (Specify)	Explain the safety precautions by insecticides.

Course duration (in hours) to attain Course Outcomes:

Course Title: Insect Taxonomy and applied entomology **Course Code:** 01ZO602

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
01ZO602 **.1.** Learn about the taxonomy, Morphology and anatomy of insects.	12	6	4	1	23
01ZO602 **.2.** Identify the importance of the insects as beneficial and harmful pests of different crop, forest, medical and veterinary field with their control measures.	12	06	7	1	26
01ZO602 **.3.** Get self-employment in the field of silk, honey and lac production.	12	06	5	1	24
01ZO602 **.4.** Identify the nutritive value of the insects.	12	06	4	1	23
01ZO602 **.5.** Identify the ecological service of the insects and its role in agriculture.	12	06	5	1	24
Total Hours	60	30	26	05	120

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Insect Taxonomy and applied entomology **Course Code:** 01ZO602

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
01ZO602 **.1.** Learn about the taxonomy, Morphology and anatomy of insects.	2	1	1	1	5
01ZO602 **.2.** Identify the importance of the insects as beneficial and harmful pests of different crop, forest, medical and veterinary field with their control measures.	2	4	2	2	10
01ZO602 **.3.** Get self-employment in the field of silk, honey and lac production.	3	5	5	2	15
01ZO602 **.4.** Identify the nutritive value of the insects.	2	3	3	2	10
01ZO602 **.5.** Identify the ecological service of the insects and its role in agriculture.	5	4	1	0	10
Total Marks	**14**	**17**	**12**	**07**	**50**

***Legend*:A,** Apply;**An,** Analyze;**E,** Evaluate;**C,** Create

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1	Shukla G.S. Upadhyaya VB Economic Zoology Rastogi publications Meerut 2014
2	ICAR bee keeping in india
3	Mathur Upadhyay A textbook of Entomology, Goel printing press 1991.
4	Sarkar S kundus , G chaki KK Introduction of Economic Zoology NCBS

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Demonstration
7. ICT Based teaching Learning
8. Brainstorming

CO, PO and PSO Mapping

Program Name: B.Sc Biology
Semester: 6th Semester
Course Title: Insect Taxonomy and applied entomology
Course Code: 01ZO602

CO/PO/PSO Mapping								
Course Outcome (Cos)	**Program Outcomes (POs)**					**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**
01ZO602 **.1.** Learn about the taxonomy, Morphology and anatomy of insects.	3	3	1	3	1	2	2	1
01ZO602 **.2.** Identify the importance of the insects as beneficial and harmful pests of different crop, forest, medical and veterinary field with their control measures.	2	1	2	3	1	3	2	1
01ZO602 **.3.** Get self-employment in the field of silk, honey and lac production.	3	1	1	3	2	3	2	1
01ZO602 **.4.** Identify the nutritive value of the insects.	2	1	1	2	2	2	2	3
01ZO602 **.5.** Identify the ecological service of the insects and its role in agriculture.	3	1	2	2	3	2	3	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5 PSO 1,2,3	01ZO602 **.1.** Learn about the taxonomy, Morphology and anatomy of insects.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	1.1,1.2,1.3	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9,1.10,1.11,1.12	1SL-1,2,3,4
PO 1,2,3,4,5 PSO 1,2,3	01ZO602 **.2.** Identify the importance of the insects as beneficial and harmful pests of different crop, forest, medical and veterinary field with their control measures.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9 SO2.10 SO2.11 SO2.12	2.1, 2.2,2.3	2.1,2.2,2.3,2.4,2.5, 2.6,2.7,2.8,2.9,2.10,2.11,2.12	2SL-1,2,3,4,5,6,7
PO 1,2,3,4,5 PSO 1,2,3	01ZO602 **.3.** Get self-employment in the field of silk, honey and lac production.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9 SO3.10 SO3.11 SO3.12	3.1,3.2,3.3,3	3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9,3.10,3.11, 3.12	3SL-1,2,3,4,5
PO 1,2,3,4,5 PSO 1,2,3	01ZO602 **.4.** Identify the nutritive value of the insects.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8 SO4.9 SO4.10 SO4.11 SO4.12	4.1,4.2,4.3	4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9,4.10,4.11, 4.12	4SL-1,2,3,4
PO 1,2,3,4,5 PSO 1,2,3	01ZO602 **.5.** Identify the ecological service of the insects and its role in agriculture.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9 SO5.10 SO5.11 SO5.12	5.1,5.2,5.3	5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,5.9,5.10,5.11, 5.12	5SL-1,2,3,4,5

CoursesCODE: 01CH603

COURSE NAME: Polymer Chemistry

Pre-requisite: Students should have basic knowledge of Basic concepts : Monomers, repeat units, degree of polymerization Linear, branched and network polymers.

Rationale: The students studying polymer chemistry should possess foundational understanding about polymer chemistry, structure, reactions and application of organic and inorganic polymers . This will provide applicalbe knoweledge about classification of polymers. polymerization : condensation, addition/radical chain-ionic and co-ordination and copolymerization. polymerization conditions and polymer reactions. polymerization in homogeneous and heterogeneous systems.

Course Outcomes:

Afterthe completionofthiscourse, thelearner will

01CH603.1: Explain the Basic concepts of Monomers, repeat units, degree of polymerization Linear, branched and network polymers and Classification of polymers.

01CH603.2: Explain average molecular weight concept. Number, weight and viscosity averagemolecular weights. Polydispersity an molecular weight distribution

01CH603.3: Describe the analysis and testing of polymers Chemical and physical analysis of polymers

01CH603.4:Explain the structure, Properties and Applications of borazines, boranes and carboranes.

silicone's, polymetalloxanes and polymetallosiloxanes,

01CH603.5: Apply the knowledge of Polymers based on Phosphorous-Phosphazenes, Polyphosphates

Polymers based on Sulphure-Tetrasulphur tetranitride and related compounds

Polymer Chemistry

Unit - 1

Basics: Importance of polymers. Basic concepts : Monomers, repeat units, degree of polymerization Linear, branched and network polymers. Classification of polymers. Polymerization : condensation, addition/radical chain- ionic and co-ordination and copolymerization. Polymerization conditions and polymer reactions. Polymerization in homogeneous and heterogeneous systems.

Unit - 2

Polymer Characterization: Polydispersion-average molecular weight concept. Number, weight and viscosity

averagemolecular weights. Polydispersity an molecular weight distribution. The practical significance of molecular weight. Measurement of molecular-weights. End-group, viscosity, light scattering, osmotic and ultracentrifugation methods.

Unit - 3

Analysis and testing of polymers Chemical analysis of polymers, spectroscopic methods, X-ray diffraction study.Microscopy. Thermal analysis and physical testing-tensile strength. Fatigue, impact. Tearresistance, Hardness and abrasion resistance.

Unit - 4

Inorganic Polymers: A general survey and scope of Inorganic Polymers special characteristics, classification, homo and hetero atomic polymers. Structure, Properties and Applications of

a. Polymers based on boron-borazines, boranes and carboranes.
b. Polymers based on Silicon, silicone's polymetalloxanes and polymetallosiloxanes, silazanes.

Unit - 5

Structure, Properties and Application of

a. Polymers based on Phosphorous-Phosphazenes, Polyphosphates
b. Polymers based on Sulphure-Tetrasulphur tetranitride and related compounds.

Co-ordination and metal chelate polymers.

Scheme of Studies:

Board ofStudy	CourseCode	CourseTitle	Scheme ofstudies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours(Cl+LI+SW+SL)	
ProgramCore(PCC)	01CH603	Polymer Chemistry	4	0	1	1	5	4

Legend: **CI:**Class room Instruction (Includesdifferentinstructionalstrategiesi.e.Lecture(L)andTutorial(T)andothers),
LI: Laboratory Instruction (Includes Practicalperformancesinlaboratoryworkshop,fieldorotherlocationsusingdifferentinstructionalstrategies)
SW: Sessional Work(includesassignment,seminar,miniprojectetc.),

SL: Self Learning,
C:Credits.

Note: SW&SL has to be planned andperformedunderthecontinuousguidanceandfeedbackofteacherto ensure outcome ofLearning.

Scheme of Assessment: Theory

Board ofStudy	CouseCode	CourseTitle	SchemeofAssessment(Marks)						
			ProgressiveAssessment(PRA)					EndSemesterAssessment (ESA)	Total Marks (PRA+ESA)
			Class/HomeAssignment 5number 3 markseach (CA)	Class Test2 (2bestout of3) 10 marks each(CT)	Seminarone (SA)	ClassAttendance (AT)	TotalMarks (CA+CT+SA+AT)		
PCC	01CH603	Polymer Chemistry	15	20	10	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs)upon the course's conclusion.

01CH603.1: Apply the concept of classification of polymers. Polymerization process of compound.
Approximate Hours

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (Cl)	Self Learning (SL)
SO1.1 understand importance of polymers. basic concepts : monomers, repeat units, degree of polymerization SO1.2 Apply linear, branched and network polymers. classification of polymers. SO1.3 Explain polymerization : condensation, addition/radical chain-ionic and co-ordination and copolymerization. SO1.4 Explain polymerization conditions and polymer reactions. SO1.5 Understand and apply Polymerization in homogeneous and heterogeneous systems.		**Unit-1.0 Basic Polymerisation** Importance of polymers. basic concepts Monomers, repeat units,degree of polymerization Linear, branched andnetwork polymers. Classification of polymers. Polymerization : condensation, addition/radical chain-ionic. Co-ordination polymerization. Copolymerisation. Polymerization conditions 1.9 Polymer reactions. T1-Polymerization in homogeneous. T2-Heterogeneous system T3- Mechanism of polymerization.	linear, branched and network polymers. classification of polymers.

SW-1Suggested Sessional Work(SW):

a.Assignments:

Discuss polymerization : condensation, addition/radical chain-ionic and co-ordination and copolymerization.

b.Mini Project:

polymerization conditions and polymer reactions.

c.Other Activities (Specify):
Note on applications of Polymerization in homogeneous and heterogeneous systems.

01CH603.2: Explain Polydispersion-average molecular weight concept. Number, weight and viscosityaveragemolecular weights.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes(SOs)	Laboratory Instruction (LI)	Class room Instruction(CI)	Self Learning(SL)

SO2.1 Understand and apply polydispersion-average molecular weight concept. SO2.2 Explain number, weight and viscosity averagemolecular weights. SO2.3 Explain polydispersity an molecular weight distribution. the practical SO2.4 understand and apply significance of molecular weight. measurement of molecular-weights. SO2.5 Explain End-group, viscosity,light scattering, osmotic and ultra centrifugation methods.		Unit-2.0 Polymer Characterization 2.1Introduction of Polymer Characterization Property of Polymer Characterization Introduction of Polydispersion 2,4Mechanism of Polydispersion The practical significance of molecular weight. Properties of molecular weight. Measurement of molecular-weights. Concept of PDI. Average molecular weight concept. T1- Number, weight and viscosity. T2- Average molecular weights. T3-Polydispersity an molecular weightdistribution.	The practical significance of molecular weight.

SW-2 Suggested Sessional Work (SW):

a.Assignments:

apply polydispersion-average molecular weight concept. number, weight and viscosity averagemolecular weights.

b.Mini Project: polydispersity an molecular weight distribution

c.Other Activities (Specify):

Write an eassy on Measurement of molecular-weights. End-group, viscosity, light scattering, osmotic and ultracentrifugation methods.

01CH603.3: describe analysis and testing of polymers chemical analysis of polymers, spectroscopic methods,x-ray diffraction study.micros

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (Cl)	Self Learning (SL)
SO3.1 Understand and apply Analysis and testing of polymers Chemical analysis of polymers **SO3.2** Explainspectroscopic methods, X-ray diffraction study.Microscopy. **SO3.3** explain thermal analysis and physical testing-tensile. so3.4 apply strength. fatigue, impact. tearresistance **SO3.5** explain and apply hardness and abrasion resistance		**Unit-3.0 Analysis and testing of polymers** Introduction of Analysis an Testing of polymers Mechanism of analysis an Testing of polymers. Propertiess of analysis and testing of polymers. Chemical analysis of polymers. Spectroscopic methods, 3.6 X-ray diffraction study. 3.7Microscopy method . Thermal analysis of polymer physical testing-tensile. T1-Strength and fatigue T2-Impact. tearresistance T3-Hardness and abrasion resistance.	spectroscopic methods, X-ray diffraction study.Microscopy.

SW-3 Suggested Sessional Work (SW):

a.Assignments:

analysis and testing of polymers chemical analysis of polymers

b.Mini Project:

spectroscopic methods, X-ray diffraction study.Microscopy.

c.Other Activities (Specify):

Tearresistance, Hardness and abrasion resistance

01CH603.4: Explain a general survey and scope of inorganic polymers special characteristics, classification, homoand hetero atomic polymers.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes(SOs)	Laboratory Instruction (LI)	Class room Instruction(CI)	Self Learning(SL)
SO4.1 Explain and apply a general survey and scope ofInorganic Polymers special characteristics, SO4.2 Explainclassification, homo and hetero atomic polymers SO4.3 Explain Structure, Properties and Applications of Polymers based on boron-borazines, boranes and carboranes. SO4.4Explain and apply Structure, Properties and Applications of Polymers based on Silicon. SO4.5 Explain and apply thesilicone's polymetalloxanes and polymetallosiloxanes, silazanes.		Unit-4.0 Inorganic Polymers A general survey and scope of Inorganic Polymers specialcharacteristics. classification of polymers. Introduction of homo polymers. Properties of homo Polymers. Introduction of hetero atomic polymers Properties of hetero atomicpolymers. Structure, Properties andApplications of Polymers. Introduction of boron-borazines,. 4.9Properties of boron-borazines,. T1-boranes and carboranes T2-.Structure, Properties and Applications of Polymers based on Silicon. T3-Explain and apply thesilicone's polymetalloxanes and polymetallosiloxanes, silazanes.	Structure, Properties and Applications of Polymers based on boron-borazines, boranes and carboranes.

SW-4 Suggested Sessional Work (SW):

a.Assignments:

Explain and apply A general survey and scope of Inorganic Polymers special characteristics

b.Mini Project:

the silicone's poly metalloxanes and polymetallosiloxanes, silazanes.

c.Other Activities (Specify):

Explain and apply thesilicone's polymetalloxanes and polymetallosiloxanes, silazanes.

01CH603.5: Apply the knowledge of the Structure, Properties and Application of Polymers based on Phosphorous-Phosphazenes, Polyphosphates.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (Cl)	Self Learning (SL)
SO5.1 Explain and apply the Polymers based on Phosphorous **SO5.2** Explain and apply the Polymers based on Phosphazenes, Phosphazenes, **SO5.3** Explain and apply Polymers based on Polyphosphates **SO5.4** Explain and apply Polymers based on Sulphure-Tetrasulphur tetranitride and related compounds. **SO5.5** Explain and apply The Co-ordination and metal chelate polymers.	.	**Unit-5.0:Structure, Properties and Application of polymer** Polymers based on Phosphorous. Polymers based on Phosphazenes. Introducton of Phosphazenes. Properties of Phosphazenes. Structure of Phosphazenes. Polymers based on Polyphosphates Introducton of Polyphosphates Properties ofPolyphosphates. Polymers based on Sulphure. T1-Tetrasulphur tetranitride and related compounds. T2-The Co-ordination and metal chelate polymers. T3- Properties of The Co-ordination and metal chelate polymers.	Polymers based on Phosphazenes, Phosphazenes, Polymers based on Polyphosphates

SW-5 Suggested Sessional Work (SW):

a.Assignments:

Structure, Properties and Application of Polymers based on Phosphorous

a.Mini Project:

Structure, Properties and Application of Polymers based on Phosphazenes, Polyphosphates.

c.Other Activities (Specify):

Polymers based on Sulphure-Tetrasulphur tetranitride and related compounds

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
01CH603.1: Apply the concept of Basics: Importance of polymers. Basic concepts : Monomers, repeat units, degree of polymerization Linear, branched and network polymers. Classification of polymers.	12	02	01	15
01CH603.2: Explain Polydispersion-average molecular weight concept. Number, weight and viscosity averagemolecular weights. Polydispersity an molecular weight distribution.	12	02	01	15
01CH603.3: Describe Analysis and testing of polymers Chemical analysis of polymers, spectroscopic methods, X-ray diffraction study.Microscopy. Thermal analysis and physical testing-tensile strength. Fatigue, impact. Tearresistance, Hardness and abrasion resistance.	12	02	01	15
01CH603.4:Explain A general survey and scope of Inorganic Polymers special characteristics, classification, homo and hetero atomic polymers. Structure, Properties and Applications of Polymers based on boron-borazines, boranes and carboranes.	12	02	01	15
01CH603.5: Apply the knowledge of the **Structure, Properties and Application of** a. Polymers based on Phosphorous-Phosphazenes, Polyphosphates b. Polymers based on Sulphure-Tetrasulphur tetranitride and related compounds. Co-ordination and metal chelate polymers.	12	02	01	15
Total Hours	60	10	05	75

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Basics: Importance of polymers. Basic concepts	03	01	01	05
CO-2	Polymer Characterization	02	06	02	10
CO-3	Analysis and testing of polymers	03	07	05	15
CO-4	Inorganic Polymers	-	10	05	15
CO-5	Structure, Properties and Application of Polymers	03	02	-	05
Total		11	26	13	50

Legend: R:Remember, U:Understand, A:Apply

The end of semester assessment for Organic Chemistry I will be held with written examination of 50marks

Note: Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks.Teachers can also design different tasks as per requirement,for end semester assessment.

Suggested Instructional/ImplementationStrategies:

1. ImprovedLecture
2. Tutorial
3. CaseMethod
4. GroupDiscussion
5. RolePlay
6. Visitto NCL, CSIR laboratories
7. Demonstration
8. ICTBasedTeachingLearning(VideoDemonstration/TutorialsCBT,Blog,Facebook,Twitter,Whatsapp,Mobile,Onlinesources)
9. Brainstorming

Suggested Learning Resources:

(j) Books

S. No.	Title	Author	Publisher	Edition& Year
1	The Chemistry of Polymers	John W Nicholson	Royal Society of Chemistry	Fourth edition 2015
2	Developments in Inorganic polymer Chemistry,	M.F. Lappert and G.J. Leigh.	Elsevier Pub. Co.	2007
3	Principles of Polymer Systems	Ferdinand Rodriguez, Claude Cohen, Christopher K. Ober, Lynden Archer	Taylor & Francis	Sixth edition 2014
4	Handbook of Polymer Synthesis	Graham Swift, Hans R. Kricheldorf, Oskar Nuyken	CRC Press	Revised edition 2004
5	Inorganic Chemistry	Gary Wulfsberg	University Science Books	Third edition 2000
6	Textbook of Polymer Science	Billmeyer	Wiley India Pvt. Limited	Third edition 2007

SuggestedWebSources:

35. https://nptel.ac.in/course.html
36. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
37. https://swayam.gov.in/explorer?category=Chemistry

Mode of Delivery:Lecture,demonstration,E-tutoring,discussion,assignments,quizzes, case study, power point;

LMS/ICT Tools: Digital Classrooms, DLMS, ZOOM, G-Suite,MSPower-Point, Online Resour

AKS University

Faculty of Basic Science

Curriculum of B. Sc. (Honours / By Research) Program

(Revised as on 01 August 2023)

Title: Polymer Chemistry **Course Code : 01CH603**

	Program Outcomes												**Program Specific Outcome**			
Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
	Knowledge	**Research Aptitude**	**Communication**	**Problem Solving**	**Individual and Team Work**	Investigation of Problems	**Modern Tool usage**	**Science and Society**	**Life-Long Learning**	**Ethics**	**Project Management**	**Environment and sustainability**	**The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry**	**To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.**	**understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon - based problems in chemical sciences.**	**Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science**

CO1: Apply the concept of Importance of polymers. Basic concepts : Monomers, repeat units, degree of polymerization Linear, branched and network polymers. Classification of polymers. Polymerization condensation, addition/radical chain-ionic and co-ordination and copolymerization.	**3**	**1**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**3**	**2**	**2**	**3**	**3**	**1**
CO2: Explain Polydispersion-average molecular weight concept. Number, weight and viscosity	**2**	**1**	**2**	**2**	**1**	**2**	**3**	**2**	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**1**

averagemolecular weights. Polydispersity an molecular weight. distribution.																
CO3 : Describe Analysis and testing of polymers Chemical analysis of polymers, spectroscopic methods, X-ray diffraction study.Microscopy	**2**	**2**	**1**	**1**	**1**	**2**	**2**	**2**	**1**	**2**	**1**	**2**	**1**	**1**	**2**	**2**
CO 4: ExplainA general survey and scope of Inorganic Polymers special characteristics, classification, homo and hetero atomic polymers. Structure, Properties and	**2**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**2**	**3**	**3**	**3**	**3**	**2**

Applications of Polymers based on boron-borazines, boranes and carboranes.																
CO 5: Apply the knowledge of the Structure, Properties and Application of Polymers.	**2**	**-**	**-**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**3**	**1**	**3**

AKS University

Faculty of Basic Science

Curriculum of B. Sc. (Honours / By Research) Program

(Revised as on 01 August 2023)

Course Curriculum Mapping

POs &PSOsNo.	Cos No. & Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1 Apply the concept of Importance of polymers. Basic concepts : Monomers, repeat units, degree of polymerization Linear, branched and network polymers. Classification of polymers. Polymerization condensation, addition/radical chain-ionic and co-ordination and copolymerization.	SO1.1SO1.2SO1.3SO1.4 SO1.5		Unit-1.0 Basic importance of polymer 1.1,1.2,1.3,1.4,1.5,1.6,1.7	linear, branched and network polymers. classification of polymers.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 2 : Explain Polydispersion-average molecular weight concept. Number, weight and viscosity averagemolecular weights. Polydispersity an molecular weight. distribution.	SO2.1SO2.2SO2.3 SO2.4 SO2.5		Unit-2 Polymer Characterization 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9	The practical significance of molecular weight.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3 Describe Analysis and testing of polymers Chemical analysis of polymers, spectroscopic methods, X-ray diffraction study.Microscopy	SO3.1SO3.2 SO3.3 SO3.4 SO3.5		Unit-3 :Analysis and testing of polymers 3.1, 3.2,3.3,3.4,3.5,3.6,3.7	spectroscopic methods, X-ray diffraction study.Microscopy.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4: ExplainA general survey and scope of Inorganic Polymers special characteristics, classification, homo and hetero atomic polymers. Structure, Properties and Applications of Polymers based on boron-borazines, boranes andcarboranes.	SO4.1SO4.2SO4.3SO4.4 SO4.5		Unit-4 : Inorganic Polymers 4.1, 4.2,4.3,4.4,4.5,4.6,4.7	boron-borazines, boranes andcarboranes.
PO1,2,3,4,5,6 7,8,9,10,11,12	CO 5: Apply the knowledge of the Structure, Properties and Application of Polymers.	SO5.1SO5.2SO5.3SO5.4 SO5.5		Unit 5: Structure, Properties and Application of	Polymers based on Polyphosphates

PSO 1,2, 3, 4				Polymers 5.1,5.2,5.3,5.4,5.5,5.6,5.7	

Curriculum Development Team:

1) Dr. Shailendra Yadav, HoD, Department of Chemistry, AKS University, Satna (M.P.).
2) Dr. Dinesh Kumar Mishra, Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
3) Dr. Samit Kumar,Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
4) Dr. Sushma Singh, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
5) Dr. Manoj Kumar Sharma, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
6) Mr. Kanha Singh Tiwari,Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).

Mrs. Nahid Usamani, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).

Program name	Bachelor of Science (B. Sc.) Biology	
Semester	6th Sem	
Course Code:	05BO601	
Course title:	Biodiversity and Economic Botany (Theory)	**Curriculum Developer**: Priya Dwivedi
Pre-requisite:	Students should have basic knowledge of Botany	
Rationale:	The B.Sc. Botany curriculum integrates the concept of biodiversity, threats, conservation strategies, and the economic potential of plant resources, including medicinal uses. Unit I covers the fundamental understanding of biodiversity and its various forms, while Unit II addresses threats and conservation methods. Unit III focuses on plant resources and their economic significance, Unit IV on other economically important plant resources, and Unit V on medicinal plants and their applications, emphasizing comprehensive botanical knowledge and practical applications.	
Course Outcomes (COs)	CO1: Apprenend plant products used in daily life CO2: Assess the diversity of plants and the plant products in human use Co3: Understand core concepts of Economic Botany CO4: Get acquainted with the resources of millets, cereals, pulses, vegetables, flowers, fibre and wild food plants. CO5: Recognize the importance of plants for enhancing immunity and their role in various medicinal systems	

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits(C) (L:T:P=3:0:1)
			CI	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Major	05BO601	Biodiversity and Economic Botany	3	1	1	1	6	3+0=1=4

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
PC	05BO601	Biodiversity and Economic Botany	**15**	**20**	**5**	**5**	**5**	**50**	**50**	**100**

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	12	4	1	5	22

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO1: Apprenend plant products used in daily life			**Unit-1**	
	SO1.1 Explain in detail introduction of biodiversity		**CI1.1** Understand the basic concept and definition of biodiversity.	**SL1.1** Search various reference books and other study material to start the learning about biodiversity
	SO1.2 Explain the history of biodiversity		**CI1.2** Explore the scope and limitations of biodiversity.	**SL1.2**Explore the historical evolution and recent advancements in biodiversity
	SO1.3 Describe the basic laboratory techniques in biodiversity		**CI1.3** Understand the concept of genetic diversity.	**SL1.3**Understand the essential infrastructure and equipment needed for an biodiversity laboratory.
	SO1.4 Explain in detail the herbarium techniques.	**LI1.1** study of herbarium techniques.	**CI1.4** Learn about species diversity.	**SL1.4**Learn about the formulation and sterilization of culture media used in biodiversity
	SO1.5 Explain the history of biodiversity		**CI1.5** Explore ecological or ecosystem diversity.	
	SO1.6 Describe the relevance of biodiversity in major group.	**LI1.2** Prepare an inventory of plants in the vicinity in the university campus.	**CI1.6** Understand agro-biodiversity.	**SL1.5**Acquire able to recall the botanical names of crops.

	SO1.7 Explain in detail the relevance of biodiversity inminor group, tribals of india.		**CI1.7** Learn about urban biodiversity, and understand the major centers of biodiversity.	
	SO1.9 Explain in detail the relevance of biodiversity life style of tribals of India, and its importence.		**CI1.9** Learn about terrestrial plants, And explore the diversity of aquatic plants.	
	.			
	SO1.11 discribe and define the branches of biodiversity.		**CI1.11** Understand the characteristics of epiphytic plants, parasitic and saprophytic plants.	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Describe in detail the history of biodiversity.
	SW1.2 Mini Project	Describe the branches of biodiversity.
	SW1.3 Other Activities (Specify)	Explain the importance of biodiversity.

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	12	4	1	5	22

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO2: Assess the diversity of plants and the plant products in human use.			**Unit-2**	
	SO2.1 Describe Understand the general concept of threats to biodiversity.	**LI2.1** To demonstrate the detail of food plant used by the tribals.	**CI2.1**Understand the general concept of threats to biodiversity..	**SL2.1** Discussion on different plant resources students are familiar with.
	SO2.2 Explain in detail about habitat destruction and its impacts.		**CI2.** Learn about habitat destruction and its impacts.	
	SO2.3 Describe habitat fragmentation.	**LI2.2** Study the intoxoicants and beverages plant used by the tribals.	**CI2.3**Understand habitat fragmentation.	**SL2.**Field trip to a local market for surveying and documenting plant resources.
	SO2.4 Explain in detail habitat transformation.		**CI2.4** Explore habitat transformation.	**SL2.3** Group work to analyze and present survey data.
	SO2.5 Explain in detail habitat degradation.		**CI2.5** Learn about habitat degradation.	**SL2.4** Create a checklist of underutilized and discontinued plants from the survey data.
	SO2.6 Explain in detail habitat loss.		**CI2.6** Understand habitat loss.	
	SO2.7 Describe the IUCN threatened categories.		**CI2.7** Learn about the IUCN threatened categories.	**SL2.5** Create maps showing the geographical distribution of different plant resources
	SO2.8 describe the concepts of endangered and endemic species.		**CI2.8** Understand the concepts of endangered and endemic species.	

	culture.			
	SO2.9 Explain the invasive species and their impact.		**CI2.9** Learn about invasive species and their impact.	
	SO2.10 Define the impact of pollution on biodiversity.		**CI2.10** • Understand the impact of pollution on biodiversity.	
	SO2.11 Explain in detail the the impact of pollution on biodiversity.		**CI2.11** Learn about the effects of overexploitation.	
	SO2.12 Describe the concept and use of biodiversity indices.		**CI2.12** • Understand the concept and use of biodiversity indices.	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Describe and define the impact of pollution on biodiversity.
	SW2.2 Mini Project	Detail study of plant used by the tribles.
	SW2.3 Other Activities (Specify)	Understand the concept and use of biodiversity indices.

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	12	4	1	2	19

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
			Unit-3	
CO3: Understand core concepts of Economic Botany	**SO3.1**Explain in detail the importance of various economical plant resources.		**CI3.1** Understand the importance of various economical plant resources.	**SL3.1** Discussion on different plant resources students are familiar with.
	SO3.2 Explain in detailed how to conduct resource surveys and documentation.		**CI3.2** Learn how to conduct resource surveys and documentation.	
	SO3.3 Detailed Study of Practical experience in resource surveying.		**CI3.3** Practical experience in resource surveying.	
	SO3.4 Explain in detailed data collected from the market survey.		**CI3.4** Analyze the data collected from the market survey.	
	SO3.5 Explain in detailed underutilized and discontinued plants.		**CI3.5** Learn about underutilized and discontinued plants.	
	CI3.6.5 describe the economic potential of various plant resources.	**LI3.1**To practice techniques of detailed study of selected plant.	**C I3.6** Understand the economic potential of various plant resources.	**SL3.2** Discussion and research on the economic potential of different plant resources.
	SO3.7 Explain in detail geographical distribution of plant resources.	**LI3.2**To demonstrate the Endangered Taxa and Forest Management.	**CI3.7** Learn about the geographical distribution of plant resources.	
	SO3.8 Explain in detail economic potential of fodders.		**CI3.8** Understand the economic potential of fodders.	

	SO3.9 Explain in detail Study of Selected Plants – True Indigo		**CI3.9** Learn about the importance of wild relatives of cultivated crops.	
	SO3.10 Explain in detail study of role of ethnobotany in modern science.		**CI3.10** Understand traditional water management techniques.	
	SO3.11 Explain in detail role of ethnic groups in conservation of plant genetic resources.		**CI3.11** Learn about traditional soil management techniques.	
	SO3.12 Explain in detail Endangered Taxa and Forest Management.		**CI3.12** Review and consolidate knowledge of plant resources.	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Describe the importance of various economical plant resources..
	SW3.2 Mini Project	Detailed study of different types of fibers and their uses.
	SW3.3 Other Activities (Specify)	Explain in scope of biodiversity.

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	12	4	1	4	21

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO4: Get acquainted with the resources of millets, cereals, pulses, vegetables, flowers, fibre and wild food plants. .			**Unit-4**	
	SO4. 1 Explain in detail of the importance of various economical plant resources.		**CI4.1** Understand the importance of various economical plant resources.	**SL4.1** Discussion on the everyday use of plant-based products.
	SO4.2 Study in detail the cotton fibers and their marketing potential.		**CI4.2** Learn about cotton fibers and their marketing potential.	**SL4.2** Research and presentation on cotton production and its economic impact.
	SO4.3 Discuss the different types of fibers and their uses.	**LI4.1**To demonstrate the principles of biodiversity	**CI4.3** Understand the different types of fibers and their uses.	
	SO4.4 Describe the natural dyes and locally available dye-yielding plants.		**CI4.4** Learn about natural dyes and locally available dye-yielding plants.	**SL4.4** Experiment with extracting dyes from local plants.
	SO4.5 Explain in detail the use of plants in herbal skin care products.		**CI4.5** Understand the use of plants in herbal skin care products.	
	SO4.6 Describe and define the plants used in herbal hair care products.	**LI4.2**To demonstrate Legal Safeguards in India of biodiversity	**CI4.6** Learn about plants used in herbal hair care products.	**SL4.6** Discussion on the benefits and preparation of herbal hair care products.
	SO4.7 Explain in detail the economic potential of jaggery and palm sugar.		**CI4.7** Understand the economic potential of jaggery and palm sugar.	
	SO4.8 Explain in detail the cane sugar and stevia as natural sweeteners.		**CI4.8** Learn about cane sugar and stevia as natural sweeteners.	

	Committees (BMC).			
	SO4.9 Discuss the the economic significance of coffee.		**CI4.9** Understand the economic significance of coffee.	
	SO4.10 Explain in detailthe tea and a range of herbal teas.		**CI4.10** Learn about tea and a range of herbal teas.	
	SO4.11 Explain in detail the stimulating and alcoholic beverages.		**CI4.11** Differentiate between stimulating and alcoholic beverages.	
	SO4.12 Discuss the marketing and economic potential of various plant resources.		**CI4.12** Review and understand the marketing and economic potential of various plant resources.	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Describe the introduction of biodiversity.
	SW4.2 Mini Project	Explain in detail to understand the different types of fibers and their uses.
	SW4.3 Other Activities (Specify)	Write a one review article on educational role of biodiversity.

Curiculum

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	12	4	1	3	20

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO5: Recognize the importance of plants for enhancing immunity and their role in various medicinal systems			**Unit-5**	
	SO5.1 Explain in detail the Introduction to Medicinal Plants	LI5.1 Demonstrate different skin diseases.	CI5.1 Understand the importance and scope of medicinal plant resources.	SL5.1 Search various reference books and other study material to start learning about medicinal plants.
	SO5.2 Explain in detail the Skin Diseases.	**LI5.2** Demonstrate different types of diseases.	CI5.2 Learn about raw drugs and their significance.	SL5.2 Explore the various types of skin diseases.
	SO5.3 Explain in detail Bronchial Inflammation and Asthma diseases.		SO5.3 Explain in detail Bronchial Inflammation and Asthma diseases. LI5.1 Demonstrate different skin diseases.	CI5.3 Understand the role of plants in Ayurveda.
	SO5.4 Explain in detail Jaundice.		LI5.4 Demonstrate different types of diseases.	CI5.4 Learn about the use of plants in Unani medicine.
	SO5.5 Explain in detail about Malaria.		CI5.5 Understand the role of plants in Siddha medicine.	
	SO5.6 Describe and define the Expulsion of Worms.		CI5.6 Learn about the use of plants in Homeopathy.	
	SO5.7 Explain in detail about Piles.		Understand the medicinal uses of algae.	
	SO5.8 Discuss the		**CI5.8** Learn about the medicinal uses of fungi.	

	Rheumatism.			
	SO5.9 Discuss the Heart Diseases.		**CI5.9** Understand the use of plants in treating common ailments.	
	SO5.10 Explain in detail Amoebic Dysentery.		**CI5.10** Understand the role of plants in traditional medicine systems.	
	SO5.11 Explain the role of medicinal plants in enhancing immunity.		**CI5.11** Learn about the active compounds in medicinal plants.	
	SO5.12 Discuss the role of medicinal plants in cancer treatment.		**CI5.12** Understand the research on medicinal plants and their anticancer properties.	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Explain in detail about medicinal plant.
	SW5.2 Mini Project	Describe in the detail different types of diseases.
	SW5.3 Other Activities (Specify)	One case research study on the use of plants in Homeopathy.

Course duration (in hours) to attain Course Outcomes:

Course Title: Biodiversity & Economic Botany **Course Code:** 05BO601

Course Outcomes (COs)	**Class lecture (CI)**	**Laboratory Instruction (LI)**	**Self-Learning (SL)**	**Sessional work (SW)**	**Total Hours (Li+CI+SL+SW)**
CO1: Understand the importance of plantsand their relationship with human being.	12	4	5	1	22
CO2: Explain how plants are a part of culture and traditions.	12	4	5	1	22
CO3: How traditional medicine can cure various diseases.	12	4	2	1	19
CO4: Analyze the medico-ethnobotanical sources in India.	12	4	4	1	21
CO5: Observe the role of medicinal plant in skin diseases.	12	4	3	1	20
Total Hours	60	20	19	05	104

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcomes:Course

Title: Biodiversity & Economic Botany **Course Code:** 05BO601

Course Outcomes	**Marks Distribution**				**Total Marks**
	R	**U**	**A**	**A**	
CO1: Understand the importance of plants and their relationship with humanbeing.	2	2	3	2	9
CO2: Explain how plants are a part of culture and traditions.	2	3	3	2	10
CO3: How traditional medicine can cure various diseases.	2	2	3	4	11
CO4: Analyze the medico-ethnobotanical sources in India.	2	2	3	3	10
CO5: Observe the role of medicinal plant in skin diseases.	2	2	2	4	10
Total Marks	10	11	14	15	50

***Legend*:R,** Remember; **U,** Understand; **A,** Apply; **A,** Analyze

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1.	Chrisgels, MJ. and Sandava, D,EPlants, Genes and erop biotechnology. Jones and Bartlett Publishers,(2003)
2.	Kochhar S.L Eonomie Botany in Tropivs, 4tth odn. Macmilan and Co, New Delhi, India. (2012)
3.	Sammbamurty, A.V.S.S, Text book of Modern Econamic Botany, Ist Edn. CBS Publishers. (2008)
4.	Simpson B.B and Ogorzaly M.C Economic Botany: Plants in Our world MeGraw Hill, USA.(2000)
5.	Wickens, G.E Economic Botany: Principles and Practices. Panima publishing corporation. (2007)

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Visit to animal biotechnology lab and stem cells biology lab
7. Demonstration
8. ICT Based teaching Learning
9. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Sc. Biology
Semester: 6th
Course Title: Biodiversity & Ecology
Course Code:

CO/PO/PSO Mapping															
Course Outcome (Cos)	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1: Understand the importance of plants and their relationship with humanbeing.	3	1	1	-	-	1	1	1	1	-	2	1	2	2	2
CO2: Explain how plants are a part of culture and traditions.	3	2	1	2	1	-	-	1	1	-	2	1	2	3	3
CO3: How traditional medicine can cure various diseases.	2	1	1	-	-	2	-	2	1	-	1	1	3	2	1
CO4: Analyze the medico-ethnobotanical sources in India.	2	3	1	1	-	1	-	1	1	1	2	1	2	2	2
CO5: Observe the role of medicinal plant in skin diseases.	2	3	-	1	2	2	1	2	1	2	1	2	2	2	2
Total Marks															

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	CO1: Understand the importance of plants and their relationship with humanbeing.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	LI 1 LI 2	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9,1.1 0,1.11,1.12	1SL-1,2,3,4,5
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	CO2: Explain how plants are a part of culture and traditions.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9 SO2.10 SO2.11 SO2.12	LI 1 LI 2	2.1,2.2,2.3,2.4,2.5, 2.6,2.7,2.8,2.9,2.1 0,2.11,2.12	2SL-1,2,3,4,5
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	CO3: How traditional medicine can cure various diseases.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9 SO3.10 SO3.11 SO3.12	LI 1 LI 2	3.1,3.2,3.3,3.4,3.5, 3.6,3.7,3.8,3.9,3.1 0,3.11,3.12	3SL-1,2
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	CO4: Analyze the medico-ethnobotanical sources in India.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8 SO4.9 SO4.10 SO4.11 SO4.12	LI 1 LI 2	4.1,4.2,4.3,4.4,4.5, 4.6,4.7,4.8,4.9,4.1 0,4.11,4.12	4SL-1,2,3,4
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	CO5: Observe the role of medicinal plant in skin diseases.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9 SO5.10 SO5.11 SO5.12	LI 1 LI2	5.1,5.2,5.3,5.4,5.5, 5.6,5.7,5.8,5.9,5.1 0,5.11,5.12	5SL-1,2,3

Program Name	**Bachelor of Science (B.Sc.)- Biology**	
Semester	6th	
CourseCode:	05ZO602	
Coursetitle:	Ecology, bio diversity and Evolution	**Curriculum Developer**: Mr. Amit Bagri
Pre-requisite:	To study this course a student must have had the subject zoology in diploma.	
Rationale:	Graduates will understand the relevance of ecological and evolutionary research for human society and economics, will be able to apply the central elements of modern ecology and evolutionary biology to interdisciplinary questions, and they will be able to contribute to finding solutions towards a sustainable use of resources relevant for our society.	
Course Outcomes (COs):	05ZO602 **.1.** have comprehensive understanding of the basis terms, principles. rules, value, & concept of ecological science. 05ZO602 **.2.** identify the different types of ecosystems and relationship between the organisms and their environment. 05ZO602 **.3.** identify the significance of bio diversity. 05ZO602 **.4.** clear understanding of the Major issue of the biodiversity. 05ZO602 **.5.** get knowledge the theories of origin and development of early life of the earth.	

Scheme of Studies:

Board of Study	**Course Code**	**CourseTitle**	**Scheme of studies (Hours/Week)**					**Total Credits(C) (L:T:P=3:0:1)**
			Cl	LI	SW	SL	**Total Study Hours(CI+LI+SW+SL)**	
MAJOR DSC 1	05ZO602	Ecology, bio diversity and Evolution	3	1	1	1	6	3+1=4

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)		
MAJOR DSC1	05ZO602	Ecology, bio diversity and Evolution	**15**	**20**	**10**	**5**	**50**	**50**	**100**

Scheme of Assessment: Practical

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)		
Major DSC 1	05ZO602	Ecology, bio diversity and Evolution	35	5	5	5	50	50	50

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

ApproximateHours

Item	Cl	LI	SW	SL	Total
Approx.Hrs	08	04	01	06	19

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
05ZO602 **.1.** have comprehensive understanding of the basis terms, principles. rules, value, & concept of ecological science.	**SO1.1** Define introduction and history of ecology	**LI1.1** Identification and study of fresh water fauna and its economic importance.	**Unit 1** **Concept of Ecology.** CI1.1 Define introduction and history of ecology	**SL1.1** Learn about introduction and history of ecology
	SO1.2 Describe about Classification of eco system.	LI1.2 Classification of eco system.	**CI1.2**Describe about Classification of eco system.	**SL1.2** learn about Classification of eco system.
	SO1.3 Explain about function of ecosystem.		CI1.3 Explain about function of ecosystem	**SL1.3** Learn about function of ecosystem
	SO1.4 Describe Bio geo chemical cycle.		CI1.4 Describe Bio geo chemical cycle.	**SL1.4** Learn about Bio geo chemical cycle.
	SO1.5 explain about carbon?		CI1.5 Study about carbon?	
	SO1.6 described about Nitrogen?		CI1.6 Study about Nitrogen?	**SL1.5** Study about Nitrogen?
	SO1.6 described Phosphorus?		CL1.7 Study about Phosphorus?	**SL1.6** Study about food chain and food web?
	SO1.7 explain food chain and food web?		CI1.8 Study about food chain and food web?	
	SO1.8 Explain about food chain and food web?			

Suggested Sessional Work (SW):*anyone*	**SW1.1** Assignments	Define introduction and history of ecology
	SW1.2 Mini Project	Describe about Classification of eco system..
	SW1.3 Other Activities (Specify)	Describe Bio geo chemical cycle.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	08	04	01	06	19

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
05ZO602 **.2.** identify the different types of ecosystems and relationship between the organisms and their environment.	**SO2.1** Define and describe basic concept and characteristics of population.	**LI2.1** Study the pond eco system	**Unit-II** **Population Concept** **CI2.1** Define and describe basic concept and characteristics of population.	**SL2.1** Learn about characteristics of population
	SO2.2 Describe about population interaction	LI2.2 Study and prepare slide	**CI2.2** Describe about population interaction	**SL2.2** Learn about mulberry silkworm, lifecycle of bombyx mori.
	SO2.3 Explain about characteristics of community.		**CI2.3** Explain about characteristics of community.	**SL2.3** Learn about characteristics of community.
	SO2.4 Describe Stratification in terrestrial and aquatic habitat.		**CI2.4** Describe Stratification in terrestrial and aquatic habitat.	**SL2.4** Learn about Stratification in terrestrial and aquatic habitat.
	SO2.5 Explain about mutualism?		**CI2.5** Explain about mutualism?	SL 2.5 Learn about mutualism?
	SO2.6 Explain about predation?		**CI2.6** Explain about predation?	SL2. 6 Learn about predation?
	SO2.7 Explain about herbivory?		CI2.7 Explain about herbivory?	
	SO2.8 Explain about carnivory?		CI2.8 Explain about carnivory?	

