Curriculum Book

and

Assessment and Evaluation Scheme

based on

Outcome Based Education (OBE)

and

Choice-Based Credit System (CBCS)

in

Bachelor of Technology in Biotechnology

B. Tech. (Biotechnology)

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

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Curriculum & Syllabus of B. Tech. Biotechnology Program

(Revised as of 2023)

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AKS University

Faculty of Life Sciences and Technology

Department of Biotechnology

Curriculum of B.Tech. Biotechnology Program

(Revised as on 2023)

Foreword

I am delighted to see that the Biotechnology Department's redesigned curriculum for the B. Tech. (Biotechnology) Programme smoothly incorporates the newest technological developments while adhering to AICTE 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 M. Sc. (Biotechnology) 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.Tech. Biotechnology 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 endeavour 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 Biotechnology Department, in consultation with an array of experts from the Biotechnology 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 Biotechnology manufacturing technology.

The curriculum tailored for the Indian biotechnology 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.Tech. Biotechnology 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 Biotechnology department has diligently adhered to the guidelines provided by the AICTE. Additionally, they have maintained a total credit requirement of 92 for the B.Tech. Biotechnology 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 — ***Professor B. A. Chopade***

01 August 2023 — *Vice-Chancellor*

Preface

As part of our commitment to ongoing enhancement, the Department of Biotechnology consistently reviews and updates its B.Tech. Biotechnology 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.Tech. Biotechnology 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 AICTE model syllabus distributed in May 2023. 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 AICTE's directives, the total credit allocation for the B.Tech. Biotechnology program is capped at 93 credits.

This curriculum is enriched with course components in alignment with AICTE guidelines, encompassing various disciplines such as Fundamental Science Concepts: 24 credits, Engineering Science: 25 credits, Humanities and Social Sciences: 12 credits, Core Program Courses: 66 credits, Elective Program Courses: 9 credits, Open Electives: 9 credits, Project and Practical Training: 17 credits, Seminars: 3 credits, Indian Knowledge System: 2 credits, Sustainable Development Goals: 2 credits.

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.

INTRODUCTION

OVERVIEW OF THE DEPARTMENT OF BIOTECHNOLOGY

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 Microbiology and Biotechnology. 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 centre of excellence for biotechnology 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 biotechnological innovation, research, and education. We are committed to advancing the frontiers of biotechnology 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 biotechnological solutions by following aspects:

M1. To develop a strong Biotechnology 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 biotechnology professionals who can contribute to the continuous improvement of biotechnological services and products.

M4. To design scientific and/or technical resources as per biotechnology 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) as defined by NBA

B. Tech. Biotechnology Graduates will be able to:

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solutions for complex engineering problems and 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.

4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

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

9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

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

Program Educational Objectives (PEOs)

Program Educational Objectives for B. Tech. Program

Students will:

PEO-1: Understand and inculcate the ability to apply, update, extend and to develop deep knowledge through flexible, research-intensive program designed to meet the current demand of academia and industry.

PEO-2: Acknowledge the basic engineering and applied biological mechanisms used in biopharmaceutical industries

PEO-3: Utilize their profession skills with social awareness and responsibility in the industry

PEO-4: Interact with their peers in biotech industry or organizations and society and contribute to the economic growth of the country

PEO-5: Participate in individual and team oriented, open ended activities promoting productive thinking to provide opportunities for students to manage and work on multidisciplinary projects through interaction with their peers in industry.

Program Specific objectives (PSOs)

Program Specific objectives (PSOs) for B.Tech. Biotechnology program

PSO 1: Acquire knowledge in domain of biotechnology enabling their applications in industry and research.

PSO 2: Empower the students to acquire technological knowhow by connecting disciplinary and interdisciplinary aspects of biotechnology.

PSO 3: Recognize the importance of Bioethics, IPR, entrepreneurship, Communication and management skills so as to usher next generation of Indian industrialists.

General Course Structure and Credit Distribution

A. Definition of Credit:

1 Hr. Lecture (L) per week	1 Credit
1 Hr. Tutorial (T) per week	1 Credit
1 Hr. Practical (P) per week	0.5 Credit
2 Hours Practical (P) per week	1 Credit

B. Range of Credits:

As per the AICTE model Curriculum for the UG Degree Course in Biotechnology, the total number of credits proposed for the Four-year B.Tech. (Biotechnology) is kept as 90.

C. Structure of UG Program in Biotechnology:

The structure of the UG program in Biotechnology shall have essentially the following categories of courses with the breakup of credits as given:

S. No.	Category	Breakup of Credits
2.	Basic Science Courses	20
3.	Engineering Science Courses	26
4.	Program Core Courses (Branch specific)	21
5.	Professional Elective Courses (Branch specific)	6
6.	Open Elective Courses (from Humanities, Technical Emerging or other Subjects)	2
7.	Project work, Seminars and Internships in Industry or elsewhere, or research courses	15

	TOTAL	92

D. Course Code and Definition:

Course code	Definitions
L	Lecture
T	Tutorial
P	Practical
C	Credits
HS	Humanities & Social Science Courses
BS	Basic Science Courses
ES	Engineering Science Courses
PC	Program Core Courses
PE	Professional Elective Courses
OE	Open Elective Courses
AU	Audit Courses
EEC	Employment Enhancement Courses (Internship / Seminar) (Project / Summer Training)

- **Course level coding scheme:** Three-digit number (odd numbers are for the odd semester courses and even numbers are for even semester courses) used as a suffix with the Course Code for identifying the level of the course. The digit at hundred's place signifies the year in which the course is offered. e.g. 101, 102 … etc. for the first year. 201, 202 …. etc. for second year. 301, 302 … for third year.

F. Evaluation Scheme (Suggestive only):

G. Mapping of Marks to Grades

Each course (Theory/Practical) is to be assigned 100 marks, irrespective of the number of credits, and the mapping of marks to grades may be done as per the following table:

Range of Marks	Assigned Grade
91-100	AA/A^+
81-90	AB/A
71-80	BB/B^+
61-70	BC/B
51-60	CC/C^+
46-50	CD/C
40-45	DD/D
< 40	FF/F (Fail due to less marks)
-	F^R (Fail due to shortage of attendance and therefore, to repeat the course)

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Department of Biotechnology

Scheme and Syllabus

The department provides a four-year **B.Tech. in Biotechnology** using a Choice Based Credit System (CBCS) that consists of four semesters. The regulations for the B.Tech. in Biotechnology provided by AKS University under the Choice Based Credit System (CBCS) are shown here.

Scheme of B. Tech. Biotech 1st Semester

S. No	Subject Code	SUBJECT	Subject AREA	Periods			Credit
				L	T	P	
1	98BI101	Biology For Engineers	BSC	1	1	-	2
2	98CH102	Engineering Chemistry	BSC	2	-	-	2
3	98BT107	Cell Biology and Genetics	BSC	3	-	-	3
4	98ME104	Basic Mechanical Engineering & Manufacturing Process	ESC	2	1	-	3
5	HSMC01	Communication Skill	HS	2	-	-	2
6	98BT106	Introduction to Biotechnology	PC	3	-	-	3
7	98ME151	Workshop Practice (lab)	ESC	-	-	2	1
8	98CH152	Engineering Chemistry (Lab)	BSC	-	-	2	1
9	98BT155	Cell Biology and Genetics Lab	BSC	-	-	2	1
10	98ME154	Basic Mechanical Engineering (Lab)	ECC	-	-	2	1
11	HSMC08	Sustainable Development Goal	HS	2	-	-	2
12	HSMC09	Sports & Yoga / NSS / NCC / UCC	AU	-	-	-	-
		Total		15	2	8	21

Scheme of B. Tech. Biotech 2nd Semester

S. No	Subject Code	SUBJECT	Subject AREA	Periods L	Periods T	Periods P	Credit
1	98MS201	Mathematics	**BSC**	**1**	**1**	**-**	**2**
2	98EE208	Basic Electrical & Electronics Engineering	**ESC**	**2**	**1**	**-**	**3**
3	98PH203	Engineering Physics	**ESC**	**2**	**1**	**-**	**3**
4	98CA204	Fundamentals of Computer & Programming	**ESC**	**1**	**1**	**-**	**2**
5	98EV205	Ecology & Environmental Science	**HS**	**2**	**-**	**-**	**2**
6	98ME206	Engineering Drawing	**ESC**	**1**	**1**	**-**	**2**
7	98BT207	Biochemistry & Metabolism	**BSC**	**2**	**1**	**-**	**3**
8	98EE254	Basic Electrical and Electronic Engineering (Lab 2)	**ESC**	**-**	**-**	**2**	**1**
9	98PH252	Engineering Physics (Lab 2)	**ESC**	**-**	**-**	**2**	**1**
10	98BT253	Biochemistry & Metabolism (Lab 3)	**BSC**	**-**	**-**	**2**	**1**
11	HSMC07	Indian Knowledge System	**HS**	**2**	**-**	**-**	**2**
		TOTAL		**13**	**6**	**6**	**22**

Scheme of B. Tech. Biotech 3rd Semester

S. No	Subject Code	SUBJECT	Subject AREA	Periods			Credit
				L	**T**	**P**	
1	98BT301	Computational Biology & Bioinformatics	**PC**	**3**	**-**	**-**	**3**
2	98BT302	Principles of Microbiology	**BSC**	**3**	**-**	**-**	**3**
3	98BT303	Biostatistics	**BSC**	**1**	**1**	**-**	**2**
4	98BT304	Biophysical Tools and Techniques	**PC**	**3**	**-**	**-**	**3**
5	98EN305	Entrepreneurship Development	**HS**	**2**	**1**	**-**	**3**
6	98ME306	Fluid Mechanics	**OS**	**2**	**-**	**-**	**2**
7	98BT351	Computational Biology & Bioinformatics (Lab)	**PC**	**-**	**-**	**2**	**1**
8	98BT352	Principles of Microbiology (Lab)	**BSC**	**-**	**-**	**2**	**1**
9	98BT353	Biostatistics (Lab)	**PC**	**-**	**-**	**2**	**1**
10	98BT354	Biophysical Tools and Techniques (Lab)	**OS**	**-**	**-**	**2**	**1**
11	98BT355	Entrepreneurship Development (Presentation)	**PS**	**-**	**-**	**2**	**1**
12	HMSC 301	Universal Human Values	**VAC**	**3**	**1**	**-**	**4**
		TOTAL		**17**	**3**	**10**	**30**

Scheme of B. Tech. Biotech 4th Semester

S. No	Subject Code	SUBJECT	Subject AREA	Periods			Credit
				L	T	P	
1	98BT401	Molecular Biology	PC	3	-	-	3
2	98BT402	Biochemical Engineering	PC	2	1	-	3
3	98BT403	Genetic Engineering and Molecular Diagnostics	PC	3	-	-	3
4	98BT404	Immunology & Immuno-Technology	PC	3	-	-	3
5	98BT405	Biosafety, Bioethics and IPRs	HS	2	-	-	2
6	98BT406	Industrial Fermentation	PC	1	1	-	2
7	98BT451	Molecular Biology (Lab)	PC	-	-	2	1
8	98BT452	Biochemical Engineering (Lab)	PC	-	-	2	1
9	98BT453	Genetic Engineering and Molecular Diagnostics (Lab)	PC	-	-	2	1
10	98BT454	Immunology & Immuno-Technology (Lab)	PC	-	-	2	1
11	98BT455	Biosafety, Bioethics and IPRs (Lab)	PC	-	-	2	1
12	98BT456	Industrial Fermentation (Lab)	HU	-	-	2	1
		Total		**14**	**2**	**12**	**22**

Scheme of B. Tech. Biotech 5th Semester

S. No	Subject Code	SUBJECT	Subject AREA	Periods			Credit
				L	T	P	
1	98BT501	Plant Biotechnology	**PC**	**3**	**-**	**-**	**3**
2	98BT502	Enzyme Engineering and Technology	**PC**	**2**	**1**	**-**	**3**
3	98BT503	Animal Biotechnology	**PC**	**3**	**-**	**-**	**3**
4	98BT504	Distillates and Fermentation Technology	**PC**	**3**	**-**	**-**	**3**
5	98BT506 -A	Nanotechnology and Engineering	**PE**	**3**	**-**	**-**	**3**
6	98BT506 -B	Pharmaceutical Biotechnology	**PE**	**3**	**-**	**-**	**3**
7	98BT506 -C	Molecular Modeling and Drug Designing	**PE**	**3**	**-**	**-**	**3**
8	98BT505	Bioseparations	**PC**	**2**	**1**	**-**	**3**
9	98BT551	Plant Biotechnology (Lab 1)	**PC**	**-**	**-**	**2**	**1**
10	98BT552	Enzyme Engineering and Technology (Lab 2)	**PC**	**-**	**-**	**2**	**1**
11	98BT553	Animal Biotechnology (Lab 3)	**PC**	**-**	**-**	**2**	**1**
12	98BT554	Distillates and Fermentation Technology (Lab 4)	**PC**	**-**	**-**	**2**	**1**
13	98BT556 -A/B/C	Nanotechnology and Engineering /Pharmaceutical Biotechnology /Molecular Modelling and Drug Designing (Lab 5)	**PE**	**-**	**-**	**2**	**1**
14	98BT555	Bioseparations (Lab 6)	**PE**	**-**	**-**	**2**	**1**
		Total		**16**	**2**	**12**	**24**

Scheme of B. Tech. Biotech 6th Semester

S. No.	Subject Code	SUBJECT	Subject AREA	Periods			Credit
				L	T	P	
1	98BT607	Advanced Bioanalytical Technique	**PC**	**3**	**-**	**-**	**3**
2	98BT602	Metabolic Engineering	**PC**	**2**	**1**	**-**	**3**
3	98BT603	Bioreactor Design	**PC**	**2**	**1**	**-**	**3**
4	98BT604	Waste Treatment	**PC**	**2**	**-**	**-**	**2**
5	98BT606-A	Food Biotechnology	**PE**	**3**	**-**	**-**	**3**
6	98BT606-B	Vaccine Biotechnology	**PE**	**3**	**-**	**-**	**3**
7	98BT606-C	Bioprograming and Soft Computing Techniques	**PE**	**3**	**-**	**-**	**3**
8	98BT605	Genomics & Proteomics	**PE**	**3**	**-**	**-**	**3**
9	98BT657	Advanced Bioanalytical Technique (Lab 1)	**PC**	**-**	**-**	**2**	**1**
10	98BT652	Metabolic Engineering (Lab 2)	**PC**	**-**	**-**	**2**	**1**
11	98BT653	Bioreactor Design (Lab 3)	**PC**	**-**	**-**	**2**	**1**
12	98BT654	Waste Treatment (Lab 4)	**PC**	**-**	**-**	**2**	**1**
13	98BT656 A/B/C	Food Biotechnology / Vaccine Biotechnology /Bioprogramming and Soft Computing Techniques (Lab 5)	**PE**	**-**	**-**	**2**	**1**
14	98BT655	Genomics & Proteomics (Lab 6)	**PE**	**-**	**-**	**2**	**1**
		Total		**15**	**2**	**12**	**23**

Scheme of B. Tech. Biotech 7th Semester

S. No.	Subject Code	SUBJECT	Subject AREA	Periods			Credit
				L	T	P	
1	98BT755	Industrial Training	**PS**	**-**	**-**	**10**	**5**
2	98BT701	Stem Cell and Tissue Engineering	**PE**	**3**	**-**	**-**	**3**
3	98BT702	Bioprocess Engineering and Unit Operation	**PC**	**2**	**1**	**-**	**3**
4	98BT704 -A	Biofuels and Bioenergy	**PE**	**2**	**-**	**-**	**2**
5	98BT704 -B	Bioremediation	**PE**	**2**	**-**	**-**	**2**
6	98Bt704- C	Metagenomics	**PE**	**2**	**-**	**-**	**2**
7	98BT703	Proteomics & Protein Engineering	**PC**	**2**	**1**	**-**	**3**
8	98BT751	Stem Cell and Tissue Engineering (Lab 1)	**PE**	**-**	**-**	**2**	**1**
9	98BT752	Bioprocess Engineering and Unit Operation (Lab 2)	**PC**	**-**	**-**	**2**	**1**
10	98BT754 A/B/C	Biofuels and Bioenergy /Bioremediation /Metagenomics LAB	**PE**	**-**	**-**	**2**	**1**
11	98BT753	Proteomics & Protein Engineering (Lab 4)	**PE**	**-**	**-**	**2**	**1**
12	98BT705	Research Methodology	**PC**	**2**	**-**	**-**	**2**
		TOTAL		**09**	**2**	**18**	**20**

Scheme of B. Tech. Biotech 8th Semester

S. No	Subject Code	SUBJECT	Subject AREA	Periods			Credit
				L	T	P	
1	98BT851	Project Work/Dissertation/Biotech industrial or Biotech in House Project or Biopreneurship / Bio-Startups	PS	-	-	18	9
		TOTAL		0	0	18	9

B. Tech. Biotechnology 1st Semester

Program Name	**Bachelor of Technology (B.Tech.)- Biotechnology**	
Semester	I	
Course Code:	98BT107	
Course title:	Cell Biology and Genetics	**Curriculum Developer**: Dr. Ashwini A. Waoo
Pre-requisite:	Student should have basic knowledge of cell structure and organelles	
Rationale:	The B.Tech first-semester course in cell biology and genetics serves as a crucial introduction to the fundamental building blocks of life—cells and genetic mechanisms. By delving into cellular structures, processes, and genetic principles, students establish a foundational understanding of life at the molecular level. This course paves the way for comprehending intricate biological phenomena, ranging from cellular functions to inheritance patterns, and sets the stage for future explorations in biotechnology, genetics, and related fields.	
Course Outcomes (COs):	**CO1-98BT107.1**: Students will demonstrate a thorough understanding of cell, cell theory, cell types and pre cellular evolution. **CO2-98BT107.2**: Students will exhibit proficiency in drawing and explaining ultrastructure of cell membrane and cell organelles. **CO3-98BT107.3**: Evaluate the roles cell division, cell cycle and cell signalling. **CO4-98BT107.4**: Students will exhibit mastery of Genetic Principles and Mendel's laws of inheritance. **CO5-98BT107.5**: Illustrate molecular organization of chromosome and its alterations.	

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)	
Program Core (PC)	98BT107 98BT155	Cell biology and genetics Cell Biology and Genetics lab	3	2	1	5	11	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 must 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)		
BSC	98BT107	Cell Biology and 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)		
BSC	98BT155	Cell Biology and 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.	

Item	Cl	LI	SW	SL	Total
Approx. Hrs	08	4	01	04	17

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**	**Course outcome (CO)**
CO1-98BT107.1: Students will demonstrate a thorough understanding of cell, cell theory, cell types and pre cellular evolution.	SO1.1: Understand the ultrastructure of the cell membrane	LI1.1: Observation of cell membrane under the microscope	CI1.1: Structure and function of cell membrane	SL1.1: Describe the ultrastructure of the cell membrane	**CO1-98BT107.1**: Students will demonstrate a thorough understanding of cell, cell theory, cell types and pre cellular evolution.
	SO1.2: Learn the structure and function of cell organelles	LI1.2: Study of cell organelles in various cell types	CI1.2: Structure and function of cell organelles	SL1.2: Explain the function of key cell organelles	
	SO1.3: Understand the structure and function of Golgi bodies		CI1.3: Golgi bodies	SL1.3: Describe the role of Golgi bodies in a cell	
	SO1.4: Understand the structure and function of cytosol		CI1.4: Cytosol		
	SO1.5: Learn the structure and function of the endoplasmic reticulum		CI1.5: Endoplasmic reticulum	SL1.4: Compare the rough and smooth endoplasmic reticulum	

	SO1.6: Understand the structure and function of ribosomes		CI1.6: Ribosomes		
	SO1.7: Learn the structure and function of mitochondria		CI1.7: Mitochondria		

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Differentiate between prokaryotic and eukaryotic cell
	SW1.2 Mini Project	Prepare list of microorganisms of prokaryotic and eukaryotic type
	SW1.3 Other Activities (Specify)	Prepare chart on tools and techniques of cell biology

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)
CO2-98BT107.2: Students will exhibit proficiency in drawing and explaining ultrastructure of cell membrane and cell organelles.	SO2.1: Understand the ultrastructure of the cell membrane	LI2.1: Observation of cell membrane under the microscope	CI2.1: Structure and function of cell membrane	SL2.1: Describe the ultrastructure of the cell membrane
	SO2.2: Learn the structure and function of cell organelles	LI2.2: Study of cell organelles in various cell types	CI2.2: Structure and function of cell organelles	SL2.2: Explain the function of key cell organelles
	SO2.3: Understand the structure and function of Golgi bodies		CI2.3: Golgi bodies	SL2.3: Describe the role of Golgi bodies in a cell
	SO2.4: Understand the structure and function of cytosol		CI2.4: Cytosol	
	SO2.5: Learn the structure and function of the endoplasmic reticulum		CI2.5: Endoplasmic reticulum	SL2.4: Compare the rough and smooth endoplasmic reticulum
	SO2.6: Understand the structure and function of ribosomes		CI2.6: Ribosomes	
	SO2.7: Learn the structure and function of mitochondria		CI2.7: Mitochondria	
	SO2.8: Understand the structure and function of peroxisomes		CI2.8: Peroxisomes	

	SO2.9: Understand the cell division and cycle: mitosis and meiosis		CI2.9: Cell division: Mitosis and Meiosis	SL2.5: Describe the stages of mitosis and meiosis
	SO2.10: Learn about cell cycle regulation		CI2.10: Cell cycle regulation	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Draw a well labelled diagram of fluid mosaic model and describe it.
	SW2.2 Mini Project	Prepare chart on cell organelles.
	SW2.3 Other Activities (Specify)	Prepare collection of photos from internet of different cellular organisations and electron micrograph of cell organelles

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)
CO3-98BT107.3: Evaluate the roles cell division, cell cycle and cell signalling.	SO3.1: Understand the process of mitosis	LI3.1: Observation of mitosis in cell samples	CI3.1: Mitosis	SL3.1: Describe the stages of mitosis
	SO3.2: Learn the process of meiosis	LI3.2: Observation of meiosis in cell samples	CI3.2: Meiosis	SL3.2: Compare mitosis and meiosis
	SO3.3: Understand cell cycle regulation		CI3.3: Cell cycle regulation	SL3.3: Explain the mechanisms of cell cycle checkpoints
	SO3.4: Learn about cell junctions		CI3.4: Cell junctions	
	SO3.5: Understand cell adhesion and extracellular matrix		CI3.5: Cell adhesion and extracellular matrix	SL3.4: Describe the role of the extracellular matrix in cell adhesion
	SO3.6: Learn about programmed cell death		CI3.6: Programmed cell death	
	SO3.7: Understand cell signaling		CI3.7: Cell signalling	
	SO3.8: Learn about signaling molecules and their receptors		CI3.8: Signalling molecules and their receptors	
	SO3.9: Understand intracellular signal transduction pathways		CI3.9: Intracellular signal transduction pathways	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Describe cell division and cell cycle
	SW3.2 Mini Project	Prepare complete draft on cell signalling and its types
	SW3.3 Other Activities (Specify)	Collect links of videos based on cell division process and explain them in front of class

Item	Cl	LI	SW	SL	Total
Approx. Hrs	08	04	01	05	18

Course Outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO4-98BT107.4: Students will exhibit mastery of Genetic Principles and Mendel's laws of inheritance.	SO4.1: Understand Mendel and his experiments	LI4.1: Observation of Mendelian inheritance in pea plants	CI4.1: Mendel and his experiments	SL4.1: Explain the significance of Mendel's experiments
	SO4.2: Learn about multiple alleles	LI4.2: Study of blood group inheritance	CI4.2: Multiple alleles	SL4.2: Describe examples of multiple alleles
	SO4.3: Understand the chromosomal theory of inheritance		CI4.3: Chromosomal theory of inheritance	SL4.3: Discuss the evidence supporting the chromosomal theory of inheritance
	SO4.4: Understand gene interactions: intragenic and intergenic		CI4.4: Intragenic and intergenic interactions	
	SO4.5: Learn about incomplete dominance		CI4.5: Incomplete dominance	SL4.4: Provide examples of incomplete dominance
	SO4.6: Understand lethal genes		CI4.6: Lethal genes	
	SO4.7: Learn about complementary and supplementary genes		CI4.7: Complementary and supplementary genes	

	SO4.8: Understand inhibitory and duplicate genes		CI4.8: Inhibitory and duplicate genes	
	SO4.9: Learn about epistatic genes and population genetics		CI4.9: Epistatic genes and population genetics	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Describe laws of inheritance given by Mendel
	SW4.2 Mini Project	Describe the examples of Intergenic interactions
	SW4.3 Other Activities (Specify)	Prepare list of assumption of Hardy-Winberg Law /equilibrium and give its derivation

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	04	01	05	19

Course Outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO5-98BT107.5: Illustrate molecular organization of chromosome and its alterations.	SO5.1: Understand chromosome structure and organization in prokaryotes	LI5.1: Observation of prokaryotic chromosome structure	CI5.1: Chromosome structure in prokaryotes	SL5.1: Describe the organization of chromosomes in prokaryotes
	SO5.2: Understand chromosome structure and organization in eukaryotes	LI5.2: Observation of eukaryotic chromosome structure	CI5.2: Chromosome structure in eukaryotes	SL5.2: Describe the organization of chromosomes in eukaryotes
	SO5.3: Learn about the extranuclear genome		CI5.3: Extranuclear genome	SL5.3: Explain the role of the extranuclear

				genome
	SO5.4: Understand abnormal chromosomes and chromosomal mutations		CI5.4: Abnormal chromosomes and chromosomal mutations	SL5.4: Describe types of chromosomal mutations
	SO5.5: Learn about deletion and duplication		CI5.5: Deletion and duplication	
	SO5.6: Understand inversion and translocation		CI5.6: Inversion and translocation	
	SO5.7: Learn about aneuploidy and polyploidy		CI5.7: Aneuploidy and polyploidy	
	SO5.8: Understand crossing over		CI5.8: Crossing over	
	SO5.9: Learn about sex determination		CI5.9: Sex determination	SL5.5: Describe mechanisms of sex determination

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Describe molecular organization of eukaryotic chromosome.
	SW5.2 Mini Project	Describe the chromosomal mutations in detail
	SW5.3 Other Activities (Specify)	Prepare a detail draft on sex determination and its examples

Course Duration (In Hours) To Attain Course Outcomes

Course Title: Cell Biology and Genetics **Course Code**: 98BT107

Course Outcomes (COs)	Class Lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (LI+CI+SL+SW)
CO1-98BT107.1: Students will demonstrate a thorough understanding of cell, cell theory, cell types and pre cellular evolution.	8	4	4	1	17
CO2-98BT107.2: Students will exhibit proficiency in drawing and explaining ultrastructure of cell membrane and cell organelles.	10	4	4	1	19
CO3-98BT107.3: Evaluate the roles cell division, cell cycle and cell signalling.	9	4	4	1	18
CO4-98BT107.4: Students will exhibit mastery of Genetic Principles and Mendel's laws of inheritance.	9	4	4	1	18
CO5-98BT107.5: Illustrate molecular organization of chromosome and its alterations.	9	4	5	1	19
Total Hours	45	20	21	05	91

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

Course Title: Cell Biology and Genetics **Course Code:** 98BT107

Course Outcomes	Marks distribution			Total Marks
	A	**An**	**E**	
CO1-98BT107.1: Students will demonstrate a thorough understanding of cell, cell theory, cell types and pre cellular evolution.	02	02	01	05
CO2-98BT107.2: Students will exhibit proficiency in drawing and explaining ultrastructure of cell membrane and cell organelles.	03	05	02	10
CO3-98BT107.3: Evaluate the roles cell division, cell cycle and cell signaling.	05	05	05	15
CO4-98BT107.4: Students will exhibit mastery of Genetic Principles and Mendel's laws of inheritance.	04	03	03	10
CO5-98BT107.5: Illustrate molecular organization of chromosome and its alterations.	05	04	01	10
Total Marks	19	19	12	50

***Legend*: A,** apply; **An,** Analyse; **E,** evaluate.

Suggested learning Resources:

(a) Books:

1. Cell & molecular biology- De Robertis B.J. publications Pvt. Ltd.
2. Cell & molecular biology - Gerald karp john wills & essential cell biology Albert's D. Bray
3. Developmental biology- SF Gilbert senior associates.
4. Molecular Biology of Cell- Alberts, B et al.
5. Genetics- Strickberger, 2^{nd}.

6. Microbial Genetics – D. Frifielder.

(b) 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. Tech. Biotechnology **Semester:** I

Course Title: Cell Biology and Genetics **Course Code:** 98BT107

CO/PO 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
CO1-98BT107.1: Students will demonstrate a thorough understanding of cell, cell theory, cell types and pre cellular evolution.	-	-	1	2	2	2	2	-	1	2	2	3	3	-	-
CO2-98BT107.2: Students will exhibit proficiency in drawing and explaining ultrastructure of cell membrane and cell organelles.	-	-	-	-	-	-	-	-	2	2	3	3	2	-	1
CO3-98BT107.3: Evaluate the roles cell division, cell cycle and cell signalling.	-	1	1	1	-	2	2	-	3	3	3	2	2	2	1
CO4-98BT107.4: Students will exhibit mastery of Genetic Principles and Mendel's laws of inheritance.	-	1	1	2	2	2	2	3	-	1	2	2	2	2	2
CO5-98BT107.5: Illustrate molecular organization of chromosome and its alterations.	1	1	1	-	-	3	3	3	1	2	3	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 1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2,3	**CO1-98BT704-B.1:** Identify the different types of bioremediation techniques, mechanism and microbes for bioremediation	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8	LI1, LI2	1.1,1.2,1.3,1.4,1.5, 1.6, 1.7, 1.8	1SL-1,2,3,4
PO 1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2,3	**CO2-98BT704-B.2:** Differentiate criteria of types of bioremediations and its detail process.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9 SO 2.10	LI1, LI2	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.10	2SL-1,2,3,4
PO1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2,3	**CO3-98BT704-B.3:** Evaluate the roles Bio sorption & Bioleaching and phytoremediation.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9	LI1, LI2	3.1,3.2,3.3,3.4,3.5, 3.6, 3.7, 3.8, 3.9	3SL-1,2,3,4
PO 1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2,3	**CO4-98BT704-B.4:** Use of Bioremediation of phenols, cyanides, dyes, understand biodegradation through pathway engineering.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8 SO4.9	LI1, LI2	4.1,4.2,4.3,4.4,4.5, 4.6, 4.7, 4.8, 4.9	4SL-1,2,3,4
PO 1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2,3	**CO5-98BT704-B.5:** Case study and demonstration of bioremediation plan for industrial waste.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9	LI1, LI2	5.1,5.2,5.3,5.4,5.5, 5.6, 5.7, 5.8, 5.9	5SL-1,2,3,4,5

Program Name	**Bachelor of Technology (B.Tech.) Biotechnology**	
Semester	I	
Course Code:	98BT101	
Course title:	Biology for Engineers	Developer: Mr. Paras Koshe
Pre-requisite:	Student should have basic knowledge about Physiology and biology and various system of our body	
Rationale:	The paper on "Biology" in B.Tech. Biotechnology program allow students to know that Biology is related to mankind ever since the origin of man, therefore this branch of science stands first in order of studies as compared to other branches of science. Ever since the origin of life man is eager to know about various phenomenon of life processes such as health and disease, birth, growth and death,	
Course Outcomes (COs):	**98BT101: 1** The basic idea of cell organization, classification of living organism and nomenclature and biodiversity covered in the unit. **98BT101: 2** Explain morphology, anatomy and function of different parts of flowering plants and emphasis on plant physiology, **98BT101: 3** Learn about the human physiology with emphasis on various organ systems. **98BT101: 4** Understand the male and female reproductive system and know about sexually transmitted diseases **98BT101: 5** The student understands the fundamentals of immunology, the Origin of life, and the mechanism of evolution.	

Scheme of Studies:

Board of study	**Course Code**	**Course Title**	**Scheme of Studies (Hrs/Week)**					**Total Credits (L:T:P=1:1:0)**
			CI	**LI**	**SW**	**SL**	**Total study Hrs. (CI+LI+SW+SL)**	
BSC	98BI101	Biology for Engineers	2	0	1	1	4	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 must 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+CAT+CT+SA+AT)		
BSC	98BI101	Biology for Engineers	**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	Cl	LI	SW	SL	Total
Approx. Hrs	06	00	01	01	08

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO 1: The basic idea of cell organization, classification of living organism and nomenclature and biodiversity covered in the unit	SO1.1: Understand the diversity of living organisms		CI1.1: Diversity of living organisms	SL1.1: Describe the major groups of living organisms
	SO1.2: Learn about the classification of living organisms		CI1.2: Classification of living organisms	
	SO1.3: Understand the systematic and binomial system of nomenclature		CI1.3: Systematic and binomial nomenclature	
	SO1.4: Learn about cell theory and organization		CI1.4: Cell theory and organization	
	SO1.5: Understand the basic chemical constituents of living bodies		CI1.5: Basic chemical constituents of living bodies	
	SO1.6: Learn about the role of chemical constituents in biological functions		CI1.6: Role of chemical constituents in biological functions	

Suggested Sessional Work (SW): ***anyone***	**SW1.1** Assignments	Describe in detail about the diversity and classification of living organism
	SW1.2 Mini Project	Draw well labelled diagram of Plant cell and animal cell.
	SW1.3 Other Activities (Specify)	Write a note on red data book and collect information about recently endangered and extinct species,

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)
CO 2: Explain morphology, anatomy and function of different parts of flowering plants and emphasis on plant physiology	SO2.1: Understand animal and plant tissues		CI2.1: Animal tissues	SL2.1: Compare and contrast animal and plant tissues
	SO2.2: Learn about the morphology, anatomy, and function of different parts of flowering plants		CI2.2: Anatomy and function of flowering plant parts	SL2.2: Describe the morphology and function of different plant parts
	SO2.3: Understand the movement of water, food, nutrients, and gases in plants		CI2.3: Movement of water, food, nutrients, and gases	SL2.3: Explain the processes involved in the movement of water and nutrients in plants
	SO2.4: Learn about plant respiration		CI2.4: Plant respiration	
	SO2.5: Understand photosynthesis in plants		CI2.5: Photosynthesis	
	SO2.6: Learn about plant growth and development		CI2.6: Plant growth and development	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Explain the process of photosynthesis in detail,
	SW1.2 Mini Project	Draw well labelled diagrams of plant tissues and animal tissues.
	SW1.3 Other Activities (Specify)	Watch animation and learn more about the plant growth and development. Grow a baby plant and watch and observe the growth and development practically and minutely.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	00	01	04	11

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO 3: Learn about the human physiology with emphasis on various organ systems of human body	SO3.1: Understand the structure and function of the digestive system		CI3.1: Digestive system	SL3.1: Describe the processes of digestion and absorption
	SO3.2: Learn about the respiratory system		CI3.2: Respiratory system	SL3.2: Explain the mechanism of breathing and gas exchange
	SO3.3: Understand the circulatory system and body fluids		CI3.3: Circulatory system and body fluids	SL3.3: Describe the path of blood flow through the heart and major blood vessels
	SO3.4: Learn about neural control and coordination		CI3.4: Neural control and coordination	SL3.4: Explain how the nervous system controls and coordinates body functions
	SO3.5: Understand chemical coordination and regulation		CI3.5: Chemical coordination and regulation	
	SO3.6: Learn about endocrine glands and their functions		CI3.6: Endocrine glands and functions	

Suggested Sessional Work (SW): *anyone*	Assignments:	Describe endocrine system and the various types of glands in body.
	Mini Project:	Draw structure of different types of system of human body. (Digestive system respiratory system)
	Other Activities (Specify):	Watch animation on explaining the organ transplantation and try to write article on red biotechnology.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	00	01	04	11

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO 4: Understand the male and female reproductive system and know about sexually transmitted diseases	SO4.1: Understand the male reproductive system		CI4.1: Male reproductive system	SL4.1: Describe the structure and function of the male reproductive system
	SO4.2: Learn about the female reproductive system		CI4.2: Female reproductive system	SL4.2: Describe the structure and function of the female reproductive system
	SO4.3: Understand the production of gametes		CI4.3: Gametogenesis	SL4.3: Explain the process of spermatogenesis and oogenesis
	SO4.4: Learn about fertilization		CI4.4: Fertilization	
	SO4.5: Understand embryo development		CI4.5: Embryo development	
	SO4.6: Learn about sexually transmitted diseases (STDs)		CI4.6: Sexually transmitted diseases	

Suggested Sessional Work (SW): ***anyone***	**Assignments:**	Suggest the aspects of reproductive health which need to be given special attention in present scenario.
	Mini Project:	Draw the structure of male and female reproductive system on chart paper.
	Other Activities (Specify):	Write an article on Medical Termination of Pregnancy (MTP).

Item	CI	LI	SW	SL	Total
Approx. Hrs	06	00	01	04	11

Course outcome (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO 5 The student gains an understanding of the fundamentals of immunology and Origin of life and mechanism of evolution	SO5.1: Understand the theories and evidence for the origin of life		CI5.1: Theories of the origin of life	SL5.1: Describe the major theories about the origin of life
	SO5.2: Learn about adaptive radiation		CI5.2: Adaptive radiation	SL5.2: Provide examples of adaptive radiation in different species
	SO5.3: Understand the mechanisms of evolution		CI5.3: Mechanisms of evolution	SL5.3: Explain the principles of natural selection and genetic drift
	SO5.4: Learn about the origin and evolution of man		CI5.4: Origin and evolution of man	SL5.4: Describe the evolutionary history of human beings
	SO5.5: Understand basic concepts of immunology		CI5.5: Basic concepts of immunology	
	SO5.6: Learn about vaccines, AIDS, and cancer		CI5.6: Vaccines, AIDS, and cancer	

Suggested Sessional Work (SW): Anyone	**Assignments:**	Detail explanation of principle of vaccine and its production
	Mini Project:	Collect some old photographs showing of early man and make poster showing evolution of man with much evidence.

	Other Activities (Specify):	Write an article on modern vaccine (Recombinant DNA vaccine and subunit vaccine)

Course Duration (in Hours) to Attain Course Outcomes

Course Title: Biology for Engineers **Course Code:** 98BT101

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
98BT101.1 The basic idea of cell organization, classification of living organism and nomenclature and biodiversity covered in the unit.	6	0	1	1	08
98BT101.2 Explain morphology, anatomy and function of different parts of flowering plants and emphasis on plant physiology,	6	0	3	1	10
98BT101.3 Learn about the human physiology with emphasis on various organ systems of human body.	6	0	4	1	11
98BT101.4 Understand the male and female reproductive system and know about sexually transmitted diseases	6	0	4	1	11
98BT101.5 The student gains an understanding of the fundamentals of immunology and Origin of life and mechanism of evolution.	6	0	4	1	11
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: Biology for Engineers **Course Code:** 52BT201

Course Outcomes	**Marks Distribution**				**Total Marks**
	A	**An**	**E**	**C**	
98BT101.1 The basic idea of cell organization, classification of living organism and nomenclature and biodiversity covered in the unit.	2	1	1	1	5
98BT101.2 Explain morphology, anatomy and function of different parts of flowering plants and emphasis on plant physiology,	2	4	2	2	10
98BT101.3 Learn about the human physiology with emphasis on various organ systems of human body.	3	5	5	2	15
98BT101.4 Understand the male and female reproductive system and know about sexually transmitted diseases	2	3	3	2	10
98BT101.5 The student gains an understanding of the fundamentals of immunology and Origin of life and mechanism of evolution.	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	Roitt I.M, Brostoff, J., Male D.K., Immunology (Illustrated Publisher, Mosby).
2	T. J. Kindt, R.A. G. B. A. Osborne, J. Kuby. Immunology (W.H. Freeman and Company, New York).
3	Biology by Peter H Raven, George B Johnson, Kenneth A. Mason, Jonathan Losos, Susan Singer (Macgraw Hill)
4	Campbell, N.A. and Reece, J.B. (2008) Biology 8th edition, Pearson Benjamin Cummings, San Francisco.

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.Tech. Biotechnology **Semester:** I

Course Title: Biology for Engineers **Course Code:** 98BT101

Course Outcome (Co)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
98BT101.1 The basic idea of cell organization, classification of living organism and nomenclature and biodiversity covered in the unit.	3	2	3	2	1	1	1	1	2	2	2	2	3	1	1
98BT101.2 Explain morphology, anatomy and function of different parts of flowering plants and emphasis on plant physiology,	2	2	3	2	2	1	1	1	2	2	2	2	2	2	1
98BT101.3 Learn about the human physiology with emphasis on various organ systems of human body.	2	2	3	2	2	1	1	1	2	2	2	2	1	2	1
98BT101.4 Understand the male and female reproductive system and know about sexually transmitted diseases	2	1	2	2	1	1	1	1	2	1	1	1	1	1	2
98BT101.5 The student gains an understanding of the fundamentals of immunology	3	3	3	2	2	2	1	1	3	2	3	2	3	2	2

and Origin of life and mechanism of evolution.															

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	**98BT101.1** The basic idea of cell organization, classification of living organism and nomenclature and biodiversity covered in the unit.	SO1.1, SO1.2 SO1.3, SO1.4SO1.5, SO1.6	**-**	1.1,1.2,1.3,1.4, 1.5,1.6	**1SL-1**
PO 1,2,3,4,5 PSO 1,2,3	**98BT101.2** Explain morphology, anatomy and function of different parts of flowering plants and emphasis on plant physiology,	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	**98BT101.3** Learn about the human physiology with emphasis on various organ systems of human body.	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-1,2,3,4**
PO 1,2,3,4,5 PSO 1,2,3	**98BT101.4** Understand the male and female reproductive system and know about sexually transmitted diseases	SO4.1 SO4.2 SO4.3 SO4.4, SO4.5, SO4.6	**-**	4.1,4.2,4.3,4.4,4.5,4.5,4.6	**4SL-1,2,3,4**
PO 1,2,3,4,5 PSO 1,2,3	**98BT101.5** The student gains an understanding of the fundamentals of immunology and Origin of life and mechanism of evolution.	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-1,2,3,4**

Program Name	**Bachelor of Technology (B.Tech.)- Biotechnology**	
Semester	I	
Course Code:	98ME104	
Course title:	Basic Mechanical Engineering and Manufacturing Process	**Curriculum Developer**: Er. Ketan Agrawal
Pre-requisite:	Students should have basic knowledge of physics.	
Rationale:	The curriculum for basic mechanical engineering and manufacturing processes provides students with foundational knowledge in mechanics, thermodynamics, and materials science, alongside practical skills in manufacturing techniques. It emphasizes industry relevance, problem-solving abilities, interdisciplinary understanding, and professional development to prepare students for successful careers in engineering.	
Course Outcomes (COs):	**CO1-98ME104.1.** Acquiring knowledge of materials and their properties for engineering applications **CO2-98ME104.2.** Understand casting and forming principles, ability to select processes, analyse defects, and optimize production for efficient manufacturing. **CO3-98ME104.3.** Acquiring knowledge of working of lathe machine and drilling machine and welding process **CO4-98ME104.4.** Enhancement of fundamental knowledge of Thermodynamics. Demonstrate various types of boilers and their relative merits and demerits. Define the fundamental of IC engine. **CO5-98ME104.5.** Explain stress, strain and their relationship with different material.	

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C) (L: T:P=2:1:1)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
ESC	98ME104 and 98ME 154	Basic Mechanical Engineering and Manufacturing Process	3	2	1	2	8	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 must 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 (Best 2 out of 3) 10 Marks each (CT)	Seminar one (SA)	Class activity (CAT)	Class attendance (AT)	Total Marks (CA+CT+CAT+SA+AT)		
ESC	98ME104	Basic Mechanical Engineering and Manufacturing Process	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)		
ECC	98ME514	Biochemical Engineering	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	02	16

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO1-98ME104.1. Acquiring knowledge of materials and their properties for engineering applications	SO1.1: Knowledge of mechanical, thermal, electrical, and chemical properties of materials.	LI1.1: Introduction of basic mechanical engineering lab.	CI1.1: Classification of engineering material, Properties of Materials: Strength, elasticity, stiffness, malleability, ductility, brittleness	SL1.1: Compare ferrous and non-ferrous materials.

	SO1.2: Ability to select materials suitable for specific engineering applications.	LI1.2: To demonstrate the working of 2-stroke petrol engine.	CI1.2: Toughness and hardness. Elementary ideas of fracture, fatigue & creep.	SL1.2: Classify different types of steel used in engineering purpose.
	SO1.3: Understanding material behaviour under various types of stress, including tensile, compressive, shear, and torsional.		CI1.3: Ferrous Materials: Carbon steels, its classification based on % carbon as low, mild, medium & high carbon steel, its properties & applications	
	SO1.4: Understand the properties and applications of wrought iron and cast iron.		CI1.4: Wrought iron. Cast iron, Alloy steels: stainless steel, tool steel	
	SO1.5: Introduction to heat treatment processes of carbon steels.		CI1.5: Elementary introduction to Heat-treatment of carbon steels: annealing, normalizing, quenching and tempering and casehardening	
	SO1.6: Understand the composition and uses of non-ferrous metals and alloys.		CI1.6: Common uses of various non-ferrous metals & alloys, its composition such as Cu-alloys: Brass, Bronze	
	SO1.7: Understand the properties and uses of aluminium alloys.		CI1.7: Al-alloys such as Duralumin	
	SO1.8: Evaluate the advantages and disadvantages of non-ferrous metals.		CI1.8: Advantages and disadvantages of non-ferrous metals	
	SO1.9: Understand the basics of material selection for engineering applications.		CI1.9: Overview of material selection criteria for various engineering applications	

Suggested Sessional Work (SW)	**SW1.1** Assignments	Compare wrought iron, cast iron and steel in terms of their mechanical properties and application.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	04	01	02	16

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO2-98ME104.2. Understand casting and forming principles, ability to select processes, analyze defects, and optimize production for efficient manufacturing.	SO2.1: Understanding the principles of molten metal flow, solidification, and mold design	LI2.1: To demonstrate the working of a 4-stroke diesel engine	CI2.1: Basic metal forming operations & uses such as Forging, Rolling	SL2.1: Understanding the principles of molten metal flow, solidification, and mold design
	SO2.2: Knowledge of forming processes including forging, rolling, extrusion, and sheet metal forming	LI2.2: To demonstrate the working of a 2-stroke petrol engine	CI2.2: Wire & Tube-drawing/making and Extrusion	SL2.2: Knowledge of forming processes including forging, rolling, extrusion, and sheet metal forming
	SO2.3: Skills to identify and analyze defects in cast and formed parts such as porosity, shrinkage, and surface irregularities		CI2.3: Applications of metal forming operations, Presswork, die & punch assembly	
	SO2.4: Understanding cutting and forming processes and their applications		CI2.4: Cutting and forming, its applications. Hot-working versus cold-working	
	SO2.5: Knowledge of pattern making and allowances, and the properties of molding sands		CI2.5: Pattern & allowances, Moulding sands and its desirable properties	
	SO2.6: Understanding the process of mold making with		CI2.6: Mould making with the use of a core, Gating system	

	the use of a core and gating system			
	SO2.7: Identify and understand casting defects, remedies, and the use of Cupola Furnace and Die-casting		CI2.7: Casting defects, remedies, Cupola Furnace, Die-casting and its uses	
	SO2.8: Revision of metal forming and casting processes		CI2.8: Revision	
	SO2.9: Assessment and evaluation of knowledge on metal forming and casting processes		CI2.9: Assessment	

Suggested Sessional Work (SW):	**SW2.1** Assignments	Explain different type of patterns used in casting process.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	04	01	02	16

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO3-98ME104.3. Acquiring knowledge of working of lathe machine and drilling machine and welding process	SO3.1: Understand lathe machine principles and perform basic lathe operations.	LI3.1: To demonstrate the working of lathe machine.	CI3.1: Basic principles of Lathe machine	SL3.1: Classify oxy-acetylene gas flames used in gas welding and their application.
	SO3.2: Describe the machines and operations of shaper, planer, drilling, milling, and grinding. Apply knowledge of machining processes to practical applications.	LI3.2: To demonstrate the working of drilling machine.	CI3.2: Operations performed on lathe machine	SL3.2: Explain lathe accessories and lathe attachments.

	SO3.3: Explain the importance and fundamental concepts of welding.		CI3.3: Basic description and operations of Shaper machine	
	SO3.4: Identify types of flames in gas welding and demonstrate their appropriate uses.		CI3.4: Basic description and operations of Drilling machine	
	SO3.5: Describe basic description and operations of milling machine.		CI3.5: Basic description and operations of Milling machine	
	SO3.6: Describe basic description and operations of grinding machine.		CI3.6: Basic description and operations of Grinding machine	
	SO3.7: Explain the importance and basic concepts of welding.		CI3.7: Importance & basic concepts of welding	
	SO3.8: Classify different welding processes.		CI3.8: Classification of welding processes	
	SO3.9: Identify and explain types of flames in gas welding and their uses.		CI3.9: Gas welding, types of flames	

Suggested Sessional Work (SW):	**SW3.1** Assignments	Classify welding processes, including gas welding, electric arc welding, resistance welding, soldering, and brazing.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	04	01	03	17

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO4-98ME104.4 Improvement of the basic understanding of thermodynamics. Give examples of different boiler types and discuss the advantages and disadvantages of each. Describe the foundation of an IC engine.	SO4.1: Analyze steam properties, processes, boiler classification, efficiency, and performance	LI4.1: To demonstrate the working of Cochran Boiler.	CI4.1: First and second law of thermodynamics	SL4.1: List down the different types of mountings used in the boiler.
	SO4.2: Describe refrigeration cycles, COP, and refrigerant properties, including eco-friendly options.	LI4.2: To demonstrate the working of Babcock and Wilcox Boiler.	CI4.2: Steam properties	SL4.2: Define thermodynamics and classify thermodynamic system.
	SO4.3: Understand the operation of two-stroke and four-stroke petrol/diesel engines.		CI4.3: Steam processes at constant pressure	SL4.3: Explain terminology of I.C. Engine.
	SO4.4: Evaluate the efficiency and performance of internal combustion engines.		CI4.4: Volume, enthalpy & entropy	
	SO4.5: Understand the classification and working of boilers.		CI4.5: Classification and working of boilers	
	SO4.6: Perform efficiency &		CI4.6: Efficiency & performance analysis	

	performance analysis of boilers.			
	SO4.7: Differentiate between natural and induced draught.		CI4.7: Natural and induced draught	
	SO4.8: Calculate the height of a chimney.		CI4.8: Calculation of chimney height	
	SO4.9: Explain refrigeration, vapor absorption & compression cycles.		CI4.9: Refrigeration, vapor absorption & compression cycles	

Suggested Sessional Work (SW):	**SW4.1** Assignments	Explain steam engines, indicator diagrams, Carnot, Otto, and diesel cycles.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	04	01	02	16

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO5-98ME104.5 Explain stress, strain and their relationship with different material.	SO5.1: Understand basics of stress, strain, and stress-strain diagrams	LI5.1: To demonstrate the working of a Double Acting Steam Engine	CI5.1: Introduction, normal and shear stresses	SL5.1: Define Poisson's ratio
	SO5.2: Apply knowledge of elastic constants and strain energy concepts	LI5.2: To demonstrate the working of different boiler mountings	CI5.2: Stress-strain diagrams for ductile materials	SL5.2: Solve numerical problems associated with bending stresses in beams
	SO5.3: Analyze pure bending of beams and torsion in shafts effectively		CI5.3: Stress-strain diagrams for brittle materials	
	SO5.4: Understand elastic constants and strain energy		CI5.4: Elastic constants, strain energy	
	SO5.5: Understand the simple bending theory		CI5.5: Introduction, simple bending theory	
	SO5.6: Analyze stress in beams of different cross sections and bending moments		CI5.6: Stress in beams of different cross sections and bending moments	
	SO5.7: Understand torsion of shafts of circular section		CI5.7: Torsion of shafts of circular section	
	SO5.8: Analyze torque and twist and shear stress due to torque		CI5.8: Torque and twist and shear stress due to torque	

	SO5.9: Evaluate the efficiency and performance of different mechanical systems		CI5.9: Revision and assessment	

Suggested Sessional Work (SW):	**SW5.1** Assignments	Draw and explain stress –strain diagram for mild steel.

Course duration (in hours) to attain Course Outcomes:

Course Title: Basic Mechanical Engineering and Manufacturing Process **Course Code:**98ME104

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Sessional work (SW)	Self-Learning (SL)	Total Hours (Li+CI+SL+SW)
CO1-98ME104.1. Acquiring knowledge of materials and their properties for engineering applications	09	04	01	02	16
CO2-98ME104.2. Understand casting and forming principles, ability to select processes, analyze defects, and optimize production for efficient manufacturing.	09	04	01	02	16
CO3-98ME104.3. Acquiring knowledge of working of lathe machine and drilling machine and welding process	09	04	01	02	16
CO4-98ME104.4. Enhancement of fundamental knowledge of Thermodynamics. Demonstrate various types of boilers and their relative merits and demerits. Define the fundamental of IC engine.	09	04	01	03	17
CO5-98ME104.5. Explain stress, strain and their relationship with different material.	09	04	01	03	17
Total Hours	45	15	5	12	82

End Semester Assessment Scheme for Setting up Question Paper and Assessment to Evaluate the Course Outcome

Course Title: Basic Mechanical Engineering and Manufacturing Process **Course Code:**98ME104

Course Outcomes	**Marks Distribution**				**Total Marks**
	A	**An**	**E**	**C**	
CO1-98ME104.1. Acquiring knowledge of materials and their properties for engineering applications	2	1	1	1	5
CO2-98ME104.2. Understand casting and forming principles, ability to select processes, analyse defects, and optimize production for efficient manufacturing.	2	4	5	1	12
CO3-98ME104.3. Acquiring knowledge of working of lathe machine and drilling machine and welding process	3	5	5	1	14
CO4-98ME104.4. Enhancement of fundamental knowledge of Thermodynamics. Demonstrate various types of boilers and their relative merits and demerits. Define the fundamental of IC engine.	2	3	5	1	11
CO5-98ME104.5. Explain stress, strain and their relationship with different material.	2	4	1	1	08
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	Sawhney GS; Fundamentals of Mechanical Engg; PHI.
2	Agrawal B & CM; Basic Mechanical Engg. Wiley India.
3	Nag PK, Tripathi et al; Basic Mechanical Engg; TMH.
4	Mubeen, A., Mechanics of solids, Pearson Education Asia.
5	Irving H. Shames, Engineering Mechanics, Prentice Hall
6	Nakra and Chaudhary; Instrumentation & measurement; TMH.
7	Nag PK; Engineering Thermodynamics; TMH.

(b) Online Resources:

1	**Link:** Coursera - Fundamentals of Manufacturing Processes
2	**Link:** MIT Open Course Ware - Introduction to Solid Mechanics
3	**Link:** edX - Introduction to Mechanical Engineering
4	**Stanford Online Course:** Manufacturing and Design

(c) 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: B. Tech. Biotechnology **Semester:** I

Course Title: Basic Mechanical Engineering and Manufacturing Process **Course Code:** 98ME104

Course Outcome (CO)	Program Outcomes (POs)											Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-98ME104.1. Acquiring knowledge of materials and their properties for engineering applications	3	2	2	2	3	1	1	1	2	1	2	1	3	2	1
CO2-98ME104.2. Understand casting and forming principles, ability to select processes, analyse defects, and optimize production for efficient manufacturing.	2	3	3	2	3	2	1	2	2	2	3	2	3	2	2
CO3-98ME104.3. Acquiring knowledge of working of lathe	2	2	3	2	3	2	2	1	2	2	2	1	2	3	2

machine and drilling machine and welding process															
CO4-98ME104.4. Enhancement of fundamental knowledge of Thermodynamics. Demonstrate various types of boilers and their relative merits and demerits. Define the fundamental of IC engine.	3	3	2	2	2	1	1	2	3	2	3	2	3	2	3
CO5-98ME104.5. Explain stress, strain and their relationship with different material.	2	2	2	1	3	2	1	2	2	2	2	1	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 1,2,3,4,5,6	**CO1-98ME104.1.** Acquiring knowledge of materials and their	SO1.1 SO1.2 SO1.3, SO1.4,	**LI 1, LI 2, LI 3**	1.1,1.2,1.3,1.4,1.5,1.6	**1SL-1,2**

PSO 1,2, 3	properties for engineering applications	SO1.5, SO1.6, SO1.7, SO1.8, SO1.9		1.7,1.8,1.9	
PO 1,2,3,4,5,6 PSO 1,2, 3	**CO2-98ME104.2.** Understand casting and forming principles, ability to select processes, analyse defects, and optimize production for efficient manufacturing.	SO2.1 SO2.2 SO2.3, SO2.4, SO2.5, SO2.6, SO2.7, SO2.8, SO2.9	**LI 1, LI 2, LI 3**	2.1, 2.2, 2.3, 2.4,2.5,2.6 2.7,2.8,2.9	**2SL-1,2**
PO 1,2,3,4,5,6 PSO 1,2, 3	**CO3-98ME104.3.** Acquiring knowledge of working of lathe machine and drilling machine and welding process	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**
PO 1,2,3,4,5,6 PSO 1,2, 3	**CO4-98ME104.4.** Enhancement of fundamental knowledge of Thermodynamics. Demonstrate various types of boilers and their relative merits and demerits. Define the fundamental of IC engine.	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**
PO 1,2,3,4,5,6 PSO 1,2, 3	**CO5-98ME104.5.** Explain stress, strain and their relationship with different material.	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**

Program Name	**Bachelor of Technology- Biotechnology**	
Semester	I	
Course Code:	98BT106	
Course title:	Introduction to Biotechnology	**Curriculum Developer**: Dr. Deepak Mishra, Dr Ashutosh Pandey
Pre-requisite:	Student should have basic knowledge of Botany, Zoology and other related fields of life sciences.	
Rationale:	The paper on Introduction to Biotechnology in a B.Tech. Biotechnology program explores the concept and techniques used for improvement development and growth of plant tissues in laboratorial conditions. It delves into the use of precise instruments and techniques for micro propagation of plants. The second part of this course will provide precise knowledge of genetic engineering tools for improvement in plant varieties and stable genetic transformation. This study enables students to understand how recombinant DNA technology helps us for development of new plant varieties. It also explores the knowledge of biotechnology for generation of novel characteristics in plants.	
Course Outcomes (COs):	**CO1-98BT106.1:** Familiarization with the basic concepts, ideas and scope of Biotechnology. **CO2-98BT106.2:** Understand concepts of cell structure, Biomolecules and microbial culture techniques. **CO3-98BT106.3:** Acquired Skills of the various methods and processes used to create recombinant DNA molecules and its application. **CO4-98BT106.4:** Recognize various methods related to tissue culture for improvement in plants and animals. **CO5-98BT106.5:** Explore application of Biotechnology for improvement and development of novel characters in living organisms.	

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits(C) (L: T:P=3:0:0)
			Cl	LI	SW	SL	Total Study Hrs. (CI+LI+SW+SL)	
Program Common (PC)	98BT106	Introduction to Biotechnology	3	0	1	5	9	3+0 = 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 must 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)		
PC	**98BT106**	Introduction To Biotechnology	**15**	**20**	**10**	**5**	**50**	**50**	**100**

<table>
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<td>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.</td>
<td>Approximate Hours
<table>
<tr><td>Item</td><td>Cl</td><td>LI</td><td>SW</td><td>SL</td><td>Total</td></tr>
<tr><td>Approx. Hrs</td><td>09</td><td>00</td><td>01</td><td>05</td><td>15</td></tr>
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Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO1-98BT106.1: Familiarization with the basic concepts, ideas and scope of Biotechnology.	SO1.1: Understand definitions and scope of biotechnology		CI1.1: Definitions and basic concepts of biotechnology	SL1.1: Read about key definitions and terminology in biotechnology
	SO1.2: Explore the historical perspectives of biotechnology		CI1.2: Historical evolution of biotechnology	SL1.2: Research key historical milestones in biotechnology
	SO1.3: Recognize the commercial potential of biotechnology		CI1.3: Commercial applications and potential of biotechnology	SL1.3: Analyze case studies on biotechnology commercialization
	SO1.4: Identify the interdisciplinary nature of biotechnology		CI1.4: Interdisciplinary challenges in biotechnology	SL1.4: Review how biotechnology integrates with other disciplines
	SO1.5: Learn about good laboratory practices		CI1.5: Principles of good laboratory practices (GLP)	SL1.5: Study guidelines and best practices for laboratory work
	SO1.6: Understand biotechnology's impact in India		CI1.6: Overview of biotechnology developments in India	
	SO1.7: Analyze global trends in biotechnology		CI1.7: Global trends and advancements in biotechnology	

	SO1.8: Evaluate the scope and importance of biotechnology		CI1.8: Scope and importance of biotechnology in modern science	
	SO1.9: Review and summarize key concepts in biotechnology		CI1.9: Summary of key concepts and their applications	

Course-Curriculum:

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Describe in detail about scope and importance of biotechnology.
	SW1.2 Mini Project	Standardize the protocols for implantation of GLP principles in biotechnological research.
	SW1.3 Other Activities (Specify)	Collection of different evidence of existence of biotechnology in ancient era.

Item	**Cl**	**LI**	**SW**	**SL**	**Total**
Approx. Hrs	09	0	01	05	15

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO2-98BT106.2: Understand concepts of cell structure, Biomolecules and microbial culture techniques.	SO2.1 Explore the concept of cell and biomolecules.		CI2.1 Cell and Biomolecules	SL2.1 Search various contents for studying cell, biomolecules, and microbial culture.
	SO2.2 Describe the structure and function of cells.		CI2.2 Ultra Structure and Function of Cells	SL2.2 Design the protocol for fermentation.

	SO2.3 Reflect on cell types.		CI2.3 Prokaryotic and Eukaryotic Cells	SL2.3 Learn about different categories of biomolecules.
	SO2.4 Explain the concept and types of biomolecules.		CI2.4 Introduction to Biomolecules	SL2.4 Standardize the protocol for microbial culture.
	SO2.5 Assess the concept of microbial culture.		CI2.5 Microbial Culture and Application: Introduction	SL2.5 Learn the methods of microbe's isolation and characterization.
	SO2.6 Explain the steps of microbial culture.		CI2.6 Microbial Culture Techniques	
	SO2.7 Explain the concept of fermentation.		CI2.7 Fermentation	
	SO2.8 Assess the role of microbial culture.		CI2.8 Application of Microbial Culture Technology	
	SO2.9 Discuss recent advancements in microbial technologies.		CI2.9 Recent Advancements in Microbial Technologies	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Describe in detail about different types of cells and classify organism based on cells
	SW2.2 Mini Project	Designing of a fermentation model.
	SW2.3 Other Activities (Specify)	Collection, isolation and characterization of microbes from different sources.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	10	00	01	05	16

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
98BT106.3: Acquired Skills of the various methods and processes used to create recombinant plants.	SO3.1 Explain the concept of recombinant DNA technology.		CI3.1 Recombinant DNA Technology: Introduction	SL3.1 Read about various types of vectors used for cloning.
	SO3.2 Assess the tools of rDNA technology.		CI3.2 Tools of rDNA Technology	SL3.2 Study the structure and function of plasmids.
	SO3.3 Explain the concept of a DNA library.		CI3.3 DNA Library	SL3.3 Illustrate the mechanism of DNA transfer.
	SO3.4 Assess the role of transformation in recombinant DNA technology.		CI3.4 Introduction of Recombinant DNA into Host Cells	
	SO3.5 Describe recombinant screening methods.		CI3.5 Identification of Recombinants	SL3.4 Study different categories of PCR.
	SO3.6 Assess the role of PCR in recombinant DNA technology.		CI3.6 Polymerase Chain Reaction (PCR)	SL3.5 Study the application of recombinant DNA technology.
	SO3.7 Describe hybridization techniques.		CI3.7 Hybridization Techniques	
	SO3.8 Describe the concept of DNA sequencing.		CI3.8 DNA Sequencing	

	SO3.9 Describe the concept of bioinformatics.		CI3.9 Introduction to Bioinformatics	
	SO3.10 Describe genome sequencing projects.		CI3.10 Genome Sequencing Projects	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Describe in detail cloning vector and mechanism of DNA transfer.
	SW3.2 Mini Project	Describe the role of different vectors in genetic transformation.
	SW3.3 Other Activities (Specify)	Prepare a list of application of genetic engineering.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	00	01	05	15

Course Outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO4-98BT106.4: Recognize various methods related to tissue culture for improvement in plants and animals.	SO4.1 Explore the concept of plant cell culture.	-	CI4.1 Plant Cell Culture and Application: Introduction	SL4.1 Learn about different categories of tissue culture.
	SO4.2 Assess the role of cell and tissue culture techniques.	-	CI4.2 Cell and Tissue Culture Techniques	SL4.2 Standardize the protocol of cell culture.
	SO4.3 Explain the applications of tissue culture.	-	CI4.3 Applications of Cell and Tissue Culture	SL4.3 Learn about various examples of tissue culture.

	SO4.4 Explain the role of transgenic plants.	-	CI4.4 Transgenic Plants with Beneficial Traits	SL4.4 Case studies related to the success of transgenics.
	SO4.5 Evaluate the impact of animal cell culture.	-	CI4.5 Animal Cell Culture and Applications: Introduction	SL4.5 Case studies related to animal cell culture.
	SO4.6 Describe the impact of animal cell culture techniques.	-	CI4.6 Animal Cell Culture Techniques	
	SO4.7 Explain primary culture and cell lines.	-	CI4.7 Primary Culture and Cell Lines	
	SO4.8 Describe applications of cell lines.	-	CI4.8 Applications of Animal Cell Culture	
	SO4.9 Explain stem cell technology.	-	CI4.9 Stem Cell Technology	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Explain about different types of tissue culture techniques.
	SW4.2 Mini Project	Describe the various techniques used in development of transgenic plants.
	SW4.3 Other Activities (Specify)	Prepare one article on stem cell technology

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

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO5-98BT106.5: Explore application of Biotechnology for improvement and development of novel characters in living organisms.	SO5.1 Define the role of biotechnology in society.	-	CI5.1 Biotechnology and Society	SL5.1 Learn about the basic concept and requirement of chloroplast genome.
	SO5.2 Execute the role of biotechnology for healthcare.	-	CI5.2 Biotechnology and Medicines	SL5.2 Review the concept of chloroplast transformation.
	SO5.3 Apply the role of biotechnology in agriculture.	-	CI5.3 Biotechnology in Agriculture	SL5.3 Learn how to apply transgenic technology in plants.
	SO5.4 Apply biotechnology for the food industry.	-	CI5.4 Food and Beverages Technology	
	SO5.5 Apply the role of biosafety and bioethics.	-	CI5.5 Biosafety and Bioethics in Biotechnology	
	SO5.6 Discuss the impact of biotechnology on environmental sustainability.	-	CI5.6 Biotechnology and Environmental Sustainability	SL5.4 Research environmental impacts of biotech applications.
	SO5.7 Analyze the economic impact of biotechnology.		CI5.7 Economic Aspects of Biotechnology	SL5.5 Review case studies on the economic impact of biotech.

	SO5.8 Evaluate current trends and prospects in biotechnology.		CI5.8 Trends and Future Prospects in Biotechnology	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Explain applications of biotechnology
	SW5.2 Mini Project	Describe the role of biotechnology in various sectors
	SW5.3 Other Activities (Specify)	Prepare a detail document on biosafety in labs

Course duration (in hours) to attain Course Outcomes

Course Title: Introduction To Biotechnology **Course Code:**98BT106

Course Outcomes (COs)	**Class lecture (CI)**	**Laboratory Instruction (LI)**	**Sessional work (SW)**	**Self-Learning (SL)**	**Total Hours (Li+CI+SL+SW)**
CO1-98BT106.1: Familiarization with the basic concepts, ideas and scope of Biotechnology.	09	0	05	01	15
CO2-98BT106.2: Understand concepts of cell structure, Biomolecules and microbial culture techniques.	09	0	05	01	15
CO3-98BT106.3: Acquired Skills of the various methods and processes used to create recombinant DNA molecules and its application.	10	0	05	01	16
CO4-98BT106.4: Recognize various methods related to tissue culture for improvement in plants and animals.	09	0	05	01	15
CO5-98BT106.5: Explore application of Biotechnology for improvement and development of novel characters in living organisms.	08	0	05	01	14
Total Hours	45	0	25	05	75

End Semester Assessment Scheme for Setting up Question Papers and Assessments to Evaluate the Course Outcome

Course Title: Introduction To Biotechnology **Course Code:** 98BT106

Course Outcomes	**Marks Distribution**				**Total Marks**
	A	**An**	**E**	**C**	
CO1-98BT106.1: Familiarization with the basic concepts, ideas and scope of Biotechnology.	2	1	1	1	5
CO2-98BT106.2: Understand concepts of cell structure, Biomolecules and microbial culture techniques.	2	4	2	2	10
CO3-98BT106.3: Acquired Skills of the various methods and processes used to create recombinant DNA molecules and its application.	2	3	3	2	10
CO4-98BT106.4: Recognize various methods related to tissue culture for improvement in plants and animals.	3	5	5	2	15
CO5-98BT106.5: Explore application of Biotechnology for improvement and development of novel characters in living organisms.	5	4	1	0	10
Total Marks	**14**	**17**	**12**	**07**	**50**

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

Suggested learning Resources:

(a) Books:

1. Introduction to Biotechnology by P. K Gupta, Rastogi Publications
2. Biotechnology by Smith, Cambridge Press
3. Textbook of Biotechnology By R C Dubey
4. Biotechnology Expending Horizons by B D Singh

(b) Online Resources:

1. Coursera - "Introduction to Biotechnology" by University of California, San Diego URL: Introduction to Biotechnology
2. edX - "Principles of Biochemistry" by Harvard University, URL: Principles of Biochemistry
3. Biotechnology Innovation Organization (BIO), URL: BIO
4. YouTube – Crash Course: "Biotechnology - Genetic Engineering and GMOs" URL: CrashCourse - Biotechnology

(c) 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. Tech. Biotechnology **Semester:** I

Course Title: Introduction To Biotechnology **Course Code:** 98BT106

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
CO1-98BT106.1: Familiarization with the basic concepts, ideas and scope of Biotechnology.	-	1	-	1	2	2	3	-	2	1	2	3	2	2	3
CO2-98BT106.2: Understand concepts of cell structure, Biomolecules and microbial culture techniques.	-	1	-	-	-	-	3	-	2	2	2	3	1	3	3
CO3-98BT106.3: Acquired Skills of the various methods and processes used to create recombinant DNA molecules and its application.	-	1	1	1	-	-	3	-	2	1	2	3	1	2	2
CO4-98BT106.4: Recognize various methods related to tissue culture for improvement in plants and animals.	-	-	1	-	2	2	3	3	1	1	3	3	1	3	3
CO5-98BT106.5: Explore application of Biotechnology for improvement and development of novel characters in living organisms.	-	-	1	-	-	2	3	3	1	2	3	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 PSO 1,2,3	**CO1-98BT106.1:** Familiarization with the basic concepts, ideas and scope of Biotechnology.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9	-	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	**CO2-98BT106.2:** Understand concepts of cell structure, Biomolecules and microbial culture techniques.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9	-	2.1, 2.2, 2.3, 2.4, 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	**CO3-98BT106.3:** Acquired Skills of the various methods and processes used to create recombinant DNA molecules and its application.	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-1,2,3,4,5
PO 1,2,3,4,5 PSO 1,2,3	**CO4-98BT106.4:** Recognize various methods related to tissue culture for improvement in plants and animals.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8 SO4.9	-	4.1,4.2,4.3,4.4, 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	**CO5-98BT106.5:** Explore application of Biotechnology for improvement and development of novel characters in living organisms.	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-1,2,3,4,5

<table>
<tr><td>Program Name</td><td colspan="2">B.Tech. Biotechnology</td></tr>
<tr><td>Semester</td><td colspan="2">I</td></tr>
<tr><td>Course Code:</td><td colspan="2">98CH102/98CH152</td></tr>
<tr><td>Course title:</td><td>Engineering Chemistry /Engineering Chemistry Lab</td><td>Curriculum Developer: Dr Ashutosh Pandey</td></tr>
<tr><td>Pre-requisite:</td><td colspan="2">Students must have fundamental knowledge of mathematics, nature of molecule, valence shell electron pair repulsion theory, and different concentration terms to understand the concept of engineering chemistry.</td></tr>
<tr><td>Rationale:</td><td colspan="2">The students studying engineering chemistry should possess foundational understanding about basic mathematics, different concentration terms and valence shell electron pair repulsion theory to understand the basic principle of chromatography and spectroscopic analysis.</td></tr>
<tr><td>Course Outcomes (COs):</td><td colspan="2">CO 98CH102.1: Apply VSEPR theory to predict the three-dimensional shapes of molecules.

CO 98CH102.2: Describe the concept of symmetry, chirality and optical activity and synthesize chiral drug molecule.

CO 98CH102.3: Explain and apply the concept of intermolecular forces, hydrogen bond, and transition metal complexes.

CO 98CH102.4: Predict the concept of thermodynamics, free energy & entropy and apply Nernst equation,water chemistry as well as explain concept of acid-base, metallurgy, Emf cell and corrosion.

CO 98CH102.5: Collectively aim to equip students with a comprehensive understanding of the theoretical principles, practical methodologies, and diverse applications of various spectroscopic techniques.</td></tr>
</table>

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C) (L:T:P)
			Cl	LI	SW	SL	Total StudyHours (CI+LI+SW+SL)	
BSC	98CH102/ 98CH152	Engineering Chemistry	2	2	1	2	7	2+1=3

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e., Lecture(L) andTutorial (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 projected.),

SL: Self-Learning,

C: Credits.

Note: SW & SL must be planned and performed under the continuous guidance and feedback teachers ensure outcome of earning.

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) (CT)	Seminar one (SA)	Class Activity one (CAT)	Class Attendance	Total Marks (CA+CT+SA+CAT)		
BS	98CH102	Engineering Chemistry	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 (3 marks each) (CA)	Viva Voce-I	Viva Voce-I	Class Attendance	Total Marks (CA+CT+SA+CAT)		
BS	98CH152	Engineering Chemistry Lab	35	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.

Item	**CI**	**LI**	**SW**	**SL**	**Total**
Approx Hrs	6	4	1	3	14

98CH102.1 Apply VSEPR theory to predict the three-dimensional shapes of molecules.	**Session Outcomes (SOs)**	**Laboratory Instructions (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
	SO1.1 Recognize the fundamental particles: electron, proton, and neutron.	LI1.1 Demonstrate the characteristics of electrons, protons, and neutrons using models.	CI1.1 Lecture on the discovery and properties of electrons, protons, and neutrons.	SL1.1 Read research articles on the discovery and impact of subatomic particles.
	SO 1.2 Describe the shapes of s, p, and d orbitals.	LI1.2 Construct 3D models of s, p, and d orbitals.	CI 1.2 Discuss the shapes and orientations of orbitals in atoms.	SL1.2 Create a diagram showing the shapes of different orbitals.
	SO 1.3 Explain the concept of quantum numbers and their types.		CI 1.3 Lecture on quantum numbers and their significance in atomic structure.	SL1.3 Study and summarize the four quantum numbers.
	SO 1.4 Apply Aufbau's principle, Hund's rule, and Pauli's principle for electron configuration.		CI 1.4 Teach the rules for filling electrons in orbitals with examples.	
	SO 1.5 Identify different types of chemical bonds: ionic, covalent, and coordinate bonds.		CI 1.5 Explain the characteristics and formation of ionic, covalent, and coordinate bonds.	

	SO 1.6 Describe the process and types of hybridization (sp, sp2, sp3, sp3d, sp3d2, and sp3d3).		CI 1.6 Lecture on hybridization and its importance in molecular geometry.	

SW-1 Suggested Sessional Work (SW):	**SW 1.1** Assignments: Applications of molecular orbital theory for the determination of bond order and magnetic behaviour. **SW 1.2** Mini Project: Hybridization and its application. **SW 1.3** Other Activities (Specify): Write an essay on different type of chemical bond.

Item	**CI**	**LI**	**SW**	**SL**	**Total**
Approx Hrs	6	4	1	2	13

98CH102.2: Describe the concept of symmetry, chirality and optical activity and synthesize chiral drug molecule.	**Session Outcomes (SOs)**	**Laboratory Instructions (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
	SO2.1: Understand the concept of representations of 3-dimensional structures.	LI2.1: To synthesize drug molecules and determine their percentage yield.	CI2.1: Lecture on representations of 3-dimensional structures.	SL2.1: Study articles on the importance of 3D structures in drug design.
	SO2.2: Explain structural isomers and stereoisomers.	LI2.2: To determine the acid value or saponification value of oil/fat.	CI2.2: Discuss structural isomers and stereoisomers with examples.	SL2.2: Read about real-life applications of structural and stereoisomers.

	SO2.3: Describe symmetry, chirality, and optical activity.		CI2.3: Explain symmetry, chirality, and optical activity with molecular models.	
	SO2.4: Explain and identify different types of reactions with mechanisms.		CI2.4: Lecture on different types of reactions including substitution, addition, elimination, oxidation, and reduction.	
	SO2.5: Apply the concept of mechanisms to synthesize drug molecules.		CI2.5: Discuss the steps and mechanisms involved in the synthesis of drug molecules.	
	SO2.6: Understand enantiomers, diastereomers, and their importance.		CI2.6: Explain the concept of enantiomers, diastereomers, and their significance in pharmaceuticals.	

SW-2 Suggested Sessional Work (SW):	**SW 2.1** Assignments**:** Conformational isomerism and conformational analysis. **SW 2.2** Case studies **SW 2.3** Other Activities (Specify): Explain the concept of enantiomers.

Item	CI	LI	SW	SL	Total
Approx Hrs	6	4	1	2	13

98CH102.3 understand the concept of Intermolecular forces, Hydrogen bond, Transition metal complexes by applying this concept	**Session Outcomes (SOs)**	**Laboratory Instructions (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
	SO3.1: Describe ionic, dipolar, London dispersion force, and van der Waals interaction.	LI3.1: Synthesize an inorganic metal complex.	CI3.1: Lecture on ionic, dipolar, London dispersion forces, and van der Waals interactions.	SL3.1: Study articles on the impact of intermolecular forces in chemical reactions.
	SO3.2: Explain hydrogen bonds and types of hydrogen bonds.	LI3.2: Determine two acid and two basic radicals.	CI3.2: Discuss the nature and types of hydrogen bonds with examples.	SL3.2: Research the role of hydrogen bonds in biological systems.
	SO3.3: Describe coordination compounds.		CI3.3: Explain coordination compounds, IUPAC naming, and Werner theory.	
	SO3.4: Describe metal-ligand bonding by VBT.		CI3.4: Lecture on metal-ligand bonding by Valence Bond Theory (VBT).	
	SO3.5: Explain metal-ligand bonding by CFT.		CI3.5: Discuss metal-ligand bonding by Crystal Field Theory (CFT) with diagrams.	
	SO3.6: Understand the energy level diagrams for transition metal ions and their magnetic properties.		CI3.6: Explain the energy level diagrams for transition metal ions and their magnetic properties.	

SW-3 Suggested Sessional Work	SW 3.1 Assignments: VBT theory, CFT theory, the energy level diagrams for transition metal ions and their

(SW):	magnetic properties SW 3.2 Mini Project: applications of transition metal complexes SW 3.3 Other Activities (Specify):

Item	CI	LI	SW	SL	Total
ApproxHrs	6	4	1	2	13

98CH102.4 Predict the concept of thermodynamics, free energy & entropy and apply Nernst equation, water chemistry as well as explain concept of acid-base, metallurgy, Emf cell and corrosion.	**Session Outcomes (SOs)**	**Laboratory Instructions (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
	SO4.1: Describe the structure of water and its significance.	LI4.1: Determine the hardness of a water sample.	CI4.1: Lecture on the molecular structure of water.	SL4.1: Read articles on the unique properties of water.
	SO4.2: Identify sources and specifications for water.	LI4.2: Test for various impurities in water.	CI4.2: Discuss the various sources of water and their specifications.	SL4.2: Research the impact of water impurities on health and industry.
	SO4.3: Explain the types and causes of water hardness.		CI4.3: Lecture on temporary and permanent hardness of water.	
	SO4.4: Understand boiler feed water and related troubles.		CI4.4: Explain scale and sludge formation in boilers.	
	SO4.5: Describe water softening methods like lime-soda and zeolite		CI4.5: Discuss boiler corrosion and its prevention.	

	processes.			
	SO4.6: Understand municipal water treatment processes.		CI4.6: Lecture on various water softening methods including carbonate, phosphate, colloidal, and Calgon conditioning.	

SW-4 Suggested Sessional Work (SW):	**SW 4.1** Assignments: Applications of green corrosion inhibitors. **SW 4.2** Mini Project: Analysis of water quality parameters. **SW 4.3** Other Activities (Specify): Write an essay on acid-base concepts, ionic and solubility product of salts.

Item	CI	LI	SW	SL	Total
ApproxHrs.	6	4	1	2	13

Course Outcomes (CO)	Session Outcomes (SOs)	Laboratory Instructions (LI)	Classroom Instruction (CI)	Self-Learning (SL)
98CH102.5: Collectively aim to equip students with a comprehensive understanding of the theoretical principles, practical methodologies, and diverse applications of various spectroscopic techniques.	SO5.1: Describe electromagnetic radiation and types of spectra.	LI5.1: Perform an experiment to determine the absorption spectrum of a given sample using UV-Visible spectroscopy.	CI5.1: Lecture on the nature of electromagnetic radiation and types of spectra.	SL5.1: Study the impact of different types of electromagnetic radiation on matter.

	SO5.2: Explain Lambert's and Beer's law and their applications.	LI5.2: Conduct a practical application of Beer's law to determine the concentration of a solution.	CI5.2: Discuss Lambert's and Beer's laws with examples and applications.	SL5.2: Research real-world applications of Lambert's and Beer's laws in industry.
	SO5.3: Understand the principle, instrumentation, and application of UV-Visible spectroscopy.		CI5.3: Lecture on the principle, instrumentation, and applications of UV-Visible spectroscopy.	
	SO5.4: Describe the principle, instrumentation, and application of IR spectroscopy.		CI5.4: Explain the working principle and applications of IR spectroscopy.	
	SO5.5: Explain the principle, instrumentation, and application of NMR spectroscopy.		CI5.5: Lecture on the principle, instrumentation, and applications of NMR spectroscopy.	
	SO5.6: Understand the introduction, types, and applications of chromatography.		CI5.6: Discuss various types of chromatography and their applications.	

SW-5 Suggested Sessional Work (SW)	**SW 5.1 Assignments:** Applications Nuclear magnetic resonance and magnetic resonance imaging **SW 5.2 Mini Project:** Fluorescence and its applications in medicine **SW 5.3 Other Activities (Specify):** Write an essay on surface characterization techniques. Diffraction and

	scattering.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Lab Instruction (LI)	Sessional Work (SW)	Self-Learning (SL)	Total hour (Cl+LI+SW+Sl)
98CH102.1: Apply VSEPR theoryto predict the three-dimensional shapes of molecules.	06	04	01	02	13
98CH102.2: Describe the concept of symmetry, chirality and optical activity and synthesize chiral drug molecule	06	04	01	02	13
98CH102.3: Explain and apply the concept of Intermolecular forces, Hydrogen bond, and transition metal complexes.	06	04	01	02	13
98CH102.4: Predict the concept ofthermodynamics, free energy &entropy and apply Nernst equation, water chemistry as well as explain concept of acid-base, metallurgy, Emf cell and corrosion.	06	04	01	02	13
98CH102.5: Collectively aim toequip students with a comprehensive understanding of the theoretical principles, practical methodologies, and diverse applications of various spectroscopic techniques.	06	04	01	02	13
Total Hours	30	20	05	10	65

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Atomic and Molecular Structure &Periodic properties	03	01	01	05
CO-2	Stereochemistry, Organic reactions andsynthesis of a drug molecule	02	06	02	10
CO-3	Intermolecular forces and Transitionmetal complexes	03	07	05	15
CO-4	Use of free energy in chemical equilibrium	-	10	05	15
CO-5	Spectroscopic techniques and applications	03	02	-	05
Total		11	26	13	50

**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

(a) Suggested books

1. Jain & Jain Engineering Chemistry Dhanpat Rai & Sons
2. Jain & Jain Engineering Chemistry Wiley India Edition
3. B.K. Sharma Industrial Chemistry Goel Publication

4. B.K. Sharma Engineering Chemistry Krishna Publication
5. S. S. Dara Engineering Chemistry S. Chand Publication
6. Shashi Chawla Engineering Chemistry Dhanpat Rai & Sons

(b) 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 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.

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

CO-PO-PSO Mapping

Program: B.Tech. Biotechnology **Course Title:** Engineering Chemistry

Course Code: 98CH102 **Semester:** I

Course Outcomes	Programme Outcome (PO)												Programme Specific Outcome (PSO)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1: Apply VSEPR theory to predict the three-dimensional shapes of molecules.	3	1	2	2	3	2	3	2	2	1	3	2	2	3	1
CO 2: Describe the concept of symmetry, chirality, and optical activity, and synthesize chiral drug molecule.	2	1	2	2	1	2	3	2	1	1	2	2	2	3	1
CO 3: Explain and apply the concept of intermolecular forces, hydrogen bond, and transition metal complexes.	2	2	1	1	1	2	2	2	1	2	1	2	1	3	1
CO 4: Predict the concept of thermodynamics, free energy & entropy, and apply Nernst equation, water chemistry as well as explain the concept of acid-base, metallurgy, Emf cell, and corrosion.	2	2	2	2	3	2	3	2	2	1	2	3	3	3	2
CO 5: Collectively aim to equip students with a comprehensive understanding of the theoretical principles, practical methodologies,	2	-	-	1	1	3	3	3	1	1	2	2	3	3	2

and diverse applications of various spectroscopic techniques.														

**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	CO1: Apply VSEPR theory to predict the three-dimensional shapes of molecules.	SO1.1, SO1.2, SO1.3, SO1.4, SO1.5, SO1.6	LI.1.1, LI.1.2,	CI 1.1, CI 1.2, CI 1.3, CI 1.4, CI 1.5, CI 1.6	SL 1.1, SL2.2
PO1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2,3	CO2: Describe the concept of symmetry, chirality and optical activity and synthesize chiral drug molecule.	SO2.1, SO2.2, SO2.3, SO2.4, SO2.5, SO2.6	LI.2.1, LI.2.2,	CI 2.1, CI 2.2, CI 2.3, CI 2.4, CI 2.5, CI 2.6	SL2.1, SL2.2
PO1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2,3	CO3: Explain and apply the concept of intermolecular forces, hydrogen bond, and transition metal complexes.	SO3.1, SO3.2, SO3.3, SO3.4, SO3.5, SO3.6	LI.3.1, LI.3.2	CI 3.1, CI 3.2, CI 3.3, CI 3.4, CI 3.5, CI 3.6	SL3.1, SL3.2

PO1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2,3	CO4: Predict the concept of thermodynamics, free energy & entropy and apply Nernst equation, water chemistry as well as explain the concept of acid-base, metallurgy, Emf cell and corrosion.	SO4.1, SO4.2, SO4.3, SO4.4, SO4.5, SO4.6	LI.4.1, LI.4.2,	CI 4.1, CI 4.2, CI 4.3, CI 4.4, CI 4.5, CI 4.6	SL4.1, SL4.2
PO1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2,3	CO 5: Collectively aim to equip students with a comprehensive understanding of the theoretical principles, practical methodologies, and diverse applications of various spectroscopic techniques.	SO5.1, SO5.2, SO5.3, SO5.4, SO5.5, SO5.6	LI5.1, LI5.2,	CI5.1, CI5.2, CI5.3, CI5.4, CI5.5, CI5.6	SL5.1, SL5.2

Program Name	**B.Tech Biotechnology**	
Semester	I	
Course Code	HSMC01	
Course title	Communication Skills	**Curriculum Developer**: Dr Ashutosh Pandey
Pre-requisite	Students should have basic knowledge of English Language	
Rationale	To compete in this fast-growing world, LSWR skills of the students should be well developed and enhanced. Besides, they must have effective communication skills as it plays a vital role in shaping individual's personality and career. It also boosts the confidence and prepares them to face the audience fearlessly	
Course Outcomes (COs)	**CO1- HSMC01.1** Students will learn confident speaking skills **CO2 - HSMC01.2** Students learn leadership skill and team spirit. **CO3- HSMC01.3** Students will be able to communicate effectively in Hindi and English languages without hindrances. **CO4- HSMC01.4** Students learn basis grammar skills **CO5- HSMC01.5** The study of Dramas and Poems written by Indian Writers.	