Suggested Sessional Work (SW) : *anyone*	**SW2.1** Assignments	Define and describe basic concept and characteristics of population.
	SW2.2 Mini Project	Describe about population interaction
	SW2.3 Other Activities (Specify)	Describe Stratification in terrestrial and aquatic habitat.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	08	02	01	07	18

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
05ZO602 **.3.** identify the significance of bio diversity.	**SO3.1** Explain the concept the habitat and ecological Niche.	LI3.1 Identify and use of important forest medicinal plants	**Unit-III Habitat Ecology** **CI3.1** Explain the concept the habitat.	**SL3.1** Learn about habitat and ecological Niche.
	SO3.2 Describe Fresh water habitat and its conservation.		**CI3.2** Describe Fresh water habitat and its conservation.	**SL3.2** Learn about about Fresh water habitat and its conservation.
	SO3.3 Describe Marine water habitat and its conservation.		**CI3.3** Describe Marine water habitat and its conservation.	**SL3.3** Learn about about Marine water habitat and its conservation.
	SO3.4 describe the terrestrial habitat and its conservation.		**CI3.4** describe the terrestrial habitat and its conservation.	**SL3.4** Learn about about terrestrial habitat and its conservation.
	SO3.5 Describe about Ecological division of India.		**CI3.5** Describe about Ecological division of India	**SL3.5** Learn about about Ecological division of India.
	SO3.6 Describe about marine water conservation.		**CI3.6** Describe about marine water conservation.	
	SO3.7 Describe Fresh water conservation.		**CI3.7** Describe Fresh water conservation.	SL3.6 Learn about about Fresh water conservation.
	SO3.8 Describe about ecological Niche?		**CI3.8** Describe about ecological Niche	SL3.7 Learn about ecological Niche

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Explain the concept the habitat and ecological Niche.
	SW3.2 Mini Project	Describe Marine water habitat and its conservation.
	SW3.3 Other Activities (Specify)	Describe about Ecological division of India.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	08	04	01	03	16

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
05ZO602 **.4.** Identify the nutritive value of the insects.	**SO4.1** Describe the meaning, value, and ethics of bio diversity.	LI4.1 Describe the meaning, value, and ethics of bio diversity.	**Unit-IV** **Bio diversity** **CI4.1** Describe the meaning, value, and ethics of bio diversity.	**SL4.1** Learn about value, and ethics of bio diversity.
	SO4.2 Describe the Importance and types of bio diversity.	LI4.2 Explaining the Hotspots and conservation of biodiversity.	**CI4.2** Describe the Importance and types of bio diversity.	**SL4.2** Discuss Importance and types of bio diversity.
	SO4.3 Explaining the Hotspots and conservation of biodiversity.		**CI4.3** Explaining the Hotspots and conservation of biodiversity.	**SL4.3** Learn about Hotspots and conservation of biodiversity.
	SO4.4 Explaining the Bio diversity protection act – 2002		**CI4.4** Explaining the Bio diversity protection act – 2002	
	SO4.5 Evaluate role of Medicinal plants of forest and its use.		**CI4.5** Evaluate role of Medicinal plants of forest and its use.	
	SO4.6 explain about Genetic biodiversity?		**CI4.6** Describe about Genetic biodiversity?	
	SO4.7 explain species biodiversity?		**CI4.7** Describe about species biodiversity?	
	SO4.8 described in situ protected areas?		**CI4.8** Describe about in situ protected areas?	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Describe the meaning, value, and ethics of bio diversity.
	SW4.2 Mini Project	Explaining the Hotspots and conservation of biodiversity.
	SW4.3 Other Activities (Specify)	Explaining the Bio diversity protection act – 2002

Item	Cl	LI	SW	SL	Total
Approx.Hrs	09	04	01	05	19

Course Outcome (CO)	SessionOutcomes(SOs)	LaboratoryInstruction(LI)	ClassroomInstruction(CI)	Self-Learning(SL)
05ZO602 **.5.** get knowledge the theories of origin and development of early life of the earth	**SO5.1** Define the history of evolution and origin of life.	LI5.1 Analogy	**Unit-V Evolution** **CI5.1** Define the history of evolution and origin of life.	**SL5.1** learn about evolution and origin of life
	SO5.2 Describe the Evidence of organic Evolution.	LI5.2 Wings of birds	**CI5.2** Describe the Evidence of organic Evolution.	**SL5.2** Describe the Evidence of organic Evolution.
	SO5.3 explain the Elementary idea of geological time scale.		**CI5.3** explain the Elementary idea of geological time scale	**SL5.3** learn Elementary idea of geological time scale
	SO5.4 Evaluate the Definition and types of adaptation.		**CI5.4** Evaluate the Definition and types of adaptation	**SL 5.4** learn about Definition and types of adaptation
	SO5.5 Explain the definition and kinds of Mimicry.		**CI5.5** Explain the definition and kinds of Mimicry.	**SL5.5** learn about definition and kinds of Mimicry.
	SO5.6 Explain the theory of evolution.		**CI5.6** Explain the theory of evolution.	
	SO5.7 Explain the modern evolution of theory.		**CI5.7** Explain the modern evolution of theory.	
	SO5.8 Explain the geological timescale.		**CI5.8** Explain the geological timescale.	
	SO5.9 Explain about Definition and kinds of mimicry.		**CI5.9** Explain about Definition and kinds of mimicry.	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Define the history of evolution and origin of life.
	SW5.2 Mini Project	explain the Elementary idea of geological time scale
	SW5.3 Other Activities (Specify)	Explain the definition and kinds of Mimicry.

Course duration (in hours) to attain Course Outcomes:

Course Title: Ecology, bio diversity and Evolution **Course Code: S3ZOOL4D**

Course Outcomes(COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
05ZO602 **.1.** have comprehensive understanding of the basis terms, principles. rules, value, & concept of ecological science.	8	04	6	1	19
05ZO602 **.2.** identify the different types of ecosystems and relationship between the organisms and their environment.	8	04	6	1	19
05ZO602 **.3.** identify the significance of bio diversity.	8	02	7	1	18
05ZO602 **.4.** clear understanding of the Major issue of the biodiversity.	8	04	3	1	16
05ZO602 **.5.** get knowledge the theories of origin and development of early life of the earth.	9	04	5	1	19
Total Hours	41	18	27	05	91

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Ecology, bio diversity and Evolution **Course Code:05ZO602**

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
05ZO602 **.1.** have comprehensive understanding of the basis terms, principles. rules, value, & concept of ecological science.	2	1	1	1	5
05ZO602 **.2.** identify the different types of ecosystems and relationship between the organisms and their environment.	2	4	2	2	10
05ZO602 **.3.** identify the significance of bio diversity.	3	5	5	2	15
05ZO602 **.4.** clear understanding of the Major issue of the biodiversity.	2	3	3	2	10
05ZO602 **.5.** get knowledge the theories of origin and development of early life of the earth.	5	4	1	0	10
Total Marks	**14**	**17**	**12**	**07**	**50**

***Legend*: A,** Apply; **An,** Analyze**,** Evaluate**,** Create

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1	Smith TH smith RL Elements of ecology.
2	Rastogi VB Animal ecology and distribution of animals Rastogi publication meerut.
3	Kotwal PC Biodiversity and Conservation.
4	Rastogi VB Evolution of Biology.

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Demonstration
7. ICT Based teaching Learning
8. Brainstorming

CO, PO and PSO Mapping

Program Name: B.Sc Biology
Semester: 6th Semester

Course Title: Ecology, bio diversity and Evolution
Course Code: 05ZO602

CO/PO/PSO Mapping								
Course Outcome (Cos)	**Program Outcomes (POs)**					**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**
S3-ZOOL4D **-A.1.** have comprehensive understanding of the basis terms, principles. rules, value, & concept of ecological science.	3	3	3	3	3	2	2	3
S3-ZOOL4D **-A.2.** identify the different types of ecosystems and relationship between the organisms and their environment.	3	1	1	3	2	3	1	2
S3-ZOOL4D **-A.3.** identify the significance of bio diversity.	2	1	2	1	2	1	3	3
S3-ZOOL4D **-A.4.** clear understanding of the Major issue of the biodiversity.	2	1	3	2	2	3	2	1
S3-ZOOL4D **-A.5.** get knowledge the theories of origin and development of early life of the earth.	3	2	3	3	2	1	3	3

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5 PSO 1,2,3	05ZO602 **.1.** have comprehensive understanding of the basis terms, principles. rules, value, & concept of ecological science.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8	1.1,1.2	1.1,1.2,1.3,1.4,1.5, 1.6, 1.7,1.8	1SL-1,2,3,4,5,6
PO 1,2,3,4,5 PSO 1,2,3	05ZO602 **.2.** identify the different types of ecosystems and relationship between the organisms and their environment.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8	2.1, 2.2	2.1, 2.2, 2.3, 2.4, 2.5, 2.6,27,2.8	2SL-1,2,3,4,5,6
PO 1,2,3,4,5 PSO 1,2,3	05ZO602 **.3.** identify the significance of bio diversity.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8	3.1,	3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8	3SL-1,2,3,4,5,6,7
PO 1,2,3,4,5 PSO 1,2,3	05ZO602 **.4.** clear understanding of the Major issue of the biodiversity.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6,SO4.7 SO4.8	4.1,4.2,	4.1,4.2,4.3,4.4, 4.5,4.6,4.7,4.8	4SL-1,2,3
PO 1,2,3,4,5 PSO 1,2,3	05ZO602 **.5.** get knowledge the theories of origin and development of early life of the earth.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 ,SO5.6,SO5.7, SO5.8, SO5.9	5.1,5.2	5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,5.9	5SL-1,2,3,4,5,

AKS University

Faculty of Basic Science

Curriculum of B. Sc. (Honours / By Research) Program

(Revised as on 01 August 2023)

Code: 05CH603

Course Name: Bio Inorganic, Bio Physical, Bio Organic Chemistry

Pre-requisite: Students must have fundamental knowledge of bio-molecules such as enzymes, vitamins,carbohydrates, nucleotides etc to understand the concept of bio-inorganic, bio-physical, bio-organic chemistry.

Rationale: The students studying bio-inorganic, bio-physical, bio-organic chemistry should possess foundational understanding about basic knowledge of standard free energy change in biological processes, exergonic and endergonic reactions etc to understand the basic principle of reactions involving biochemical processes.

Course Outcomes

After the completion of this course, the learner will able to

05CH603**.1**: Explain structure and function of metal complexes or metallo-proteins involved in storage &transportation of oxygen as well in transmission of energy.

05CH603**.2**: Explain structure and function of metalloproteins like cytochrome and iron-sulphur proteinsinvolved in electron transport processes and also describe various reactions calalysed by enzymes.

05CH603**.3**: Explain the concept of enzymes and apply its production, purification and applications in variousareas.

05CH603**.4**: Describe mechanisticdetails of chemical reactions of various co-enzymic form of vitamins and alsodescribe structure and function of proteins.

05CH603**.5:** Explain standard free energy change in biochemical reactions and apply the same concept tohydrolysis and synthesis of ATP.

Unit-I : Metal ions in Biological System

A] Structure and Function of hemoglobin, myoglobin, hemocyanins and hemerythrin,

B] Metal compexes in transmission of energy: chlorophylls, photosystem I and photosystem II in cleavage ofwater

Unit-II : Electron transfer in Biological System

Structure and function of metalloproteins in electron transport processes-cytochromes and ion-sulphur proteins

Kinds of Reactions Catalysed by Enzymes

Nucleophilic displacement on a phosphorus atom. Isomerization and rearrangement reactions, enolicintermediates in iomerization reactions. Enzyme catalyzed carboxylation and decarboxylation reaction.

Unit-III : Enzymes and their biotechnological applications

Introduction of bioorganic chemistry and Enzymes, coenzymes, prosthetic groups, apoenzymes. Properties of enzymes like catalytic power, specificity and regulation. Proximity effects and molecular adaptation. Transition- state theory and orientation

Nomenclature and classification of enzymes. Fischer's lock and key and Koshland's induced fit hypothesis.

Large-scale production and purification of enzymes, techniques and methods of immobilization of enzymes, effect of immobilization on enzyme activity, enzymes and recombinant DNA technology.

Unit-IV : Co- Enzyme Chemistry and Biopolymer Interaction

A] Cofactors as derived from vitamins. Structure and biological functions of coenzyme A, thiamine pyrophosphate(TPP), pyridoxal phosphate, NAD+, NADP+ , FMN, FAD, lipoic acid, vitamin B12. Mechanisms of reactions catalyzed by the above cofatctors.

B] Biomimetic chemistry, crown ethers, cryptates.

C] Polypeptide and protein structures, introduction to protein folding problem. Forces involved in biopolymer interactions.

Unit-V : Cell membrane and transport of Ions

Structure and functions of biological cell membrane, ion transport through cell membrane, Structure andfunctions of DNA and RNA in living systems.

Bioenergetics

Standard free energy change in biochemical reactions, exergonic, endergonic. Hydrolysis of ATP, synthesis of ATPfrom ADP.

Biopolymer and their molecular weight

Evaluation of size, shape, molecular weight Methods for determination of molar mass of biopolymers (a) Viscositymethod (b) Sedimentation methods (c) Osmotic pressure methods

Scheme of Studies:

Board Of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits(C)
			Cl	LI	SW	SL	Total Study Hours (Cl+LI+SW+SL)	
ProgramCore(PCC)	05CH603	Bioinorganic, biophysical, bioorganic chemistry	4	0	1	1	6	4

AKS University

Faculty of Basic Science

Curriculum of B. Sc. (Honours / By Research) Program

(Revised as on 01 August 2023)

Legend : CI: Class room Instruction(Includesdifferentinstructionalstrategiesi.e.Lecture(L)andTutorial (T)andothers),**LI:** Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different in structional strategies)

W:Sessional Work(includesassignment,seminar,miniprojectetc.),
SL: Self Learning,
C: Credits.

Note:

SW&SLhastobeplannedandperformedunderthecontinuousguidanceandfeedbackofteacherto ensure outcome ofLearning.

SchemeofAssessment: Theory

Board of Study	Couse Code	Course Title	SchemeofAssessment(Marks)						
			Progressive Assessment(PRA)					EndSemester Assessment	Total Marks
			Class/HomeAssignment 5number 3 mar ksearch (CA)	Class Test2 (2bestout of3) 10 marks each(CT)	Seminarone (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)	**(ESA)**	(PRA+ESA)
PCC	05CH603	Bioinorganic, biophysical, bioorganic chemistry	15	20	10	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Unit-I Metal ions in Biological System

A] Structure and Function of hemoglobin, myoglobin, hemocyanins and hemerythrin,
B] Metal compexes in transmission of energy: chlorophylls, photosystem I and photosystem II in cleavage of water

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	LI	CI	SL

After the completion of topics students will be able to SO1.1 understand the function of metal or metal ions in biological system SO1.2 describe the structure and restate the functions of hemoglobin and myoglobin, SO1.3 describe the structure and restate the functions of hemocyanins and hemerythrin SO1.4 understand metal complexes in transmission of energy such as chlorophylls SO1.5 explain photosystem I and photosystem II in cleavage of water		**Unit-I (**76CH-304.1)**: Metal ions in Biological System** Introduction to m**etal ions in BiologicalSystem** Structure and Function of hemoglobin Structure and Function of myoglobin Structure and Function of hemocyanins Structure and Function of hemerythrin Metal compexes in transmission of energy Chlorophylls Chlorophylls Photosystem I Photosystem II in cleavage of water Class test Class test	• Chlorophyll a • Chlorophyll b

SW-1Suggested Sessional Work (SW):

Assignments: Structure and Function of hemoglobin

Mini Project:

Other Activities (Specify): Structure and Function of hemerythrin

Unit-II Electron transfer in Biological System

[A] Structure and function of metalloproteins in electron transport processes-cytochromes and ion-sulphur proteins [B] **Kinds of Reactions Catalysed by Enzymes:** Nucleophilic displacement on a phosphorus atom. Isomerization and rearrangement reactions, enolic intermediates in iomerization reactions. Enzyme catalyzed carboxylation and decarboxylation reaction.

Activity	**AppX Hrs**
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (Cl)**	**Self Learning(SL)**

SO2.1 describe the structure and function of metalloproteins **SO2.2** describe structure and function of metalloproteins in electron transport processes-cytochromes **SO2.3 explain s**tructure and functionof metalloproteins in electron transport processes-ion-sulphurproteins **SO2.4** understand the kinds of reactions Catalysed by Enzymes such as nucleophilic displacement on a phosphorus atom **SO2.5** explain enzyme catalyzed carboxylation and decarboxylation reaction		Electron transfer in Biological System Structure and function of metalloproteins in electron transport processes-cytochromes Structure and function of metalloproteins in electron transport processes-ion-sulphur proteins Structure and function of metalloproteins in electron transport processes-ion-sulphur proteins Kinds of Reactions Catalysed by Enzymes Nucleophilic	

SW-2 Suggested Sessional Work (SW):

Assignments: ion-sulphur proteins

Mini Project:

Other Activities (Specify): Nucleophilic displacement on a phosphorus atom

Unit-III Enzymes and their biotechnological applications

Introduction of bioorganic chemistry and Enzymes, coenzymes, prosthetic groups, apoenzymes. Properties of enzymes like catalytic power, specificity and regulation. Proximity effects and molecular adaptation. Transition-state theory and orientation Nomenclature and classification of enzymes. Fischer's lock and key and Koshland's induced fit hypothesis.

Large-scale production and purification of enzymes, techniques and methods of immobilization of enzymes, effect of immobilization on enzyme activity, enzymes and recombinant DNA technology.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
After the completion of topics students will be able to **SO3.1** understand bioorganic chemistry and its applications **SO3.2** understand the properties of enzymes and transition state **SO3.3** explain nomenclature and classification of enzymes. **SO3.4** describe production and purification of enzymes **SO3.5** describe recombinant DNA technology		**Unit-III (**76CH-304**.3): Enzymes and their biotechnological applications** understand bioorganic chemistry and its applications coenzymes, prosthetic groups, apoenzymes Properties of enzymes like catalytic power, specificity and regulation. Proximity effects and molecular adaptation. Transition-state theory and orientation Nomenclature and classification of enzymes. Fischer's lock and key and Koshland's induced fit hypothesis. Large-scale production and purification of enzymes Techniques and methods of immobilization of enzymes Effect of immobilization on enzymeactivity, enzymes Recombinant DNA technology. Test	• Nucleotide • Nucleoside • DNA

SW-3 Suggested Sessional Work (SW):

Assignments: recombinant DNA Technology

Mini Project:

Other Activities (Specify):

Unit-IV Co- Enzyme Chemistry and Biopolymer Interaction

A] Cofactors as derived from vitamins. Structure and biological functions of coenzyme A, thiamine pyrophosphate (TPP), pyridoxal phosphate, NAD+, NADP+ , FMN, FAD, lipoic acid, vitamin B12. Mechanisms of reactions catalyzed by the above cofatctors.

B] Biomimetic chemistry, crown ethers, cryptates.

C] Polypeptide and protein structures, introduction to protein folding problem. Forces involved in biopolymer interactions.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction(CI)	Self Learning (SL)
After the completion of topics		**Unit-IV (**76CH-304**.4): Co- Enzyme Chemistry and**	• Amino acid
students will be able to **SO4.1 understand** the terms of coenzyme and cofactors **SO4.2 explain structure** and biological functions of coenzyme A **SO4.3 explain structure** and biological functions of coenzyme of Vitamin B-complex **SO4.4** Biomimetic chemistry, crown ethers, cryptates. **SO4.5** Explain structure and functions of polypeptides and proteins structures		**Biopolymer Interaction** Cofactors as derived from vitamins Structure and biological functions of coenzyme A Structure and biological functions of coenzyme of Thiamine pyrophosphate (TPP) Structure and biological functions of coenzyme like pyridoxal phosphate Structure and biological functions of coenzyme like NAD+, NADP+ Structure and biological functions of coenzyme such as FMN, FAD Structure and biological functions of coenzyme lipoic acid and vitamin B12 Biomimetic chemistry crown ethers cryptates Structure and functions of polypeptideand protein Forces involved in biopolymer interactions.	• Physic-chemical properties • Vitamins

SW-4 Suggested Sessional Work (SW)
Assignment: Vitamins and cofactors
Mini Project:

Other Activities (Specify): Enzymes and coenzymes

Unit-V : Cell membrane and transport of Ions

Structure and functions of biological cell membrane, ion transport through cell membrane, Structure and functions of DNA and RNA in living systems.

Bioenergetics

Standard free energy change in biochemical reactions, exergonic, endergonic. Hydrolysis of ATP, synthesis of ATP from ADP.

Biopolymer and their molecular weight

Evaluation of size, shape, molecular weight Methods for determination of molar mass of biopolymers (a) Viscosity method (b) Sedimentation methods (c) Osmotic pressure methods

Activity	AppX Hrs
CI	12
LI	0

SW	2
SL	1
Total	15

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (Cl)**	**Self Learning (SL)**
After the completion of topics students. will be able to **SO5.**1 understand structure and functions of biological cell membrane and ion transportation through cell membrane **SO5.2** explains structure and functions of DNA and RNA in living systems **SO5.3** apply the concept ofbioenergetics to describe the hydrolysis of ATP **SO5.**4 explains the viscosity and sedimentation methods to evaluate the the size, shape and molecular weight of biopolymers **SO5.5** explains the osmotic pressure methods to evaluate the the size, shape and molecular weight of biopolymers		**Unit-V (**76CH-304**.5): Cell membrane and transport of Ions** Structure and functions of biological cellmembrane ion transport through cell membrane Structure and functions of DNA and RNA inliving systems **Bioenergetics** Standard free energy change in biochemicalreactions Exergonic and endergonic Hydrolysis of ATP synthesis of ATP from ADP **Biopolymer and their molecular weight** Evaluation of size, shape, molecular weight Methods for determination of molar mass of biopolymers by Viscosity method By sedimentation methods By osmotic pressure methods	• Molar mass • Gibbs free energy

SW-5 Suggested Sessional Work (SW):

Assignments: Structure and functions of DNA and RNA in living systems.

Mini Project:

Other Activities (Specify): Synthesis of ATP from ADP.

Brief of Hours suggested for the Course Outcome

Course Outcomes	**Class Lecture (Cl)**	**Sessional Work (SW)**	**Self Learning (Sl)**	**Total hour (Cl+SW+Sl)**

05CH603**.1**: explain structure and function of metal complexes or metallo-proteins involved in storage & transportation of oxygen as well in transmission of energy.	12	02	01	15
05CH603**.2**: explain structure and function of metalloproteins like cytochrome and iron-sulphur proteins involved in electron transport processes and also describe various reactions calalysed by enzymes.	12	02	01	15
05CH603**.3**: understand the concept of enzymes anddescribe its production, purification and applications in various areas.	12	02	01	15
05CH603**.4**:Describe mechanisticdetails of chemical reactions of various co-enzymic form of vitamins and also describe structure and function of proteins.	12	02	01	15
05CH603**.5:** Explain standard free energy change in biochemical reactions and apply the same concept to hydrolysis and synthesis of ATP.	12	02	01	15
Total Hours	60	10	05	75

Suggestion for End Semester Assessment

Suggested Specification Table(ForESA)

CO	UnitTitles	MarksDistribution			TotalMarks
		R	U	A	
CO-1	**Metal ions in Biological System**	03	01	01	05
CO-2	**Electron transfer in Biological System**	02	06	02	10
CO-3	**Enzymes and their biotechnological applications**	03	07	05	15
CO-4	**Co- Enzyme Chemistry and Biopolymer Interaction**	-	10	05	15
CO-5	**Cell membrane and transport of Ions**	03	02	-	05
Total		11	26	13	50

Legend: R:Remember, U:Understand, A:Apply

The written examination of 50 marks will be held at theendofsemesterfor Inorganic Chemistry

Note.Detailed Assessmentrubricneedtobepreparedbythecoursewiseteachersforabovetasks. Teacherscanalsodesigndifferenttasksasperrequirement,forendsemesterassessment.

SuggestedInstructional/ImplementationStrategies:

19. ImprovedLecture
20. Tutorial
21. CaseMethod
22. GroupDiscussion
23. RolePlay
24. Visitto NCL, CSIR laboratories
25. Demonstration
26. ICTBasedTeachingLearning(VideoDemonstration/TutorialsCBT,Blog,Facebook,Twitter,Whatsapp,Mobile,Onlinesources)
27. Brainstorming

SuggestedLearningResources:

(j) Books:

S. No.	Title	Author	Publisher	Edition& Year
1	Principles of Biochemistry,	A.L. Lehninger	Worth Publishers	4th edition
2	Principles of Bioinorganic Chemistry	S. J Lippard	Paperback	2nd edition
3	Biochemistry	L. Stryer, W.H.Freeman.	Universities Press	First Edition (1 January 2010)

SuggestedWebSources:

27. https://celqusb.files.wordpress.com/2017/12/inorganic-chemistry-g-l-miessler-2014.pdf
28. https://www.slideshare.net/MANISHSAHU106/inert-and-labile-complexes
29. https://swayam.gov.in/explorer?category=Chemistry

ModeofDelivery:Lecture,demonstration,E-tutoring,discussion,assignments,quizzes, case study, power point;

LMS/ICT Tools: Digital Classrooms, DLMS, ZOOM, G-Suite,MSPower-Point, Online Resources

AKS University

Faculty of Basic Science

Curriculum of B. Sc. (Honours / By Research) Program

(Revised as on 01 August 2023)

Course Title: Bio Inorganic, Bio Physical, Bio Organic Chemistry Course Code : 05CH603

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
		Research Aptitude	Communication	Problem Solving	Individual and Team Work	Investigation of Problems	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and sustainability	The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry	To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.	understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon-based problems in chemical sciences.	Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science
CO1: explain structure and function of metal complexes or metallo-proteins involved in storage & transportation of oxygen as well in transmission of energy.	**3**	**1**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**3**	**2**	**2**	**3**	**3**	**1**
CO2:explain structure	**2**	**1**	**2**	**2**	**1**	**2**	**3**	**2**	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**1**

and function of metalloproteins like cytochrome and iron-sulphur proteins involved in electron transport processes and also describe various reactions calalysed by enzymes.																
CO3:understand the concept of enzymes and describe its production, purification and applications in various areas.	**2**	**2**	**1**	**1**	**1**	**2**	**2**	**2**	**1**	**2**	**1**	**2**	**1**	**1**	**2**	**2**
CO4: Describe mechanisticdetails of chemical reactions of various co-enzymic form of vitamins and also describe structure and function of proteins.	**2**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**2**	**3**	**3**	**3**	**3**	**2**
CO5: Explain standard free energy change in biochemical reactions and apply the same concept to hydrolysis and synthesis of ATP.	**2**	**-**	**-**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**3**	**1**	**3**

Legend: 1–Low, 2–Medium, 3–HigH

AKS University

Faculty of Basic Science

Curriculum of B. Sc. (Honours / By Research) Program

(Revised as on 01 August 2023)

Curriculum Map:

POs &PSOsNo.	Cos No. & Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1: explain structure and function of metal complexes or metallo-proteins involved in storage & transportation of oxygen as well in transmission of energy.	SO1.1 SO 1.2SO 1.3 SO1.4 SO1.5		Unit-1.**Metal ions in Biological System** 1.1,1.2,1.3 ,1.4,1.5,1. 6,1.7	• Chlorophyll a • Chlorophyll b
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO2: explain structure and function of metalloproteins like cytochrome and iron-sulphur proteins involved in electron transport processes and also describe various reactions calalysed by enzymes.	SO2.1 SO 2.2SO 2.3 SO2.4 SO2.5		Unit-2 **Electron transfer in Biological System** 2.1,2.2,2.3,2.4,2. 5,2.6, 2.7, 2.8,2.9	• Metalloproteins
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3: understand the concept of enzymes and describe its production, purification and applications in various areas.	SO3.1SO3 .2 SO3.3 SO3.4 SO3.5		Unit-3 :**Enzymes and their biotechnological applications** 3.1, 3.2,3.3,3.4,3.5,3. 6,3.7	• Nucleotide • Nucleoside • DNA
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4: Describe mechanisticdetails of chemical reactions of various co-enzymic form of vitamins and also describe structure and function of proteins.	SO4.1 SO 4.2SO 4.3 SO4.4 SO4.5		Unit-4 : **Co-Enzyme Chemistry and Biopolymer Interaction** 4.1, 4.2,4.3,4.4,4.5,4. 6,4.7	• Amino acid • Physic-chemical properties • Vitamins
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 5: Explain standard free energy change in biochemical reactions and apply the same concept to hydrolysis and synthesis of ATP.	SO5.1 SO 5.2SO 5.3 SO5.4		Unit 5: **Cell membrane and transport of Ions** 5.1,5.2,5.3,5.4,5 .5,5.6,5.7	• Molar mass • Gibbs free energy

		SO5.5			

Curriculum Development Team:

1. Dr. Shailendra Yadav, HoD, Department of Chemistry, AKS University, Satna (M.P.).
2. Dr. Dinesh Kumar Mishra, Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
3. Dr. Samit Kumar,Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
4. Dr. Sushma Singh, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
5. Dr. Manoj Kumar Sharma, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
6. Mr. Kanha Singh Tiwari,Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
7. Mrs. Nahid Usamani, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).

Program name	Bachelor of Science (B. Sc.)Botany	
Semester	6th Semester	
Course Code:	05BO604	
Course title:	Ethnobotany (Theory)	**Curriculum Developer**:Kirti Singh Lab Technician
Pre-requisite:	Students should have basic knowledge of ethnobotany	
Rationale:	Ethnobotany is a life science which studies the interaction between human beings and flora in particular and broadly deals with the investigations, observations, and identifications of botanical diversity used for the prevention and treatment of human livestock ailments.an ethnobotanist thus strives to document the local customs involving the practical uses of local flora for many aspects of life such as plant as medicines, foods, intoxicants and clothing. The aim of ethnobotanists is to explore how these plants are used as food, clothing, shelter, fodder, fuel, furniture and how medicinal use of such plant is associated to other characteristics of the plant species.	
Course Outcomes (COs):	**CO1**: Understand the importance of plants and their relationship with human being. **CO2**: Explain how plants are a part of culture and traditions. dise **CO3**: How traditional medicine can cure various ases. **CO4**: Analyze the medico-ethnobotanical sources in India. **CO5**: Observe the role of medicinal plant in skin diseases.	

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits(C) (L:T:P=3:0:1)
			CI	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
MAJOR DSC 2	05BO604	Ethnobotany	3	1	1	1	6	3+0+1=4

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
MAJOR DSC 2	05BO604	Ethnobotany	**15**	**20**	**5**	**5**	**5**	**50**	**50**	**100**

Scheme of Assessment: Practical

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)		
MAJOR DSC2	**05BO654**	Ethnobotany	35	5	5	5	50	50	50

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	9	4	1	5	19

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)

CO1: Understand the importance of plants and their relationship with human being.			**Unit-1**	
	SO1.1 Explain in detail introduction of ethnobotany.		**CI1.1** Brief detail of introduction of Ethnobotany.	**SL1.1** Search various reference books and other study material to start the learning about ethnobotany.
	SO1.2 Explain the history of ethnobotany.		**CI1.2** Brief detail of concept of ethnobotany.	**SL1.2**Explore the historical evolution and recent advancements in ethnobotany.
	SO1.3 Describe the basic laboratory techniques in ethnobotany.		**CI1.3** Study the scope of ethnobotany.	**SL1.3**Understand the essential infrastructure and equipment needed for an ethnobotany laboratory.
	SO1.4 Explain in detail the herbarium techniques.	LI1.1study of herbarium techniques.	**CI1.4** Study the objectives of ethnobotany.	**SL1.4**Learn about the formulation and sterilization of culture media used in ethnobotany.
	SO1.5 Explain the history of ethnobotany.		**CI1.5** Study the history of ethnobotany.	
	SO1.6 Describe the relevance of ethnobotany in major ethnic group.	LI1.2 Prepare an inventory of plants in the vicinity in the college campus.	**CI1.6** study the relevance of ethnobotany in the major ethnic groups.	**SL1.5**Acquire able to recall the botanical names of crops.
	SO1.7 Explain in detail the relevance of ethnobotany in minor ethnic group and describe the relevance of ethnobotany tribals of India.		**CI1.7** study the relevance of ethnobotany in the minor ethnic group and discuss the relevance of ethnobotany for tribals of India.	
	SO1.8 Explain in detail the relevance of ethnobotany life style of tribals of India and explain in details the importance of ethnobotany		**CI1.8** Discuss the relevance of ethnobotany lifestyle of tribals of India and discuss the importance of ethnobotany.	
	SO1.9 Explain the branches of ethnobotany and describe and define the branches of		**CI1.9** Study the branches of ethnobotany and ethnobotany as an interdisciplinary science.	

	ethnobotany.			

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Describe in detail the history of ethnobotany.
	SW1.2 Mini Project	Describe the branches of ethnobotany.
	SW1.3 Other Activities (Specify)	Explain the importance of ethnobotany..

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	9	2	1	5	17

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO2: Explain how plants are a part of culture and traditions.			**Unit-2**	
	SO2.1 Describe and define the food plants used by the tribals.		**CI2.1** Brief detail of food plant used by the tribals.	**SL2.1** Search various reference books and other study material to start the learning about ethnobotany.
	SO2.2 Explain in detail the intoxicants and beverages plant.		**CI2.2**Discuss the intoxicants and beverages plant used by the tribals.	

	SO2.3 Describe the Resins and oils and miscellaneous plant used by the tribals.	**LI2.1** Study the intoxoicants and beverages plant used by the tribals.	**CI2.3**Study the Resins and oils and miscellaneous plant used by the tribals.	**SL2.Learn about different miscellaneous plant used by the tribals.**
	SO2.4 Explain in detail the plant in mythology.		**CI2.4**Study the plant in mythology.	**SL2.3**Acquire knowledge of plant in mythology..
	SO2.5 Explain in detail the taboos and totems in relation to plants,folklore.		**CI2.5**Study the taboos and totems in relation to plants,folklore.	**SL2.4**Familiarize yourself taboos and totems in relation to plants, folklore.
	SO2.6 Explain in detail the plant in similes and metaphors.		**CI2.6**Study the plants in similes and metaphors.	
	SO2.7 Explain in detail the wildlife protection and plant uses and explain in detail the role of plants in totemic belief and rituals.		**CI2.7** Describe the wildlife protection and plant uses and describe the role of plants in totemic belief and rituals.	**SL2.5**Develop ability in wildlife protection and plant uses.
	SO2.8 Explain the ethical consideration in sustainable harvesting practices and study the techniques for documenting plant uses and cultural practices.		**CI2.8** Study the ethical consideration in sustainable harvesting practices and study the techniques for documenting plant uses and cultural practices.	
	SO2.9 Explain in detail the ethics of research involving indigenous knowledge system and identification of local plants and their traditional uses.		**C12.**9 Describe the ethics of research involving indigenous knowledge systems and study the identification of local plants and their traditional uses.	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Describe and define the wildlife protection and plant uses.
	SW2.2 Mini Project	Detail study of plant used by the tribles.
	SW2.3 Other Activities (Specify)	Study one review article on wildlife protection.

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	9	2	1	2	14

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO3: How traditional medicine can cure various diseases.			**Unit-3**	
	SO3. 1 Explain in detail Introduction to Medico-Ethnobotanical Sources in India.		**CI3.1** Introduction to Medico-Ethnobotanical Sources in India.	**SL3.1** Search various reference books and other study material to start the learning about introduction to Medico-Ethnobotanical Sources in India.
	SO3.2 Explain in detailed Study of Selected Plants - NEEM		**CI3.2** Detailed Study of Plants Selected –NEEM	
	SO3.3 Detailed Study of Plants Selected -Tulsi		**CI3.3** Detailed Study of Plants Selected –Tulsi	
	SO3.4 Explain in detailed Study of Selected Plants - Nirgundi		**CI3.4** Detailed Study of Selected Plants –Nirgundi	
	SO3.5 Explain in detailed Study of Selected Plants –		**CI3.5** Detailed Study of Selected Plants –Glory Lily	

	Glory Lily			
	CI3.6.5 Explain in detailed Study of Selected Plants – Giloy	**LI3.1**To practice techniques of detailed study of selected plant.	**C I3.6** Detailed Study of Selected Plants –Giloy	**SL3.2**Explore the detailed study of selected plants.
	SO3.7 Explain in detail Study of Selected Plants – Palash and Amaltas.		**CI3.7** Detailed Study of Selected Plants –Palash and Amaltas.	
	SO3.8 Explain in detail Study of Selected Plants – True Indigo and role of ethnobotany in modern science.		**CI3.8** Detailed Study of Selected Plants –True Indigo and role of Ethnobotany and role of Ethnobotany in modern medicine.	
	SO3.9 Explain in detail role of ethnic groups in conservation of plant genetic resources and Explain in detail Endangered Taxa and Forest Management.		**CI3.9** Role of Ethnic Groups in Conservation of Plant Genetic Resources and study the Endangered Taxa and Forest Management.	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Describe the role of ethnobotany in modern medicine.
	SW3.2 Mini Project	Detailed study of selected plant.
	SW3.3 Other Activities (Specify)	Explain in scope of ethnobotany.

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	9	4	1	4	18

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO4: Analyze the medico-ethnobotanical sources in India.			**Unit-4**	
	SO4. 1 Explain in detail of introduction to ethnobotany.		**CI4.1** Brief detail of Introduction to Ethnobotany	**SL4.1** Search various reference books and other study material to start the learning about ethnobotany.
	SO4.2 Study the Ethnobotany as a Tool to Protect Interests of Ethnic Groups		**CI4.2** Study the Ethnobotany as a Tool to Protect Interests of Ethnic Groups	**SL4.2**To independently explore the ethnobotany as a tool to protect interests of etnic groups.
	SO4.3 Discuss the definition and scope of ethnobotany.	**LI4.1**To demonstrate the principles of ethnobotany.	**CI4.3** .Brief detail of definition and Scope of ethnobotany.	
	SO4.4 Describe the Biopiracy and Intellectual Property Rights		**CI4.4 Discuss the** Biopiracy and Intellectual Property Rights[IPR]	**SL4.3**To independently explore the Biopiracy and Intellectual Property Rights[IPR].

	SO4.5 Explain in detail the Protection of Traditional Knowled		**CI4.5 Discuss the** Protection of Traditional Knowledge of ethnobotany.	
	SO4.6 Describe and define the equitable Benefit Sharing	**LI4.2**To demonstrate Legal Safeguards in India of ethnobotany.	**CI4.6** Brief in detail Equitable Benefit Sharing of ethanobotany.	**SL4.4**To independently explore the brief in detail Equitable Benefit Sharing of ethanobotany.
	SO4.7 Explain in detail the s Peoples Biodiversity Register (PBR) and Explain in detail the a Biodiversity Management Committees (BMC).		**CI4.7**Study the Peoples Biodiversity Register (PBR) and Discuss the Biodiversity Management Committees (BMC).	
	SO4.8 Explain in detail the Case Study: Kani Tribe of Kerala of ethnobotany and Study the Educational Role of ethnobotany.		CI4.8 Discuss the Case Study: Kani Tribe of Kerala of ethnobotany and Study the Educational Role of ethnobotany.	
	SO4.9 Explain in detailed the Future Challenges and Opportunities of ethnobotany and hypothetical scenario of bioprospecting in a tribal area.		CI4.9 Study the Future Challenges and Opportunities of ethnobotany and hypothetical scenario of bioprospecting in a tribal area.	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Describe the introduction of ethnobotany.
	SW4.2 Mini Project	Explain indetail future challenges and opportunities of ethnobotany..
	SW4.3 Other Activities (Specify)	Write a one review article on educational role of ethnobotany.

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	9	2	1	3	15

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO5:Observe the role of medicinal plant in skin diseases.			**Unit-5**	
	SO5.1 Explain in detail the Introduction to Medicinal Plants		**CI5.1** Brief in detail of Introduction to Medicinal Plants.	**SL5.1** Search various reference books and other study material to start the learning aout medicinal plant.
	SO5.2 Explain in detail the Skin Diseases.		**CI5.2** Study the Skin Diseases.	**SL5.2**Explore the various types of skin diseases.
	SO5.3 Explain in detail the Bronchial Inflammation and Asthma	**LI5.1**To demonstrate skin diseases.	**CI5.3** Study the Bronchial Inflammation and Asthma.	
	SO5.4 Explain in detail Jaundice		**CI5.4** Detail explanation of Jaundice	**SL5.3**Explore the detailed explanation of Asthma,jaundice,Malaria.
	SO5.5 Explain in detail about Malaria.		**CI5.5**Detail explanation of Malaria	

	SO5.6 Describe and define the Expulsion of Worms.		**CI5.6**Study the Expulsion of Worms.	
	SO5.7 Explain in detail about Piles and discuss the : Rheumatism.		**CI5.7**Study about Piles and discuss the : Rheumatism.	
	SO5.8 Discuss the Heart Diseases and Explain in detail Amoebic Dysentery.		CI5.8 Discuss the Heart Diseases and Study about Amoebic Dysentery.	
	SO5.9 Explain Leukoderma and Review and Application.		CI5.9 Explain Leukoderma and Study Review and Application	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Explain in detail about medicinal plant.
	SW5.2 Mini Project	Describe in the detail different types of diseases.
	SW5.3 Other Activities (Specify)	One case research study on heart diseases.

Course duration (in hours) to attain Course Outcomes:

Course Title: Ethnobotany **Course Code:** 05BO604

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1: Understand the importance of plants and their relationship with human being.	9	4	5	1	19
CO2: Explain how plants are a part of culture and traditions.	9	2	5	1	17
CO3: How traditional medicine can cure various diseases.	9	2	2	1	14
CO4: Analyze the medico-ethnobotanical sources in India.	9	4	4	1	18
CO5:Observe the role of medicinal plant in skin diseases.	9	2	3	1	15
Total Hours	45	14	19	05	83

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcomes:

Course Title: Ethnobotany **Course Code;05BO604**

Course Outcomes	Marks Distribution				Total Marks
	R	U	A	A	
CO1: Understand the importance of plants and their relationship with human being.	2	2	3	2	9
CO2: Explain how plants are a part of culture and traditions.	2	3	3	2	10
CO3: How traditional medicine can cure various diseases.	2	2	3	4	11
CO4: Analyze the medico-ethnobotanical sources in India.	2	2	3	3	10
CO5: Observe the role of medicinal plant in skin diseases.	2	2	2	4	10
Total Marks	**10**	**11**	**14**	**15**	**50**

***Legend*:R,** Remember; **U,** Understand; **A,** Apply; **A,** Analyze

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1.	S.K. Jain ,Manual of ethnobotany , scientific Publishers, Jodhpur,1995.
2.	S.K. Jain(ed.) Glimpses of Indian Ethnobotany, Oxford and IBH,NEW Delhi-1981
3.	S.K. Jain, countributions of Indian ethnobotony, Scientific publishers, Jodhpur
4.	S.K. Jain(ed) methods and approaches in ethnobotany, society of ethnobotanist, Lucknow.
5.	Rajiv K. Sinha -Ethnobotany the Renaissance of Traditional Herbal medicine.

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Visit to animal biotechnology lab and stem cells biology lab
7. Demonstration
8. ICT Based teaching Learning
9. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Sc. BOTANY

Semester: 6th sem

Course Title: Ethnobotany

Course Code;05BO604

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

CO/PO/PSO Mapping															
Course Outcome (Cos)	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1: Understand the importance of plants and their relationship with human being.	3	1	1	-	-	1	1	1	1	-	2	1	2	2	2
CO2: Explain how plants are a part of culture and traditions.	3	2	1	2	1	-	-	1	1	-	2	1	2	3	3
CO3: How traditional medicine can cure various diseases.	2	1	1	-	-	2	-	2	1	-	1	1	3	2	1
CO4: Analyze the medico-ethnobotanical sources in India.	2	3	1	1	-	1	-	1	1	1	2	1	2	2	2
CO5:Observe the role of medicinal plant in skin diseases.	2	3	-	1	2	2	1	2	1	2	1	2	2	2	2
Total Marks															

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO1-05BO604.1**: Understand the importance of plants and their relationship with human being.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9	LI 1 LI 2	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9,	1SL-1,2,3,4,5
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO2-05BO604.2:** Explain how plants are a part of culture and traditions.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9	LI 1	2.1,2.2,2.3,2.4,2.5, 2.6,2.7,2.8,2.9,	2SL-1,2,3,4,5
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO3-05BO604.3**: How traditional medicine can cure various diseases.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9	LI 1	3.1,3.2,3.3,3.4,3.5, 3.6,3.7,3.8,3.9,	3SL-1,2
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO4-05BO604.4**: Analyze the medico-ethnobotanical sources in India.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8 SO4.9	LI 1 LI 2	4.1,4.2,4.3,4.4,4.5, 4.6,4.7,4.8,4.9,	4SL-1,2,3,4
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO5-05BO604.5**:Observe the role of medicinal plant in skin diseases.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9	LI 1	5.1,5.2,5.3,5.4,5.5, 5.6,5.7,5.8,5.9,	5SL-1,2,3

Program Name	**Bachelor of Science (B.Sc.)- Biology**	
Semester	6th	
Course Code:	05ZO605	
Course title:	Genetics	**Curriculum Developer**: Mr. Amit Bagri
Pre-requisite:	To study this course a student must have had the subject zoology in diploma.	
Rationale:	Genetics research studies how individual genes or groups of genes are involved in health and disease. Understanding genetic factors and genetic disorders is important in learning more about promoting health and preventing disease.	
Course Outcomes (COs):	05ZO605 **.1.** Gain knowledge of basic principles of inheritance and variations DNA, RNA and their function. 05ZO605 **.2.** deeper understanding of linkage, sex determination, sex linkage, mutations and mutagens. 05ZO605 **.3.** Gain knowledge of human karyotypic, genome project, inheritance, of blood group and genetic disease of human. 05ZO605 **.4.** demonstrate gene therapy PCR, DNA finger printing technique. 05ZO605 **.5.** find job opportunities in hospitals, forensic science research Associate, animal breeder	

Scheme of Studies:

Board of Study	**Course Code**	**Course Title**	**Scheme of studies (Hours/Week)**					**Total Credits(C) (L:T:P=3:0:1)**
			Cl	LI	SW	SL	**Total Study Hours (CI+LI+SW+SL)**	
MAJOR DSC 02	05ZO605	Genetics	3	1	1	1	6	3+1=4

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory and Practical

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)		
MAJOR DSC 02	05ZO605	Genetics	**15**	**20**	**10**	**5**	**50**	**50**	**100**

Scheme of Assessment: Practical

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)		
Major DSC 2	05ZO605	Genetics	35	5	5	5	50	50	50

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx.HR	09	04	01	04	18

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
05ZO605 **.1.** Gain knowledge of basic principles of inheritance and variations DNA, RNA and their function	**SO1.1** Define introduction and historical background of genetics.	**LI1.1** Study of DNA, RNA	**Unit 1** **Overview of Genetics.** **CI1.1** Define introduction and history of ecology	**SL1.1** Learn about introduction and historical background of genetics.
	SO1.2 Describe definition, scope and importance of genetics.		**CI1.2** Describe definition of genetics.	**SL1.2** learn about definition, scope and importance of genetics.
	SO1.3 Explain structure and types of genetics.	**LI1.2** Study of monohybrid and dihybrid cross	**CI1.3** Explain structure and types of genetics	**SL1.3** Learn about structure and types of genetics
	SO1.4 Describe Mendel's law of heredity.		**CL1.4** Describe Mendel's law of heredity.	**SL1.4** Learn about Mendel's law of heredity.
	SO1.5 Describe scope of genetics?		**CI1.5** Describe scope of genetics.	
	SO1.6 Describe importance of genetics.		**CI1.6** Describe importance of genetics.	
	SO1.7 Explain heredity?		**CL1.7** Study of heredity?	
	SO1.8 described about RNA?		**CI1.8** Study of RNA?	
	SO1.9 Explain about variations?		**CI1.9** Study of Variations?	

Suggested Sessional Work (SW):*anyone*	**SW1.1** Assignments	Define introduction and history of ecology
	SW1.2 Mini Project	Describe definition, scope and importance of genetics.
	SW1.3 Other Activities (Specify)	Describe mendels law of heredity.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	08	02	01	04	15

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
05ZO605 **.2.** deeper understanding of linkage, sex determination, sex linkage, mutations and mutagens.	**SO2.1** Define and describe chemistry of gene	**LI2.1** Verification of Mendelian ratio	**Unit-II** **Gene and genetic material** **CI2.1** Define and describe chemistry of gene	**SL2.1** Learn about chemistry of gene
	SO2.2 Describe concept of DNA replication.		**CI2.2** Describe concept of DNA replication.	**SL2.2** Learn about DNA replication.
	SO2.3 Explain nucleosome solenoid model.		**CI2.3** Explain nucleosome solenoid model.	**SL2.3** Learn about nucleosome solenoid model. .
	SO2.4 Describe Types of genes and Genetic code.		**CI2.4** Describe Types of genes.	**SL2.4** Learn about Types of genes and Genetic code.
	SO2.5 Explain nucleic acid?		**CI2.5** Explain nucleic acid?	
	SO2.6 Explain split genes?		**CI2.6** Explain split genes?	
	SO2.7 Explain genetic code?		**CI2.7** Explain genetic code?	
	SO2.8 Explain pseudogenes?		**CI2.8** Explain pseudogenes?	

Suggested Sessional Work (SW) :*anyone*		
	SW2.1 Assignments	Define and describe chemistry of gene.
	SW2.2 Mini Project	Describe concept of DNA replication.
	SW2.3 Other Activities (Specify)	Describe Types of genes and Genetic code.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	10	06	01	05	22

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
05ZO605 **.3.** Gain knowledge of human karyotypic, genome project, inheritance, of blood group and genetic disease of human.	**SO3.1** Explain the concept the gene linkage and recombination.	**LI3.1** Identify and use of important forest medicinal plants	**Unit-III Linkage and chromosomal aberrations.** **CI3.1** Explain the concept the gene linkage	**SL3.1** Learn about the gene linkage and recombination.
	SO3.2 Describe Sex determinations.	**LI3.2** Describe about types of Mutations and mutagens.	**CI3.2** Describe Sex determinations.	**SL3.2** Learn about about Sex determinations.
	SO3.3 Describe Sex linked Inheritance	**LI3.3** Problems related to sex linked inheritance.	**CI3.3** Describe Sex linked Inheritance.	**SL3.3** Learn about about Sex linked Inheritance
	SO3.4 describe the structure change in chromosomes.		**CI3.4** describe the structure change in chromosomes.	**SL3.4** Learn about about structure change in chromosomes.
	SO3.5 Describe about types of Mutations and mutagens.		**CI3.5** Describe about types of mutagens.	**SL3.5** Learn about about types of Mutations and mutagens.
	SO3.6 Explain the concept the recombination?		**CI3.6** Explain the concept the recombination	
	SO3.7 Describe about types of mutagens?		**CI3.7** Describe about types of mutagens?	
	SO3.8 Explain polyploidy?		**CI3.8** Explain polyploidy?	
	SO3.9 Explain structure change in chromosome?		**CI3.9** Explain structure change in chromosome?	
	SO3.10 Explain chromosome duplication?		**CI3.10** Explain chromosome duplication?	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Describe Sex determinations.
	SW3.2 Mini Project	describe the structure change in chromosomes.
	SW3.3 Other Activities (Specify)	Describe about types of Mutations and mutagens.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	08	04	01	03	16

Course Outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
05ZO605 **.4.** demonstrate gene therapy PCR, DNA finger printing technique.	**SO4.1** Describe the human chromosomes.	**LI4.1** Study a different type of chromosome.	**Unit-IV** **Human genetics** **CI4.1** Describe the human chromosomes.	**SL4.1** Learn about human chromosomes.
	SO4.2 Describe the Common genetic disorder.	**LI4.2** Study of genetic disease of human	**CI4.2** Describe the Common genetic disorder.	**SL4.2** Discuss Common genetic disorder.
	SO4.3 Explaining the Multiple factors and blood group.		**CI4.3** Explaining the Multiple factors.	**SL4.3** Learn about Multiple factors and blood group.
	SO4.4 Explaining the fraternal, Maternal, and Siamese Twins.		**CI4.4** Explaining the fraternal, Twins.	
	SO4.5 Evaluate role of Transgenic and Knockout animals and their applications.		**CI4.5** Evaluate role of Transgenic and Knockout animals and their applications	
	SO4.6 Explaining the blood group?		**CI4.6** Explaining the blood group.	
	SO4.7 Explaining the Maternal Twins?		**CI4.7** Explaining the Maternal Twins.	
	SO4.8 Explaining the Siamese Twins.?		**CI4.8** Explaining the Siamese Twins.	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Describe the Common genetic disorder.
	SW4.2 Mini Project	Explaining the Multiple factors and blood group.
	SW4.3 Other Activities (Specify)	Evaluate role of Transgenic and Knockout animals and their applications.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	08	04	01	04	17

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
05ZO605 **.5.** find job opportunities in hospitals, forensic science research Associate, animal breeder.	**SO5.1** Define the Germline, and somatic cell gene therapy	**LI5.1** Study of PCR	**Unit-V** **Genetic engineering** **CI5.1** Define the Germline gene therapy	**SL5.1** learn about Germline, and somatic cell gene therapy
	SO5.2 Describe the Recombinant DNA technology		**CI5.2** Describe the Recombinant DNA technology	**SL5.2** Describe the Recombinant DNA technology
	SO5.3 explain the Gene cloning		**CI5.3** explain the Gene cloning	**SL5.3** learn Gene cloning
	SO5.4 Evaluate the Gene library		**CI5.4** Evaluate the Gene library	**SL5.4** Explain the PCR?
	SO5.5 Explain the DNA finger printing.		**CI5.5** Explain the DNA finger printing	
	SO5.6 Explain the somatic cell gene therapy		**CI5.6** Define the somatic cell gene therapy	
	SO5.7 Explain the PCR?		**CI5.7** Explain the PCR?	
	SO5.8 Explain the genetic engineering?		**CI5.8** Explain the genetic engineering?	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Describe the Recombinant DNA technology
	SW5.2 Mini Project	explain the Gene cloning
	SW5.3 Other Activities (Specify)	Explain the DNA finger printing

Course duration (in hours) to attain Course Outcomes:

Course Title: Genetic **Course Code:** 05ZO605

Course Outcomes (COs)	**Class lecture (CI)**	**Laboratory Instruction (LI)**	**Self-Learning (SL)**	**Sessional work (SW)**	**Total Hours (Li+CI+SL+SW)**
05ZO605 **.1.** Gain knowledge of basic principles of inheritance and variations DNA, RNA and their function.	9	4	4	1	18
05ZO605 **.2.** deeper understanding of linkage, sex determination, sex linkage, mutations and mutagens.	8	2	4	1	15
05ZO605 **.3.** Gain knowledge of human karyotypic, genome project, inheritance, of blood group and genetic disease of human.	10	6	5	1	22
05ZO605 **.4.** demonstrate gene therapy PCR, DNA finger printing technique.	8	4	3	1	16
05ZO605 **.5.** find job opportunities in hospitals, forensic science research Associate, animal breeder	8	2	4	1	15
Total Hours	43	18	20	05	94

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Genetics **Course Code:** 05ZO605

Course Outcomes	**Marks Distribution**				**Total Marks**
	A	**An**	**E**	**C**	
S3-ZOOL2T **-A.1.** Gain knowledge of basic principles of inheritance and variations DNA, RNA and their function.	2	1	1	1	5
S3-ZOOL2T **-A.2.** deeper understanding of linkage, sex determination, sex linkage, mutations and mutagens.	2	4	2	2	10
S3-ZOOL2T **-A.3.** Gain knowledge of human karyotypic, genome project, inheritance, of blood group and genetic disease of human.	3	5	5	2	15
S3-ZOOL2T **-A.4.** demonstrate gene therapy PCR, DNA finger printing technique	2	3	3	2	10
S3-ZOOL2T **-A.5.** find job opportunities in hospitals, forensic science research Associate, animal breeder	5	4	1	0	10
Total Marks	**14**	**17**	**12**	**07**	**50**

***Legend*:A,** Apply;**An,** Analyze;**E,** Evaluate;**C,** Create

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1	Gardner MJ principal of Genetics
2	Singh BD, Gupta Pk, Verma PS and Agrwal BK Genetics
3	Singh BD purohit Biotechnology.
4	Khanna pragya , pal ajay Cell and molecular biologya

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Demonstration
7. ICT Based teaching Learning
8. Brainstorming

CO, PO and PSO Mapping

Program Name: B.Sc Biology
Semester: 6th Semester
Course Title: Genetic
Course Code: 05ZO605

CO/PO/PSO Mapping								
Course Outcome (Cos)	**Program Outcomes (POs)**					**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**
05ZO605 **.1.** Gain knowledge of basic principles of inheritance and variations DNA, RNA and their function.	2	3	1	3	1	2	2	1
05ZO605 **.2.** deeper understanding of linkage, sex determination, sex linkage, mutations and mutagens.	3	1	3	3	3	2	2	2
05ZO605 **.3.** Gain knowledge of human karyotypic, genome project, inheritance, of blood group and genetic disease of human.	2	3	1	3	2	1	2	3
05ZO605 **.4.** demonstrate gene therapy PCR, DNA finger printing technique	3	1	3	2	2	2	2	3
05ZO605 **.5.** find job opportunities in hospitals, forensic science research Associate, animal breeder	2	3	1	3	2	2	3	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5 PSO 1,2,3	05ZO605 **.1.** Gain knowledge of basic principles of inheritance and variations DNA, RNA and their function.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9	1.1,1.2	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9	1SL-1,2,3,4
PO 1,2,3,4,5 PSO 1,2,3	05ZO605 **.2.** deeper understanding of linkage, sex determination, sex linkage, mutations and mutagens.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8	2.1,	2.1,2.2,2.3,2.4,2.5, 2.6,2.7,2.8	2SL-1,2,3,4
PO 1,2,3,4,5 PSO 1,2,3	05ZO605 **.3.** Gain knowledge of human karyotypic, genome project, inheritance, of blood group and genetic disease of human.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9 SO3.10	3.1,3.2,3.3	3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9,3.10	3SL-1,2,3,4,5
PO 1,2,3,4,5 PSO 1,2,3	05ZO605 **.4.** demonstrate gene therapy PCR, DNA finger printing technique	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8	4.1,4.2,4	4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8	4SL-1,2,3
PO 1,2,3,4,5 PSO 1,2,3	05ZO605 **.5.** find job opportunities in hospitals, forensic science research Associate, animal breeder	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8	5.1,5.2	5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8	5SL-1,2,3,4

B.Sc. VIth Semester

CODE: 05CH606

COURSE NAME: Pharmaceutical and Medicinal Chemistry

Pre- requisite: To study this course the students must have the subject Chemistry in Diploma Course of B.Sc. or equivalent

Rationale: Pharmaceutical chemistry revolves around the design, synthesis, and development of new drugs. It involves the study of organic and medicinal chemistry principles to create compounds that can be used as pharmaceuticals. Medicinal chemists work on understanding the relationship between chemical structure and biological activity, aiming to create molecules that can specifically target diseases by interacting with biological targets like proteins, enzymes, or receptors in the body.

Course Outcomes:

After successfully competing this course module students will be able to:

05CH606.1- Understand importance of pharmaceutical chemistry and pharmacopeia.

05CH606.2- Learn intellectual property rights, patents trademark and copyright

05CH606-.3 Understand definition, classification of the drugs with examples and structures.

05CH606.4- Describe the structure activity relation of some important class of drugs.

05CH606.5- Describe the overall process of drug discovery and the role played by medicinal chemistry in this process.

UNIT-I

Pharmaceutical Chemistry: Introduction to pharmacy, career in pharmacy, codes of Pharmaceutical pharmaceutical ethics, importance of pharmaceutical Chemistry, , pharmacopeia and its history (IP, BP, USP, NF) Drug and cosmetic act with special reference to schedule M, GMP, GLP, GCP, USFDA, NDA, clinical trial. Concept of quality and total quality management, quality assurance and quality control, IPQA, IPQC. Documentation and maintenance of record, intellectual

Property rights, patents, trademark, copyright, patent act.

UNIT-II Pharmacognosy

Definition, history, scope and development of Pharmacognosy.

Classification and Sources of drugs: classification of drugs, sources and uses of natural drug products, biological (plants, animals and microbes), geographical, marine and mineral sources.

Drug Receptors: Introduction to drug receptors, nature of drug receptors, different bonding involved in drug- receptor interaction, drug receptor theories.

Drug absorption: routes of drug administration, absorption of drugs and factors affecting absorption.

UNIT-III

Molecular Modeling and Drug Design-

Drug design and development an overview, analogues and prodrugs structure and activity relationship between chemical (SAR), factors governing drug design. Approaches to drug design, receptor site theory. Introduction to combinatorial synthesis in drug discovery. Factors affecting bioactivity, QSAR-Free-Wilson analysis, structure a biological activity Hansch analysis, relationship between Free-Wilson analysis and Hansch analysis.

UNIT-IV

Antibiotics and Antibacterial

Introduction, Antibiotic B-Lactam Type Penicillin, Cephalosporins, Antitubercular Streptomycin, Broad Spectrum Antibiotics Tetracyclines, Anticancer Dactinomycin (Actinomycin D)

UNIT-V

Antifungal and Non-steroidal Anti- inflammatory

Antifungal: Polyenes, Antibacterial-Ciprofloxacin, Norfloxacin, Antiviral - Acyclovir

Antimalarials: Chemotherapy of MalariaSAR, Chloroquine, Chloroguanideand Mefloquine.

Non-steroidal: Anti-inflammatory Drugs: Diclofenac Sodium, Ibuprofen and Netopam..

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (Cl+LI+SW+SL)	
ProgramCore (PCC)	**05CH606**	Pharmaceutical and Medicinal Chemistry	4	4	1	1	6	6

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) And others),

LI: Laboratory Instruction (Includes Practical performances in laboratory workshop,field or other locations using different instructional strategies)

SW: Sessional Work (includes assignment, seminar, mini project etc.),

SL: Self Learning,

C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback ofteacher to ensure outcome of Learning.

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title	**Scheme of Assessment (Marks)**						
			Progressive Assessment (PRA)					**End Semester Assessment**	**Total Marks**
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA +AT)	**(ESA)**	(PRA+ ESA)
PCC	**05CH606**	Pharmaceutical and Medicinal Chemistry	15	20	10	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

05CH606.1-Understand importance of pharmaceutical chemistry and pharmacopeia.

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Approximate Hours

Activity	**Apex Hrs**
Cl	12
LI	12
SW	2
SL	1
Total	28

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO1.1 Understood development, design, and synthesis of drugs. SO1.2 Understood molecular structures, pharmacokinetics, drug interactions, and the latest advancements in the field. SO1.3 Understood the significance of drug development and how it contributes to society's well-being could be a source of pride. SO1.4 Understood broader vision of healthcare and scientific progress and values in the relationship. SO1.5 Understand and apply QA involves the planned and systematic activities implemented in a quality	Preparation of Pharmaceutical compounds a) Acetanilide b) Aromatic water c) Lotion d) Aspirin	**Unit-1 Pharmaceutical Chemistry** 1.1 Introduction to pharmacy, career in pharmacy, 1.2 codes of Pharmaceutical pharmaceutical ethics 1.3 importance of pharmaceutical Chemistry, , pharmacopeia 1.4 its history (IP, BP, USP, NF) 1.5 Drug and cosmetic act 1.6 Special reference to schedule GMP, GLP, 1.7 GCP, USFDA, NDA, 1.8 clinical trial. 1.9 Concept of quality	Concept of quality and total quality management

system and QC involves the operational techniques and activities used to fulfill quality requirements		1.10 total quality management, quality assurance 1.11 Quality control, IPQA, IPQC. 1.12 Documentation and maintenance of record, intellectual		**SW-1**

Suggested Sessional Work (SW):

a. Assignments:

Introduction to pharmacy, career in pharmacy

b. Mini Project:

Concept of quality and total quality management, quality assurance and quality control, IPQA, IPQC

c. Other Activities (Specify):

Pharmacopeia and its history (IP, BP, USP, NF)

05CH606.2- Understand definition, classification of the drugs with examples and structures.

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Activity	AppX Hrs
Cl	12
LI	12
SW	2
SL	1
Total	27

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (Cl)	Self Learning (SL)

SO2.1 Understood discovery of new drugs or developing natural-based products, contributing to innovations in the pharmaceutical and healthcare industries. SO2.2 Understood and explores natural products from plants, microbes, or other biological sources for their medicinal and therapeutic properties. SO2.3 Explain and apply drug receptors is fundamental in pharmacology and drug design. SO2.4 Understood the interaction between drugs and their receptors is crucial in drug development. SO2.5 Understood drug absorption is critical in determining the dosage, frequency of administration, and overall efficacy of medications	Preparation of pharmaceutical compound a) Tincture lodine b) Alum c) Ferrous Ammonium sulphate d) Antimony potassium tartrate	**Unit-2.0 Pharmacognosy** 2.1 Definition, history, scope 2.2 Development of Pharmacognosy. 2.3 Classifications of drugs, 2.4 Sources and uses of natural drug products, 2.5 Biological (plants, animals and microbes), 2.6 Geographical, marine and mineral sources. 2.7 Drug Receptors: Introduction to drug receptors, 2.8 Nature of drug receptors. 2.9 Different bonding involved in drug- receptor interaction 2.10 Drug receptor theories. 2.11 Drug absorption: routes of drug administration, 2.12 Absorption of drugs and factors affecting absorption.	classification of drugs, sources and uses of natural drug products

SW-2 Suggested Sessional Work (SW):

A .Assignments:

Discussion of classification of drugs, sources and uses of natural drug products.

b. Mini Project:

Drug- receptor interaction, drug receptor theories

c. Other Activities (Specify):

Write an essay on absorption of drugs and factors affecting absorption.

05CH606.3- Describe the structure activity relation of some important class of drugs.

Activity	AppX Hrs
Cl	12
LI	12
SW	2
SL	1
Total	27

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Understood, visualized and predict how drugs interact with biological targets at the molecular level **SO3.2** studied about target structure and interactions to create highly specific and effective medications. .**SO3.3** Understood about specific biological targets (proteins, receptors, enzymes) involved in diseases **SO3.4** S tudied about QSAR which helps in the rational design of new drugs by predicting the biological activities of novel compounds before their synthesis and experimental testing. **SO3.5** Understood about methods which are complementary and aid in optimizing drug design by guiding the synthesis of new compounds.	**3.** Isolation of caffeine from tea leaves. 4. Extraction of active constituents	**Unit-3.0 Molecular Modeling and Drug Design-** 3.1 Drug design and development. 3.2 an overview, analogues and prodrugs 3.3 structure and activity relationship between chemical (SAR) 3.4 Fctors governing drug design. 3.5 Approaches to drug design, 3.6 Receptor site theory. 3.7 Introduction to combinatorial synthesis in drug discovery. 3.8 Factors affecting bioactivity 3.9 QSAR-Free-Wilson analysis, 3.10 Sructure a biological activity Hansch analysis 3.11 Relationship between Free-Wilson analysis and 3.12 Hansch analysis	Drug design, factors governing drug design.

SW-3 Suggested Sessional Work (SW):

a. Assignments:

Analogues and prodrugs structure and activity relationship between chemical (SAR)

b. Mini Project:

Drug design factors governing drug design. And approaches to drug design

c. Other Activities (Specify):

Explanatory note on QSAR analysis for drugs.

05CH606.4-Describe the overall process of drug discovery and the role played by medicinal chemistry in this process.

Activity	AppX Hrs
Cl	12
LI	12
SW	2
SL	1
Total	27

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (Cl)	Self Learning (SL)
SO4.1 studied about Antibiotics are a class of medications used to treat bacterial infections by either killing bacteria (bactericidal) or inhibiting their growth (bacteriostatic). SO4.2 Understand Beta-lactam antibiotics have been fundamental used in treating bacterial infections . SO4.3 studied about Streptomycin which is an important antibiotic used in the treatment of tuberculosis (TB) SO4.4 Understood about Tetracyclines work by inhibiting bacterial protein synthesis.	5. Identification of crude drug. 6. Morphology of turmeric, ginger, Mentha.	Unit-4.0 Antibiotics and Antibacterial 4.1 Introduction, Antibiotics 4.2 **Types of Antibiotics Broad** **4.3 Spectrum vs. Narrow Spectrum. 4.4 Development of New Antibiotics** 4.5 B-Lactam **Chemical Structure** Beta-lactam antibiotics , 4.6 Type Penicillin**.** **4.7 Mechanism of Action** 4.8 Cephalosporins, Antitubercular Streptomycin, 4.9 **Usage in Tuberculosis Treatment**	Introduction, Antibiotics **Types of Antibiotics Broad**

SO4.5 Understood about Dactinomycin which works by inhibiting DNA replication and transcription		4.10 Broad Spectrum Antibiotics Tetracyclines. 4.11 **Types and Examples, Mechanism of Action** 4.12 Anticancer Dactinomycin (Actinomycin D) **Mechanism of Action Clinical Uses, Administration and Side Effects**	

SW-4 Suggested Sessional Work (SW):

a. Assignments:

Antitubercular Streptomycin

b. Mini Project:

b. Broad Spectrum Antibiotics Tetracyclines

c. Other Activities (Specify):

Anticancer Dactinomycin (Actinomycin D)

05CH606.5- Related the structure and physical properties of drugs to their pharmacological activity. Explain physio-chemical properties related to QSAR.

Activity	AppX Hrs
Cl	12
LI	12
SW	2
SL	1
Total	27

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 Understood - **Antifungal:** Polyenes, which are a class of antifungal medications primarily used to treat systemic fungal infections. **SO5.2** Understands that By blocking viral DNA synthesis, acyclovir helps reduce the severity and duration of herpes outbreaks. **SO5.3** Studied about SAR in antimalarial drug development involves a balance between potency, selectivity, pharmacokinetics, and safety profiles **SO5.4**Understood that efficacy of these drugs has been impacted by the development of drug-resistant strains of the malaria parasite. **SO5.5** studied about Anti-inflammatory drugs that are medications designed to reduce inflammation, alleviating pain, swelling, redness, and heat associated with various conditions.	7. Preparation of suspension, Emulsions, ointment. 8. Preparation of simple syrup as per IP and USP. 9. Preparation of pharmaceutical buffer and study of its theoretical and calculated PH. 10 Inorganic preparations of compounds like Zinc Oxide, calcium carbonate, Magnesium Carbonate.	**Unit-5. Antifungal and Non-steroidal Anti- inflammatory** **5.1** Antifungal**:-** Polyenes, 5.2 Antibacterial-Ciprofloxacin **5.3** Norfloxacin, Antiviral - Acyclovir **5.4** Antimalarials: Chemotherapy of Malaria 5.5 SAR structure-activity relationship 5.6 **Quinoline-based drugs Resistance management** **5.7** Chloroquine, 5.8 Chloroguanide and Mefloquine. 5.9 Quinoline methanols, prophylactic drug **5.10 Non-steroidal:** Anti-inflammatory Drugs: Diclofenac Sodium, 5.11 Ibuprofen and Netopam, **Nonsteroidal** **5.12 Anti-Inflammatory Drugs (NSAIDs** .	Mechanism of Norfloxacin and acyclovir both medications used to treat different types of infections.

SW-5: Suggested Sessional Work (SW):

a. **Assignments:**
Antifungal: Polyenes, Antibacterial , Ciprofloxacin **.**

b. **Mini Project:**
Chemotherapy of Malaria SAR

c. Other Activities (Specify):

Non-steroidal: Anti-inflammatory Drugs

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Laboratory instruction (LI)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
05CH606.1: Understand importance o	12	12	02	01	29
05CH606.2: Learn intellectual property rights, patents trademark and copyright .	12	12	02	01	27
05CH606.3- Understand definition, classification of the drugs with examples and structures.	12	12	02	01	27
05CH606.4-Describe the overall process of drug discovery and the role played by medicinal chemistry in this process.	12	12	02	01	27
05CH606.5- Related the structure and physical properties of drugs to their pharmacological activity. Explain physio- chemical properties related to QSAR.	12	12	02	01	27
Total Hours	60	60	15	05	100

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	**Pharmaceutical Chemistry**	03	01	01	05
CO-2	**Pharmacognosy**	02	06	02	10
CO-3	**Molecular Modeling and Drug Design-**	03	07	05	15
CO-4	**Antibiotics and Antibacterial**	-	10	05	15
CO-5	**Antifungal and Non-steroidal Anti-inflammatory**	03	02	-	05
Total		11	26	13	50

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for Organic Chemistry I will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks.Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play

6. Visit to NCL, CSIR laboratories
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT,Blog, Facebook,Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books :

S. No.	Title	Author	Publisher	Edition & Year
1	ORGANIC MEDICINAL AND PHARMACEUTICAL CHEMISTRY	John M. Beale	Wolters Kluwer Lippincott Williams & Wilkins	TWELFTH EDITION
2	TEXTBOOK OF PHARMACOGNOSY AND PHYTOCHEMISTRY	Biren N. Shah A.K. Seth	ELSEVIER	First Edition 2010
3	Molecular Modeling in Drug Design	Rebecca Wade and Outi Salo-Ahen ,	MDPI	March 2019
4	A Pharmacological Guide to Non-Steroidal Anti-Inflammatory Medications	**Pugazhenthan Thangaraju**	NOVA	2021
5	Antibiotic Basics for Clinicians	Alan R. Hauser	WOLTER KLUWERS	March 2012

Mode of Delivery: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point;

LMS/ICT Tools: Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Course Title: Pharmaceutical and Medicinal Chemistry **Course Code : 05CH606**

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	**PO 2**	**PO3**	**PO4**	**PO5**	**PO 6**	**PO7**	**PO8**	**PO9**	**PO1 0**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
	Knowledge	**Research Aptitude**	**Communication**	**Problem Solving**	**Individual and Team Work**	Investigation of Problems	**Modern Tool usage**	**Science and Society**	**Life-Long Learning**	**Ethics**	**Project Management**	**Environment and sustainability**	**The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry**	**To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.**	**understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon- based problems in chemical sciences.**	**Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science**
S3-CHEM2T 1: Understand importance of pharmaceutical	**3**	**1**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**3**	**2**	**2**	**3**	**3**	**1**

chemistry and pharmacopeia.																
S3-CHEM2T 2: Learn intellectual property rights, patents trademark and copyright	**2**	**1**	**2**	**2**	**1**	**2**	**3**	**2**	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**1**
S3-CHEM2T- Understand definition, classification of the drugs with examples and structures	**2**	**2**	**1**	**1**	**1**	**2**	**2**	**2**	**1**	**2**	**1**	**2**	**1**	**1**	**2**	**2**
S3-CHEM2T - Describe the overall process of drug discovery and the role played by medicinal chemistry in this process.	**2**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**2**	**3**	**3**	**3**	**3**	**2**
S3-CHEM2T- Related the structure and physical properties of drugs to their pharmacological	**2**	**-**	**-**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**3**	**1**	**3**

activity. Explain physio-chemical properties related to QSAR.																

Legend:1–Low,2–Medium, 3–High

POs &PSOsNo.	Cos No. &Titles	SOsNo.	aboratory instruction (LI)	Classroom Instruction(CI)	arning(SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	**05CH606.1:** Understand importance of pharmaceutical chemistry and pharmacopeia. .	SO1.1SO 1.2SO1. 3SO1.4 SO1.5		Unit-1.0 Symmetry and Group Theory 1.1,1.2,1.3,1.4,1.5,1.6,1.7	Character tables and their use in spectroscopy.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	**05CH606.2**: Learn intellectual property rights, patents trademark and copyright	SO2.1SO 2.2SO2. 3 SO2.4 SO2.5		Unit-2 **Vibrational Spectroscopy** 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9	Resonance Raman Spectroscopy, coherent anti-stokes Raman Spectroscopy (CARS).
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	**05CH606.3**Understand definition, classification of the drugs with examples and structures	SO3.1SO 3.2 SO3.3 SO3.4 SO3.5		Unit-3 : **Mössbauer Spectroscopy** 3.1, 3.2,3.3,3.4,3.5,3.6,3.7	Nature of M-L bond, coordination number, structure and detection of oxidation state.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	**05CH606.4-** Understand definition, classification of the drugs with examples and structures**.**	SO4.1SO 4.2SO4. 3SO4.4 SO4.5		Unit-4 : : **Magnetic Resonance Spectroscopy** .1, 4.2,4.3,4.4,4.5,4.6,4.7	Quadrupole nuclei, quadrupole moments, electric field gradient, Coupling Constant splitting. Applications
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	**05CH606.5**-Describe the overall process of drug discovery and the role played by medicinal chemistry in this process	SO5.1SO 5.2SO5. 3SO5.4 SO5.5		**Unit 5: X-ray Diffraction , Electron Diffraction** **Neutron Diffraction** 1,5.2,5.3,5.4,5.5,5.6,5.7	Low energy electron diffraction and structure of surfaces. ,

Program name	Bachelor of Science (B. Sc.(Hons))- Biology	
Semester	7th	
Course Code:	01BO701	
Course title:	Mycology & Plant Pathology	**Curriculum Developer**: Dr. Monika Soni, Assistant Professor
Pre-requisite:	Students should have basic knowledge of Mycology & Plant Pathology	
Rationale:	Mycology and Plant Pathology are critical fields of study within biology and agriculture, encompassing the understanding and management of fungi and plant diseases. It equips students with the knowledge and skills to address challenges in agriculture, industry, and environmental management, contributing to sustainable practices and innovations that benefit society.	
Course Outcomes (COs):	**CO1-01BO701.1:** To Describe the introduction, definition of different terms, and basic concepts of mycology. **CO2-01BO701.2:** To explain the morphology and characters of different groups of fungi. **CO3-01BO701.3:** Acquire knowledge about the natural benefits and harmful effects of fungi. **CO4-01BO701.4:** Know about the organisms and casual factors responsible for plant diseases. **CO5-01BO701.5:** To comprehend the mechanism of transmission, cause, and control measures of plant diseases.	

Board of Study	CourseCode	Course Title	Scheme of studies (Hours/Week)					Total Credits(C) (L:T:P=4:0:2)
			CI	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Major	01BO701	Mycology & Plant Pathology	4	2	1	2	9	4+0+2=6

Scheme of Studies:

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
PC	01BO701	Mycology & Plant Pathology	15	20	5	5	5	50	50	100

Scheme of Assessment: Practical

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)		
PC	01BO751	Mycology & Plant Pathology	35	5	5	5	50	50	50

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	12	6	1	2	21

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO1-01BO701.1: To Describe the introduction, definition of different terms, and basic concepts of mycology			**Unit-1**	
	SO1.1 Understand the basic characteristics and classification of fungi		**CI1.1** General Characteristics of Fungi	**SL1.1** To independently study and understand the general characteristics, cell ultra-structure, thallus organization, modes of nutrition, and reproduction in fungi
	SO1.2 Learn about the detailed cell structure of fungi	**LI1.1** To study the general characteristics, and cell ultra-structure	**CI1.2** Cell Ultra-Structure of Fungi	
	SO1.3 Understand the various forms and structures of fungal thalli	**LI1.2** To study the thallus organization, and modes of nutrition in fungi	**CI1.3** Thallus Organization	
	SO1.4 Explore the nutritional modes and substrate relationships of fungi		**CI1.4** Mode of Nutrition in Fungi	
	SO1.5 & SO1.6 Introduce the asexual reproduction mechanisms in fungi	**LI1.3** To investigate the reproductive structures and processes in fungi and understand their economic importance	**CI1.5 & CI1.6** Asexual Reproduction in Fungi	
	SO1.7 & SO1.8 Cover the sexual reproduction mechanisms in fungi		**CI1.7 & CI1.8** Sexual Reproduction in Fungi	
	SO1.9 Discuss the positive and negative impacts of fungi on economy and society		**CI1.9** Economic Importance of Fungi	**SL1.2** To independently study and understand the economic importance of fungi,

				heterothallism, parasexuality, and mycorrhizal associations
	SO1.10 & SO1.11 Understand advanced genetic concepts in fungal reproduction		**CI1.10 & CI1.11** Heterothallism and Parasexuality	
	SO1.12 Learn about the symbiotic relationship between fungi and plant roots		**CI1.12** Mycorrhizal Association	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Learn about the detailed cell structure of fungi.
	SW1.2 Mini Project	Introduce the asexual & sexual reproduction mechanisms in fungi.
	SW1.3 Other Activities (Specify)	Literature survey about the symbiotic relationship between fungi and plant roots.

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	12	6	1	2	21

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
			Unit-2	

CO2-01BO701.2: To explain the morphology and characters of different groups of fungi	**SO2.1** Discuss the Introduction to fungal classification		**CI2.1** Introduction to fungal classification	
	SO2.2 Understand the recent trends in fungal classification as outlined by **Alexopoulos**		**CI2.2** Recent trends in classification-**Alexopoulos**	**SL2.1** To understand recent trends in fungal classification as described by **Alexopoulos and Ainsworth**, and how these trends impact the understanding of fungal diversity and taxonomy
	SO2.3 Understand the recent trends in fungal classification as outlined by **Ainsworth**		**CI2.3** Recent trends in classification-**Ainsworth**	
	SO2.4 Learn about the **Mastigomycotina** subclass, focusing on Phytophthora and Albugo	**LI2.1** To familiarize students with the morphological characteristics of **Mastigomycotina** (Phytophthora and Albugo)	**CI2.4** Morphology and general characteristics of different groups of fungi up to generic level: **Mastigomycotina** (*Phytophthora, Albugo*)	**SL2.2** To study and understand the morphology and general characteristics of specific fungal groups, focusing on **Mastigomycotina, Zygomycotina, Deuteromycotina, Ascomycotina,** and **Basidiomycotina**
	SO2.5 & SO2.6 Explore the **Zygomycotina** subclass with a focus on Mucor and Pilobolus		**CI2.5 & CI2.6** Morphology and general characteristics of different groups of fungi up to generic level: **Zygomycotina** (*Mucor, Pilobolus*)	
	SO2.7 & SO2.8 Study the **Deuteromycotina** subclass with a focus on Alternaria and Cercospora	**LI2.2** To investigate and identify the morphological characteristics of **Deuteromycotina** (Alternaria and Cercospora)	**CI2.7 & CI2.8** Morphology and general characteristics of different groups of fungi up to generic level: **Deuteromycotina** (*Alternaria, Cercospora*)	

	SO2.9 & SO2.10 Understand the **Ascomycotina** subclass with an emphasis on Penicillium and Peziza		**CI2.9 & CI2.10** Morphology and general characteristics of different groups of fungi up to generic level: **Ascomycotina** (*Penicillium, Peziza*)	
	SO2.11 & SO2.12 Learn about the **Basidiomycotina** subclass, focusing on Puccinia and Ustilago	**LI2.3** To investigate and identify the morphological characteristics of **Basidiomycotina** (*Puccnia, Ustilago*)	**CI2.11 & CI2.12** Morphology and general characteristics of different groups of fungi up to generic level: **Basidiomycotina** (*Puccnia, Ustilago*)	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Understand the recent trends in fungal classification as outlined by **Ainsworth**
	SW2.2 Mini Project	Learn about the **Basidiomycotina** subclass, focusing on Puccinia and Ustilago
	SW2.3 Other Activities (Specify)	Literature survey on any one subclass of fungi

Course-Curriculum:

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Item	CI	LI	SW	SL	Total
Approx. Hours	12	6	1	2	21

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)

CO3-01BO701.3: Acquire knowledge about the natural benefits and harmful effects of fungi			**Unit-3**	
	SO3.1 Understand the concept of plant diseases and the historical development of plant pathology		**CI3.1** Introduction to Plant Diseases and the History of Plant Pathology	**SL3.1** To explore the fundamental concepts of plant diseases, their historical context, and classification systems
	SO3.2 Explore the classification systems for plant diseases	**LI3.1** To identify and classify various plant diseases based on their symptoms, causal agents, and classification systems	**CI3.2** Classification of Plant Diseases	
	SO3.3 Understand the process of infection in plant diseases	**LI3.2** To observe and analyse the stages of disease development in plants and evaluate chemical and biological control methods	**CI3.3** Development of Plant Diseases: Infection	**SL3.2** To study the development of plant diseases, the factors influencing disease progression, and control methods
	SO3.4 Explore how pathogens colonize host plants		**CI3.4** Development of Plant Diseases: Colonization	
	SO3.5 Learn about how plant disease symptoms develop and manifest		**CI3.5** Development of Plant Diseases: Symptom Development	
	SO3.6 Identify and understand the factors influencing plant disease development		**CI3.6** Factors Responsible for the Development of Plant Diseases	
	SO3.7 & SO3.8 Understand the principles and practices of chemical control in plant disease management	**LI3.3** To evaluate the chemical and biological control methods in plant disease management	**CI3.7 & CI3.8** General Principles of Disease Control: Chemical Control	

	SO3.9 & SO3.10 Explore biological control methods for managing plant diseases		**CI3.9 & CI3.10** General Principles of Disease Control: Biological Control	
	SO3.11 & SO3.12 Understand integrated approaches to plant disease management		**CI3.11 & CI3.12** Integrated Disease Management	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Explore the classification systems for plant diseases
	SW3.2 Mini Project	Understand the process of infection in plant diseases and Explore how pathogens colonize host plants
	SW3.3 Other Activities (Specify)	Write a one review article on integrated approaches to plant disease management

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	12	6	1	2	21

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO4-01BO701.4: Know about the organisms and casual factors responsible for plant diseases			**Unit-4**	
	SO4.1 Understand the dynamics of host-parasite interactions, including		**CI4.1** Host-Parasite Interaction and Recognition	**SL4.1** To understand the concepts of host-parasite interactions, plant defense mechanisms, and the role of

	recognition and infection mechanisms			enzymes, toxins, and growth regulators in disease development
	SO4.2 Explore the structural defenses that plants use to protect themselves from pathogens	**LI4.1** To explore how plants interact with pathogens and how they defend themselves through structural and biochemical mechanisms.	**CI4.2** Structural Defense Mechanisms in Plants	
	SO4.3 Understand the biochemical defenses that plants use to combat pathogen attacks		**CI4.3** Biochemical Defense Mechanisms in Plants	
	SO4.4 Explore how enzymes, toxins, and growth regulators contribute to disease development in plants	**LI4.2** To study the role of enzymes, toxins, and growth regulators in disease development	**CI4.4** Disease Development: Enzymes, Toxins, and Growth Regulators	
	SO4.5 & SO4.6 Understand integrated disease management strategies and their application	**LI4.3** To develop an integrated disease management plan.	**CI4.5 & CI4.6** Integrated Disease Management (IDM): Concepts and Strategies	**SL4.2** To understand integrated disease management strategies and the principles and significance of plant quarantine
	SO4.7 & SO4.8 Understand the principles and significance of plant quarantine in disease management		**CI4.7 & CI4.8** General Principles of Plant Quarantine	
	SO4.9 & SO4.10 Learn about methods and technologies for detecting and diagnosing plant diseases		**CI4.9 & CI4.10** Disease Detection and Diagnostics	
	SO4.11 & SO4.12 Explore the environmental and host		**CI4.11 & CI4.12** Environmental and Host Factors in Disease Development	

	factors that influence disease development			

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Explore the structural, & biochemical defenses that plants use to protect themselves from pathogens
	SW4.2 Mini Project	Explore how enzymes, toxins, and growth regulators contribute to disease development in plants
	SW4.3 Other Activities (Specify)	Review and apply the concepts learned throughout the course to practical scenarios

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	12	6	1	2	21

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO5-01BO701.5: To comprehend the mechanism of transmission, cause, and control measures of plant diseases			**Unit-5**	
	SO5.1 & SO5.2 Introduce students to the general concept of symptomatology in plant diseases and the importance of recognizing symptoms for effective management		**CI5.1 & CI5.2** Introduction to Plant Disease Symptomatology	
	SO5.3 & SO5.4 Study the plant diseases caused by fungi, focusing on	**LI5.1** To investigate fungal plant diseases (fungi) by examining symptoms, understanding their etiology,	**CI5.3 & CI5.4** Plant Diseases Caused by Fungi: Symptomatology, Etiology, and Control	**SL5.1** To independently study and understand the symptomatology, etiology, and control methods for plant

	symptoms, causes, and control strategies	and exploring control measures.		diseases caused by fungi and bacteria
	SO5.5 & SO5.6 Explore the plant diseases caused by bacteria, with a focus on their symptoms, causes, and control methods	**LI5.2** To investigate bacterial plant diseases (bacteria) by examining symptoms, understanding their etiology, and exploring control measures	**CI5.5 & CI5.6** Plant Diseases Caused by Bacteria: Symptomatology, Etiology, and Control	
	SO5.7 & SO5.8 Understand plant diseases caused by viruses, including symptoms, causes, and available control methods	**LI5.3** To investigate bacterial plant diseases (virus) by examining symptoms, understanding their etiology, and exploring control measures	**CI5.7 & CI5.8** Plant Diseases Caused by Viruses: Symptomatology, Etiology, and Control	**SL5.2** To independently explore the symptomatology, etiology, and control methods for plant diseases caused by viruses, nematodes, and mollicutes
	SO5.9 & SO5.10 Investigate the plant diseases caused by nematodes, covering symptoms, causes, and control strategies		**CI5.9 & CI5.10** Plant Diseases Caused by Nematodes: Symptomatology, Etiology, and Control	
	SO5.11 & SO5.12 Study the plant diseases caused by mollicutes, focusing on their symptoms, causes, and control strategies		**CI5.11 & CI5.12** Plant Diseases Caused by Mollicutes: Symptomatology, Etiology, and Control	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Explore the plant diseases caused by bacteria, with a focus on their symptoms, causes, and control methods
	SW5.2 Mini Project	Understand plant diseases caused by viruses, including symptoms, causes, and available control methods
	SW5.3 Other Activities (Specify)	Analyse the real-world case studies of plant disease management, focusing on different pathogens

Course duration (in hours) to attain Course Outcomes:

Course Title: Mycology & Plant Pathology **Course Code:** 01BO701

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1-01BO701.1: To Describe the introduction, definition of different terms, and basic concepts of mycology	12	6	2	1	21
CO2-01BO701.2: To explain the morphology and characters of different groups of fungi	12	6	2	1	21
CO3-01BO701.3: Acquire knowledge about the natural benefits and harmful effects of fungi	12	6	2	1	21
CO4-01BO701.4: Know about the organisms and casual factors responsible for plant diseases	12	6	2	1	21
CO5-01BO701.5: To comprehend the mechanism of transmission, cause, and control measures of plant diseases	12	6	2	1	21
Total Hours	60	30	10	05	105

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcomes:

Course Title: Mycology & Plant Pathology **Course Code:** 01BO701

Course Outcomes	**Marks Distribution**				**Total Marks**
	R	**U**	**A**	**A**	
CO1-01BO701.1: To Describe the introduction, definition of different terms, and basic concepts of mycology	2	2	3	2	9
CO2-01BO701.2: To explain the morphology and characters of different groups of fungi	2	3	3	2	10
CO3-01BO701.3: Acquire knowledge about the natural benefits and harmful effects of fungi	2	2	3	4	11
CO4-01BO701.4: Know about the organisms and casual factors responsible for plant diseases	2	2	3	3	10
CO5-01BO701.5: To comprehend the mechanism of transmission, cause, and control measures of plant diseases	2	2	2	4	10
Total Marks	**10**	**11**	**14**	**15**	**50**

***Legend*: R,** Remember; **U,** Understand; **A,** Apply; **A,** Analyze

Suggested learning Resources:

(a) Books:

S.No.	**Title/Author/Publisher details**
1.	Alexopoulos, C.J., Mims, C.W., Blackwell, M. **Introductory Mycology**, John Wiley &Sons (Asia) Singapore. 4th edition. (1996)
2.	Gupta VK & Sharma RC. (Eds). (1995). **Integrated Disease Management and Plant Health**. Scientific Publ., Jodhpur
3.	Sethi, I.K. and Walia, S.K. **Text book of Fungi and Their Allies**, Macmillan Publishers India Ltd (2011)
4.	Sharma, P.D, **Plant Pathology**, Rastogi Publication, Meerut, India. (2011)
5.	Upadhyay RK & Mukherjee KG. (1997). **Toxins in Plant Disease Development and Evolving Biotechnology**. Oxford & IBH, New Delhi.