Scheme of Studies:

Board of Study	CourseCode	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)	
HS	HSMC01	Communication Skills	2	0	1	1	4	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 must 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)	Classroom Activity; (CA)	Class Attendance; (AT)	Total Marks (CA+CT+SA+AT)		
HS	HSMC01	Communication Skills	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	06	0	01	02	08

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO1- HSMC01: Students will learn confident speaking skills	SO1.1: Understand linguistic techniques		CI1.1: Lecture on syntax and morphology	SL1.1: Read articles on linguistic techniques and their applications
	SO1.2: Explore modern usages of language		CI1.2: Discuss modern language changes and their impacts	SL1.2: Research contemporary language usage in digital communication
	SO1.3: Improve reading comprehension		CI1.3: Lecture on strategies for effective reading comprehension	
	SO1.4: Develop skills in English phonetic symbols		CI1.4: Demonstration and practice of the International Phonetic Alphabet (IPA)	
	SO1.5: Enhance oral presentation skills		CI1.5: Workshop on organizing and delivering effective presentations	
	SO1.6: Understand audition communication		CI1.6: Lecture on the role of audition in effective communication	

Suggested Sessional Work (SW): *anyone*	SW1.1 Assignments SW 1.2 Mini Project SW 1.3 Other Activities (Specify)

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	00	01	01	08

Course Outcome (CO)	**Session Outcomes (SOs)**	**LaboratoryInstruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO2- HSMC01: Students learn leadership skill and team spirit	SO2.1: Write definitions of engineering terms		CI2.1: Lecture on defining engineering terms	SL2.1: Research and write definitions of common engineering terms
	SO2.2: Describe objects in engineering		CI2.2: Discuss the descriptions of various engineering objects	
	SO2.3: Explain engineering processes		CI2.3: Lecture on key engineering processes	
	SO2.4: Understand principles of engineering		CI2.4: Explain fundamental engineering principles	
	SO2.5: Listen to and comprehend topics of general interest		CI2.5: Engage in listening activities on general interest topics	
	SO2.6: Reproduce information from business and daily life		CI2.6: Discuss scenarios from business, travel, health, and more	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments **SW2.2** Mini Project **SW2.3** Other Activities (Specify)

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	0	01	02	09

Course Outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO3 HSMC01.3 Students will be able to communicate effectively in Hindi and English languages without hindrances	SO3.1: Understand the format of formal letters		CI3.1: Lecture on the structure and components of formal letters	SL3.1: Read sample formal letters and identify key components
	SO3.2: Write applications		CI3.2: Workshop on writing applications	SL3.2: Draft an application for a hypothetical job or position
	SO3.3: Draft enquiry letters		CI3.3: Discuss the purpose and structure of enquiry letters	
	SO3.4: Write letters calling for quotations		CI3.4: Lecture on how to write letters calling for quotations	
	SO3.5: Prepare tender documents		CI3.5: Workshop on the components of tender documents	

	SO3.6: Draft order and complaint letters		CI3.6: Discuss the structure and tone of order and complaint letters	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments **SW3.2** Mini Project **SW3.3** Other Activities (Specify)

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	0	01	02	09

Course Outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO4-HSMC01.4 Students learn basis grammar skills	SO4.1: Master precise writing		CI4.1: Lecture on techniques for precise writing	SL4.1: Read and summarize complex texts
	SO4.2: Develop skills in noting and drafting		CI4.2: Workshop on noting and drafting	SL4.2: Draft notes on given topics
	SO4.3: Describe simple engineering objects and processes		CI4.3: Lecture on technical descriptions	SL4.3: Write technical descriptions of simple engineering objects
	SO4.4: Write comprehensive reports		CI4.4: Discuss the structure and components of report writing	

	SO4.5: Practice note writing		CI4.5: Workshop on effective note writing	
	SO4.6: Create slogans and write comments		CI4.6: Lecture on slogan writing and effective commenting	

Suggested Sessional Work (SW): ***anyone***	SW4.1 Assignments SW4.2 Mini Project SW4.3 Other Activities (Specify)

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	0	01	03	09

Course Outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO5- HSMC01.5 The study of Dramas and Poems written by Indian Writers.	SO5.1: Write technical observation reports		CI5.1: Lecture on the structure and components of observation reports	SL5.1: Review and analyze sample observation reports
	SO5.2: Develop skills in writing survey reports		CI5.2: Discuss the methodology and format of survey reports	SL5.2: Conduct a mini-survey and draft a report
	SO5.3: Write trouble reports		CI5.3: Lecture on identifying and reporting technical issues	SL5.3: Practice writing trouble reports on hypothetical scenarios

	SO5.4: Draft laboratory reports		CI5.4: Discuss the format and details required in laboratory reports	
	SO5.5: Create project reports on engineering subjects		CI5.5: Workshop on compiling comprehensive project reports	
	SO5.6: Enhance speaking skills for presentations		CI5.6: Lecture on effective presentation techniques	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments **SW5.2** Mini Project **SW5.3** Other Activities (Specify)

Course Duration (in Hours) To Attain Course Outcomes

Course Title: Communication Skills **Course Code:** 56MB205

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (LI+CI+SL+SW)
CO1- HSMC01.1 Students will learn confident speaking skills	6	0	1	1	8
CO2- HSMC01.2 Students learn leadership skill and team spirit	6	0	2	1	9
CO3- HSMC01.3 Students will be able to communicate effectively in Hindi and English languages without hindrances	6	0	2	1	9
CO4- HSMC01.4 Students learn basis grammar skills	6	0	2	1	9
CO5-- HSMC01.5 The study of Dramas and Poems written by Indian Writers	6	0	3	1	10
Total Hours	30	0	10	05	45

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

Course Title: Communication Skills **Course Code: HSMC01**

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
CO1- HSMC01.1 Students will learn confident speaking skills	2	1	1	1	5
CO2- HSMC01.2 Students learn leadership skill and team spirit	2	4	2	2	10
CO3- HSMC01.3 Students will be able to communicate effectively in Hindi and English languages without hindrances	2	3	3	2	10
CO4- HSMC01.4 Students learn basis grammar skills	3	5	5	2	15
CO5-- HSMC01.5 The study of Dramas and Poems written by Indian Writers	5	4	1	0	10
Total Marks	**14**	**17**	**12**	**07**	**50**

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

Suggested learning Resources:

(a) Books:

S. No.	Title/Author/Publisher details
1	Communication Skills by Dr. Meenu Pandey Nirali Praksahan.
2	A Practical Guide to English Grammar by K.P. Thakur
3	English Conversation Practise by Grant Taylor Tata McGraw Hill Education Private Limited.
4	Advanced Language Practice by Michael Vince Macmillan Education, Oxford 2003
5	Six Weeks to Words of Power by Wilfred Funk W.R. Goyal Publishers and Distributors

(b) Online Resources:

(c) 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: BTech Biotechnology **Semester:** I

Course Title: Communication Skills **Course Code:** HSMC01

Course Outcome (COs)	Program Outcomes												Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-HSMC01 Students will learn confident speaking skills	1	1	2	1	2	3	-	3	3	3	3	3	1	1	2
CO2-HSMC01 Students learn leadership skill and team spirit	1	2	2	2	2	2	-	3	2	3	1	3	1	2	2
CO3-HSMC01.3 Students will be able to communicate effectively in Hindi and English languages	1	1	2	2	3	2	-	3	2	3	2	3	1	1	2

without hindrances															
CO4-HSMC01.4 Students learn basic grammar skills	-	1	1	1	2	2	-	1	2	3	2	3	-	1	1
CO5-HSMC01.5 The study of Dramas and Poems written by Indian Writers	-	1	1	1	-	-	-	3	2	3	3	3	-	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 1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2,3	**CO1- HSMC01** Students will learn confident speaking skills	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5, SO1.6		CI1.1, CI 1.2, CI 1.3,CI1.4, CI 1.5, CI1.6	1SL-1,2
PO 1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2,3	**CO2- HSMC01** Students learn leadership skill and team spirit	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5, SO2.6		CI 2.1, CI 2.2, CI 2.3, CI2.4, CI2.5, CI2.6	2SL-1,2
PO 1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2,3	**CO3- HSMC01.3** Students will be able to communicate effectively in Hindi and English languages without hindrances	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5, SO3.6		CI 3.1, CI 3.2, CI 3.3, CI 3.4, CI3.5, CI3.6	3SL-1
PO 1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2,3	**CO4-HSMC01.4** Students learn basis grammar skills	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5, SO4.6		CI 4.1, CI 4.2, CI 4.3, CI 4.4, CI4.5, CI4.6	SL4-1,2
PO 1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2,3	**CO5- HSMC01.5** The study of Dramas and Poems written by Indian Writers	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5, SO5.6		CI 5.1, CI 5.2, CI 5.3, CI 5.4, CI 5.5, CI5.6	5SL-1,2

Program Name	**Bachelor of Technology (B.Tech.) Biotechnology**	
Semester	I	
Course Code	VAC-101	
Course title	Sustainable Development Goals (SDGs)	**Curriculum Developer**: Dr Ashutosh Pandey
Pre-requisite	Student should have basic knowledge of Environment, Natural resources, Climate change and sustainability	
Rationale	The goal is to promote sustainable development, balancing economic, environmental, and social needs for prosperity for present and future generations. Students will be trained in efficient natural resource management and environmental pollution prevention, using environmental management tools to improve environmental quality, assess local vulnerabilities, and achieve sustainable developmental needs.	
Course Outcomes (COs)	**VAC101.1:** Critically evaluate the 17 new UN Sustainable Development Goals and grasp sustainable development's history, theories, and concepts. **VAC101.2:** Explore strategies for assessing sustainable development and learn about the science, technology, economics, and politics behind it. **VAC101.3:** Understand resource overuse, population growth, economic growth, sustainability, and renewable resource transition challenges. **VAC101.4:** Understand attitudes towards people, society, and sustainable development causes and solutions and evaluate solution arguments' quality, credibility, and limitations. **VAC101.5:** Do design thinking methods accelerate SDG implementation? Develop values-based sustainable development education knowledge and tool	

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C) (L: T:P)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core VAC	VAC101	Sustainable Development Goal	2	0	1	1	4	0

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 project).

SL: Self Learning,

C: Credits.

Note: SW & SL must 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 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)		
VAC	VAC101	Sustainable Development Goal	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.

Item	CI	LI	SW	SL	Total
Approx Hrs	06	00	01	01	08

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
VAC101.1: Critically evaluate the 17 new UN Sustainable Development Goals and grasp sustainable development's history,	SO1.1: Understand the Need for and Importance of Sustainable Development		CI1.1: Historical & Policy Perspectives of Sustainable Development	SL1.1: Research and Reflect on the Challenges & Strategies of Attaining SDGs in Your Own Country

theories, and concepts.	SO1.2: Understand the Historical & Policy Perspectives of Sustainable Development		CI1.2: Sustainable Development: World and India Perspective	
	SO1.3: Understand Sustainable Development from a World and India Perspective		CI1.3: Introduction to 17 SDGs	
	SO1.4: Gain Knowledge of the 17 SDGs		CI1.4: Specific Learning Objectives for Different SDGs	
	SO1.5: Explain Specific Learning Objectives for Different SDGs		CI1.5: Challenges & Strategies of Attaining SDGs in Developed and Developing Nations	
	SO1.6: Explain the Challenges & Strategies of Attaining SDGs in Developed and Developing Nations		CI1.6: Different SDG Goals Details and Their Importance	

SW-1 Suggested Sessional Work (SW)	**SW1.1** Assignments: Overview of SDGs, Sustainable Consumption and Production, Details of 17 SDGs **SW1.2** Other Activities (Specify): Note down the different challenges in our state and district to achieve SDG

Item	CI	LI	SW	SL	Total
Approx Hrs	06	00	01	01	08

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
VAC101.2: Explore strategies for assessing sustainable development and learn about the science, technology, economics, and politics behind it.	SO2.1: Explain Sustainable Development		CI2.1: Focus of NEP-2020 on SDG	SL2.1: Research and Reflect on the Tools, Systems, and Innovation for Sustainability in Education
	SO2.2: Understand the NEP-2020 and SDG		CI2.2: Education for Sustainable Development (ESD)	
	SO2.3: Discuss Higher Education's Role in Achieving SDGs		CI2.3: Berlin Declaration 2021 on ESD	
	SO2.4: Explain How Education Contributes to Sustainable Development		CI2.4: Integration of ESD in Curriculum and Textbooks	
	SO2.5: Explain the Measuring Techniques for Sustainability		CI2.5: Tools, Systems, and Innovation for Sustainability	
	SO2.6: Special Focus on SDG 4 - Quality Education and Lifelong Learning		CI2.6: Measuring Sustainability: How Do We Measure Sustainability	

SW-1 Suggested Sessional Work (SW)	**SW2.1 Assignments:** Education role to achieve SDGs, the role of education in Sustainable Development, Measuring techniques of sustainability, Sustainability Indicators **SW2.2 Other Activities (Specify):** Seminar and group discussion on ESD and measuring sustainability millennium development goals (MDGs)

Item	CI	LI	SW	SL	Total
Approx Hrs	06	00	01	01	08

Course Outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
VAC101.3: Understand resource overuse, population growth, economic growth, sustainability, and renewable resource transition challenges.	SO3.1: Understand current economic issues in the context of the global sustainable development debate		CI3.1: Circular Economy (Basic Model of Reuse, Recycle, and Reduce)	SL3.1: Research and Reflect on the Non-Renewable Energy Resources in Your Region
	SO3.2: Outline of health, hygiene, and water sanitation issues		CI3.2: Rural & Urban Problems & Challenges	
	SO3.3: Discuss the renewable energy resources and their importance in the present scenario		CI3.3: Sustainable Production and Consumption	
	3.4: Explain the importance of sustainable production and consumption		CI3.4: Renewable Energy	
	SO3.5: Explain the problems and solutions in rural and urban areas		CI3.5: Health & Hygiene, Water, Sanitation & Water Management	
	SO3.6: Understanding the SDGs		CI3.6: Waste Management	

SW-1 Suggested Sessional Work (SW):	**SW 3.1** Assignments: Ecofriendly energy resources importance, types of waste and its management, Urban Problems & Challenges **SW 3.2** Other Activities (Specify): Visit of wastewater treatment plant, visit of water treatment process.

Item	CI	LI	SW	SL	Total
Approx Hrs	06	00	01	01	08

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
VAC101.4 Understand attitudes towards people, society, and sustainable development causes and solutions and evaluate solution arguments' quality, credibility, and limitations.	SO4.1: Understand environmental sustainability is crucial in reducing the impacts of climate change		CI4.1: The Greenhouse Effect: Causes and Consequences	SL4.1: Research and Reflect on Carbon Credit and Carbon Trading, and the Kyoto Protocol
	SO4.2: Discuss causes of emission of GHGs and its consequences		CI4.2: Climate Change: A Threat to Sustainable Development	
	SO4.3: Explain how climate change and sustainable development both play a role in shaping the human and environmental factors of the world		CI4.3: Adaptation to Current and Future Climate Regimes	
	SO4.4: Explain the importance of sustainable production and consumption		CI4.4: The Consequences: Crop Failure	
	SO4.5: Climate change is disrupting national economies and affecting lives and livelihoods, especially for the most vulnerable, and its mitigation		CI4.5: Solutions: Technology and Lifestyle Changes	
	SO4.6: Understanding the SDGs		CI4.6: Mitigating Climate Change	

SW-4 Suggested Sessional Work (SW):	**SW 4.1** 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 **SW 4.2** Other Activities (Specify):

Item	CI	LI	SW	SL	Total
Approx Hrs	06	00	01	01	08

Course Outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
VAC101.5 Do design thinking methods accelerate SDG implementation? Develop values-based sustainable development education knowledge and tool	SO5.1: Understand the relevance and the concept of sustainability and the global initiatives in this direction		CI5.1: Corporate Social Responsibility	SL5.1: Research and Reflect on the United Nations Goals for Peace and Justice
	SO5.2: Understand the role of Corporations and Ecological Sustainability		CI5.2: Sustainable Products and Services	
	SO5.3: Explain the role of CSR in Sustainability		CI5.3: Business and Environment	
	SO5.4: Understand the SD challenge for companies, their responsibility and their potentials for action		CI5.4: Corporations and Ecological Sustainability	
	SO5.5: Discuss the role of world government for world justice and peace		CI5.5: Life Cycle Assessment: LCA Overview and Application	

	SO5.6: Understand the SDGs		CI5.6: World Peace and Justice: United Nations Goals for Peace and Justice, World Government for Peace	

SW-5 Suggested Sessional Work (SW):	**SW 5.1** Assignments: Consumption patterns and lifestyles, Company perspectives for environmental sustainability and an introduction to economic growth. Other Activities (Specify):

Brief of Hours suggested for the Course Outcome

Course Outcomes (CO)	Class Lecture (Cl)	Lab Instructions (LI)	Sessional Work (SW)	Self-Learning (Sl)	Total hour (Cl+LI+SW+Sl)
VAC101.1: Critically evaluate the 17 new UN Sustainable Development Goals and grasp sustainable development's history.	6	0	1	1	8
VAC101.2: Explore strategies for assessing sustainable development and learn about the science, technology, economics, and politics behind it.	6	0	1	1	8
VAC101.3: Understand resource overuse, population growth, economic growth, sustainability, and renewable resource transition challenges.	6	0	1	1	8
VAC101.4 Understand attitudes towards people, society, and sustainable development causes and solutions and evaluate solution arguments' quality, credibility, and limitations.	6	0	1	1	8
VAC101.5 Do design thinking methods accelerate SDG implementation? Develop values-based sustainable development education knowledge and tool	6	0	1	1	8
Total Hours	30	0	5	5	40

Suggestion for End Semester Assessment

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Need for 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. Faculty can also design different tasks as per requirement, for end semester assessment.

Suggested Learning Resources:

(a) Books:

1. Surender Kumar and Shunsuke Managi, 2009: *The Economics of Sustainable Development: The Case of India (Natural Resource Management and Policy)*, Springer Switzerland.
2. Onyeka Osuji, New Edition June 2022: *Corporate Social Responsibility in Developing and Emerging Markets*, Cambridge.

3. Ram Kumar Mishra, Ch Lakshmi Kumari, Sandeep Chachra, P.S. Janaki Krishna, March 2022: *Smart Cities for Sustainable Development*, Springer Switzerland.
4. Tracey Strange and Anne Bayley: *Sustainable Development: Linking Economy, Society, Environment*.
5. Sushma Goyal, 2016: *Management of Resources For Sustainable Development*, The Orient Blackswan.
6. S. Ramaswamy and Sathis G. Kumar, 2009: *Energy, Environment and Sustainable Development: Issues and Policies*, Regal Publications.
7. 9b)Daniel Yergin, September 2015: *The New Map: Energy, Climate, and the Clash of Nations*, Penguin Press.
8. Laurie, R., Nonoyama-Tarumi, Y., Mckeown, R., & Hopkins, C., 2016: *Contributions of Education for Sustainable Development (ESD) to Quality Education: A Synthesis of Research. Journal of Education for Sustainable Development*, 10(2), 226–242.
9. OECD, 2019: *Sustainable Results in Development: Using the SDGs for Shared Results and Impact*, OECD Publishing, Paris.
10. Ziai, Aram, 2016: *Development Discourse and Global History from Colonialism to the Sustainable Development Goals*, Routledge, London & New York.
11. Hazra, Somnath., Bhukta, Anindya, 2020: *Sustainable Development Goals: An Indian Perspective*, Springer Switzerland.
12. HM Saxena, January 2021: *Environmental Ecology, Biodiversity and Climate Change*, Rawat Publication.

(b) Online resources

1. URL: United Nations Sustainable Development Goals
2. URL: [UN SDG Goals AIU Publications] (https://www.aiu.ac.in/documents/AIU_Publications/UN-SDG goals)
3. URL: UNESCO Education for Sustainable Development
4. URL: NPTEL Online Course on Sustainable Development
5. URL: [Berlin Declaration on Education for Sustainable Development] (https://www.iau-hesd.net/news/5180-berlin-declaration-education-sustainable development-adopted-unesco-esd-conference-17-19)

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. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

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 Title: Sustainable Development Goals (SDGs) **Course Code:** VAC101

Course Outcome (CO)	Programme Objectives (POs)												Programme Specific Objective (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
VAC101.1 Need for and Importance of Sustainable Development	1	2	3	2	3	2	1	2	3	1	2	3	1	2	3
VAC101.2 Education for Sustainable Development (ESD): Tools, Systems, and Innovation for Sustainability	2	1	2	3	2	1	2	3	1	2	3	1	2	3	1
VAC101.3 Discuss the sustainable production and consumption	3	2	1	2	3	1	2	3	2	1	2	3	3	2	1
VAC101.4 How Climate	1	3	2	1	3	2	1	3	2	3	1	2	2	1	3

Change may be Threat to Sustainable Development															
VAC101.5 Role of Corporations and Ecological Sustainability	2	1	3	2	1	3	2	1	3	2	3	1	3	2	1

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	**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 SO1.6	-	Unit-1.0 Introduction to Sustainable Development: 1.1,1.2,1.3,1.4,1.5,1.6	SL1
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 SO2.6	-	Unit-2 Special focus on SDG 4-Quality Education and Lifelong Learning: 2.1,2.2,2.3,2.4,2.5,2.6	SL1
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 SO3.6	-	Unit-3: Understanding the SDGs: 3.1, 3.2,3.3,3.4,3.5,3.6	SL1

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 SO4.6	-	Unit-4 : Climate Change, Energy and Sustainable Development 4.1, 4.2,4.3,4.4,4.5,4.6	SL1
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 SO5.6	-	Unit 5: Sustainable Business Practices, LCA and World peace and justice 5.1,5.2,5.3,5.4,5.5,5.6	SL1

Program Name	**Bachelor of Technology (B.Tech.)- Biotechnology**	
Semester	I	
Course Code	98ME151	
Course title	Workshop Practice Lab	**Curriculum Developer**: Er. Ketan Agrawal
Pre-requisite	Basic knowledge of mathematical skills with some scientific temperament.	
Rationale	It is a place of work that prepares a variety of jobs and products using different kinds of instruments, hand tools, and machines. To prepare products, the workshop divides into various branches based on the nature of the work. 1. Fitting shop; 2. Welding shop 3. Shop for sheet metal 4. M/C Shop; 5. Foundry & Forging Shop, etc.	
Course Outcomes (COs)	**CO1-98ME151.1:** Understand various production processes, select appropriate methods for different materials, optimize manufacturing efficiency, and ensure product quality. **CO2-98ME151.2**: Acquired proficiency in using hand tools, understanding different types of fits and tolerances, interpreting engineering drawings, and precision measurement techniques. **CO3-98ME151.3:** Develop fundamental wood measuring, cutting, and joining skills. Gain expertise in handling various carpentry tools and machinery. **CO4-98ME151.4:** Appreciate and access the use of casting processes in manufacturing and understand the workings of various casting processes. **CO5-98ME151.5:** Analyze and access the importance of welding processes in manufacturing and apply knowledge to select an appropriate welding process based on the type of industrial application.	

Scheme of Studies:

oard of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits(C) (L: T:P=0:0:1)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
ESC	98ME151	Workshop Practice Lab	0	2	1	1	4	0+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 must 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 (CAT)	Class Attendance (AT)	Total Marks (CA+CT+CAT+SA+AT)		
ESC	98ME151	Workshop Practice Lab	**35**	**-**	**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** / Cl / LI / SW / SL / Total **Approx. Hrs** / 0 / 06 / 01 / 01 / 08

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO1-98ME151.1: Understand various production processes, selecting appropriate methods for different materials, optimizing manufacturing efficiency, and ensuring product quality.		LI1.1: Safety aspects pertaining to common manufacturing practices.		SL1.1: Introduction to additive manufacturing.
		LI1.2: Introduction of tools and machines used in each process.		
		LI1.3: Basic instructions and procedures for using lathe and drilling machine.		

Suggested Sessional Work (SW):	**SW1.1** Assignments	Enumerate general safety rules applicable in workshop.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	0	06	01	01	08

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO2-98ME151.2: Acquired proficiency in using hand tools, understanding different types of fits and tolerances, interpreting engineering drawings, and precision measurement techniques.		LI2.1: Instructions for using proper fitting tools in the correct way.		SL2.1: Types of drilling tools and threading tools.
		LI2.2: Drawing of a simple workpiece for carrying out different fitting operations.		
		LI2.3: Demonstration of different inspection, checking, and measuring methods used for proper fitting work.		

Suggested Sessional Work (SW):	SW2.1 Assignments	Classification and uses of different fitting hand tools.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	0	06	01	01	08

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO3-98ME151.3. Develop fundamental skills such as measuring, cutting and joining wood. Gain expertise in handling various carpentry tools and machinery.		LI3.1: Carpentry tools introduction.		SL3.1: Explain defects in timber and conversion of wood.
		LI3.2: Drawing of a simple workpiece for		

		preparation of common carpentry joinery work.		
		LI3.3: Demonstration of different inspection, checking, and measuring methods used for proper carpentry work.		

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments: Explain the different types of wood working machines used in modern woodwork **SW3.2** Mini Project: Production of any one type of joints listed below- Dovetail Joint/Corner Joint/Mortise and Tenon Joint etc.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	0	06	01	01	08

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO4-98ME151.4: Appreciate and access the use of casting processes in manufacturing and understand the workings of various casting processes.		LI4.1: Safety instructions for foundry shop, pattern making, and mould preparation.		SL4.1: Explain types of moulding sand.
		LI4.2: Drawing of a simple workpiece for preparation of a pattern.		
		LI4.3: Instructions for sand preparation, mould preparation, melting, and casting properly in a safe manner.		

Suggested Sessional Work (SW):	**SW4.1** Assignments	Explain various defects generated during casting process.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	0	06	01	01	08

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO5-98ME151.5: Analyze and access the importance of welding processes in manufacturing and apply knowledge to select an appropriate welding process based on the type of industrial application.		LI5.1: Welding tools introduction for Electric Arc Welding process.		SL5.1: Study of TIG and MIG welding processes.
		LI5.2: Drawing of a simple welded joint viz. square butt joint, T joint, Lap joint, etc.		
		LI5.3: Actual production of a welded joint as described above.		

Suggested Sessional Work (SW):	**SW5.1** Mini Project	Preparing lap joint using arc welding process.

Course Duration (in Hours) to Attain Course Outcomes

Course Title: Workshop Practice Lab **Course Code:**98ME151

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (LI+CI+SL+SW)
CO1-98ME151.1: Understand various production processes, selecting appropriate methods for different materials, optimizing manufacturing efficiency, and ensuring product quality.	-	6	1	1	8
CO2-98ME151.2: Acquired proficiency in using hand tools, understanding different types of fits and tolerances, interpreting engineering drawings, and precision measurement techniques.	-	6	1	1	8
CO3-98ME151.3. Develop fundamental skills such as measuring, cutting and joining wood. Gain expertise in handling various carpentry tools and machinery.	-	6	1	1	8
CO4-98ME151.4: Appreciate and access the use of casting processes in manufacturing and understand the workings of various casting processes.	-	6	1	1	8
CO5-98ME151.5: Analyze and access the importance of welding processes in manufacturing and apply knowledge to select an appropriate welding process based on the type of industrial application.	-	6	1	1	8
Total Hours	-	30	05	05	40

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

Course Title: Workshop Practice Lab **Course Code:**98ME151

Course Outcomes	**Marks Distribution**				**Total Marks**
	A	**An**	**E**	**C**	
CO1-98ME151.1: Understand various production processes, selecting appropriate methods for different materials, optimizing manufacturing efficiency, and ensuring product quality.	2	1	1	1	5
CO2-98ME151.2: Acquired proficiency in using hand tools, understanding different types of fits and tolerances, interpreting engineering drawings, and precision measurement techniques.	2	4	4	2	12
CO3-98ME151.3. Develop fundamental skills such as measuring, cutting and joining wood. Gain expertise in handling various carpentry tools and machinery.	3	5	3	3	14
CO4-98ME151.4: Appreciate and access the use of casting processes in manufacturing and understand the workings of various casting processes.	2	3	4	2	11
CO5-98ME151.5: Analyze and access the importance of welding processes in manufacturing and apply knowledge to select an appropriate welding process based on the type of industrial application.	2	3	1	2	8
Total Marks	**11**	**16**	**13**	**10**	**50**

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

CO, PO and PSO Mapping

Program Name: B. Tech. Biotechnology **Semester:** I

Course Title: Workshop Practice Lab **Course Code:** 98ME151

Course Outcome (CO)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1: Understand various production processes, selecting appropriate methods for different materials, optimizing manufacturing efficiency, and ensuring product quality.	3	3	2	2	3	2	2	2	3	2	2	2	3	2	2
CO2: Acquired proficiency in using hand tools, understanding different types of fits and tolerances, interpreting engineering drawings, and precision	2	2	3	2	2	3	2	1	2	1	1	2	2	3	2

measurement techniques.															
CO3: Develop fundamental skills such as measuring, cutting, and joining wood. Gain expertise in handling various carpentry tools and machinery.	2	2	2	2	1	2	2	1	1	1	1	1	1	2	3
CO4: Appreciate and access the use of casting processes in manufacturing and understand the workings of various casting processes.	3	2	3	3	3	2	2	2	3	2	2	2	3	3	2
CO5: Analyze and assess the importance of welding processes in manufacturing and apply knowledge to select an appropriate welding process based on the type of industrial application.	3	2	3	3	3	2	2	2	3	2	2	2	3	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 PSO 1,2, 3	**CO1-98ME151.1:** Understand various production processes, selecting appropriate methods for different materials, optimizing manufacturing efficiency, and ensuring product quality.		LI 1.1 LI 1.2 LI 1.3		1SL-1
PO 1,2,3,4,5,6 PSO 1,2, 3	**CO2-98ME151.2:** Acquired proficiency in using hand tools, understanding different types of fits and tolerances, interpreting engineering drawings, and precision measurement techniques.		LI 2.1 LI 2.2 LI 2.3		2SL-1
PO 1,2,3,4,5,6 PSO 1,2, 3	**CO3-98ME151.3.** Develop fundamental skills such as measuring, cutting and joining wood. Gain expertise in handling various carpentry tools and machinery.		LI 3.1 LI 3.2 LI 3.3		3SL-1
PO 1,2,3,4,5,6 PSO 1,2, 3	**CO4-98ME151.4:** Appreciate and access the use of casting processes in manufacturing and understand the workings of various casting processes.		LI 4.1 LI 4.2 LI 4.3		4SL-1
PO 1,2,3,4,5,6 PSO 1,2, 3	**CO5-98ME151.5:** Analyze and access the importance of welding processes in manufacturing and apply knowledge to select an appropriate welding process based on the type of industrial application.		LI 5.1 LI 5.2 LI 5.3		5SL-1

Suggested learning Resources:

(a) Books:

1. Hajra Choudhury S.K., Hajra Choudhury A.K., and Nirjhar Roy S.K., *Elements of Workshop Technology*, Media Promoters and Publishers Private Limited, Mumbai, Vol. I (2008) and Vol. II (2010).
2. Kalpakjian S. and Steven S. Schmid, *Manufacturing Engineering and Technology*, Pearson Education India, 2002.

3. Rao P.N., *Manufacturing Technology*, Tata McGraw Hill House, Vol. I and Vol. II (2007).
4. Roy A. Lindberg, *Processes and Materials of Manufacture*, Prentice Hall India, 4th edition, 1998.

(b) Online Resources:

1. NPTEL Online Courses (NPTEL) Comprehensive courses on various manufacturing processes, materials, and workshop practices.
2. MIT OpenCourseWare (MIT OCW) Free lecture notes, exams, and videos on manufacturing processes and mechanical engineering.
3. Coursera (Coursera) Courses in manufacturing and workshop practices from top universities and companies.
4. edX (edX) Courses on manufacturing technology and related subjects from universities like MIT, Harvard, and more.
5. NYC CNC (YouTube) Detailed tutorials and practical demonstrations on CNC machining and other manufacturing processes.
6. Welding Tips and Tricks (YouTube) Practical tips and tutorials on various welding techniques.
7. Khan Academy (Khan Academy) Educational resources on materials science and basic engineering principles.
8. Engineering Toolbox (Engineering Toolbox) Engineering resources including materials properties and machining data.
9. Free Engineering Books (Free Engineering Books) Free downloads of e-books on workshop practices, machining, and manufacturing technology.
10. TWI Global (TWI Global) Resources and articles on welding, joining, and other manufacturing processes.
11. Manufacturing Processes and Workshop Technology (Google Books) Search for textbooks and reference books on workshop practice and manufacturing processes.

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

Program Name	**Bachelor of Technology (B.Tech.)- Biotechnology**	
Semester	I	
Course Code	HSMC09	
Course title	Sports and Yoga	**Curriculum Developer**: Er. Ketan Agrawal, Assistant Professor
Pre-requisite	Student should have basic knowledge of Applications of Yoga and Meditation and its concepts.	
Rationale	The Sports and Yoga subject is essential for students to understand both the historical and practical aspects of Yoga. Students should grasp Yoga's original texts and principles to preserve its authentic practices. Simultaneously, they need practical knowledge of how Yoga enhances sports performance, flexibility, and mental focus. This integrated understanding ensures that students can effectively apply Yoga techniques to improve athletic performance while respecting its traditional roots, promoting a holistic approach to health and fitness.	
Course Outcomes (COs)	**HSMC09.1**: A student shall be able to describe the brief introduction of yoga and its practices. **HSMC09.2**: A student shall be able to describe pranayama with the practice of bandh and mudra. **HSMC09.3**: A student shall be able to describe meditation techniques and their benefits. **HSMC09.4**: A student shall be able to explain the physical and mental benefits of regular yoga practice and how it enhances overall well-being. **HSMC09.5**: A student shall be able to integrate yoga practices with sports training to improve flexibility, strength, and performance in athletic activities.	

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C) (L: T:P=0:0:0)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
AU	HSMC09	Sports & Yoga	3	2	1	1	7	0

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.

Assessment Scheme: 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 (CAT)	Class Attendance (AT)	Total Marks (CA+CT+CAT+SA+AT)		
ESC	HSMC09	Yoga and Sports	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.	

Item	CI	LI	SW	SL	Total
Approx Hrs.	05	04	01	01	11

Course Outcome (CO)	Session Outcome (SO)	Laboratory Instructions (LI)	Classroom Instructions (CI)	Self-Learning (SL)
HSMC09.1: A student shall be able to describe the brief introduction of yoga and its practices.	SO1.1 Understand the Introduction to Yoga and Yogic Practices	LI1.1 Basic instructions and procedures for Yoga practice	CI1.1 Overview of Yoga: Etymology, definitions, aim, objectives, and misconceptions	SL1.1 Study of the foundational principles of Yoga
	SO1.2 Understand Shatkarma: meaning, purpose, and significance in Yoga Sadhana	LI1.2 Introduction to Shatkarma techniques and their applications	CI1.2 Discussion on Shatkarma practices and their role in Yoga	
	SO1.3 Describe the rules and regulations to be followed by Yoga practitioners		CI1.3 Exploration of rules, regulations, and common misconceptions about Yoga	
	SO1.4 Explain Yoga practices: Asanas, Pranayama, and Meditation		CI1.4 Analysis of different Yoga practices and their benefits	
	SO1.5 Analyze the benefits of Yoga in physical and mental health		CI1.5 Evaluation of Yoga's impact on physical and mental health	

Item	CI	LI	SW	SL	Total
Approx Hrs.	05	04	01	01	11

Course Outcome (CO)	Session Outcome (SO)	Laboratory Instructions (LI)	Classroom Instructions (CI)	Self-Learning (SL)
HSMC09.2: A student shall be able to describe pranayama with the practice of bandh and mudra.	SO2.1 Understand the Breathing Practices and Pranayama	LI2.1 Instructions on sectional breathing techniques: Abdominal, Thoracic, and Clavicular	CI2.1 Overview of sectional breathing techniques and their benefits	SL2.1 Study of breathing practices and their impact on health
	SO2.2 Understand the Concept of Puraka, Rechaka, and Kumbhaka	LI2.2 Guidelines for practicing Puraka, Rechaka, and Kumbhaka	CI2.2 Discussion on Puraka, Rechaka, and Kumbhaka techniques and their significance in Pranayama	
	SO2.3 Describe the Concept of Bandha and Mudra		CI2.3 Analysis of Bandha and Mudra practices and their roles in Yoga	
	SO2.4 Understand Anuloma-Viloma/Nadi Shodhana		CI2.4 Overview and benefits of Anuloma-Viloma/Nadi Shodhana	
	SO2.5 Understand Shitali and Bhramari techniques		CI2.5 Exploration of Shitali and Bhramari techniques and their benefits	

Item	CI	LI	SW	SL	Total
Approx Hrs.	05	04	01	01	11

Course Outcome (CO)	Session Outcome (SO)	Laboratory Instructions (LI)	Classroom Instructions (CI)	Self-Learning (SL)
HSMC09.3: A student shall be able to describe meditation techniques and their benefits.	SO3.1: Understand the Practices Leading to Meditation	LI3.1: Introduction to meditation practices, including recitation of Pranava Mantra	CI3.1: Overview of various practices leading to meditation such as Pranava Mantra and Anter Maun	SL3.1: Study of meditation practices and their impact on mental clarity
	SO3.2: Understand the Recitation of Pranava Mantra	LI3.2: Instructions for the correct recitation of Pranava Mantra	CI3.2: Exploration of Pranava Mantra's significance and its role in meditation	
	SO3.3: Describe Breath Meditation		CI3.3: Analysis of Breath Meditation techniques and their benefits	
	SO3.4: Understand Anter Maun		CI3.4: Overview of Anter Maun and its role in meditation practices	
	SO3.5: Describe Om Dhyana		CI3.5: Discussion on Om Dhyana techniques and their benefits	

Item	CI	LI	SW	SL	Total
Approx Hrs.	05	04	01	02	12

Course Outcome (CO)	Session Outcome (SO)	Laboratory Instructions (LI)	Classroom Instructions (CI)	Self-Learning (SL)
HSMC09.4: A student shall be able to explain the physical and mental benefits of regular yoga practice and how it enhances overall well-being.	SO4.1: Understand the Ashtanga of Yoga: Yama, Niyama, Aasanas, Pranayama, Pratyahara, Dharana, Dhyana, Samadhi	LI4.1: Basic instructions for practicing each aspect of Ashtanga Yoga	CI4.1: Overview and detailed discussion of the Ashtanga of Yoga and its components	SL4.1: Study the comprehensive impact of each Ashtanga component on holistic well-being
	SO4.2: Understand the Benefits of Yoga	LI4.2: Explanation of the physiological and psychological benefits of Yoga	CI4.2: Exploration of various benefits of Yoga, including physical health, mental clarity, and emotional stability	SL4.2: Research on empirical evidence supporting the benefits of Yoga
	SO4.3: Understand the Need of Yoga in contemporary lifestyle		CI4.3: Analysis of why Yoga is essential for maintaining balance in today's fast-paced world	
	SO4.4: Describe Surya Namaskar and its components		CI4.4: Overview of the sequence, benefits, and techniques of Surya Namaskar	
	SO4.5: Analyze the overall impact of		CI4.5: Discussion on the practical aspects of	

	integrating Yoga into daily routines		incorporating Yoga into everyday routines for improved quality of life	

Item	**CI**	**LI**	**SW**	**SL**	**Total**
Approx Hrs.	05	04	01	02	12

Course Outcome (CO)	**Session Outcome (SO)**	**Laboratory Instructions (LI)**	**Classroom Instructions (CI)**	**Self-Learning (SL)**
HSMC09.5: A student shall be able to integrate yoga practices with sports training to improve flexibility, strength, and performance in athletic activities.	SO5.1: Understand the importance of self-awareness in maintaining an active lifestyle	LI5.1: Guidelines for self-assessment and goal setting for physical fitness	CI5.1: Overview of how self-awareness contributes to a successful active lifestyle	SL5.1: Study of self-assessment tools and techniques for improving physical fitness
	SO5.2: Learn strategies to increase physical fitness effectively	LI5.2: Introduction to various physical fitness exercises and routines	CI5.2: Analysis of different methods to enhance physical fitness, including exercise types and intensity	SL5.2: Research on effective fitness routines and their impact on overall health
	SO5.3: Develop strategies to make productive use of free time for physical activity		CI5.3: Discussion on maximizing free time for physical activities and balancing it with other responsibilities	
	SO5.4: Understand the benefits of staying active during weekly holidays		CI5.4: Exploration of the impact of regular activity during holidays on overall fitness and well-being	

	SO5.5: Recognize the value of consistent effort in achieving a healthy lifestyle		CI5.5: Discussion on the role of persistence and effort in sustaining a healthy lifestyle	

Course Duration (in Hours) to Attain Course Outcomes

Course Title: Workshop Practice Lab **Course Code:**98ME151

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (LI+CI+SL+SW)
HSMC09.1: A student shall be able to describe the brief introduction of yoga and its practices.	5	4	1	1	11
HSMC09.2: A student shall be able to describe pranayama with the practice of bandh and mudra.	5	4	1	1	11
HSMC09.3: A student shall be able to describe meditation techniques and their benefits.	5	4	1	1	11
HSMC09.4: A student shall be able to explain the physical and mental benefits of regular yoga practice and how it enhances overall well-being.	5	4	1	2	12
HSMC09.5: A student shall be able to integrate yoga practices with sports training to improve flexibility, strength, and performance in athletic activities.	5	4	1	2	12
Total Hours	25	20	05	07	57

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

Course Title: Workshop Practice Lab **Course Code:**98ME151

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
HSMC09.1: A student shall be able to describe the brief introduction of yoga and its practices.	2	1	1	1	5
HSMC09.2: A student shall be able to describe pranayama with the practice of bandh and mudra.	2	4	4	2	12
HSMC09.3: A student shall be able to describe meditation techniques and their benefits.	3	5	3	3	14
HSMC09.4: A student shall be able to explain the physical and mental benefits of regular yoga practice and how it enhances overall well-being.	2	3	4	2	11
HSMC09.5: A student shall be able to integrate yoga practices with sports training to improve flexibility, strength, and performance in athletic activities.	2	3	1	2	8
Total Marks	**11**	**16**	**13**	**10**	**50**

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

Suggested learning Resources:

(a) Books:

1- Singh S.P. & yogi Mukesh, Foundation of Yoga, Standard Publication, New Delhi ,2010

2- Swami Dherendra Brhamchari, Yogasana Vigyaan, Dherendra Yoga Prakshan , New Delhi 1966

3- Sarswati , Swami Satyananda , Asan Pranayama Mudra Bandha ,Yog Prakshan Trust Munger ,2013

4- H.R. Nagendra , Asan Pranayama Mudra Bandha,Swami Vivekananda Yog Prakshan ,Banglore 2002

5- Ishwer Bhardwaj, Saral Yogashan, Satyam Publication House, New Delhi 2018

6- Shri Ram Chauhan, Mudra Rahasya, Bhartiye Yog Sansthan, New Delhi 2014

7- Dr Vishwanath Prasad Sangha, Dhyan Yog, Bhartiye Yog Sansthan , New Delhi 1987

8- Shri Deshraj, Dhyan Sadhna, Bhartiye Yog Sansthan , New Delhi 2015

9- Bhartiye Yog Sansthan, New Delhi 2014

(b) Online Resources:

Suggested instructions/Implementation strategies:

10. Improved lecture
11. Tutorial
12. Case method
13. Group Discussion
14. Role play
15. Visit to Beverage producing plants & Distillery/Fermenter units
16. Demonstration
17. ICT Based teaching Learning
18. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Tech. Biotechnology **Semester:** I

Course Title: Workshop Practice Lab **Course Code:** 98ME151

Course Outcome (CO)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
HSMC09.1: A student shall be able to describe the brief introduction of yoga and its practices.	3	3	2	2	3	2	2	2	3	2	2	2	3	2	2
HSMC09.2: A student shall be able to describe pranayama with the practice of bandh and mudra.	2	2	3	2	2	3	2	1	2	1	1	2	2	3	2
HSMC09.3: A student shall be able to describe meditation techniques and their benefits.	2	2	2	2	1	2	2	1	1	1	1	1	1	2	3
HSMC09.4: A student shall be able to explain the physical and mental benefits of	3	2	3	3	3	2	2	2	3	2	2	2	3	3	2

regular yoga practice and how it enhances overall well-being.															
HSMC09.5: A student shall be able to integrate yoga practices with sports training to improve flexibility, strength, and performance in athletic activities.	3	2	3	3	3	2	2	2	3	2	2	2	3	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 PSO 1,2, 3	**HSMC09.1**: A student shall be able to describe the brief introduction of yoga and its practices.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5	LI 1.1 LI 1.2 LI 1.3	1.1,1.2,1.3,1.4,1.5	1SL-1
PO 1,2,3,4,5,6 PSO 1,2, 3	**HSMC09.2**: A student shall be able to describe pranayama with the practice of bandh and mudra.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5	LI 2.1 LI 2.2 LI 2.3	2.1,2.2,2.3,2.4,2.5	2SL-1
PO 1,2,3,4,5,6 PSO 1,2, 3	**HSMC09.3**: A student shall be able to describe meditation techniques and their benefits.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5	LI 3.1 LI 3.2 LI 3.3	3.1,3.2,3.3,3.4,3.5	3SL-1
PO 1,2,3,4,5,6 PSO 1,2, 3	**HSMC09.4**: A student shall be able to explain the physical and mental benefits of regular yoga practice and how it enhances overall well-being.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5	LI 4.1 LI 4.2 LI 4.3	4.1,4.2,4.3,4.4,4.5	4SL-1
PO 1,2,3,4,5,6 PSO 1,2, 3	**HSMC09.5**: A student shall be able to integrate yoga practices with sports training to improve flexibility, strength, and performance in athletic activities.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5	LI 5.1 LI 5.2 LI 5.3	5.1,5.2,5.3,5.4,5.5	5SL-1

Program Name	**Bachelor of Technology (B.Tech.)- Biotechnology**	
Semester	I	
Course Code	Core-1 NCC Awareness	
Course title	NCC Awareness	**Curriculum Developer**: Er. Ketan Agrawal, Assistant Professor
Pre-requisite	Certificate course with NCC major subject.	
Rationale	Students studying NCC Awareness theory.	
Course Outcomes (COs)	**Core-1 NCC Awareness CO1** To develop knowledge about discipline, character, brotherhood, the spirit of adventure, and ideals of selfless service. **Core-1 NCC Awareness CO2** It also enlightens leadership qualities among young students. **Core-1 NCC Awareness CO3** To promote National Integration among cadets through state awareness programmes, debates, demonstrations, and cultural presentations. **Core-1 NCC Awareness CO4** this subject aims to develop the students of personality, physical and mental health, and social quality. **Core-1 NCC Awareness CO5** It also provides knowledge about different social activity- tree plantation, blood donation, first aid and how to organize different social awareness programs in educational institutions.	

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
AU	Core-1 NCC Awareness	NCC Awareness	6	0	0	0	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 must 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 -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)		
AU	Core-1 NCC Awarene ss	NCC Awarene ss	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.	