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Demonstration
7. ICT Based teaching Learning
8. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Sc. (Hons.) Biology

Semester: 7th Semester **Course Title:** Mycology & Plant Pathology **Course Code:** 01BO701

CO/PO/PSO Mapping															
Course Outcome (Cos)	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1-01BO701.1: To Describe the introduction, definition of different terms, and basic concepts of mycology	3	2	-	2	2	1	-	-	1	1	2	-	2	2	2
CO2-01BO701.2: To explain the morphology and characters of different groups of fungi	3	3	1	2	3	1	-	-	-	2	3	1	2	2	3
CO3-01BO701.3: Acquire knowledge about the natural benefits and harmful effects of fungi	2	1	1	2	2	2	-	2	-	2	1	1	3	2	1
CO4-01BO701.4: Know about the organisms and casual factors responsible for plant diseases	2	3	-	3	2	2	-	2	-	2	2	1	3	2	2
CO5-01BO701.5: To comprehend the mechanism of transmission, cause, and control measures of plant diseases	3	3	-	3	2	2	2	2	1	2	2	2	3	2	2
Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3															

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO1-01BO701.1:** To Describe the introduction, definition of different terms, and basic concepts of mycology	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	LI 1 LI 2 LI 3	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9,1.10,1.11, 1.12	1SL-1,2
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO2-01BO701.2:** To explain the morphology and characters of different groups of fungi	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9 SO2.10 SO2.11 SO2.12	LI 1 LI 2 LI 3	2.1,2.2,2.3,2.4,2.5, 2.6,2.7,2.8,2.9,2.10,2.11, 2.12	2SL-1,2
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO3-01BO701.3:** Acquire knowledge about the natural benefits and harmful effects of fungi	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9 SO3.10 SO3.11 SO3.12	LI 1 LI 2 LI 3	3.1,3.2,3.3,3.4,3.5,3.6,3. 7,3.8,3.9,3.10,3.11,3.12	3SL-1,2
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO4-01BO701.4:** Know about the organisms and casual factors responsible for plant diseases	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8 SO4.9 SO4.10 SO4.11 SO4.12	LI 1 LI 2 LI 3	4.1,4.2,4.3,4.4,4.5,4.6,4. 7,4.8,4.9,4.10,4.11,4.12	4SL-1,2
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO5-01BO701.5:** To comprehend the mechanism of transmission, cause, and control measures of plant diseases	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9 SO5.10 SO5.11 SO5.12	LI 1 LI 2 LI 3	5.1,5.2,5.3,5.4,5.5,5.6,5. 7,5.8,5.9,5.10,5.11,5.12	5SL-1,2

Program Name	**Bachelors of Science (B.Sc.)**	
Semester	7th	
Course Code:	01ZO702	
Course title:	Genetics and molecular Biology	**Curriculum Developer**: Mr. Amit Bagri
Pre-requisite:	To study this course, student must have had Zoology in B.Sc. 3rd year/ Degree	
Rationale:	Molecular Biology and Genetics seek to understand how the molecules that make up cells determine the behavior of living things. Biologists use molecular and genetic tools to study the function of those molecules in the complex milieu of the living cell.	
Course Outcomes (COs):	01ZO702 **.1:** Gain knowledge of basic principle of inheritance and variations DNA, RNA and their function? 01ZO702**.2:** Deeper understand of linkage, Sex determination, sex chromosomes, mutations and mutagens? 01ZO702**.3:** Gain knowledge of human karyotype, human genome project, Gene therapy. 01ZO702**.4:** Structure and function of cell organelles. 01ZO702**.5:** Membrane system and cell singling.	

Scheme of Studies:

Board of Study	**Course Code**	**Course Title**	**Scheme of studies (Hours/Week)**					**Total Credits(C) (L: T:P=3:0:1)**
			Cl	LI	SW	SL	**Total Study Hours (CI+LI+SW+SL)**	
MAJOR	01ZO702	Genetics and molecular Biology	4	2	1	2	9	4+2=6

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory and Practical

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)		
MAJOR	01ZO702	Genetics and molecular Biology	**15**	**20**	**10**	**5**	**50**	**50**	**100**

Scheme of Assessment: Practical

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)		
Major	01ZO702	Genetics and molecular Biology	35	5	5	5	50	50	50

Course-Curriculum:

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Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	06	01	04	23

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
01ZO702 **.1:** Gain knowledge of basic principle of inheritance and variations.	**SO1.1** Define Introduction, Historical background, And importance of Genetics.	**LI1.1** Study of chromosome through models, charts, and photograph.	**Unit 1** **CI1.1Define Introduction, Historical background, And importance of Genetics.**	**SL1.1** Define Introduction, Historical background, And importance of Genetics.
	SO1.2 Describe Mendel's law of heredity		CI1.2 Describe Mendel's law of heredity	**SL1.2** Describe Mendel's law of heredity
	SO1.3 Explain about Nucleocytoplasmic Interaction.	**LI1.2** Study of DNA & RNA .	CI1.3 Explain about Nucleocytoplasmic Interaction.	**SL1.3** Learn about Nucleocytoplasmic Interaction.
	SO1.4 Describe Variations, and types of variations	LI1.3 Study of the formula for variation?	CI1.4 Describe Variations, and types of variations	**SL1.4** Describe Variations, and types of variations.
	SO1.5 Explain in detail 5 types of variations?		CI1.5 What are the 5 types of variations?	
	SO1.6 Describe the formula for variation?		CI1.6 What is the formula for variation?	
	SO1.7 Describe The major variations?		CI1.7 What are major variations?	
	SO1.8 explain the two causes of variation?		CI1.8 What are the two causes of variation?	
	SO1.9 Explain the concept of variation?		CI1.9 What is the concept of variation?	
	SO1.10 Explain the inherited trait?		CI1.10 What is an inherited trait?	
	SO1.11 Why are we interested in inheritance?		CI1.11 Why are we interested in inheritance?	
	SO1.12 What is the distinction between meiosis and mitosis		CI1.12 What is the distinction between meiosis and mitosis?	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Describe Mendel's law of heredity
	SW1.2 Mini Project	Explain about Nucleocytoplasmic Interaction.
	SW1.3 Other Activities (Specify)	Describe Variations, and types of variations.

Item	Cl	LI	SW	SL	Total
Approx Hrs	12	06	01	05	24

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
01ZO702 **.2:** Deeper understand of linkage, Sex determination,	**SO2.1** Assess the concept of Gene linkage and recombination.	**LI2.1** Identification of DNA.	**Unit-II** **CI2.1** Assess the concept of Gene linkage.	**CI2.2** Assess the concept of Gene linkage and recombination.
	SO2.2 Explain about Sex determinations.		CI2.2 Explain about Sex determinations.	**SL2.1** Explain about Sex determinations.
	SO2.3 Explain about Sex linked inheritance.	**LI2.2** Identification of problem related to genetics.	**CI2.3** Explain about Sex linked inheritance	**SL2.2** Learn structure and function of Sex-linked inheritance
	SO2.4 Explain about Mutations, types of mutation.	**LI2.3** problem related to sex linked in hesitance.	**CI2.4** Explain about Mutations.	**SL2.3** Learn about Mutations, types of mutation.
	SO2.5 Describe the human karyotype and human genome project.		**CI2.5** Describe the human karyotype.	**SL2.5 Learn** structure and function of human karyotype and human genome project.
	SO2.6 Describe structure and function of Gene therapy.		**CI2.6** Describe structure and function of Gene therapy.	
	SO2.7 Explain the concept of recombination.		**CI2.7** Assess the concept of recombination.	
	SO2.8 describe about types of mutation.		**CI2.8** Explain about types of mutation.	
	SO2.9 explain the human genome project.		**CI2.9** Describe the human genome project.	
	SO2.10 How are genotypes and phenotypes related?		**CI2.10** How are genotypes and phenotypes related?	
	SO2.11 What are genes?		**CI2.11** What are genes?	
	SO2.12 What is the difference between DNA and RNA?		**CI2.12** What is the difference between DNA and RNA?	

Suggested Sessional Work (SW) : *anyone*		
	SW2.1 Assignments	Explain about Sex determinations.
	SW2.2 Mini Project	Explain about Mutations, types of mutation.
	SW2.3 Other Activities (Specify)	Describe structure and function of Gene therapy.

Item	Cl	LI	SW	SL	Total
Approx Hrs	12	08	01	04	25

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
01ZO702 **.3:** Gain knowledge of human karyotype, human genome project, Gene therapy.	**SO3.1** Explain the concept and structure of Plasma membrane.	**SL3.1** Quantification of DNA.	**Unit-III** **CI3.1** Explain the structure of Plasma membrane.	**SL3.1** Read about of Plasma membrane.
	SO3.2 Assessing the modification of plasma membrane.	**SL3.2** Quantification of RNA.	**CI3.2** Assessing the modification of plasma membrane.	**SL3.2** Illustrate structure of modification of plasma membrane.
	SO3.3 Explaining Membrane permeability.	**SL3.3** Separation of different types of DNA	**CI3.3** Explaining Membrane permeability	**SL3.3** Study the Membrane permeability.
	SO3.4 explain solute transport by simple diffusion	**SL3.4** Estimation of RNA	**CI3.4** explain solute transport by simple diffusion.	
	SO3.5 Describe about cell surface receptors.		**CI3.5** Describe about cell surface receptors.	
	SO3.6 Explain signal transduction.		**CI3.6** Explain signal transduction.	**SL3.4** Study the signal transduction.
	SO3.7 Explain the concept of Plasma membrane.		**CI3.7** Explain the concept of Plasma membrane.	
	SO3.8 described about transgenic animals?		**CI3.8** Explain about transgenic animals?	
	SO3.9 How similar are the genes of different species?		**CI3.9** How similar are the genes of different species?	
	SO3.10 What are the 3 main types of genetics?		**CI3.10** What are the 3 main types of genetics?	
	SO3.11 What is the structure and function of DNA		**CI3.11** What is the structure and function of DNA	
	SO3.12 How do mutations occur, and what are their effects on an organism?		**CI3.12** How do mutations occur, and what are their effects on an organism?	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Explain the concept and structure of Plasma membrane
	SW3.2 Mini Project	explain Hormones and their receptors.
	SW3.3 Other Activities (Specify)	Explain signal transduction.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	12	04	01	04	21

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
01ZO702 **.4:** Structure and function of cell organelles.	**SO4.1** Exploring the Structure and concept of nucleus.	**LI4.1** Estimation of DNA by diphenol Amine method.	**Unit-IV** **CI4.1** Exploring the concept of nucleus.	**SL4.1** Learn about Structure and concept of nucleus
	SO4.2 Explain the structure and organization of chromosome.	**Li4.2** Explain the structure and organization of chromosome.	**CI4.2** Explain the structure and organization of chromosome.	**SL4.2** Discuss structure and organization of chromosome.
	SO4.3 Explaining the DNA Double helix model.		**CI4.3** Explaining the DNA Double helix model.	**SL4.3** Learn about DNA Double helix model.
	SO4.4 Explaining the role of DNA Replications.		**CI4.4** Explaining the role of DNA Replications.	
	SO4.5 Evaluate DNA damage and repair.		**CI4.5** Evaluate DNA damage and repair.	**SL4.4** Learn about Evaluate DNA damage and repair.
	SO4.6 Describe the Types of RNA.		**CI4.6** Describe the Types of RNA.	
	SO4.7 Exploring the Structure of nucleus.		**CI4.7** Exploring the Structure of nucleus.	
	SO4.8 How do Mendelian laws of inheritance work?		**CI4.8** How do Mendelian laws of inheritance work?	
	SO4.9 Explain DNA repair?		**CI4.9** Study about DNA repair?	
	SO4.10 What are the genetic bases of common hereditary diseases?		**CI4.10** What are the genetic bases of common hereditary diseases?	
	SO4.11 How do polygenic traits differ from single-gene traits?		**CI4.11** How do polygenic traits differ from single-gene traits?	
	SO4.12 described about SOS repair?		**CI4.12** Study about SOS repair?	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Exploring the Structure and concept of nucleus.
	SW4.2 Mini Project	Explaining the DNA Double helix model.
	SW4.3 Other Activities (Specify)	Evaluate DNA damage and repair.

Item	Cl	LI	SW	SL	Total
Approx Hrs	12	06	01	03	22

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
01ZO702 **.5:** Membrane system and cell singling.	**SO5.1** Define the concept of Genome organization in eukaryotes and prokaryotes.	**LI5.1** Study about translation?	**Unit-V** **CI5.1** Define the concept of Genome organization in eukaryotes and prokaryotes.	**SL5.1** learn about basic concept Genome organization in eukaryotes and prokaryotes.
	SO5.2 Able to execute role of Genetic code.	**LI5.2** STUDY OF of Gene expression.	**CI5.2** Able to execute role of Genetic code.	**SL5.2**Review concept of Genetic code.
	SO5.3 Apply the role of Gene expression.	**LI5.3** Study of the role of Transcription and translation.	**CI5.3** Apply the role of Gene expression.	**SL5.3**learn Gene expression.
	SO5.4 Evaluate the role of Transcription and translation.		**CI5.4** Evaluate the role of Transcription and translation.	
	SO5.5 Assess the Gene regulation.		**CI5.5** Assess the Gene regulation.	
	SO5.6 Explain about transcription?		**CI5.6** Study about transcription?	
	SO5.7 described about translation?		**CI5.7** Study about translation?	
	SO5.8 described Study about RNA polymerase?		**CI5.8** Study about RNA polymerase?	
	SO5.9 What is the role of epigenetics in human health and disease?		**CI5.9** What is the role of epigenetics in human health and disease?	
	SO5.10 How do mutations contribute to the process of evolution?		**CI5.10** How do mutations contribute to the process of evolution?	
	SO5.11 explain about genome?		**CI5.11** Study about genome?	
	SO5.12 What are the genetic causes of congenital disorders?		**CI5.12** What are the genetic causes of congenital disorders?	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Able to execute role of Genetic code. .
	SW5.2 Mini Project	Apply the role of Gene expression.
	SW5.3 Other Activities (Specify)	Evaluate the role of Transcription and translation.

Course duration (in hours) to attain Course Outcomes:

Course Title: Genetics and molecular Biology **Course Code:** 01ZO702

Course Outcomes(COs)	**Class lecture (CI)**	**Laboratory Instruction(LI)**	**Self-Learning (SL)**	**Sessional work (SW)**	**Total Hours (Li+CI+SL+SW)**
01ZO702 **.1:** Gain knowledge of basic principle of inheritance and variations.	12	06	4	1	23
01ZO702 **.2:** Deeper understand of linkage, Sex determination,	12	06	5	1	24
01ZO702 **.3:** Gain knowledge of human karyotype, human genome project, Gene therapy.	12	08	4	1	25
01ZO702 **.4:** Structure and function of cell organelles.	12	04	4	1	21
01ZO702 **.5:** Membrane system and cell singling.	12	06	3	1	22
Total Hours	60	30	20	05	115

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Genetics and molecular Biology **Course Code:** 01ZO702

Course Outcomes	**Marks Distribution**				**Total Marks**
	A	**An**	**E**	**C**	
01ZO702 **.1:** Gain knowledge of basic principle of inheritance and variations.	2	1	1	1	5
01ZO702 **.2:** Learning in-depth information regarding the composition and characteristics of numerous categories of carbohydrates.	2	4	2	2	10
01ZO702 **.3:** Gain knowledge of human karyotype, human genome project, Gene therapy.	3	5	5	2	15
01ZO702 **4:** Structure and function of cell organelles.	2	3	3	2	10
01ZO702 **.5:** Membrane system and cell singling.	5	4	1	0	10
Total Marks	**14**	**17**	**12**	**07**	**50**

***Legend*:A,** Apply;**An,** Analyze;**E,** Evaluate;**C,** Create

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1	Khanna pragya pal ajay , Cell and molecular Biology
2	Gupta P.K.. Molecular Biology and Genetic engineering.
3	Singh BD, Purohit Biotechnology
4	Singh BD, Gupta PK, Verma , PS and Agrawal , VK GENETICS

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Demonstration
7. ICT Based teaching Learning
8. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Sc. biology
Semester: 7th semester
Course Title: Genetics and molecular Biology
Course Code: 01ZO702

CO/PO/PSO Mapping								
Course Outcome (Cos)	**Program Outcomes (POs)**					**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**
01ZO702 **.1:** Gain knowledge of basic principle of inheritance and variations.	3	3	2	3	3	2	1	3
01ZO702 **.2:** Deeper understand of linkage, Sex determination,	2	1	1	3	2	1	2	2
01ZO702 **.3:** Gain knowledge of human karyotype, human genome project, Gene therapy.	3	3	1	3	2	1	2	3
01ZO702 **.4:** Structure and function of cell organelles.	2	1	2	2	1	2	2	1
01ZO702 **.5:** Membrane system and cell singling.	2	3	1	2	2	2	3	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5 PSO 1,2,3	01ZO702 **.1:** Gain knowledge of basic principle of inheritance and variations.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	1.1,1.2,1.3	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9.1.10,1.11,1.12	1SL-1,2,3,4
PO 1,2,3,4,5 PSO 1,2,3	01ZO702 **.2:** Deeper understand of linkage, Sex determination,	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9 SO2.10 SO2.11 SO2.12	2.1, 2.2, 2.3	2.1,2.2,2.3,2.4,2.5, 2.6,2.7,2.8,2.9,2.10,2.11,2.12	2SL-1,2,3,4,5
PO 1,2,3,4,5 PSO 1,2,3	01ZO702 **.3:** Gain knowledge of human karyotype, human genome project, Gene therapy.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9 SO3.10 SO3.11 SO3.12	3.1,3.2,3.3,3.4	3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9,3.10,3.11,3 .12	3SL-1,2,3,4
PO 1,2,3,4,5 PSO 1,2,3	01ZO702 **.4:** Structure and function of cell organelles.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8 SO4.9 SO4.10 SO4.11 SO4.12	4.1,4.2	4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9,4.10,4.11,4. 12	4SL-1,2,3,4
PO 1,2,3,4,5 PSO 1,2,3	01ZO702 **.5:** Membrane system and cell singling.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9 SO5.10 SO5.11 SO5.12	5.1,5.2,5.3	5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,5.9,5.10,5.11,5 .12	5SL-1,2,3

AKS University

Faculty of Basic Science

Curriculum of B. Sc. (Honours / By Research) Program

(Revised as on 01 August 2023)

B.Sc. VIIth Semester

CODE: 01CH703

COURSE NAME: Group theory and Spectroscopy I

Pre-requisite: Students should have basic knowledge of symmetry and group theory, electromagnetic radiation, interaction of electromagnetic radiation with matter and spectroscopy.

Rationale: The students studying group theory and spectroscopy should possess foundational understanding about, symmetry, EMR, NMR,PES.

Course Outcomes:

After the completion of this course, the learner will

01CH703.1: Explain and apply the basic concept symmetry and group theory.

01CH703.2: Describe fundamental aspects of spectroscopy and apply the knowledge these aspects on solving problem related to these.

01CH703.3: Apply the basic concept of microwave and its principle

01CH703.4:Explain and apply the principle of atomic spectroscopy and photo electron spectroscopy**.**

01CH703.5: Apply the knowledge of NMR principle, instrumentation and applications. And apply the knowledge to solve issues related to NMR spectroscopy

Unit-I: Symmetry and Group Theory

Symmetry elements and Symmetry operations, definitions of group, subgroups, relationship between orders of a finite group and its subgroup. Conjugacy relation and classes.

Unit-II: Unifying Principles

Electromagnetic radiation, interaction of electromagnetic radiation with matter –Absorption, emission, transmission, reflection, refraction, dispersion, polarization and scattering. Uncertainty relation and natural line width and natural line broadening, transition probability, results of time dependent perturbation theory, transition moment, selection rules, Intensity of spectral lines, Born Oppenheimer approximation, rotational, Vibrational and electronic levels.

Unit-III: Microwave Spectroscopy

Classification of molecules, rigid rotor model, effect of isotopic substitution on the transition frequencies, intensities, non rigid rotors . Stark effect, nuclear and electron spin interaction and effect of external field.

Unit-IV: Electronic Spectroscopy

A-Atomic Spectroscopy: Energies of atomic orbitals, vector representation of momenta and vector coupling, spectra of hydrogen atoms and alkali metal atoms.

Photo electron spectroscopy: Basic principles, photo-electric effect, ionization process, Koopman's theorem, photo electron spectra of simple molecules.

Unit-V: Nuclear Magnetic Resonance Spectroscopy

Nuclear spin, nuclear resonance, saturation, shielding of magnetic nuclei, chemical shift and its measurements, factors influencing chemical shift, deshielding, spin-spin interactions, factor influencing coupling constant"J". Classification (ABX,AMX,ABC,A2B2,etc.), spin decoupling, basic ideas about instrument.

Scheme of Studies:

Board Of Study	Course Code	Course Title	Scheme ofstudies(Hours/Week)					Total Credits(C)
			CI	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
Program Core	01CH703	Group theory and	4	0	1	1	6	4

(PCC)		spectroscopy						

Legend: **CI:** Class room Instruction (Includes different instructional strategies i.e .Lecture (L) and Tutorial (T) And others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locates using different instructional strategies) **SW:** Seasonal Work (includes assignment, seminar, mini project etc.), **SL:** Self Learning,
C: Credits.

Note: SW& SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment: Theory

Board of Study	Course Code	Course Title	**Scheme of Assessment (Marks)**						
			Progressive Assessment(PRA)					**End Semester Assessment (ESA)**	**Total Marks** (PRA+ESA)
			Class/Home Assignment 5 number 3marks each	Class Test 2 (2best out of3) 10 mark	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)		

			(CA)	s each(C T)					
PCC	01CH703	Group theory and spectros copy	15	20	10	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs)upon the course's conclusion.

01CH703.1: Explain and apply the basics concept symmetry and group theory.

Approximate Hours

Activity	Apex Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO1.1Restate the concept of symmetry and symmetry elements. SO1.2 Apply concept of symmetry operation on compounds SO1.3 Describe different types of symmetry elements. SO1.4 Discuss about plane of symmetry and its types. SO1.5 Explain and apply the group , sub group and classes of symmetry elements of a molecule.		**Unit-1 symmetry and group theory** Introduction of symmetry symmetry elements identity proper axis of symmetry improper axis of symmetry plane of symmetry in version centre symmetry operation group and sub groupT1 Order of group T2 class of group T3 prediction of symmetry elements of molecules	Prediction of symmetry elements in benzene, PtCI4.

SW-1Suggested Sessional Work(SW):

a. Assignments:

Discuss the Symmetry elements and Symmetry operations of various types of molecules.

b. Mini Project:

group, subgroups, order of group of symmetry elements.

c. Other Activities (Specify):

Note on relationship between orders of a finite group and its subgroup

01CH703.2: Describe fundamental aspects of spectroscopy and apply the knowledge these aspects on solving problem related to these.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (Cl)	Self Learning(SL)
SO2.1 Restate the term electromagnetic radiation. **SO2.2** Describe the interaction of electromagnetic radiationwith matter with different phenomenon. **SO2.3** Discuss transmission,reflection, refraction		**Unit-2.0 Unifying Principles** Introduction of EMR discovery, properties of EMR. Types of electromagnetic radiation. Born Oppenheimer approximation. Interaction of electromagnetic radiation with matter 2.6absorption and emission 2.7Phenomenon's of transmission, reflection and refraction of light 2.8The phenomenon of scattering	interaction of electromagnetic radiation with matter

SO2.4 Explain and apply thephenomenon of scattering and polarization of light, its types and uses. **SO2.5** Explain elementary idea Uncertainty relation andnatural line width and natural line broadening, transition probability.		and polarization of light, its types and uses. 2.9 Uncertainty relation and naturalline width T1-Natural line broadening, transitionprobability. T2-Selection rule T3- factors affecting band width broadening.	

SW-2 Suggested Sessional Work (SW):

A .Assignments:

Discussion of different phenomenon's of electromagnetic radiation interaction with matter.

b. Mini Project:

Natural line width and natural line broadeningand factors affecting band width broadening.

c. Other Activities (Specify):

Write an essay on electromagnetic radiation, interaction of electromagnetic radiation with matter

01CH703.3: Describe details ofclassification of molecules, classical model of rigid rotator and analyses effect of isotopic substitution on the transition frequencies, intensities and stark effect.

Activity	AppX Hrs
Cl	15
LI	0

SW	2
SL	1
Total	15

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO3.1 Restate classification of molecules, homo and hetroatomic microwave activity. **SO3.2** Explain, moment of inertia, kinetic energy and rotational energyof rigid rotator by classical model. **SO3.3** Explain selection rule and spectral intensities of rigid rotator. **SO3.4** Describe the effectof isotopic substitution on the transition frequencies**.** **SO3.5** Explain and apply starkeffect, nuclear and electron spin interaction and effect of external field.		**Unit-3.0 Microwave Spectroscopy** Classification of molecules homo and hetroatomic molecules microwave activity microwave activity. 3.4Moment of inertia of rigidrotator. 3.5kinetic energy of rigid rotator. 3.6rotational energyof rigid rotator by classical model Mathematical derivation of rigid rotator by classical model selection rule and spectral intensities of rigid rotator. effect of isotopic	Microwave activity of different molecules.

		substitution on the transition frequencies. T1 stark effect T2 Types of stark effect, T3nuclear and electron spin interaction and effect of external field.	

SW-3 Suggested Sessional Work (SW):

a. Assignments:

Isotopic substitution on the transition frequencies**.**

b. Mini Project:

Stark effect, nuclear and electron spin interaction and effect of external field.

c. Other Activities (Specify):

Explanatory note on importance of Microwave Spectroscopy

01CH703.4: Explain energies of atomic orbital's, vector representation of momenta and vector coupling, spectra of hydrogen atoms and Photo electron spectroscopy

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Explain and apply about Atomic Spectroscopy, Energies of atomic orbital's, vibronic transition. **SO4.2** Restate vector coupling of electron of atom andvector representation of momenta		**Unit-4.0 Atomic Spectroscopy** 4.1 Energies of atomic orbital's 4.2 electronic transition, 4.3 frank Condon principle. 4.4 vector representation of momenta 4.5 vector coupling of electron of atom. 4.6The spectra of hydrogen atoms with spectral lines and	Types of electronic transition and vibronic transition.

SO4.3 Describe the spectra of hydrogen atoms with spectral lines and importance. **SO4.4** Discuss Photo electron spectroscopy- Basic principles, mechanism of photoelectric effect. **SO4.5** Explain and apply instrumentation of photo electron spectrometer and its application		importance. 4.7 Photo electron spectroscopy- 4.8 Types of PES, Basic principles, 4.9 mechanism of photoelectric effect, ionization process. T1 Instrumentation of photo electron spectrometer T2 its application. T3 PES Spectra of molecules	

Suggested Sessional Work (SW):

a. Assignments:

Spectra of hydrogen atom and spectral line with importance.

b. Mini Project:

Vector representation of momenta and vector coupling of electron of atom.

b. Other Activities (Specify):

Importance and applications of photo electron spectroscopy.

01CH703.5: Apply the knowledge of the Nuclear Magnetic Resonance Spectroscopy, NMR activity,chemical shift andits measurements, factors influencing chemical shift, spin-spin interactions, basic ideas about instrument.

Activy	AppX Hrs
Cl	12
LI	0

SW	2
SL	1
Total	15

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO5.1 Explain and apply the introduction of NMR ,Nuclear spin, nuclear resonance **SO5.2** Describe shielding and deshielding of magnetic nuclei. **SO5.3** Restatechemical shift , delta value and its measurements and factors influencing chemical shift, **SO5.4** Discuss spin-spin interactions, factor influencing coupling constant. **SO5.5** Restate spins decoupling and basic ideas about instrumentation of NMR spectrophotometer.	.	**Unit-5.0 Nuclear Magnetic Resonance Spectroscopy.** 5.1 introduction of NMR. 5.2Nuclear spin quantum number NMR activity, nuclear resonance Shielding and deshielding of magnetic nuclei. chemical shift, delta value and TMS scale. delta value and its measurements 5.7factors influencing chemical shift. 5.8 spin-spin interactions, 5.9Factor influencing coupling constant "J" T1-Classification (ABX, AMX, ABC,	Chemical shift and its measurements of different organic compound.

		A2B2 etc.) T2 Spin decoupling and basic ideas about it. T3-Instrumentation of NMR spectrophotometer.	

SW-5 Suggested Sessional Work (SW):

a. Assignments:

Chemical shift and its measurements of different organic compound.

c. *Mini Project:*

Spin-spin interactions and coupling constant "J" for (ABX,AMX,ABC,A2B2,etc.),

d. *Other Activities (Specify):*

Basic ideas about instrumentation of NMR spectrophotometer.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
01CH703.1: Explain and apply the basic concept symmetry and group theory.	12	02	01	15
01CH703.2: Describe fundamental aspects of spectroscopy and apply the knowledge these aspects on solving problem related to these	12	02	01	15
01CH703.3: Apply the basic concept of microwave and its principle.	12	02	01	15
01CH703.4 Explain and apply the principle of atomic spectroscopy and photo electron spectroscopy .	12	02	01	15
01CH703.5: Explain of NMR principle, instrumentation and applications. And apply the knowledge to solve issues related to NMR spectroscopy.	12	10	05	15

Total Hours	60	10	05	75

Suggestion for End Semester Assessment

Suggested Specification Table(For ESA)

CO	UnitTitles	MarksDistribution			Total Marks
		R	U	A	
CO-1	Symmetry and Group Theory	03	01	01	05
CO-2	Unifying Principles	02	06	02	10
CO-3	Microwave Spectroscopy	03	07	05	15
CO-4	Electronic Spectroscopy	-	10	05	15
CO-5	Nuclear Magnetic Resonance Spectroscopy	03	02	-	05
Total		11	26	13	50

Legend: **R:Remember, U:Understand, A:Apply**

The end of semester assessment for Organic Chemistry I will be held withwritten examination of 50marks

Note.Detailed Assessmentrubric need to be prepared by the course wise teachers for above tasks.Teachers can also design different tasks as per requirement,for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to NCL, CSIR laboratories

7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration /Tutorials CBT,Blog,Facebook,Twitter,Whatsapp,Mobile,Online sources)
9. Brain storming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition& Year
1	Modern Spectroscopy	J. M. Hoilas	John Wiley.	Revised editionedition2020
2	Applied Electron Spectroscopy for Chemical Analysis	Ed. H. Windawi and F. L. HO	Wiley Interscience.	New edition, 2021
3	NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry	R. V. Parish	Ellis Harwood.	New edition, 2021
4	Physical Mehtods in Chemistry	R. S. Drago	Saunders	Revised edition
5	Chemical Applications of Group Theory	F. A. Cotton.	--	Revised edition
6	Introduction to Molacular Spectroscopy	G. M. Barrow	McGRraw Hill.	2020Revised edition

SuggestedWebSources:

6. https://nptel.ac.in/course.html
7. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5

8. https://swayam.gov.in/explorer?category=Chemistry

ModeofDelivery:Lecture,demonstration,E-tutoring,discussion,assignments,quizzes, case study, power point;

AKS University

Faculty of Basic Science

Curriculum of B. Sc. (Honours / By Research) Program

(Revised as on 01 August 2023)

Title: Group Theory and Spectroscopy I **Course Code : 01CH703**

	Program Outcomes												Program Specific Outcome			
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
Course Outcomes	**Knowledge**	**Research Aptitude**	**Communication**	**Problem Solving**	**Individual and Team Work**	Investigation of Problems	**Modern Tool usage**	**Science and Society**	**Life-Long Learning**	**Ethics**	**Project Management**	**Environment and sustainability**	**The detailed functional knowledge of theoretical concepts and**	**To integrate the gained knowledge with various contemporary and evolving areas in chemical**	**understand, analyze, plan and implement qualitative as well as quantitative**	**Provide opportunities to excel in academics, research or Industry by research**

													experimental aspects of chemistry	**sciences like analytical, synthetic, pharmaceutical etc.**	**analytical synthetic and phenomenon-based problems in chemical sciences.**	**based innovative knowledge for sustainable development in chemical science**
CO1: Explain and apply the basic concept symmetry and group theory.	**3**	**1**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**3**	**2**	**2**	**3**	**3**	**1**
CO 2 Describe fundamental aspects of spectroscopy and apply the knowledge these	**2**	**1**	**2**	**2**	**1**	**2**	**3**	**2**	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**1**

aspects on solving problem related to these																
CO3 Apply the basic concept of microwave and its principle	**2**	**2**	**1**	**1**	**1**	**2**	**2**	**2**	**1**	**2**	**1**	**2**	**1**	**1**	**2**	**2**
CO 4: Explain and apply the principle of atomic spectroscopy and photo electron spectroscopy	**2**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**2**	**3**	**3**	**3**	**3**	**2**
CO 5 Explain of NMR principle, instrumentation and applications. And apply the knowledge to solve issues	**2**	**-**	**-**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**3**	**1**	**3**

related to NMR spectroscopy																

Legend:1–Low,2–Medium, 3–High

AKS University

Faculty of Basic Science

Curriculum of B. Sc. (Honours / By Research) Program

(Revised as on 01 August 2023)

Course Curriculum Map:

POs & PSOsNo.	COsNo.&Titles	SOsNo.	Laboratory Instuction (LI)	Classroom Instruction(CI)	Self Learning(SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1: : Explain and apply the basic concept symmetry and group theory.	SO1.1 SO 1.2 SO1.3 SO1.4 SO1.5		Unit-1.0 group theory and spectroscopy 1.1,1.2,1.3,1.4,1.5,1.6,1.7	Prediction of symmetry elements in benzene, PtCI4.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 2 : Describe fundamental aspects of spectroscopy and apply the knowledge these aspects on solving problem related to these	SO2.1 SO 2.2 SO2.3 SO2.4 SO2.5		Unit-2 Unifying Principles 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9	interaction of electromagnetic radiation with matter
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3 : Apply the basic concept of microwave and its principle	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5		Unit-3 : Microwave Spectroscopy 3.1, 3.2,3.3,3.4,3.5,3.6,3.7	Microwave activity of different molecules.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4: Explain and apply the principle of atomic spectroscopy and photo electron spectroscopy	SO4.1 SO 4.2 SO4.3 SO4.4 SO4.5		Unit-4 : Electronic Spectroscopy 4.1, 4.2,4.3,4.4,4.5,4.6,4.7	Types of electronic transition and vibronic transition
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 5: Explain of NMR principle, instrumentation and applications. And apply the knowledge to solve issues related to NMR spectroscopy	SO5.1 SO 5.2 SO5.3 SO5.4 SO5.5		Unit 5: Nuclear Magnetic Resonance Spectroscopy 5.1,5.2,5.3,5.4,5.5,5.6,5.7	Chemical shift and its measurements of different organic compound

AKS University

Faculty of Basic Science

Curriculum of B. Sc. (Honours / By Research) Program

(Revised as on 01 August 2023)

Curriculum Development Team:

1. Dr. Shailendra Yadav, HoD, Department of Chemistry, AKS University, Satna (M.P.).
2. Dr. Dinesh Kumar Mishra, Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
3. Dr. Samit Kumar,Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
4. Dr. Sushma Singh, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
5. Dr. Manoj Kumar Sharma, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
6. Mr. Kanha Singh Tiwari,Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
7. Mrs. Nahid Usamani, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).

Program name	**Bachelor of Science (B.Sc.)- Biology**	
Semester	7th	
Course Code:	05BO701	
Course title:	Plant Tissue culture and Biotechnology	Developer: Kamlesh Kumar Soni
Pre-requisite:	Student should have basic knowledge biology and biotechnology	
Rationale:	"Plant Tissue Culture and Biotechnology" are critical subjects for students as it provides essential insights into manipulating plant cells and tissues to propagate plants, develop disease-resistant varieties, and enhance agricultural productivity. These skills are vital for addressing global challenges in food security, sustainable agriculture, and environmental conservation through innovative biotechnological approaches	
Course Outcomes (COs):	CO 1 Understand the techniques of biotechnology and tissue culture and its applications. CO 2: Learn various aspects of IPR CO 3: Have insights into the various biotransformation processes and development of useful strains. CO 4: Know recombinant DNA technology and its use in the production of transgenic plants. CO 5: Get deep knowledge about cloning vehicles, phages, restriction endonucleases and blotting techniques	

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits(C) (L:T:P=3:0:1)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
ProgramCommon (PC)	05BO701	Plant Tissue culture and Biotechnology	3	1	1	1	6	3+1=4

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
PC	05BO701	Plant Tissue culture and Biotechnology	15	20	5	5	5	50	50	100

Unit-I:

Course-Curriculum:
This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	10	04	01	03	18

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO 1: Understand the techniques of biotechnology and tissue culture and its applications.	SO 1.1: Know the broad scope of biotechnology	LI 1.1: Callus preparation	CI 1.1 Concept and scope of Biotechnology.	SL 1.1: Study the discovery of PTC
	SO 1.2: Learn the fundamental of Callus preparation and art of single cell organogenesis	LI 1.2: Prepare nutrient media	CI 1.2 Concept of cellular differentiation and totipotency.	SL 1.2 Study the fundamentals of Organogenesis
	SO 1.3: Various techniques applied in PTC		CI 1.3 Techniques of plant tissue culture	SL 1.3 Read how Media was discovered for the PTC
	SO 1.4 Learn how to culture the cell and organ		CI 1.4 Cell culture and organ culture.	
	SO 1.5 Learn how various microorganism are disinfected		CI 1.5 Sterilization techniques used in tissue culture.	
	SO 1.6 Learn what are various types of media used to grow the plants		CI 1.6 Types of culture media used in tissue culture.	
	SO 1.7 What are the various effect on nutrient deficiencies		CI 1.7 Effect of Nutrient deficiencies in plant growth	
	SO 1.8 Learn how minimal media are used and plant developed resistance against stress		CI 1.8 In-vitro auxotroph	
	SO 1.9 Learn How to develop the plant against the biotic stress		CI 1.9 Disease resistance	
	SO 1.10 Learn How to develop the plant against the abiotic stress		CI 1.10 Salt and drought resistance.	

Suggested Sessional Work (SW): *anyone*	SW1.1 Assignments	Highlight major contributors to plant tissue culture
	SW1.2 Mini Project	Descibe the Callus induction and suspension culture method and their translation role
	SW1.3 Other Activities (Specify)	Evaluate the somatic embryogenesis and its future prospects

Unit-II:

Course-Curriculum:
This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	10	04	01	02	17

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO 2: Learn various aspects of IPR	SO 2.1: Learn how seedless plant can be developed invitro	LI 2.1: Micropropagation	CI 2.1Micropropagation: techniques	SL 2.1: Know the fundamental of sterilization
	SO 2.2 How micropropagation is affected by various factors	LI 2.2: protoplast isolation	CI 2.2 Factors affecting the micropropagation	SL 2.2: find the case study on application of micropropagation
	SO 2.3 How haploid plants are produced using the anther culture		CI 2.3 Production of haploids: anther culture	
	SO 2.4 Learn how to pollen is used for haploid production		CI 2.4 Production of haploids: pollen culture	
	SO 2.5 How embryo is developed and used to develop the whole plant		CI 2.5 Somatic embryogenesis	
	SO 2.6 Understand how somatic variation is created		CI 2.6 Soma clonal variation	
	SO 2.7 Why protoplast isolation and culture in important		CI 2.7 Protoplast culture: isolation, culture and	
	SO 2.8 How protoplasts are fused and used in plant biotechnology		CI 2.8 fusion of protoplast and its application	
	SO 2.9 Understand the fusion of two cell and fusion of cytoplasm of one cell with fusion of nuclear genome.		CI 2.9 Somatic hybridization, hybrids and cybrids	
	SO 2.10 Apply the hybrid and cybrid to genetic study		CI 2.10 Application of hybrid and cybrids	

Suggested Sessional Work (SW): *anyone*	SW1.1 Assignments	Explain protoplast isolation and its application
	SW1.2 Mini Project	What are the various Phytohormones and their essentiality in PTC
	SW1.3 Other Activities (Specify)	Discus the various advantages of soma clonal variation

Unit-III:

Course-Curriculum:
This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	04	01	02	16

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO 3: Have insights into the various biotransformation processes and development of useful strains.	SO 3.1: Discuss about methods to isolate the important compounds and their purification	LI 3.1: Endosperm Culture	CI 3.1 Biotransformation: production of useful compounds through cell culture;	SL 3.1: Learn secondary metabolites
	So 3.2 Know how factor affects and able to overcome the issues	LI 3.2: Embryo culture	CI 3.2 Factors affecting yield of compounds produced through cell culture	SL 3.2: Details on bioreactor
	SO 3.3 Learn the bioreactor		CI 3.3 Bioreactors: Principles and design.	
	SO 3.4 How artificial seeds are develop and its importance		CI 3.4 Artificial seeds	
	SO 3.5 detail understanding on metabolites		CI 3.5 Secondary metabolites	
	SO 3.6 Know in details about cryopreservation and its role in plant tissue culture		CI 3.6 Techniques and applications of cryopreservation	
	SO 3.7 Understand why novel products should be protected by a person and how important it is		CI 3.7 General idea about patents.	
	SO 3.8 know the differences among the various patenting		CI 3.8Copyright,	
	SO 3.9 Understand why trademark is essential		CI 3.9 Trademarked geographical indication.	

Suggested Sessional Work (SW): *anyone*	Assignments:	What do you think about the embryo Culture, explain its translation role PTC
	Mini Project:	Discus how production an important molecules can be scaleup using PTC
	Other Activities (Specify):	Criticize the endosperm culture and write your comments on it

Unit IV:	
Course-Curriculum: This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (Cos) upon the course's conclusion.	Approximate Hours Item | Cl | LI | SW | SL | Total Approx. Hrs | 10 | 04 | 01 | 02 | 17

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO 4: Know recombinant DNA technology and its use in the production of transgenic plants.	SO 4.1 How recombinant proteins are prepared and its application	LI 4.1 DNA isolation	CI 4.1 The recombinant DNA concept	SL 4.1 Read why RDT is important
	SO 4.2 Understand the concept behind cloning	LI 4.2 Restriction digestion of DNA	CI 4.2 Principle of cloning	SL 4.2 Gain more insight and its application
	SO 4.3 How DNA is isolated and why it is important		CI 4.3 Isolation and purification of DNA	
	SO 4.4 Know types and application of RE in molecular biology and RDT		CI 4.4 Restriction endonuclease: properties and types.	
	SO 4.5 Learn how a transgenics or recombinant are selected using various methods		CI 4.5 Selection and screening of recombinant clone.	
	SO 4.6 Understand how markers are used in screening		CI 4.6 Selectable and scorable markers used in cloning	
	SO 4.7 Understand the different blotting techniques and their role in biotechnology		CI 4.7 Blotting techniques: Southern Blotting	
	SO 4.8 Learn the RNA identification from the tissues		CI 4.8 Northern Blotting	
	SO 4.9 Learn the protein identification from the tissues		CI 4.9 Western Blotting	
	SO 4.10 Creation of new strain using the various strategies		CI 4.10 Strategies of microbial strain improvement	

Suggested Sessional Work (SW): *anyone*	Assignments:	Discuss restriction digestion is applied to develop recombinant DNA
	Mini Project:	Literature on current status of explain the various blotting techniques and their application
	Other Activities (Specify):	Think and deliver a presentation; development and selection of recombinant

Unit-V:

Course-Curriculum:
This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	10	04	01	02	17

Course outcome (COs)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO 5: Get deep knowledge about cloning vehicles, phages, restriction endonucleases and blotting techniques	SO 5.1: Develop skill to make cloning vector	LI 5.1: Demonstrate the difference in media of organic farming and chemical media	CI 5.1 Cloning vehicles salient features	SL 5.1: Deep knowledge on vectors
	SO 5.2 Know about the cloning vectors and their construction	LI 5.2: Demonstration of crop rotation effect	CI 5.2 Plasmid and cloning vectors	SL 5.2: Enhance your knowledge about the recombinant tools
	SO 5.3 Create the new vector to clone larger DNA fragment		CI 5.3 Cosmid	
	SO 5.4 Understand the importance of Ti Plasmid in Plant Biotechnology		CI 5.4 Ti plasmid	
	SO 5.5 Understand why viral DNA is important		CI 5.5 Single-stranded DNA, viruses	
	SO 5.6 Know how CaMV and Lambda phase are used as vectors in plant transformation		CI 5.6 CaMV, Lambda phage vectors, M13 vectors.	
	SO 5.7 Develop skill to create the vector		CI 5.7 Expression vectors	
	SO 5.8 Develop skill to make libraries		CI 5.8 Cloning construction of genomic Library	
	SO 5.9 Learn the construction of cDNA library and its uses		CI 5.9 cDNA library.	
	SO 5.10 Various application r-DNA		CI 5.10 Application of r-DNA technology in plant improvement	

Suggested Sessional Work (SW): Anyone	Assignments:	Study various types of cloning vectors
	Mini Project:	Assignments on r-DNA technology
	Other Activities (Specify):	Explain the expression vectors

Course duration (in hours) to attain Course Outcomes **(Course title:** Tissue culture and organic farming **) (Course code:** 05BO701**)**					
Course Outcomes (COs)	**Class lecture (CI)**	**Laboratory Instruction (LI)**	**Self-Learning (SL)**	**Sessional work (SW)**	**Total Hours (Li+CI+SL+SW)**
CO 1: Understand the techniques of biotechnology and tissue culture and its applications.	10	4	3	1	18
CO 2: Learn various aspects of IPR	10	4	2	1	17
CO 3: Have insights into the various biotransformation processes and development of useful strains.	9	4	2	1	17
CO 4: Know recombinant DNA technology and its use in the production of transgenic plants.	10	4	2	1	17
CO 5: Get deep knowledge about cloning vehicles, phages, restriction endonucleases and blotting techniques	10	4	2	1	17
Total Hours	49	20	11	05	86

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome: **Course title:** Tissue culture and organic farming**) (Course code:)**					
Course Outcomes	**Marks Distribution**				**Total Marks**
	A	**An**	**E**	**C**	
CO 1: Understand the techniques of biotechnology and tissue culture and its applications.	2	1	1	1	5
CO 2: Learn various aspects of IPR	2	4	2	2	10
CO 3: Have insights into the various biotransformation processes and development of useful strains.	3	5	5	2	15
CO 4: Know recombinant DNA technology and its use in the production of transgenic plants.	2	3	3	2	10
CO 5: Get deep knowledge about cloning vehicles, phages, restriction endonucleases and blotting techniques	5	4	1	0	10
Total Marks	**14**	**17**	**12**	**07**	**50**
Legend: A-Apply, A- Analyze, E- Evaluate, C- Create					

Suggested learning Resources:

S.no.	Title	Author	Publisher	Edition & Year
1	Introduction to Plant Biotechnology.	H. S. Chawla	Oxford & IBH Publishing Co. Pvt. Ltd New Delhi	3 & 2020
2	Plant Tissue Culture: Theory and Practice	Bhojwani, S.S. and Razdan, M.K.	Elsevier Science Amsterdam, The Netherlands,	1 & 2003
3	Plant Biotechnology	B.D. Singh	Kalyani Publication	4 & 2022
4	An Introduction to Plant Tissue Culture	Razdan, M.K.	Latest Ed., Oxford & IBH	3 & 2024
5	Biotechnology	B D SINGH	Kalyani Publication	4 & 2010

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Visit to Cement Plant
7. Demonstration
8. ICT Based teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, WhatsApp, Mobile, Online sources)
9. Brainstorming

CO, PO and PSO Mapping

Program Title: B. Sc. Biology, 7th Sem
Course Code: 05BO701
Course Title: Plant Tissue culture and Biotechnology

CO/PO Mapping															
Course Outcome	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1: Understand the techniques of biotechnology and tissue culture and its applications.	**2**	**2**	**2**	**3**	**2**	**1**	**-**	**2**	**1**	**3**	**3**	**2**	**3**	**3**	**2**
CO 2: Learn various aspects of IPR	**2**	**-**	**2**	**3**	**3**	**1**	**1**	**1**	**-**	**2**	**3**	**2**	**2**	**1**	**3**
CO 3: Have insights into the various biotransformation processes and development of useful strains.	**3**	**-**	**2**	**3**	**2**	**2**	**-**	**2**	**-**	**1**	**1**	**2**	**2**	**2**	**1**
CO 4: Know recombinant DNA technology and its use in the production of transgenic plants.	**3**	**2**	**2**	**3**	**2**	**2**	**-**	**1**	**1**	**2**	**1**	**-**	**2**	**2**	**2**
CO 5: Get deep knowledge about cloning vehicles, phages, restriction endonucleases and blotting techniques	**3**	**-**	**2**	**-**	**1**	**2**	**3**	**2**	**1**	**2**	**1**	**2**	**2**	**3**	**2**
Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3															

Program Title: B. Sc. Biology, 7th Sem

Course Code: 05BO701
Course Title: Plant Tissue culture and Biotechnology

Course Curriculum Map:					
POs & PSOs No.	COs No	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO 1:** Understand the history of Plant tissue culture & various beneficial applications	1.1, 1.2, 1.3, 1.4, 1.5, 1.5, 1.7, 1.8, 1.9, 1.10	LI 1 LI 2	1.1, 1.2, 1.3, 1.4, 1.5, 1.5, 1.7, 1.8, 1.9, 1.10	1 SL-1,2,3
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO 2:** Advance the experimental acts and application of different tissue culture techniques	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.10	LI 1 LI 2	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.10	2 SL-1,2
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO 3:** Transfer the knowledge to the benefit of society by applying the tissue culture techniques	33.1, 3.2, 3.3, 3.4 3.5,3.6, 3.7, 3.8, 3.9	LI 1 LI 2	3.1, 3.2, 3.3, 3.4 3.5,3.6, 3.7, 3.8, 3.9	3 SL-1,2
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO 4:** Comprehensive information on govt. initiative and importance of organic forming	4.1,4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10	LI 1 LI 2	4.1,4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10	4 SL-1,2
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO 5:** Understand and apply the concepts of organic forming to save the environments and society	5.1, 5.2, 5.3,5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10	LI 1 LI 2	5.1, 5.2, 5.3,5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10	5 SL-1,2

Program Name	**Bachelors of Science (B.Sc.)-biology**	
Semester	7th	
CourseCode:	05ZO702	
Coursetitle:	Immunology	**Curriculum Developer**: Mr. Amit Bagri
Pre-requisite:	To study this course, student must have had Zoology in B.Sc. 3rd year/ Degree.	
Rationale:	Vaccines are amongst the most successful measures of modern medicine — they save several million lives annually and have remarkable cost efficiency. Bacterial pathogens that are controlled successfully by vaccines include Clostridium tetani, Corynebacterium diphtheriae and Haemophilus influenzae b. Conjugate vaccines against meningococci and pneumococci are also available but need further improvements.	
Course Outcomes (COs):	05ZO702 **.1:** Introduction, Definition, Scope and significance of immunology. 05ZO702 .**2:** Innate and adaptive immunity. 05ZO702 **.3:** Structure and function of different classes of immunoglobulins. 05ZO702 **.4:** MHC, Complement System, hypersensitivity & various types of vaccines. 05ZO702 .5: Clinical research assistant in hospital, laboratory technician.	