Item	CI	LI	SW	SL	Total
Approx Hrs.	5	0	0	0	5

Course Outcome (Cos)	**Session Outcomes (SOs)**	**Learning Instructions (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
Core-1 NCC Awareness CO1 To develop knowledge about discipline character, brotherhood, the spirit of adventure and ideals of selfless service.	SO1.1 Understand the History of National Cadet Corps		CI1.1 Overview of the National Cadet Corps of Independent India	
	SO1.2 Understand the National Cadet Corps of Independent India		CI1.2 Discussion on the Motto of the National Cadet Corps	
	SO1.3 Understand the Aims and Objectives		CI1.3 Exploration of the Aims and Objectives of NCC	
	SO1.4 Preparation of NCC Flag		CI1.4 Examination of the NCC Emblem, Flag, and Song	
	SO1.5 Preparation of NCC song		CI1.5 Analysis of the Organization of NCC: Army, Navy, and Air Wing	

Item	CI	LI	SW	SL	Total
Approx Hrs.	5	0	0	0	5

Course Outcome (CO)	Session Outcomes (SOs)	Learning Instructions (LI)	Classroom Instruction (CI)	Self-Learning (SL)
Core-1 NCC Awareness **CO2** It also enlightens leadership qualities among young students.	SO2.1 Understand the number of lectures		CI2.1 Overview of the number of lectures required	
	SO2.2 Understand about the Navy and Air Force		CI2.2 Discussion on the roles and functions of the Navy and Air Force	
	SO2.3 Preparation of the Army		CI2.3 Examination of the organizational structure of the Army, Navy, and Air Force	
	SO2.4 Understand the command and control		CI2.4 Exploration of the regimental structure, command, and control	
	SO2.5 Preparation of Honors and Awards		CI2.5 Analysis of the badges and ranks in the Army, Navy, and Air Force	
	SO2.6 Understanding the Honors and Awards		CI2.6 Overview of the various honours and awards given in the defence services	

Item	CI	LI	SW	SL	Total
Approx Hrs.	5	0	0	1	5

Course Outcome (CO)	Session Outcomes (SOs)	Learning Instructions (LI)	Classroom Instruction (CI)	Self-Learning (SL)
Core-1 NCC Awareness CO3: To promote National Integration among cadets through state awareness programme, debates, demonstrations, cultural presentation.	SO3.1 Meaning and concept of Introduction to personality development		CI3.1 Overview of the factors influencing and shaping personality	SL3.1 Study of decision making and problem-solving techniques
	SO3.2 Understand the meaning of personality development		CI3.2 Exploration of the concept and importance of personality development	
	SO3.3 Understanding the change your mindset		CI3.3 Discussion on techniques to change and develop a positive mindset	
	SO3.4 Understanding about decision making		CI3.4 Analysis of decision-making processes and strategies	
	SO3.5 Understand teamwork		CI3.5 Examination of the principles and benefits of teamwork	

	SO3.6 Understanding social skills and etiquette		CI3.6 Overview of social skills, etiquettes, and manners	

Item	CI	LI	SW	SL	Total
Approx Hrs.	5	0	0	0	5

Course Outcome (CO)	**Session Outcomes (SOs)**	**Learning Instructions (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
Core-1 NCC Awareness CO4 The aim of this subject is to develop the students of personality, physical and mental health, and social quality.	SO4.1 Understanding about the Introduction of leadership	LI4.1 Introduction to leadership	CI4.1 Overview of leadership and its importance	SL4.1 Study of leadership case studies
	SO4.2 Preparation of types of Leadership		CI4.2 Exploration of different types of leadership	
	SO4.3 Understanding about how to develop leadership		CI4.3 Discussion on techniques to develop leadership skills	
	SO4.4 Understanding about the Leadership traits		CI4.4 Analysis of essential leadership traits and their significance	
	SO4.5 Preparation of Leadership case study		CI4.5 Examination of leadership case study: Field Marshal General Sam H.F.J. Manekshaw	

	SO4.6 Understanding the contributions of General K.M. Cariappe		CI4.6 Examination of leadership case study: General K.M. Cariappe	

Item	CI	LI	SW	SL	Total
Approx Hrs.	5	0	0	0	5

Course Outcome (CO)	**Session Outcomes (SOs)**	**Learning Instructions (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
Core-1 NCC Awareness **CO5** It also provides knowledge about different social activity- tree plantation, blood donation, first aid and how to organize different social awareness programs in educational institutions.	SO5.1 Understanding the importance of tree plantation		CI5.1 Overview of the benefits and methods of tree plantation	SL5.1 Study of effective social awareness programs
	SO5.2 Understanding the significance of blood donation		CI5.2 Discussion on the importance of blood donation and how to organize a blood donation camp	
	SO5.3 Understanding the basics of first aid		CI5.3 Instruction on basic first aid techniques and their application in emergency situations	
	SO5.4 Understanding how to organize social awareness programs in educational institutions		CI5.4 Exploration of methods to raise social awareness within educational settings	
	SO5.5 Understanding the role of educational		CI5.5 Examination of case studies on successful	

	institutions in social activities		social awareness programs organized by educational institutions	

Brief of Hours suggested for the Course Outcome

Course Outcomes (CO)	Class Lecture (Cl)	Sessional Work (SW)	Self-Learning (SL)	Total Hours (Cl+SW+SL)
CO1. To develop knowledge about discipline, character, brotherhood, the spirit of adventure, and ideals of selfless service.	5	0	0	5
CO2. It also enlightens leadership qualities among young students.	5	0	0	5
CO3. To promote National Integration among cadets through state awareness programs, debates, demonstrations, cultural presentations, etc.	5	0	0	5
CO4. The aim of this subject is to develop the students' personality, physical and mental health, and social quality.	5	0	0	5
CO5. It also provides knowledge about different social activities - tree plantation, blood donation, first aid, and how to organize different social awareness programs in educational institutions.	5	0	0	5

Suggestion for End Semester Assessment

CO	Unit	Marks Distribution	Total

	Titles	R	U	A	Marks
CO1. To develop knowledge about discipline, character, brotherhood, the spirit of adventure, and ideals of selfless service.	History of National Cadet Corps:	01	01	03	05
CO2. It also enlightens leadership qualities among young students.	Introduction to Defense Services:	01	01	03	05
CO3. To promote National Integration among cadets through state awareness programs, debates, demonstrations, cultural presentations, etc.	Personality development	-	03	10	13
CO4. The aim of this subject is to develop the students' personality, physical and mental health, and social quality.	Leadership, first aid	-	03	10	13
CO5. It also provides knowledge about different social activities - tree plantation, blood donation, first aid, and how to organize different social awareness programs in educational institutions.	First aid	01	03	10	14
Total		03	12	36	50

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

The end of semester assessment for NCC Awareness 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

CO-PO-PSO Mapping

Course Outcomes (COs)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1. To develop knowledge about discipline, character, brotherhood, the spirit of adventure, and ideals of selfless service.	3	2	2	2	2	3	3	2	2	2	1	2	2	3	1
CO2. It also enlightens leadership qualities among young students.	2	3	2	2	2	2	3	2	2	2	2	3	2	2	1
CO3. To promote National Integration among cadets through state awareness programs, debates, demonstrations, cultural	2	2	3	2	2	2	2	3	3	2	2	2	3	2	2

presentations, etc.															
CO4. The aim of this subject is to develop the students' personality, physical and mental health, and social quality.	3	2	2	3	2	2	2	2	2	2	3	2	2	3	2
CO5. It also provides knowledge about different social activities - tree plantation, blood donation, first aid, and how to organize different social awareness programs in educational institutions.	2	2	3	2	3	2	2	2	2	2	2	2	3	2	3

Course Curriculum Map

POs & PSOs /*-No.	COs No.& Titles	SOs No.	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 To develop knowledge about discipline character, brotherhood, the spirit of adventure and ideals of selfless service.	SO1:1.1 SO2:1.2 SO3:1.3 SO4:1.4 SO5:1.5	Unit-1.0 History of National Cadet Corps: 1.1,1.2,1.3,1.4,1.5	
PO: 1,2,3,4,5,6,7,8,9,10,11,12 PSO: 1,2,3	CO.2 It also enlightens leadership qualities among young students.	SO1:2.1 SO2:2.2 SO3:2.3 SO4:2.4 SO5:2.5	Unit-2.0 Introduction to Defense Services 2.1,2.2,2.3,2.4,2.5	
PO: 1,2,3,4,5,6,7,8,9,10,11,12 PSO: 1,2,3	CO.3 To promote National Integration among cadets through state awareness programme, debates, demonstrations, cultural presentation etc.	SO1:3.1 SO2:3.2 SO3:3.3 SO4:3.4 SO5:3.5	Unit-3: Personality development 3.1,3.2,3.3,3.4,3.5	
PO: 1,2,3,4,5,6,7,8,9,10,11,12 PSO: 1,2,3	CO.4 The aim of this subject is to develop the students of personality, physical and mental health, and social quality.	SO1:4.1 SO2:4.2 SO3:4.3 SO4:4.4 SO5:4.5	Unit-4: Leadership, first aid 4.1,4.2,4.3,4.4,4.5	
PO: 1,2,3,4,5,6,7,8,9,10,11,12 PSO: 1,2,3	CO5. It also provides knowledge about different social activities - tree plantation, blood donation, first aid, and how to organize different social awareness programs in educational institutions.	SO1:5.1 SO2:5.2 SO3:5.3 SO4:5.4 SO5:5.5	5.1,5.2,5.3,5.4,5.5	

Course Curriculum:

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6 PSO 1,2, 3	CO.1 To develop knowledge about discipline character, brotherhood, the spirit of adventure and ideals of selfless service.	SO1.1 SO1.2 SO1.3	LI 1.1 LI 1.2 LI 1.3		1SL-1
PO 1,2,3,4,5,6 PSO 1,2, 3	CO.2 It also enlightens leadership qualities among young students.	SO2.1 SO2.2 SO2.3	LI 2.1 LI 2.2 LI 2.3		2SL-1
PO 1,2,3,4,5,6 PSO 1,2, 3	CO.3 To promote National Integration among cadets through state awareness programme, debates, demonstrations, cultural presentation etc.	SO3.1 SO3.2 SO3.3	LI 3.1 LI 3.2 LI 3.3		3SL-1
PO 1,2,3,4,5,6 PSO 1,2, 3	CO.4 The aim of this subject is to develop the students of personality, physical and mental health, and social quality.	SO4.1 SO4.2 SO4.3	LI 4.1 LI 4.2 LI 4.3		4SL-1
PO 1,2,3,4,5,6 PSO 1,2, 3	CO5. It also provides knowledge about different social activities - tree plantation, blood donation, first aid, and how to organize different social awareness programs in educational institutions.	SO5.1 SO5.2 SO5.3	LI 5.1 LI 5.2 LI 5.3		5SL-1

B. Tech. Biotechnology 2^{nd} Semester

Program Name	**Bachelor of Technology (B.Tech.)- Biotechnology**	
Semester	II	
Course Code:	98BT207	
Course title:	Biochemistry and Metabolism	**Curriculum Developer**: Chahana Desai, Teaching Associate
Pre-requisite:	Students should have basic cellular and molecular knowledge of biomolecules,	
Rationale:	Biochemistry combines biology and chemistry to study living matter. It powers scientific and medical discovery in fields such as pharmaceuticals, forensics and nutrition and Metabolism consists of a series of reactions that occur within cells of living organisms to sustain life. The process of metabolism involves many interconnected cellular pathways to ultimately provide cells with the energy required to carry out their function.	
Course Outcomes (COs):	**CO1-98BT207.1.** Summarize concepts of cell biology. **CO2-98BT207.2.** Explain the structure and function of biological molecules **CO3-98BT207.3.** Analyze enzyme kinetic data and regulation of enzyme activity. **CO4-98BT207.4.** Identify the key molecules involved in regulation of metabolic pathways and disorders **CO5-98BT207.5.** Understand the basic mechanisms of metabolic pathways **CO6-98BT207.6.** Evaluate total generation and consumption of ATP in each metabolic pathway	

Scheme of Studies:

Board of Study	CourseCode	Course Title	Scheme of studies (Hours/Week)					Total Credits(C) (L: T:P=2:1:1)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
BSC	98BT207	Biochemistry and metabolism	3	2	1	2	3+2+2+2=8	2+1+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 must 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 (CAT)	Class Attendance (AT)	Total Marks (CA+CT+CAT+SA+AT)		
BSC	98BT207	Biochemistry 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	09	02	01	02	14

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO1-98BT207.1 Summarize concepts of cell biology.	SO1.1 Explain concept of Biochemistry	LI1.1 Basic instruments used in biochemical processes	CI1.1 Definition, scope, and importance of biochemistry	SL1.1 Find out some scope of biochemistry
	SO1.2 Define Basic terminology related to biochemistry	LI1.2Demonstrate the working of pH meter	CI1.2 Hydrogen bonding and structure of water molecule	SL1.2 Draw and elaborate structure of water molecule
	SO1.3 Elaborate the various types of bond formation		CI1.3 Chemical foundation of biology: pH, buffer	SL1.3 Write down different types of bonds with required diagrams
	SO1.4 Define the mechanism of pH and buffers		CI1.4 Weak bonds and covalent bonds	
	SO1.5 Explain the concept of and types of biomolecules		CI1.5 Structure, properties, and function of carbohydrate	
	SO1.6 Relate the concept of how biomolecules are involved in various processes		CI1.6 Classification of carbohydrate	
	SO1.7 Outline differences between various biomolecules		CI1.7 Biological role of peptidoglycan	

	SO, 1.8 Define the mechanism of biological separations		CI 1.8 Lipids: classification, structure, and function	
	SO, 1.9 Explain the role of peptidoglycan		CI1.9 Structure and function of fatty acid	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Describe in detail about the scope and importance of biochemistry.
	SW1.2 Mini Project	Draw a diagram of pH meter and its mechanism.
	SW1.3 Other Activities (Specify)	Draw a structure of water molecule and its properties.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	04	01	03	17

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO2-98BT207.2. Explain the structure and function of biological molecules	SO2.1 Explain concept of and types of biomolecules	LI2.1 Perform Benedict's test for reducing sugars	CI2.1 Structure, properties, and function of carbohydrate	SL2.1 Structures of various biomolecules
	SO2.2 Relate the concept of how biomolecules are involved in various processes	LI2.2 Perform Iodine test for starch	CI2.2 Classification of carbohydrate	SL2.2 Different types of bonds present in each biomolecule
	SO2.3 Outline differences between various biomolecules	LI2.3 Perform Biuret test for protein	CI2.3 Biological role of peptidoglycan	SL2.3 Write down a few points on the importance of biomolecules
	SO2.4 Define the mechanism of biological separations	LI2.4 Perform Emulsion test for lipids	CI2.4 Lipids: classification, structure, and function	

	SO2.5 Explain the role of peptidoglycan		CI2.5 Structure and function of fatty acid	
	SO2.6 Compare and contrast the structure of nucleic acids		CI2.6 Protein classification, primary, secondary, tertiary, and quaternary structure	
	SO2.7 Discuss the role of enzymes in biological processes		CI2.7 Enzyme kinetics and regulation	
	SO2.8 Illustrate the metabolic pathways of carbohydrates		CI2.8 Glycolysis and Krebs cycle	
	SO2.9 Analyze the impact of mutations on protein function		CI2.9 Genetic mutations and protein synthesis	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Describe types and importance of biomolecules.
	SW2.2 Mini Project	Make a flow chart on types of biomolecules with examples.
	SW2.3 Other Activities (Specify)	Make Power point presentation on how biomolecules are generated?

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	03	01	02	15

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO3-98BT207.3 Analyse enzyme kinetic data and regulation of enzyme activity.	SO3.1 Elucidate the characteristics and nomenclature parameters of the enzymes	LI3.1 Perform the Centrifugation process as Unit Operation	CI3.1 Introduction, characteristics, and nomenclature of enzymes	SL3.1 Find out the examples of different groups of enzymes according to their classification
	SO3.2 Classify the different types of enzymes according to various criteria		CI3.2 Classification of enzymes	SL3.2 What are vitamins and how are

				they important to our body?
	SO3.3 Elaborate on the importance, types, and classification of vitamins with their respective functions		CI3.3 Application of enzymes	
	SO 3.4 Explain the role of plant and animal hormones		CI3.4 Vitamins: Introduction, classification, and function	
	SO 3.5 Discuss micro and macronutrients		CI3.5 Micro and macronutrients	
	SO 3.6 Introduce the importance of plant and animal hormones		CI3.6 Introduction and importance of plant and animal hormones	
	SO 3.7 Explain the concept of enzymes	LI3.2 Basic instruments used in biochemical processes	CI 3.7 Definition, scope, and importance of biochemistry	
	SO 3.8 Define Basic terminology related to enzyme kinetics	LI3.3 Demonstrate the working of pH meter	CI 3.8 Hydrogen bonding and structure of water molecule	
	SO 3.9Elaborate the various types of bond formation		CI 3.9 Chemical foundation of biology: pH, buffer	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Classification of vitamins and its sources. Differentiate between fat soluble and water-soluble vitamins.
	SW3.2 Mini Project	Differentiate between micronutrient and macronutrients
	SW3.3 Other Activities (Specify)	Prepare one Power point presentation on Mechanism of action of enzymes.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	02	01	03	15

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO4-98BT207.4 Identify the key molecules involved in regulation of metabolic pathways and disorders. Evaluate total generation and consumption of ATP in each metabolic pathway	SO4.1: Understand the role and characteristics of enzymes.	LI4.1: Perform enzyme assays to determine activity and specificity.	CI4.1: Lecture on the biochemical properties and functions of enzymes.	SL4.1: Research and prepare a report on the latest advancements in enzyme technology.
	SO4.2: Classify enzymes based on their types of reactions.	LI4.2: Analyze vitamin content in food samples using spectrophotometry.	CI4.2: Discuss case studies on industrial applications of enzymes.	SL4.2: Create a chart that categorizes vitamins based on solubility and their functions.
	SO4.3: Explain the application of enzymes in various industries.		CI4.3: Group activities to classify and name different enzymes.	SL4.3: Develop a presentation on the role of different hormones in plant and animal growth.
	SO4.4: Describe the importance of vitamins and their functions.		CI4.4: Presentation on the health benefits and sources of vitamins.	
	SO4.5: Differentiate between water-soluble and fat-soluble vitamins.		CI4.5: Interactive session on the role of macronutrients in the diet.	
	SO4.6: Identify the role of macronutrients in human health.		CI4.6: Explain the differences between micro and macronutrients.	
	SO4.7: Understand the significance of micronutrients and their sources.		CI4.7: Debate on the importance of plant hormones in agriculture.	
	SO4.8: Explain the role of plant hormones in growth and development.		CI4.8: Analyse the physiological effects of animal hormones through examples.	

	SO4.9: Discuss the importance of animal hormones in regulating bodily functions.		CI4.9: Quizzes on the classification and function of vitamins and nutrients.	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Detailed description about pentose phosphate pathway
	SW4.2 Mini Project	Draw a flow chart of glycolysis and TCA cycle
	SW4.3 Other Activities (Specify)	Find out some videos about how lipid metabolism takes place.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	02	01	03	15

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO5-98BT207.5 Metabolism- Basic concept, anabolism and catabolism, carbohydrate metabolism, glycolysis, gluconeogenesis, TCA, pentose phosphate pathway and its significance. Lipid metabolism- β-oxidation and ω-oxidation, biosynthesis of fatty	SO5.1: Understand the basic concepts of metabolism.	LI5.1: Perform experiments to measure the rate of glycolysis in yeast cells.	CI5.1: Lecture on the fundamental principles of metabolism.	SL5.1: Research and prepare a report on the significance of the TCA cycle.
	SO5.2: Differentiate between anabolism and catabolism.	LI5.2: Analyze the levels of key intermediates in the TCA cycle.	CI5.2: Discussion on anabolic and catabolic pathways.	SL5.2: Create a flowchart of the glycolysis pathway.
	SO5.3: Explain the steps and significance of glycolysis.		CI5.3: Group activity to map out the glycolysis pathway.	SL5.3: Develop a presentation on the pentose phosphate pathway and its significance.
	SO5.4: Describe gluconeogenesis and its importance.		CI5.4: Presentation on the key enzymes involved in gluconeogenesis.	

	SO5.5: Understand the TCA cycle and its role in metabolism.		CI5.5: Lecture on the TCA cycle and its integration with other pathways.	
	SO5.6: Explain the pentose phosphate pathway.		CI5.6: Interactive session on the significance of the pentose phosphate pathway.	
	SO5.7: Describe β-oxidation and ω-oxidation of fatty acids.		CI5.7: Discussion on the steps involved in β-oxidation and ω-oxidation.	
	SO5.8: Understand the biosynthesis of fatty acids.		CI5.8: Lecture on the biosynthesis of fatty acids and its regulation.	
	SO5.9: Explain the regulation of carbohydrate and lipid metabolism.		CI5.9: Quizzes on carbohydrate and lipid metabolism pathways.	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Explain general mechanism of urea cycle
	SW5.2 Mini Project	Describe the biosynthesis of purine and pyrimidine nucleotides and various reactions of amino acids.
	SW5.3 Other Activities (Specify)	Prepare power point presentation of urea cycle.

Course Duration (in hours) to Attain Course Outcomes

Course Title: Biochemistry and metabolism **Course Code:** 98BT207

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1-98BT207.1. Summarize concepts of cell biology	9	2	2	1	14
CO2-98BT207.2. Explain the structure and function of biological molecules	9	4	3	1	17
CO3-98BT207.3. Analyse enzyme kinetic data and regulation of enzyme activity	9	3	2	1	15
CO4-98BT207.4. Identify the key molecules involved in regulation of metabolic pathways and disorders. Evaluate total generation and consumption of ATP in each metabolic pathway	9	2	3	1	15
CO5-98BT207.5. Understand the basic mechanisms of metabolic pathways	9	2	3	1	15
Total Hours	45	13	13	05	76

End semester Assessment Scheme for Setting up Question Paper and Assessment to Evaluate the Course Outcome

Course Title: Biochemistry and metabolism **Course Code:** 98BT207

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
CO1-98BT207.1. Summarize concepts of cell biology	2	1	1	1	5
CO2-98BT207.2. Explain the structure and function of biological molecules.	2	4	4	1	11
CO3-98BT207.3. Analyze enzyme kinetic data and regulation of enzyme activity.	3	5	4	1	13
CO4-98BT207.4. Identify the key molecules involved in regulation of metabolic pathways and disorders. Evaluate total generation and consumption of ATP in each metabolic pathway.	2	3	5	1	11
CO5-98BT207.5. Understand the basic mechanisms of metabolic pathways.	5	4	1	0	10
Total Marks	**14**	**17**	**15**	**04**	**50**

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

Suggested Learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1	Outlines of Biochemistry: Conn & Stump
2	Principles of Biochemistry: Voet & Voet
3	Principles of Biochemistry: Jeffory Zubey
4	Clinical Biochemistry: D.C Deb.
5	Biochemistry: Stryer
6	Lehninger's Principles of Biochemistry: Nelson & Cox

(b) Online Resources:

1	https://ocw.mit.edu/courses/7-05-general-biochemistry-spring-2020/
2	https://www.nobelprize.org/prizes/lists/all-nobel-prizes-in-chemistry/
3	Biochemical Principles of Energy Metabolism | Coursera

(c) 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. Tech. Biotechnology **Semester:** II Semester

Course Title: Biochemistry and metabolism **Course Code:** 98BT207

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
CO1-98BT207.1. Summarize concepts of cell biology	-	1	-	1	2	2	3	-	2	2	3	3	1	2	1
CO2-98BT207.2. Explain the structure and function of biological molecules	-	1	-	-	-	-	3	-	2	2	3	3	3	-	2
CO3-98BT207.3. Analyse enzyme kinetic data and regulation of enzyme activity	-	1	1	1	-	-	3	-	2	2	3	3	1	2	-
CO4-98BT207.4. Identify the key molecules involved in regulation of metabolic pathways and disorders.	-	-	1	-	2	2	3	3	2	2	3	3	2	1	3
CO5-98BT207.5. Understand the basic mechanisms of metabolic pathways	-	-	1	-	-	2	3	3	2	2	3	3	1	1	2
CO6-98BT207.6. Evaluate total generation and consumption of ATP in each metabolic pathway	-	-	1	1	2	2	3	3	2	2	3	3	2	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 1,2,4,5,6 7,9,10,11,12 PSO 1,2, 3	**CO1-98BT207.1.** Summarize concepts of cell biology	SO1.1 SO1.2 SO1.3 SO1.4	LI 1 LI 2	1.1,1.2,1.3,1.4	1SL-1,2,3
PO 1,2,7,8,9,10,11,12 PSO 1, 3	**CO2-98BT207.2.** Explain the structure and function of biological molecules	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5	LI 1 LI 2 LI 3 LI 4	2.1, 2.2, 2.3, 2.4, 2.5,2.6	2SL-1,2,3
PO 1,2,3,4,5,6 7,9,10,11,12 PSO 1,2	**CO3-98BT207.3.** Analyse enzyme kinetic data and regulation of enzyme activity	SO3.1 SO3.2 SO3.3 SO3.4	LI 1	3.1,3.2,3.3,3.4,3.5, 3.6	3SL-1,2
PO 1,2,3,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO4-98BT207.4.** Identify the key molecules involved in regulation of metabolic pathways and disorders. Evaluate total generation and consumption of ATP in each metabolic pathway	SO4.1 SO4.2 SO4.3 SO4.4	LI 1	4.1,4.2,4.3,4.4,4.5, 4.6,4.7	4SL-1,2,3
PO 1,2,3,6 7,8,9,10,11,12 PSO 1,2, 3	**CO5-98BT207.5.** Understand the basic mechanisms of metabolic pathways	SO5.1 SO5.2 SO5.3	LI 1	5.1,5.2,5.3,5.4,5.5,	5SL-1,2

Program Name	**Bachelor of Technology (B.Tech.)- Biotechnology**	
Semester	II	
Course Code:	98EV205	
Course title:	**Ecology & Environmental Studies**	**Curriculum Developer**: Ms. Suman Patel
Pre-requisite:	The student must have a knowledge about the environmental components, pollution, biodiversity, and ecosystem at senior secondary, **Class** 12^{th} level.	
Rationale:	Ecology and environmental science integrate concepts from various disciplines, including biology, chemistry, physics, geography, sociology, and economics. This interdisciplinary approach encourages students to think critically, make connections between different fields of study, and apply their knowledge to real-world problems. It also prepares them for careers in fields such as environmental management, conservation biology, renewable energy, and sustainability.	
Course Outcomes (COs):	**CO1-98EV205.1:** Learn about environment and Natural resources. **CO2-98EV205.2:** Students will learn about natural resources, their importance and environmental impacts of human activities on natural resource. **CO3-98EV205.3:** Gain knowledge about ecosystems & the conservation of biodiversity and its importance. **CO4-98EV205.4:** Aware students about problems of environmental pollution, its impact on human and ecosystem and control measures. **CO5-98EV205.5:** Apply the knowledge to resolve various social & environmental issues.	

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)	
HS	98EV205	Ecology & Environmental Studies	2	0	1	2	5	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 must 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)		
HS	98EV205	Ecology & Environmental Studies	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	0	01	02	09

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
98EV205.1: Learn about environment and Natural resources.	SO1.1: Define the scope and importance of natural resources.	LI1.1: Conduct an experiment to assess the impact of deforestation on soil quality.	CI1.1: Lecture on the definition and importance of natural resources.	SL1.1: Research and write a report on the need for public awareness regarding natural resource conservation.
	SO1.2: Understand the need for public awareness about environmental issues.		CI1.2: Discuss the need for public awareness and its impact on resource conservation.	SL1.2: Develop a presentation on sustainable practices for conserving water resources.
	SO1.3: Identify problems associated with the over-exploitation of forest resources.		CI1.3: Case study analysis on deforestation and its effects.	
	SO1.4: Explain the issues related to water resources, including over-utilization, floods, and droughts.		CI1.4: Group discussion on the benefits and problems of dams.	
	SO1.5: Describe the challenges of land resource management, including land degradation, soil erosion, and desertification.		CI1.5: Lecture on land degradation, soil erosion, and desertification.	
	SO1.6: Discuss the conflicts over water resources and the role of dams in water management.		CI1.6: Interactive session on conflicts over water resources.	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments: Describe in detail components of environment. **SW1.2**Mini Project **SW1.3** Other Activities (Specify)

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	0	01	02	09

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
98EV205.2: Students will learn about natural resource, its importance and environmental impacts of human activities on natural resource.	SO2.1: Understand world food problems and their causes.		CI2.1: Lecture on the global food crisis and contributing factors.	SL2.1: Research and write a report on the effects of modern agriculture on food security.
	SO2.2: Discuss the effects of modern agriculture practices.		CI2.2: Group discussion on sustainable agricultural practices.	SL2.2: Develop a presentation on the benefits and challenges of alternate energy sources.
	SO2.3: Explain the problems associated with fertilizer and pesticide use.		CI2.3: Case study analysis on the environmental impact of fertilizers and pesticides.	
	SO2.4: Identify the uses and environmental effects of extracting and using mineral resources.		CI2.4: Lecture on the exploitation of mineral resources and its environmental consequences.	
	SO2.5: Describe the growing energy needs and the role of renewable and non-renewable energy sources.		CI2.5: Discussion on the comparison between renewable and non-renewable energy sources.	

	SO2.6: Explain the role of individuals in conserving natural resources and promoting equitable use for sustainable lifestyles.		CI2.6: Interactive session on the role of individuals in resource conservation.	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments: Discuss the roll of an individual in conservation of natural resources. **SW2.2** Mini Project **SW2.3** Other Activities (Specify)

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	0	01	03	10

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
98EV205.3: Gain knowledge about ecosystem and the conservation of biodiversity and its importance.	SO3.1: Understand the concept of an ecosystem and its components.		CI3.1: Lecture on the structure and function of ecosystems.	SL3.1: Research and prepare a report on the value of biodiversity at global and local levels.
	SO3.2: Describe the structure and function of different ecosystems.		CI3.2: Discussion on energy flow and ecological succession in ecosystems.	SL3.2: Create a presentation on the types and characteristics of terrestrial and aquatic ecosystems.
	SO3.3: Explain energy flow and ecological succession in ecosystems.		CI3.3: Case study analysis of food chains, food webs, and ecological pyramids.	SL3.3: Write an essay on the threats to biodiversity and conservation strategies.
	SO3.4: Identify food chains, food webs, and ecological pyramids.		CI3.4: Lecture on food chains, food webs, and ecological pyramids.	
	SO3.5: Understand the diversity of ecosystems and their classification.		CI3.5: Presentation on the biogeographical classification of India.	
	SO3.6: Discuss the threats to biodiversity and conservation strategies.		CI3.6: Interactive session on endangered and endemic species of India.	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments: Describe the structure of pond ecosystem. **SW2.2** Mini Project **SW2.3** Other Activities (Specify)

Item	Cl	LI	SW	SL	Total
Approx.Hrs	06	0	01	02	9

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
98EV205.4: Aware students about problems of environmental pollution, its impact on human and ecosystem and control measures.	SO4.1: Define various types of pollution and their causes.		CI4.1: Lecture on the definition, causes, and effects of air and water pollution.	SL4.1: Research and write a report on the effects of noise and thermal pollution.
	SO4.2: Explain the effects and control measures of air and water pollution.		CI4.2: Discussion on control measures for air and water pollution.	SL4.2: Develop a presentation on solid waste management strategies.
	SO4.3: Describe the causes and effects of soil, marine, and noise pollution.		CI4.3: Case study analysis on soil and marine pollution.	SL4.3: Write an essay on the role of individuals in preventing pollution.
	SO4.4: Discuss control measures for soil, marine, and noise pollution.		CI4.4: Lecture on control measures for noise and marine pollution.	
	SO4.5: Understand the role of solid waste management in urban and industrial contexts.		CI4.5: Group discussion on urban and industrial waste management practices.	
	SO4.6: Review disaster management strategies for floods, earthquakes, cyclones, and landslides.		CI4.6: Interactive session on disaster management and case studies.	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments: Discuss the effects of air pollution on plants, humans, animals and environment **SW4.2** Mini Project **SW4.3** Other Activities (Specify)

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	0	01	02	09

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
98EV205.5: Apply the knowledge to resolve various social & environmental issues.	SO5.1: Understand the principles of sustainable development.		CI5.1: Lecture on the concept and principles of sustainable development.	SL5.1: Research and write a report on urban problems related to energy and water conservation.
	SO5.2: Explain water conservation methods including rainwater harvesting and watershed management.		CI5.2: Discussion on rainwater harvesting and watershed management techniques.	SL5.2: Develop a presentation on the resettlement and rehabilitation of people and its associated problems.
	SO5.3: Discuss environmental ethics and possible solutions.		CI5.3: Interactive session on environmental ethics and possible solutions.	SL5.3: Write an essay on the impact of climate change and global warming.
	SO5.4: Describe the impacts of climate change, global warming, and acid rain.		CI5.4: Lecture on climate change, global warming, acid rain, and ozone layer depletion.	
	SO5.5: Identify the causes and effects of ozone layer depletion and nuclear accidents.		CI5.5: Case study analysis on nuclear accidents and their environmental impact.	
	SO5.6: Understand environmental legislation and the importance of public awareness.		CI5.6: Discussion on environmental legislation and public awareness strategies.	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments: Explain rainwater harvesting system. **SW5.2** Mini Project **SW5.3** Other Activities (Specify)

Course Duration (in Hours) to Attain Course Outcomes

Course Title: Ecology & Environmental Studies **Course Code:**98EV205

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1-98EV205.1: Learn about environment and Natural resources	6	0	2	1	9
CO2-98EV205.2: Students will learn about natural resource, its importance and environmental impacts of human activities on natural resource	6	0	2	1	9
CO3-98EV205.3: Gain knowledge about ecosystem & the conservation of biodiversity and its importance	6	0	3	1	10
CO4-98EV205.4: Aware students about problems of environmental pollution, its impact on human and ecosystem and control measures	6	0	2	1	9
CO5-98EV205.5: Apply the knowledge to resolve various social & environmental issues	6	0	2	1	9
Total Hours	30	0	11	05	46

End Semester Assessment Scheme for Setting Up Question Paper and Assessment to Evaluate the Course Outcome

Course Title: Ecology & Environmental Studies **Course Code:** 98EV205

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
CO1-98EV205.1: Learn about environment and Natural resources.	2	1	1	1	5
CO2-98EV205.2: Students will learn about natural resources, its importance and environmental impacts of human activities on natural resource.	2	4	2	2	10
CO3-98EV205.3: Gain knowledge about ecosystem & the conservation of biodiversity and its importance.	2	3	3	2	10
CO4-98EV205.4: Aware students about problems of environmental pollution, its impact on human and ecosystem and control measures.	3	5	5	2	15
CO5-98EV205.5: Apply the knowledge to resolve various social & environmental issues.	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	A textbook of Environmental Studies, Erach Bharucha, UGC Publication Delhi
2	A textbook of Environmental science: Purohit Shami & Agrawal, Agrobios Student edition Jaipur
3	A textbook of Environmental Studies: Kaushi & Kaushik New age International Publication
4	Paryavaran Addhyan: MP Hindi Granth Academy

(b) Online Resources:

1. Khan Academy – Ecology: Khan Academy Ecology Course
2. National Geographic – Environment: National Geographic Environment

3. Coursera - Ecology and Environmental Science Courses: Coursera Ecology Courses

(c) 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.Tech. Biotechnology | **Semester:** II Semester

Course Title: Ecology & Environmental Studies | **Course Code:** 98EV205

Course Outcomes (COs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-98EV205.1: Learn about environment and Natural resources.	3	3	2	2	1	1	2	1	2	1	1	1	3	2	2
CO2-98EV205.2: Students will learn about natural resource, its importance and environmental impacts of human activities on natural resource.	3	3	2	3	2	2	3	2	2	1	2	1	3	2	3
CO3-98EV205.3: Gain knowledge about ecosystem & the conservation of biodiversity and its importance.	3	3	2	3	2	2	3	2	2	1	2	1	3	3	3
CO4-98EV205.4: Aware students about problems of environmental pollution, its impact on human and ecosystem and control measures.	3	3	3	3	3	3	3	3	2	2	3	2	3	3	3
CO5-98EV205.5: Apply the knowledge to resolve various social & environmental issues.	3	3	3	3	3	3	3	3	2	3	3	2	3	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	**CO1-98EV205.1:** Learn about environment and Natural resources.	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, 1.9	1SL-1,2,3,4,5
PO 1,2,3,4,5 PSO 1,2,3	**CO2-98EV205.2:** Students will learn about natural resource, its importance and environmental impacts of human activities on natural resource.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5		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 PSO 1,2,3	**CO3-98EV205.3:** Gain knowledge about ecosystem & the conservation of biodiversity and its importance.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5		3.1,3.2,3.3,3.4,3.5, 3.6, 3.7, 3.8	3SL-1,2,3,4,5
PO 1,2,3,4,5 PSO 1,2,3	**CO4-98EV205.4:** Aware students about problems of environmental pollution, its impact on human and ecosystem and control measures.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5		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	**CO5-98EV205.5:** Apply the knowledge to resolve various social & environmental issues.	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-1,2,3,4,5

Program Name	**Bachelor of Technology (B.Tech.)- Biotechnology**	
Semester	II	
Course Code:	98ME206	
Course title:	Engineering Drawing	**Curriculum Developer**: Er. Alok Ranjan Tiwari
Pre-requisite:	Student should have basic knowledge of Geometry, Geometrical Shapes, basic knowledge of Computer, Mouse and keyboard use, navigating menus and dialogs, managing files and directories, etc.	
Rationale:	The students studying Graphics are essential in mechanical engineering, allowing engineers to visualize and communicate complex ideas clearly and concisely. Using graphics, engineers can create detailed plans for construction projects, analyses structural components, and convey design concepts to clients and stakeholders.	
Course Outcomes (COs):	**CO1-98ME206.1.** Get introduced with Engineering Graphics and visual aspects of design. **CO2-98ME206.2.** Know and use common drafting tools with the knowledge of drafting standards. **CO3-98ME206.3.** Apply computer aided drafting techniques to represent line, surface or solid models in different Engineering viewpoints. **CO4-98ME206.4.** Produce part models; carry out assembly operation and show working procedure of a designed project work using animation. **CO5-98ME206.5.** To make the student understand the viewing perception of a solid object in Isometric and perspective Projection, Design modulation and simulation by Auto CAD	

Scheme of Studies:

Board of Study	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)	
ESC	98ME206	Engineering Drawing	2	0	1	1	4	1+1=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 must 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 (CAT)	Class Attendance (AT)	Total Marks (CA+CT+CAT+SA+AT)		
ESC	98ME206	Engineering Drawing	**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 Hrs**

Item	Cl	LI	SW	SL	Total
Approx.Hrs	6	0	01	02	09

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO1-98ME206.1. Get introduced with Engineering Graphics and visual aspects of design.	SO1.1: Understand the concept and applications of representative factor scales.		CI1.1: Lecture on the representative factor and its applications in scales.	SL1.1: Research and prepare a report on the different types of scales used in engineering drawing.

	SO1.2: Learn the construction techniques of plain scales.		CI1.2: Demonstrate the construction of plain scales.	SL1.2: Develop a presentation on the importance and applications of plain scales.
	SO1.3: Understand diagonal scales and their usage.		CI1.3: Discuss the construction and use of diagonal scales.	
	SO1.4: Learn to construct scales of chords.		CI1.4: Lecture on the construction and use of scales of chords.	
	SO1.5: Understand the construction of ellipse, parabola, and hyperbola by different methods.		CI1.5: Discuss different methods for constructing ellipse, parabola, and hyperbola.	
	SO1.6: Learn to draw normal and tangent lines to conic sections.		CI1.6: Lecture on constructing normal and tangent lines to ellipse, parabola, and hyperbola.	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Ellipes by concentric circle method, Cycloid, Involutes of Circle
	SW1.2 Mini Project	Model of Hexagon, Pentagon, Square

Item	Cl	LI	SW	SL	Total
Approx.Hrs	6	0	01	02	09

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO2-98ME206.2. Know and use common drafting tools with the knowledge of drafting standards.	SO2.1: Understand the different types of projection.		CI2.1: Lecture on the types of projection and their applications.	SL2.1: Research and write a report on the historical development of projection techniques.
	SO2.2: Learn the principles of orthographic projection.		CI2.2: Demonstrate the process of creating orthographic projections.	SL2.2: Develop a presentation comparing first and third angle projection methods.
	SO2.3: Differentiate between first and third angle projection.		CI2.3: Discussion on the differences between first and third angle projections.	
	SO2.4: Understand the projection of points and lines.		CI2.4: Lecture on projecting points and lines in different planes.	
	SO2.5: Learn to project a line inclined to one plane.		CI2.5: Demonstrate the projection of lines inclined to one plane.	
	SO2.6: Understand the projection of a line inclined to both planes.		CI2.6: Interactive session on projecting lines inclined to both planes.	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Draw Projection of point & Projection of Straight Line
	SW2.2 Mini Project	Make a project on different first & Third angle projection

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	00	01	02	09

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO3-98ME206.3. Apply computer aided drafting techniques to represent line, surface or solid models in different engineering viewpoints.	SO3.1: Understand the projection of planes such as circles and polygons in different positions.	-	CI3.1: Lecture on the principles of projecting planes in different positions.	SL3.1: Research and create a report on the applications of plane projections in engineering.
	SO3.2: Learn to project polyhedrons like prisms in different positions.	-	CI3.2: Demonstrate the projection techniques for prisms.	SL3.2: Develop a presentation on the significance of prism projections in technical drawing.
	SO3.3: Understand the projection of pyramids in various orientations.	-	CI3.3: Discussion on the methods for projecting pyramids.	
	SO3.4: Learn the projection techniques for solids of revolution such as cylinders.	-	CI3.4: Lecture on projecting cylinders in different positions.	
	SO3.5: Understand the projection of cones in various orientations.	-	CI3.5: Demonstrate the projection methods for cones.	
	SO3.6: Apply knowledge of projecting different solids in practical scenarios.	-	CI3.6: Interactive session on the applications of projections of solids in engineering and design.	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Draw three problems of projection of plane
	SW3.2 Mini Project	Make models of plane and solid by thermocol

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	00	01	02	09

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO4-98ME206.4. Produce part models; carry out assembly operation and show working procedure of a designed project work using animation.	SO4.1: Understand the sectioning of right solids by normal planes.		CI4.1: Lecture on the principles of sectioning right solids with normal planes.	SL4.1: Research and write a report on the applications of solid sectioning in engineering.
	SO4.2: Learn to section right solids using inclined planes.		CI4.2: Demonstrate sectioning techniques for right solids with inclined planes.	SL4.2: Develop a presentation on the importance of inclined plane sectioning in design.
	SO4.3: Understand the intersection of cylinders.		CI4.3: Discussion on the methods for determining the intersection of cylinders.	
	SO4.4: Learn the development of surfaces using the parallel line method.		CI4.4: Lecture on the parallel line method for surface development of right solids.	
	SO4.5: Understand the radial line method for surface development.		CI4.5: Demonstrate the radial line method for developing surfaces of right solids.	
	SO4.6: Apply knowledge of sectioning and surface development in practical scenarios.		CI4.6: Interactive session on the applications of sectioning and surface development in engineering and design.	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Develop prism and cylinder
	SW4.2 Mini Project	Develop pyramid and Cone

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	00	01	02	09

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO5-98ME206.5 To make the student understand the viewing perception of a solid object in Isometric and perspective Projection, Design modulation and simulation by Auto CAD	SO5.1: Understand the concept of isometric scale and isometric axes.		CI5.1: Lecture on isometric scale, axes, and their applications.	SL5.1: Research and write a report on the historical development and applications of isometric projections.
	SO5.2: Learn to create isometric projections from orthographic drawings.		CI5.2: Demonstrate the process of converting orthographic drawings to isometric projections.	SL5.2: Develop a presentation on the significance of isometric projections in engineering design.
	SO5.3: Introduction to Computer Aided Drafting (CAD).		CI5.3: Lecture on the benefits and applications of CAD in engineering.	
	SO5.4: Understand the basic commands of CAD software.		CI5.4: Demonstrate basic drafting commands in CAD such as line, circle, polygon.	
	SO5.5: Learn transformations and editing commands in CAD.		CI5.5: Lecture on transformation and editing commands like move, rotate, mirror, array.	
	SO5.6: Apply CAD skills to solve projection problems.		CI5.6: Interactive session on solving projection problems using CAD.	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Draw Isometric view of a cone resting centrally on a cube
	SW5.2 Mini Project	Drawing of different orthographic view of planes and solid by Auto CAD commands

Course duration (in hours) to Attain Course Outcomes

Course Title: Bioprocess Equipment Design **Course Code:**98ME206

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1-98ME206.1. Get introduced with Engineering Graphics and visual aspects of design.	6	0	2	1	9
CO2-98ME206.2. Know and use common drafting tools with the knowledge of drafting standards.	6	0	2	1	9
CO3-98ME206.3. Apply computer aided drafting techniques to represent line, surface or solid models in different engineering viewpoints.	6	0	2	1	9
CO4-98ME206.4. Produce part models; carry out assembly operation and show working procedure of a designed project work using animation.	6	0	2	1	9
CO5-98ME206.5. To make the student understand the viewing perception of a solid object in Isometric and perspective Projection, Design modulation and simulation by Auto CAD	6	0	2	1	9
Total Hours	30	00	10	5	45

End semester Assessment Scheme for Setting up Question Paper and Assessment to Evaluate the Course Outcome

Course Title: Engineering Drawing **Course Code:**98ME206

Course Outcomes	**Marks Distribution**				**Total Marks**
	A	**An**	**E**	**C**	
CO1-98ME206.1. Get introduced with Engineering Graphics and visual aspects of design.	2	1	1	1	5
CO2-98ME206.2. Know and use common drafting tools with the knowledge of drafting standards.	2	4	5	1	12
CO3-98ME206.3. Apply computer aided drafting techniques to represent line, surface or solid models in different engineering viewpoints.	3	5	5	1	14
CO4-98ME206.4. Produce part models; carry out assembly operation and show working procedure of a designed project work using animation.	2	3	5	1	11
CO5-98ME206.5. To make the student understand the viewing perception of a solid object in Isometric and perspective Projection, Design modulation and simulation by Auto CAD	2	4	1	1	10
Total Marks	**11**	**17**	**17**	**05**	**50**

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

CO, PO and PSO Mapping

Program Name: B.Tech. Biotechnology **Semester:** II Semester

Course Title: Engineering Drawing **Course Code:** 98ME206

Course Outcomes (COs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-98ME206.1. Get introduced with Engineering Graphics and visual aspects of design.	3	2	2	1	2	1	1	1	2	1	1	1	3	2	2
CO2-98ME206.2. Know and use common drafting tools with the knowledge of drafting standards.	3	3	2	1	2	1	1	1	2	1	1	1	3	2	2
CO3-98ME206.3. Apply computer aided drafting techniques to represent line, surface or solid models in different engineering viewpoints.	3	3	3	2	3	2	2	1	2	1	2	2	3	3	3
CO4-98ME206.4. Produce part models; carry out assembly operation and show working procedure of a designed project work using animation.	3	3	3	3	3	3	3	1	3	2	3	2	3	3	3
CO5-98ME206.5. To make the student understand the viewing perception of a solid object in Isometric and perspective Projection, Design modulation and simulation by Auto CAD	3	3	3	3	3	2	2	2	3	2	3	2	3	3	3

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

Course Curriculum Map

POs & PSOs No.	COs	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6 PSO 1,2, 3	**CO1-98ME206.1** Get introduced with Engineering Graphics and visual aspects of design.	SO1.1 SO1.2 SO1.3 SO1.4		1.1,1.2,1.3,1.4,1.5,1.6	**1SL-1,2**
PO 1,2,3,4,5,6 PSO 1,2, 3	**CO2-98ME206.2** Know and use common drafting tools with the knowledge of drafting standards.	SO2.1 SO2.2 SO2.3 SO2.4		1.1,1.2,1.3,1.4,1.5,1.6	**2SL-1,2**
PO 1,2,3,4,5,6 PSO 1,2, 3	**CO3-98ME206.3** Apply computer aided drafting techniques to represent line, surface or solid models in different engineering viewpoints.	SO3.1 SO3.2		1.1,1.2,1.3,1.4,1.5,1.6	**3SL-1,2**
PO 1,2,3,4,5,6 PSO 1,2, 3	**CO4-98ME206.4** Produce part models; carry out assembly operation and show working procedure of a designed project work using animation.	SO4.1 SO4.2 SO4.3		1.1,1.2,1.3,1.4,1.5,1.6	**4SL-1,2**
PO 1,2,3,4,5,6 PSO 1,2, 3	**CO5-98ME206.5** To make the student understand the viewing perception of a solid object in Isometric and perspective Projection, Design modulation and simulation by Auto CAD	SO5.1 SO5.2 SO5.3		1.1,1.2,1.3,1.4,1.5,1.6	**5SL-1,2**

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1	Computer Aided Engg drawing, VTU Belgaum, Visvesvaraya Tech. University
2	Engineering Drawing, Bhatt N.D., Panchal V.M. & Ingle P.R., Charotar Publishing House
3	Engineering Drawing, R.K. Dawan, S. Chand Publication.
4	Engineering Drawing, Agrawal and Agrawal, TMH

(b) Online Resources:

1. Online Resource for Ecology and Environment Ecology and Environmental Science by The Nature Conservancy
2. Online Resource for Ecology and Environment EPA's Environmental Education
3. Online Resource for Ecology and Environment National Geographic's Environment Section

(c) 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

Program Name	**Bachelor of Technology (B.Tech.)- Biotechnology**	
Semester	II	
Course Code:	98PH203	
Course title:	Engineering Physics	**Curriculum Developer**: Dr. O.P. Tripathi, and Mr. Saket Kumar
Pre-requisite:	Students should be familiar with the fundamentals of Wave Mechanics laser & fiber optics, Quantum Mechanics, Solid State Physics & Superconductivity, and Nano Technology.	
Rationale:	Students should study fundamentals of Wave Mechanics, Laser & Fiber Optics, Quantum Mechanics, Solid State Physics & Superconductivity, and Nano Technology to understand their impact on modern technology and scientific advancement. These fields are essential in optics, acoustics, quantum mechanics, telecommunications, medical imaging, and more. Mastering these disciplines equips students to contribute to cutting-edge research and innovation.	
Course Outcomes (COs):	**CO1-98PH203.1:** Through this chapter students are brought to learn about historical development of optics, atomic physics and biomechanics to the modern concepts. **CO2-98PH203.2:** Explain the concept of coherence and its importance in laser operation and optical fiber communication. **CO3-98PH203.3:** Quantum mechanics math covers operators, eigenvalues, eigenvectors, phase, group velocities, uncertainty principle, Debroglie's matter waves, Schrodinger's wave equation, wave function interpretation, eigenvalues, and Compton's effect. **CO4-98PH203.4:** Evaluate current research topics and advancements in solid-state physics and superconductivity, including high-temperature superconductors, topological superconductors, and quantum computing applications. **CO5-98PH203.5:** Investigate the applications of nanotechnology in various fields, including electronics, nanorobotics, quantum computing, space energy, DNA manipulation, biomedical engineering, polymers, textiles, and nano composites.	

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C) (L+T+P)
			CI	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
ESC	98PH203	Engineering Physics	3	2	1	2	8	4

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

Scheme of Assessment (Marks)											
Board of Study	Course Code	Course Title	Progressive Assessment (PRA)							End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test2 (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)			
ESC	98PH203	Engineering Physics	15	20	5	5	5	50		50	100

Course-Curriculum Detailing:

This course syllabus outlines the expected learning outcomes that students should achieve through different modes of instruction, such as classroom instruction (CI), laboratory instruction (LI), sessional work (SW), and self-learning (SL), at both the course and session levels. Students should demonstrate their mastery of Session Outcomes (SOs) as the course proceeds, which will lead to their overall attainment of Course Outcomes (COs) at the end of the course.	

Item	CI	LI	SW	SL	Total
Approx Hrs	12	04	01	02	19

Course Outcome (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
98PH203.1: Through this chapter students are brought to learn about historical development of optics, atomic physics and biomechanics to the modern concepts.	SO 1.1: Understanding interference, coherent sources, and the principle of superposition for various applications in physics, optics, acoustics, and engineering.	LI 1.1: Demonstration of coherent sources and superposition principles.	CI 1.1: Explanation of interference, coherent sources, and principle of superposition.	SL 1.1: Study historical experiments on interference and superposition principles.
	SO 1.2: Design and analyze interference-based devices, such as interferometers, for precision measurements.	LI 1.2: Demonstration of different types of interference.	CI 1.2: Discussion on types of interference and their practical applications.	SL 1.2: Research practical applications of interference in various fields.
	SO 1.3: Experimental explanation about interference from parallel thin films.		CI 1.3: Study the effects of parallel thin films on interference patterns.	
	SO 1.4: Experimental explanation about wedge-shaped films.		CI 1.4: Explanation of interference in wedge-shaped films and related phenomena.	
	SO 1.5: Experimental explanation about Newton’s rings and Michelson’s Interferometer, and their applications.		CI 1.5: Detailed study of Newton’s rings and Michelson’s Interferometer.	
	SO 1.6: Introduce Fresnel diffraction, diffraction at a straight edge, and diffraction at double and n-slits.		CI 1.6: Explanation of Fresnel diffraction and its mathematical formulations.	

	SO 1.7: Explain the dispersive and resolving power of diffraction gratings and prisms.		CI 1.7: Study the principles behind diffraction gratings and resolving power calculations.	
	SO 1.8: Explain the production of plane-polarized light by different methods.		CI 1.8: Explanation of polarization and polarizing materials.	
	SO 1.9: Discuss Brewster's law, Malus's law, and double refraction.		CI 1.9: Detailed explanation of Brewster's and Malus's laws and their applications.	
	SO 1.10: Explain double refraction using Nicol prism.		CI 1.10: Discuss the phenomenon of double refraction and the use of Nicol prisms.	
	SO 1.11: Explain quarter and half-wave plates.		CI 1.11: Explanation of phase retardation using quarter and half-wave plates.	
	SO 1.12: Explain the components and function of a polarimeter.		CI 1.12: Explanation of polarimeter components and calibration procedures.	

SW-1 Suggested Sessional Work (SW)	**SW-1 Suggested Sessional Work (SW):** **A. Assignments:** **1.** Explain the phenomenon of wave reflection and calculate the reflection coefficient for a given interface. **2.** Wave Equation Problems: a. Derive the wave equation for a traveling wave on a string under tension. b. Solve the wave equation to find the general solution for a harmonic wave propagating in one dimension. c. Investigate the behavior of standing waves on a vibrating string and determine the node and antinode positions. d. Analyze the properties of electromagnetic waves and relate them to Maxwell's equations.

	Mini Project: Develop computational models to study wave interference, diffraction, and scattering effects in complex geometries and materials.
	Other Activities (Specific): **BS-101.2:** Explain the concept of coherence and its importance in laser operation and optical fiber communication.

Item	CI	LI	SW	SL	Total
Approx Hrs	09	04	01	01	16

Course Outcome (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
98PH203.2: Explain the concept of coherence and its importance in laser operation and optical fiber communication.	SO 2.1: Understand LASER principles, including absorption, stimulated and spontaneous emission, coherence, pumping, and population inversion.	LI 2.1: Conduct hands-on experiments to demonstrate LASER principles, such as: LASER beam propagation and divergence	CI 2.1: Define LASER (Light Amplification by Stimulated Emission of Radiation) and its basic principles.	SL 2.1: Emphasize the importance of proper training, handling, and maintenance of LASER systems.
	SO 2.2: Discuss the coherence, directionality, and monochromaticity of laser light.		CI 2.2: Explanation of coherence, directionality, and monochromaticity of laser light.	
	SO 2.3: Provide a mathematical explanation of Einstein's coefficients.		CI 2.3: Discussion on the significance of Einstein's coefficients in LASER operations.	
	SO 2.4: Explain the principle and working of He-Ne and Ruby lasers with energy level diagrams.		CI 2.4: Detailed study of the working principles of He-Ne and Ruby lasers.	

	SO 2.5: Provide a fundamental overview of optical fibers and their types.		CI 2.5: Explanation of different types of optical fibers and their applications.	
	SO 2.6: Explain the principle of total internal reflection (TIR) and its significance in optical fiber transmission.	LI 2.2: Engage students in activities such as measuring numerical aperture, analyzing dispersion characteristics, and testing fiber coupling techniques to reinforce theoretical concepts and practical skills.	CI 2.6: Explanation of TIR and its role in optical fibers.	
	SO 2.7: Explain the role of each component in transmitting, receiving, and processing optical signals.		CI 2.7: Discussion on optical communication system components and their functions.	
	SO 2.8: Explore practical applications of optical communication, including telecommunications and data networking.		CI 2.8: Discussion on emerging applications in fiber-optic sensing, biomedical imaging, and quantum communication.	
	SO2.9: Apply differentiation techniques to solve real-world problems.		CI2.9: Discussion on the applications of differentiation in various fields.	

SW-2 Suggested Sessional Work (SW)	**SW2.1 Assignments:** • Determine the equation of motion for system • What would be the steady state of solution. **SW2.2 Other Activities (Specific):**

Item	CI	LI	SW	SL	Total
Approx Hrs	10	04	01	02	19

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instructions (LIs)	Classroom Instruction (CIs)	Self-Learning (SL)
CO3-98PH203.3: Quantum mechanics math covers operators, eigenvalues, eigenvectors, phase, group velocities, uncertainty principle, Debroglie's matter waves, Schrodinger's wave equation, wave function interpretation, eigenvalues, and Compton's effect.	SO 3.1: Explain the difference between phase velocity and group velocity.	LI 3.1: Conduct experiments to measure phase and group velocities using wave packets.	CI 3.1: Explain the relationship between phase velocity and group velocity.	
	SO 3.2: Explain the uncertainty principle with elementary proof and applications.	LI 3.2: Provide opportunities for students to practice calculating uncertainty relations and interpreting their physical meaning in different scenarios.	CI 3.2: Discussion on the commutator relationship and its implications for position and momentum uncertainties.	SL 3.1: Research historical experiments demonstrating the uncertainty principle.
	SO 3.3: Present de Broglie's concept of matter waves.		CI 3.3: Explain de Broglie's equation: $\lambda = h / p$, where h is Planck's constant.	SL 3.2: Explore applications of matter waves in modern physics.
	SO 3.4: Explain Schrödinger's wave equation (time-dependent and time-independent).		CI 3.4: Explain the significance of the time-independent Schrödinger equation: $\hat{H}\Psi = E\Psi$.	
	SO 3.5: Discuss the interpretation of wave functions and the matching of impedances.		CI 3.5: Classroom discussion on the interpretation of wave functions in quantum mechanics.	
	SO 3.6: Present the mathematical definition of eigenvalues and eigenfunctions.		CI 3.6: Explain the role of eigenvalues and eigenfunctions in linear transformations and operators.	

	SO 3.7: Derive the Compton shift formula using relativistic energy and momentum conservation principles.		CI 3.7: Discuss the implications of the Compton effect in quantum mechanics and particle physics.	
	SO 3.8: Discuss the concept of quantum tunneling and its applications.		CI 3.8: Explain quantum tunneling, its principles, and its significance in quantum mechanics.	
	SO 3.9: Explain the concept of wave-particle duality.		CI 3.9: Discuss the historical context and significance of wave-particle duality in quantum mechanics.	
	SO3.10 Assessment and revision		CI 3.10: Assessment and revision	

SW-3 Suggested Sessional Work (SW) *(anyone)*	**SW 3.1: Assignments** In the double-hole experiment using white light, consider two points on the projection screen, one corresponding to a path difference of 5000 Å (point A), and the other corresponding to a path difference of 40,000 Å (point B). Find all the wavelengths (in the visible region) which correspond to constructive and destructive interference at point A and B. **SW3.2 Mini Project:** Discuss how Compton scattering is used in Compton cameras for gamma-ray imaging, electron microscopy, and spectroscopy techniques**.** **SW3.3 A. Other Activities:** Discuss limitations of the classical Compton shift formula and extensions to the theory, such as the Klein-Nishina formula for higher-energy photons and relativistic corrections.

Item	CI	LI	SW	SL	Total
Approx Hrs	08	04	01	04	13

Course Outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LIs)**	**Classroom Instruction (CIs)**	**Self-Learning (SLs)**
98PH203.4: Evaluate current research topics and advancements in solid-state physics and superconductivity, including high-temperature superconductors, topological superconductors, and quantum computing applications.	SO 4.1: Define energy bands as ranges of allowed energy levels for electrons in solids.	LI 4.1: Conduct interactive demonstrations to illustrate energy bands using models or simulations.	CI 4.1: Explain the formation of energy bands in solids due to the periodic arrangement of atoms.	SL 4.1: Research historical developments in solid-state physics and energy band theory.
	SO 4.2: Introduce the concept of classification of matter based on properties.	LI 4.2: Conduct activities categorizing various materials based on their properties.	CI 4.2: Discuss the importance of classifying matter in physics and materials science.	SL 4.2: Explore different classifications of matter and their significance.
	SO 4.3: Explain the concept of the band gap in semiconductors.		CI 4.3: Discuss the role of band gaps in determining the electrical properties of semiconductors.	
	SO 4.4: Introduce PN junction diodes and Zener diodes, including their I-V characteristics.		CI 4.4: Explain how Zener diodes operate in the breakdown region and illustrate the I-V characteristics of PN junction diodes.	
	SO 4.5: Define a tunnel diode and its characteristics.		CI 4.5: Explain the concept of negative differential resistance (NDR) in tunnel diodes.	

	SO 4.6: Introduce the Hall effect and its applications.		CI 4.6: Explain the Hall coefficient and its significance in understanding the Hall effect.	
	SO 4.7: Explain the distinctions between Type-I and Type-II superconductors.		CI 4.7: Discuss the characteristics of superconductors and the Meissner effect.	
	SO 4.8: Discuss practical applications of superconductivity.		CI 4.8: Explain various applications of superconductors in technology and medicine.	

SW- 4 Suggested Sessional Work (SW) *(anyone)*	**SW 4.1 Assignments** • Explore the applications of P-N junction diodes in electronic circuits, including rectification, signal detection, and voltage regulation. • Provide examples of practical applications of the Hall effect in devices such as Hall sensors, magnetic field sensors, and magnetic flux measurement systems. Discuss the advantages and limitations of using the Hall effect for these purposes **SW4.2 Mini Project** **SW4.3 Other Activities** • Engage students in circuit analysis exercises involving PN junction diodes and Zener diodes, challenging them to design and analyze simple diode circuits. • Conduct hands-on experiments to demonstrate the Hall effect using a Hall probe and magnetic field source, allowing students to observe the generation of Hall voltage in real-time.

Item	CI	LI	SW	SL	Total
Approx Hrs	9	4	01	4	18

Course Outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-learning**
98PH203.5: Investigate the applications of nanotechnology in various fields, including electronics, nanorobotics, quantum computing, space energy, DNA manipulation, biomedical engineering, polymers, textiles, and nano composites.	SO 5.1: Understand the concept of nanotechnology and its significance in various fields.	LI 5.1: Conduct experiments to demonstrate nanoscale properties using nanomaterials.	CI 5.1: Explain the fundamentals of nanotechnology, including concepts of quantum dots, quantum wires, and quantum wells.	SL 5.1: Research the historical development of nanotechnology and its implications in various fields.
	SO 5.2: Discuss the unique properties of materials at the nanoscale compared to bulk materials.	LI 5.2: Perform comparative analysis of the properties of bulk and nanoscale materials.	CI 5.2: Discuss how size and structure affect the properties of materials at the nanoscale.	SL 5.2: Explore literature on the unique behaviors of nanoscale materials.
	SO 5.3: Describe different types of nanomaterials, including nanoparticles, nanowires, nanotubes, and nanocomposites.		CI 5.3: Explain the differences between various nanomaterials and their specific properties and applications.	SL 5.3: Investigate the applications of different types of nanomaterials in industry.
	SO 5.4: Explore techniques used for the preparation of nanomaterials and nanofibers.		CI 5.4: Discuss various methods for synthesizing nanomaterials and their importance in nanotechnology.	SL 5.4: Research advancements in preparation techniques for nanomaterials.
	SO 5.5: Explain characterization techniques for nanomaterials using XRD and SEM.		CI 5.5: Discuss the principles and applications of XRD and SEM in analyzing nanomaterials.	

	SO 5.6: Discuss potential applications of nanotechnology in medicine and electronics.		CI 5.6: Explain the impact of nanotechnology on fields like drug delivery and DNA sequencing.	
	SO 5.7: Explore the role of nanotechnology in environmental remediation.		CI 5.7: Discuss case studies on the use of nanotechnology for water purification and air filtration.	
	SO 5.8: Investigate the future trends in nanotechnology and its implications for society.		CI 5.8: Discuss ethical considerations and societal impacts of nanotechnology advancements.	

SW- 5 Suggested Sessional Work (SW) (anyone)	**SW 5.1 Assignments:** • Discuss the different types of nanomaterials, including nanoparticles, carbon nanotubes, nano clays, nano mud, and nano fibers. Explain their structures, properties, and potential applications. • Explain how nanomaterials can be characterized using techniques such as X-ray diffraction (XRD) and scanning electron microscopy (SEM). Discuss the principles behind these characterization methods and their applications in nanoscience. **SW5.2 Mini Project** **SW5.3 Other Activities**

Brief of Hours Suggested for the Course Outcome

Course Outcomes	Class Lecture (CI)	Laboratory Instructions (LI)	Sessional Work (SW)	Self Learning (SL)	Total hour (Cl+LI+SW+SL)
98PH203.1: Through this chapter students are brought to learn about historical development of optics, atomic physics and biomechanics to the modern concepts.	12	4	01	02	19
98PH203.2: Explain the concept of coherence and its importance in laser operation and optical fiber communication.	9	04	01	01	15
98PH203.3: Evaluate current research topics and advancements in solid-state physics and superconductivity, including high-temperature superconductors, topological superconductors, and quantum computing applications.	10	04	01	02	19
98PH203.4: Evaluate current research topics and advancements in solid-state physics and superconductivity, including high-temperature superconductors, topological superconductors, and quantum computing applications.	08	04	01	4	13
98PH203.5: Investigate the applications of nanotechnology in various fields, including electronics, nanorobotics, quantum computing, space energy, DNA manipulation, biomedical engineering, polymers, textiles, and nano composites.	9	4	01	4	18
Total Hours	**48**	**20**	**05**	**13**	**84**

Suggestion for End Semester Assessment

Unit	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
Unit-1	Wave Mechanics	03	01	01	05
Unit-2	Laser & Fiber Optics	02	06	02	10
Unit-3	Quantum Mechanics	03	07	05	15
Unit-4	Solid State Physics & Superconductivity	-	10	05	15
Unit-5	Nano Technology	03	02	-	05
Total		11	26	13	50

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

The end of semester assessment for Introduction to Portland cement will be held with writtenexamination 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.

CO-PO-PSO Mapping

Course Outcome (Cos)	Programme Outcome (PO)												Programme Specific Outcome (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
98PH203.1: Through this chapter students are brought to learn about historical development of optics, atomic physics and biomechanics to the modern concepts.	3	3	1	2	1	1	1	1	1	1	3	2	2	1	3
98PH203.2: Explain the concept of coherence and its importance in laser operation and optical fiber communication.	3	3	3	3	2	1	3	2	2	3	2	1	2	3	2
98PH203.3: Evaluate current research topics and advancements in solid-state physics and superconductivity, including high-temperature superconductors, topological superconductors, and quantum computing applications.	3	3	3	3	2	1	2	1	1	2	1	2	3	2	3
98PH203.4: Evaluate current research topics and advancements in solid-state physics and superconductivity, including high-temperature superconductors,	3	3	2	3	3	3	2	2	2	3	2	3	2	3	2

topological superconductors, and quantum computing applications.															
98PH203.5: Investigate the applications of nanotechnology in various fields, including electronics, nanorobotics, quantum computing, space energy, DNA manipulation, biomedical engineering, polymers, textiles, and nano composites.	3	3	2	3	3	2	1	3	2	3	2	2	2	3	3

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

Course Curriculum Map

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	**98PH203.1:** Through this chapter students are brought to learn about historical development of optics, atomic physics and biomechanics to the modern concepts.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5, SO1.6, SO1.7, SO1.8, SO1.9 SO 1.10 SO1.11 SO1.12	**1LI-1,2**	CI1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9,1.10,1.11,1.12	**1SL-1,2**
PO 1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2, 3	**98PH203.2:** Explain the concept of coherence and its importance in laser operation and optical fiber communication.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5, SO2.6, SO2.7, SO2.8, SO2.9	**1LI-1,2**	CI1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9	**2SL-1**
PO 1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2, 3	**98PH203.3:** Evaluate current research topics and advancements in solid-state physics and superconductivity, including high-temperature superconductors, topological	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5, SO3.6, SO3.7, SO3.8,	**1LI-1,2**	CI1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9,1.10	**3SL-1,2**

	superconductors, and quantum computing applications.	SO3.9 SO3.10			
PO 1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2, 3	**98PH203.4:** Evaluate current research topics and advancements in solid-state physics and superconductivity, including high-temperature superconductors, topological superconductors, and quantum computing applications.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5, SO4.6, SO4.7, SO4.8	**1LI-1,2**	CI1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8	**4SL-1,2**
PO 1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2, 3	**98PH203.5:** Investigate the applications of nanotechnology in various fields, including electronics, nanorobotics, quantum computing, space energy, DNA manipulation, biomedical engineering, polymers, textiles, and nano composites.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5, SO5.6, SO5.7, SO5.8, SO5.9	**1LI-1,2**	CI1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.	**5SL-1,2,3,4**

Suggested Learning Resources:

(a) Books:

1. Engineering Physics by A.B. Bhattacharya, Khanna Publishing House, Revised edition 21, 2020
2. Physics for Engineers by N.K. Verma, Prentice Hall India, 2017

3. Physics of Vibrations and Waves by H.J. Pain, National Council for Cement and Building Materials, 5th Edition, Wiley, 2006
4. Optics by Ajoy Ghatak, McGraw Hill Education India, 2017
5. Department Provided Lab Manual
6. Engineering Physics Lab Manual

(b) Online Resources:

1. MIT OpenCourseWare (OCW): Free courses in Physics, including Engineering Physics. MIT OCW Physics
2. Coursera: Courses from various universities on topics relevant to Engineering Physics. Coursera Physics Courses
3. edX: Courses from institutions like Harvard and MIT on advanced physics topics. edX Physics Courses
4. YouTube Channels: MinutePhysics: Short videos on various physics topics. MinutePhysics YouTube Channel, Veritasium: Explores complex physics concepts. Veritasium YouTube Channel, MIT OpenCourseWare: Full lectures and courses. MIT OCW YouTube Channel
5. HyperPhysics: Exploration environment for physics concepts. HyperPhysics
6. The Feynman Lectures on Physics: Classic physics textbook series available for free online. The Feynman Lectures on Physics
7. OpenStax: Free textbooks, including College Physics. OpenStax College Physics
8. arXiv: Repository of electronic preprints approved for publication. arXiv Physics
9. Google Scholar: Web search engine indexing scholarly literature. Google Scholar
10. PhET Interactive Simulations: Free interactive math and science simulations. PhET Simulations
11. Physlets: Interactive physics animations and simulations. Physlets

(c) 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

Program Name	**BTech Biotechnology**	
Semester	II	
Course Code:	**98EE208**	
Course title:	Basic Electrical & Electronics Engineering	**Curriculum Developer**: Er. K K Tripathi, Assistant Professor
Pre-requisite:	Students should have basic knowledge of electrical and electronics circuits.	
Rationale:	A process of introducing formal knowledge of basic electrical elements and AC, DC, and magnetic circuit in electrical and electronic devices along with necessary knowledge about single-phase Transformer.	
Course Outcomes (COs):	**CO1-98EE208.1.** Recall the concepts of voltage, current, power and energy for different circuit elements. Apply the Kirchhoff laws to identify the node voltages and branch currents, apply different network theorems in the complex networks. **CO2-98EE208.2.** Understand the concept of single phase and poly phase AC circuits and construct the phasor diagrams. **CO3-98EE208.3.** Understand the basic operating principle, types, efficiency of Transformers. **CO4-98EE208.4.** Design and analyze the different types of digital circuits. **CO5-98EE208.5.** Understand and analyze the various types of semiconductor devices.	

Scheme of Studies:

Board of Study	CourseCode	Course Title	Scheme of studies (Hours/Week)					Total Credits(C) (L: T:P=2:1:1)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
ESC	98EE208	Basic Electrical & Electronics Engineering	3	2	1	1	7	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	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 (CAT)	Class Attendance (AT)	Total Marks (CA+CT+CAT+SA+AT)		
ESC	98EE208	Basic Electrical & Electronics Engineering	**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	09	03	1	02	15

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO1-98EE208.1. Recall the concepts of voltage, current, power and energy for different circuit elements. Apply the Kirchhoff laws to identify the node voltages and	SO1.1: Understand the importance of electrical engineering in daily life.	LI1.1: Explore real-world applications of electrical engineering.	CI1.1: Lecture on the significance of electrical engineering in various industries.	SL1.1: Research and write a report on the impact of electrical engineering in modern society.

branch currents, apply different network theorems in the complex networks.				
	SO1.2: Identify different electrical elements and their classifications.		CI1.2: Discuss various electrical elements and their classifications.	
	SO1.3: Understand the basic concepts of electrical networks.		CI1.3: Lecture on the fundamentals of electrical network theory.	
	SO1.4: Differentiate between active and passive elements in a circuit.	LI1.2: Identify active and passive elements in sample circuits.	CI1.4: Discuss the characteristics of active and passive circuit elements.	
	SO1.5: Understand voltage and current sources.		CI1.5: Lecture on voltage and current sources, including dependent and independent sources.	
	SO1.6: Perform source conversion in electrical circuits.		CI1.6: Demonstrate source conversion techniques with examples.	
	SO1.7: Analyze DC circuits using the mesh method.	LI1.3: Practice DC circuit analysis using the mesh method.	CI1.7: Lecture on the mesh analysis method for DC circuits.	
	SO1.8: Analyze DC circuits using the nodal method.		CI1.8: Demonstrate the nodal analysis method with practical examples.	
	SO1.9: Apply Thevenin's and superposition theorems to solve circuits.		CI1.9: Lecture on Thevenin's and superposition theorems with problem-solving sessions.	SL1.2: Develop a presentation on the application of Thevenin's theorem in circuit design.

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Numerical Problems on mesh and nodal analysis.
	SW1.2 Assignments	Derive different network theorems
	SW1.3 Other Activities (Specify)	Make a power point presentation on "Importance of electrical engineering in day-to-day life"

Item	Cl	LI	SW	SL	Total
Approx. Hrs	7	02	1	02	12

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO2-98EE208.2. Understand the concept of single phase and poly phase AC circuits and construct the phasor diagrams.	SO2.1: Understand the basics of 1-phase AC circuits under sinusoidal steady state.	LI2.1: Measure voltage and current in 1-phase AC circuits.	CI2.1: Lecture on 1-phase AC circuits and sinusoidal steady state.	SL2.1: Research and write a report on the applications of 1-phase AC circuits.
	SO2.2: Differentiate between active, reactive, and apparent power.		CI2.2: Discuss the concepts of active, reactive, and apparent power.	
	SO2.3: Explain the physical meaning of reactive power.		CI2.3: Lecture on the physical interpretation and significance of reactive power.	
	SO2.4: Calculate power factor and its importance in AC circuits.		CI2.4: Demonstrate power factor calculation with examples.	
	SO2.5: Analyze 3-phase balanced supply systems.	LI2.2: Experiment with 3-phase balanced supply and measure power.	CI2.5: Lecture on 3-phase balanced supply systems and their analysis.	
	SO2.6: Understand 3-phase unbalanced supply systems and their challenges.		CI2.6: Discuss the differences and challenges of unbalanced 3-phase systems.	
	SO2.7: Explain star and delta connections in 3-phase systems.		CI2.7: Lecture on star and delta connections and their applications.	SL2.2: Develop a presentation on the advantages and

				disadvantages of star and delta connections.

Suggested Sessional Work (SW):	**SW2.1** Assignments	Find current, voltage and power of a purely inductive circuit.
	SW2.2 Assignments	Find current, voltage, power and impedance of RLC series circuit.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	11	03	01	03	18

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO3-98EE208.3. Understand the basic operating principle, types, efficiency of Transformers.	SO3.1: Review the laws of electromagnetism and their applications.	LI3.1: Demonstrate the laws of electromagnetism using practical examples.	CI3.1: Lecture on the fundamental laws of electromagnetism.	SL3.1: Research and prepare a report on historical experiments in electromagnetism.
	SO3.2: Understand the concepts of mmf and flux and their relationships.		CI3.2: Discuss mmf, flux, and their interrelationships.	
	SO3.3: Analyze magnetic circuits and their characteristics.		CI3.3: Lecture on the analysis of magnetic circuits with examples.	
	SO3.4: Explain the basic concepts and construction features of single-phase transformers.		CI3.4: Lecture on single-phase transformer construction and operation.	
	SO3.5: Understand voltage, current, and impedance transformation in transformers.	LI3.2: Conduct experiments on voltage and current transformation	CI3.5: Discuss voltage, current, and impedance transformation principles.	

		in transformers.		
	SO3.6: Analyze equivalent circuits and phasor diagrams of transformers.		CI3.6: Lecture on equivalent circuits and phasor diagrams.	
	SO3.7: Explain voltage regulation, losses, and efficiency of transformers.		CI3.7: Discuss voltage regulation, losses, and efficiency calculations.	
	SO3.8: Conduct OC and SC tests on transformers and interpret the results.	LI3.3: Perform OC and SC tests on transformers and analyze the data.	CI3.8: Lecture on OC and SC tests and their significance.	
	SO3.9: Understand the importance of transformer protection mechanisms.		CI3.9: Discuss various transformer protection methods and devices.	SL3.2: Create a presentation on transformer protection mechanisms.
	SO3.10: Explain the troubleshooting and maintenance procedures for transformers.		CI3.10: Lecture on troubleshooting and maintenance practices.	
	SO3.11: Describe the maintenance of transformer oil and drying out processes.		CI3.11: Discuss the methods for maintaining transformer oil and drying out.	SL3.3: Develop a maintenance schedule for a transformer.

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Write a note on circuit breaker.
	SW3.2 Assignments	Discuss various losses associated with transformer.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	10	04	01	02	17

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO4-98EE208.4. Design and analyse the different types of digital circuits.	SO4.1: Understand number systems used in digital electronics.	LI4.1: Experiment on converting between decimal, binary, octal, and hexadecimal.	CI4.1: Lecture on the various number systems and their uses.	SL4.1: Research the history and development of digital number systems.
	SO4.2: Learn about complements, operations, and conversions in number systems.		CI4.2: Discuss the concepts of complements and number operations.	
	SO4.3: Understand floating point and signed numbers in digital electronics.		CI4.3: Lecture on floating point representation and signed numbers.	
	SO4.4: Explore Demorgan's theorem and basic logic gates.		CI4.4: Lecture on Demorgan's theorem and its applications.	
	SO4.5: Understand the function and representation of logic gates.	LI4.2: Implement basic logic gates using digital electronics kits.	CI4.5: Discuss the AND, OR, NOT, NOR, NAND, EX-NOR EX-OR gates.	
	SO4.6: Learn to create and interpret truth tables for logic gates.		CI4.6: Lecture on constructing truth tables for different logic gates.	
	SO4.7: Design and analyze half and full adder circuits.	LI4.3: Construct half and full adder circuits and	CI4.7: Lecture on the design and operation of adder circuits.	SL4.2: Research applications of adders in digital systems.

		test their functionality.		
	SO4.8: Understand the operation of R-S and J-K flip flops.		CI4.8: Discuss the principles of R-S and J-K flip flops.	
	SO4.9: Learn about proportional, integral, and derivative controls.	LI4.4: Implement a PID control system and analyze its response.	CI4.9: Lecture on PID control and its application in process control.	
	SO4.10: Explore computer interfacing and applications in fermentation processes.		CI4.10: Discuss computer interfacing techniques in fermentation processes.	SL4.3: Develop a project proposal for using computer interfacing in a bioreactor.

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Implement logic circuit for full adder.
	SW4.2 Mini Project	Implement logic circuit for SR flip flop.
	SW4.3 Mini Project	Perform various arithmetic operation on various types of number system.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	9	03	1	2	15

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO5-98EE208.5 Understand and analyse the various types of semiconductor devices.	SO5.1: Understand the different types of passive components: resistors, inductors, and capacitors.	LI5.1: Experiment on measuring and identifying resistors, inductors, and capacitors.	CI5.1: Lecture on the properties and types of resistors, inductors, and capacitors.	SL5.1: Research and present a report on applications of passive components in electronic circuits.
	SO5.2: Learn the basics of semiconductors and their importance in electronics.		CI5.2: Lecture on the fundamentals of semiconductors.	
	SO5.3: Explore the V-I characteristics of diodes.		CI5.3: Lecture and demonstration on the V-I characteristics of diodes.	
	SO5.4: Understand the structure and working of bipolar junction transistors (BJT).	LI5.2: Experiment on the V-I characteristics of BJTs.	CI5.4: Discuss the working principle and applications of BJTs.	SL5.2: Study and write about the historical development of BJTs and their impact on technology.
	SO5.5: Learn about CC (common collector), CB (common base), and CE (common emitter) transistor configurations.		CI5.5: Lecture on the different transistor configurations.	
	SO5.6: Understand the different modes of operation of BJTs.		CI5.6: Discuss the active, cutoff, and saturation modes of BJTs.	
	SO5.7: Explore the concept of DC biasing in BJTs.		CI5.7: Lecture on DC biasing techniques for BJTs.	SL5.3: Create a simulation of a transistor amplifier circuit and analyze its performance.
	SO5.8: Apply knowledge of BJTs in practical circuits.		CI5.8: Discuss practical applications of BJTs in electronic circuits.	

Suggested Sessional Work (SW):	**SW5.1** Assignments	Describe how transistor works as an amplifier.
	SW5.2 Assignments	How will you compare different configuration of transistor.
	SW5.3 Assignments	Find the current gain in various configuration of transistor.

Course duration (in hours) to attain Course Outcomes:

Course Title: Basic Electrical & Electronics Engineering **Course Code:** 98EE208

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (LI+CI+SL+SW)
CO1-98EE208.1. Recall the concepts of voltage, current, power and energy for different circuit elements. Apply the Kirchhoff laws to identify the node voltages and branch currents, apply different network theorems in the complex networks.	9	3	2	1	15
CO2-98EE208.2. Understand the concept of single phase and poly phase AC circuits and construct the phasor diagrams.	11	3	3	1	18
CO3-98EE208.3. Understand the basic operating principle, types, efficiency of Transformers.	7	2	2	1	12
CO4-98EE208.4. Design and analyse the different types of digital circuits.	10	4	2	1	17
CO5-98EE208.5. Understand and analyse the various types of semiconductor devices.	9	3	2	1	15
Total Hours	46	15	11	5	72

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

Course Title: Bioreactor Engineering **Course Code:** 55MBT102

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
CO1-98EE208.1. Recall the concepts of voltage, current, power and energy for different circuit elements. Apply the Kirchhoff laws to identify the node voltages and branch currents, apply different network theorems in the complex networks.	2	1	1	1	5
CO2-98EE208.2. Understand the concept of single phase and poly phase AC circuits and construct the phasor diagrams.	2	4	5	1	12
CO3-98EE208.3. Understand the basic operating principle, types, efficiency of Transformers.	3	5	5	1	14
CO4-98EE208.4. Design and analyse the different types of digital circuits.	2	3	5	1	11
CO5-98EE208.5. Understand and analyse the various types of semiconductor devices.	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:

1. Integrated Electronics by Millman and Halkias, McGraw Hill
2. Electronics Devices and Circuits by R. Boylested and L. Nashelsky, Prentice Hall India
3. Digital Logic and Computer Design by M. M. Mano, Pearson Education India
4. Theory and Problems of Basic Electrical Engineering by D.P. Kothari and I. J. Nagrath, Prentice Hall India Learning Private Limited
5. Basic Electrical Engineering by D. C. Kulshreshtha, McGraw Hill
6. Fundamentals of Electrical Engineering by Ashfaq Hussain, Dhanpat Rai and Co

(b) 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: B. Tech. Biotechnology **Semester:** II Semester

Course Title: Basic Electrical and Electronic Engineering **Course Code:** 98EE208

Course Outcome (Cos)	**Program Outcomes (POs)**												Program Specific Outcomes (PSOs)		
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1-98EE208.1. Recall the concepts of voltage, current, power and energy for different circuit elements. Apply the Kirchhoff laws to identify the node voltages and branch currents, apply different network theorems in the complex networks.	3	3	2	2	2	1	1	1	2	2	2	2	3	2	2
CO2-98EE208.2. Understand the concept of single phase and poly phase AC circuits and construct the phasor diagrams.	3	2	2	2	2	1	1	1	2	2	2	2	3	3	2
CO3-98EE208.3. Understand the basic operating principle, types, efficiency of Transformers.	3	2	2	2	2	1	1	1	2	2	2	2	3	3	2
CO4-98EE208.4. Design and analyse the different types of digital circuits.	3	3	3	2	3	1	1	1	2	3	2	2	3	3	3
CO5-98EE208.5. Understand and analyse the various types of semiconductor devices.	3	2	2	2	2	1	1	1	2	2	2	2	3	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	**CO1-98EE208.1.** Recall the concepts of voltage, current, power and energy for different circuit elements. Apply the Kirchhoff laws to identify the node voltages and branch currents, apply different network theorems in the complex networks.	SO1.1 SO1.2 SO1.3 SO1.4	**LI 1** **LI 2** **LI 3** **LI 4**	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	**1SL-1**
PO 1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2, 3	**CO2-98EE208.2.** Understand the concept of single phase and poly phase AC circuits and construct the phasor diagrams.	SO2.1 SO2.2 SO2.3	**LI 1**	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**
PO 1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2, 3	**CO3-98EE208.3.** Understand the basic operating principle, types, efficiency of Transformers.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5	**LI 1** **LI 2** **LI 3**	3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8	**3SL-1**
PO 1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2, 3	**CO4-98EE208.4.** Design and analyse the different types of digital circuits.	SO4.1 SO4.2 SO4.3 SO4.4	**LI 1**	4.1,4.2,4.3,4.4, 4.5 4.6,4.7,4.8,4.9,4.10	**4SL-1,2**
PO 1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2, 3	**CO5-98EE208.5.** Understand and analyse the various types of semiconductor devices.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5	**LI 1** **LI 2** **LI 3** **LI 4**	5.1,5.2,5.3,5.4,5.5, 5.6 5.7,5.8,5.9,5.10	**5SL-1**

Program Name	Bachelor of Technology (B.Tech.)- Biotechnology	
Semester	II	
CourseCode:	98CA204	
Coursetitle:	Fundamentals of Computer and Programming	**Curriculum Developer**: Er. Vinay Shrivastava
Pre-requisite:	Students should have basic knowledge of computer engineering & programming.	
Rationale:	The Fundamental of Computer & Programming covers multimedia techniques, image, coloring, and digital transmission. It covers various internet and multimedia applications, enabling coding work and targeting specific audiences online. Configuration and customization are crucial for achieving desired outcomes in programming and multimedia. This subject enables effective online work and enables effective targeting strategies.	
CourseOutcomes (COs):	**CO1- 98CA204.1.** Illustrate the terminologies associated with computing and its devices. **CO2- 98CA204.2.** Explain the importance of C programming and characteristics of programming language. **CO3- 98CA204.3.** Explain the importance of conditional statements and arithmetic programming in C language. **CO4- 98CA204.4.** Explain the importance of C array and functions of programming in C language. **CO5- 98CA204.5** Acquire the basic and advances knowledge of ms-word, ms-excel, ms-powerpoint.	

Scheme of Studies:

Board of Study	CourseCode	CourseTitle	Scheme ofstudies (Hours/Week)					Total Credits(C) (L: T:P=1:1:0)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
ESC	98CA204	Fundamentals of computer & programming	2	-	1	1	4	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 Activity (CAT)	Class Attendance (AT)	Total Marks (CA+CT+CAT+SA+AT)		
PC	98CA204	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	06	00	01	02	09

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO1- 98CA204.1. Illustrate the terminologies associated with computing and its devices.	SO1.1: Understand the basic introduction to computers.		CI1.1: Lecture on the introduction and history of computers.	SL1.1: Research and present a report on the evolution of computers.
	SO1.2: Learn the characteristics of computers.		CI1.2: Discuss the characteristics and capabilities of modern computers.	

	SO1.3: Understand different types of computer memory.		CI1.3: Lecture on primary and secondary memory in computers.	
	SO1.4: Explore various types of programming languages.		CI1.4: Discuss machine languages, assembly languages, and high-level languages.	SL1.2: Study the differences between programming languages and their applications.
	SO1.5: Learn basic DOS commands.		CI1.5: Demonstrate and practice basic DOS commands.	
	SO1.6: Apply DOS commands for file and directory management.		CI1.6: Hands-on session on file and directory management using DOS commands.	

Suggested Sessional Work (SW): anyone	**SW1.1 Assignments:** Describe in detail "Applications of computer in various Sectors".

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	00	01	02	09

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO2- 98CA204.2. Explain the importance of C programming and characteristics of programming language.	SO2.1: Understand the historical development of the C programming language.		CI2.1: Lecture on the history and evolution of C programming.	SL2.1: Research the key milestones in the development of C and its impact.
	SO2.2: Identify the C character set and their usage.		CI2.2: Introduction to the C character set.	
	SO2.3: Differentiate between types of C constants and variables.		CI2.3: Discuss types of C constants and variables.	
	SO2.4: Learn C keywords, identifiers, and literals.		CI2.4: Lecture on C keywords, identifiers, and literals.	SL2.2: Create a glossary of C keywords with examples.
	SO2.5: Understand basic input and output functions in C.		CI2.5: Demonstrate usage of printf and scanf functions.	
	SO2.6: Apply various operators in C programming.		CI2.6: Lecture on arithmetic, relational, assignment, logical, increment and decrement, and conditional operators in C.	

Suggested Sessional Work (SW): anyone	**SW2.1 Assignments:** Describe C language development

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)
CO3- 98CA204.3 Explain the importance of conditional statements and arithmetic programming in C language.	SO3.1: Understand the control instructions in C.		CI3.1: Introduction to control instructions in C.	SL3.1: Research and report on different control structures in C.
	SO3.2: Implement decision control structures using if statements.		CI3.2: Lecture on if, if-else, and if-else if statements.	
	SO3.3: Utilize nested if statements for complex decision-making.		CI3.3: Examples and practice problems using nested if statements.	
	SO3.4: Understand and apply loop control structures.		CI3.4: Lecture on while, for, do-while, odd loop, and nested loop.	SL3.2: Develop small projects to practice different loop structures.
	SO3.5: Use case control structures and statements like break and continue.		CI3.5: Discussion on case control structure and break, continue statements.	
	SO3.6: Learn and apply the use of goto and exit statements.		CI3.6: Lecture on goto and exit statements with examples.	SL3.3: Write a program to demonstrate the use of goto and exit.

Suggested Sessional Work (SW): anyone	SW3.1 Assignments	Describe conditional statements

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	00	01	01	08

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO4- 98CA204.4. Explain the importance of C array and functions of programming in C language.	SO4.1: Understand the concept of arrays and their uses.		CI4.1: Introduction to arrays and their importance.	SL4.1: Research and write a report on the applications of arrays.
	SO4.2: Learn array initialization techniques.		CI4.2: Methods of initializing arrays in C.	
	SO4.3: Understand and implement 2D arrays.		CI4.3: Explanation and examples of 2D arrays.	
	SO4.4: Practice initialization of 1D and 2D arrays.		CI4.4: Hands-on session on initializing 1D and 2D arrays.	
	SO4.5: Understand the need for functions in programming.		CI4.5: Lecture on the necessity and advantages of using functions.	
	SO4.6: Learn to declare, define, and call functions in C.		CI4.6: Explanation of function declaration, definition, and calling.	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Coding array and function.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	00	01	01	8

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO5- 98CA204.5 Acquire the basic and advances knowledge of ms-word, ms-excel, ms-powerpoint.	SO5.1: Understand the basic features and functions of MS-Office.		CI5.1: Introduction to MS-Office and its components.	SL5.1: Research on the evolution of MS-Office and its impact on productivity.
	SO5.2: Learn the functionalities and applications of MS Word.		CI5.2: Overview of MS Word features and basic operations.	SL5.2: Prepare a report on the advantages of using MS Word for documentation.

	SO5.3: Master the use of menus, commands, and toolbars in MS Word.		CI5.3: Demonstration of MS Word menus, commands, and toolbars.	
	SO5.4: Perform arithmetic operations in Excel and understand its functionalities.		CI5.4: Introduction to Excel functions and basic arithmetic operations.	
	SO5.5: Develop skills in creating and formatting PowerPoint presentations.		CI5.5: Overview of PowerPoint features and presentation design.	
	SO5.6: Understand networking concepts, including types, protocols, and security.		CI5.6: Introduction to networking, protocols, and cybersecurity.	

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: 98CA204**

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instructions (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1- 98CA204.1. Illustrate the terminologies associated with computing and its devices.	6	-	2	1	9
CO2- 98CA204.2. Explain the importance of C programming and characteristics of programming language.	6	-	2	1	9
CO3- 98CA204.3. Explain the importance of conditional statements and arithmetic programming in C language.	6	-	3	1	10
CO4- 98CA204.4. Explain the importance of C array and functions of programming in C language.	6	-	1	1	8
CO5- 98CA204.5 Acquire the basic and advances knowledge of ms-word, ms-excel, ms-powerpoint.	6	-	1	1	8
Total Hours	30	00	09	05	44

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

Course Title: Fundamentals of Computer & Programming **Course Code:** 98CA204

Course Outcomes	**Marks Distribution**				**Total Marks**
	A	**An**	**E**	**C**	
CO1- 98CA204.1. Illustrate the terminologies associated with computing and its devices.	1	2	1	1	5
CO2- 98CA204.2. Explain the importance of C programming and characteristics of programming language.	1	5	4	2	12
CO3- 98CA204.3. Explain the importance of conditional statements and arithmetic programming in C language.	1	5	5	3	14
CO4- 98CA204.4. Explain the importance of C array and functions of programming in C language.	1	5	3	2	11
CO5- 98CA204.5 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

CO, PO and PSO Mapping

Program Name: B. Tech. Biotechnology **Semester:** II Semester
Course Title: Fundamentals of Computer & Programming **Course Code:** 98CA204

Course Outcome (CO)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1- 98CA204.1. Illustrate the terminologies associated with computing and its devices.	3	2	2	1	2	1	1	1	2	2	1	2	3	2	2
CO2- 98CA204.2. Explain the importance of C programming and characteristics of programming language.	3	3	2	2	2	1	1	1	2	2	2	2	3	3	2
CO3- 98CA204.3. Explain the importance of conditional statements and arithmetic programming in C language.	3	3	3	2	2	1	1	1	2	2	2	2	3	3	3
CO4- 98CA204.4. Explain the importance of C array and functions of programming in C language.	3	3	3	2	3	1	1	1	2	2	2	2	3	3	3
CO5- 98CA204.5 Acquire the basic and advances knowledge of ms-word, ms-excel, ms-powerpoint.	3	2	2	1	3	1	1	1	2	3	2	2	3	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 1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2, 3	**CO1- 98CA204.1.** 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 1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2, 3	**CO2- 98CA204.2.** 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 1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2, 3	**CO3- 98CA204.3.** 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 1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2, 3	**CO4- 98CA204.4.** 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 1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2, 3	**CO5- 98CA204.5** 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**

Suggested Learning Resources:

(a) Books:

1. Fundamentals of Computers by E. Balagurusamy
2. Fundamentals of Computers by P.K. Sinha
3. Fundamentals of Computers by V. Rajaraman
4. Let Us C by Yashwant Kanitkar

(b) Online Resources

1. Computer Basics - Computer Hope provides definitions for many computing terms.
2. TechTerms - A dictionary of computer and technology terms.
3. HowStuffWorks - Offers articles explaining computing concepts and devices.
4. Conditional Statements in C - Programiz provides tutorials on conditional statements in C.
5. Arithmetic Operations in C - Tutorialspoint explains arithmetic operations in C.
6. W3Schools C Programming - Basic to advanced C programming concepts, including conditional statements and arithmetic operations

(c) 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

Program Name	**Bachelor of Technology (B.Tech.)- Biotechnology**	
Semester	II	
CourseCode:	98MS201	
Coursetitle:	Mathematics	**Curriculum Developer**: Ms. Arpana Tripathi
Pre-requisite:	Students should have basic knowledge of calculus	
Rationale:	Modeling and Analysis: Engineers use mathematical models to represent real-world systems, whether they are designing structures, optimizing processes, or simulating physical phenomena. Mathematics is a critical aspect of engineering as it provides the tools and techniques necessary for modeling and analyzing complex systems. In engineering, mathematics is used extensively for designing and analyzing structures and machines.	
CourseOutcomes (COs):	**CO1-98BT506-A.1.** Explain the basic concept of vectors and coordinate geometry **CO2-98BT506-A.2.** Apply differentiation and integration in vector &scalar valued functions **CO3-98BT506-A.3.** Classify and solve the ordinary differential equation with constant coefficients **CO4-98BT506-A.4.** Explain the basic concept of Laplace Transforms **CO5-98BT506-A.5.** Apply Basic numerical methods for finding roots differentiation and integration.	