Scheme of Studies:

Board of Study	**Course Code**	**CourseTitle**	**Scheme of studies (Hours/Week)**					**Total Credits(C) (L:T:P=3:0:1)**
			Cl	LI	SW	SL	**Total Study Hours(CI+LI+SW+SL)**	
MAJOR DSC	05ZO702	Immunology	3	1	1	1	6	3+1=4

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)		
MAJOR DSC	05ZO702	Immunology	**15**	**20**	**10**	**5**	**50**	**50**	**100**

Scheme of Assessment: Practical

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)		
MAJOR DSC	05ZO702	Immunology	35	5	5	5	50	50	50

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

ApproximateHours

Item	Cl	LI	SW	SL	Total
Approx.Hrs	09	04	01	06	20

Course outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction(CI)	Self-Learning(SL)
05ZO702 **.1:** Introduction, Definition, Scope and significance of immunology.	**SO1.1** Define and describe historical background of immunology.	**LI1.1** E demonstration of morphology of lymphoid organs.	**Unit 1** **CI1.1** Define historical background of immunology.	**SL1.1** Define and describe historical background of immunology.
	SO1.2 Describe Introduction, Definition, Scope of immunology.		**CI1.2** Describe of immunology.	**SL1.2** Describe Introduction, Definition, Scope of immunology.
	SO1.3 Explain about lymph and lymphatic system.	**LI1.2** Histological study of spleen.	**CI1.3** Explain about lymph?	**SL1.3** Learn about lymph and lymphatic system.
	SO1.4 Describe Nonspecific resistance to disease.		**CI1.4** Describe Nonspecific resistance to disease.	**SL1.4** Describe Nonspecific resistance to disease.
	CI1.5 Describe historical background of immunology.		**CL1.5** Describe historical background of immunology.	**SL1.5** Study about production of microbial chemicals?
	SO1.6 Describe Definition, immunology.		**CI1.6** Describe Definition, immunology.	SL1.6 LEARN about lymphatic system.
	SO1.7 Describe Scope of immunology.		**CI1.7** Describe Scope of immunology.	
	SO1.8 Explain about lymphatic system.		**CI1.8** Explain about lymphatic system.	
	SO1.9 Study about skin and mucous membrane?		**CI1.9** Study about skin and mucous membrane?	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Describe Introduction, Definition, Scope of immunology.
	SW1.2 Mini Project	Explain about lymph and lymphatic system.
	SW1.3 Other Activities (Specify)	Describe Nonspecific resistance to disease

Item	Cl	LI	SW	SL	Total
Approx.Hrs	09	06	01	06	22

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
05ZO702 .**2:** Innate and adaptive immunity	**SO2.1** Assess the concept of Innate immunity	**LI2.1** Preparation of stained blood film to blood cells.	**Unit-II** **CI2.1** Assess the concept of Innate immunity	**SL2.1** Assess the concept of Innate immunity
	SO2.2 Explain Adaptive immunity.		**CI2.2** Explain Adaptive immunity.	**SL2.2** Explain Adaptive immunity.
	SO2.3 Explain Passive Immunity.	**LI2.2** Identification of various immune cell by morphology	**CI2.3** Explain Passive Immunity.	**SL2.3** Learn Passive Immunity.
	SO2.4 Explain Active immunity.	**LI2.3** Explain cell involved in innate immunity?	**CI2.4** Explain Active immunity.	**SL2.4** Learn Active immunity.
	SO2.5 Describe the role of immune dysfunction.		**CI2.5** Describe the role of immune dysfunction.	**SL2.5** Describe the role of immune dysfunction.
	SO2.6 Explain cell involved in innate immunity?		**CI2.6** Explain cell involved in innate immunity?	**SL2.6** Explain cell involved in innate immunity?
	SO2.7 Explain molecules involved in innate immunity		**CI2.7** Explain molecules involved in innate immunity	
	SO2.8 Explain cells mediated immunity?		**CI2.8** Explain cells mediated immunity?	
	SO2.9 Explain Humoral immunity?		**CI2.9** Explain Humoral immunity?	

Suggested Sessional Work (SW) : *anyone*		
	SW2.1 Assignments	Explain Adaptive immunity.
	SW2.2 Mini Project	Explain Active immunity.
	SW2.3 Other Activities (Specify)	Describe the role of immune dysfunction.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	09	06	01	05	21

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self-Learning (SL)
05ZO702 **.3:** Structure and function of different classes of immunoglobulins.	**SO3.1** Explain the Antigenicity and immunogenicity.	**LI3.1** ABO blood group typing and RH factor.	**Unit-III** **CI3.1** Explain the Antigenicity	**SL3.1** Read about Antigenicity and immunogenicity.
	SO3.2 Assessing the Complete Antigen.	**LI3.2** Total count of leucocytes.	**CI3.2** Assessing the Complete Antigen.	**SL3.2** Illustrate structure of Complete Antigen.
	SO3.3 Explain Chemical nature of Antigens.	**LI3.3** Demonstration of elesa	**CI3.3** Explain Chemical nature of Antigens.	**SL3.3** Study the Chemical nature of Antigens.
	SO3.4 Role of dendritic cell **s.**		**CI3.4** Role of dendritic cell**s.**	**SL3.4** Explain the immunogenicity.
	SO3.5 Describe about Diversity of antigenic receptors.		**CI3.5** Describe about Diversity of antigenic receptors.	**SL3.5** Describe about Diversity of antigenic receptors.
	SO3.6 Explain the immunogenicity.		**CI3.6** Explain the immunogenicity.	
	SO3.7 Explain the B cells?		**CI3.7** Explain the B cells?	
	SO3.8 Explain the t cells?		**CI3.8** Explain the t cells?	
	SO3.9 Study the antigens?		**CI3.9** Study the antigens?	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Explain the Antigenicity and immunogenicity. .
	SW3.2 Mini Project	Explain Chemical nature of Antigens.
	SW3.3 Other Activities (Specify)	Role of dendritic cell**s.**

Item	Cl	LI	SW	SL	Total
Approx.Hrs	09	02	01	05	17

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction. (CI)	Self-Learning (SL)
05ZO702 **.4** MHC, Complement System, hypersensitivity & various types of vaccines.	**SO4.1** Structure and function of different classes of immunoglobulins.	**LI4.1** Identification of various immune cell by morphology	**Unit-IV** **CI4.1** Structure different classes of immunoglobulins.	**SL4.1** Learn about different classes of immunoglobulins.
	SO4.2 Antigen, antibody interactions.		**CI4.2** STUDY OF Antigen.	**SL4.2** Discuss types and structure of Antigen, antibody interactions
	SO4.3 Explaining Immunoassays.		**CI4.3** Explaining Immunoassays.	**SL4.3** Learn about Immunoassays.
	SO4.4 Explaining the hybridoma technology, monoclonal antibodies in therapeutics and diagnosis.		**CI4.4** Explaining the hybridoma technology.	
	SO4.5 Evaluate role of cytokines. Therapeutics Cytokines.		**CI4.5** Evaluate role of cytokines. Therapeutics Cytokines	**SL4.4** Learn about role of cytokines. Therapeutics Cytokines
	SO4.6 Explain function of different classes of immunoglobulins.		**CI4.6** function of different classes of immunoglobulins.	**SL4.5** Explaining the monoclonal antibodies.
	SO4.7 explain Study of interactions.		**CI4.7** Study of interactions.	
	SO4.8 explain Study of antibody		**CI4.8** STUDY OF antibody.	
	SO4.9 Explaining the monoclonal antibodies.		**CI4.9** Explaining the monoclonal antibodies.	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Explaining Immunoassays.
	SW4.2 Mini Project	Evaluate role of cytokines. Therapeutics Cytokines.
	SW4.3 Other Activities (Specify)	Structure and function of different classes of immunoglobulins.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	09	04	01	05	19

Course Outcome (CO)	SessionOutcomes(SOs)	LaboratoryInstruction(LI)	ClassroomInstruction(CI)	Self-Learning(SL)
05ZO702 .5: Clinical research assistant in hospital, laboratory technician.	**SO5.1** Define the concept of MHC molecule.	**LI5.1** Explain the vaccines	**Unit-V** **CI5.1** Define the concept of MHC molecule.	**SL5.1** learn about basic concept MHC molecule
	SO5.2 Able to execute role of Endogenous and exogeneous pathways of antigens processing and preservation.	**LI5.2** Explain the types of vaccines.	**CI5.2** Able to execute role of Endogenous and exogeneous pathways of antigens processing and preservation.	**SL5.2**Review concept of execute role of Endogenous and exogeneous pathways of antigens processing and preservation.
	SO5.3 Apply the role of complement system, components and pathways of compliments activation.		**CI5.3** Apply the role of complement system.	**SL5.3** learn how to complement system, components and pathways of compliments activation.
	SO5.4 Evaluate the hypersensitivity.		**CI5.4** Evaluate the hypersensitivity.	**SL5.4** learn about hypersensitivity.
	SO5.5 Explain the vaccines and types of vaccines.		**CI5.5** Explain the vaccines and types of vaccines	**SL5.5** Explain the vaccines and types of vaccines
	SO5.6 explain the role of components		**CI5.6** Apply the role of components	
	SO5.7 described the role of pathways of compliments activation.		**CI5.7** Apply the role of pathways of compliments activation.	
	SO5.8 explain the MHC?		**CI5.8** Study the MHC?	
	SO5.9 explain types of complement system?		**CI5.9** Study of types of complement system?	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Explain general mechanism of cell signalling pathways.
	SW5.2 Mini Project	Describe the various components and types of membrane transport.
	SW5.3 Other Activities (Specify)	Prepare one model for showing mechanism of cell signalling

Course duration (in hours) to attain Course Outcomes:

Course Title: Immunology **Course Code:** 05ZO702

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction(LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1- 05ZO702 **.1:** Introduction, Definition, Scope and significance of immunology.	09	04	6	1	20
CO2- 05ZO702 .**2:** Innate and adaptive immunity	09	06	6	1	22
CO3- 05ZO702**.3:** Structure and function of different classes of immunoglobulins.	09	06	5	1	21
CO4- 05ZO702**.4** MHC, Complement System, hypersensitivity & various types of vaccines.	09	02	5	1	17
CO5- 05ZO702.5: Clinical research assistant in hospital, laboratory technician.	09	04	5	1	19
Total Hours	45	22	27	05	99

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Immunology **Course Code:** 05ZO702

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
CO1- 05ZO702 **.1:** Introduction, Definition, Scope and significance of immunology.	2	1	1	1	5
CO2-05ZO702 .**2:** Innate and adaptive immunity	2	4	2	2	10
CO3- 05ZO702 **.3:** Structure and function of different classes of immunoglobulins.	3	5	5	2	15
CO4- 05ZO702 **.4** MHC, Complement System, hypersensitivity & various types of vaccines.	2	3	3	2	10
CO5-05ZO702 .5: Clinical research assistant in hospital, laboratory technician.	5	4	1	0	10
Total Marks	**14**	**17**	**12**	**07**	**50**

***Legend*:A,** Apply;**An,** Analyze;**E,** Evaluate;**C,** Create

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1	Narasimha murthy C V Immunology notes.
2	Rastogi S C Elements of immunology CBS Publication.
3	Gupta SK Essentials of Immunology Arya publication
4	Reddy Rajeshwar k , Text Book Immunology AITBS Publishers 3rd edition INDIA

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Demonstration
7. ICT Based teaching Learning

CO, PO and PSO Mapping

Program Name: B.Sc. biology
Semester: 7th semester
Course Title: Immunology
Course Code: 05ZO702

CO/PO/PSO Mapping								
Course Outcome (Cos)	**Program Outcomes (POs)**					**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**
CO1- 05ZO702 **.1:** Introduction, Definition, Scope and significance of immunology.	2	3	1	3	1	2	2	1
CO2- 05ZO702 **.2:** Innate and adaptive immunity	3	1	3	2	2	1	2	2
CO3- 05ZO702 **.3:** Structure and function of different classes of immunoglobulins.	2	2	1	3	2	3	2	1
CO4- 05ZO702 **.4** MHC, Complement System, hypersensitivity & various types of vaccines.	2	1	1	1	2	2	2	3
CO5-05ZO702 .5: Clinical research assistant in hospital, laboratory technician.	3	3	3	2	2	1	3	1

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5 PSO 1,2,3	05ZO702**.1:** Introduction, Definition, Scope and significance of immunology.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9	1.1,1.2	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9	1SL-1,2,3,4,5,6
PO 1,2,3,4,5 PSO 1,2,3	05ZO702 .**2:** Innate and adaptive immunity	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9	2.1, 2.2, 2.3	2.1,2.2,2.3,2.4,2.5, 2.6,2.7,2.8,2.9	2SL-1,2,3,4,5,6
PO 1,2,3,4,5 PSO 1,2,3	05ZO702 **.3:** Structure and function of different classes of immunoglobulins.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9	3.1,3.2,3.3,3	3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9	3SL-1,2,3,4,5
PO 1,2,3,4,5 PSO 1,2,3	05ZO702 **.4** MHC, Complement System, hypersensitivity & various types of vaccines.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8 SO4.9	4.1,	4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9	4SL-1,2,3,4,5
PO 1,2,3,4,5 PSO 1,2,3	05ZO702 5: Clinical research assistant in hospital, laboratory technician.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9	5.1,5.2	5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,5.9	5SL-1,2,3,4,5

AKS University

Faculty of Basic Science

Curriculum of B. Sc. (Honours / By Research) Program

(Revised as on 01 August 2023)

Code: 05CH703
Course Name: Industrial Chemistry

Pre-requisite: Students should have basic knowledge of chemical industry, theoretical aspect of glass, ceramics, fertilizer and cement manufacturing soap, match,metal powders'.

Rationale: The students studying organic chemistry should possess foundational understanding about chemical bonding, structure, reactions and stereochemistry of organic compounds. This will provide applicalbe knoweledge about Nature of bonding in organic compounds, stereochemistry of organic compounds, reaction mechanisms, structure and reactivity, aliphatic and aromatic nucleophilic substitution

CourseOutcomes:

Afterthe completionofthiscourse, thelearner willbeableto:

05CH703.1: Apply quality of raw materials and energy for specific chemical industry

05CH703.2: Expert in theoretical aspect of glass, ceramics, fertilizer and cementmanufacturing.

05CH703.3: Explain preparation of materials in small scaleindustries like soap, match,metal powders etc

05CH703.4:Perform work according to need of sugar industry

05CH703.5: Capable to provide solution of environmental issues related tochemical industry

Unit I

Raw Materials and Energy for Chemical Industry: Raw materials – Characteristics of raw materials and their resources – methods of raw material concentrations – integral utilization of raw materials. Energy for chemical industry – Fuels – classification of fuels – coal – fuel gases and liquid fuels – petroleum – cracking – Octane number – cetane number – composition and uses of coal gas, water gas, producer gas,oil gas and gobar gas.

Unit II

Cement, Ceramics, Glass and Fertilizers Cement: Manufacture – Wet Process and Dry process. Types, Analysis of major constituents, setting of cement, reinforced concrete. Cement industries in India. Ceramics: Important clays and feldspar, glazing and verification.

Glass: Types, Composition, manufacture of Optical glass, colored glasses, lead glass and neutron absorbing glass. Fertilizers: Fertilizer industries in India, Manufacture of ammonia, ammonium salts, urea, superphosphate, triple superphosphate and nitrate salts.

Unit III

Small Scale Chemical Industries Electrothermal and electrochemical industries: electroplating surface coating industries – oils, fats and waxes – soaps and detergents – cosmetics. Match industries and fire works: manufacture of some industrially important chemicals like potassium chlorate, and red

phosphorus – metal powders.

Unit IV

Sugar and Agro Chemical Sugar: Cane sugar manufacture, recovery of sugar from molasses, sugar estimation, sugar industries in India. Agrochemical industries: Important categories of insecticides, fungicides, herbicides. Mode of action and synthesis of common pesticides like Gammexane, DDT, alathrin, Parathion, Malathion, Baygon, DDVP, Warfarin.

Unit V

Industrial Pollution & Chemical Toxicology Introduction – causes of industrial pollution – thermal power plants – nuclear power reactors– fertilizers and chemical industry – pulp and paper industries – agro based industries – cement industry. Toxic Chemicals in the environment – biochemical effects of arsenic, cadmium, lead, mercury and cyanide.

AKS University

Faculty of Basic Science

Curriculum of B. Sc. (Honours / By Research) Program

(Revised as on 01 August 2023)

SchemeofStudies:

Board ofStudy	CourseCode	CourseTitle	Scheme ofstudies(Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
ProgramCore(PCC)	05CH703	INDUSTRIAL Chemistry	4	0	1	1	5	4

Legend: **CI:** Class room Instruction (Includes different in structional strategies i.e. Lecture
(L) and Tutorial
(T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop,field or other location susing different in structional strategies)
SW: Sessional Work (includes assignment,seminar, miniproject etc.),
SL: Self Learning,

C: Credits.

Note:

SW&SLhastobeplannedandperformedundertheconti nuousguidanceandfeedbackofteacherto ensure outcome ofLearning.

AKS University

Faculty of Basic Science

Curriculum of B. Sc. (Honours / By Research) Program

(Revised as on 01 August 2023)

Scheme of Assessment: Theory

Board ofStudy	CouseCode	CourseTitle	SchemeofAssessment(Marks)						
			ProgressiveAssessment(PRA)					EndSemesterAssessment (ESA)	Total Marks (PRA+ESA)
			Class/HomeAssignment5number 3 mark seach (CA)	Class Test2 (2bestout of3) 10 marks each(CT)	Seminarone (SA)	ClassAttendance (AT)	TotalMarks (CA+CT+SA +AT)		
PCC	05CH703	IndustralL Chemistry	15	20	10	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

05CH703.1: Apply quality of raw materials and energy for specific chemical industry

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self Learning (SL)
SO1.1 Expain Raw materials Characteristics of raw materials and their resources.		Unit-1. Raw Materials and Energy for Chemical Industry	Characteristics of raw
SO1.2 Apply methods of raw material concentrations ,integral utilization of raw materials SO1.3 Explain Fuels , classification of fuels coal fuel gases and liquid fuels SO1.4 Describe petroleum , cracking, Octane number , cetane number SO1.5 explain following topic-water gas, producer gas, oil gas and gobar gas.		methods of raw material concentrations integral utilization of rawmaterials Energy for chemical industry Fuels , classification of fuels coal solid fuel gases and liquid fuels petroleum – cracking Octane number – cetane number composition and uses of coal gas, water gas, producer gas, oil gas and gobar gas. T1- Fuels and characterization T2- raw material method T3 classification of coal analysis	materials and their resources compositio n and uses fuels

SW-1SuggestedSessionalWork(SW):

a.Assignments: discuss Raw materials – Characteristics of raw materials and their resources – methodsof raw material concentrations – integral utilization of raw materials

b.Mini Project: Fuels – classification of fuels

c.Other Activities (Specify):

- Note on applications of coal gas, water gas, producer gas, oil gas and gobar gas.

05CH703.2: Explain in theoretical aspect of glass, ceramics, fertilizer and cementmanufacturing.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 Describe & apply Cement: Manufacture – Wet Process and Dry process **SO2.2** Explain Analysis of major constituents, setting of cement, reinforced concrete. Cement industries in India **SO2.3** Explain Glass: Types, Composition, manufacture of Optical glass, colored glasses, lead glass and neutron absorbingglass. **SO2.4** Understand and apply Glass: Types, Composition,		Unit-2 Cement, Ceramics, Glass and Fertilizers Cement: Manufacture Wet Process and Dry process. Types ofcement . Analysis of major constituents, setting of cement, reinforced concrete.Cement industries in India. Ceramics Important clays and feldspar,glazing and verification. Glass Types, Composition, manufacture of Optical glass, colored glasses, lead glass and neutron absorbing glass. Fertilizers Fertilizer industries in India, Manufacture of ammonia, ammonium salts,	Types of cement . Glass: Types, Composition, manufacture of Optical glass, colored glasses, lead glass and neutron absorbing glass Fertilizers use
manufacture of Optical glass, colored glasses, lead glass and neutron absorbing glass. **SO2.5** Explain Fertilizers: Fertilizer industries in India, Manufactureof ammonia, ammonium salts, urea, superphosphate, triple superphosphate and nitrate salts.		urea, superphosphate, triple superphosphate and nitrate salts. T1- manufacture of Fertilizers T2- Manufacture of ammonia, ammonium salts, T3- setting and hardning of cement	

SW-2 Suggested Sessional Work (SW):

a.Assignments:

Apply Glass Types, Composition, manufacture of Optical glass, colored glasses, lead glass and neutron absorbing glass.

b.Mini Project: Fertilizers: Fertilizer industries in India,

c.Other Activities (Specify): Write uses of Fertilizers.

05CH703.3: Explain preparation of materials in small scale industries like soap, match,metal powders etc

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Understand and applySmall Scale Chemical Industries **SO3.2** ExplainElectrothermal and electrochemical industries **SO3.3** Explain electroplating – surface coating industries **SO3.4** Apply effect oils, fats and waxes – soaps and detergents – cosmetics **SO3.5** Explain and apply Match industries and fire works: manufacture of some industrially important chemicals like potassium chlorate, and red phosphorus – metal powders.		**Unit-3.** Small Scale Chemical Industries Electrothermal and electrochemical industries electroplating surface coating industries oils, fats and waxes soaps and detergents cosmetics. Match industries and fire works manufacture of some industrially important chemicals potassium chlorate, and red phosphorus – metal powders. T1- manufacture of some industrially chemical T2- manufacture of soap and detergents. T3- important chemicals potassium chlorate, and red phosphorus – metal powders.	oils, fats and waxes chemicals like potassium chlorate, and red phosphorus – metal powders.

SW-3 Suggested Sessional Work (SW):

a.Assignments: soaps and detergents – cosmetics.

b.Mini Project: Match industries and fire works

c.Other Activities (Specify): manufacture of some industrially important chemicals potassium chlorate, and red phosphorus – metal powders.

05CH703.4: Explain Perform work according to need of sugar industry.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Explain and apply Sugar and Agro ChemicalSugar: **SO4.2** ExplainCane sugar manufacture, recovery ofsugar from molasses, **SO4.3** Explain Agrochemical industries **SO4.4**Explain and apply Important categories of insecticides, fungicides, herbicides **SO4.5** Explain and apply synthesis of common pesticides like Gammexane, DDT, alathrin, Parathion, Malathion, Baygon, DDVP,Warfarin.		**Unit-4** Sugar and Agro Chemical Sugar Cane sugar manufacture, recovery of sugar from molasses, sugar estimation, sugar industries in India. Agrochemical industries Important categories of insecticides, fungicides, herbicides. Mode of action and synthesis of common pesticides Gammexane, DDT, alathrin, Parathion, Malathion, Baygon, DDVP, Warfarin. T1- manufacture of suger . T2- synthesis of common pesticides T3- synthesis of fungicides	sugar estimation, sugar industries in India. Agrochemical industries

SW-4 Suggested Sessional Work (SW):

a.Assignments: Cane sugar manufacture, recovery of sugar from molasses,

b.Mini Project: synthesis of common pesticides like Gammexane, DDT, alathrin, Parathion, Malathion,Baygon, DDVP, Warfarin.

c.Other Activities (Specify):

Impotance and applications of insecticides, fungicides, herbicides.

05CH703.5: Apply the knowledge of the Capable to provide solution of environmental issues related tochemical industry

Activity	AppX Hrs
Cl	07
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (Cl)	Self Learning (SL)

SO5.1 Explain and apply Industrial Pollution & Chemical Toxicology Introduction **SO5.2** Explain causes of industrial pollution thermal power plants power reactors– fertilizers andchemical industry **SO5.3** Explain and apply effect of pulp and paper industries – agro based industries – cement industry **SO5.4** Explain Toxic Chemicals in the environment – **SO5.5** Explain and apply biochemical effects of arsenic, cadmium, lead, mercury and cyanide.	.	**Unit-5-** 5.1 Industrial Pollution 5.2 Chemical Toxicology 5.3causes of industrial pollution thermal power plants power reactors– fertilizers andchemical industry pulp and paper industries agro based industries – cement industry. Toxic Chemicals in the environment biochemical effects of arsenic, cadmium, lead, mercury and cyanide. T1- Toxic Chemicals in the environment T2- biochemical effects of many chemicals. T3- causes of industrial pollution	Toxic Chemicals in the environment – biochemical effects of arsenic, cadmium, lead, mercury and cyanide.

SW-5 Suggested Sessional Work (SW):

a.Assignments: power reactors– fertilizers andchemical industry, causes of industrial pollution –

thermal power plants

b.Mini Project: Toxic Chemicals in the environment

c.Other Activities (Specify): biochemical effects of arsenic, cadmium, lead, mercury and cyanide

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
2CH702.1: Apply quality of raw materials and energy for specific chemical industry	12	02	01	15

05CH703.2: Expert in theoretical aspect of glass, ceramics, fertilizer and cement manufacturing.	12	02	01	15
05CH703.3: Explain preparation of materials in small scale industries like soap, match, metal powders etc	12	02	01	15
05CH703.4:Perform work according to need of sugar industry	12	02	01	15
05CH703.5:. Capable to provide solution of environmental issues related to chemical industry	12	02	01	15
Total Hours	60	10	05	75

Suggestion for End Semester Assessment

SuggestedSpecificationTable(ForESA)

CO	**UnitTitles**	**MarksDistribution**			**Total Marks**
		R	**U**	**A**	
CO-1	Unit1	03	01	01	05
CO-2	Unit 2	02	06	02	10
CO-3	Unit 3	03	07	05	15
CO-4	Unit4	-	10	05	15
CO5	Unit 5	3	2	0	05
Total		11	26	13	50

Legend: R:Remember, U:Understand, A:Apply

The end of semester rassessment for industrial chemistry will be held with written examination of 50 marks

Note.Detailed Assessment rubric need to be prepared by the cours ewiseteachersforabovetasks.Teacherscanalsodesigndifferenttasksasperrequ irement,for endsemester assessment.

Suggested Instructional/Implementation Strategies:

37. ImprovedLecture
38. Tutorial
39. CaseMethod
40. GroupDiscussion
41. RolePlay
42. Visitto NCL, CSIR laboratories
43. Demonstration
44. ICTBasedTeachingLearning(VideoDemonstration/T utorialsCBT,Blog,Facebook,Twitter,Whatsapp,Mob ile,Onlinesources)
45. Brainstorming

Suggested Learning Resources:

(j) Books:

(k) (m)

S. No.	Title	Author	Publisher	Edition& Year
1	Chemical Technology,Vol.1	I.Mukhlyonov(ed.), ,	Mir publication, Moscow	III edn., 1979
2	Environmental Chemistry,	A.K.De.,	Wiley Eastern Ltd.,11	edn., Meerut 1989.Chs 5-7
3	Industrial chemistry	B.K Sharma	Goel publishing house	
4	, Industrial Chemistry	B.N.Chakrabarty,	, Oxford&IBH Publishing Co.,New Delhi, 1981.	.,New Delhi, 1981.
5	Industrial Chemistry,	P.P.Singh, T.M.Joseph, R.G.Dhavale,	, Himalaya Publishing House, Bombay,	, 4th edn., 1983

6	, Environmental Pollution and Health Hazards – Causes and Control	A.K. Mukherjee,	Galgotia Press, New Delhi 1986.	Press, New Delhi 1986.

Suggested Web Sources

1. https://nptel.ac.in/course.html
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
3. https://swayam.gov.in/explorer?category=Chemistry

Mode Of Transaction:Lecture,demonstration,E-tutoring,discussion,assignments,quizzes, case study,power point;
LMS/ICT Tools: Digital Classrooms, DLMS, ZOOM, G-Suite,MSPower-Point, Online ResourcesDelhi 1986…….

AKS University
Faculty of Basic Science
Curriculum of B. Sc. (Honours / By Research) Program
(Revised as on 01 August 2023)

Cours title ; Industrial Chemistry

Course code: 05CH703

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Knowledge	Research Aptitude	Communication	Problem Solving	Individual and Team Work	Investigation of Problems	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and sustainability	The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry	To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.	understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon-based problems in chemical sciences.	Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science
CO1 : Apply quality of raw materials and energy for specific chemical industry	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO 2 : : Expert in theoreticalaspect of glass, ceramics, fertilizer and cementmanufacturing	2	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3 : Explain preparation ofmaterials in small scale industries like soap, match, metal powders etc	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO 4: Perform work according to need of sugar industry	2	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
CO 5:. Capable to provide solution of envirmental issues related to chemical industry	2	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

Course Curriculum Mapping

POs &PSOsNo.	COsNo.&Titles	SOsNo.	LaboratoryInstruction(LI)	Classroom Instruction(CI)	Self Learning(SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1:Apply quality of raw materials and energy for specific chemical industry	SO1.1SO1. 2S O1.3SO1.4 SO1.5		Unit-1.Raw Materials and Energy forChemical Industry 1.1,1.2,1.3,1.4,1.5,1.6,1.7	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 2 : Expert in theoretical aspect of glass, ceramics, fertilizer and cement manufacturing.	SO2.1SO2. 2SO2.3 SO2.4 SO2.5		Unit-2. Cement, Ceramics, Glass andFertilizers Cement: Manufacture 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9	.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3 : : Explain preparation of materials in small scale industries like soap, match, metal powders etc	SO3.1SO3. 2SO3.3 SO3.4 SO3.5		Unit-3 : Small Scale Chemical IndustriesElectrothermal and electrochemical industries 3.1, 3.2,3.3,3.4,3.5,3.6,3.7	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4: Perform work according toneed of sugar industry	SO4.1SO4. 2S O4.3SO4.4 SO4.5		Unit-4 : Sugar and Agro Chemical Sugar4.1, 4.2,4.3,4.4,4.5,4.6,4.7	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 5: :. Capable to provide solution of envirmental issues related to chemical industry	SO5.1SO5. 2SO5.3SO5 .4 SO5.5		Unit 5: Industrial Pollution &Chemical Toxicology 5.1,5.2,5.3,5.4,5.5,5.6,5.7	Toxic Chemicals in the environment .

Curriculum Development Team:

1. Dr. Shailendra Yadav, HoD, Department of Chemistry, AKS University, Satna (M.P.).
2. Dr. Dinesh Kumar Mishra, Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
3. Dr. Samit Kumar,Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
4. Dr. Sushma Singh, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
5. Dr. Manoj Kumar Sharma, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
6. Mr. Kanha Singh Tiwari,Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
7. Mrs. Nahid Usamani, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).

Program name	B.Sc. Biology	
Semester	7th	
Course Code:	02RM701A	
Course title:	Research Techniques in Plant Science	**Curriculum Developer**: Yashasvi Shrivastava
Pre-requisite:	Students must be familiar with basic term and need of research.	
Rationale:	Studying research techniques in plant science equips students with essential skills to investigate plant biology, genetics, and ecology. It enables the application of advanced methodologies to solve agricultural, environmental, and biotechnological challenges, fostering innovation and contributing to sustainable practices and scientific advancements in plant research.	
Course Outcomes (COs):	**CO1:** Develop proficiency in various microscopy and imaging techniques, enhancing the ability to visualize, measure, and analyze plant structures at microscopic and ultrastructural levels. **CO2:** Develop comprehensive skills in herbarium techniques, from specimen collection and preparation to digital documentation and storage, supporting plant taxonomy and research. **CO3:** Develop proficiency in cell fractionation and analytical techniques, including cell disruption, centrifugation, spectrophotometry, and chromatography, for advanced plant science research. **CO4:** Acquire fundamental skills in biostatistics for data analysis and understand computational tools and research areas in bioinformatics for sequence alignment and biological data interpretation. **CO5:** Develop skills in conducting and writing detailed case studies and botanical surveys, and understand their significance and limitations in plant science research.	

Scheme of Studies:

Board of Study	CourseCode	Course Title	Scheme of studies (Hours/Week)					Total Credits(C) (L:T:P=3:0:1)
			CI	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Core Course	02RM701A	Research Techniques in Plant Science	3	1	1	1	6	3+1=4

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
PC	02RM701A	Research Techniques in Plant Science							**70**	**100**

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	10	2	1	3	16

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO1: Develop proficiency in various microscopy and imaging techniques, enhancing the ability to visualize, measure, and analyze plant structures at microscopic and ultrastructural levels.			**Unit-1** Imaging Techniques in Plant Science: Principles and Applications	
	SO1.1. Understanding the basic principles of light microscopy and its application in observing plant cell structures.	**LI1.1** Use a light microscope to observe and document plant cell structures. Create a detailed lab report with labeled diagrams.	**CI1.1** Principles and Applications of Light Microscopy**: (2 Lectures)**	**SL1.1** Understand the strengths and applications of different microscopy techniques.
	SO1.2 Using dark-field microscopy to enhance contrast in unstained samples, allowing the visualization of live and transparent specimens.		**CI1.2** Principles and Applications of Dark-Field Microscopy**:**	**SL1.2** Learn to interpret electron microscopy images and understand plant cell ultrastructure.
	SO1.3 Employing phase-contrast microscopy to visualize transparent specimens by enhancing contrast based on refractive index differences.		**CI1.3** Principles and Applications of Phase-Contrast Microscopy**:**	**SL1.3** Learn the principles and applications of basic staining techniques to enhance microscopic observations.

	SO1.4 Utilizing digital microscopy for capturing and analyzing high-resolution images of plant samples.		**CI1.4** Principles and Applications of Digital Microscopy**:**	
	SO1.5 Exploring the ultrastructure of plant cells with TEM, which provides high-resolution images by transmitting electrons through thin specimens.		**CI1.5** Principles and Applications of Transmission Electron Microscopy (TEM)**:**	
	SO1.6 Visualizing the surface morphology of plant tissues with SEM, which produces detailed three-dimensional images by scanning the surface with electrons.		**CI1.6** Principles and Applications of Scanning Electron Microscopy (SEM)**:**	
	SO1.7 Measuring microscopic structures accurately using micrometric techniques with stage and ocular micrometers.		**CI1.7** Principles and Applications of Micrometry (Stage and Ocular)**:**	
	SO1.8 Applying micrometry in plant science to measure cell dimensions, growth patterns, and other microscopic features.		**CI1.8** Applications of Micrometry**:**	
	SO1.9 Using Camera Lucida for accurate drawing of microscopic specimens by superimposing the image onto the drawing surface.		**CI1.9** Principles and Applications of Camera Lucida**:**	

	SO1.10 Enhancing visibility of plant cell components with basic staining techniques such as iodine, safranin, and fast green.		**CI1.10** Basic Staining Techniques Used in Plant Science (2 lectures)	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Study prepared TEM and SEM images of plant cells. Identify key structures and create a presentation explaining the ultrastructure of the observed cells.
	SW1.2 Mini Project	Measure various plant cell dimensions using stage and ocular micrometers. Record and analyze the data to understand cell size variation.
	SW1.3 Other Activities (Specify)	

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	7	2	1	2	12

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO2- 02RM701A **.2:** Develop			**Unit-2** Herbarium Techniques: Principles and Practices	

comprehensive skills in herbarium techniques, from specimen collection and preparation to digital documentation and storage, supporting plant taxonomy and research.	**SO2.1**. Understanding the purpose and goals of creating a herbarium, including plant preservation, research, and education.	LI2.1 Conduct a field trip to collect plant specimens. Record detailed field notes, including location, habitat, and plant characteristics.	**CI2.1** Introduction and Objectives of Herbarium**:**	**SL2.1** . Understand the importance of proper storage techniques to maintain specimen integrity.
	SO2.2 Recognizing the significance of herbarium collections in taxonomy, biodiversity conservation, and historical record-keeping.		**CI2.2** Importance of Herbarium**:**	**SL2.2** Learn the process of digitizing herbarium collections to improve accessibility and support digital research.
	SO2.3 Learning the methods for collecting plant specimens in the field and accurately recording relevant data and observations.		**CI2.3** Collection Process and Field Notes**:**	
	SO2.4 Techniques for properly preparing plant specimens for long-term preservation, including drying and pressing.		**CI2.4** Preparation of Specimen**:**	
	SO2.5 Procedures for mounting specimens on herbarium sheets and providing detailed labels with essential information.		**CI2.5** Mounting and Labeling**:**	

	SO2.6 Best practices for storing herbarium sheets to ensure their preservation, including environmental control and pest management.		**CI2.6** Techniques for Storing Herbarium Sheets**:**	
	SO2.7 Creating and managing digital records of herbarium specimens to enhance accessibility and research capabilities.		**CI2.7** Digital Herbarium**:**	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Reflect on and articulate the multifaceted value of herbarium collections in scientific and educational contexts.
	SW2.2 Mini Project	Mount dried plant specimens on herbarium sheets and create detailed labels with botanical information and collection data.
	SW2.3 Other Activities (Specify)	

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	9	2	1	1	13

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO3- 02RM701A **.3:** Develop proficiency in cell fractionation and analytical techniques, including cell disruption, centrifugation, spectrophotometry, and chromatography, for advanced plant science research.			**Unit-3** Cell Fractionation and Analytical Techniques in Plant Science	
	SO3. 1 Understanding the tools and principles used in cell fractionation to separate cellular components.	LI3.1 Isolate different cellular organelles from plant cells using differential centrifugation.	**CI3.1** Cell Fractionation: Instruments and Principles**:**	SL3.1 Learn the use of spectrometry for ananysis of various copounds
	SO3.2 Techniques for using a sonicator to disrupt cells and release their contents.		**CI3.2** Handling and Application of Cell Disruption (Sonicator)**:**	
	SO3.3 Methods for using centrifuges to separate cellular components based on density.		**CI3.3.** Handling and Application of Centrifuge and Ultracentrifuge**:**	
	SO3.4 Principles and applications of spectrophotometry in measuring absorbance and concentration of substances.		**CI3.4** Spectrophotometer: UV and Visible**:**	
	SO3.5 Techniques for separating and identifying compounds using paper and TLC.		**CI3.5** Chromatography: Paper and Thin-Layer Chromatography (TLC)**:**	
	SO3.6 Advanced method for separating, identifying, and quantifying compounds in complex mixtures.		**CI3.6** High-Performance Liquid Chromatography (HPLC)**:**	

	SO3.7 Technique for separating ions and polar molecules based on their charge.		**CI3.7** Ion-Exchange Chromatography**:**	
	SO3.8 Techniques for separating and analyzing macromolecules (DNA, RNA, proteins) based on their size and charge.		**CI3.8** Electrophoresis**:**	
	SO3.9 Instrument and methods for measuring the acidity or alkalinity of plant samples.		**CI3.9** pH Meter**:**	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Maintain protocol of various techniques learnt.
	SW3.2 Mini Project	Prepare samples and run an HPLC analysis to separate and quantify compounds in a plant extract. Interpret the chromatograms.
	SW3.3 Other Activities (Specify)	

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	10	4	1	4	19

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO4-05BT601.4: Acquire fundamental skills in biostatistics for data analysis and understand computational tools and research areas in bioinformatics for sequence alignment and biological data interpretation.			**Unit-4** Biostatistics and Computational Biology	
	SO4.1 Understanding fundamental statistical concepts, including data, population, samples, and parameters.	LI4.1 Analyze a biological dataset using statistical methods to calculate measures of central tendency and variability.	**CI4.1** Basic Idea of Statistics**:**	**SL4.1** Collect a dataset and represent it both in tabular form and using various types of graphs (e.g., bar charts, histograms, pie charts).
	SO4.2 Techniques for representing data in tabular and graphical forms.	LI4.2 Perform sequence alignment using BLAST and CLUSTAL and interpret the results.	**CI4.2 :** Representation of Data**:**	**SL4.2** Calculate the arithmetic mean, median, mode, standard deviation, and standard error for a given dataset. Analyze and interpret the results.
	SO4.3 Calculating and interpreting the arithmetic mean, median, and mode.		**CI4.3.** Measures of Central Tendency**: (2 lectures)**	SL4.3 Gain hands-on experience with sequence alignment tools and learn to interpret alignment results.
	SO4.4 Understanding variability and precision in data.		**CI4.4** Standard Deviation and Standard Error**: (2 lectures)**	**SL4.4** . Understand the applications of CLUSTAL and gain proficiency in multiple sequence alignment.
	SO4.5 Overview of bioinformatics, its branches, and its goals in biological research.		**CI4.5** Bioinformatics: Introduction, Branches, and Aim**:**	
	SO4. Using FASTA, BLAST, and CLUSTAL for		**CI4.6** Tools for Sequence Alignment**: (2 lectures)**	

	comparing and aligning biological sequences.			
	SO4.7 Exploring various research domains within bioinformatics		**CI4.7** Research Areas of Bioinformatics**:**	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Explore the functionalities of CLUSTAL for multiple sequence alignment. Align a set of sequences and analyze the evolutionary relationships.
	SW4.2 Mini Project	Use online tools (BLAST and FASTA) to perform sequence alignments of DNA or protein sequences. Compare the results and document the alignment process.
	SW4.3 Other Activities (Specify)	

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	5	4	1	3	13

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO5-05BT601.5: Develop skills in conducting and writing detailed case studies and botanical surveys, and understand their			**Unit-5**	
	SO5.1 Understanding the methodologies for conducting case studies and botanical surveys in plant science.	**LI5.1** Conduct a botanical survey to document plant species diversity and environmental conditions in a selected area.	**CI5.1.** Description and Methods of Case Study and Botanical Survey**:**	**SL5.1** Review and analyze published case studies on threats to biodiversity. Summarize key findings and

significance and limitations in plant science research.				discuss their implications for conservation.
	SO5.2 Structuring case studies with introduction, methodology, results, discussion, and conclusion sections.	**LI5.2** Write a comprehensive case study on a selected topic in plant science, following a structured format.	**CI5.2** Format for Writing Case Studies**:**	**SL5.2** Learn about the methods and significance of studying carbon sequestration in plants.
	SO5.3 Investigating topics such as pollution, climate change, carbon sequestration, ecological studies, and threats to biodiversity.		**CI5.3** Examples of Case Studies in Botany**: (2 lectures)**	**SL5.3** Understand the methodologies and outcomes of case studies focused on biodiversity threats.
	SO5.4 Crafting detailed case studies and discussing their findings and implications.		**CI5.4** Writing Case Studies in Plant Science and Their Outcomes**: (2 lectures)**	
	SO5.5 Understanding the importance and constraints of case study research in plant science.		**CI5.5** Significance of Case Study and Its Limitations:	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Research and write a case study on the impact of climate change on a specific plant species or ecosystem. Include sections on methodology, results, and discussion.
	SW5.2 Mini Project	Perform a botanical survey in a local area, documenting the diversity of plant species, their habitats, and environmental conditions.
	SW5.3 Other Activities (Specify)	

Course duration (in hours) to attain Course Outcomes:

Course Title: Research Techniques in Plant Science **Course Code:** 02RM701A

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1: Develop proficiency in various microscopy and imaging techniques, enhancing the ability to visualize, measure, and analyze plant structures at microscopic and ultrastructural levels.	10	2	3	1	16
CO2: Develop comprehensive skills in herbarium techniques, from specimen collection and preparation to digital documentation and storage, supporting plant taxonomy and research.	7	2	2	1	12
CO3: Develop proficiency in cell fractionation and analytical techniques, including cell disruption, centrifugation, spectrophotometry, and chromatography, for advanced plant science research.	9	2	1	1	13
CO4: Acquire fundamental skills in biostatistics for data analysis and understand computational tools and research areas in bioinformatics for sequence alignment and biological data interpretation.	7	4	4	1	16
CO5: Develop skills in conducting and writing detailed case studies and botanical surveys, and understand their significance and limitations in plant science research.	5	4	3	1	13
Total Hours	39	14	13	5	70

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcomes:

Course Title: Research Techniques in Plant Science **Course Code:** **02RM701A**

***Legend*: R,** Remember; **U,** Understand; **A,** Apply; **A,** Analyze

Course Outcomes	**Marks Distribution**				**Total Marks**
	R	**U**	**A**	**A**	
CO1: Develop proficiency in various microscopy and imaging techniques, enhancing the ability to visualize, measure, and analyze plant structures at microscopic and ultrastructural levels.	4	4	3	3	14
CO2: Develop comprehensive skills in herbarium techniques, from specimen collection and preparation to digital documentation and storage, supporting plant taxonomy and research.	3	3	4	4	14
CO3: Develop proficiency in cell fractionation and analytical techniques, including cell disruption, centrifugation, spectrophotometry, and chromatography, for advanced plant science research.	3	6	3	2	14
CO4: Acquire fundamental skills in biostatistics for data analysis and understand computational tools and research areas in bioinformatics for sequence alignment and biological data interpretation.	3	6	3	2	14
CO5: Develop skills in conducting and writing detailed case studies and botanical surveys, and understand their significance and limitations in plant science research.	3	3	6	2	14
Total Marks	**16**	**22**	**19**	**13**	**70**

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1.	Dowdy, S., Wearden, S. and Chilko, D., Statistics for Research, Wiley series (2004). 2nd ed.
2.	Walpole, R.E., Myers, R.H., Myers, S.L. and Ye, K., Probability and Statistics for Engineers and Scientists, Dorling Kindersley (2007). 7th ed.
3.	Jhonson, R.A, Gupta C. B., Miller and Freund's Probability and Statistics for Engineers, Dorling Kindersley (2007). 7th ed.
4.	Meyer, P.L. Introductory Probability and Statistical Applications, Addison Wesley (1970).
5.	Kumar Satish, Harjinder Singh and Vikas Tyagi, Modern Phytotechnique and Biostatistics, Pragati Prakashan.