Scheme of Studies:

Board ofStudy	CourseCode	CourseTitle	Scheme ofstudies (Hours/Week)					Total Credits(C) (L: T:P=1:1:0)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
BSC	98MS201	Mathematics	2	0	1	2	5	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)		
BSC	98MS201	Mathematics	15	20	5	5	5	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	06	00	01	2	09

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO1-56MB205.1: Explain The Concept of Determinant and Matrix	SO1.1: Define Cramer's rule for solving simultaneous equations.		CI1.1: Lecture on the theory of Cramer's rule.	SL1.1: Write a report on solving simultaneous equations using Cramer's rule.
	SO1.2: Explain the solution methods for quadratic equations.		CI1.2: Class activity on solving quadratic equations.	
	SO1.3: Describe the properties and classification of matrices.		CI1.3: Lecture on special types of matrices and their characteristics.	
	SO1.4: Perform basic arithmetic operations on matrices.		CI1.4: Lecture on arithmetic operations involving matrices.	
	SO1.5: Compute the transpose of a matrix and understand its significance.		CI1.5: Practical session on calculating and using matrix transposes.	
	SO1.6: Find the inverse of a matrix and use it to solve simultaneous equations.		CI1.6: Demonstration of matrix inversion and solving equations.	SL1.2: Create a project on real-world applications of matrix inversion and simultaneous equations.

	SW1.1 Assignments	Describe in detail about the Determinant of the matrix

Suggested Sessional Work (SW): *anyone*	**SW1.2**Mini Project	Draw a well labelled diagram of a matrices
	SW1.3 Other Activities (Specify)	Write an article on "Latest research in the field of mathematics"

Item	Cl	LI	SW	SL	Total
Approx.Hrs	06	00	01	2	09

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO2-98BT506-A Define the role of Differentiation of standard function and Integration	SO2.1: Define limits and functions and their role in differentiation.		CI2.1: Lecture on the concept of limits and functions.	SL2.1: Write a report on the significance of limits in differentiation.
	SO2.2: Explain the definition and process of differentiation.		CI2.2: Class activity on differentiating standard functions.	
	SO2.3: Apply the chain rule to differentiate composite functions.		CI2.3: Class exercise on differentiating using the chain rule.	
	SO2.4: Perform implicit differentiation and logarithmic differentiation.		CI2.4: Discussion on practical applications of implicit differentiation.	SL2.2: Create a presentation on the use of logarithmic differentiation in solving real-world problems.
	SO2.5: Understand and apply parametric differentiation and successive differentiation.		CI2.5: Class activity on parametric and successive differentiation.	
	SO2.6: Explain integration as the inverse of differentiation		CI2.6: Lecture on integration techniques including parts,	

	and solve integrals.		substitution, and partial fractions.	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	To solve Parametric differentiation, successive differentiation substitution and partial fraction
	SW2.2 Other Activities (Specify)	Attain at least one seminar or online talk on Calculus and its applications

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	00	01	02	09

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
98BT506-A.3. Comprehend the working Equations of first order and first degree, variable separable	SO3.1: Explain the formation of differential equations.		CI3.1: Equations of first order and first degree, variable separable, homogeneous and linear differential equations.	SL3.1: Study and summarize the concepts of equations of first order and first degree.
	SO3.2: Learn the concept of linear differential equations.		CI3.2: Characteristics of equations reducible to linear differential equations.	SL3.2: Research and review homogeneous and linear differential equations.
	SO3.3: Define the working of the integral.		CI3.3: Linear differential equations of order greater than one with constant coefficients.	
	SO3.4: Learn about the complementary function in differential equations.		CI3.4: Application of linear differential equations.	

	SO3.5: Analyze linear differential equations of order greater than one.		CI3.5: Complementary function and particular integral in linear differential equations.	
	SO3.6: Understand the characteristics of variable separable equations.		CI3.6: Characteristics of variable separable equations.	

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	00	01	02	16

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO4-98BT506-A.4: Introduction transforms of elementary function, properties of linearity	SO4.1: Observe the role of linearity and shifting in Laplace Transforms.		CI4.1: Definition and transforms of elementary functions in Laplace Transforms.	SL4.1: Read and summarize information on elementary functions in Laplace Transforms.
	SO4.2: Explore common applications of inverse Laplace Transforms.		CI4.2: Define and understand the properties of linearity in Laplace Transforms.	SL4.2: Study and review the properties of transforms of elementary functions.
	SO4.3: Analyze the working and applications of Laplace Transforms.		CI4.3: Define and understand the properties of shifting in Laplace Transforms.	
	SO4.4: Recognize various applications of linearity		CI4.4: Introduction to inverse Laplace	

	and shifting in Laplace Transforms.		Transforms and their applications.	
	SO4.5: Discover the applications of transforms of elementary functions.		CI4.5: Application of transforms of elementary functions in solving differential equations.	
	SO4.6: Investigate the disadvantages of Laplace Transforms.		CI4.6: Discuss and analyze the disadvantages and limitations of Laplace Transforms.	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Write an article on "Role of transforms in elementary function"
	SW4.2 Other Activities (Specify)	Make a presentation on Non-Viral Gene therapy techniques

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	00	01	02	09

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
98BT506-A.5. To Examine Distance between two points area of triangle, a locus of points, straight line, slope	SO5.1: Introduce Analytical Plane Geometry and understand its basic concepts.		CI5.1: Introduction to Analytical Plane Geometry and basic forms (double intercept, normal, slope-point).	SL5.1: Investigate the role of Geometry in practical applications.
	SO5.2: Recognize the limitations of Geometry in real-life applications.		CI5.2: Define and understand certain coordinates and their significance in Analytical Plane Geometry.	**SL5.2:** Explore various kinds of Geometry and their limitations.

	SO5.3: Analyze principles and concepts of Geometry and their applications.		CI5.3: Calculate distance between two points and area of a triangle using Analytical Plane Geometry.	
	SO5.4: Define the concept of locus of points, straight line, slope, and intercept form.		CI5.4: Understand and apply the concepts of locus of points, straight line, and slope-intercept form.	
	SO5.5: Explore applications of straight lines and slopes in Analytical Plane Geometry.		CI5.5: Apply concepts of straight lines and slopes to solve problems in Analytical Plane Geometry.	
	SO5.6: Understand and use the two-point form and general equation of the first degree.		CI5.6: Learn about and solve problems using the two-point form and general equation of the first degree.	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Write an article on "Role of Geometry and its Properties"
	SW5.2 Other Activities (Specify)	Make a presentation on Lab-On-A-Chip technique with applications

Course duration (in hours) to attain Course Outcomes:

Course Title: Mathematics **Course Code:** 98MS201

Course Outcomes (COs)	**Class lecture (CI)**	**Laboratory Instruction (LI)**	**Sessional work (SW)**	**Self-Learning (SL)**	**Total Hours (Li+CI+SW+SL)**
CO1-98MS201**.1:** Explain Determinant and Matrix	6	0	1	2	09
CO2-98MS201**.2:** Apply differentiation and integration in vector &scalar valued functions	6	0	1	2	09
CO3-98MS201**.3:** Classify and solve the ordinary differential equation with constant coefficients	6	0	1	2	09
CO4-98MS201**.4:** Explain the basic concept of Laplace Transforms	6	0	1	2	09
CO5-98MS201**.5:** Apply Basic numerical methods for finding roots differentiation and integration	6	0	1	2	09
Total Hours	30	0	05	10	45

End Semester Assessment Scheme for Setting Up Question Paper and Assessment to Evaluate the Course Outcome

Course Title: Mathematics **Course Code:** 98MS201

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
CO1-98MS201**.1:** Explain Determinant and Matrix	2	1	1	1	5
CO2-98MS201**.2:** Apply differentiation and integration in vector &scalar valued functions	3	4	2	1	10
CO3-98MS201**.3:** Classify and solve the ordinary differential equation with constant coefficients	4	5	5	1	15
CO4-98MS201**.4:** Explain the basic concept of Laplace Transforms	3	4	3	0	10
CO5-98MS201**.5:** Apply Basic numerical methods for finding roots differentiation and integration	5	4	1	0	10
Total Marks	**17**	**18**	**12**	**03**	**50**

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

CO, PO and PSO Mapping

Program Name: B. Tech. Biotechnology **Semester:** II Semester
Course Title: Mathematics **Course Code:** 98MS201

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
CO1-98MS201**.1:** Explain Determinant and Matrix	-	-	-	1	2	2	2	-	1	2	2	3	3	3	1
CO2-98MS201**.2:** Apply differentiation and integration in vector &scalar valued functions	-	-	-	-	-	-	3	-	2	2	3	3	1	1	2
CO3-98MS201**.3:** Classify and solve the ordinary differential equation with constant coefficients	-	1	1	2	-	-	2	-	1	1	1	2	1	3	1
CO4-98MS201**.4:** Explain the basic concept of Laplace Transforms	-	1	1	-	2	2	2	2	-	1	-	-	1	2	2
CO5-98MS201**.5:** Apply Basic numerical methods for finding roots differentiation and integration	1	1	1	-	-	2	3	3	1	2	2	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 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO1-**98MS201**.1:** Explain Determinant and Matrix	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5	**LI 1**	1.1,1.2,1.3,1.4,1.5	**1SL-1,2,3,4,5**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO2-**98MS201**.2:** Apply differentiation and integration in vector &scalar valued functions	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5	**LI 1** **LI 2**	2.1, 2.2, 2.3, 2.4, 2.5	**2SL-1,2,3**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO3-**98MS201**.3:** Classify and solve the ordinary differential equation with constant coefficients	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5	**LI 1**	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-**98MS201**.4:** Explain the basic concept of Laplace Transforms	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5	**LI 1**	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-**98MS201**.5:** Apply Basic numerical methods for finding roots differentiation and integration	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5	**LI 1**	5.1,5.2,5.3,5.4,5.5	**5SL-1,2,3,4,5**

Suggested learning Resources:

(a) Books:

1. Mathematics Part I - Textbook for Class XI, NCERT Publication
2. Mathematics Part II - Textbook for Class XI, NCERT Publication
3. Analytic Geometry - Shantinarayan, HC Sinha, DK Jha, Sharma
4. Ordinary Differential Equations - Golden Series, NP Bali

5. Differential Equations - Chaurasia, V B L, Indus Valley Publications, Jaipur, 2006

(b) 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

Program Name	**Bachelor of Technology (B.Tech.)- Biotechnology**	
Semester	II	
CourseCode:	HSMC07	
Coursetitle:	Fundamentals of Indian Knowledge System	**Curriculum Developer**: Ms. Arpana Tripathi
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 spheres of life.	
Course Outcomes (COs):	**CO-HSMC07.1:** To understand the ancient civilization, Indian knowledge systems, concept of Panch Mahabhuta, origin of the name Bharat Varsha, ancient rivers, ancient universities, and ancient agriculture. **CO-HSMC07.2:** Students will be able to learn about ancient books, religious places, the basic concepts of Indian dance, music, and arts, as well as the fundamental aspects of Sangeeta and Natyashashtra. **CO-HSMC07.3:** Students will be able to gain knowledge on Vedic Science, Astronomy, Astrovastu, Vedic Mathematics, Aeronautics, Metallurgy, Nakhatras, Panchang, and Concepts of Zero, Pi, and Point. **CO-HSMC07.4:** Understanding Ancient Engineering, Science and Technology, Town Planning, Temple Architecture, Chemistry and Metallurgy, and Metal Manufacturing. **CO-HSMC07.5:** Students will be able to understand life, nature, and health through the basic concepts of Ayurveda and Yoga, Traditional Medicinal Systems, Ethnomedicine, Nature Conservation, and World Heritage Sites.	

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	
HS	HSMC07	Indian Knowledge System	2	0	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.

Assessment Scheme: 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)		
HS	HSMC07	Indian Knowledge System	15	20	5	5	5	50	50

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.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	00	01	01	08

Course Outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO-HSMC07.1: To understand the ancient civilization, Indian knowledge systems, concept of Panch Mahabhuta, origin of the name Bharat Varsha, ancient rivers, ancient universities, and ancient agriculture.	SO1.1: Understand Overview of Indian Knowledge Systems (IKS)		CI1.1: Overview of Indian Knowledge Systems (IKS)	SL1.1 Golden era of India
	SO1.2: Understand Classification of Ancient IKS texts		CI 1.2: Classification of Ancient IKS texts	
	SO1.3: Understand Introduction to Panch Mahabhutas (Earth, Water, Fire, Sky, and Air)		CI 1.3: Introduction to Panch Mahabhutas (Earth, Water, Fire, Sky, and Air)	
	SO1.4: Understand Origin of the name Bharatvarsha: the Land of Natural Endowments		CI 1.4: Origin of the name Bharatvarsha: the Land of Natural Endowments	
	SO1.5: Understand Rivers of ancient India (The Ganga, Yamuna, Godawari, Saraswati, Narmada, Sindhu, and Kaveri)		CI1.5: Rivers of ancient India (The Ganga, Yamuna, Godawari, Saraswati, Narmada, Sindhu, and Kaveri)	
	SO1.6: Understand Ancient Agriculture and ancient Universities: Takshashila and Nalanda, Gurukul system		CI 1.6: Agriculture system in ancient India, Ancient Universities: Takshashila and Nalanda, Gurukul system	

SW-1 Suggested Sessional Work (SW)	SW1.1 Assignments: Concepts of Panch Mahabhuta, Classification of ancient texts, origin of ancient rivers SW1.2 Mini Project: Ancient Universities: Takshashila and Nalanda, SW1.3 Other Activities (Specify):

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	00	01	01	08

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO-HSMC07.2: Students will be able to learn about ancient books, religious places, the basic concepts of Indian dance, music, and arts, as well as the fundamental aspects of Sangeeta and Natyashashtra	SO2.1: Understand the Ancient Indian Books: Vedas, Puranas, Shastras, Upanishads, Mahakavyas (Ramayana & Mahabharata), Smrities, Samhitas		CI2.1: Ancient Indian Books: Vedas, Puranas, Shastras, Upanishads, Mahakavyas (Ramayana & Mahabharata), Smrities, Samhitas	SL1.1Access to texts such as the Vedas, Puranas, and Upanishads.
	SO2.2: Understand the Religious Places: Puries, Dhams, Jyotiralinga, Shaktipeeths, Kumbha Mela		CI 2.2: Religious Places: Puries, Dhams, Jyotiralinga, Shaktipeeths, Kumbha Mela	
	SO2.3: Understand the Legendary Places of Madhya Pradesh: Ujjain, Chitrakoot, Omkareshwar, Bharhut, Maihar		CI 2.3: Legendary Places of Madhya Pradesh: Ujjain, Chitrakoot, Omkareshwar, Bharhut, Maihar	
	SO2.4: Understand the Basic Concept of Indian Art, Music and Dance, Indian Musical Instruments		CI 2.4: Basic Concept of Indian Art, Music and Dance, Indian Musical Instruments	
	SO2.5: Understand the Fundamental Aspects of Sangeeta and Natya Shastra		CI 2.5: Fundamental Aspects of Sangeeta and Natya Shastra	
	SO2.6: Understand the Different Schools of Music, Dance, and Painting in Different Regions of India		CI 2.6: Different Schools of Music, Dance, and Painting in Different Regions of India	

SW-2 Suggested Sessional Work (SW): anyone	**SW 2.1 Assignments:** Visit of Chitrakoot, Maihar and Bharhuta **SW 2.2 Mini Project:** Kumbhmela, Story of Ramayana and Mahabharata **SW 2.3 Other Activities (Specify):**

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	00	01	01	08

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO-HSMC07.3: Students will be able to gain knowledge on Vedic Science, Astronomy, Astrovastu, Vedic Mathematics, Aeronautics, Metallurgy, Nakhatras, Panchang, and Concepts of Zero, Pi, and Point.	SO3.1: Understand Vedic Cosmology		CI 3.1: Vedic Cosmology	SL 3.1 Vedic Astronomy and Mathematics - The Historical Development
	SO3.2: Understand Astronomy, Astrovastu, Vedang Jyotish, Nakshatras, Navagraha, Rashis, Vastushastra and their related plants		CI 3.2: Astronomy, Astrovastu, Vedang Jyotish, Nakshatras, Navagraha, Rashis, Vastushastra and their related plants	
	SO3.3: Understand Time and Calendar, Panchang		CI 3.3: Time and Calendar, Panchang	
	SO3.4: Understand the Concept of Zero, Point, Pi -number system, Pythagoras		CI 3.4: Concept of Zero, Point, Pi -number system, Pythagoras	
	SO3.5: Understand Vedic Mathematics, Vimana-Aeronautics, Basic idea of planetary model of Aryabhatta		CI 3.5: Vedic Mathematics, Vimana-Aeronautics, Basic idea of planetary model of Aryabhatta	
	SO3.6: Understand the Varanamala of Hindi language based on classification of sounds on the basis of their origin, Basic purpose of science of Vyakarana		CI 3.6: Varanamala of Hindi language based on classification of sounds based on their origin, Basic purpose of science of Vyakarana	

SW-3 Suggested Sessional Work (SW)	**SW3.1 Assignments:** Varanamala of Hindi language based on classification of sounds based on their origin **SW3.2 Mini Project:** Nakshatras, Navagraha and their related plants **SW3.3 Other Activities (Specify):**

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	00	01	01	08

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO-HSMC07.4: Understanding Ancient Engineering, Science and Technology, Town Planning, Temple Architecture, Chemistry and Metallurgy, and Metal Manufacturing.	SO 4.1: Understand the Engineering Science and Technology in Vedic and Post-Vedic Era		**CI** 4.1: Engineering Science and Technology in Vedic and Post-Vedic Era	SL3.1Temple Architecture of India
	SO 4.2: Understand Town and Home Planning, Sthapatyaveda		**CI** 4.2: Town and Home Planning, Sthapatyaveda	
	SO 4.3: Understand Chemistry and Metallurgy as gleaned from Archaeological Artifacts		**CI** 4.3: Chemistry and Metallurgy as gleaned from Archaeological Artifacts	
	SO 4.4: Understand the Chemistry of Dyes, Pigments used in Paintings, Fabrics, Potteries, and Glass		**CI** 4.4: Chemistry of Dyes, Pigments used in Paintings, Fabrics, Potteries, and Glass	
	SO 4.5: Understand Temple Architecture: Khajuraho, Sanchi Stupa, Chonsath Yogini Temple		**CI** 4.5: Temple Architecture: Khajuraho, Sanchi Stupa, Chonsath Yogini Temple	
	SO 4.6: Understand Mining and Manufacture in India of Iron, Copper, Gold from Ancient Times		**CI** 4.6: Mining and Manufacture in India of Iron, Copper, Gold from Ancient Times	

SW-4 Suggested Sessional Work (SW)	**SW 4.1 Assignments:** Varanamala of Hindi language based on classification of sounds based on their origin **SW4.2 Mini Project:** Nakshatras, Navagraha and their related plants **SW 4.3 Other Activities (Specify):**

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	00	01	01	08

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO-HSMC07.5: Students will be able to understand life, nature, and health through the basic concepts of Ayurveda and Yoga, Traditional Medicinal Systems, Ethnomedicine, Nature Conservation, and World Heritage Sites.	SO 5.1: Understand the Fundamentals of Ayurveda (Charaka & Shushruta) and Yogic Science (Patanjali), Ritucharya and Dinacharya		CI 5.1: Fundamentals of Ayurveda (Charaka & Shushruta) and Yogic Science (Patanjali), Ritucharya and Dinacharya	**SL5.1** Ethnobotany and Ethnomedicine of India
	SO 5.2: Understand the Traditional System of Indian Medicines (Ayurveda, Siddha, Unani, and Homoeopathy)		CI 5.2: Traditional System of Indian Medicines (Ayurveda, Siddha, Unani, and Homoeopathy)	
	SO 5.3: Understand Fundamentals of Ethnobotany and Ethnomedicines of India		CI 5.3: Fundamentals of Ethnobotany and Ethnomedicines of India	
	SO 5.4: Understand Nature Conservation in Indian Ancient Texts		CI 5.4: Nature Conservation in Indian Ancient Texts	
	SO 5.5: Understand the Introduction to Plant Science in Vrikshayurveda		CI 5.5: Introduction to Plant Science in Vrikshayurveda	
	SO 5.6: Understand the World Heritage Sites of Madhya Pradesh: Bhimbetka, Sanchi, Khajuraho		CI 5.6: World Heritage Sites of Madhya Pradesh: Bhimbetka, Sanchi, Khajuraho	

SW-5 Suggested Sessional Work (SW):	**SW 5.1 Assignments:** Visit to world Heritage Site Khajuraho **SW 5.2 Mini Project:** Ritucharya and Dincharya, Ethnomedicinal plants **SW 5.3 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)
HSMC07. 1: To understand Indian Civilization and Indian Knowledge Systems	6	1	1	8
HSMC07. 2: Students will have the ability to apply the knowledge gained about Indian Art, Literature and Religious Places	6	1	1	8
HSMC07. 3: Student will be able to understand the Ancient Science, Astronomy and Vedic Mathematics	6	1	1	8
HSMC07. 4: Understand the Engineering, Technology and Architecture	6	1	1	8
HSMC07. 5: Understand about the Life, Nature and Health	6	1	1	8
Total	30	5	5	40

Suggestion for End Semester Assessment

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
CO1-98MS201**.1:** Indian Civilization and Indian Knowledge Systems	2	1	1	1	5
CO2-98MS201**.2:** Indian Art, Literature and Religious Places	3	4	2	1	10
CO3-98MS201**.3:** Ancient Science, Astronomy and Vedic Mathematics	4	5	5	1	15
CO4-98MS201**.4:** Engineering, Technology and Architecture	3	4	3	0	10
CO5-98MS201**.5:** Life, Nature and Health	5	4	1	0	10
Total Marks	**17**	**18**	**12**	**03**	**50**

Legend: A, apply; An, Analyze, E-Evaluate, C, Create

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.

COs, POs and PSOs Mapping

Programme Title: B.Tech-Biotechnology **Semester:** II
Course Title: Fundamentals of Indian Knowledge System **Course Code:** HSMC07

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
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.	-	-	-	1	2	2	2	-	1	2	2	3	3	3	1
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.	-	-	-	-	-	-	3	-	2	2	3	3	1	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.	-	1	1	2	-	-	2	-	1	1	1	2	1	3	1
CO- 4: Understanding on ancient Engineering, Science and Technology, Town Planning, Temple architecture,	-	1	1	-	2	2	2	2	-	1	-	-	1	2	2

Chemistry and Metallurgy, Metal manufacturing etc.															
CO- 5: Student will able to understand about the Life, Nature and Health through basic concept of Ayurveda and Yoga, Traditional Medicinal Systems, Ethnomedicine, Nature conservation, World Heritage Sites etc.	1	1	1	-	-	2	3	3	1	2	2	2	1	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.	SO1.1SO1.2SO1. 3SO1.4 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.	SO2.1SO2.2SO2. 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.	SO3.1SO3.2 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.	SO4.1SO4.2SO4. 3SO4.4 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.	SO5.1SO5.2SO5. 3SO5.4, SO5.5		Unit 5: **Life, Nature and Health** 5.1,5.2,5.3,5.4,5.5,5.6	

Suggested Learning Resources:

(a) Books:

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 - Createpace Independent Publishing, 2014
4. A History of Agriculture in India - Randhava, M.S. - ICAR, New Delhi, 1980
5. Panch Mahabhuta - Yogcharya, Jnan Dev - Yog Satsang Ashram, 2021
6. The Indian Rivers - Singh, Dhruv Sen - Springer, 2018
7. The Wonder That Was India - Basam, Arthur Llewellyn - 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

(b) 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

Curriculum Development Team:

1. Er. Anant Kumar Soni, Hon'ble Pro-Chancellor and Chairman, AKS University, Satna (M.P.).
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12. Shri Vivek Shrivastava, Examination, AKS University, Satna (M.P.).
13. Shri Manish Agrawal, Department of Mining, AKS University, Satna (M.P.).

B. Tech. Biotechnology 3rd Semester

Program Name	B.Tech. Biotechnology	
Semester	**III**	
Course Code:	**98BT302**	
Course title:	**Principles of Microbiology**	**Curriculum Developer**: Mr. Vivek Kumar Agnihotri, Assistant Professor
Pre-requisite:	To understand and work effectively in microbiology, especially when preparing consortia as you described, it's important to have a strong foundation in the basics of microbiology.	
Rationale:	Understanding the principle of microbiology revolves around microorganisms, their functions, and their roles in various environments, including their interactions with humans, animals, plants, and the ecosystem. The rationale for studying microbiology is multi-faceted, encompassing scientific, medical, environmental, and industrial perspectives.	
Course Outcomes (COs):	**CO1.** Understand the different fields in microbiology. **CO2.** Understand the growth and control of microbes as well as different bacteriological techniques involved in microbiology. **CO3.** Acknowledged about the different types of microorganisms and their significance. **CO4.** How to interact microorganisms with higher organisms. **CO5.** Identify novel microbes by using standard operating procedures used in microbiology.	

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)**	
BSC	**98BT302**	**Principles of Microbiology**	4	0	0	0	4	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 Attendance (AT)	Total Marks (CA+CT+SA+AT)		
Program Elective (PE)	**98BT302**	Principles of Microbiology		20	5	5	5	50	50

Course-Curriculum:

<table>
<tr>
<td>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.</td>
<td>Approximate Hours
<table>
<tr><td>Item</td><td>Cl</td><td>LI</td><td>SW</td><td>SL</td><td>Total</td></tr>
<tr><td>Approx. Hrs</td><td>09</td><td>04</td><td>01</td><td>04</td><td>18</td></tr>
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Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO1: Understand the different fields in microbiology.	**SO1.1** Know about the Microbial World	**LI1.1** Learn how to handle pathogens	**CI1.1** Introduction to the microbial world	**SL1.1** Remember Carriers in Disease Transmission
	SO1.2 Learn about the History of Microorganisms	**LI1.2** Practice historical resume techniques	**CI1.2** Historical Resume	**SL1.2** Explore the microflora of the university
	SO1.3 Know about the life of Microbes	**LI1.3** Prepare and observe microbial samples	**CI1.3** Microbial life	**SL1.3** Investigate microbial life in local environments
	SO1.4 Know about Prokaryotic & Eukaryotic Microorganisms		**CI1.4** Prokaryotes & Eukaryotes	**SL1.4** Compare prokaryotic and eukaryotic microorganisms
	SO1.5 Learn about the Archea & Protozoa		**CI1.5** Archea & Protozoa	
	SO1.6 Learning of classification of microorganisms		**CI1.6** Classification of microorganisms	
	SO1.7 Know about the Microbial Cell Structure		**CI1.7** Structure of microbial cell	
	SO1.8 Know about the cyanobacteria		**CI1.8** Characteristics of cyanobacteria	
	SO1.9 Know about the actinomycetes		**CI1.9** Characteristics of actinomycetes	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Summarizes classification of microorganism- Bacteria.
	SW1.2 Mini Project	Demonstrate how to isolate microbes from soil.
	SW1.3 Other Activities (Specify)	

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	04	01	02	16

Course Outcome (CO)	Session Outcomes (SOs)	LaboratoryInstruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO2: Understand the growth and control of microbes as well as different bacteriological techniques involved in microbiology.	SO2.1 Understand the basic principles of light microscopy	LI2.1 Prepare sample for light microscopy	CI2.1 Light microscope: basic principles	SL2.1 Create a chart of the parts of a light microscope
	SO2.2 Learn about phase contrast microscopy		CI2.2 Types of phase contrast microscopy	SL2.2 Draw a diagram of phase contrast microscopy
	SO2.3 Learn about dark field microscopy		CI2.3 Basic principles of dark field microscopy	
	SO2.4 Learn about fluorescent microscopy		CI2.4 Basic principles and types of fluorescent microscopy	
	SO2.5 Understand the principles of electron microscopy	LI2.2 Prepare sample for electron microscopy	CI2.5 Principles of electron microscope	
	SO2.6 Learn about the working and function of electron microscopy		CI2.6 Working and function of electron microscope	
	SO2.7 Know about electron probe microscopy		CI2.7 Electron probe microscopy	
	SO2.8 Understand the types of electron microscopy (TEM, SEM, STEM)		CI2.8 Types of electron microscopy: TEM, SEM, STEM	
	SO2.9 Learn about sample preparation for electron microscopy	LI2.3 Sample preparation for EM analysis	CI2.9 Sample preparation for EM analysis	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Justify the role of SEM and TEM in biotechnology.
	SW2.2 Mini Project	Differentiate between SEM and TEM.
	SW2.3 Other Activities (Specify)	Incorporate some YouTube videos based on features of how TEM works.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	04	1	3	**17**

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO3: Acknowledged about the different types of microorganisms and their significance.	SO3.1 Understand the mathematical expression of microbial growth	LI3.1 Calculate microbial growth rates	CI3.1 Mathematical expression of microbial growth	SL3.1 Review and summarize mathematical models of microbial growth
	SO3.2 Learn to interpret growth curves		CI3.2 Growth curve: phases and characteristics	SL3.2 Plot and analyze a growth curve from experimental data
	SO3.3 Measure microbial growth accurately		CI3.3 Methods for measuring microbial growth	
	SO3.4 Understand synchronous culture techniques		CI3.4 Synchronous culture: principles and applications	
	SO3.5 Learn about continuous culture systems		CI3.5 Continuous culture: concepts and methods	
	SO3.6 Understand the cultivation of microorganisms	LI3.2 Practice cultivation techniques	CI3.6 Cultivation of microorganisms: methods and conditions	
	SO3.7 Learn about sterilization techniques		CI3.7 Sterilization methods and their applications	
	SO3.8 Understand biosafety in microbial work		CI3.8 Biosafety guidelines and practices	
	SO3.9 Learn about pure culture techniques		CI3.9 Pure culture techniques and isolation methods	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Write about Sterilization Techniques.
	SW3.2 Mini Project	

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	04	01	03	17

	SW3.3 Other Activities (Specify)	Know about Biosafety Levels.

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO4: How to interact microorganisms with higher organisms.	SO4.1 Identify different types of pathogens	LI4.1 Identification of pathogens in clinical samples	CI4.1 Types of pathogens and their characteristics	SL4.1 Research and summarize case studies of specific pathogens
	SO4.2 Understand the sources of infection, including carriers and vectors		CI4.2 Sources of infection: carriers and vectors	SL4.2 Explore local carriers and vectors of infectious diseases
	SO4.3 Learn about congenital infections		CI4.3 Congenital infections: causes and effects	
	SO4.4 Understand modes and sources of infection		CI4.4 Modes of infection and sources	
	SO4.5 Study pathogenesis of bacterial infections		CI4.5 Pathogenesis of bacterial infections	
	SO4.6 Study pathogenesis of fungal infections		CI4.6 Pathogenesis of fungal infections	
	SO4.7 Study pathogenesis of viral infections		CI4.7 Pathogenesis of viral infections	
	SO4.8 Study pathogenesis of protozoan infections		CI4.8 Pathogenesis of protozoan infections	
	SO4.9 Learn about prophylaxis and preventive measures	LI4.2 Techniques for testing antimicrobial efficacy	CI4.9 Prophylaxis and preventive measures for infections	

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	04	01	03	17

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Write about the Morphology and Pathogenesis of Herpes Virus.
	SW4.2 Mini Project	
	SW4.3 Other Activities (Specify)	Search and learn via YouTube how to take Preventive Measures and Chemotherapy for the Papova Virus.

Course Outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO5: Identify novel microbes by using standard operating procedures used in microbiology.	SO5.1 Understand methods to assess microbial diversity	LI5.1 Use methods to assess microbial diversity	CI5.1 Methods for assessing microbial diversity	SL5.1 Research and summarize various methods of assessing microbial diversity
	SO5.2 Learn about culture-dependent methods and their merits and demerits		CI5.2 Culture-dependent methods: merits and demerits	SL5.2 Compare culture-dependent and culture-independent methods in microbial studies
	SO5.3 Learn about culture-independent methods and their merits and demerits		CI5.3 Culture-independent methods: merits and demerits	
	SO5.4 Understand molecular analysis techniques for bacterial communities	LI5.2 Perform molecular analysis of bacterial communities	CI5.4 Molecular analysis techniques: density gradient, gel electrophoresis	
	SO5.5 Study density gradient centrifugation for bacterial analysis		CI5.5 Density gradient centrifugation: principles and applications	

	SO5.6 Learn about gel electrophoresis for bacterial community analysis		CI5.6 Gel electrophoresis: techniques and interpretation	
	SO5.7 Understand Restriction Fragment Length Polymorphism (RFLP)		CI5.7 RFLP: principles and applications	
	SO5.8 Learn about 16S rRNA gene analysis for microbial diversity		CI5.8 16S rRNA gene analysis: methods and significance	
	SO5.9 Compare and contrast molecular techniques for bacterial community analysis		CI5.9 Comparison of molecular techniques for bacterial analysis	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Write about the Microbial Diversity
	SW5.2 Mini Project	
	SW5.3 Other Activities (Specify)	Try to learn about 16s RNA Sequencing.

Course duration (in hours) to attain Course Outcomes:

Course Title: Principles of Microbiology **Course Code:** 98BT302

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1. Understand the different fields in microbiology.	09	04	04	01	18
CO2. Understand the growth and control of microbes as well as different bacteriological techniques involved in microbiology.	09	04	02	01	16

CO3. Acknowledged about the different types of microorganisms and their significance.	09	04	03	01	17
CO4. How to interact microorganisms with higher organisms.	09	04	03	01	17
CO5. Identify novel microbes by using standard operating procedures used in microbiology	09	04	03	01	17
Total Hours	45	20	15	05	85

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

Course Title: Principles of Microbiology **Course Code:** 98BT302

Course Outcomes	**Marks Distribution**				**Total Marks**
	U	**A**	**An**	**E**	
CO1. Understand the different fields in microbiology.	02	03	04	1	10
CO2. Understand the growth and control of microbes as well as different bacteriological techniques involved in microbiology.	03	04	02	1	10
CO3. Acknowledged about the different types of microorganisms and their significance.	02	05	02	1	10
CO4. How to interact microorganisms with higher organisms.	02	05	02	1	10
CO5. Identify novel microbes by using standard operating procedures used in microbiology	03	03	03	1	10
Total Marks	12	20	13	05	50

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

Suggested learning Resources:

(a) Books:

List of Books	
1	Textbook of Microbiology, R.C. Dubey and D. K. Maheshwari, S. Chand Publications, 5 & 2022
2	Microbiology, M.J. Pelczar, E.C.S Chan and N.R. Kreig, McGraw Hill, 5 & 2002
3	General Microbiology, R. Y. Stanier, E. A. Adelberg, J. L. Ingraham, Mac Millan Press, 1 & 2014
4	General Microbiology, Hans G. Schlegel, Cambridge University Press, 7 & 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 Microbiology lab
7. Demonstration
8. ICT Based teaching Learning
9. Brainstorming

CO, PO, and PSO Mapping

Program Name: B.Tech. Biotechnology **Semester:** III[rd] Sem

Course Title: Principles of Microbiology **Course Code:** 98BT302

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 different fields in microbiology.	1	-	-	1	2	2	1	-	1	2	2	3	3	3	1
CO2. Understand the growth and control of microbes as well as different bacteriological techniques involved in microbiology.	1	-	2	-	-	-	3	2	2	2	3	3	1	1	2
CO3. Acknowledged about the different types of microorganisms and their significance.	1	1	1	1	1	-	2	-	3	1	1	2	1	1	1
CO4. How to interact microorganisms with higher organisms.	-	1	1	-	2	2	2	3	-	1	-	-	1	2	3
CO5. Identify novel microbes by using standard operating procedures used in microbiology	1	1	1	-	-	2	3	3	1	2	2	2	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 4, 5, 6, 7, 9, 10, 11, 12 PSO 1,2, 3	**CO1**. Understand the different fields in microbiology.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6	IL 1 IL 2	1.1,1.2,1.3,1.4,1.5,1.6	1SL-1,2
PO 7,9,10,11,12 PSO 1,2, 3	**CO2.** Understand the growth and control of microbes as well as different bacteriological techniques involved in microbiology.	SO2.1 SO2.2 SO2.3 SO2.4	IL 1 IL 2	2.1, 2.2, 2.3, 2.4	2SL-1,2
PO 2,3,4, 7,9,10,11,12 PSO 1,2, 3	**CO3.** Acknowledged about the different types of microorganisms and their significance.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6	IL 1 IL 2	3.1,3.2,3.3,3.4,3.5	3SL-1,2
PO 2,3,5,6 7,8,10,11,12 PSO 1,2, 3	**CO4.** How to interact microorganisms with higher organisms.	SO4.1 SO4.2 SO4.3 SO4.4, SO 4.5, SO4.6	IL 1 IL 2	4.1,4.2,4.3,4.4,4.5,4.6	4SL-1,2
PO 1,2,3,6 7,8,9,10,11,12 PSO 1, 3	**CO5.** Identify novel microbes by using standard operating procedures used in microbiology	SO5.1 SO5.2 SO5.3 SO5.4, SO5.5	IL 1 IL 2	5.1,5.2,5.3,5.4,5.5	5SL-1

Program Name	**Bachelor of Technology (B Tech) -Biotechnology**	
Semester	III Semester	
Course Code:	98BT304	
Course title:	Biophysical Tools and Techniques	**Curriculum Developer**: Dr. Deepak Mishra, Professor
Pre-requisite:	Student should have basic knowledge of Biotechnology, Biochemistry and Laboratory skills.	
Rationale:	The Bio physical tools and techniques course for B Tech Biotechnology students is integral for equipping them with essential skills in utilizing advanced instruments crucial for biotechnological research. It focuses on bridging biological principles with physical and chemical methodologies, enabling comprehensive study of biomolecules, cellular processes, and environmental interactions. Practical training with instruments such as spectrophotometers, chromatographs, and microscopes enhances students' proficiency in experimental design, data analysis, and interpretation. This hands-on experience not only prepares them for academic research but also for careers in biotechnology, pharmaceuticals, and healthcare industries where such skills are in high demand. Moreover, the course emphasizes ethical considerations in research, ensuring responsible and effective use of bio physical tools. By fostering critical thinking and problem-solving abilities, it cultivates innovation and prepares students to tackle complex challenges in biotechnological applications. Ultimately, the course aims to empower B Tech Biotechnology students with the knowledge and practical expertise needed to contribute meaningfully to advancements in biological sciences and related fields.	
Course Outcomes (COs):	**CO1-98BT304.1:** Familiarization with the basic concept’s good laboratory practices, Quality Management and basic instrumentation. **CO2-98BT304.2:** Acquired knowledge and technical Skills of advanced molecular biology Techniques. **CO3-98BT304.3:** Equipped to comprehend the fundamentals of Chromatography Techniques and its application. **CO4-98BT304.4:** Recognize various methods related to Electrophoresis and its applications. **CO5-98BT304.5:** Explore role of centrifugation and physical methods of imaging of biological molecules.	

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)	
Program Common (PC)	98BT304	Biophysical Tools and Techniques	3	2	1	3	09	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 must 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)	Activity	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)		
PC	98BT304	Biophysical Tools and Techniques	**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	09	04	01	03	17

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO1-98BT304.1: Familiarization with the basic concept's good laboratory practices, Quality Management and basic instrumentation	SO1.1 Understand the concept of Good Laboratory Practice (GLP)	Li1.1 Demonstrate proper lab notebook documentation practices	CI1.1 Lecture on principles of GLP and its importance in research	SL1.1 Read a chapter on GLP from a designated textbook
	SO1.2 Comprehend quality management in a laboratory setting	Li1.2 Conduct a mock audit of laboratory procedures	CI1.2 Discuss quality control and quality assurance processes in labs	SL1.2 Watch a video on quality management systems
	SO 1.3 Describe the steps involved in analysis		CI 1.3 Outline the steps of qualitative and quantitative analysis	SL1.3 Write a report summarizing an analysis method of choice
	SO1.4 Differentiate between qualitative and quantitative analysis		CI 1.4 Compare and contrast qualitative vs. quantitative analysis in class	
	SO 1.5 Explain biosafety guidelines and handling problems in the lab		CI 1.5 Review biosafety levels and guidelines in biotechnology	
	SO 1.6 Understand the working principle and instrumentation of common biotech lab instruments		CI 1.6 Overview of the principles and uses of key lab instruments	
	SO 1.7 Prepare different types of solutions		CI 1.7 Explain the process of making standard solutions and buffers	

	SO 1.8 Conduct different types of titrations		CI 1.8 Detailed lecture on titration techniques and calculations	
	SO 1.9 Describe the principles of osmosis and diffusion		CI 1.9 Teach the concepts of osmosis and diffusion with examples	

Suggested Sessional Work (SW):*anyone*	**SW1.1** Assignments	Describe in detail about instruments used in biotechnology lab.
	SW1.2 Mini Project	Prepare list of articles used in your lab and classify them
	SW1.3 Other Activities (Specify)	Preparation of GLP manual for biotechnology laboratory.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	04	01	03	17

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO2-98BT304.2: Acquired knowledge and technical Skills of advanced molecular biology Techniques.	2.1 Understand the principles of DNA isolation	2.1 Perform DNA extraction from plant tissue	2.1 Lecture on the basic principles of DNA isolation	2.1 Read research papers on DNA isolation methods
	2.2 Comprehend the principles of RNA isolation	2.2 Isolate RNA from cultured cells	2.2 Discuss the methodologies of RNA extraction and purification	2.2 Study protocols for RNA isolation from various sources
	2.3 Explain the process of protein isolation		2.3 Overview of protein extraction techniques	2.3 Review articles on protein isolation methods
	2.4 Describe the technique of DNA fingerprinting		2.4 Lecture on DNA fingerprinting and its applications	
	2.5 Understand DNA footprinting methodology		2.5 Explain DNA footprinting and its role in molecular biology	
	2.6 Comprehend the concept of DNA imprinting		2.6 Discuss the principles of DNA imprinting and its biological significance	
	2.7 Understand the use of DNA microarray technology		2.7 Teach the working principle and applications of DNA microarrays	

	2.8 Explain the process of DNA sequencing		2.8 Discuss the various DNA sequencing technologies and their applications	
	2.9 Describe Southern, Northern, and Western blotting techniques		2.9 Detailed lecture on Northern and Western blotting techniques	

Suggested Sessional Work (SW):*anyone*	**SW2.1** Assignments	Assess the role of different blotting techniques
	SW2.2 Mini Project	Designing of poster for molecular biology techniques
	SW2.3 Other Activities (Specify)	To demonstration of protocols for molecular biology techniques.

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)**
CO3-98BT304.3: Equipped to comprehend the fundamentals of Chromatography Techniques and its applications.	**SO3.1** Explain the concept of chromatography	**LI3.1** Perform paper chromatography	**CI3.1** Separation and identification of material: concept of chromatography	**SL3.1** Collection of books and study materials for study chromatography
	SO3.2 Assessing the principle of chromatography		**CI3.2** principle of chromatography	**SL3.2** Study different factors affecting chromatography
	SO3.3 Explaining concept of paper chromatography	**LI3.2** Perform thin layer chromatography	**CI3.3** paper chromatography	**SL3.3** categorization of different types of chromatography
	SO3.4 Assessing thin layer chromatography		**CI3.4** thin layer chromatography	
	SO3.5 Describe about		**CI3.5** Column	**SL3.4** Study of role of

	column chromatography		chromatography	chromatography for separation
	SO3.6 Assessing the concept of adsorption chromatography		**CI3.6** adsorption chromatography	**SL3.5** Assess application of chromatography
	SO3.7 Describe about gas liquid chromatography		**CI3.7** gas liquid chromatography	
	SO3.8 Describe about affinity chromatography		**CI3.8** affinity chromatography	
	SO3.9 Describe about gel permeation chromatography		**CI3.9** gel permeation chromatography	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Describe in detail about different types of chromatography.
	SW3.2 Mini Project	Describe the role of different chromatography techniques
	SW3.3 Other Activities (Specify)	Standardization of protocol for chromatography.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	09	04	01	05	20

Course Outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO4-98BT304.4: Recognize various methods related to Electrophoresis and its applications.	4.1 Understand the concept and basic principle of electrophoresis	4.1 Perform a basic gel electrophoresis experiment	4.1 Lecture on the concept and principle of electrophoresis	4.1 Read research articles on the history and development of electrophoresis
	4.2 Identify factors affecting electrophoretic mobility	4.2 Test the effects of different buffer pH levels on electrophoretic mobility	4.2 Discuss factors affecting electrophoretic mobility (pH, voltage, etc.)	4.2 Study case studies on troubleshooting electrophoresis experiments
	4.3 Explain free electrophoresis		4.3 Lecture on the principles and applications of free electrophoresis	4.3 Review protocols and papers on free electrophoresis
	4.4 Describe moving boundary electrophoresis		4.4 Detailed lecture on moving boundary electrophoresis	4.4 Watch a video tutorial on moving boundary

				electrophoresis
	4.5 Understand zone electrophoresis		4.5 Discuss the principles and applications of zone electrophoresis	4.5 Write a report on zone electrophoresis methods
	4.6 Comprehend paper electrophoresis		4.6 Lecture on paper electrophoresis and its historical significance	
	4.7 Explain gel electrophoresis		4.7 Overview of gel electrophoresis techniques and applications	
	4.8 Understand capillary electrophoresis		4.8 Teach the working principle and applications of capillary electrophoresis	
	4.9 Describe immunoelectrophoresis and isoelectric focusing		4.9 Lecture on immunoelectrophoresis and isoelectric focusing	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Explain general characteristics and silent features of centrifugation
	SW4.2 Mini Project	Describe the role of physical methods of imaging biological molecules.
	SW4.3 Other Activities (Specify)	Standardization of protocol of centrifugation used for biological research.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	04	01	05	19

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO4-98BT304.4: Recognize various methods related to Electrophoresis and its applications.	5.1 Understand the basic principle of sedimentation	5.1 Demonstrate sedimentation using a simple centrifuge	5.1 Lecture on the basic principles of sedimentation	5.1 Read research articles on sedimentation in biological systems
	5.2 Identify factors affecting sedimentation	5.2 Investigate the effects of particle size on sedimentation rate	5.2 Discuss factors affecting sedimentation (particle size, density, etc.)	5.2 Study case studies on sedimentation analysis in different materials
	5.3 Explain the use of ultracentrifuge		5.3 Lecture on the principles and applications of ultracentrifugation	5.3 Review protocols for ultracentrifugation experiments
	5.4 Understand the role of analytical centrifuge		5.4 Detailed lecture on analytical centrifugation	5.4 Watch a video tutorial on analytical centrifugation techniques
	5.5 Describe differential centrifugation		5.5 Discuss the principles and steps of differential centrifugation	5.5 Write a report on the applications of differential centrifugation
	5.6 Comprehend density gradient centrifugation		5.6 Lecture on the methodology and applications of density gradient centrifugation	
	5.7 Explain physical methods of imaging intact biological structures		5.7 Overview of X-ray imaging and its applications	
	5.8 Understand the principles of CAT-Scan		5.8 Lecture on the principles and applications of CAT-Scan	
	5.9 Describe the uses of ECG and EEG		5.9 Discuss the working principles and uses of ECG and EEG	

	SW5.1 Assignments	Understanding the Basic Principles and Factors Affecting Sedimentation

Suggested Sessional Work (SW): *anyone*	**SW5.2** Mini Project	To explore physical methods of imaging intact biological structures using X-ray, CAT-Scan, ECG, and EEG.
	SW5.3 Other Activities (Specify)	To understand the operation and applications of ultracentrifuges and analytical centrifuges.