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Visit to botanical garden
7. Demonstration
8. ICT Based teaching Learning
9. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Sc. Biology

Semester: 7th Semester

Course Title: Research Techniques in Plant Science

Course Code: 02RM701A

CO/PO/PSO Mapping															
Course Outcome (Cos)	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1: Develop proficiency in various microscopy and imaging techniques, enhancing the ability to visualize, measure, and analyze plant structures at microscopic and ultrastructural levels.	3	2	-	2	2	1	-	-	1	1	2	-	2	2	2
CO2: Develop comprehensive skills in herbarium techniques, from specimen collection and preparation to digital documentation and storage, supporting plant taxonomy and research.	3	3	1	2	3	1	-	-	-	2	3	1	2	2	3
CO3: Develop proficiency in cell fractionation and analytical techniques, including cell disruption, centrifugation, spectrophotometry, and chromatography, for advanced plant science research.	2	1	1	2	2	2	-	2	-	2	1	1	3	2	1
CO4: Acquire fundamental skills in biostatistics for data	2	3	-	3	2	2	-	2	-	2	2	1	3	2	2

analysis and understand computational tools and research areas in bioinformatics for sequence alignment and biological data interpretation.															
CO5: Develop skills in conducting and writing detailed case studies and botanical surveys, and understand their significance and limitations in plant science research.	3	3	-	3	2	2	2	2	1	2	2	2	3	2	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
	CO1- 02RM701A .1: Develop proficiency in various microscopy and imaging techniques, enhancing the ability to visualize, measure, and analyze plant structures at microscopic and ultrastructural levels.	SO1.1, SO1.2, SO1.3, SO1.4, SO1.5, SO1.6, SO1.7, SO1.8, SO1.9, SO1.10	LI 1	1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 1.10	1.1, 1.2, 1.3
	CO2- 02RM701A .2: Develop comprehensive skills in herbarium techniques, from specimen collection and preparation to digital documentation and storage, supporting plant taxonomy and research.	SO2.1, SO2.2, SO2.3, SO2.4, SO2.5, SO2.6, SO2.7	LI 1	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7	2.1, 2.2
	CO3- 02RM701A .3: Develop proficiency in cell fractionation and analytical techniques, including cell	SO3.1, SO3.2, SO3.3, SO3.4, SO3.5 ,SO3.6,	LI 1	3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9	3.1

	disruption, centrifugation, spectrophotometry, and chromatography, for advanced plant science research.	SO3.7, SO3.8, SO3.9			
	CO4- 02RM701A .4: Acquire fundamental skills in biostatistics for data analysis and understand computational tools and research areas in bioinformatics for sequence alignment and biological data interpretation.	SO4.1, SO4.2, SO4.3, SO4.4, SO4.5, SO4.6, SO4.7	LI 1 LI 2	4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7	4.1, 4.2, 4.3, 4.4
	CO5- 02RM701A .5: Develop skills in conducting and writing detailed case studies and botanical surveys, and understand their significance and limitations in plant science research.	SO5.1, SO5.2, SO5.3, SO5.4, SO5.5	LI 1 LI 2	5.1, 5.2, 5.3, 5.4, 5.5	5.1, 5.2, 5.3

Program Name	**Basters of Science (B.Sc.)- biology**	
Semester	7th sem	
Course Code:	02RM701B	
Course title:	Research Methodology in Zoology	**Curriculum Developer**: Mr. Amit Bagri
Pre-requisite:	To study this course, student must have had Zoology in B.Sc. 3rd year/ Degree.	
Rationale:	These techniques provide valuable tools for understanding biological processes and advancing the field of biotechnology, and employers in academia, industry, and government highly seek after them.	
Course Outcomes (COs):	**CO1-02RM701B.1:** Nature scope and applications of bioinstrumentation. **CO2- 02RM701B.2:** principle and application of microscopy, Microtomy, and spectrophotometry. **CO3- 02RM701B.3:** Separation technique, Centrifugation, chromatography, Electrophoresis and PCR **CO4- 02RM701B.4:** cytological technique, tissue culture and cryopreservation **CO5- 02RM701B.5:** Bioinformatics, basic data science essential software and tools	

Scheme of Studies:

Board of Study	**Course Code**	**Course Title**	**Scheme of studies (Hours/Week)**					**Total Credits(C) (L:T:P=3:0:1)**
			Cl	LI	SW	SL	**Total Study Hours(CI+LI+SW+SL)**	

MAJOR	02RM701B	Research Methodology in Zoology	4	2	1	5	12	3+1=4

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory and Practical

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)		
MAJOR	02RM701B	Research Methodology in Zoology	**15**	**20**	**10**	**5**	**50**	**50**	**100**

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Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

ApproximateHours

Item	Cl	LI	SW	SL	Total
Approx.Hrs	10	06	01	04	21

Course outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction(CI)	Self-Learning(SL)
CO1-02RM701B.1: Nature scope and applications of bioinstrumentation.	**SO1.1** Define and Concept of research technique.	**LI1.1** Microtome	**Unit 1** Define and Concept of research technique.	**SL1.1** Search various reference books and study material to start the learning
	SO1.2 Describe about Principle, Applications and types of Microscopy.		**CI1.1** Describe about Principle of Microscopy.	**SL1.2** Check the properties of Microscopy
	SO1.3 Explain about types and process of Microtomy.	**LI1.2** Identification of PCR	**CI1.2** Explain about types Microtomy.	**SL1.3** Learn about Microtomy.
	SO1.4 Describe Principle and applications of Spectrophotometry.	**Li1.3** Explain about process of Microtomy.	**CI1.3** Describe Principle of Spectrophotometry.	**SL1.4** Learn about Spectrophotometry.
	SO1.5 Describe about Applications of Microscopy.		**CI1.4** Describe about Applications of Microscopy.	
	SO1.6 Describe about types of Microscopy.		**CI1.5** Describe about types of Microscopy.	
	SO1.7 Explain about process of Microtomy.		**CI1.6** Explain about process of Microtomy.	
	SO1.8 Describe applications of Spectrophotometry?		**CI1.7** Describe applications of Spectrophotometry?	
	SO1.9 Explain types of spectrophotometry?		**CI1.8** Study types of spectrophotometry?	
	SO1.10 Study about uv visible?		**CI1.9** Study about uv visible?	
			CI1.10 Study about lambert laws?	

Suggested Sessional Work (SW):*anyone*	**SW1.1** Assignments	Describe about Principle, Applications and types of Microscopy.
	SW1.2 Mini Project	Explain about types and process of Microtomy.
	SW1.3 Other Activities (Specify)	Describe Principle and applications of Spectrophotometry.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	13	04	01	03	21

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
CO2- 02RM701B.2: principle and application of microscopy, Microtomy, and spectrophotometry.	**SO2.1** Describe about Principle, Applications and types of Centrifugations.	**LI2.1** Identification of Microtome	**Unit-II** **CI2.1** Describe about Principle of Centrifugations.	**SL2.1** Enlist the different properties of Centrifugations.
	SO2.2 Describe about definition, Principle, Applications and types of Chromatography.		**CI2.2** Describe about definition, of Chromatography.	**SL2.2** Assess role of Chromatography.
	SO2.3 Describe about Principle, Applications and types of Electrophoresis.	**LI2.2** Identification of electrophoresis	**CI2.3** Describe about Principle, Applications and types of Electrophoresis.	**SL2.3** Learn structure and function of Electrophoresis.
	SO2.4 Describe about Applications of Centrifugations. **SO2.5** Describe about types of Centrifugations.		**CI2.4** Describe about Applications of Centrifugations. **CI2.5** Describe about types of Centrifugations.	
.	**SO2.6** Describe about Principle of Chromatography.		**CI2.6** Describe about Principle of Chromatography.	
	SO2.7 Describe about Applications of Chromatography.		**CI2.7** Describe about Applications of Chromatography.	
	SO2.8 Describe about types of Chromatography.		**CI2.8** Describe about types of Chromatography.	
	SO2.9 Explain about column chromatography?		**CI2.9** Study about column chromatography?	
	SO2.10 Explain about thin layer chromatography?		**CI2.10** Study about thin layer chromatography?	
	SO2.11 Explain about Paper chromatography?		**CI2.11** Study about Paper chromatography?	
	SO2.12 Explain about electrophoresis?		**CI2.12** Study about electrophoresis?	
	SO2.13 Explain about principle of electrophoresis?		**CI2.13** Study about principle of electrophoresis?	

Suggested Sessional Work (SW) :*anyone*	**SW2.1** Assignments	Describe about Principle, Applications and types of Centrifugations.
	SW2.2 Mini Project	Describe about definition, Principle, Applications and types of Chromatography.
	SW2.3 Other Activities (Specify)	Describe about Principle, Applications and types of Electrophoresis.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	11	06	01	03	21

Course Outcome (CO)	Session Outcomes(SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning(SL)**
CO3- 02RM701B.3: Separation technique, Centrifugation, chromatography, Electrophoresis and PCR.	**SO3.1** Explain the concept, principle, types of PCR.	**LI3.1** PCR	**Unit-III** **CI3.1** Explain the concept of PCR.	**SL3.1** Read about various types of nucleic acids and its PCR.
	SO3.2 explain design and functioning of tissue culture laboratory	**LI3.2** Chromatography.	**CI3.2** Explain functioning of tissue culture laboratory?	**SL3.2** design and functioning of tissue culture laboratory
	SO3.3 Explaining properties of cryo techniques	**LI3.3** Incubator	**CI3.3** Explaining properties of cryo techniques	**SL3.3** Explaining properties of cryo techniques.
	SO3.4 Explain the types of PCR.		**CI3.4** Explain the types of PCR.	
	SO3.5 Explain the principle of PCR.		**CI3.5** Explain the principle of PCR.	
	SO3.6 explain design of tissue culture laboratory?		**CI3.6** explain design of tissue culture laboratory?	

	SO3.7 explain Study of autoclave?		**CI3.7** Study of autoclave?	
	SO3.8 explain Study of laminar air flow?		**CI3.8** Study of laminar air flow?	
	SO3.9 explain Study of Incubator?		**CI3.9** Study of Incubator?	
	SO3.10 explain cryopreservation technique?		**CI3.10** Study of cryopreservation technique?	
	SO3.11 explain about Study of tissue?		**CI3.11** Study of tissue?	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Explain the concept, principle, types of PCR.
	SW3.2 Mini Project	explain design and functioning of tissue culture laboratory
	SW3.3 Other Activities (Specify)	Explaining properties of cryo techniques

Item	Cl	LI	SW	SL	Total
Approx. Hrs	11	06	01	02	20

Course Outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO4- 02RM701B.4: cytological technique, tissue culture and cryopreservation	**SO4.1** Exploring the concept of Bioinformatics.	**LI4.1** Study of Autoclave?	**Unit-IV** **CI4.1** Exploring the concept of Bioinformatics.	**SL4.1** Learn about different classes of Bioinformatics.
	SO4.2 Explain various Database.	**LI4.2** Cytological and sterilization technique?	**CI4.2** Explain various Database.	**SL4.2** Discuss types and structure of Database.

	SO4.3 Explaining the role of Bioinformatics and resources.	**LI4.3** Estimation of alignment?	**CI4.3** Explaining the role of Bioinformatics and resources.	
	SO4.4 Explaining the role of Bioinformatics.?		**CI4.4** Explaining the role of Bioinformatics.?	
	SO4.5 Explaining the nature of Bioinformatics?		**CI4.5** Explaining the nature of Bioinformatics?	
	SO4.6 Explaining the scope of Bioinformatics?		**CI4.6** Explaining the scope of Bioinformatics?	
	SO4.7 Explaining the Application of Bioinformatics?		**CI4.7** Explaining the Application of Bioinformatics?	
	SO4.8 Explaining the gene bank?		**CI4.8** Study of gene bank?	
	SO4.9 Explaining the DDBJ?		**CI4.9** Study of DDBJ?	
	SO4.10 Explaining the NCBI?		**CI4.10** Study of NCBI?	
	SO4.11 Explaining the PHYLOGENY?		**CI4.11** Study of PHYLOGENY?	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Exploring the concept of Bioinformatics.
	SW4.2 Mini Project	Explain various Database.
	SW4.3 Other Activities (Specify)	Explaining the role of Bioinformatics and resources.

Course duration (in hours) to attain Course Outcomes:

Course Title: Research Methodology in Zoology **Course Code:** 02RM701B

Course Outcomes(COs)	Class lecture (CI)	Laboratory Instruction(LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1-02RM701B.1: Nature scope and applications of bioinstrumentation.	10	6	4	1	21
CO2- 02RM701B.2: principle and application of microscopy, Microtomy, and spectrophotometry.	13	4	3	1	21
CO3- 02RM701B.3: Separation technique , Centrifugation, chromatography, Electrophoresis and PCR.	11	6	3	1	21
CO4- 02RM701B.4: cytological technique , tissue culture and cryopreservation	11	6	2	1	20
Total Hours	45	22	12	04	83

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Research technique in biological science **Course Code:** 02RM701B

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
CO1-02RM701B.1: Nature scope and applications of bioinstrumentation.	2	1	1	1	5
CO2- 02RM701B.2: principle and application of microscopy, Microtomy, and spectrophotometry.	2	4	2	2	10
CO3- 02RM701B.3: Separation technique, Centrifugation, chromatography, Electrophoresis and PCR.	3	5	5	2	15
CO4- 02RM701B.4: cytological technique, tissue culture and cryopreservation	2	3	3	2	10
CO5- 02RM701B.5: Bioinformatics, basic data science essential software and tools	5	4	1	0	10
Total Marks	**14**	**17**	**12**	**07**	**50**

***Legend*: A,** apply; **An,** analyze; **E,** evaluate; **C,** Create

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1	Upadhya A, Upadhya K, And Nath Nirmala, Biophysical chemistry, Himalay publishing company, Mumbai first edition
2	Fogel GB, and Corne DW, Evolutionary Computation in bioinformatics,

3	Sharma S, Verma A, Introduction to instrumentation in life Science.

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Demonstration
7. ICT Based teaching Learning
8. Brainstorming

CO, PO and PSO Mapping

Program Name: B.Sc. biology
Semester: 7th Sem
Course Title: Research Methodology in Zoology
Course Code: 02RM701B

CO/PO/PSO Mapping								
Course Outcome (Cos)	**Program Outcomes (POs)**					**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**
CO1-02RM701B.1: Nature scope and applications of bioinstrumentation.	3	3	1	3	3	2	3	3
CO2- 02RM701B.2: principle and application of microscopy, Microtomy, and spectrophotometry..	2	1	3	3	2	1	2	2
CO3- 02RM701B.3: Separation technique , Centrifugation, chromatography, Electrophoresis and PCR.	3	2	1	3	2	1	2	3
CO4- 02RM701B.4: cytological technique , tissue culture and cryopreservation	3	1	1	2	1	2	1	1
CO5- 02RM701B.5: Bioinformatics , basic data science essential software and tools	1	2	2	2	2	2	3	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5 PSO 1,2,3	**CO1-02RM701B.1:** Nature scope and applications of bioinstrumentation.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10	1.1,1.2,1.3	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9,1.10	1SL-1,2,3,4
PO 1,2,3,4,5	**CO2- 02RM701B.2:** principle and application	SO2.1 SO2.2 SO2.3	2.1, 2.2	2.1,2.2,2.3,2.4,2.5,	2SL-1,2,3

PSO 1,2,3	of microscopy, Microtomy, and spectrophotometry.	SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9 SO2.10 SO2.11 SO2.12 SO2.13		2.6,2.7,2.8,2.9,2.10,2.11,2.12,2.13	
PO 1,2,3,4,5 PSO 1,2,3	**CO3- 02RM701B.3:** Separation technique, Centrifugation, chromatography, Electrophoresis and PCR.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9 SO3.10 SO3.11	3.1,3.2,3.3	3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9,3.10,3.11	3SL-1,2,3
PO 1,2,3,4,5 PSO 1,2,3	**CO4- 02RM701B.4:** cytological technique, tissue culture and cryopreservation	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8 SO4.9 SO4.10 SO4.11	4.1,4.2,4.3	4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9,4.10,4.11	4SL-1,2

Course Name: Research Methodology & Research Ethics

Course Code: 02RM701C

Pre-requisite: Students must have fundamental knowledge of precision and accuracy, types of error, data collections, mean, median and mod etc to understand the concept of research program and its methodology.

Rationale: The rationale for choosing a specific research methodology is crucial as it provides a solid foundation for the entire research process. The choice of methodology should align with the research objectives and questions, guiding the researcher in collecting, analyzing, and interpreting data.

Course Outcomes:
After the completion of this course, the learner will able to
02RM701C.1: Discuss the purpose of research, research process and research design by acquiring the knowledge of types and method of research.

02RM701C.2: Conceptualize and design research projects, including selecting appropriate data collection methods and planning for subsequent analysis.

02RM701C.3: Explain the processing and analysis of data with the skills and knowledge necessary to manage and analyze data effectively.

02RM701C.4:Understand a foundational understanding of the ethical considerations, philosophical principles, and standards of scientific conduct that are crucial in various fields of study.
02RM701C.5: Explain of the ethical considerations and standards related to publishing academic and research work.

UNIT-I (02RM701C.1): Introduction & Research design
Nature and objectives of research, Methods of Research: historical, descriptive and experimental. Types of Research, Research process, research approaches, criteria for good

research meaning of research design .

UNIT II (02RM701C.2): Data Collection & Analysis

Types of data, methods and techniques of data collection, Hypothesis Testing, primary and secondary data, meta analysis, historical methods, content analysis, devices used in data collection.

UNIT III (02RM701C.3): Processing and analysis of data

Measures of central Tendency. Measures of dispersion. Measures of variation. Measures of central tendency vs. measures of dispersion. Normal distribution. Measures of skewness and Interpretation. Correlation and regression: types & application. Chi-square test its purpose and use.

UNIT IV (02RM701C.4): Philosophy, Ethics & Scientific conduct

Introduction to philosophy: definition, nature and scope, concept, branches, Ethics: definition, moral philosophy, nature of moral judgements and reactions, Ethics with respect to science and research Intellectual honesty and research integrity,

UNIT V (02RM701C.5): Publication Ethics

Publication ethics: definition, introduction and importance , Best practices / standards setting initiatives and guidelines: COPE, WAME, etc. Conflicts of interest Pblication misconduct: definition, concept, problems that lead to unethical behavior and vice versa.

Reference Book
Research in Education, 10th Edition,
Best & KahnResearch Methodology
C.R.KOTHAR
Methodology of Educational Research,

Lokesh KoulSUGGESTED WEB

SOURCES

- https://nptel.ac.in/course.html
- https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
- https://swayam.gov.in/explorer?category=Chemistry

Mode OF Transaction:Lecture,demonstration,E-tutoring,discussion,assignments,quizzes, case study, powerpoint; LMS/ICT Tools**:**

Digital Classrooms, DLMS, ZOOM, G-Suite,MSPower-Point, Online Resources.

Mappingof COandPO for

76CH-401 Scheme of

Studies:

Board ofStudy	CourseCode	CourseTitle	Scheme ofstudies (Hours/Week)					Total Credits(C)
			Cl	LI	SW	SL	Total Study Hours(Cl+LI+SW+SL)	
ProgramCore(PCC)	02RM701C	Research Methodology & Research Ethics	2	0	1	1	4	2

Legend :

CI: ClassroomInstruction(Includesdifferentinstructionalstrategiesi.e.Lecture(L)andTutorial (T)andothers),
LI: LaboratoryInstruction(IncludesPracticalperformancesinlaboratoryworksh op,fieldorotherlocationsusingdifferentinstructionalstrategies)
SW: SessionalWork(includesassignment,seminar,miniprojectetc.),
SL: SelfLearning,
C: Credits.

Note:

SW&SL has to be planned and performed under the continuous guidance and feedbackk of teacher to ensure outcome of Learning.

SchemeofAssessment: Theory

Board ofSt	Course Code	CourseTitle	SchemeofAssessment(Marks)		
			ProgressiveAssessment(RA)	EndSemesterA	Total

udy			Class/HomeAssignment5number 3 markseach (CA)	Class Test2 (2bestout of3) 10 marksearch(CT)	Seminarone + Class activity	ClassAttendance (AT)	Total Marks (CA+CT +SA +AT)	**ssessment (ESA)**	**Marks** (PRA+ ESA)
PCC	02RM701C	Research Methodology & Research Ethics	15	20	10	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs)upon the course's conclusion.

UNIT-I (02RM701C.1): Introduction & Research design

Nature and objectives of research, Methods of Research: historical, descriptive and experimental. Types of Research, Research process, research approaches, criteria for good research meaning of research design.

Activity	**AppX Hrs**
Cl	06
LI	0
SW	1
SL	1
Total	08

Session Outcomes (SOs)	**LI**	**CI**	**SL**

After the completion of topics students will be able to SO1.1 understand the nature and objectives of research SO1.2 describe the methods of research like historical, descriptive and experimental SO1.3 explain the criteria for good research like meaning of research design		**UNIT-I (76CH401.1): Introduction & Research design** Introduction to nature and objectives of research Methods of Research: historical, descriptiveand experimental. Types of Research Research process Research approaches Criteria for good research meaning of research design.	• Error types of error

SW-1 Suggested Sessional Work(SW):

Assignments: Precision and accuracy

Mini Project:

Other Activities (Specify):

UNIT II (02RM701C.2): Data Collection & Analysis

Types of data, methods and techniques of data collection, Hypothesis Testing, primary and secondary data, meta analysis, historical methods, content analysis, devices used in data collection.

Activity	AppX Hrs
Cl	06
LI	0
SW	1
SL	1
Total	08

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
After the completion of topics students will be able to **SO2.1** understand the types ofdata, methods and techniques of data collection **SO2.2** Explain primary and secondary data **SO2.3 Explain** devices used in data collection		**UNIT II (**76CH-401**.2): Data Collection & Analysis** Types of data, methods and techniques of data collection Hypothesis Testing, 2.15Primary and secondary data2.16Deta analysis 2.17Historical methods T1. Content analysis, devices used in data collection.	• Sampling of materials

SW-2 Suggested Sessional Work (SW):

Assignments: Mean, median and mod

Mini Project:

Other Activities (Specify):

UNIT III (02RM701C.3): Processing and analysis of data

Measures of variation. Measures of central tendency vs. measures of dispersion. Normal distribution. Measures ofskewers and Interpretation. Correlation and regression: types & application. Chi-square test its purpose and use.

Activity	AppX Hrs
Cl	06
LI	0
SW	1
SL	1
Total	08

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
After the completion of topics students will be able to **SO3.1** understand the measures of central tendency vs. measures of dispersion **SO3.2** understand measures of skewers and Interpretation **SO3.3** explain correlation and regression: types & application		**UNIT III (**76CH-401**.3): Processing and analysis of data** Measures of central Tendency Measures of dispersion Measures of variation Normal distribution Measures of skewers and Interpretation Correlation and regression: types & application	• Chi-square test, its purpose and use.

SW-3 Suggested Sessional Work (SW):

Assignments: Chi-square test its purpose and use

Mini Project:

Other Activities (Specify):

UNIT IV (**02RM701C.4): Philosophy, Ethics & Scientific conduct**

Introduction to philosophy: definition, nature and scope, concept, branches, Ethics: definition, moral philosophy, nature of moral judgments and reactions, Ethics with respect to science and research Intellectual honesty and research integrity,

Activity	AppX Hrs
Cl	06
LI	0
SW	1
SL	1
Total	08

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
After the completion of topics students will be able to **SO4.1 understand** the term philosophy **SO4.2 explain the term e**thics with respect to science and research **SO4.3 explain i**ntellectual honesty and research integrity		UNIT IV (76CH-401**.4): Philosophy, Ethics & Scientific conduct** Introduction to philosophy Introduction to ethics: definition, moral philosophy Nature of moral judgments and reactions Ethics with respect to science and research Intellectual honesty T1 Research integrity	• Ethics with respect to science

SW-4 Suggested Sessional Work (SW)

Assignment: Nature of moral judgments and reactions

Mini Project:

Other Activities (Specify):

UNIT V

(02RM701C.5): Publication Ethics

Publication ethics: definition, introduction and importance , Best practices / standards setting initiatives and guidelines: COPE, WAME, etc. Conflicts of interest Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa.

Activity	AppX Hrs
Cl	06
LI	0
SW	1
SL	1
Total	08

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
After the completion of topics. students will be able to **SO5.**1 understand publication ethics **SO5.2** explains best practices and standards setting initiatives **SO5.3 Explain the c**onflicts of interest and publication misconduct		UNIT V (76CH-401.5): Publication Ethics Publication ethics: definition, introduction and importance Best practices / standards setting initiatives and guidelines COPE WAME Conflicts of interest Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa.	• Best practices

SW-5 Suggested Sessional Work (SW):

Assignments: Standards setting initiatives and guidelines: COPE, WAME, etc

Mini Project:

Other Activities (Specify):

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
02RM701C.1: Discuss the purpose of research, research process and research design by acquiring the knowledge of types and method of research	12	02	01	15
02RM701C.2: conceptualize and design research projects, including selecting appropriate data collection methods and planning for subsequent analysis.	12	02	01	15
02RM701C.3: explain the processing and analysis of data with the skills and knowledge necessary to manage and analyze data effectively.	12	02	01	15

02RM701C.4:understand a foundational understanding of the ethical considerations, philosophical principles, and standards of scientific conduct that are crucial in various fields of study.	12	02	01	15
02RM701C.5: Explain of the ethical considerations and standards related to publishing academic and research work.	12	02	01	15
Total Hours	60	10	05	75

Suggestion for End Semester Assessment

SuggestedSpecificationTable(ForESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	76CH401.1: Discuss the purpose of research, research process and research design by acquiring the knowledge of types and method of research	03	01	01	05
CO-2	76CH-401.2: Conceptualize and design research projects, including selecting appropriate data collection methods and planning for subsequent analysis.	02	06	02	10
CO-3	76CH-401.3: Explain the processing and analysis of data with the skills and knowledge necessary to manage and analyze data effectively.	03	07	05	15
CO-4	76CH-401.4:Understand a foundational understanding of the ethical considerations, philosophical principles, and standards ofscientific conduct that are crucial in various fields of study.	-	10	05	15
CO-5	76CH-401.5: Explain of the ethical considerations and standards related to publishing academic and research work.	03	02	-	05
Total		11	26	13	50

Legend: R:Remember, U:Understand, A:Apply

The written examination of 50 marks will be held at the end of semester for Inorganic Chemistry

Note.Detailed Assessment need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement ,for end semester assessment.

SuggestedInstructional/ImplementationStrategies:

46. Improved Lecture
47. Tutorial
48. Case Method
49. Group Discussion
50. Role Play
51. Visitto NCL, CSIR laboratories
52. Demonstration
53. ICT Based Teaching Learning (VideoDemonstration/TutorialsCBT,Blog,Facebook,Twitter,Whatsapp ,Mobile,Onlinesources)
54. Brainstorming

Suggested Learning Resources:

(k) Books:

S. No.	Title	Author	Publisher	Edition& Year
1	Research Methodology	C.R. Kothari	New Age International Publisher	2nd Revision edition
2	Handbook ofResearch Methodology	Dr. Shanti Bhushan Mishra and Dr. Shashi Alok	Educreation Publishing	2nd edition

SuggestedWebSources:

35. https://celqusb.files.wordpress.com/2017/12/inorganic-chemistry-g-l-miessler-2014.pdf
36. https://www.slideshare.net/MANISHSAHU106/inert-and-labile-complexes
37. https://swayam.gov.in/explorer?category=Chemistry

ModeofDelivery:Lecture,demonstration,E-tutoring,discussion,assignments,quizzes, case study, power point;

LMS/ICT Tools: Digital Classrooms, DLMS, ZOOM, G-Suite,MSPower-Point, Online Resource

AKS University
Faculty of Basic Science
Curriculum of B. Sc. (Honours / By Research) Program
(Revised as on 01 August 2023)

Title:Research Methodology & Research Ethics **Course Code : 02RM701C**

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Knowledge	Research Aptitude	Communication	Problem Solving	Individual and Team Work	Investigation of Problems	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and sustainability	The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry	To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical,synthetic, pharmaceutical etc.	understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon-based problems in chemical sciences.	Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science
76CH401.1: Discuss the purpose of research, research process and research design by acquiring the knowledge of types and method of research	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
76CH-401.**2**: conceptualize and design research projects, including selecting appropriate data collection methods and planning for subsequent analysis.	2	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
76CH-401.**3**: explain the processing and analysis of data with the skills and knowledge necessary to manage and analyze data effectively.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
76CH-401.**4**:understand a foundational understanding of the ethicalconsiderations, philosophical principles, and standards of scientific conduct that are crucial in various fields of study.	2	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
76CH-401.**5:** Explain of the ethical considerations and standards related to publishing academic and research work.	2	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

Legend: **1–Low,** **2–Medium,** **3–High**

Course Curriculum Map:

POs &PSOsNo.	Cos No. & Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	76CH401.1: Discuss the purpose of research, research process and research design by acquiringthe knowledge of types and method of research	SO1.1SO 1.2SO1.3 SO1.4 SO1.5		UNIT-I (76CH401.1): Introductio n & Research design 1.1,1.2,1.3, 1.4,1.5,1.6, 1.7	• Error types of error
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	76CH-401.2: conceptualize and design research projects, including selecting appropriate data collection methods and planning for subsequent analysis.	SO2.1SO 2.2SO2.3 SO2.4 SO2.5		UNIT II (76CH-401.2): Data Collection & Analysis 2.1,2.2,2.3,2.4,2. 5,2.6, 2.7, 2.8,2.9	• Sampling of materials
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	76CH-401.3: explain the processing and analysis of data with the skills and knowledge necessary to manage and analyze data effectively.	SO3.1SO3 .2 SO3.3 SO3.4 SO3.5		UNIT III (76CH-401.3): Processing and analysis of data3.1, 3.2,3.3,3.4,3.5,3.6,3.7	• Chi-square test, itspurpose and use.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	76CH-401.4:understand a foundati onalunderstanding of the ethical considerations, philosophical principles, and standards of scientific conduct that are crucial in various fields of study.	SO4.1SO 4.2SO4.3 SO4.4 SO4.5		UNIT IV (76CH-401.4): Philosophy, Ethics & Scientific conduct4.1, 4.2,4.3,4.4,4.5,4.6,4.7	• Ethics with respect to science
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	76CH-401.5: Explain of the ethical considerations and standards related to publishing academic and research work.	SO5.1SO 5.2SO5.3 SO5.4 SO5.5		UNIT V (76CH-401.5): Publica tion Ethics 5.1,5.2 ,5.3,5. 4,5.5,5 .6,5.7	• Best practices

Curriculum Development Team:

1. Dr. Shailendra Yadav, HoD, Department of Chemistry, AKS University, Satna (M.P.).
2. Dr. Dinesh Kumar Mishra, Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
3. Dr. Samit Kumar,Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
4. Dr. Sushma Singh, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
5. Dr. Manoj Kumar Sharma, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
6. Mr. Kanha Singh Tiwari,Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
7. Mrs. Nahid Usamani, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).

Program name	Bachelor of Science(B. Sc) Botany	
Semester	8th	
Course Code:	01BO801	
Course title:	Diversity of Plants	**Curriculum Developer**: Kirti Singh Lab Technician
Pre-requisite:	Students should have basic knowledge of diversity of plant.	
Rationale:	Biodiversity of plants ensures a resource for new food crops and medicines. Plant life balances ecosystems, protects watersheds, mitigates erosion, moderates climate, and provides shelter for many animal species. Threats to plant diversity, however, come from many angles. The explosion of the human population, especially in tropical countries where birth rates are highest and economic development is in full swing, is leading to human encroachment into forested areas. To feed the larger population, humans need to obtain arable land which leads to massive clearing of trees. The need for more energy to power larger cities and economic growth results in the construction of dams, the consequent flooding of ecosystems, and increased emissions of pollutants. Other threats to tropical forests come from poachers who log trees for their precious wood. Ebony and Brazilian rosewood, both on the endangered list, are examples of tree species driven almost to extinction by indiscriminate logging.	
Course Outcomes (COs):	**CO1:** Understand the classification and description of plants. **CO2:** Acquire knowledge about plants and their utilization. **CO3:** Identify the economic importance of plants. **CO4:** Recognize basic distribution patterns and structural organization of plants. **CO5:** Comprehend concepts in the evolution of plants.	

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits(C) (L:T:P=4:0:1)
			CI	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
Program Common (PC)	01BO801	Diversity of plants	4	2	1	2	9	4+0+2=6

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
PC	**01BO801**	Diversity of plants	**15**	**20**	**5**	**5**	**5**	**50**	**50**	**100**

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	12	4	1	5	22

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO1: Understand the classification and description of plants.			**Unit-1**	
	SO1.1 Explain in detail introduction of Algae.	**LI1.1**Microscopicexamination of different algal forms.	**CI1.1** Brief detail of Introduction to Algae	**SL1.1** Search various reference books and other study material to start the learning about Algae.
	SO1.2 Explain the detail of general characteristics of Algae.	**LI1.2** Observing Vaucheria under the microscope.	**CI1.2** Brief detail of general characteristics of Algae	**SL1.2** Explore the fundamental characteristics that define algae.
	SO1.3 Describe the Classification of Algae: Basis and Trends.		**CI1.3** Explain Classification of Algae: Basis and Trends.	**SL1.** 3 Understand the basis of algal classification and recent trends.
	SO1.4 Explain in detail the Chlorophyta (Green Algae) – Oedogonium.		**CI1.4** Study the Chlorophyta (Green Algae) – Oedogonium.	**SL1.4** Study the morphology, anatomy, and reproduction of Chlorophyta, focusing on Oedogonium.

	SO1.5 Describe and define the Charophyta (Stoneworts) - Chara.		**CI1.5** Study the Charophyta (Stoneworts) – Chara.	
	SO1.6 Explain in detail the Xanthophyta (Yellow-Green Algae) – Vaucheria.		**CI1.6** Study the Xanthophyta (Yellow-Green Algae) – Vaucheria.	**SL1.5** Investigate the characteristics of Xanthophyta, focusing on Vaucheria.
	SO1.7 Explain in detail the Bacillariophyta (Diatoms).		**CI1.7** Explain Bacillariophyta (Diatoms).	
	SO1.8 Describe the structure and life cycle of Phaeophyta, particularly Ectocarpus.		**CI1.8** Examine the structure and life cycle of Phaeophyta, particularly Ectocarpus.	
	SO1.9 Explain in detail the unique features of Rhodophyta, focusing on Polysiphonia.		**CI1.9 Study the** unique features of Rhodophyta, focusing on Polysiphonia.	
	SO1.10Explain in detail ecological roles and interactions of algae.		**CI1.10 Study the** ecological roles and interactions of algae.	
	SO1.11 Explain in detail economic significance of algae in various industries.		**CI1.11** Discuss the economic significance of algae in various industries.	
	SO1.12 Explain Recent Trends and Future Prospects in Algal Research.		**CI1.12** Study the Recent Trends and Future Prospects in Algal Research	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Describe in detail the history of Algae.
	SW1.2 Mini Project	Role of algae in ecosystems.
	SW1.3 Other Activities (Specify)	Explain the different types of Algae.

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	12	4	1	5	22

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO2: Acquire knowledge about plants and their utilization.			**Unit-2**	
	SO2.1 Describe and define Introduction to Fungi.	**LI2.1 To** demonstrate general characteristics and classification of fungus.	**CI2.1 Study** Introduction to Fungi.	**SL2.1** Search various reference books and other study material to start the Introduction to Fungi
	SO2. Explain Reproduction in Fungi.	**LI2.2**To study the characteristics of Rhizopus	**CI2.2** Discuss the Reproduction in Fungi.	**SL2.2** understand the classification system
	SO2.3 Explain classification of fungi	.	**CI2.3 Define** classification of fungi.	**SL2.3** This class focuses on the diverse substrate relationships in fungi and their ecological significance.

	SO2.4 Describe the Substrate Relationships in Fungi.		**CI2.4 Define** Substrate Relationships in Fungi.	**SL2.4**Understand the general characteristics of Zygomycotina, focusing on Rhizopus.
	SO2.5 Explain in detail the Zygomycotina - Rhizopus.		**CI2.5**Study Zygomycotina - Rhizopus	**SL2.5** Explore the general characteristics of Ascomycotina, with emphasis on Erysiphe
	SO2.6 Explain in detail the General Characteristics of Mastigomycotina (Peronospora).		**CI2.6** Study the General Characteristics of Mastigomycotina (Peronospora).	
	SO2.7 Explain in detail the Ascomycotina.		**CI2.7** Describe the Ascomycotina.	.
	SO2.8 Explain in detail the Basidiomycotina – Agaricus.		**CI2.8** Study the Basidiomycotina – Agaricus.	
	SO2.9 Describe the Deuteromycotina – Curvularia.		**CI2.9** Study the Deuteromycotina - Curvularia	
	SO2.10 Define the Heterothallism and Parasexuality.		**CI2.10Study the** Heterothallism and Parasexuality.	
	SO2.11 Explain the : Economic Importance of Fungi		**CI2.11Study the** Economic Importance of Fungi.	
	CI2.12 Define the review and assessment of fungi.		**CI2.12 Study the review and assessment of fungi.**	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Describe and define the classification of fungi.
	SW2.2 Mini Project	Detail study of different types of fungus.
	SW2.3 Other Activities (Specify)	Study one review article on fungus.

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	12	6	1	2	21

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO3: Identify the economic importance of plants.			**Unit-3**	
	SO3. 1 Explain in detail Introduction to Bryophytes.	**LI3.1**To demonstrate the classification of Bryophytes.	**CI3.1** Brief details of Introduction to Bryophytes.	**SL3.1** Search various reference books and other study material to start the learning about Bryophytes.
	SO3.2 Explain in detail the classification of Bryophytes.	**LI3.2** To observe Marchantia samples under a microscope to identify key structures.	**CI3.2** Study the Classification of Bryophytes.	**SL3.2** Learn the morphological and anatomical features of Anthocerotopsida, specifically Anthoceros
	SO3.3 Explain in detail the distribution of bryophytes.	LI 3.3 Photograph of Section of Riccia	**CI3.3** Study the distribution of Bryophytes.	
	SO3.4 Explain in detail the Morphology of Hepaticopsida.		**CI3.4** Study the Morphology of Hepaticopsida.	
	SO3.5 Explain in detail the		**CI3.5** Study the Reproduction in	

	tReproduction in Hepaticopsida.		Hepaticopsida.	
	SO3.6 Explain in detail the Morphology and Anatomy of Anthocerotopsida (Anthoceros).		**CI3.6**Brief detail of Morphology and Anatomy of Anthocerotopsida (Anthoceros).	
	SO3.7 Explain in detail the Reproduction in Anthocerotopsida.		**CI3.7**.Study the Reproduction in Anthocerotopsida.	
	SO3.8 Explain in detail the Morphology and Anatomy of Musci.		**CI3.8** Study the Morphology and Anatomy of Musci.	
	SO3.9 Explain in detail the Reproduction in Musci (Funaria).		**CI3.9Study the** Reproduction in Musci (Funaria).	
	SO3.10Explain in detail the Degeneration of Gametophyte and evolution of Sporophyte.		**CI3.10 Study the** Degeneration of Gametophyte and evolution of Sporophyte.	
	SO3.11 Explain in detail the 1.4 Economic Importance of Bryophytes..		**CI3.11 Study the** Economic Importance of Bryophytes.	
	SO3.12 Explain in detail Fossil Bryophyte.		**CI3.12 Study the** Fossil Bryophytes.	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Describe the Bryophytes.
	SW3.2 Mini Project	Describe the classification and distribution of Bryophytes.
	SW3.3 Other Activities (Specify)	Explain in detail Fossil Bryophytes.

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	12	4	1	4	21

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO4: Recognize basic distribution patterns and structural organization of plants.			**Unit-4**	
	SO4. 1 Explain in detail Introduction of Pteridophyta.	**LI4.1**To demonstrate the classification of Pteridophyta	**CI4.1** Brief detail of Introduction of Pteridophyta.	**SL4.1** Search various reference books and other study material to start the learning about Pteridophyta.
	SO4.2 Explain in detail the Classification and Evolution of Pteridophyta.	**LI4.2**To prepare slides for anatomical studies.	**CI4.2** Study the Classification and Evolution of Pteridophyta.	**SL4.2** Explore detailed classification, focusing on phylogenetic relationships and evolutionary trends.
	SO4.3 Discuss the Stelar Organization in Pteridophyta		**CI4.3** Stydy the Stelar Organization in Pteridophyta	
	SO4.4 Describe and define the Heterospory and Seed Habit.		**CI4.4 Study the** Heterospory and Seed Habit.	**SL4.3** Explore heterospory and the evolution of the seed habit in Pteridophyta.

	SO4.5 Explain in detail the Origin of Leaf and Telome Concept.		**CI4.5** Study the Origin of Leaf and Telome Concept.	
	SO4.6 Describe and define the Morphology and Anatomy of Psilopsida (Psilotum).		**CI4.6 Study the** Morphology and Anatomy of Psilopsida (Psilotum)	**SL4.4** Explore the morphology and anatomy of Psilopsida, focusing on Psilotum.
	SO4.7 Explain in detail the Reproduction and Interrelationship of Psilopsida.		**CI4.7 Study the** Reproduction and Interrelationship of Psilopsida	
	SO4.8 Explain in detail the Morphology and Anatomy of Lycopsida (Selaginella).		**CI4.8** Study the Morphology and Anatomy of Lycopsida (Selaginella).	
	SO4.9 Discuss the Reproduction and Interrelationship of Lycopsida.		**CI4. 9Study the** Reproduction and Interrelationship of Lycopsida	
	SO4.10 Discuss the Morphology and Anatomy of Equisetopsida (Equisetum).		CI4.10 Study the Morphology and Anatomy of Equisetopsida (Equisetum)	
	SO4.11 Define the Reproduction and Interrelationship of Equisetopsida.		**CI4.11 Study the** Reproduction and Interrelationship of Equisetopsida	
	SO4.12 Explain in detail Economic Importance of Pteridophyta.		**CI4.12 Study the** Economic Importance of Pteridophyta Importance of Pteridophyta	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Describe the Pteridophyta..
	SW4.2 Mini Project	Explain in detail classification of Pteridophyta..
	SW4.3 Other Activities (Specify)	Write a one review article on ar Pteridophyta.

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Item	CI	LI	SW	SL	Total
Approx. Hours	12	6	1	3	22

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)		Self-Learning (SL)
CO5: Comprehend concepts in the evolution of plants.			**Unit-5**	
	SO5.1 Explain in detail Introduction to Paleobotany	**LI5.1**To Demonstrate the Paleobotany.	**CI5. Study the** Introduction to Paleobotany	**SL5.1** Search various reference books and other study material to start the learning about Paleobotany
	SO5.2 Explain in detail the Geological Time Scale	**LI5 2.** Lab examination of Gnetum leaves and stems.	**CI5.** Study the Geological Time Scale	**SL5.2** Gain an understanding of the geological time scale and its relevance to Paleobotany.
	SO5.3 Explain in detail the Fossils and Fossilization	LI 5.3. T.S. & L.S. of gymnosperm stem	**CI5.3** Study the Fossils and Fossilization	**SL5.3** Delve deeper into the processes of fossilization and the study of taphonomy
	SO5.4 Explain in detail Fossilization and Taphonomy		**CI5.4** Detail explanation of Fossilization and Taphonomy.	

	SO5.5 Explain in detail Methods of Studying Fossils		**CI5.5 Study the** Methods of Studying Fossils	
	SO5.6 Describe and define the Major Plant Fossil Groups		**CI5.6**Study the Major Plant Fossil Groups	
	SO5.7 Explain in detail the General Characteristics of Gymnosperms		**CI5.7**Study the general Characteristics of Gymnosperms.	
	SO5.8 Define the Fossil Gymnosperms - Lyginopteris		**CI5.8**Discuss the Fossil Gymnosperms – Lyginopteris.	
	SO5.9 Discuss the Study of Cycadales (Cycas).		**CI5.9** Discuss the Study of Cycadales (Cycas)	
	SO5.10 Define the Study of Coniferales (Pinus).		**CI5.10 Study the** Study of Coniferales (Pinus).	
	SO5.11 Discuss the Study of Gnetales (Gnetum).		**CI5.11 Study the** Study of Gnetales (Gnetum) **.**	
	SO5.12Define the Economic Importance of Gymnosperms.		**CI5.12 Study the** Economic Importance of Gymnosperms.	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Explain in detail Paleobotany
	SW5.2 Mini Project	Describe in the detail the Gymnosperms.
	SW5.3 Other Activities (Specify)	Analyze fossil specimens of various plant groups.

Course duration (in hours) to attain Course Outcomes:

Course Title: Plant diversity **Course Code:** 01BO801

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1: Understand the classification and description of Plant	12	4	5	1	22
CO2: Acquire knowledge about plants and their utilization	12	4	5	1	22
CO3: Identify the economic importance of plants	12	6	2	1	21
CO4: Recognize basic distribution patterns and structural organization of plants.	12	4	4	1	21
CO5: Comprehend concepts in the evolution of plants.	12	6	3	1	22
Total Hours	60	23	19	05	108

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcomes:

Course Title: Plant diversity **Course Code:** 01BO801

***Legend*:R,** Remember; **U,** Understand; **A,** Apply; **A,** Analyze

Course Outcomes	Marks Distribution				Total Marks
	R	U	A	A	
CO1: Understand the classification and description of Plant	2	2	3	2	9
CO2: Acquire knowledge about plants and their utilization	2	3	3	2	10
CO3: Identify the economic importance of plants	2	2	3	4	11
CO4: Recognize basic distribution patterns and structural organization of plants.	2	2	3	3	10
CO5: Comprehend concepts in the evolution of plants.	2	2	2	4	10
Total Marks	**10**	**11**	**14**	**15**	**50**

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1.	An Introduction to the Algae. Morries, I. 1986Cambridge University Press, U.K.
2.	**The Biology of Algae, Round, F.E.1986 Cambridge University Press, Cambridge.**
3.	The algae: A review. Prescott G. W. (1969). Nelson, London.
4.	Algae. S. Chand & Co., Vashishta B.R. (1988). New Delhi.
5.	The interrelationships of the Bryophyte. S.R. Technic, Cavers, F. (1976). Ashok Rajpath, Patna.

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Visit to animal biotechnology lab and stem cells biology lab
7. Demonstration
8. ICT Based teaching Learning
9. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Sc. Botany

Semester-8th sem

Course Title: Plant diversity

CO/PO/PSO Mapping															
Course Outcome (Cos)	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1: Understand the classification and description of Plant	3	2	-	2	2	1	-	-	1	1	2	-	2	2	2
CO2: Acquire knowledge about plants and their utilization	3	3	1	2	3	1	-	-	-	2	3	1	2	2	3
CO3: Identify the economic importance of plants	2	1	1	2	2	2	-	2	-	2	1	1	3	2	1
CO4: Recognize basic distribution patterns and structural organization of plants.	2	3	-	3	2	2	-	2	-	2	2	1	3	2	2
CO5: Comprehend concepts in the evolution of plants.	3	3	-	3	2	2	2	2	1	2	2	2	3	2	2

Course Code: -01BO801

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO1-01BO8011.1**: Understand the classification and description of Plant.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9,SO1.10,SO1.11,SO1.12.	LI 1 LI 2	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9,1.1 0,1.11,1.12.	1SL-1,2,3,4,5
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO2-S4-B0TA1T1.2**: Acquire knowledge about plants and their utilization.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9 SO2.10 SO2.11 SO2.12	LI 1 LI 2	2.1,2.2,2.3,2.4,2.5, 2.6,2.7,2.8,2.9,2.1 0,2.11,2.12.	2SL-1,2,3,4,5
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO3-01BO8011.3**: Identify the economic importance of plants.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9 SO3.10 SO3.11 SO3.12	LI 1 LI 2	3.1,3.2,3.3,3.4,3.5, 3.6,3.7,3.8,3.9,3.1 0,3.11,3.12	3SL-1,2
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO4-01BO8011.4:** Recognize basic distribution patterns and structural organization of plants.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8 SO4.9 SO4.10 SO4.11 SO4.12	LI 1 LI 2	4.1,4.2,4.3,4.4,4.5, 4.6,4.7,4.8,4.9,4.1 0,4.11,4.12	4SL-1,2,3,4
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO5-01BO8011.5:** Comprehend concepts in the evolution of plants.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9 SO5.10 SO5.11 SO5.12	LI 1 LI2 LI3	5.1,5.2,5.3,5.4,5.5, 5.6,5.7,5.8,5.9,5.1 0,5.11,5.12	5SL-1,2,3

Program Name	**Bachelors of Science (B.Sc.)- biology**	
Semester	8th	
Course Code:	01ZO802	
Coursetitle:	Museology and Taxidermy	**Curriculum Developer**: Mr. Amit Bagri
Pre-requisite:	To study this course student must have had the subject zoology in B.Sc. 3rd Year/Degree	
Rationale:	Taxidermy is the art of preserving an animals' body by mounting or stuffing, for the purpose of display or study. Animals are often, but not always, portrayed in a lifelike state.	
Course Outcomes (COs):	01ZO802 **.1:** Understand how to established and maintain an animal museum. 01ZO802 **.2:** Understand the significance of museum. 01ZO802 **.3:** learn the procedure of taxidermy. 01ZO802 **.4:** learn the technique of the preparing Alizarin skeletal staining. 01ZO802 **.5:** know about employment opportunities as taxidermist, curator, Museum maintenance technician and museum keeper.	

Scheme of Studies:

Board of Study	**Course Code**	**Course Title**	**Scheme of studies (Hours/Week)**					**Total Credits(C) (L: T:P=4:0:2)**
			Cl	LI	SW	SL	**Total Study Hours (CI+LI+SW+SL)**	
MAJOR	01ZO802	Museology and Taxidermy	4	2	1	2	9	4+2=6

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory and Practical

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)		
MAJOR	01ZO802	Museology and Taxidermy	**15**	**20**	**10**	**5**	**50**	**50**	**100**

Scheme of Assessment: Practical

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)		
Major	01ZO802	Museology and Taxidermy	35	5	5	5	50	50	50

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	12	04	01	04	21

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
01ZO802 **.1:** Understand how to established and maintain an animal museum.	**SO1.1** Define and Describe concept, DEVELOPMENT AND TYPES OF MUSEUMS.	**LI1.1** Collection, preservation curation, and identification of animals.	**Unit 1** Define and Describe concept, DEVELOPMENT	**SL1.1** Search various reference books and study material to start the learning
	SO1.2 Describe about Characteristic features of Ideal Museum.		**CI1.1** Describe about Characteristic features of Ideal Museum.	**SL1.2** Check the Characteristic features of Ideal Museum.
	SO1.3 Explain about collection of animal method.	**LI1.2** Preparations and Identification of nets and gears.	**CI1.2** Explain about collection of animal method.	**SL1.3** Learn about collection of animal method.
	SO1.4 Describe collection and preservation technique of vertebrate's animals.		**CI1.3** Describe collection of vertebrates animals.	**SL1.4** Enlist the collection and preservation technique of vertebrates animals.
	SO1.5 Describe collection and preservation technique of In vertebrates animals.		**CI1.4** Describe catching by hand?	
	SO1.6 Define and Describe concept, TYPES OF MUSEUMS.		**CI1.5** Define and Describe concept, TYPES OF MUSEUMS.	
	SO1.7 Describe preservation technique of vertebrate's animals.		**CI1.6** Describe preservation technique of vertebrate's animals.	
	SO1.8 Describe netting?		**CI1.7** Describe netting?	
	SO1.9 Describe digging and draining?		**CI1.8** Describe digging and draining?	
	SO1.10 Describe trapping?		**CI1.9** Describe trapping?	
	SO1.11 Describe shooting?		**CI1.10** Describe shooting?	
	SO1.12 explain concept of museum ?		**CI1.11** Study of museum?	
			CI1.12 explain concept of museum ?	

Suggested Sessional Work (SW):*anyone*	**SW1.1** Assignments	Describe about Characteristic features of Ideal Museum
	SW1.2 Mini Project	Describe collection and preservation technique of vertebrate's animals.
	SW1.3 Other Activities (Specify)	Describe collection and preservation technique of In vertebrates animals

Item	Cl	LI	SW	SL	Total
Approx.Hrs	13	06	01	04	24

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self -Learning (SL)
01ZO802 **.2:** Understand the significance of museum.	**SO2.1** Assess the concept of collection and preservation of insects.	**LI2.1** Identification and labelling of collected animals.	**Unit-II** **CI2.1** Assess the concept of collection of insects.	**SL2.1** Enlist the concept of collection and preservation of insects.
	SO2.2 Explain about collection and preservation of Fishes.		**CI2.2** Explain about and preservation of Fishes.	**SL2.2** Assess about collection and preservation of Fishes.
	SO2.3 Explain about Embaling.	**LI2.2** Preparation of paraments slides, locally available small organism.	**CI2.3** Explain about Embalming.	**SL2.3** Learn Embaling.
	SO2.4 Explain about Injecting	**LI2.3** Preparation of basic fixatives, stains and regents.	**CI2.4** Explain about Injecting	**SL2.4** Learn about Injecting
	SO2.5 Explain the concept of preservation of insects. **SO2.6** Explain about preservation of Fishes.		**CI2.5** Assess the concept of preservation of insects. **CI2.6** Explain about preservation of Fishes.	
	SO2.7 Describe colleting net?		**CI2.7** Describe colleting net?	
	SO2.8 Describe aspirator and traps?		**CI2.8** Describe aspirator and traps?	
	SO2.9 Describe killing bottle and insect's box?		**CI2.9** Describe killing bottle and insects box?	
	SO2.10 Describe protection of insects?		**CI2.10** Describe protection of insects?	
	SO2.11 Study of fish trap?		**CI2.11** Study of fish trap?	
	SO2.12 Describe deep frizzing?		**CI2.12** Describe deep frizzing?	
	SO2.13 Describe chemical preservation?		**CI2.13** Describe chemical preservation?	

Suggested Sessional Work (SW) :*anyone*		
	SW2.1 Assignments	Assess the concept of collection and preservation of insects.
	SW2.2 Mini Project	Explain about Embaling.
	SW2.3 Other Activities (Specify)	Explain about Injecting.

Item	Cl	LI	SW	SL	Total
Approx .Hrs	13	06	01	04	24

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
01ZO802 **.3:** learn the procedure of taxidermy.	**SO3.1** Explain the Definition, History, scope and significance of Taxidermy.	**LI3.1** Observe and understand the procedure of taxidermy.	**Unit-III** **CI3.1** Explain the Definition Taxidermy.	**SL3.1** Read about various types of nucleic acids and its derivatives.
	SO3.2 Assessing the protection and storage of animal before taxidermy.	**LI3.2** Observe and understand the birds Skelton.	**CI3.2** Assessing the protectio of animal before taxidermy.	**SL3.2** Illustrate structure of different types of DNA and RNA
	SO3.3 Explaining types and process of taxidermy.	**LI3.3** Assessing the protection and storage of animal before taxidermy.	**CI3.3** Explaining types of taxidermy.	**SL3.3** Study the variation in DNA structure from Watson and Crick model.
	SO3.4 Assessing Rogue taxidermy.		**CI3.4** Assessing Rogue taxidermy.	**SL 3.4** Study the mechanism of central dogma
	SO3.5 Describe about Anthropomorphic taxidermy.		**CI3.5** Describe about Anthropomorphic taxidermy.	
	SO3.6 Assessing the conservation and restoration of taxidermy.		**CI3.6** Assessing the conservation and restoration of taxidermy.	
	SO3.7 Explain the, History of Taxidermy.		**CI3.7** Explain the, History of Taxidermy.	
	SO3.8 Explain the scope of Taxidermy.		**CI3.8** Explain the scope of Taxidermy.	
	SO3.9 Explain the significance of Taxidermy.		**CI3.9** Explain the significance of Taxidermy.	
	SO3.10 Explaining process of taxidermy.		**CI3.10** Explaining process of taxidermy.	
	SO3.11 Assessing the storage of animal before taxidermy.		**CI3.11** Assessing the storage of animal before taxidermy.	
	SO3.12 Explain skin mount?		**CI3.12** Explain skin mount?	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Assessing Rogue taxidermy.
	SW3.2 Mini Project	Describe about Anthropomorphic taxidermy.
	SW3.3 Other Activities (Specify)	Assessing the conservation and restoration of taxidermy.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	10	04	01	04	19

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
01ZO802 **.4:** learn the technique of the preparing Alizarin skeletal staining.	**SO4.1** Exploring the Preparation of Skelton.	**LI4.1** Alizarin Skelton stating.	**Unit-IV** **CI4.1** Exploring the Preparation of Skelton.	**SL4.1** Learn about Skelton
	SO4.2 Assessing Labelling and marketing kit		**CI4.2** Assessing Labelling and marketing kit	**SL4.2** Discuss Labelling and marketing kit
	SO4.3 Explaining the Purpose of cataloging.		**CI4.3** Explaining the Purpose of cataloging.	**SL4.3** Learn about Purpose of cataloging.
	SO4.4 Explaining the arrangement of Specimens and slides.	**LI4.2** Physical/virtual visit in museum.	**CI4.4** Explaining the arrangement of Specimens and slides.	
	SO4.5 Evaluate role of fatty acids, phospholipids		**CI4.5** Evaluate role of fatty acids, phospholipids	**SL4.4** Learn about role of fatty acids, phospholipids
	SO4.6 Describe the precaution.		**CI4.6** Describe the precaution.	
	SO4.7 Describe the steps?		**CI4.7** Describe the steps?	
	SO4.8 Describe the removal of the soft organs?		**CI4.8** Describe the removal of the soft organs?	
	SO4.9 Describe the removal of the muscles?		**CI4.9** Describe the removal of the muscles?	
	SO4.10 Describe the preservation?		**CI4.10** Describe the preservation?	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Explaining the Purpose of cataloguing.
	SW4.2 Mini Project	Explaining the arrangement of Specimens and slides.
	SW4.3 Other Activities (Specify)	Describe the precaution.

Course duration (in hours) to attain Course Outcomes:

Course Title: Museology and Taxidermy **Course Code:** 01ZO802

Course Outcomes(COs)	Class lecture (CI)	Laboratory Instruction(LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
01ZO802 **.1:** Understand how to established and maintain an animal museum.	12	4	4	1	21
01ZO802 **.2:** Understand the significance of museum.	13	6	4	1	24
01ZO802 **.3:** learn the procedure of taxidermy.	12	6	4	1	23
01ZO802 **.4:** learn the technique of the preparing Alizarin skeletal staining.	10	4	4	1	19
01ZO802 **.5:** know about employment opportunities as taxidermist, curator, Museum maintenance technician and museum keeper.					
Total Hours	47	20	16	04	87

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Museology and Taxidermy **Course Code:** 01ZO802

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
01ZO802 **.1:** Understand how to established and maintain an animal museum.	2	1	1	1	5
01ZO802 **.2:** Understand the significance of museum.	2	4	2	2	10
01ZO802 **.3:** learn the procedure of taxidermy.	3	5	5	2	15
01ZO802 **.4:** learn the technique of the preparing Alizarin skeletal staining.	2	3	3	2	10
01ZO802 **.5:** know about employment opportunities as taxidermist, curator, Museum maintenance technician and museum keeper.	5	4	1	0	10
Total Marks	**14**	**17**	**12**	**07**	**50**

***Legend*: A,** Apply;**An,** Analyze;**E,** Evaluate;**C,** Create

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1	Alexis turner, TAXIDERMY , Thomas and Hudson
2	Dalela RC, & Sharma RS, ANIMAL TAXONOMY AND MEUSEOLOGY jp nath & company meerut
3	Anderson Rudolph Method of collecting & preserving vertebrates animals.

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture

2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Demonstration
7. ICT Based teaching Learning
8. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Sc. biology
Semester: 8th
Course Title: Museology and Taxidermy
Course Code: 01ZO802

CO/PO/PSO Mapping								
Course Outcome (Cos)	**Program Outcomes (POs)**					**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**
01ZO802 **1:** Understand how to established and maintain an animal museum.	3	3	1	3	1	2	2	1
01ZO802 **.2:** Understand the significance of museum.	2	1	3	2	2	2	2	2
01ZO802**.3:** learn the procedure of taxidermy.	3	1	1	3	2	1	2	3
01ZO802 **.4:** learn the technique of the preparing Alizarin skeletal staining.	2	1	3	2	2	3	2	3
01ZO802 **.5:** know about employment opportunities as taxidermist, curator, Museum maintenance technician and museum keeper.	3	1	1	2	2	2	3	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5 PSO 1,2,3	01ZO802 **1:** Understand how to established and maintain an animal museum.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12	1.1,1.2	1.1,1.2,1.3,1.4,1.5 1.6,1.7,1.8,1.9,1.10,1.11,1.12	1SL-1,2,3,4
PO 1,2,3,4,5 PSO 1,2,3	01ZO802 **.2:** Understand the significance of museum.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9 SO2.10 SO2.11 SO2.12 SO2.13	2.1, 2.2, 2.3	2.1,2.2,2.3,2.4,2.5, 2.6,2.7,2.8,2.9,2.10,2.11,2.12,2.13	2SL-1,2,3,4
PO 1,2,3,4,5 PSO 1,2,3	01ZO802 **.3:** learn the procedure of taxidermy.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9 SO3.10 SO3.11 SO3.12	3.1,3.2,3.3	3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9,3.10,3 .11,3.12	3SL-1,2,3,4
PO 1,2,3,4,5 PSO 1,2,3	01ZO802 **.4:** learn the technique of the preparing Alizarin skeletal staining.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8 SO4.9 SO4.10	4.1,4.2	4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9,4.10	4SL-1,2,3,4
PO 1,2,3,4,5 PSO 1,2,3	01ZO802 **.5:** know about employment opportunities as taxidermist, curator, Museum maintenance technician and museum keeper.				

B.Sc. VIIIth Semester

Code: 01CH803

Course Name: Differaction Methods And Spectroscopy II

Pre-requisite: Students should have basic knowledge of symmetry, symmetry elements, and symmetry operation. They may also know about EMR, mode of vibration, M-L bond, coordination number, diffraction, Scattering and reflection.

Rationale: Up on completion of the course student shall be able to learn about system property analyzed using group theory. They reveal information on the hyperfine interactions and ESR, *acquainted with paramagnetic species.* Understand elucidation of the crystal structure by using x-ray.

CourseOutcomes:

Afterthe completionofthiscourse, thelearner will –

01CH803.1: Explain the symmetry and group theory provides a powerful framework to understand and analyze patterns, structures, and behaviors across various disciplines.

01CH803.2: Describe and apply the knowledge which helps in identifying and characterizing specific vibrational frequencies..

01CH803.3: Collectively aim to provide students with a comprehensive discussion of the theory, operation, data analysis, and applications of Raman spectroscopy.

01CH803.4:Students would gain a comprehensive apply the theoretical foundations, practical aspects, and diverse applications of ESR spectroscopy.

01CH803.5: Collectively aim to equip students with a comprehensive explanation of the theoretical principles, practical methodologies, and diverse applications of diffraction techniques.

UNIT-I

Symmetry and Group Theory: Schonflies symbols, representations of groups by matrices (representation for the C_n, C_{nv}, C_{nh}, etc groups to be worked out explicitly). Character of a representation. The great orthogonality theorem (without proof) and its importance. Character tables and their use in spectroscopy.

UNIT-II Vibrational Spectroscopy

A- **Infrared Spectroscopy:** Review of linear harmonic oscillator, vibration energies of diatomic molecules, Zero point energy, force constants and bond strengths, anharmonicity, Morse potential energy diagrams, vibration-rotation spectroscopy, P,Q,R branch's, breakdown of Oppenhimer approximation, vibration of poly atomic molecules, selection rules, normal modes of vibrations, group frequencies, overtones, hot bands, factors affecting band positions and intensities, far IR region, metal ligand vibrations,

UNIT-III

Raman Spectroscopy:

Classical and quantum theories of Raman effect. Pure vibrational- rotational Raman Spectra, mutual exclusion

principle, Resonance Raman Spectroscopy, coherent anti-stokes Raman Spectroscopy (CARS).

UNIT-IV

Magnetic Resonance Spectroscopy

a.Electron spin Resonance Spectroscopy

Basic principles, zero field splitting and Kramer's degeneracy, factors affecting the 'g' value. Isotropic and anisotropic hyperfine coupling constants, spin Hamiltonian, spin densities and McConnell relationship, measurement techniques, applications.

b.Nuclear Quadrupole Resonance Spectroscopy

Quadrupole nuclei, quadrupole moments, electric field gradient, coupling constant splitting. Applications.

UNIT-V

X-ray Diffraction

a. Bragg condition, Miller indices, Laue method, Bragg method, Debye-Scherrer method of X-ray structural analysis of crystals, index reflections, identification of unit cells from systematic absences in diffraction pattern..

b.Electron Diffraction

Scattering intensity vs. scattering angle, Wierl equation, measurement technique, elucidantion of structre of simplegas phase molecules. Low energy electron diffraction and structure of surfaces.

c. Neutron Diffraction

Scattering of neutrons by solids and liquieds, magnetic scattering, measurement techniques. Elucidation of structureof Magnetically ordered unit cell.

Scheme of Studies:

Board ofStudy	CourseCode	CourseTitle	Scheme ofstudies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours(Cl+LI+SW+SL)	
ProgramCore(PCC)	01CH803	Diffraction Methods And Spectroscopy II	4	0	1	1	6	4

Legend:

CI: Class room Instruction(Includesdifferentinstructionalstrategiesi.e.Lecture(L)andTutorial (T)Andothers),

LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different in structional strategies)

SW: Sessional Work (includes assignment, seminar,miniprojectetc.),

SL: Self Learning,
C: Credits.

Note: SW& SL has to be planned and performed under the continuous guidance and feed back of teacher to ensure outcome ofLearning.

Scheme of Assessment: Theory

Board ofStudy	Couse Code	CourseTitle	SchemeofAssessment(Marks)						
			ProgressiveAssessment(PRA)					EndSemesterAssessment (ESA)	Total Marks (PRA+ESA)
			Class/HomeAssignment 5number 3 marksea ch (CA)	Class Test2 (2bestout of3) 10 marks each(CT)	Seminarone (SA)	ClassAttendance (AT)	TotalMarks (CA+CT+SA +AT)		
PCC	01CH803	Diffraction Methods And Spectroscopy II	15	20	10	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs)upon the course's conclusion.

01CH803.1: Explain the symmetry and group theory provides a powerful framework to understand and analyze

patterns, structures, and behaviors across various disciplines

Approximate Hours

Activity	Apex Hrs
CI	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO1.1 Restate group operations, including, identity element, inverses, and their significance in defining groups. SO1.2 Describe mathematical representations of groups by matrices. SO1.3 Explain and apply the applications of group actions in permutation groups and geometry. SO1.4 Discuss the representation of character table for different point group. SO1.5 Explain and apply representation theory, character theory, and the relationship between groups and linear transformations		**Unit-1 Symmetry and Group Theory** symmetry and symmetry elements Schonflies symbols of symmetry element s, Point group of molelcules. Identification of point group. Representations of groupsby matrices Matrices representation for the C_n, C_{nv}, C_{nh}, etc group's symmetry operation. Irreversible reducible (IR) representation of point group Formation of character table for C_n, C_{nv}, C_{nh}, etc group's. Reversible	Worked out C_n, C_{nv},C_{nh}, etc groups.

		reducible (RR) representation of point group bycharacter table. T1-Explanation the great orthogonality theorem (without proof) and T2- its importance. T3- Character tables and their use in spectroscopy. .	

SW-1Suggested Sessional Work(SW):

a. Assignments:

Discuss the Character table representation for C2V and C3V point group.

b. Mini Project:

The great orthogonality theorem (without proof) and its importance.

c. Other Activities (Specify):
Character tables and their use in spectroscopy.

01CH803.2: Describe and apply the knowledge which helps in identifying and characterizing specific vibrational frequencies.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO2. Restate the classificationof different types of vibrational modes in molecules. **SO2.2** Describe the fundamental principles of vibrational spectroscopy, including the interaction oflight with molecular vibrations, the concept of infrared (IR) **SO2.3** Explain and apply Zero point energy, force constants and bond strengths **SO2.4** Restate the concept ofanharmonicity, Morse potential energy diagrams, vibration-rotation spectroscopy, P, Q, R branch's . **SO2.5** Discuss factors affecting band positions andintensities, Classical and quantum theories of Raman effect..		**Unit-2.0 Infrared Spectroscopy** Classification of different types molecules vibrational modes in molecules (stretching, bending, torsional, etc.). degree of freedom IR activity. Review of linear harmonic oscillator, vibrational energies of diatomic molecules. Zero point energy, overtones, hot bands, factors affecting band positions, force constants and intensities, T1-Breakdown of Oppenhimer approximation, vibration of poly atomic molecules, selection rules. T2- Pure vibrational- rotational Raman Spectra, mutual exclusion principle. T3- factors affecting band positions and intensities, far IR region, metal ligand vibrations,	Resonance Raman Spectroscopy, coherent anti-stokes Raman Spectroscopy (CARS).

SW-2 Suggested Sessional Work (SW):

A .Assignments:

Discussion of Morse potential energy diagrams, vibration-rotation spectroscopy, P,Q,R branch's.

b. Mini Project:

Problem-solving exercises involving spectral interpretation, solving practical spectroscopic problems, and identifying unknown compounds from spectra.

c. Other Activities (Specify):

Write an essay on Resonance Raman Spectroscopy, coherent anti-stokes Raman Spectroscopy (CARS).

01CH803.3: Collectively aim to provide students with a comprehensive discussion of the theory, operation, data analysis, and applications of Raman spectroscopy

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (Cl)	Self Learning (SL)
SO3.1 Restate Classical and quantum theories of Raman effect **SO3.2** Discuss the Pure vibrational-rotational Raman Spectra. **SO3.3** Explain and apply mutual exclusion principle, Resonance **SO4** Discuss Raman Spectroscopy, coherent anti-stokes Raman Spectroscopy (CARS).		**Unit-3.0 Raman Spectroscopy**: 3.1Introduction of raman effect. Cause of raman effect. elastic collision. inelastic collision. Classical theories of Raman effect. Quantum theories of Raman effect. Pure vibration	(CARS). at

		al-rotational Raman Spectra, mutual exclusion principle, Resonance Raman Spectroscopy, T1-coherent anti-stokes Raman Spectroscopy (CARS). T2-. apply mutual exclusion principle, Resonance T3- Application of Raman spectroscopy	

SW-3 Suggested Sessional Work (SW):

a.Assignments:

Classical and quantum theories of Raman effect.

b.Mini Project:

Coherent anti-stokes Raman Spectroscopy (CARS).

c.Other Activities (Specify):

Explanatory note on importance of Raman Spectroscopy

01CH803.4: Students would gain a comprehensive apply the theoretical foundations, practical aspects, and diverse applications of ESR spectroscopy**.**

Activity	AppX Hrs
CI	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes(SOs)	Laboratory Instruction (LI)	Class room Instruction(CI)	Self Learning(SL)
SO4.1 Explain and apply materials with unpaired electrons, Introduction of ESR, basic principles of ESR SO4.2 Restate Theory/origin of an ESR Signal, Zeeman effect magnetic moment and spin quantum number. SO4.3 Discuss zero fields splitting and Kramer's degeneracy. SO4.4Explain and apply Isotropic and anisotropic hyperfine coupling constants,spin densities and McConnell relationship. SO4.5 Discuss valuable insights into the molecular structure, dynamics, and composition of materials containing nuclei with a non-zero quadrupole moment,		Unit-4.0 Magnetic Resonance Spectroscopy- ESR Spectroscopy& NQR Local environment of the molecule, Electron distribution within the molecule, Magnitude of magnetic moment, Identification of free radicals 4.4. Determination of structure of molecules. Magnetic moment and spinquantum number, gyromagnetic ratio Lande g factor, bohr magneton. Factors affecting the 'g' value. zero field splitting Kramer's degeneracy, degeneracy of the electron spin states degeneracyof the electron spin states, T1- Hyperfine splitting: Selection Rule, Super hyperfinesplitting , T2- Zero field splitting and Kremer degeneracy spin Hamiltonian, spin densities and McConnell relationship **T3-**Quadrupole nuclei, quadrupole moments, electric field gradient, coupling constant splitting.Applications	Factors affecting the 'g' value. Isotropic and anisotropic hyperfine coupling constants

SW-4 Suggested Sessional Work (SW):

e. Assignments:

Zero field splitting and Kramer's degeneracy

b. Mini Project:

Application of ESR and NQR

f. Other Activities (Specify):

Analysis of polynuclear hydrocarbons

01CH803.5: Collectively aim to equip students with a comprehensive explanation of the theoretical principles, practical methodologies, and diverse applications of diffraction techniques.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes(SOs)	Laboratory Instruction (LI)	Class room Instruction(Cl)	Self Learning(SL)
SO5.1 Apply introduction of X-ray Diffraction determination crystallographic structure of materials. SO5.2 Describe identification of unit cells from systematic absences in diffraction pattern.. SO5.3 Analyzing the diffraction pattern produced when electrons interact with a crystal, SO5.4Explain and apply Low energy electron diffraction and structure of	.	Unit-5.0 X-ray Diffraction , Electron Diffraction, Neutron Diffraction Determination crystallographic structure of materials. Bragg condition, Miller indices, Laue method, Bragg method.	magnetic scattering, measurement techniques

		Debye-Scherrer method of X- ray structural analysis of crystals, index reflections,	
surfaces. SO5.5 Explain and apply basic ideas about Neutron DiffractionScattering of neutrons by solids and liquids'		Scattering intensity vs. scattering angle, Wierl equation, measurement technique, deduction of positions of atomsin the crystal lattice 5.8Measurement technique, elucidation of structure of simple gas phase molecules. 5.9 LEED and structure of surfaces. T1- Scattering of neutrons by solids and liquids, T2-magnetic scattering, measurement techniques. T3-Elucidation of structure of Magnetically ordered unit cell.	

SW-5 Suggested Sessional Work (SW):

a. Assignments:

Identification of unit cells from systematic absences in diffraction pattern.

g. Mini Project:

Measurement technique, elucidation of structure of simple gas phase molecules

h. Other Activities (Specify):

Scattering of neutrons by solids and liquids, magnetic scattering

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
01CH803.1: Understand the symmetry and group theory provides a powerful framework to understand and analyze patterns, structures, and behaviors across various disciplines	12	02	01	15
01CH803.2: Describe and apply the knowledge which helps in identifying and characterizing specific vibrational frequencies.	12	02	01	15
01CH803.3: Collectively aim to provide students with a comprehensive understanding of the theory, operation, data analysis, and applications of Raman spectroscopy.	12	02	01	15
01CH803.4:Students would gain a comprehensive understanding of the theoretical foundations, practical aspects, and diverse applications of ESR spectroscopy.	12	02	01	15
01CH803.5: Collectively aim to equip students with a comprehensive understanding of the theoretical principles, practical methodologies, and diverse applications of diffraction techniques.	12	02	01	15

Total Hours	60	10	05	75

Suggestion for End Semester Assessment

Suggested SpecificationTable(ForESA)

CO	UnitTitles	MarksDistribution			Total Marks
		R	U	A	
CO-1	Symmetry and Group Theory	03	01	01	05
CO-2	Vibrational Spectroscopy	02	06	02	10
CO-3	Raman Spectroscopy	03	07	05	15
CO-4	Magnetic Resonance Spectroscopy	-	10	05	15
CO-5	X-ray Diffraction , Electron Diffraction Neutron Diffraction	03	02	-	05
Total		11	26	13	50

Legend: **R:Remember, U:Understand, A:ApplyTheendofsemesterassessmentforOrganic Chemistry I willbeheldwithwrittenexaminationof50 marks**

Note.DetailedAssessmentrubricneedtobepreparedbythecoursewiseteachersforabovetasks. TeacherscanalsodesigndifferenttasksasperrequirementforendsemesterassessmentforOrganic Chemistry I willbeheldwithwrittenexaminationof50 marks

Suggested Instructional/Implementation Strategies:

37. ImprovedLecture
38. Tutorial
39. CaseMethod
40. GroupDiscussion
41. RolePlay
42. Visitto NCL, CSIR laboratories
43. Demonstration
44. ICTBasedTeachingLearning(VideoDemonstration/TutorialsCBT,Blog,Facebook,Twitter,Whatsapp,Mobile,Onlinesources)

45. Brainstorming

Suggested Learning Resources

(a) Books:

S.No.	Title	Author	Publisher	Edition& Year
1	Modern Spectroscopy	J. M. Hoilas	John Wiley.	Revised editionedition2020
2	Applied Electron Spectroscopy for Chemical Analysis	Ed. H. Windawi and F. L. HO	Wiley Interscience.	New edition, 2021
3	NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry	R. V. Parish	Ellis Harwood.	New edition, 2021
4	Physical Mehtods in Chemistry	R. S. Drago	Saunders College.	Revised edition
5	Chemical Applications of Group Theory	F. A. Cotton.	--	Revised edition
6	Introduction to Molacular Spectroscopy	G. M. Barrow	McGRraw Hill.	Revised edition

SuggestedWebSources:

20. https://nptel.ac.in/course.html
21. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
22. https://swayam.gov.in/explorer?category=Chemistry

ModeofDelivery:Lecture,demonstration,E-tutoring,discussion,assignments,quizzes, case study, power point;

LMS/ICT Tools: Digital Classrooms, DLMS, ZOOM, G-Suite,MSPower-Point, Online Resources

AKS University

Faculty of Basic Science

Curriculum of B. Sc. (Honours / By Research) Program

(Revised as on 01 August 2023)

Course Title: Group theory and spectyroscvopy **Course Code : 76CH204**

	Program Outcomes												Program Specific Outcome			
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7	PO 8	PO 9	PO 10	PO 11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
Course Outcomes	Knowledge	Research Aptitude	Communication	Problem Solving	Individual and Team Work	Investigation of Problems	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and sustainability	The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry	To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.	understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon- based problems in chemical sciences.	Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science
CO1: Explanation the symmetry and group theory provide a powerful framework	**3**	**1**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**3**	**2**	**2**	**3**	**3**	**1**

to understand and analyze patterns, structures, and behaviors across various disciplines																
CO2: Describe and apply the knowledge which helps in identifying and characterizing specific vibrational frequencies.	**2**	**1**	**2**	**2**	**1**	**2**	**3**	**2**	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**1**
CO3 Collectively aim to provide students with a comprehensive discuss the theory, operation, data analysis, and applications of Raman spectroscopy.	**2**	**2**	**1**	**1**	**1**	**2**	**2**	**2**	**1**	**2**	**1**	**2**	**1**	**1**	**2**	**2**
CO 4 Students would gain a comprehensive apply of the theoretical founda tions, practical	**2**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**2**	**3**	**3**	**3**	**3**	**2**

aspects, and diverse applications of ESR spectroscopy.																
CO 5 Collectively aim to equip students with a comprehensive explanation of the theoretical principles, practical methodologies, and diverse applications of diffraction techniques.	**2**	**-**	**-**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**3**	**1**	**3**

Legend:1–Low,2–Medium, 3–High

POs &PSOsNo.	Cos No. &Titles	SOsNo.	Laboratory instruction(LI)	Classroom Instruction(CI)	Self Learning(SL)	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO1: Understand the symmetry and group theory provide a powerful framework to understand and analyze patterns, structures, and behaviors across various disciplines.	SO1.1SO1.2S O1.3SO1.4 SO1.5		Unit-1.0 Symmetry and Group Theory 1.1,1.2,1.3,1.4,1.5,1.6,1.7	Character tables spectroscopy.	an theius i d r e n
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO2: Describe and apply the knowledge which helps in identifying and characterizing specific vibrational frequencies.	SO2.1SO2.2S O2.3 SO2.4 SO2.5		Unit-2 Vibrational Spectroscopy 2.7, 2.8,2.9	2.1,2.2,2.3,2.4,2.5, 2.6,	Resonance Raman Spectroscopy, coherent ant i-stokes Raman Spectroscopy (CARS).

PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3 Collectively aim to provide students with a comprehensive understanding of the theory, operation, data analysis, and applications of Raman spectroscopy	SO3.1SO3.2SO3.3 SO3.4 SO3.5		Unit-3 :Mössbauer Spectroscopy 3.1, 3.2,3.3,3.4,3.5,3.6,3.7	Nature of M-L bond, coordination number, structure and detection of oxidation state.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4 Students would gain a comprehensive understanding of the theoretical foundations, practical aspects, and diverse applications of ESR spectroscopy.	SO4.1SO4.2SO4.3SO4.4 SO4.5		Unit-4 : :Magnetic Resonance Spectroscopy 4.1, 4.2,4.3,4.4,4.5,4.6,4.7	Quadrupole nuclei, quadrupole moments, electric field gradient, coupling constant splitting. Applications
PO1,2,3,4,5,6	CO 5 Collectively aim to equip students with a comprehensive	SO5.1SO5.2SO5.3SO5.4		Unit 5: X-ray Diffraction , Electron DiffracNeutron Diffraction 5.1,5.2,5.3,5.4,5.5,5.6,5.7	Low energy electron diffraction and structure of surfaces.

7,8,9,10,11, 12 PSO 1,2, 3, 4	understanding of the theoretical principles, practical methodologies, and diverse applications of diffraction techniques.	SO5.5			,

Curriculum Development Team:

1. Dr. Shailendra Yadav, HoD, Department of Chemistry, AKS University, Satna (M.P.).
2. Dr. Dinesh Kumar Mishra, Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
3. Dr. Samit Kumar,Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
4. Dr. Sushma Singh, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
5. Dr. Manoj Kumar Sharma, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
6. Mr. Kanha Singh Tiwari,Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
7. Mrs. Nahid Usamani, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).