Course duration (in hours) to attain Course Outcomes:

Course Title: Biophysical Tools and Techniques **Course Code:**98BT304

Course Outcomes(COs)	**Class lecture (CI)**	**Laboratory Instruction(LI)**	**Self-Learning (SL)**	**Sessional work (SW)**	**Total Hours (Li+CI+SL+SW)**
CO1-98BT304.1: Familiarization with the basic concepts good laboratory practices, Quality Management and basic instrumentation.	9	4	3	1	17
CO2-98BT304.2: Acquired knowledge and technical Skills of advanced molecular biology Techniques.	9	4	3	1	17
CO3-98BT304.3: Equipped to comprehend the fundamentals of Chromatography Techniques and its application.	9	4	5	1	19
CO4-98BT304.4: Recognize various methods related to Electrophoresis and its applications.	9	4	5	1	19
CO5-98BT304.5: Explore role of centrifugation and physical methods of imaging of biological molecules.	9	4	5	1	19
Total Hours	45	20	21	05	91

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Explain about different factors affecting electrophoresis and its performance.
	SW4.2 Mini Project	Compare different protocols of gel electrophoresis.
	SW4.3 Other Activities (Specify)	Prepare one article on application of electrophoresis for biological research.

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

Course Title: Biophysical Tools and Techniques **Course Code:** 98BT304

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
CO1-98BT304.1: Familiarization with the basic concepts good laboratory practices, Quality Management and basic instrumentation.	2	1	1	1	5
CO2-98BT304.2: Acquired knowledge and technical Skills of advanced molecular biology Techniques.	2	3	2	2	9
CO3-98BT304.3: Equipped to comprehend the fundamentals of Chromatography Techniques and its application.	2	4	3	2	11
CO4-98BT304.4: Recognize various methods related to Electrophoresis and its applications.	3	4	4	2	13
CO5-98BT304.5: Explore role of centrifugation and physical methods of imaging of biological molecules.	5	4	2	1	12
Total Marks	**14**	**16**	**12**	**08**	**50**

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

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1	Biochemical Calculations by Irwin H. Segel, John Wiley & Sons (2nd Edition), 1975
2	Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker
3	Principles of Physical Biochemistry, K.E. Van Holde, Prentice Hall.
4	Principles and Practice of Bioanalysis, Richard F. Venn
5	Biochemical Calculations by Irwin H. Segel

(b) Online Resources:

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.Tech.. Biotechnology **Semester:** III Semester

Course Title: Biophysical Tools and Techniques **Course Code:** 52BT208

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
CO1-98BT304.1: Familiarization with the basic concepts good laboratory practices, Quality Management and basic instrumentation.	1	2	3	2	2	2	3	2	2	1	2	3	2	2	3
CO2-98BT304.2: Acquired knowledge and technical Skills of advanced molecular biology Techniques.	1	2	2	1	2	3	3	2	1	2	2	2	2	3	3
CO3-98BT304.3: Equipped to comprehend the fundamentals of Chromatography Techniques and its application.	1	2	2	2	1	2	3	1	2	1	2	2	1	2	3
CO4-98BT304.4: Recognize various methods related to Electrophoresis and its applications.	1	1	3	1	1	2	3	1	2	2	1	3	1	2	3
CO5-98BT304.5: Explore role of centrifugation and physical methods of imaging of biological molecules.	1	2	3	1	1	2	2	1	1	2	2	3	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, 6, 7,8,9,10,11, 12 PSO 1,2,3	**CO1-98BT304.1:** Familiarization with the basic concepts good laboratory practices, Quality Management and basic instrumentation.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10	1.1,1.2	1.1,1.2,1.3,1.4,1.5, 1.6, 1.7, 1.8, 1.9,1.10	1SL-1,2,3
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	**CO2-98BT304.2:** Acquired knowledge and technical Skills of advanced molecular biology Techniques.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9 SO2.10	2.1, 2.2	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8,2.9,2.10	2SL-1,2,3
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	**CO3-98BT304.3:** Equipped to comprehend the fundamentals of Chromatography Techniques and its application.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9	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
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	**CO4-98BT304.4:** Recognize various methods related to Electrophoresis and its applications.	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-1,2,3,4,5
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	**CO5-98BT304.5:** Explore role of centrifugation and physical methods of imaging of biological molecules.	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-1,2,3,4,5

Program Name	**Bachelor of Technology B.Tec.(H)-Biotechnology**	
Semester	III Semester	
Course Code:	98EN305	
Course title:	Entrepreneurship Development	**Curriculum Developer**: Mr. Dhirendra Mishra,
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?	
Course Outcomes (COs):	**CO1-98EN305** Basic aspects of establishing a business in a competitive environment **CO2-98EN305** Apply the basic understanding to examine the existing business ventures **CO3-98EN305** Examine various business considerations such as marketing, financial and teaming etc. **CO4-98EN305** Assessing strategies for planning a business venture **CO5-98EN305** Create business ideas that can drive the innovative society	

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme ofstudies (Hours/Week)					Total Credits(C) (L: T:P=2:1:0)
			Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
HS	98EN305	Entrepreneurship Development	3	0	1	3	7	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 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
			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)		
HS	98EN305	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.	**ApproximateHours**

Item	Cl	LI	SW	SL	Total
Approx.Hrs	09	00	01	02	12

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO1-98EN305.1: Basic aspects of establishing a business in a competitive environment	1.1 Understand the meaning and definition of entrepreneurship		1.1 Lecture on the definition and key concepts of entrepreneurship	1.1 Read a book on famous entrepreneurs and their journeys
	1.2 Comprehend the needs and importance of entrepreneurship		1.2 Classroom discussion on the importance of entrepreneurship for economic growth	1.2 Watch TED Talks on entrepreneurship and innovation
	1.3 Identify factors influencing entrepreneurship		1.3 Lecture on internal and external factors influencing entrepreneurship	
	1.4 Describe the promotion of entrepreneurship		1.4 Discuss government and private sector initiatives for promoting entrepreneurship	
	1.5 Understand the characteristics of successful entrepreneurs		1.5 Classroom activity: Group discussion on traits of successful entrepreneurs	
	1.6 Explain the role of innovation in entrepreneurship		1.6 Lecture on the importance of innovation in entrepreneurial success	
	1.7 Understand the challenges faced by entrepreneurs		1.7 Discuss common challenges and obstacles in entrepreneurship	
	1.8 Comprehend the concept of entrepreneurial mindset		1.8 Lecture on developing an entrepreneurial mindset	
	1.9 Understand the features of a successful entrepreneurship ecosystem		1.9 Discuss the components of a supportive entrepreneurship ecosystem	

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	09	00	01	02	12

Course Outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO2-98EN305.2: Know various form of business organization.	2.1 Understand the different forms of business organization		2.1 Lecture on sole proprietorship, partnership, and corporation	2.1 Read case studies on different business organizations
	2.2 Comprehend the characteristics of each business form		2.2 Discuss the advantages and disadvantages of different business forms	2.2 Watch video lectures on business structures
	2.3 Identify the steps in project identification		2.3 Lecture on the process of identifying a business project	

	2.4 Understand the criteria for selecting a product		2.4 Classroom discussion on factors influencing product selection	
	2.5 Describe the stages of project formulation		2.5 Explain the components of project formulation in a detailed lecture	
	2.6 Understand how to assess project feasibility		2.6 Lecture on the methods of assessing technical, financial, and market feasibility	
	2.7 Comprehend the importance of feasibility studies		2.7 Discuss the role of feasibility studies in project success	
	2.8 Learn to use project management tools		2.8 Overview of project management software and tools in a classroom setting	
	2.9 Understand the impact of project management on business success		2.9 Discuss real-world examples of successful and failed projects	

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	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	09	00	01	02	12

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO3-98EN305.3: Correlation among various types of loans and repayment of loans.	3.1 Understand the importance of finance and the role of loans and repayments		3.1 Lecture on the importance of finance and loan management	3.1 Read articles on successful loan management strategies
	3.2 Identify the characteristics of business finance		3.2 Discuss key characteristics of business finance such as risk, return, and liquidity	3.2 Watch webinars on business finance fundamentals
	3.3 Explain sources of fixed capital and their management		3.3 Lecture on various sources of fixed capital and their management	
	3.4 Comprehend working capital management and its sources		3.4 Detailed discussion on working capital management, including sources and strategies	
	3.5 Understand how to apply for loans and manage repayments		3.5 Classroom activity on preparing a loan application and repayment plan	
	3.6 Describe inventory management of direct and indirect raw materials		3.6 Lecture on inventory management practices for direct and indirect raw materials	
	3.7 Understand the importance of inventory management		3.7 Classroom discussion on the impact of inventory management on business operations	
	3.8 Learn techniques for effective inventory management		3.8 Overview of inventory management techniques such as JIT (Just-In-Time) and EOQ (Economic Order Quantity)	
	3.9 Evaluate real-world examples of fixed and working capital management		3.9 Case study analysis of companies fixed and working capital management practices	

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	09	00	01	02	12

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO4-98EN305.4 Assessing strategies for planning a business venture	4.1 Understand the meaning and importance of marketing		4.1 Lecture on the fundamental concepts of marketing and its significance	4.1 Read articles on the role of marketing in business success
	4.2 Comprehend the marketing-mix and its components		4.2 Discuss the 4Ps (Product, Price, Place, Promotion) and their role in marketing strategy	4.2 Watch videos on the application of the marketing-mix in different industries
	4.3 Explain product management concepts, including product line and product mix		4.3 Lecture on product line, product mix, and their management	
	4.4 Understand the stages of the product life cycle		4.4 Classroom discussion on the product life cycle stages (Introduction, Growth, Maturity, Decline)	
	4.5 Analyze the importance of marketing research and surveys		4.5 Lecture on the role of marketing research and the benefits of surveys	
	4.6 Understand the process of conducting marketing research		4.6 Classroom activity on designing and conducting a marketing survey	
	4.7 Comprehend physical distribution and stock management		4.7 Lecture on physical distribution methods and stock management techniques	
	4.8 Explore strategies for effective stock management		4.8 Discuss inventory control techniques such as Just-In-Time (JIT) and Economic Order Quantity (EOQ)	
	4.9 Evaluate real-world examples of product management and distribution		4.9 Case study analysis of successful product management and distribution strategies	

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	09	00	01	02	12

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO5-98EN305.5: To compare various government policy for international business and analyzed institutions support for export.	5.1 Understand the meaning and significance of international business		5.1 Lecture on the definition and importance of international business	5.1 Read articles on global business strategies and trends
	5.2 Comprehend the process of selecting a product for international markets		5.2 Discuss criteria for product selection for international markets	5.2 Watch webinars on international product strategies
	5.3 Learn how to select a market for international business		5.3 Lecture on market selection criteria and methods for international expansion	
	5.4 Understand the principles of export financing		5.4 Classroom discussion on various export financing options such as letters of credit and export credit insurance	
	5.5 Explore institutional support available for exports		5.5 Lecture on the roles of export promotion agencies and government institutions in supporting exports	
	5.6 Evaluate real-world examples of successful market entry strategies		5.6 Case study analysis of businesses that have successfully entered international markets	
	5.7 Understand the challenges and risks in international business		5.7 Discuss common challenges such as cultural differences, legal issues, and economic instability	
	5.8 Learn about the documentation and compliance required for international trade		5.8 Lecture on the essential documentation and compliance requirements for international trade	

	5.9 Analyze the impact of global trade policies on international business		5.9 Classroom discussion on the effects of global trade policies, tariffs, and trade agreements	

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 institutes those support for export and 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:** 98EN305

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.	9	0	2	1	12
CO2-98EN3055.2: Apply the basic understanding to examine the existing business ventures.	9	0	2	1	12
CO3-98EN305.3: Examine various business considerations such as marketing, financial and teaming etc.	9	0	2	1	12
CO4-98EN305.4: Assessing strategies for planning a business venture	9	0	2	1	12
CO5-98EN305.5: Create business ideas that can drive the innovative society	9	0	2	1	12
Total Hours	45	00	10	05	60

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

Course Title: Entrepreneurship Development **Course Code:** 98EN305

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
CO1-98EN3055.1: Understand basic aspects of establishing a business in a competitive environment.	2	1	1	1	5
CO2-98EN305.2: Apply the basic understanding to examine the existing business ventures.	2	4	2	2	10
CO3-98EN3055.3: Examine various business considerations such as marketing, financial and teaming.	3	5	5	2	15
CO4-98EN305.4: Assessing strategies for planning a business venture	2	3	3	2	10
CO5-98EN305.5: 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:

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

(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: Bachelor of Technology-Biotechnology **Semester:** III Semester
Course Title: Entrepreneurship Development **Course Code:** 98EN305

CO/PO/PSO Mapping								
Course Outcome (Cos)	**Program Outcomes (POs)**					**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**
CO1-98EN3055.1: Understand basic aspects of establishing a business in a competitive environment.	2	-	-	1	2	2	2	1
CO2-98EN305.2: Apply the basic understanding to examine the existing business ventures.	-	-	-	-	-	1	1	2
CO3-98EN305.3: Examine various business considerations such as marketing, financial and teaming etc. .	-	1	1	1	-	1	1	1
CO4-98EN305.4: Assessing strategies for planning a business venture.	-	1	1	-	2	1	1	3
CO5-98EN305.5: Create business ideas that can drive the innovative society.	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	**CO1-98EN305.1:** 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 PSO 1,2,3	**CO2-98EN305.2:** 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 PSO 1,2,3	**CO3-98EN305.3:** 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 PSO 1,2,3	**CO4-98EN305.4:** Assessing strategies for planning a business venture.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7		4.1,4.2,4.3,4.4,4.5, 4.6,4.7	**4SL-1,2,3**

PO 1,2,3,4,5 PSO 1,2,3	**CO5-98EN305.5:** 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	**B. Tech. Biotech Semester**	
Semester	**III**	
Course Code:	**98BT301**	
Course title:	Computational Biology & Bioinformatics	**Curriculum Developer**: Mr. Piyush Kant Rai, Assistant Professor
Pre-requisite:	Biology fundamentals (molecular biology, genetics), programming (Python), statistics, mathematics, bioinformatics tools, genomics, NGS technologies, Linux/Unix, version control, and effective communication.	
Rationale:	The proposed syllabus integrates essential elements for bioinformatics proficiency. It combines foundational biology with practical programming skills, statistical and mathematical methods, and database management. This comprehensive approach ensures students acquire the necessary tools to analyze biological data, fostering a robust understanding of bioinformatics principles and applications.	
Course Outcomes (COs):	**98BT301.1:** The unit will explain bioinformatics history, homology, and utilize sequence databases (EMBL, GENBANK, Entrez, Unigene). **98BT301.2:** Analyze protein information from PDB, SWISS-PROT, TREMBL databases, mastering their structures for effective utilization in research. **98BT301.3:** Operates diverse data generation techniques, understand bioinformatics challenges, and apply problem-solving skills in biological analyses. **98BT301.4:** Master sequence and phylogeny analysis, detect ORFs, understand sequence assembly, mutation matrices, BLAST usage, and interpret results. **98BT301.5:** Navigate databases, execute similarity searches (BLAST, FASTA), and annotate genomes, integrating pattern finding and gene identification.	

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)	
PC	98BT301	Computational Biology and Bioinformatics	3	2	1	2	8	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 must 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)		
PC	**98BT301**	Computational Biology and Bioinformatics	15	20	5	10	50	50	100

Course-Curriculum:

<table>
<tr>
<td>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.</td>
<td>Approximate Hours
<table>
<tr><td>Item</td><td>Cl</td><td>LI</td><td>SW</td><td>SL</td><td>Total</td></tr>
<tr><td>Approx. Hrs</td><td>09</td><td>04</td><td>01</td><td>02</td><td>16</td></tr>
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Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO1-98BT301.1: The unit will explain bioinformatics history, homology, and utilize sequence databases (EMBL, GENBANK, Entrez, Unigene).	SO1.1 Understand the concept of computational biology	Li1.1Analyze computational biology case studies	CI1.1 Lecture on the fundamentals of computational biology and its importance	SL1.1 Read a review article on the evolution of computational biology
	SO1.2 Introduction to bioinformatics	LI1.2 Hands-on session with bioinformatics tools	CI1.2 Lecture on the basics of bioinformatics and its role in computational biology	SL1.2 Watch an introductory video on bioinformatics tools and techniques
	SO1.3 Review the history of bioinformatics		CI1.3 Classroom discussion on the historical development of bioinformatics	
	SO1.4 Learn basic terminology used in bioinformatics		CI1.4 Lecture on key bioinformatics terms and definitions	
	SO1.5 Understand the scope and applications of bioinformatics		CI1.5 Discuss the various applications of bioinformatics in research and industry	
	SO1.6 Introduction to the National Center for Biotechnology Information (NCBI)		CI1.6 Lecture on the role of NCBI and its resources	
	SO1.7 Define and understand biological sequence databases		CI1.7 Classroom discussion on the importance and uses of biological sequence databases	
	SO1.8 Overview of various primary and secondary biological databases		CI1.8 Lecture on primary databases (e.g., GenBank, EMBL, DDBJ) and secondary databases (e.g., SwissProt, PIR)	

	SO1.9 Introduction to specific databases: GenBank, EMBL, DDBJ, Swiss Prot, PIR, MIPS, TIGR, TAIR		CI1.9 Classroom activity: Explore and compare different databases such as GenBank, SwissProt, and TAIR	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Summarizes the GenBank, EMBL and DDBJ. .
	SW1.2 Mini Project	Demonstrate how to retrieve data from EMBL.
	SW1.3 Other Activities (Specify)	correlate the data redundancy among INSDC databases.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	**09**	04	01	2	**16**

Course Outcome (CO)	**Session Outcomes (SOs)**	**LaboratoryInstruction (LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
CO2-49BT505.2: Analyze protein information from PDB, SWISS-PROT, TREMBL databases, mastering their structures for effective utilization in research.	SO2.1 Define biological databases and their significance	2.1 Create a comparative report on different biological databases	CI 2.1 Lecture on the definition and importance of biological databases	SL2.1 Read articles on the role of biological databases in research
	SO 2.2 Identify and describe different types of biological databases		CI 2.2 Lecture on types of biological databases: primary, secondary, and others	SL2.2 Watch videos explaining various types of biological databases
	SO 2.3 Overview primary and secondary databases	2.2 Explore primary and secondary databases to understand their features	CI 2.3 Classroom discussion on the characteristics of primary and secondary databases	
	SO 2.4 Understand nucleic acid sequence databases (NCBI, EMBL, DDBJ)		CI 2.4 Lecture on nucleic acid sequence databases and their roles	
	SO 2.5 Explore the SWISS-PROT protein sequence database		CI 2.5 Classroom lecture on SWISS-PROT and its significance in protein sequence analysis	
	SO 2.6 Learn database searching techniques using BLAST and FASTA		CI 2.6 Lecture on BLAST and FASTA algorithms and their applications	
	SO 2.7 Perform and interpret BLAST searches		CI 2.7 Classroom activity on interpreting BLAST search results	
	SO 2.8 Perform and interpret FASTA searches		CI 2.8 Classroom discussion on the differences between BLAST and FASTA	

	SO 2.9 Compare results from BLAST and FASTA searches		CI2.9 Case study analysis of BLAST and FASTA results to understand their efficacy	

Item	Cl	LI	SW	SL	Total
Approx. Hrs	**09**	**04**	**01**	04	**18**

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Justify the role of SwissProt in biotechnology.
	SW2.2 Mini Project	Interpret the TrEMBL result concerning the DNA.
	SW2.3 Other Activities (Specify)	Incorporate some youtube videos based on features of TrEMBL construction.

Course Outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO3-49BT505.3 Operates diverse data generation techniques, understand bioinformatics challenges, and apply problem-solving skills in biological analyses.	SO3.1 Understand the concepts of local and global alignments	LI3.1 Perform local and global alignments using alignment tools	CI3.1 Lecture on the difference between local and global alignments	SL3.1 Read articles on the applications of local and global alignments
	SO 3.2 Learn pairwise sequence alignment techniques	LI3.2 Use software to perform pairwise alignments and analyze results	CI3.2 Lecture on pairwise alignment methods and algorithms	SL3.2 Watch tutorials on pairwise sequence alignment techniques
	SO 3.3 Understand substitution scoring and gap penalties		CI3.3 Classroom discussion on scoring systems and the impact of gap penalties	SL3.3 Study different substitution matrices and their use cases
	SO 3.4 Comprehend the statistical significance of sequence alignments		CI3.4 Lecture on the statistical methods for evaluating alignment significance	SL3.4 Explore statistical models used in sequence alignment significance

	SO 3.5 Learn about multiple sequence alignment methods		CI3.5 Classroom discussion on various methods for multiple sequence alignment	
	SO 3.6 Explore progressive alignment methods		CI 3.6 Lecture on progressive alignment methods and their applications	
	SO 3.7 Understand motifs and patterns in sequences		CI 3.7 Classroom discussion on the identification and significance of motifs and patterns	
	SO 3.8 Compare results from different alignment methods		CI 3.8 Classroom activity analyzing and comparing alignment results from different methods	
	SO 3.9 Apply sequence alignment techniques to real-world data		CI 3.9 Case study analysis of real-world applications of sequence alignment	

Item	Cl	LI	SW	SL	Total
Approx. Hrs	**09**	**04**	**01**	04	**18**

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Write about Local and global alignment.
	SW3.2 Mini Project	
	SW3.3 Other Activities (Specify)	Search and find the amrita lab and there find alignment methods.

Course Outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO4-49BT505.4 Master sequence and phylogeny analysis, detect ORFs, understand sequence assembly,	SO4.1 Understand the elements of a phylogenetic model	LI4.1 Construct a basic phylogenetic model using sample data	CI 4.1 Lecture on the elements and structure of phylogenetic models	SL4.1 Read articles on the development and use of phylogenetic models

mutation matrices, BLAST usage, and interpret results.	SO4.2 Learn data analysis techniques for phylogenetics	LI4.2 Analyze genetic data for phylogenetic studies using software tools	CI 4.2 Lecture on methods of data analysis in phylogenetics	SL4.2 Watch tutorials on phylogenetic data analysis
	SO4.3 Understand tree building methods		CI 4.3 Classroom discussion on different tree building methods	SL4.3 Research different phylogenetic tree building algorithms
	SO 4.4 Learn tree evaluation techniques		CI 4.4 Lecture on tree evaluation methods and criteria	SL4.4 Study case studies on phylogenetic tree evaluation
	SO 4.5 Explore methods for searching for a phylogenetic tree		CI 4.5 Classroom discussion on techniques for searching phylogenetic trees	
	SO 4.6 Understand the use of phylogenetic software		CI 4.6 Lecture on various phylogenetic software tools	
	SO 4.7 Learn to use CLUSTAL for phylogenetic analysis		CI 4.7 Classroom demonstration on using CLUSTAL for phylogenetic analysis	
	SO 4.8 Learn to use PHYLIP for phylogenetic analysis		CI 4.8 Classroom demonstration on using PHYLIP for phylogenetic analysis	
	SO 4.9 Understand UPGMA for phylogenetic analysis		CI4.9 Lecture on the UPGMA method and its applications	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Write about mathematical associated with phylogenetic analysis.
	SW4.2 Mini Project	
	SW4.3 Other Activities (Specify)	Search and learn via YouTube how to interpret phylogenetic tree.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	**09**	04	01	04	18

Course Outcome (CO)	**Session Outcomes (SOs)**	**LaboratoryInstruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO5-49BT505.5: Navigate databases, execute similarity searches (BLAST, FASTA), and annotate genomes, integrating pattern finding and gene identification.	SO5.1 Understand the physical properties of proteins	LI5.1 Analyze the physical properties of a given protein sample	CI 5.1 Lecture on the physical properties of proteins	SL5.1 Read articles on protein physical properties
	SO 5.2 Learn about secondary structures of proteins	LI5.2 Predict secondary structures using computational tools	CI 5.2 Classroom discussion on alpha and beta structures	SL5.2 Study secondary structure prediction methods
	SO 5.3 Understand alpha and beta structures		CI 5.3 Lecture on the significance of alpha and beta structures	SL5.3 Explore case studies involving alpha and beta structures
	SO 5.4 Learn about protein motifs		CI 5.4 Classroom discussion on common protein motifs	SL5.4 Research different protein motifs and their functions
	SO 5.5 Understand tertiary structures of proteins		CI 5.5 Lecture on the formation and significance of tertiary structures	
	SO 5.6 Explore specialized protein structures		CI 5.6 Classroom discussion on specialized structures and their functions	

	SO 5.7 Learn about protein conformation		CI 5.7 Lecture on protein conformation and its importance	
	SO 5.8 Understand the role of bioinformatics in drug discovery		CI 5.8 Lecture on bioinformatics applications in drug discovery	
	SO 5.9 Learn about docking and prediction of drug quality		CI5.9 Classroom discussion on docking methods and drug quality prediction	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Write about protein function aspect and its properties.
	SW5.2 Mini Project	
	SW5.3 Other Activities (Specify)	Try to learn and apply Rasmol to learn protein structure using virtual lab.

Course duration (in hours) to attain Course Outcomes

Course Title: Computational biology and bioinformatics **Course Code:** 98BT301

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1-98BT301.1: The unit will explain bioinformatics history, homology, and utilize sequence databases (EMBL, GENBANK, Entrez, Unigene).	9	4	2	1	16
CO2-98BT301.2: Explain Bioinformatics resources, computational tools and associated algorithms	9	4	2	1	16

CO3-98BT301.3: Analyze protein information from PDB, SWISS-PROT, TREMBL databases, mastering their structures for effective utilization in research.	9	4	4	1	18
CO4-98BT301.4: Analyze evolutionary tree to understand evolutionary genetics	9	4	4	1	18
CO5-98BT301.5: Compare sequence alignment tools to predict structures & functions of gene, RNA and Proteins & Predict protein structures and its functional annotations through databases	9	4	4	1	18
Total Hours	45	20	16	5	86

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

Course Title Computational biology and bioinformatics **Course Code** 98BT301

Course Outcomes	**Marks Distribution**				**Total Marks**
	A	**An**	**E**	**C**	
CO1-98BT301.1: The unit will explain bioinformatics history, homology, and utilize sequence databases (EMBL, GENBANK, Entrez, Unigene).	02	03	04	1	10
CO2-98BT301.2: Analyze protein information from PDB, SWISS-PROT, and TREMBL databases, mastering their structures for effective utilization in research.	03	04	02	1	10
CO3-98BT301.3: Analyze protein information from PDB, SWISS-PROT, TREMBL databases, mastering their structures for effective utilization in research.	02	05	02	1	10
CO4-98BT301.4: Analyze evolutionary tree to understand evolutionary genetics	02	05	02	1	10
CO5-98BT301.5: Compare sequence alignment tools to predict structures & functions of gene, RNA and Proteins & Predict protein structures and its functional annotations through databases.	03	04	03	1	11

Total Marks	12	21	13	05	51

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

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1	Bioinformatics Thomas Dandekar, Meik Kunz Springer-Verlag GmbH Germany, part of Springer Nature 2023
2	Introduction to bioinformatics, Arthur Lesk Oxford University Press 2023
3	Essential bioinformatics, Jin Xiong, Cambridge University Press 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 Research lab (BSL-1)
7. Demonstration
8. ICT Based teaching Learning
9. Brainstorming

CO, PO and PSO Mapping

Program Name: B.Tech. Biotechnology **Semester:** III

Course Title: Computational Biology and Bioinformatics **Course Code:** 98BT301

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**
CO1-98BT301.1: The unit will explain bioinformatics history, homology, and utilize sequence databases (EMBL, GENBANK, Entrez, Unigene).	-	-	-	1	2	2	1	-	1	2	2	3	3	3	1
CO2-98BT301.2: Analyze protein information from PDB, SWISS-PROT, and TREMBL databases, mastering their structures for effective utilization in research.	-	-	-	-	-	-	3	-	2	2	3	3	1	1	2
CO3-98BT301.3: Analyze protein information from PDB, SWISS-PROT, TREMBL databases, mastering their structures for effective utilization in research.	-	1	1	1	-	-	2	-	3	1	1	2	1	1	1
CO4-98BT301.4: Analyze evolutionary tree to understand evolutionary genetics	-	1	1	-	2	2	2	3	-	1	-	-	1	2	3
CO5-98BT301.5: Compare sequence alignment tools to predict structures & functions of gene, RNA and Proteins & Predict protein structures and its functional annotations through databases.	1	1	1	-	-	2	3	3	1	2	2	2	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 4,5,6 7,9,10,11,12 PSO 1,2, 3	**CO1-98BT301.1:** The unit will explain bioinformatics history, homology, and utilize sequence databases (EMBL, GENBANK, Entrez, Unigene).	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9	**IL 1 IL 2**	1.1,1.2,1.3,1.4,1.5,1.6, 1.7 1.8 1.9	**1SL-1,2**
PO 7,9,10,11,12 PSO 1,2, 3	**CO2-98BT301.2:** Analyze protein information from PDB, SWISS-PROT, and TREMBL databases, mastering their structures for effective utilization in research.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9	**IL 1 IL 2**	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7 2.8 2.9	**2SL-1,2**
PO 2,3,4, 7,9,10,11,12 PSO 1,2, 3	**CO3-98BT301.3:** Analyze protein information from PDB, SWISS-PROT, TREMBL databases, mastering their structures for effective utilization in research.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9	**IL 1 IL 2**	3.1,3.2,3.3,3.4,3.5, 3.6, 3.7, 3.8, 3.9	**3SL-1,2,3,4**
PO 2,3,5,6 7,8,10,11,12 PSO 1,2, 3	**CO4-98BT301.4:** Analyze evolutionary tree to understand evolutionary genetics	SO4.1 SO4.2 SO4.3 SO4.4,SO 4.5,SO4.6 SO4.7 SO4.8 SO4.9	**IL 1 IL 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 1,2,3,6 7,8,9,10,11,12 PSO 1, 3	**CO5-98BT301.5:** Compare sequence alignment tools to predict structures & functions of gene, RNA and Proteins & Predict protein structures and its functional annotations through databases.	SO5.1 SO5.2 SO5.3 SO5.4,SO5.5 SO5.6 SO5.7 SO5.8 SO5.9	**IL 1 IL 2**	5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,5.9	**5SL-1,2,3,4**

Program Name	**Bachelor of Technology (B.Tech.)- Biotechnology**	
Semester	III	
CourseCode:	**98ME306**	
Coursetitle:	Fluid Mechanics	**Curriculum Developer**: Er. Lokesh Agrawal, Assistant Professor
Pre-requisite:	Students should have a solid foundation in physics, calculus, mechanics, thermodynamics, biology, and chemistry.	
Rationale:	Fluid mechanics is crucial in biotechnology for understanding fluid behaviors in biological systems, such as cell cultures, bioreactors, and drug delivery. Mastery of fluid mechanics enables optimization of processes like fermentation and separation techniques. This knowledge aids in designing efficient biotechnological processes, enhancing productivity and sustainability.	
CourseOutcomes (COs):	**CO1-98ME356.1** Understand fundamental properties of fluids and their practical significance. **CO2: 98ME356.2** Comprehension of fluid motion, kinematics, and various types of fluid flow dynamics **CO3: 98ME356.3** Apply Bernoulli's equation and related principles to solve fluid dynamics problems. **CO4: 98ME356.4** Demonstrate proficiency in material and energy balance calculations in unit operations **CO5: 98ME356.5** Proficiency in Process Equipment Operation, Optimization, and Power Consumption Analysis.	

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)	
OS	98ME306	Fluid Mechanics	2	0	1	2	5	2+0+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 must 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)		
OS	98ME306	Fluid Mechanics	**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.	**ApproximateHours**

Item	Cl	LI	SW	SL	Total
Approx.Hrs	06	00	01	04	11

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO1-98ME356.1. Understand fundamental properties of fluids and their practical significance.	1.1 Understand the difference between ideal and real fluids		1.1 Lecture on the characteristics of ideal and real fluids	1.1 Read articles on the applications of ideal and real fluids
	1.2 Learn about Newtonian and Non-Newtonian fluids		1.2 Classroom discussion on Newtonian and Non-Newtonian fluids	1.2 Study case studies on Newtonian and Non-Newtonian fluids
	1.3 Understand the properties of fluid (mass density, weight density, etc.)		1.3 Lecture on properties of fluids and their significance	1.3 Research different fluid properties and their industrial applications
	1.4 Learn about viscosity and surface tension		1.4 Lecture on viscosity and surface tension and their effects	1.4 Watch tutorials on measuring viscosity and surface tension
	1.5 Understand gas laws and humidity		1.5 Classroom discussion on gas laws and their applications in fluids	
	1.6 Understand fluid statics (pressure, Pascal's law, hydrostatic law)		1.6 Lecture on fluid statics: pressure, Pascal's law, and hydrostatic law	

Suggested Sessional Work (SW):*anyone*	**SW1.1** Assignments	Explore and differentiate between Newtonian and non-Newtonian fluids. Provide real-world examples of each type
	SW1.2 Mini Project	Document and observe these scenarios, noting down relevant data such as fluid types, dimensions, and observed behaviors.
	SW1.3 Other Activities (Specify)	Make a power point presentation on "Buoyancy and Floatation"

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)
CO2-98ME356.2 Comprehension of fluid motion, kinematics, and various types of fluid flow dynamics.	2.1 Understand the description of fluid motion		2.1 Lecture on the basic principles of fluid motion	2.1 Read articles on real-world applications of fluid motion
	2.2 Learn the Lagrangian and Eulerian approaches		2.2 Classroom discussion on Lagrangian and Eulerian approaches	2.2 Study case studies comparing the two approaches
	2.3 Identify different types of fluid flow		2.3 Lecture on types of fluid flow (laminar, turbulent, etc.)	2.3 Research examples of different fluid flow types in nature and industry
	2.4 Understand and apply the continuity equation		2.4 Lecture on the continuity equation and its applications	
	2.5 Learn about the acceleration of a fluid particle		2.5 Classroom discussion on fluid particle acceleration	
	2.6 Understand the motion of fluid particles along a curved path and vortex motion		2.6 Lecture on curved path motion and vortex motion	

Suggested Sessional Work (SW):*anyone*	**SW2.1** Assignments	Define laminar, turbulent, and transitional flow. Compare and contrast these types of flow, highlighting their characteristics and the factors influencing their occurrence. Provide real-world examples for each type of flow.
	SW2.2 Mini Project	Make a project on the continuity equation and its significance in fluid dynamics.
	SW2.3 Other Activities (Specify)	Make Power point presentation on Vortex Motion.

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)
CO3-98ME356.3 Apply Bernoulli's equation and related principles to solve fluid dynamics problems of motion.	3.1 Understand and derive Euler's Equation		3.1 Lecture on the derivation and significance of Euler's Equation	3.1 Read articles on the historical development and applications of Euler's Equation
	3.2 Learn the principles and applications of Bernoulli's Equation		3.2 Lecture on Bernoulli's Equation and its practical applications	3.2 Study case studies on Bernoulli's Equation in engineering and natural systems
	3.3 Understand the working and applications of a Venturimeter		3.3 Classroom discussion on the design and use of Venturimeters	3.3 Research various industrial applications of Venturi meters
	3.4 Learn the working principles of a Pitot tube		3.4 Lecture on the Pitot tube and its application in flow measurement	
	3.5 Understand the concepts of kinetic energy and momentum correction factors		3.5 Lecture on kinetic energy and momentum correction factors in fluid flow	
	3.6 Learn about flow through pipelines and flow measurement techniques		3.6 Classroom discussion on flow through pipelines and various flow measurement techniques	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Derive and explain the impulse momentum equation for a control volume. Discuss its significance in analyzing fluid flow problems and provide examples demonstrating its application.
	SW3.2 Mini Project	Collect and compile the data obtained from each flow measurement device.
	SW3.3 Other	Prepare one Power point presentation on "Different flow measurement device"

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	00	01	04	11

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO4-98ME356.4 Demonstrate proficiency in material and energy balance calculations in unit operations	4.1 Understand the basic concepts of material balances		4.1 Lecture on the fundamentals of material balances	4.1 Read chapters on material balances from a chemical engineering textbook
	4.2 Apply material balance concepts to unit operations		4.2 Classroom discussion on material balance applications in unit operations	4.2 Solve practice problems on material balances in various unit operations
	4.3 Learn to solve material balance problems in bioprocesses		4.3 Lecture on material balances in bioprocesses	4.3 Review case studies on material balance applications in bioprocesses
	4.4 Understand the basic concepts of energy balances		4.4 Lecture on the fundamentals of energy balances	4.4 Study examples of energy balances in chemical engineering
	4.5 Learn about sensible and latent heats		4.5 Lecture on sensible and latent heats	
	4.6 Apply thermo chemical calculations using steam tables		4.6 Classroom discussion on thermo chemical calculations and steam tables	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	"Describe the importance of simultaneous material and energy balance in bioprocesses. Provide real-world examples to illustrate its application."
	SW4.2 Mini Project	Utilize energy balance concepts to determine energy inputs (sensible and latent heats) and losses.
	SW4.3 Other Activities (Specify)	Make a Power point presentation on " Energy balance in various bioprocesses"

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	00	01	04	11

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO5-98ME356.5 Proficiency in Process Equipment Operation, Optimization, and Power Consumption Analysis.	5.1 Understand the basic principles of agitation and its applications		5.1 Lecture on the fundamentals of agitation in chemical processes	5.1 Read chapters on agitation and mixing from a chemical engineering textbook
	5.2 Learn about fluid flow through packed columns		5.2 Classroom discussion on the principles of fluid flow through packed columns	5.2 Solve practice problems related to fluid flow in packed columns
	5.3 Understand the concept of fluidization		5.3 Lecture on fluidization and its industrial applications	5.3 Watch tutorials on fluidization processes and their applications
	5.4 Explore different fluid transport mechanisms		5.4 Classroom discussion on fluid transport mechanisms	5.4 Review case studies on fluid transport in various industries
	5.5 Learn about the equipment used for gas movement		5.5 Lecture on gas moving devices and their applications	
	5.6 Calculate power requirements for agitation		5.6 Classroom discussion on the calculation of power requirements for different agitation systems	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Explain the significance of fluidization in packed columns and its impact on fluid transport efficiency. Provide examples to illustrate.
	SW5.2 Mini Project	Prepare a comprehensive report detailing the project methodology, findings, and recommendations for optimizing fluid dynamics in process equipment.
	SW5.3 Other Activities (Specify)	Prepare one article on the "How Mixing effects the working mechanism of Impellers"

Course duration (in hours) to attain Course Outcomes:

Course Title: Fluid Mechanics **Course Code:**98ME356

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction(LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1-98ME356.1. Understand fundamental properties of fluids and their practical significance.	06	00	04	1	11
CO2-98ME356.2. Comprehension of fluid motion, kinematics, and various types of fluid flow dynamics	06	00	03	1	10
CO3-98ME356.3. Apply Bernoulli's equation and related principles to solve fluid dynamics problems.	06	00	03	1	10
CO4-98ME356.4. Demonstrate proficiency in material and energy balance calculations in unit operations	06	00	04	1	11
CO5-98ME356.5. Proficiency in Process Equipment Operation, Optimization, and Power Consumption Analysis.	06	00	04	1	11
Total Hours	30	00	18	05	53

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

Course Title: Fluid Mechanics **Course Code:** 98ME356

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
CO1-98ME356.1. Understand fundamental properties of fluids and their practical significance.	2	1	1	1	5
CO2-98ME356.2. Comprehension of fluid motion, kinematics, and various types of fluid flow dynamics	2	4	5	1	12

CO3-98ME356.3. Apply Bernoulli's equation and related principles to solve fluid dynamics problems.	3	5	5	1	14
CO4-98ME356.4. Demonstrate proficiency in material and energy balance calculations in unit operations	2	3	5	1	11
CO5-98ME356.5. Proficiency in Process Equipment Operation, Optimization, and Power Consumption Analysis.	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	Fluid Mechanics & Hydraulic Machines, S.S. Rattan: Khanna Book Publishing
2	Introduction to Fluid Mechanics, P.J. Pritchard, A.T. McDonald and R.W. Fox, Wiley India
3	Fluid Mechanics- F.M. White – Tata McGraw Hill.
4	Introduction to Fluid Mechanics and Fluid Machines, S. K. Som, G. Biswas and S. Chakraborty, Tata McGraw Hill ”

(b) 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: B. Tech. Biotechnology **Semester:** III Semester

Course Title: Fluid Mechanics **Course Code:** 98ME356

CO/PO/PSO Mapping									
Course Outcome (Cos)	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1-98ME356.1. Understand fundamental properties of fluids and their practical significance.	1	1	-	1	2	1	2	2	1

CO2-98ME356.2. Comprehension of fluid motion, kinematics, and various types of fluid flow dynamics	1	1	1	-	-	1	1	1	2
CO3-98ME356.3. Apply Bernoulli's equation and related principles to solve fluid dynamics problems.	1	1	1	1	2	1	1	1	1
CO4-98ME356.4. Demonstrate proficiency in material and energy balance calculations in unit operations	1	-	1	-	-	1	1	1	3
CO5-98ME356.5. Proficiency in Process Equipment Operation, Optimization, and Power Consumption Analysis.	1	-	1	1	2	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 1,2,3,4,5,6 PSO 1,2, 3	**CO1-98ME356.1.** Understand fundamental properties of fluids and their practical significance.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6		1.1,1.2,1.3,1.41.5,1.6	**1SL-1,2,3,4**
PO 1,2,3,4,5,6 PSO 1,2, 3	**CO2-98ME356.2.** Comprehension of fluid motion, kinematics, and various types of fluid flow dynamics	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 1,2,3,4,5,6 PSO 1,2, 3	**CO3-98ME356.3.** Apply Bernoulli's equation and related principles to solve fluid dynamics problems.	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-1,2,3**
PO 1,2,3,4,5,6 PSO 1,2, 3	**CO4-98ME356.4.** Demonstrate proficiency in material and energy balance calculations in unit operations	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO 4.6		4.1,4.2,4.3,4.4, 4.5,4.6	**4SL-1,2,3,4**
PO 1,2,3,4,5,6 PSO 1,2, 3	**CO5-98ME356.5.** Proficiency in Process Equipment Operation, Optimization, and Power Consumption Analysis.	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-1,2,3,4**

Program Name	**B.Tech. Biotechnology**	
Semester	III	
CourseCode:	98BT303	
Coursetitle:	Biostatistics	**Curriculum Developer**: KEERTI SAMDARIYA, Assistant Professor
Pre-requisite:	Student should have basic knowledge of biostatistics, their role and application in biological field.	
Rationale:	The paper on BIOSTATISTICS in an B.Tech Biotechnology program explores the role of biostatistics and their activity in biological systems. Biostatistics pertains to the acquisition and interpretation of quantitative information in medical research. Finding the correct mathematical hypotheses, biological models, and statistical tests is essential for adequate study designs as a mandatory prerequisite for useful study outcomes.	
CourseOutcomes (COs):	**98BT303.1:** Describe the roles biostatistics serves in the discipline of public health. **98BT303.2:** Apply basic statistical concepts commonly used in public health and health Sciences **98BT303.3:** Demonstrate basic analytical techniques to generate results **98BT303.4:** Interpret results of commonly used statistical analyses in written summaries **98BT303.5:** Demonstrate statistical reasoning skills accurately and contextually	

Scheme of Studies:

Board of Study	CourseCode	Course Title	Scheme of studies (Hours/Week)					Total Credits (C) (L: T:P)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
BSC	98BT303	Biostatistics	2	0	1	1	5	1+1+1= 3

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 must 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 (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 Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
BSC	98BT303	Biostatistics	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.

Item	**CI**	**LI**	**SW**	**SL**	**Total**
Approx. Hrs.	**06**	**4**	**01**	**02**	**13**

CO.1 98BT303.1: Describe the roles biostatistics serves in the discipline of public health.	**Session Outcomes (SOs)**	**LaboratoryInstruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
	SO1.1 Understand the definitions, historical development, and applications of biostatistics.	LI1.1 Conduct a historical analysis of key developments in biostatistics through a lab presentation.	CI1.1 Lecture: Introduction to biostatistics - Definitions, historical resume, and applications.	SL1.1 Research and write a report on the historical milestones in the field of biostatistics.
	SO 1.2 Identify and apply different methods of sampling.	LI1.2 Perform a simple random sampling and non-random sampling exercise using a dataset.	CI 1.2 Discussion: Methods of sampling - Random sampling and non-random sampling.	SL1.2 Develop a flowchart illustrating the steps involved in different sampling methods.
	SO 1.3 Understand sampling errors and non-sampling errors.		CI 1.3 Case Study: Identify sampling and non-sampling errors in a real-world study.	
	SO 1.4 Learn the types of data and methods for data collection.		CI 1.4 Workshop: Types of data and methods for data collection.	
	SO 1.5 Understand how to organize data into a frequency distribution.		CI 1.5 Practical: Organize a dataset into a frequency distribution.	
	SO 1.6 Develop skills in presenting data effectively.		CI 1.6 Presentation: Effective methods of data presentation.	

SW-1 Suggested Sessional Work (SW): anyone	1.1. Assignments: Differentiate between Random Sampling and Non-random sampling, portance of biostatistics and their applications 1.2 Mini Project: Measures of central Tendency by suitable examples. 1.3 Other Activities (Specify): Find out some you tube videos based on history, methods, and application of biostatistics.

Item	CI	LI	SW	SL	Total
Approx. Hrs.	06	04	01	02	13

CO.2 98BT303.2: Apply basic statistical concepts commonly used in public health and health Sciences	**Session-Outcomes (SOs)**	**Laboratory-Instruction (LI)**	**Classroom-Instruction (CI)**	**Self-Learning (SL)**
	SO2.1 Understand the concept and importance of measures of central tendency.	LI2.1 Calculate the mean, median, and mode of a given dataset.	CI2.1 Lecture: Introduction to measures of central tendency.	SL2.1 Research and compare the uses of mean, median, and mode in different fields.
	SO 2.2 Calculate the mean of a dataset accurately.	LI2.2 Perform calculations to find the mean of various datasets.	CI 2.2 Practical: Calculation of mean from provided data.	SL2.2 Research and compare the uses of mean, median, and mode in different fields
	SO 2.3 Calculate the median of a dataset accurately.		CI 2.3 Practical: Calculation of median from provided data.	
	SO 2.4 Calculate the mode of a dataset accurately.		CI 2.4 Practical: Calculation of mode from provided data.	
	SO 2.5 Evaluate the merits and demerits of mean, median, and mode in different scenarios.		CI 2.5 Discussion: Merits and demerits of mean, median, and mode.	
	SO 2.6 Understand the concept and importance of measures of dispersion, including range, mean deviation, and standard deviation.		CI 2.6 Lecture: Introduction to measures of dispersion - Range, mean deviation, and standard deviation.	