Program Name	**Bachelor of Science (B.Sc.)- Biology**	
Semester	8th	
Course Code:	02BO801	
Course title:	Industrial Microbiology	**Curriculum Developer**: Er. Arpit Srivastava, Assistant Professor
Pre-requisite:	Students should have basic knowledge of microbiology and fermentation.	
Rationale:	Industrial microbiology assists industrial production processes using variety of microbial strains. They may examine microbial growth found in the pipes of a chemical factory, monitor the impact industrial waste has on the local ecosystem, or oversee the microbial activities used in cheese production to ensure quality. Fermentation is frequently used for the cultivation of biomass and in the production of enzymes, pharmaceuticals, energy, food and feedstock, bioactive compounds, biopolymers, etc., in which different microorganisms, and including filamentous fungi, are involved. The overall objective of this subject is to make student more relative about their best career opportunity in this field.	
Course Outcomes (COs):	**CO1:** Describe the fundamentals of Industrial Microbiology and Fermentation Technology **CO2:** Define the role of microbiology for the production of desired bioproducts **CO3:** Derive the working mechanism of upstream and downstream processing **CO4:** Interpretate the mechanism of fermentation process in industry **CO5:** Examine the mechanism of biological product development using microbes	

Scheme of Studies:

Board of Study	CourseCode	Course Title	Scheme of studies (Hours/Week)					Total Credits(C) (L:T:P=3:0:1)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Common (PC)	02BO801	Industrial Microbiology	3	1	1	1	6	3+1=4

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)		
PC	02BO801	Industrial Microbiology	**15**	**20**	**10**	**5**	**50**	**50**	**100**

Scheme of Assessment: Practical

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)					
			Progressive Assessment (PRA)				End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 7 marks each (CA)	Seminar (SA)	Class Attendance (AT)	Total Marks (CA+SA+AT)	Practical End Semester	Total
PC	02BO801	Industrial Microbiology	**35**	**10**	**5**	**50**	**50**	**100**

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	10	04	01	05	20

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1: Describe the fundamentals of Industrial Microbiology and Fermentation Technology	**SO1.1** Explain History and Scope of Industrial Microbiology	**LI1.1** Isolation and identification of bacteria, yeast, and fungi from different available sources.	**Unit-1** **CI1.1** History and Scope of Industrial Microbiology	**SL1.1** Search various reference books and study material to start the learning of microorganisms
	SO1.2 Elaborate the Developments of industrial microbiology	**LI1.2** Inoculation of fungi on sterilized glucose and sucrose solutions and identification of the different types of amino acids and organic acids in filtrate during different incubation periods. (by using Chromatography)	**CI1.2** Development and Scope of Industrial Microbiology	**SL1.2** Find out the literature showing use of fermentation technology in ancient India
	SO1.3 Explain Use of Fermentation equipment: Principle, Design, and construction of fermenters.		**CI1.3** Use of Fermentation equipment: Principle, Design, and construction of fermenters.	**SL1.3** Derive the equation representing various mode of fermentations
	SO1.4 Elaborate the Scope and Application of industrial microbiology in human welfare		**CI1.4** Scope and Application of industrial microbiology in human welfare	**SL1.4** Explore different bioproducts manufacture in laboratory
	SO1.5 Contrast Types of fermenters. Batch and Continuous fermenters and their applications.		**CI1.5** Types of fermenters. Batch and Continuous fermenters and their applications.	**SL1.5** Draw a well labelled diagram of a fermenter
	SO1.6 Contrast the characteristics of fermentation media, Raw materials (substrates)		**CI1.6** Characteristics of fermentation media, Raw materials (substrates)	
	SO1.7 Contrast Down streaming Process and product recovery		**CI1.7** Down streaming Process and product recovery	

	SO1.8 Explain Basics of Fermenter		**CI1.8** Basics of Fermenter/bioreactor	
	SO1.9 Describe Examples of Fermentation		**CI1.9** Examples of Fermentation	
	SO1.10 Describe Overview different steps in Fermentation		**CI1.10** Overview of different steps in Fermentation	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Describe in detail "Applications of Microorganisms in various Sectors"
	SW1.2 Mini Project	Draw various types of Fermenters with specifications
	SW1.3 Other Activities (Specify)	List down the tables of different domains of microorganisms which are industrially important

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	10	06	01	05	22

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO2: Define the role of microbiology for the production of desired bioproducts	**SO2.1** Explain the Use of microorganisms in industries through ages.	**LI2.1** Inoculation of bacteria on sterilized glucose and sucrose Solutions.	**Unit-2** **CI2.1** Use of microorganisms in industries through ages.	**SL2.1** Search various reference books and study material to start the learning of microorganisms
	SO2.2 Derive the Commercial use of microorganisms and microbial strains.	**LI2.2** Isolation and identification of different types of fungi from rotten fruits, and vegetables.	**CI2.2** Commercial use of microorganisms and microbial strains.	**SL2.2** Find out the literature showing use of fermentation technology in ancient India
	SO2.3 Compare Strategies for isolation and screening of industrially important microorganisms.	**LI2.3** To prepare the different kinds of nutrient media for microbial culture	**CI2.3** Strategies for isolation and screening of industrially important microorganisms.	**SL2.3** Derive the equation representing various mode of fermentations
	SO2.4 Differentiate Strategies for improvement of industrially important microbial Strains.		**CI2.4** Strategies for improvement of industrially important microbial Strains.	**SL2.4** Explore different bioproducts manufacture in laboratory
	SO2.5		**CI2.5**	**SL2.5**

	Describe the Hygiene and safety in fermentation industries		Hygiene and safety in fermentation industries	Draw a well labelled diagram of a bioreactor
	SO2.6 Examine the Primary and secondary screening, strain development		**CI2.6** Primary and secondary screening, strain development	
	SO2.7 Analyse the industrial fermentation- measurement of parameters		**CI2.7** Overview on industrial fermentation- measurement of parameters	
	SO2.8 Explain Crude and synthetic media; molasses, corn-steep liquor, sulphite waste liquor, whey and yeast extract		**CI2.8** Crude and synthetic media; molasses, corn-steep liquor, sulphite waste liquor, whey and yeast extract	
	SO2.9 Describe Cell disruption techniques		**CI2.9** Cell disruption techniques	
	SO2.10 Derive the equations for Derivation for batch-Fed Batch and Continuous reactors		**Ci2.10** Derivation for batch-Fed Batch and Continuous reactors	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Write down any 5 kinds of Unit Operations used in Downstream Processing
	SW1.2 Mini Project	Draw a well labelled diagram of Bacterial Cell Wall showing gram+/- staining
	SW1.3 Other Activities (Specify)	Watch animation related to working of different kinds of bioreactor used in various industries

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	10	06	01	05	22

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO3: Derive the working mechanism of upstream and downstream processing	**SO3.1** Explain the role of Metabolic pathways	**LI3.1** Isolation and identification of	**Unit-3** **CI3.1** Industrial production and applications	**SL3.1** Search various reference books and study material to start the

		different types of bacteria from rotten fruits, and vegetables	of vinegar	learning of microorganisms
	SO3.2 Define the concept of biological product production	**LI3.2** Collection of different types of mushrooms from local area/ region	**CI3.2** Industrial production and applications of Acetic acid	**SL3.2** Find out the literature showing use of Lactic Acid in industries
	SO3.3 Understand the steps of ABE fermentation	**LI3.3** To prepare the different kinds of nutrient media for microbial culture	**CI3.3** 2 Industrial production and applications of Citric acid	**SL3.3** Derive the mechanism for fermentation of ethanol
	SO3.4 Comprehend the concept of microbial production of enzymes		**CI3.4** Industrial production and applications of antibiotics; Penicillin	**SL3.4** Write about different bioproducts manufacture in laboratory
	SO3.5 Examine the role of metabolic pathways in prokaryotes and eukaryotes		**CI3.5** Industrial production and applications of amino acids; Glutamic acid.	**SL3.5** Find out the applications of enzymes in industries
	SO3.6 Demonstrate Industrial production and applications of amino acids; Lysine		**CI3.6** Industrial production and applications of amino acids; Lysine	
	SO3.7 Interpret Industrial production and applications of Insulin		**CI3.7** Industrial production and applications of Insulin	
	SO3.8 Illustrate Industrial production and applications of Vitamin B12		**CI3.8** Industrial production and applications of Vitamin B12	
	SO3.9 Determine Industrial production and applications of Vitamin B2		**CI3.9** Industrial production and applications of Vitamin B2	
	SO3.10 Demonstrate Industrial production and applications of Biopolymers		**CI3.10** Industrial production and applications of Biopolymers	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Describe in detail cultivation of microorganisms
	SW3.2 Mini Project	Prepare a flowchart showing industrial production of biological products using fermentation
	SW3.3 Other Activities (Specify)	Make a Power Point Presentation on “Different Types of Microbial Culture Media”

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	10	04	01	05	20

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO4: Interpretate the mechanism of fermentation process in industry	**SO4.1** Demonstrate the Microbes as a source of Single Cell Protein (SCP).	**LI4.1** Preparation of spawn for cultivation of edible mushrooms.	**Unit-4** **CI4.1** Microbes as a source of Single Cell Protein (SCP).	**SL4.1** Find out more antibiotics and their production process
	SO4.2 Explain Mushroom cultivation and its nutritional value	**LI4.2** Observation of the antagonism of three antibiotics against common plant pathogens in Petri plates (disc methods).	**CI4.2** Mushroom cultivation and its nutritional value	**SL4.2** List out the role of Antibiotic Resistance Genes
	SO4.3 Classify the difference between Dairy products from microorganisms; butter, yogurt, and cheese.		**CI4.3** Dairy products from microorganisms; butter, yogurt, and cheese.	**SL4.3** Explore the medical applications of Steroids
	SO4.4 Recognize the Food conversions: Lactic acid conversions		**CI4.4** Food conversions: Lactic acid conversions	**SL4.4** Make a flowchart showing metabolic pathway for Vitamin B_{12} and Vitamin B_2
	SO4.5 Derive the Use of microbes in Bread and Bakery production.		**CI4.5** Use of microbes in Bread and Bakery production.	**SL4.5** Explore how Biogas is produced in rural areas of India
	SO4.6 Explain Microbial production of Ethanol		**CI4.6** Microbial production of Ethanol	
	SO4.7 Elaborate the production of Wine		**CI4.7** Wine production	
	SO4.8 Explain ABE Fermentation		**CI4.8** ABE Fermentation	
	SO4.9 Interpret Solid State Fermentation		**CI4.9** Solid State Fermentation	

	SO4.10 Interpret Submerged State Fermentation		**CI4.10** Submerged State Fermentation	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Explain the role of Antibiotics and its disadvantages
	SW4.2 Mini Project	Describe how therapeutics being produced in biotech-based industries
	SW4.3 Other Activities (Specify)	Make a list of "Biogas producing centres in India"

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	10	04	01	03	18

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO5: Examine the mechanism of biological product development using microbes	**SO5.1** Identify Modern trends in microbial production of bioplastics	**LI5.1** To perform the growth of Algae using a photobioreactor column	**Unit-5** **CI5.1** Biopesticides: bacterial, fungal, and viral control of insect pests.	**SL5.1** Explore the various kinds of biopolymers and their applications
	SO5.2 Recognize the production mechanism of different polymer		**CI5.2** Biofertilizer: production and method of application	**SL5.2** Read research on advancement in production of biofertilizers
	SO5.3 Explain the role of biofertilizers in agriculture		**CI5.3** Biofertilizers (Nitrogen fixer Azotobacter, Phosphate solubilizing microorganisms)	**SL5.3** Find out different centres where Single Cell Proteins are used
	SO5.4 Comprehend the role of Azotobacter in biofertilizer		**CI5.4** Bioremediation	
	SO5.5 Production mechanism and importance of Single cell protein		**CI5.5** Production of Biogas from agricultural wastes.	
	SO5.6 Differentiate Different kinds		**CI5.6** Different kinds of	

	of agricultural wastes		agricultural wastes	
	SO5.7 Interpret Downstream processing of Protein based products		**CI5.7** Downstream processing of Protein based products	
	SO5.8 Derive Numerical associated with Microbial growth kinetics		**CI5.8** Derivation and Numerical associated with Microbial growth kinetics	
	SO5.9 Solve Numerical associated with production of different compounds from fermentation		**CI5.9** Numerical associated with production of different compounds from fermentation	
	SO5.10 Demonstrate Production of Amino acid – Typtophan from fermentation		**CI5.10** Production of Amino acid – Typtophan from fermentation	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Explain general characteristics of Biopolymers & their applications
	SW5.2 Mini Project	Describe the production process of Single Cell Production
	SW5.3 Other Activities (Specify)	Prepare one article on Applications of Biofertilizers

Course duration (in hours) to attain Course Outcomes:

Course Title: Industrial Microbiology **Course Code:** 02BO801

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1: Describe the fundamentals of Industrial Microbiology and Fermentation Technology	10	4	5	1	20
Co2: Define the role of microbiology for the production of desired bioproducts	10	6	5	1	22
CO3: Elaborate the working mechanism of upstream and downstream processing	10	6	5	1	22
CO4: Interpretate the mechanism of fermentation process in industry	10	4	5	1	20
CO5: Examine the mechanism of biological product development using microbes	10	4	3	1	18
Total Hours	50	24	23	05	102

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Industrial Microbiology **Course Code:** 02BO801

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
CO1: Describe the fundamentals of Industrial Microbiology and Fermentation Technology	2	1	1	1	5
Co2: Define the role of microbiology for the production of desired bioproducts	2	4	2	2	10
CO3: Elaborate the working mechanism of upstream and downstream processing	3	5	5	2	15
CO4: Interpretate the mechanism of fermentation process in industry	2	3	3	2	10
CO5: Examine the mechanism of biological product development using microbes	5	4	1	0	10
Total Marks	**14**	**17**	**12**	**07**	**50**

***Legend*: A,** Apply; **An,** Analyze; **E,** Evaluate; **C,** Create**Suggested learning Resources:**

(a) Books:

(b)

S.No.	Title/Author/Publisher details
1	Textbook of Microbiology by Ananthnarayanan and Paniker's, eighth edition, Universities Press
2	Microbiology; Lansing M Prescott, John P. Harley, Donald A Klein, Sixth edition, Mc Graw Hill Higher education.
3	J.E. Bailey and D.F. Ollis, Biochemical Engineer-ing Fundamentals, McGraw-Hill, New York
4	Industrial Microbiology and Biotechnology, Pradeep Verma, Springer, 2022
5	An Introduction to Industrial Microbiology, Sivakumar, K. Sukesh and Joe, S. Chand Publications, 2010

(c) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion

5. Role play
6. Visit to Industrial plant of Biotech-based organizations
7. Demonstration
8. ICT Based teaching Learning
9. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Sc. Biology
Semester: 8th Semester
Course Title: Industrial Microbiology
Course Code: 02BO801

CO/PO/PSO Mapping															
Course Outcome (Cos)	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1: Describe the fundamentals of Industrial Microbiology and Fermentation Technology	2	-	-	1	2	1	2	1	1	2	3	1	2	2	1
Co2: Define the role of microbiology for the production of desired bioproducts	-	1	1	-	-	1	1	2	1	1	1	1	1	1	2
CO3: Elaborate the working mechanism of upstream and downstream processing	1	1	1	1	-	1	1	1	2	2	2	2	1	1	1
CO4: Interpretate the mechanism of fermentation process in industry	1	1	1	-	2	2	3	1	1	1	2	2	1	1	3
CO5: Examine the mechanism of biological product development using microbes	1	1	1	-	-	2	-	2	-	1	1	3	1	3	2

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2,3	**CO1-.1:** Describe the fundamentals of Industrial Microbiology and Fermentation Technology	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6	**LI 1** **LI 2**	1.1,1.2,1.3,1.4,1.5 1.6	**1SL-1,2,3,4,5**
PO 1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2,3	**CO2-.2:** Define the role of microbiology for the production of desired bioproducts	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7	**LI 1** **LI 2** **LI 3**	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7	**2SL-1,2,3,4,5**
PO 1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2,3	**CO3-.3:** Elaborate the working mechanism of upstream and downstream processing	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5	**LI 1** **LI 2** **LI 3**	3.1,3.2,3.3,3.4,3.5	**3SL-1,2,3,4,5**
PO 1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2,3	**CO4-.4:** Interpretate the mechanism of fermentation process in industry	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5	**LI 1** **LI 2**	4.1,4.2,4.3,4.4, 4.5	**4SL-1,2,3,4,5**
PO 1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2,3	**CO5-.5:** Examine the mechanism of biological product development using microbes	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5	**LI 1**	5.1,5.2,5.3,5.4,5.5	**5SL-1,2,3**

Program Name	**Bachelors of Science (B.Sc.)**	
Semester	8th	
Course Code:	02ZO802	
Course title:	Ethology and Biostatistics	**Curriculum Developer**: Mr. Amit Bagri
Pre-requisite:	To study this course, student must have had Zoology in B.Sc. 3rd year/ Degree	
Rationale:	Biostatistics is the application of statistical techniques to scientific research in health-related fields, including medicine, biology, and public health, and the development of new tools to study these areas.	
Course Outcomes (COs):	02ZO802 **.1:** To understand and apply the knowledge of behavior and biometry. 02ZO802 **.2:** To study and analyze the complex and diverse approaches of behavior. 02ZO802 **.3:** To Enumerate biological rhythms, Communication in animals and their social organization. 02ZO802 **. 4:** To know the scope and deployment entrepreneurship by understand behavior, statistical interpretation of data which will help them to select future carrier opportunities.	

Scheme of Studies:

Board of Study	**Course Code**	**Course Title**	**Scheme of studies (Hours/Week)**					**Total Credits(C) (L: T:P=3:0:1)**
			Cl	LI	SW	SL	**Total Study Hours (CI+LI+SW+SL)**	
MINOR	02ZO802	Ethology and Biostatistics	4	2	1	2	9	3+1=4

Legends: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others);
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other instructional strategies);
SW: Sessional Work (includes assignment, seminar, mini project etc.);
SL: Self Learning;
C: Credits.
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to achieve course outcome.

Scheme of Assessment: Theory and Practical

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)		
MINOR	02ZO802	Ethology and Biostatistics	**15**	**20**	**10**	**5**	**50**	**50**	**100**

Scheme of Assessment: Practical

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 7 marks each (CA)	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)		
Minor	02ZO802	Ethology and Biostatistics	35	5	5	5	50	50	50

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Approximate Hours

Item	Cl	LI	SW	SL	Total
Approx. Hrs	15	04	01	05	25

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1- 02ZO802 **.1:** To understand and apply the knowledge of behavior and biometry.	**SO1.1** Define and describe historical background and concept of ethology.	**LI1.1** To study chemotaxis, geotaxis, phototaxis behavior In protozoa.	**Unit 1** **CI1.1** Concept of historical background of ethology.	**SL1.1** Search historical background and concept of ethology.
	SO1.2 Describe about Fixed action plan, Innate and acquired behavior.		**CI1.2** Describe about Fixed action plan?	**SL1.2** Check the Fixed action plan, Innate and acquired behavior.
	SO1.3 Explain about Kinesis, Taxes, Reflexes, Tropism, Motivation.	**LI1.2** To study learning behavior in mice, & Dog with bread.	**CI1.3** Explain about Kinesis?	**SL1.3** Learn about Kinesis, Taxes, Reflexes, Tropism, Motivation.
	SO1.4 Describe neurological control of behaviors.		**CI1.4** Describe neurological control of behaviors.	**SL1.4** Describe neurological control of behaviors.
	SO1.5 Study the hormonal control of behaviors.		**CI1.5** Study the hormonal control of behaviors.	SL1.5 Describe about Innate and acquired behavior.
	SO1.6 Study of Biological clocks and rhythmic behaviors.		**CI1.6** Study of Biological clocks and rhythmic behaviors.	
	SO1.7 Describe about Innate and acquired behavior.		**CI1.7** Describe about Innate and acquired behavior.	
	SO1.8 Explain about Taxes?		**CI1.8** Explain about Taxes?	
	SO1.9 Explain about Reflexes?		**CI1.9** Explain about Reflexes?	
	SO1.10 Explain about Tropism?		**CI1.10** Explain about Tropism?	
	SO1.11 Explain about Motivation?		**CI1.11** Explain about Motivation?	
	SO1.12 explain rhythmic behaviors.?		**CI1.12** Study of rhythmic behaviors.?	
	SO1.13 explain circadian?		**CI1.13** Study of circadian?	
	SO1.14 explain circannual?		**CI1.14** Study of circannual?	
	SO1.15 described circalunar rhythms?		**CI1.15** Study of circalunar rhythms?	

Suggested Sessional Work (SW):*anyone*	**SW1.1** Assignments	Concept of historical background of ethology.
	SW1.2 Mini Project	Describe neurological control of behaviors.
	SW1.3 Other Activities (Specify)	Explain about Kinesis, Taxes, Reflexes, Tropism, Motivation.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	15	10	01	05	31

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
CO2- 02ZO802 **.2:** To study and analyze the complex and diverse approaches of behavior.	**SO2.1** Trial and Error learning, Imprinting, habituation.	**LI2.1** To study schooling behaviour in fishes.	**Unit-II** STUDY OF Trial-and-Error learning,	**SL2.1** Enlist the different properties of carbohydrates
	SO2.2 Explain about reasoning Cognitive skills in behaviors.		**CI2.1** Explain about reasoning Cognitive skills in behaviors.	**SL2.2** Assess biological role of carbohydrate.
	SO2.3 Explain about Memory basic concept and types.	**LI2.2** To observe nest and nesting in insects.	**CI2.2** Explain about Memory basic concept.	**SL2.3** Learn structure and function of monosaccharide
	SO2.4 Explain about Social behaviors.	**LI2.3** Study of parental care in birds.	**CI2.3** Explain about Social behaviors.	**SL2.4** Learn structure and function of oligosaccharide
	SO2.5 explain Imprinting?	**LI2.4** Study of Imprinting?	**CI2.4** Study of Imprinting?	**SL2.5** Learn about Imprinting?
	SO2.6 described habituation.	**LI2.5** Study of habituation.	**CI2.5** Study of habituation.	
	SO2.7 described about Memory and types.		**CI2.6** Explain about Memory and types.	
	SO2.8 described conditional references.?		**CI2.7** Study of conditional references.?	
	SO2.9 described social behavior homing.		**CI2.8** Study of social behavior homing.	
	SO2.10 described social behavior territoriality?		**CI2.9** Study of social behavior territoriality?	
	SO2.11 explain social behavior habituation?		**CI2.10** Study of social behavior habituation?	
	SO2.12 explain Parental care in bees?		**CI2.11** Study of Parental care in bees?	
	SO2.13 explain dance in bees?		**CI2.12** Study of dance in bees?	
	SO2.14 explain pheromone in bees?		**CI2.13** Study of pheromones in bees?	
	SO2.15 explain social organization in insects?		**CI2.14** Study of social organization in insects?	
			CI2.15 Study of primates in insects?	

Suggested Sessional Work (SW) :*anyone*		
	SW2.1 Assignments	Explain about reasoning Cognitive skills in behaviours.
	SW2.2 Mini Project	Explain about Memory basic concept and types.
	SW2.3 Other Activities (Specify)	Explain about Social behaviours.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	15	8	01	05	29

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO3- 02ZO802 **.3:** To Enumerate biological rhythms, Communication in animals and their social organization.	**SO3.1** Explain the concept and structure of preliminary Concept and development of biostatistics	**SL3.1** Calculation of Mean, Medium and mode.	**Unit-III** **CI3.1** Explain the concept and structure of preliminary Concept	**SL3.1** Read about various types of preliminary Concept and development of biostatistics
	SO3.2 Assessing the Central tendency with problems.	**SL3.2** Correlation	**CI3.2** Assessing the Central tendency with problems.	**SL3.2** Central tendency with problems.
	SO3.3 Calculation of Mean, Medium and mode.	**SL3.3** Data line diagram	**CI3.3** Calculation of Mean	**SL3.3** Study the Calculation of Mean, Medium and mode.
	SO3.4 Measures of variations.	**SL3.4** Bar graphs	**CI3.4** Study of Measures of variations.	SL3.4Study of Measures of variations.
	SO3.5 Describe about Test methods, Z test, F test, T test		**CI3.5** Describe about Test methods, Z test,	SL3.5 Calculation of Mean
	SO3.6 Explain the concept and structure development of biostatistics.		**CI3.6** Explain the concept and structure development of biostatistics.	
	SO3.7 Describe about Test methods, F test		**CI3.7** Describe about Test methods, F test	
	SO3.8 explain Calculation of Medium		**CI3.8** Calculation of Medium	
	SO3.9 explain Calculation of mode.		**CI3.9** Calculation of mode.	
	SO3.10 Describe about Test method, T test.		**CI3.10** Describe about Test method, T test.	
	SO3.11 explain Calculation of SD?		**CI3.11** Calculation of SD?	
	SO3.12 explain Calculation of SE?		**CI3.12** Calculation of SE?	
	SO3.13 explain Calculation of experimental problems?		**CI3.13** Calculation of experimental problems?	
	SO3.14 Study of Measures of variations co variance?		**CI3.14** Study of Measures of variations co variance?	
	SO3.15 Study of Anova technique?		**CI3.15** Study of Anova technique?	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Explain the concept and structure of preliminary Concept and development of biostatistics.
	SW3.2 Mini Project	Calculation of Mean, Medium and mode.
	SW3.3 Other Activities (Specify)	Describe about Test methods, Z test, F test, T test.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	15	10	01	04	30

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO4- 02ZO802 **. 4: To know** the scope and deployment entrepreneurship by understand behavior, statistical interpretation of data which will help them to select future carrier opportunities	**SO4.1** Exploring the concept of theoretical Distribution – Monomial – Binomial	**LI4.1** Chi square test.	**Unit-IV** **CI4.1** Exploring the concept of theoretical Distribution – Monomial – Binomial	**SL4.1** Learn about different classes theoretical Distribution – Monomial – Binomial
	SO4.2 Assessing role of Correlations	**LI4.2** Pie chart	**CI4.2** Assessing role of Correlations.	**SL4.2** Discuss of Correlations.
	SO4.3 Explaining the Tabulation table.	**LI4.3** Graphical re presentation	**CI4.3** Explaining the Tabulation table.	**SL4.3** Learn about Tabulation table
	SO4.4 Explaining the role of Presentation of data Line diagram, graphs, histograms.	**LI4.4** Anova technique	**CI4.4** Explaining the role of Presentation of data Line.	
	SO4.5 Evaluate role of Chi square test.	LI4.5 What is a good chi-squared value?	**CI4.5** Evaluate role of Chi square test.	**SL4.4** Learn about role of Chi square test.
	SO4.6 Describe the Probability.		**CI4.6** Describe the Probability.	
	SO4.7 Exploring the concept of theoretical Distribution – Binomial		**CI4.7** Exploring the concept of theoretical Distribution – Binomial	
	SO4.8 Explaining the role of Presentation of graphs.		**CI4.8** Explaining the role of Presentation of graphs.	
	SO4.9 Explaining the role of Presentation of histograms.		**CI4.9** Explaining the role of Presentation of histograms.	
	SO4.10 Explaining the role of Presentation of diagram.		**CI4.10** Explaining the role of Presentation of diagram.	
	SO4.11 What is chi-square test related to?		**CI4.11** What is chi-square test related to?	
	SO4.12 explain the two common types of chi-square tests?		**CI4.12** What are the two common types of chi-square tests?	
	SO4.13 described type of data is suitable for a chi-square test?		**CI4.13** What type of data is suitable for a chi-square test?	
	SO4.14 explain the properties of chi-square?		**CI4.14** What are the properties of chi-square?	
	SO4.15 described good chi-squared value?		**CI4.15** What is a good chi-squared value?	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Explaining the Tabulation table.
	SW4.2 Mini Project	Describe the Probability.
	SW4.3 Other Activities (Specify)	Evaluate role of Chi square test.

Course duration (in hours) to attain Course Outcomes:

Course Title: Ethology and Biostatistics **Course Code:** 02ZO802

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction(LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1- 02ZO802 **.1:** To understand and apply the knowledge of behaviour and biometry.	15	4	5	1	25
CO2- 02ZO802 **.2:** To study and analyse the complex and diverse approaches of behaviour.	15	10	5	1	31
CO3- 02ZO802 **.3:** To Enumerate biological rhythms, Communication in animals and their social organization.	15	8	5	1	29
CO4- 02ZO802**. 4: To know** the scope and deployment entrepreneurship by understand behaviour, statistical interpretation of data which will help them to select future carrier opportunities	15	10	4	1	30
Total Hours	60	32	19	04	115

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome:

Course Title: Ethology and Biostatistics **Course Code:** 02ZO802

Course Outcomes	Marks Distribution				Total Marks
	A	**An**	**E**	**C**	
CO1- 02ZO802 **.1:** To understand and apply the knowledge of behaviors and biometry.	2	1	1	1	5
CO2- 02ZO802 **.2:** To study and analyses the complex and diverse approaches of behaviors.	2	4	2	2	10
CO3- 02ZO802 **.3:** To Enumerate biological rhythms, Communication in animals and their social organization.	3	5	5	2	15
CO4- 02ZO802 **. 4: To know** the scope and deployment entrepreneurship by understand behaviors, statistical interpretation of data which will help them to select future carrier opportunities	2	3	3	2	10
Total Marks	**9**	**13**	**11**	**07**	**40**

***Legend*:A,** Apply;**An,** Analyze;**E,** Evaluate;**C,** Create

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1	Mathur reena, Animal behaviour Rastogi publication Shivaji road 1996
2	Bhaskar H V human and animal behaviour Campus book international 4831/24 new delhi 2007
3	Singh S p and tomar V S Evolution and behaviour Rastogi publication meerut 2005
4	Prasad sadguru Elements of biostatistics Rastogi publication meerut 1997

(b) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Demonstration
7. ICT Based teaching Learning
8. Brainstorming

CO, PO and PSO Mapping

Program Name: B.Sc. Biology
Semester: 8th Semester
Course Title: Ethology and Biostatistics
Course Code: 02ZO802

CO/PO/PSO Mapping								
Course Outcome (Cos)	**Program Outcomes (POs)**					**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**
CO1- 02ZO802 **.1:** To understand and apply the knowledge of behaviour and biometry.	2	3	1	3	3	2	2	3
CO2- 02ZO802 **.2:** To study and analyses the complex and diverse approaches of behaviours.	3	2	2	2	2	1	2	2
CO3- 02ZO802 **.3:** To Enumerate biological rhythms, Communication in animals and their social organization.	2	1	1	3	2	2	2	3
CO4- 02ZO802 **. 4: To know** the scope and deployment entrepreneurship by understand behaviour, statistical interpretation of data which will help them to select future carrier opportunities	2	2	2	1	2	2	2	1

Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5 PSO 1,2,3	**CO1-** 02ZO802 **.1:** To understand and apply the knowledge of behaviour and biometry.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12 SO1.13 SO1.14 SO1.15	1.1,1.2	1.1,1.2,1.3,1.4,1.5, 1.6, 1.7,1.8,1.9,1.10,1.11,1.12,1.13,1.14,1.15	1SL-1,2,3,4,5
PO 1,2,3,4,5 PSO 1,2,3	**CO2-** 02ZO802 **.2:** To study and analyses the complex and diverse approaches of behaviours.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9 SO2.10 SO2.11 SO2.12 SO2.13 SO2.14 SO2.15	2.1, 2.2, 2.3,2.4,2.5	2.1, 2.2, 2.3, 2.4,2.5,2.6,2.7,2.8,2.9,2.10,2.11,2.12,2.13,2.14,2.15	2SL-1,2,3,4,5
PO 1,2,3,4,5 PSO 1,2,3	**CO3-** 02ZO802 **.3:** To Enumerate biological rhythms, Communication in animals and their social organization.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9 SO3.10 SO3.11 SO3.12 SO3.13 SO3.14 SO3.15	3.1,3.2,3.3,3.4,	3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9,3.10,3.11,3.11,3.12,3.13,3.14,3.15	3SL-1,2,3,4,5
PO 1,2,3,4,5 PSO 1,2,3	**CO4-** 02ZO802 **. 4:** To know the scope and deployment entrepreneurship by understand behaviour, statistical interpretation of data which will help them to select future carrier opportunities.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6, SO4.7 SO4.8 SO4.9 SO4.10 SO4.11 SO4.12 SO4.13 SO4.14 SO4.15	4.1,4.2,4.3,4.4,4.5	4.1,4.2,4.3,4.4, 4.5, 4.6,4.7,4.8,4.9,4.10,4.11,4.12,4.13,4.14,4.15	4SL-1,2,3,4

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Course Name: Chemistry of Materials,

Corse Code 02CH803

Pre-requisite: Students should have basic knowledge of the chemistry of the design, synthesis, and characterization of assemblies of molecules whose properties arise from interactions between them of Chemistry of Material.
Rationale: The students studying chemistry of Materials should possess foundational understanding about Nanmaterials , Thermotropic liquid crystal, Ionic conductors, and application , High Tc superconductivity and Molecular hyperpolarisability. This will provide applicable knoweledge about Ceramic structures , mechanical properties Dielectric susceptibility and dielectric constants chemistry of Material.

CourseOutcomes:

Afterthe completionofthiscourse, the learner will
02CH803.1 Apply the concept of *Ceramics*, Composites and Nanomaterials explain the characterization, properties and applications.
02CH803.2 Explain the Liquid crystals the positional order and bond orientation and Optical properties of liquid crystals by Liquid crystals.
02CH803.3 Explain the mechanism of ionic conduction, interstitial jumps (Frenkel); vacancy mechanism, diffusion superionic conductors, phase transtions and mechanism of conduction in superionic conductors. Examples and applications of ionic conductors.
02CH803.4 Explain the High Tc superconductivity Preparation and characterization of 1-2-3 and 2-1-4 materials. Normal state properties, anisotropy, Tempature dependence of electrical resistance.
02CH803.5 Apply the knowledge of the Molecular rectifiers and transistors, artificial photosynthetic devices, optical storage memory and switches, sensors. Conducting organics, organic superconductors, magnetism in organic materials. Fullerenes, doped and superconductors.

UNIT I: *Ceramics*, Composites and Nanomaterials.Ceramic structures, mechanical properties, clay products. Refractories, characterization, properties and
applications. Microscopic composites, dispersion-strengthened and particle-reinforced composites, macroscopic composites. Nanocrystalline phase,
preparation procedures, properties and applications.

UNIT II: Liquid Crystals.Thermotropic liquid crystals, positional order, bond orientational order, nematic and smectic mesophases. Molecular arrangement in
smectic A and smectic C phases, optical properties of liquid crystals. Dielectric susceptibility and dielectric constants. Lyotropic phases and their description of
ordering in liquid crystals.

UNIT III: Ionic Conductors.Types of ionic conductors, mechanism of ionic conduction, interstitial jumps (Frenkel); vacancymechanism, diffusion superionic
conductors, phase transtions and mechanism of conduction in superionic conductors. Examples and applications of ionic conductors.

UNIT IV: High Tc Materials. High Tc superconductivity. Preparation and characterization of 1-2-3 and 2-1-4 materials. Normal state properties, anisotropy,
temperature dependence of electrical resistance, and optical phonon modes. Superconducting state; heat capacity;coherence length, elastic constants,

microwave absorption-pairing and multigap structure in high Tc materials. Applications of high Tc materials.

UNIT V: Organic Solids, Fullerenes, Molecular Devices.Conducting organics, organic superconductors, magnetism in organicmaterials. Fullerenes, doped,
fullerenes as superconductors. Molecular rectifiers and transistors, artificial photosynthetic devices, optical storage memory and switches, sensors.Non-linear optical materials, non-linear optical effects. Molecular hyperpolarisability.

Scheme of Studies:

Board ofStudy	CourseCode	CourseTitle	Scheme ofstudies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours(Cl+LI+SW+SL)	
ProgramCore(PCC)	**02CH803**	Chemistry of material	4	0	1	1	6	4

Legend: **CI:**Class room Instruction (Includesdifferentinstructionalstrategiesi.e.Lecture(L)andTutorial(T)and others),
LI: Laboratory Instruction (Include sPractica lperformancesi nlaboratory workshop,fieldorotherlocationsusingdifferentinstructionalstrategies)
SW: Sessiona lWork (include sassignment,seminar,miniprojectetc.),
SL: Self Learning,
C:Credits.

Note: SW&SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome ofLearning.

Scheme of Assessment: Theory

Board ofStudy	Course Code	CourseTitle	SchemeofAssessment(Marks)						
			ProgressiveAssessment(PRA)					EndSemesterAssessment	Total Marks
			Class/HomeAssignment5number3mark seach (CA)	Class Test2 (2bestout of3) 10 marks each(CT)	Seminarone (SA)	ClassAttendance (AT)	TotalMarks (CA+CT+SA+AT)	(ESA)	(PRA+ESA)

PCC	**02CH803**	**Chemistr yof material**	15	20	10	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

02CH803.1: Apply the concept of *Ceramics*, Composites and Nanomaterials explain the characterization, properties and applications.

Approximate Approximate Hours

Activity	**AppX Hrs**
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction(CI)	Self Learning(SL)
SO1.1 Explain and Apply the mechanical properties Refractories, characterization, properties and applicatons. SO1.2 Apply the clay products characterization, properties and applicatons. SO1.3 Explain Microscopic composites, dispersion-strengthened. SO1.4 Explain the particle-reinforced composites, macroscopic composites. SO1.5 , Apply the concept of macroscopic composites.		Unit-1.0 *Ceramics*, Composites and Nanomaterials. properties and applicatons. characterization, propertiesand applications. , dispersion- strengthened. preparation procedures, properties and applications. Draw the Ceramicstructures. Define the mechanicalproperties. Clay products. particle-reinforcedcomposites.	Nanocrystalline phase, preparation procedures, properties and applications.

		Microscopic composites. T-1Refractories, characterization, properties andApplications. Apply the concept of dispersion-strengthened. Nano crystalline phase, preparation procedures.	

SW-1 SuggestedSessionalWork(SW):

a.Assignments: Discuss Microscopic composites, dispersion-strengthened and particle-reinforced composites,macroscopic composites.

b.Mini Project: Apply the project of clay products. Refractories, characterization, properties and applications.

c.Other Activities (Specify):
Note on applications of Nanocrystalline phase and macroscopic composites.

02CH803.2: Explain the Liquid crystals the positional order and bond orientation and Optical properties of liquid crystals by Liquid crystals.

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Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 Describe & apply Cement:Manufacture – Wet Process and Dry process **SO2.2** Explain Analysis of majorconstituents, setting of cement, reinforced concrete. Cement industries in India **SO2.3** Explain Glass: Types, Composition, manufacture of Optical glass, colored glasses, lead glass and neutron absorbingglass. **SO2.4** Understand and apply Glass: Types, Composition, manufacture of Optical glass, colored glasses, lead glass and neutron absorbing glass. **SO2.5** Explain Fertilizers: Fertilizer industries in India, Manufacture of ammonia, ammonium salts, urea, superphosphate, triple superphosphate and nitrate salts.		Unit-2 Cement, Ceramics, Glass and FertilizersCement: Manufacture Wet Process and Dry process. Types ofcement . Analysis of major constituents, setting of cement, reinforced concrete.Cement industries in India. Ceramics Important clays and feldspar,glazing and verification. Glass Types, Composition, manufacture of Optical glass, colored glasses,lead glass and neutron absorbing glass. Fertilizers Fertilizer industries in India, Manufacture of ammonia, ammonium salts, urea, superphosphate, triple superphosphate and nitrate salts.T1- manufacture of Fertilizers T2- Manufacture of ammonia, ammonium salts,T3- setting and hardning of cement	Types of cement .Glass: Types, Composition, manufacture of Optical glass, colored glasses, lead glass and neutron absorbingglass Fertilizers use

SW-2 Suggested Sessional Work (SW):

a.Assignments: .Thermotropic liquid crystals, positional order, bond orientational order.

b.Mini Project: Explain and apply the optical properties of liquid crystals.

c.Other Activities (Specify):
description of ordering in liquid crystals.

02CH803.3: Explain the mechanism of ionic conduction, interstitial jumps (Frenkel); vacancy mechanism, diffusion superionic
conductors, phase transtions and mechanism of conduction in superionic conductors. Examples and applications of ionic conductors.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes(SOs)	Laboratory Instruction (LI)	Class room Instruction(CI)	Self Learning(SL)
SO3.1 Explain the Types of ionic conductors. SO3.2 Discuss the interstitial jumps (Frenkel); vacancy mechanism. SO3.3 Explain the Diffusion superionic conductors, SO3.4 phase transtions and mechanism of conduction. superionic conductors. SO3.5 Application of ionic conductors and examples.		Unit-3.0 Ionic Conductors. mechanism of ionicconduction. Mechanism of Frenkel. Diffusion and mechanism of superionic conductors. Example and applications. vacancy mechanism. superionic Conductors phase transitions Types of ionic conductors interstitial jumps (Frenkel)T-1 Types of ionic conductors, mechanism of ionic conduction. T-2 mechanism of conduction in superionic conductors. T-3 applications of ionic conductors.	mechanism of conduction insuperionic conductors.Examples and applications of ionic conductors.

SW-3 Suggested Sessional Work (SW):

a.Assignments: Types of ionic conductors, mechanism of ionic conduction.

b.Mini Project: Examples and applications of ionic conductors.

c.Other Activities (Specify): Apply the concept ofdiffusion superionic conductors, phase transtions and mechanism.

02CH803.4: Explain Preparation and characterization of 1-2-3 and 2-1-4 materials. Normal state properties, anisotropy, temperature dependence of electrical resistance, and optical phonon modes. Superconducting state; heat capacity; coherence length, elastic constants, microwave absorption-pairing and multigap structure in high Tc materials. Applicationsof high Tc materials.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes(SOs)	Laboratory Instruction (LI)	Class room Instruction(CI)	Self Learning(SL)
SO4.1 Explain High Tc superconductivity. SO4.2 ExplainPreparation and characterization of 1-2-3 and 2-1-4 materials. SO4.3Explain the anisotropy, temperature dependence of electrical resistance, and optical phonon modes. SO4.4 Explain Superconducting state; heat capacity; coherence length, elastic constants. SO4.5 Apply the concept of microwave absorption-pairing and multigap structure in high Tc		Unit-4.0 High Tc Materials4.1The Preparation of Tc superconductivity. characterization of 1-2-3 and 2-1-4 materials. Normal state properties. 4.4anisotropy and optical phonon modes. Discuss the microwave absorption-pairing. Draw the multigap structure. Applications of high Tc materials.	Superconducting sta Discuss the microwave absorption-pairing and multigap structure in high Tc materials.

materials. Applications of high Tc materials.		optical phonon modes. Superconducting state; heatcapacity. Explain the heat capacity; coherence length, elastic constants. microwave absorption-pairing Draw the structure in high Tc materials.	

SW-4 Suggested Sessional Work (SW):

a.Assignments: Preparation and characterization of 1-2-3 and 2-1-4 materials.

b.Mini Project: Discuss theSuperconducting state; heat capacity

c.Other Activities (Specify): Importance andApplications of high Tc materials.

02CH803.5: Apply the knowledge of the Conducting organics, organic superconductors, magnetism in organic materials. Fullerenes, doped, fullerenes as superconductors. Molecular rectifiers and transistors, artificial photosynthetic devices, optical storage memory and switches, sensors. Non-linear optical materials, non-linear optical effects. Molecular hyperpolarisability.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 Explain organic superconductors, magnetism in organic materials. **SO5.2** Explain Fullerenes, doped, fullerenes as superconductors. **SO5.3** Explain and apply Molecular rectifiers and transistors, artificial photosynthetic devices, optical storage memory and switches, sensors. **SO5.4**Explain and apply the Non-linear optical materials, non-linear optical effects. **SO5.5** Explain and apply Molecular hyperpolarisability.	.	**Unit-5.0: 5.1**Organic Solids, Fullerenes, Molecular Devices. Apply the knowledge of magnetism in organic materials. Fullerences as supercondors. Artificial photosyntheticdevices. optical storage memory and switches, sensors. Effects of non-linear optical materials. Hyperpolarisability molecular compounds. Non-linear optical materials, non-linear optical effects. Explain the Molecular hyperpolarisability. Discuss the Molecular rectifiers and transistors. Explain the artificial photosynthetic devices.	Explain the Fullerenes, doped, fullerenes as superconductors.

SW-5 Suggested Sessional Work (SW):

a.Assignments: Organic materials in magnetism of superconductors**.**

b.Mini Project: Artificial photosynthetic devices, optical storage memory and switches, sensors.

c.Other Activities (Specify):

Effects of Non-linear optical materials.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
02CH803.1: Understand the concept ofheterocyclic chemistry composites and Nonmaterial's compound properties and application and Microscopic composites in chemistry of material.	12	02	01	15
02CH803.2: Explain Liquid crystals the positional order and bond orientation and Optical properties of liquid crystals by Liquid crystals.	12	02	01	15
02CH803.3:Describe the mechanism of ionic conduction diffusion superionic, and application by ionic conductors.	12	02	01	15
02CH803.4 Explain the High Tc superconductivity Preparation and characterization of 1-2-3 and 2- 1-4 materials. Normal state properties, anisotropy, Tempature dependence of electrical resistance.	12	02	01	15
02CH803.5:. Apply the knowledge of the Molecular rectifiers and transistors, artificial photosynthetic devices, optical storage memory and switches, sensors. Conducting organics, organic superconductors, magnetism in organic materials. Fullerenes, doped and superconductors.	12	02	01	15
Total Hours	60	10	05	75

Suggestion for End Semester Assessment

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Suggested Specification Table (ForESA)

CO	UnitTitles	MarksDistribution			Total Marks
		R	U	A	
CO-1	*Ceramics*, Composites and Nanomaterials.	03	01	01	05
CO-2	Liquid Crystals.	02	06	02	10
CO-3	Ionic Conductors.	03	07	05	15
CO-4	High Tc Materials	-	10	05	15
CO-5	Organic Solids, Fullerenes, Molecular Devices.	03	02	-	05
Total		11	26	13	50

Legend: **R:Remember, U:Understand, A:Apply**

The end of semester r as sessment for Organic Chemistry I will be held with written examination of 50 marks

Note.Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks.Teachers can also design different tasks as perrequirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

Improved Lecture/Tutorial/Case Method/Group Discussion /Role Play
Visitto NCL, CSIR laboratories
Demonstration
ICTBased Teaching Learning (Video Demonstration /Tutorials CBT, Blog, Facebook, Twitter, Whatsapp,Mobile, Online sources)Brainstorming

Suggested Learning Resources:

(j) Books:

S. No.	Title	Author	Publisher	Edition& Year
1	Material Science and Engineering-An Introduction	W.D. Callister	Wiley	1990
2	Solid State Physics	N.W. Ashcroft	N.D. Mermin, Saunders College	1998
3	Principles of the Solid State	H.V. Keer	Wiley Eastern.	2006

4	Materials Science	J.C. Anderson, K.D. Leaver, J.M. Alexander and R.D. Rawlings,	ELBS.	1994
5	Thermotropic Liquid Crystals.	G.W. Gray, editor, John Wiley.	Wiley	1993
6	Handbook of Liquid Crystals	Kelker and Hatz, Chemie Verlag.	Ke lker	1996

Suggested Web Sources:https://nptel.ac.in/course.html

https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
https://swayam.gov.in/explorer?category=Chemistry

ModeofDelivery: Lecture,demonstration,E-tutoring,discussion, assignments,quizzes, case study, power point;

LMS/ICT Tools: Digital Classrooms, DLMS, ZOOM, G-Suite,MSPower-Point, Online Resources

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Course Title: Chemistry of Material **Course Code :02CH803**

	Program Outcomes												Program Specific Outcome			
	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
Course Outcomes	Knowledge	Research Aptitude	Communication	Problem Solving	Individual and Team Work	Investigation of Problems	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and sustainability	The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry	To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.	understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomeno n-based problems in chemical sciences.	Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science

CO1 : Apply the concept of Ceramics, Composites and Nanomaterials explain the characterization, properties and applications.	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO 2 : Explain the Liquid crystals the positional order and bond orientation and Optical properties of liquid crystals by Liquid crystals.	2	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3 :Explain the mechanism of ionic	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2

conduction, interstitial jumps (Frenkel); vacancy mechanism, diffusion superionic conductors, phase transtions and mechanism of conduction in superionic conductors. Examples and applications of ionic conductors.																
CO 4: Explain the High Tc superconductivity Preparation and characterization of 1-2-3	2	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2

and 2-1-4 materials. Normal state properties, anisotropy, Tempature dependence of electrical resistance.																
CO 5: Applythe knowledge of the Molecular rectifiers and transistors, artificial photosynthetic devices, optical storage memory and switches, sensors. Conducting organics, organic superconductors, magnetism in	2	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

organic materials. Fullerenes, doped and superconductors.																

Legend:1–Low,2–Medium, 3–High

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POs &PSOsNo.	COsNo.&Titles	SOsNo.	LaboratoryInstruction(LI)	Classroom Instruction(CI)	Self Learning (SL)	Self Learning(SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1:. Apply the concept of *Ceramics*, Composites and Nanomaterials explain the characterization, properties and applications. .	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5		Unit-1.0 *Ceramics*, Composites and Nanomaterials. 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9	Nanocrystalline phase, preparation procedures, properties and applications.	Aromaticity in annulenes,Inclusion Compounds
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 2 : Explain Liquid crystals the positional order and bond orientation and Optical properties of liquid crystals by Liquid crystals.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5		Unit-2 Liquid Crystals. 2.1,2.2,2.3,2.4,2.5,2.6,2.7,2.8,2.9	positional order, bond orientational order.	Interconversion of Fischer, Newman, Sawhorse and flying wedge formulae. (practice) Conformational analysis, simple, acyclic systems.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3 : Explain the mechanism of ionic conduction, interstitial jumps (Frenkel); vacancy mechanism, diffusion superionic conductors, phase transtions and mechanism of conduction in superionic conductors. Examples and applications of ionic conductors.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5		Unit-3 :Ionic Conductors. 3.1, 3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9	mechanism of conduction in superionic conductors. Examples and applications of ionic conductors	neration, structure, stability andreactivity of carbocations, carbanions Taftequation

PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4: Explain the High Tc superconductivity Preparation and characterization of 1-2- 3 and 2-1-4 materials. Normal state properties, anisotropy, Tempature dependence of electrical resistance.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5		Unit-4 :High Tc Materials. 4.1,4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8, 4.9	Discuss the microwave absorption-pairing and multigap structure in high Tc materials.	Nucleophilic substitution at an aliphatic trigonal carbon. Phase transfer catalysis
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 5: : Apply the knowledge of the Molecular rectifiers and transistors, artificial photosynthetic devices, optical storage memory and switches, sensors. Conducting organics, organic superconductors, magnetism in organic materials. Fullerenes, doped and superconductors.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5		Unit 5: Organic Solids, Fullerenes, Molecular Devices 5.1,5.2,5.3,5.4,5.5 ,5.6,5.7,5.8,,5.9	Explain the Fullerenes, doped, fullerenes as superconductors.	Alkylation,amination SRN1 mechanism

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Curriculum Development Team:

1. Dr. Shailendra Yadav, HoD, Department of Chemistry, AKS University, Satna (M.P.).
2. Dr. Dinesh Kumar Mishra, Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
3. Dr. Samit Kumar,Asso. Prof. , Department of Chemistry, AKS University, Satna (M.P.).
4. Dr. Sushma Singh, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
5. Dr. Manoj Kumar Sharma, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
6. Mr. Kanha Singh Tiwari,Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).
7. Mrs. Nahid Usamani, Asst. Prof. Department of Chemistry, AKS University, Satna (M.P.).