SW-2 Suggested Sessional Work (SW)	a. Assignments: Calculate mean median and mode by related questions., write short note on range b. Mini Project: Measures of central Tendency by suitable examples. c. Other Activities (Specify): Find out some you tube videos based on calculation method of mean median and mode.

Item	CI	LI	SW	SL	Total
Approx. Hrs.	06	04	01	02	13

CO.3 98BT303.3: Demonstrate basic analytical techniques to generate results	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
	SO3.1 Understand the definition and fundamental concepts of probability.	LI3.1 Conduct an experiment to demonstrate basic probability principles using real-life examples.	CI3.1 Lecture: Introduction to probability - Definitions and fundamental concepts.	SL3.1 Research and summarize the historical development and applications of probability theory.
	SO3.2 Apply theorems of probability to solve problems.	LI3.2 Perform calculations using theorems of probability on given datasets.	CI3.2 Discussion: Theorems of probability and their applications.	SL3.2 Develop a set of practice problems involving probability theorems and provide solutions.
	SO3.3 Understand and apply the addition rule in probability.		CI3.3 Practical: Using the addition rule to solve probability problems.	
	SO3.4 Understand and apply the multiplication rule in probability.		CI3.4 Practical: Using the multiplication rule to solve probability problems.	
	SO3.5 Understand the concept and applications of probability distributions, including binomial, Poisson, and normal distributions.		CI3.5 Lecture: Introduction to probability distributions - Binomial, Poisson, and normal distributions.	
	SO3.6 Perform calculations using binomial, Poisson, and normal probability distributions.		CI3.6 Workshop: Solving problems using binomial, Poisson, and normal distributions.	

SW-3 Suggested Sessional Work (SW):	**a. Assignments:** Write about probability distribution and Calculate probability by suitable examples **b. Mini Project:** how probability is important in biological system? **c. Other Activities (Specify):** Find out some you tube videos based on probability theorems.

Item	**CI**	**LI**	**SW**	**SL**	**Total**
Approx. Hrs.	06	04	01	02	13

CO.4 98BT303.4: Interpret results of commonly used statistical analyses in written summaries	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
	SO4.1 Understand the concept and importance of correlation and regression in statistical analysis.	LI4.1 Conduct an experiment to calculate the correlation coefficient between two variables using a given dataset.	CI 4.1 Lecture: Introduction to correlation and regression - Definitions and significance.	SL4.1 Research and write a report on the historical development and applications of correlation and regression analysis.
	SO 4.2 Identify and differentiate between positive and negative correlation.	LI4.2 Perform an analysis to identify positive and negative correlations in various datasets.	CI 4.2 Practical: Identifying types of correlation - Positive and negative.	SL4.2 Develop a set of practice problems involving identification of positive and negative correlations and provide solutions.
	SO 4.3 Calculate the correlation coefficient and interpret its meaning.		CI 4.3 Workshop: Calculation and interpretation of the correlation coefficient.	
	SO 4.4 Understand the principles of linear regression and how to derive the regression equation.		CI 4.4 Lecture: Principles of linear regression and derivation of the regression equation.	
	SO 4.5 Apply linear regression techniques to analyze relationships between variables.		CI 4.5 Practical: Applying linear regression to analyze relationships between variables in given datasets.	
	SO 4.6 Interpret the results of regression analysis to make predictions and informed decisions.		CI4.6 Discussion: Interpreting regression analysis results for predictions and decision-	

			making.	

SW-4 Suggested Sessional Work (SW):	SW 4.1. Assignments: Illustrating Principles of Correlation and Regression and Explain application of regression equation. SW4.2 Mini Project: how regression equation is important in area of biological research? SW 4.3 Other Activities (Specify): **Find out some you tube videos based on Correlation and Regression.**

Item	**CI**	**LI**	**SW**	**SL**	**Total**
Approx. Hrs.	06	04	01	02	13

CO.5 98BT303.5: Demonstrate statistical reasoning skills accurately and contextually	**Session Outcomes (SOs)**	**LaboratoryInstruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
	SO5.1 Understand the concept of significance testing and its importance in hypothesis testing.	LI5.1 Conduct a hypothesis test using a dataset, including the formulation of null and alternative hypotheses.	CI5.1 Lecture: Introduction to significance testing - Concepts of null and alternative hypotheses.	SL5.1 Research and write a report on the historical development and applications of hypothesis testing in statistics.
	SO5.2 Understand the procedure for testing hypotheses.	LI5.2 Perform the procedure for testing hypotheses on sample data, including calculating p-values and making decisions.	CI5.2 Workshop: Procedure of hypothesis testing - Steps and methodologies.	SL5.2 Develop a detailed guide on the steps involved in hypothesis testing, including examples and common pitfalls.
	SO5.3 Understand and apply the T-Test for small samples.		CI5.3 Lecture: Introduction to T-Test - Properties and applications.	
	SO5.4 Calculate and interpret the T-Test results for small sample sizes.		CI5.4 Practical: Applying the T-Test to small samples and interpreting results.	
	SO5.5 Understand the properties of the Chi-Square distribution and its applications.		CI5.5 Lecture: Properties of Chi-Square distribution and its relevance in statistical testing.	

	SO5.6 Perform Chi-Square tests for independence and homogeneity, including interpretation of results.		CI5.6 Practical: Performing and interpreting Chi-Square tests for independence and homogeneity using sample data.	

SW-5 Suggested Sessional Work (SW):	SW 5.1 Assignments: Differentiate null and alternative hypothesis and explain chi square test. SW 5.2 Mini Project: How T-Test and Chi-Square test are playing important role in biostatistics? SW 5.3 Other Activities (Specify): Find out some you tube videos based on Test of significance.

Brief of hours suggested for the Course Outcome

Course Outcomes (COs)	**Class lecture (Cl)**	**Laboratory Instruction (LI)**	**Self-Learning (SL)**	**Sessional work (SW)**	**Total Hours (Li+CI+SL+SW)**
CO1. Describe the roles biostatistics serves in the discipline of public health.	**6**	**4**	**2**	**1**	**13**
CO2. Apply basic statistical concepts commonly used in public health and health Sciences	**6**	**4**	**2**	**1**	**13**
CO3. Demonstrate basic analytical techniques to generate results	**6**	**4**	**2**	**1**	**13**
CO4. Interpret results of commonly used statistical analyses in written summaries	**6**	**4**	**2**	**1**	**13**
CO5. Demonstrate statistical reasoning skills accurately and contextually	**6**	**4**	**2**	**1**	**13**
Total Hours	**30**	**20**	**10**	**05**	**65**

Suggestion for End semester Assessment

Course Outcome	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO1	Introduction to Biostatistics	03	02	04	09
CO2	Measures of central Tendency	04	05	02	11
CO3	Probability	02	06	02	10
CO4	Correlation and Regression	03	05	02	10
CO5	Test of significance	03	04	03	10
Total		**15**	**22**	**13**	**50**

Legend: R: Remember **U:** understand **A:** Apply

The end of semester assessment for biostatistics will be held with the written examination 50 Marks.

Suggested learning Resources:

(a) Books:

S.no.	**Title**	**Author**	**Publisher**	**Edition & Year**
1	Biostatistics	P.N.Arora, P.K.Malhan	Himalaya Publishing House	2 & 2005
2	Fundamentals of biostatistics	Khan and khanam	Ukaaz Publication	2 & 2004
3	Elements Of Biostatistics,	Prasad	Rastogi Publication	3& 2009

CO, PO and PSO Mapping

Program Title: B. Tech. Biotechnology　　　　**Semester:** 3rd

Course Code: 98BT303　　　　**Course Title: Biostatistics**

CO/PO 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**
98BT303.1	-	-	-	1	2	2	2	-	1	2	2	3	3	2	1
98BT303.2	-	-	-	-	-	-	3	-	2	2	3	3	2	1	2
98BT303.3	-	1	1	1	-	-	2	-	3	1	1	2	1	2	1
98BT303.4	-	1	1	-	2	2	2	3	-	1	-	-	2	2	3
98BT303.5	1	1	1	-	-	2	3	3	1	2	2	2	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)
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	98BT303.1 Describe the roles biostatistics serves in the discipline of public health.	SO1.1 SO1.2 SO1.3 SO1.4, SO1.5 SO1.6	**LI 1** **LI 2**	Unit-1 Introduction to Biostatistics 1.1,1.2,1.3,1.4,1.5, 1.6	**1SL-1,2,**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	98BT303.2 Apply basic statistical concepts commonly used in public health and health Sciences	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6	**LI 1** **LI 2**	Unit-2 Measures of central Tendency 2.1, 2.2, 2.3, 2.4, 2.5,2.6	**2SL-1,2**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	98BT303.3 Demonstrate basic analytical techniques to generate results	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6	**LI 1** **LI 2**	Unit-3 Probability 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	98BT303.4 Interpret results of commonly used statistical analyses in written summaries	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6	**LI 1** **LI 2**	Unit-4 Correlation and Regression 4.1,4.2,4.3,4.4,4.5, 4.6	**4SL-1,2**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	98BT303.5 Demonstrate statistical reasoning skills accurately and contextually	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6	**LI 1** **LI 2**	Unit-5 Test of significance 5.1,5.2,5.3,5.4,5.5,5.6	**5SL-1,2**

Program Name	**B.Tech. Biotechnology**	
Semester	III	
Course Code:	HMSC301	
Course title:	Universal Human Values	**Curriculum Developer**: Dr Ashutosh Pandey, Assistant Professor
Pre-requisite:	Creating awareness among the students on a holistic perspective about life.	
Rationale:	The purpose is to help develop a holistic perspective about life. A self- reflective methodology of teaching is adopted. It opens the space for the student to explore his/her role (value) in all aspects of living – as an individual, as a member of a family, as a part of the society and as a unit in nature. Through this process of self-exploration, students can discover the values intrinsic in them.	
Course Outcomes (COs):	**HMSC 301.1:** To explore the importance of understanding classroom value inputs, skills vs. values, education's needs, foundations, curriculum, and procedure in assessing happiness, prosperity, and society. **HMSC 301.2:** Differentiate the Self and Body and grasp Self-Harmony and Self-Body Coexistence. **HMSC 301.3:** To explore how trust, respect, and other naturally appropriate feelings in human-human relationships contribute to a peaceful society. **HMSC 301.4:** Understand the harmony in nature and existence, and workout their mutually fulfilling participation in nature. **HMSC 301.5:** Students will have the ability to apply the gained knowledge in Implications of Holistic Understanding- A Look at Professional Ethics**.**	

Scheme of Studies:

Course Category	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C) (L:T:P)
			CI	LI	SW	SL	Total Hours (CI+LI+SW+SL)	
VAC	UHV	Universal Human Values	4 (3+1)	0	1	1	1	4

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 projectetc.),
SL: SelfLearning,
C: Credits

Note: Proposed examination scheme (Marking) as per the recommendation of University Grant Commission (UGC) for Under Graduate Courses in Fundamentals of Universal Human Values 2022-23 onwards 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

Course Category	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 (HA)	Class Test 2 (2 best out of 3)10 marks each (CT)	Seminar one (TSN)	Class Activity anyone (TCA)	Class Attendance (TA)	Total, Marks (HA+CT+TSN+TCA+TA)		
VAC	HSMC	Universal Human Value	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.

Item	SO	LI	SW	SL	Total
Approx Hrs.	12	0	01	02	15

HMSC 301.1: To explores the importance of understanding classroom value inputs, skills vs. values, education's needs, foundations, curriculum, and procedure in assessing happiness, prosperity, and society.	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**SelfLearning (SL)**
	SO1.1 Understand the need for and importance of value education.		CI 1.1 Lecture: Introduction to value education - Need, guidelines, content, and process.	SL1.1 Research and prepare a report on the role of value education in personal and professional life.
	SO1.2 Explain the basic guidelines and content for value education.		CI 1.2 Workshop: Basic guidelines and content for value education.	SL1.2 Reflective essay on how value education can influence societal change.
	SO 1.3 Understand the process of self-exploration and its significance.		CI 1.3 Lecture: Self-exploration – Its content and process.	
	SO 1.4 Explain the concepts of 'Natural Acceptance' and 'Experiential Validation' in self-exploration.		CI 1.4 Practical: Exercises on self-exploration using natural acceptance and experiential validation.	
	SO 1.5 Understand the basic human aspirations of continuous happiness and prosperity.		CI 1.5 Discussion: Continuous happiness and prosperity - Basic human aspirations.	
	SO 1.6 Explain the concepts of right understanding, relationships, and physical facilities in fulfilling human aspirations.		CI 1.6 Lecture: Right understanding, relationship, and physical facilities - Their role in human aspirations.	

	SO 1.7 Critically appraise the current scenario of understanding happiness and prosperity.		CI 1.7 Workshop: Understanding happiness and prosperity - A critical appraisal of the current scenario.	
	SO 1.8 Understand the method to fulfill human aspirations by living in harmony at various levels.		CI 1.8 Lecture: Methods to fulfill human aspirations - Living in harmony at various levels.	
	SO 1.9 Develop a personal plan for living in harmony with oneself and others.		CI 1.9 Practical: Developing a personal plan for living in harmony.	
	SO 1.10 Reflect on the impact of value education on personal and societal well-being.		CI 1.10 Discussion: Impact of value education on personal and societal well-being.	
	SO 1.11 Explore the relationship between value education and sustainable development.		CI 1.11 Lecture: Value education and its contribution to sustainable development.	
	SO 1.12 Evaluate the role of educational institutions in promoting value education.		CI1.12 Seminar: The role of educational institutions in promoting value education.	

Suggested Sessional Work (SW)	**SW 1.1 Assignments:** Continuous Happiness and Prosperity–the Basic Human Aspirations **SW 1.2 Mini Project:** Relationship and Physical Facility **SW 1.3 Other Activities (Specify):** Quiz, Class Test

Item	**SO**	**LI**	**SW**	**SL**	**Total**
Approx Hrs.	11	0	01	02	14

HMSC 301.2: Differentiate the Self and Body and grasp Self-Harmony and Self-Body Coexistence.	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
	SO2.1 Understand the concept of harmony in the human being and the self.		CI 2.1 Lecture: Introduction to harmony in the human being and the self.	SL2.1 Research and write an essay on different philosophical perspectives of self and harmony.
	SO 2.2 Explain the co-existence of the sentient 'I' and the material 'Body'.		CI 2.2 Lecture: Understanding human being as a co-existence of the sentient 'I' and the material 'Body'.	SL2.2 Reflective journal on personal experiences of the relationship between 'I' and the body.
	SO 2.3 Differentiate between the needs of Self ('I') and the 'Body' - Sukh and Suvidha.		CI 2.3 Discussion: Needs of Self ('I') and 'Body' - Sukh (happiness) and Suvidha (facilities).	
	SO 2.4 Understand the Body as an instrument of 'I' (I being the doer, seer, and enjoyer).		CI 2.4 Lecture: The Body as an instrument of 'I' - Roles of doer, seer, and enjoyer.	

	SO 2.5 Describe the characteristics and activities of ‘I’ and harmony in ‘I’.		CI 2.5 Workshop: Exploring characteristics and activities of ‘I’ - Finding harmony within.	
	SO 2.6 Understand the harmony of ‘I’ with the Body: Sanyam and Swasthya.		CI 2.6 Lecture: Harmony of ‘I’ with the Body - Sanyam (self-regulation) and Swasthya (health).	
	SO 2.7 Appraise physical needs correctly in the context of harmony and well-being.		CI 2.7 Practical: Appraising physical needs correctly to maintain harmony and well-being.	
	SO 2.8 Understand the detailed meaning of Prosperity.		CI 2.8 Lecture: Prosperity - Detailed understanding and its implications.	
	SO 2.9 Develop programs for Sanyam (self-regulation) and Swasthya (health).		CI 2.9 Workshop: Developing personal programs for Sanyam and Swasthya.	
	SO 2.10 Reflect on personal practices and their alignment with the concept of Sanyam and Swasthya.		CI 2.10 Discussion: Reflecting on personal practices and their alignment with Sanyam and Swasthya.	

	SO 2.11 Evaluate the impact of Sanyam and Swasthya on overall well-being.		CI 2.11 Lecture: Evaluating the impact of Sanyam and Swasthya on individual and societal well-being.	

Suggested Sessional Work (SW-2)	**SW 2.1: Assignments:** Harmony in the self **SW 2.2: Mini Project:** Body an instrument **SW 2.3: Other Activities (Specify):** Quiz, Class Test.

Item	SO	LI	SW	SL	Total
Approx. Hrs.	13	0	01	05	19

HMSC 301.3: To explore how trust, respect, and other naturally appropriate feelings in human-human relationships contribute to a peaceful society.	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
	SO3.1 Understand the concept of harmony in the family and its importance as the basic unit of human interaction.		CI 3.1 Lecture: Introduction to harmony in the family - The basic unit of human interaction.	SL3.1 Research and write an essay on the significance of family harmony in societal development.
	SO 3.2 Explain the values in human-human relationships, including the meanings of Nyaya and Ubhay-tripti.		CI 3.2 Workshop: Understanding values in human-human relationships - Nyaya and Ubhay-tripti.	SL3.2 Reflective journal on personal experiences and observations of values in human relationships.
	SO 3.3 Understand the foundational values of trust (Vishwas) and respect (Samman) in relationships.		CI 3.3 Lecture: Trust (Vishwas) and Respect (Samman) as foundational values of relationships.	
	SO 3.4 Differentiate between intention and competence in the context of Vishwas.		CI 3.4 Discussion: Understanding Vishwas - Intention vs. competence.	
	SO 3.5 Explain the meaning of Samman and differentiate between respect and differentiation.		CI 3.5 Lecture: Understanding Samman - Difference between respect and differentiation.	
	SO 3.6 Identify and understand other salient values in relationships.		CI 3.6 Workshop: Exploring other salient values in relationships.	
	SO 3.7 Understand the concept of harmony in society as an extension of the family.		CI 3.7 Lecture: Harmony in society - An extension of the family.	

	SO 3.8 Explain the comprehensive human goals: Samadhan, Samridhi, Abhay, and Sah-astitva.		CI 3.8 Discussion: Comprehensive human goals - Samadhan, Samridhi, Abhay, and Sah-astitva.	
	SO 3.9 Visualize a universal harmonious order in society - Undivided Society (Akhand Samaj) and Universal Order (Sarvabhaum Vyawastha).		CI3.9 Seminar: Universal harmonious order in society - Undivided Society and Universal Order.	
	SO 3.10 Understand the role of family and educational institutions in promoting harmony in society.		CI 3.10 Lecture: The role of family and educational institutions in societal harmony.	SL3.3 Prepare a report on how educational institutions can contribute to societal harmony.
	SO 3.11 Reflect on the interrelationship between individual actions and societal harmony.		CI3.11 Discussion: Interrelationship between individual actions and societal harmony.	SL3.4 Write a reflective essay on personal actions that can promote societal harmony.
	SO 3.12 Evaluate personal values and their alignment with the concept of societal harmony.		CI 3.12 Lecture: Personal values and their alignment with societal harmony.	SL3.5 Create a personal action plan to enhance alignment with societal harmony.
	SO 3.13 Explore the impact of global cultural differences on achieving a universal harmonious order.		CI3.13 Seminar: Impact of global cultural differences on universal harmonious order.	

Suggested Sessional Work (SW-3):	**SW 3.1 Assignments:** Respect their right evaluation **SW 3.2 Mini Project:** Trust is the fundamental value of relationships **SW 3.3 Other Activities (Specify):** Quiz, Class Test.

Item	SO	LI	SW	SL	Total
Approx. Hrs.	12	0	01	04	17

HMSC 301.4: Understand the harmony in nature and existence, and workout their mutually fulfilling participation in nature.	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
	SO4.1 Understand the concept of harmony in nature and its significance.		CI 4.1 Lecture: Introduction to harmony in nature.	SL4.1 Research and write a report on the importance of harmony in nature for sustainable living.
	SO4.2 Explain the interconnectedness and mutual fulfillment among the four orders of nature.		CI4.2 Workshop: Exploring interconnectedness and mutual fulfillment in nature.	SL4.2 Reflective journal on personal observations of interconnectedness in nature.
	SO4.3 Understand recyclability and self-regulation in nature.		CI4.3 Lecture: Recyclability and self-regulation in nature.	
	SO4.4 Explore the concept of existence as co-existence (Sah-astitva) of mutually interacting units.		CI4.4 Discussion: Understanding existence as co-existence.	
	SO4.5 Understand the holistic perception of harmony at all levels of existence.		CI4.5 Lecture: Holistic perception of harmony at all levels of existence.	
	SO 4.6 Identify examples of mutual fulfillment in nature.		CI4.6 Workshop: Identifying mutual fulfillment in nature.	

	SO 4.7 Analyze the role of natural cycles in maintaining harmony in nature.		CI4.7 Discussion: Natural cycles and their role in maintaining harmony.	
	SO 4.8 Explore the concept of co-existence in various cultures and philosophies.		CI 4.8 Seminar: Co-existence in different cultures and philosophies.	SL4.3 Prepare a project proposal for a community-based initiative to promote harmony with nature.
	SO 4.9 Understand the impact of human activities on the harmony in nature.		CI 4.9 Lecture: Human activities and their impact on natural harmony.	
	SO 4.10 Identify ways to restore and maintain harmony in nature through sustainable practices.		CI 4.10 Workshop: Sustainable practices to restore and maintain natural harmony.	
	SO 4.11 Reflect on personal actions and their alignment with natural harmony.		CI 4.11 Discussion: Personal actions and natural harmony.	SL4.4 Write a reflective essay on personal actions that can promote societal harmony.
	SO 4.12 Evaluate the importance of educating others about harmony in nature and existence.		CI4.12Lecture: The importance of education in promoting harmony in nature and existence.	

Suggested Sessional Work (SW-4):	**SW 4.1 Assignments:** Harmony in nature **SW 4.2 Mini Project:** Exploring4 orders of nature **SW 4.3 Other Activities (Specify):** Quiz, Class Test.

Item	SO	LI	SW	SL	Total
Approx. Hrs.	12	0	01	05	18

HMSC 301.5: Students will have the ability to apply the gained knowledge in Implications of Holistic Understanding-A Look at Professional Ethics.	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
	SO5.1 Understand the natural acceptance of human values.		CI 5.1 Lecture: Introduction to natural acceptance of human values.	SL5.1 Reflective journal on personal values and natural acceptance.
	SO 5.2 Explain the definitiveness of ethical human conduct.		CI 5.2 Workshop: Exploring definitiveness of ethical human conduct.	SL 5.2 Write an essay on the importance of ethical conduct in professional life.
	SO 5.3 Understand the basis for humanistic education.		CI 5.3 Lecture: Basis for humanistic education.	SL 5.3 Interview educators about the challenges and benefits of humanistic education.
	SO 5.4 Explore the concept of a humanistic constitution and humanistic universal order.		CI 5.4 Seminar: Humanistic constitution and universal order.	SL 5.4 Research and write a paper on the impact of a humanistic constitution on societal well-being.
	SO 5.5 Identify the competence in professional ethics required for augmenting the universal human order.		CI 5.5 Lecture: Competence in professional ethics.	

	SO 5.6 Understand the ability to utilize professional competence for promoting people-friendly and eco-friendly production systems.		CI 5.6 Workshop: People-friendly and eco-friendly production systems.	
	SO 5.7 Analyze the scope and characteristics of eco-friendly technologies and management models.		CI 5.7 Discussion: Characteristics of eco-friendly technologies and management models.	
	SO 5.8 Evaluate case studies of typical holistic technologies, management models, and production systems.		CI 5.8 Seminar: Case studies of holistic technologies, management models, and production systems.	
	SO 5.9 Understand the strategy for transitioning from the current state to a universal human order at the individual level.		CI 5.9 Lecture: Strategy for transitioning to universal human order at the individual level.	
	SO 5.10 Explore the role of socially and ecologically responsible engineers, technologists, and managers.		CI 5.10 Workshop: Role of responsible engineers, technologists, and managers.	SL 5.5 Prepare a project proposal for implementing a socially responsible engineering practice in your community.
	SO 5.11 Understand the strategy for transitioning to a universal human order at the societal level.		CI 5.11 Lecture: Strategy for transitioning to universal human order at the societal level.	

	SO 5.12 Explore the role of mutually enriching institutions and organizations in achieving a universal human order.		CI5.12 Seminar: Role of enriching institutions and organizations.	

Suggested Sessional Work (SW-5): anyone	**SW 5.1 Assignments:** Human conduct **SW 5.2 Mini Project:** Humanistic constitution **SW 5.3 Other Activities (Specify):** Quiz, Class Test**.**

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)
HMSC 301.1: To explores the importance of understanding classroom value inputs, skills vs. values, education's needs, foundations, curriculum, and procedure in assessing happiness, prosperity, and society.	12	0	01	02	15
HMSC 301.2: Differentiate the Self and Body and grasp Self-Harmony and Self-Body Coexistence.	11	0	01	02	14
HMSC 301.3: To explore how trust, respect, and other naturally appropriate feelings in human-human relationships contribute to a peaceful society.	13	0	01	05	19
HMSC 301.4: Understand the harmony in nature and existence, and workout their mutually fulfilling participation in nature.	12	0	01	04	17
HMSC 301.5: Students will have the ability to apply the gained knowledge in Implications of Holistic Understanding- A Look at Professional Ethics.	12	0	01	05	18
Total Hours	60	0	05	18	83

Suggestion for End Semester Assessment: Suggested Specification Table

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	**HMSC 301.1:** To explores the importance of understanding classroom value inputs, skills vs. values, education's needs, foundations, curriculum, and procedure in assessing happiness, prosperity, and society.	02	04	05	11
CO-2	**HMSC 301.2:** Differentiate the Self and Body and grasp Self-Harmony and Self-Body Coexistence.	03	07	04	14
CO-3	**HMSC 301.3:** To explore how trust, respect, and other naturally appropriate feelings in human-human relationships contribute to a peaceful society.	02	06	02	10
CO-4	**HMSC 301.4:** Understand the harmony in nature and existence, and workout their mutually fulfilling participation in nature.	03	03	02	08
CO-5	**HMSC 301.5:** Students will have the ability to apply the gained knowledge in Implications of Holistic Understanding- A Look at Professional Ethics.	03	02	02	07
Total		13	22	15	50

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

The end of semester assessment 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. Demonstration
7. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Online sources)
8. Brainstorming
9. Seminar
10. Workshop

SuggestedLearningResources:

(a) Books:

S. No.	Title	Author	Publisher	Edition&Year
1	Jeevan Vidya: Ek Parichaya	A Nagaraj	Jeevan Vidya Prakashan, Amarkantak	1998
2	Human Values	A.N.Tripath	New AgeIntl. Publishers, New Delhi,	2004
3	Universal Human Values		AICTE	2021

4	Human Values and Professional Ethics	R.R. Gaur, R Sangal And G P Bagaria	Excel Book Publisher	2009
5	Vyavaharvadï Samajshastra	A Nagaraj	Jeevan VidyaPrakashan, Amar kantak	1999
6	Manava Vyavahara Darsana	A Nagaraj	Jeevan Vidya Prakashan, Amarkantak	2003
7	Foundations of Ethics and Management,	BP Banerjee	ExcelBook	2005
8	Fundamentals of Ethicsfor Scientists & Engineers	EGSeebauer& RobertL.Berry	OxfordUniversity Press.	2000
9	Engineering Ethichs (includingHumanValues)	MGovindrajran,S Natrajan and V.S. SenthilKumar	Eastern Economy Edition,PrenticeHall ofIndiaLtd.	-

Curriculum Development Team

1. Professor G C Mishra, Director Cement Technology, AKS University
2. Professor Mahendra Tiwari
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4. DrRahul Omar, Assistant Professor , Dept. of Cement Technology
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6. Dr Gaurav Shukla , Assistant Professor , Dept of Cement Technology
7. ErPriynka Singh, Assistant Professor , Dept. of Cement Technology
8. Er A K Bhattacharya, Faculty , Dept. of Cement Tech.(Former GM M/s Dalmia Cement)
9. Sh Rajesh Kushuwaha, Faculty, Faculty , Dept. Cement Tech. (former Manager M/s JP cement)

10. Sh V K Singh, Sr Faculty, Dept. Cement Tech. (Former GM M/s Maihar Cement)

COs, POsandPSOs Mapping

Program Title: B.TechCourse Code: HMSC301; Course Title: Universal Human Values

Course Outcomes	Program Outcomes												ProgramSpecificOutcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
	Engineering 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 for production	Ability to understand the day to plant operational problems of cement	Ability to understand the latest cement manufacturing technology	Ability to use the research based innovative knowledge for sustainable
HMSC 301.1 To understanding Value Education	2	2	3	2	1	1	1	3	2	1	1	2	2	2	2	2
HMSC 301.2 Students will have the ability to learn about Harmony in the Human Being	2	2	1	3	1	2	1	3	2	2	2	2	2	2	2	2
HMSC 301.3 Student will be able to gain knowledge on Harmony in the Family and Society.	2	1	2	1	1	2	2	3	2	1	2	3	2	2	2	2
HMSC 301.4 Understanding Harmony in the Nature/Existence.	1	1	1	2	1	2	1	3	2	1	2	2	2	2	3	3
HSMC301.5: Student will able to understand about Implications of Holistic Understanding- A Look at Professional Ethics.	1	1	1	1	1	2	2	3	1	2	2	2	3	2	3	2

Legend:1–Low,2–Medium,3–High

Course Curriculum Map: Physics-I

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 PSO1,2,3,4	**HMSC 301.1** To understanding Value Education	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9 SO1.10 SO1.11 SO1.12		**Unit-1: Understanding Value Education** 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9 , 1.10, 1.11, 1.12	SL1,2
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO1,2,3,4	**HMSC 301.2** Students will have the ability to learn about Harmony in the Human Being	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9 SO2.10 SO2.11		**Unit-2: Harmony in the Huma Being** 2.1,2.2,2.3,2.4,2.5,2.6,2.7, 2.8,2.9, 2.10, 2.11	SL1,2
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO1,2,3,4	**HMSC 301.3** Student will be able to gain knowledge on Harmony in the Family and Society.	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		**Unit-3: Harmony in the Family and Society** 3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9 3.10 3.11 3.12 3.13	SL1,2,3,4
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO1,2,3,4	**HMSC 301.4** Understanding Harmony in the Nature/Existence.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8 SO4.9 SO4.10 SO4.11 SO4.12		**Unit-4: Harmony in th Nature/Existence** **Implications of Holistic** 4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9, 4.10 4.11 4.12	SL1,2,3,4,5
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO1,2,3,4	**HSMC301.5** Student will able to understand about Implications of Holistic Understanding- A Look at Professional Ethics.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9 SO5.10 SO5.11 SO5.12		**Unit 5: Understanding- A Look at Professional Ethics** 5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8, 5.9, 5.10 5.11 5.12	SL1,2,3,4

B. Tech. Biotechnology 4^{th} Semester

Program Name	**Bachelor of Technology (B.Tech.)- Biotechnology**	
Semester	IV	
Course Code:	98BT402	
Course title:	Biochemical Engineering	**Curriculum Developer**: Er. Arpit Srivastava, Assistant Professor
Pre-requisite:	Students should have basic knowledge of basic mathematical calculations, and fermentation.	
Rationale:	Biochemical engineering provides information in bioprocess engineering, bioinformatics, and biotechnology for students. In India and outside, there is a lot of opportunity for biochemical engineers. Across a range of industries, biochemical engineers can find work. They work in the food industry, nuclear industry, healthcare industry, chemical manufacturing firms, pharmaceutical industry, research labs, and other sectors. Biochemical engineers develop novel products and manufacturing methods from biological materials by utilizing cutting-edge technology and their expertise in biology, chemistry, and engineering. They frequently collaborate in a laboratory setting with scientists and other engineers to evaluate material interactions in order to generate product concepts.	
Course Outcomes (COs):	**CO1-98BT402.1.** Illustrate the basic mechanism of Biochemical Engineering & Mass Balance **CO2-98BT402.2.** Discuss the role of Energy Balance in bioprocessing **CO3-98BT402.3.** Comprehend & distinguish among the working mechanism of Heat transfer **CO4-98BT402.4.** Interpretate the mechanism of Biochemical Kinetics **CO5-98BT402.5.** Examine and demonstrate the mechanism of Cellular Metabolism and Kinetics	

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)**	
Program Common (PC)	98BT402	Biochemical Engineering	2	2	1	3	8	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	98BT402	Biochemical Engineering	**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	98BT452	Biochemical Engineering	35	5	5	5	50	50	50

Course-Curriculum:

<table>
<tr>
<td>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.</td>
<td>Approximate Hours
<table>
<tr><td>Item</td><td>Cl</td><td>LI</td><td>SW</td><td>SL</td><td>Total</td></tr>
<tr><td>Approx. Hrs</td><td>06</td><td>04</td><td>01</td><td>05</td><td>16</td></tr>
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Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-98BT402.1 Illustrate the basic mechanism of Biochemical Engineering & Mass Balance	**SO1.1** Explain concept of Biochemical engineering	**LI1.1** To determine the biomass yield	**Unit-1** **CI1.1** Outline of Biochemical Engineering	**SL1.1** Practice to operate scientific calculator
	SO1.2 Define Basic terminology, scope and application	**LI1.2** To determine the consumption of substrate	**CI1.2** Significance of Biochemical Engineering	**SL1.2** Solve numerical problems related to Mass Balance
	SO1.3 Elaborate the scientific applications of Mass balance		**CI1.3** Thermodynamic preliminaries, law of conservation of mass	**SL1.3** Write down few points on Microbial growth kinetics
	SO1.4 Define the mechanism of Conservation of Mass in biochemical engineering		**CI1.4** Types of material balances, Procedure of material balance	**SL1.4** Learn to calculate the mass balance based numerical
	SO1.5 Describe Material balance and its significance		**CI1.5** Material balance with: recycle, bypass, and purge stream	**SL1.5** Understand the basic problem solving related to biomass-substate based yield
	SO1.6 Interpret and solve stoichiometry of growth and product formation, Derive Biomass yield, Theoretical yield, Oxygen demand, Max. possible Yield		**CI1.6** Derive and Solve numerical related to stoichiometry of growth and product formation Derive Biomass yield, Theoretical yield, Oxygen demand, Max. possible Yield	

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	04	01	05	16

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Describe in detail about the role of Biochemical Engineering in Product development
	SW1.2 Mini Project	Differentiate between Upstream and Downstream processing
	SW1.3 Other Activities (Specify)	Draw a flowchart compiling all procedures used in Mass Balance equations

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO2-98BT402.2. Discuss the role of Energy Balance in bioprocessing	**SO2.1** Explain concept of Energy balance	**LI2.1** Demonstrate the working of Energy balance in fermentation process	**Unit-2** **CI2.1** Basic energy concepts, units, Energy balance equations	**SL2.1** Find out the role of Kinetic, Potential and Internal energy in biochemical engineering
	SO2.2 Distinguish between Adiabatic process, Steady state process	**LI2.2** To perform the experiment of production of microbial biomass	**CI2.2** Adiabatic process, Steady state process	**SL2.2** Read the difference between Adiabatic process, Steady state process
	SO2.3 Outline the mechanism of Enthalpy change in Non-Reactive process		**CI2.3** Enthalpy change in Non-Reactive process	**SL2.3** Write down few points on Enthalpy change in Non-Reactive process
	SO2.4 Define the mechanism of biological separations		**CI2.4** Procedure for energy balance calculation	**SL2.4** Solve all numerical related to energy balance equations
	SO2.5 Explain the role of Rotary vacuum filtration unit		**CI2.5** Enthalpy change due to Reaction	
	SO2.6 Illustrate the mechanism of change in Phase due to energy, critical mechanism of Energy and Mass Balance equation, Solve numerical		**CI2.6** Change of Phase, Energy and Mass Balance equation corelation, Fermentation Energy	

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	04	01	04	15

	problem related to energy balance and phase changes			

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Solve numerical on the basis of energy balance equation
	SW2.2 Mini Project	Make a project on Adiabatic process and Steady State process
	SW2.3 Other Activities (Specify)	Make a Power point presentation on Energy mass balance

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO3-98BT402.3. Comprehend & distinguish among the working mechanism of Heat transfer	**SO3.1** Elucidate the Mechanism of heat transfer, Equipment of heat transfer	**LI3.1** To perform the Heat transfer to observe how heat transfer occurring in fermentation technology	**Unit-3** **CI3.1** Mechanism of heat transfer, Equipment of heat transfer	**SL3.1** Find out the process of heat transfer in fermentation
	SO3.2 Derive the mathematical expression for Conduction, Heat transfer between fluids	**LI3.2** to perform the experiment on heat transfer	**CI3.2** Conduction, Heat transfer between fluids	**SL3.2** Read the process of Conduction, Convection and Radiation
	SO3.3 Distinguish Heat Transfer and Overall heat transfer coefficient		**CI3.3** Heat Transfer and Overall heat transfer coefficient	**SL3.3** Solve numerical problem given in textbooks of Heat transfer
	SO3.4 Solve numerical on Heat transfer coefficients		**CI3.4** Calculations of Heat transfer coefficients	
	SO3.5 Explain the role of Mass transfer in biochemical engineering		**CI3.5** Mass Transfer - Introduction	

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	04	01	05	16

	SO3.6 Discuss Liquid –Liquid Mass transfer		**CI3.6** Liquid –Liquid Mass transfer	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Derive the equations for Heat Transfer for conduction, convection in fermentation technology
	SW3.2 Mini Project	Describe the role of heat Transfer coefficients
	SW3.3 Other Activities (Specify)	Prepare one Power point presentation on "Double Pipe Heat Exchangers and its mechanism"

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO4-98BT402.4. Interpretate the mechanism of Biochemical Kinetics	**SO4.1** Elucidate the Fundamental Reaction Kinetics	**LI4.1** To perform the kinetics of enzyme using graphical method	**Unit-4** **CI4.1** Fundamental Reaction Kinetics	**SL4.1** Find out the Fundamental Reaction Kinetics
	SO4.2 Distinguish among Rates of Chemical Reaction, Elementary Reaction and Equilibrium	**LI4.2** To check the enzyme kinetics of the bacterial microbes	**CI4.2** Rates of Chemical Reaction, Elementary Reaction and Equilibrium	**SL4.2** Understand how the rate of chemical reaction occurs
	SO4.3 Analyse the Temperature Dependence of Reaction Rate Constant k		**CI4.3** Temperature Dependence of Reaction Rate Constant k	**SL4.3** Evaluate and derive Temperature Dependence of Reaction Rate Constant k
	SO4.4		**CI4.4**	**SL4.4**

Item	Cl	LI	SW	SL	Total
Approx. Hrs	6	04	01	04	15

	Distinguish among the Rate Equations for First- and Second-Order Reactions		Rate Equations for First- and Second-Order Reactions	Derive different kinds of enzyme reaction kinetic study
	SO4.5 Discuss Enzyme Reaction Kinetics		**CI4.5** Enzyme Reaction Kinetics	
	SO4.6 Evaluate Enzyme Reaction Kinetics		**CI4.6** Evaluation of Enzyme Reaction Kinetics	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Determine the working mechanism and applications of enzymes
	SW4.2 Mini Project	Derive the MM Equation for ES complex theory
	SW4.3 Other Activities (Specify)	Make a project on "Inhibitors for enzyme reactions"

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO5-98BT402.5. Examine and demonstrate the mechanism of Cellular Metabolism and Kinetics	**SO5.1** Elucidate Carbohydrate Metabolism, Glycolysis	**LI5.1** To determine the ATPs produced in Glycolysis	**Unit-5** **CI5.1** Carbohydrate Metabolism, Glycolysis	**SL5.1** Find out the role of glycolysis
	SO5.2 Discuss the role of TCA cycle	**LI5.2** To determine the protein 3D structure, function and annotations using	**CI5.2** Metabolic Pathway of TCA cycle	**SL5.2** List down various kinds of metabolites produced in TCA cycle

		Protein Data Bank (PDB database)		
	SO5.3 Analyse the working of Electron transport system		**CI5.3** Electron transport system	**SL5.3** Draw the flow chart for ETC
	SO5.4 Discuss Oxidative Phosphorylation		**CI5.4** Oxidative Phosphorylation	**SL5.4** Draw the flow chart for Oxidative Phosphorylation
	SO5.5 Describe Microbial growth curve		**CI5.5** Microbial Growth curve	**SL5.5** Draw the graph for Microbial Growth curve
	SO5.6 Derive Cell Growth kinetics in Batch culture		**CI5.6** Cell Growth kinetics in Batch culture	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Explain general mechanism of Cell Growth kinetics
	SW5.2 Mini Project	Describe the Biomass and Product based yield factors
	SW5.3 Other Activities (Specify)	Write metabolic pathway for TCA cycle

Course duration (in hours) to attain Course Outcomes:

Course Title: Biochemical Engineering **Course Code:** 98BT402

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO5-98BT402.5. Examine and demonstrate the mechanism of Cellular Metabolism and Kinetics	6	4	5	1	16
CO2-98BT402.2. Discuss the role of Energy Balance in bioprocessing	6	4	5	1	16
CO3-98BT402.3. Comprehend & distinguish among the working mechanism of Heat transfer	6	4	4	1	15

CO4-98BT402.4. Interpretate the mechanism of Biochemical Kinetics	6	4	5	1	16
CO5-98BT402.5. Examine and demonstrate the mechanism of Cellular Metabolism and Kinetics	6	4	4	1	15
Total Hours	30	20	23	05	78

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

Course Title: Biochemical Engineering **Course Code:** 98BT402

Course Outcomes	**Marks Distribution**				**Total Marks**
	A	**An**	**E**	**C**	
CO5-98BT402.5. Examine and demonstrate the mechanism of Cellular Metabolism and Kinetics	2	1	1	1	5
CO2-98BT402.2. Discuss the role of Energy Balance in bioprocessing	2	4	5	1	12
CO3-98BT402.3. Comprehend & distinguish among the working mechanism of Heat transfer	3	5	5	1	14
CO4-98BT402.4. Interpretate the mechanism of Biochemical Kinetics	2	3	5	1	11
CO5-98BT402.5. Examine and demonstrate the mechanism of Cellular Metabolism and Kinetics	5	4	1	0	10
Total Marks	**14**	**17**	**17**	**04**	**52**

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

Suggested learning Resources:

(a) Books:

(b)

S.No.	Title/Author/Publisher details
1	Pauline M. Doran, “Bioprocess engineering principles”: Academic press
2	James E. Bailey & David F. Ollis- Biochemical engineering fundamentals
3	Peter F. Stanbury, Allan Whitaker “Principles of fermentation technology”

4	Fundamentals of Biochemistry. Author, JL Jain et al. Edition, reprint. Publisher, S. Chand Publishing, 2004.
5	Biotechnology-Questioning The Reasons: 2^{nd} Edition, Book Rivers Publication

(c) Online Resources:

Suggested instructions/Implementation strategies:

1. Improved lecture
2. Tutorial
3. Case method
4. Group Discussion
5. Role play
6. Visit to Waste water/Effluent Treatment plant and downstream pharmaceutical plants
7. Demonstration
8. ICT Based teaching Learning
9. Brainstorming

CO, PO and PSO Mapping

Semester: IV Semester

Course Title: Biochemical Engineering

Course Code: 98BT402

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**
CO5-98BT402.5. Examine and demonstrate the mechanism of Cellular Metabolism and Kinetics	-	1	-	1	2	2	3	-	3	2	2	3	1	2	1
CO2-98BT402.2. Discuss the role of Energy Balance in bioprocessing	-	1	-	-	-	-	3	-	2	2	3	3	3	-	2
CO3-98BT402.3. Comprehend & distinguish among the working mechanism of Heat transfer	-	1	1	1	-	-	3	-	3	1	1	2	1	2	-
CO4-98BT402.4. Interpretate the mechanism of Biochemical Kinetics	-	-	1	-	2	2	3	3	-	1	3	3	2	1	3
CO5-98BT402.5. Examine and demonstrate the mechanism of Cellular Metabolism and Kinetics	1	-	1	-	-	2	3	3	1	2	2	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 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO5-98BT402.1.** Examine and demonstrate the mechanism of Cellular Metabolism and Kinetics	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	**CO2-98BT402.2.** Discuss the role of Energy Balance in bioprocessing	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6	**LI 1** **LI 2**	2.1, 2.2, 2.3, 2.4, 2.5, 2.6	**2SL-1,2,3,4,5**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO3-98BT402.3.** Comprehend & distinguish among the working mechanism of Heat transfer	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6	**LI 1** **LI 2**	3.1,3.2,3.3,3.4,3.5, 3.6	**3SL-1,2,3,4**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO4-98BT402.4.** Interpretate the mechanism of Biochemical Kinetics	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6	**LI 1** **LI 2**	4.1,4.2,4.3,4.4, 4.5, 4.6	**4SL-1,2,3,4,5**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO5-98BT402.5.** Examine and demonstrate the mechanism of Cellular Metabolism and Kinetics	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6	**LI 1** **LI 2**	5.1,5.2,5.3,5.4,5.5, 5.6	**5SL-1,2,3,4**

Program Name	**Bachelor of Technology (B Tech) -Biotechnology**	
Semester	IV	
Course Code:	98BT404	
Course title:	Biosafety, Bioethics and IPRs	**Curriculum Developer**: Dr. Deepak Mishra, Professor
Pre-requisite:	Student should have basic knowledge of Biotechnology, Genetic Engineering and Research.	
Rationale:	The paper on Biosafety, Bioethics and IPRs in a B Tech Biotechnology program is interconnected concepts that serve to ensure the responsible and ethical use of biotechnology and biological resources. They encompass various aspects, from safety and ethics in research to the protection of intellectual property. The primary goal biosafety is to ensure the safe handling, transport, and disposal of biological materials, especially those with hazardous potential. This is crucial in laboratories, research facilities, and industrial settings where biological research is conducted. Bioethics guides decision-making, ensuring that scientific progress respects human rights, dignity, and welfare. It covers informed consent, privacy, research ethics, animal welfare, and issues surrounding emerging technologies like genetic engineering and cloning. IPRs incentivize innovation by allowing researchers and inventors to profit from their work.	
Course Outcomes (COs):	**CO1-98BT404.1:** Familiarization with the basic concepts, key principles and regulations of biosafety in biotechnological research. **CO2-98BT404.2:** Acquired Skills to analyze and address ethical, legal, and socioeconomic, health and safety implications of biotechnology. **CO3-98BT404.3:** Equipped to comprehend the fundamentals of IPRs, including the legal frameworks and laws. **CO4-98BT404.4:** Recognize various methods related to patents and the patenting process law and regulations in India. **CO5-98BT404.5:** Explore role of regulatory framework for recombinant DNA research, Biotechnology and food safety laws.	

Scheme of Studies:

Board of Study	Course Code	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)	
PC	98BT405	Biosafety, Bioethics and IPRs	2	2	1	3	8	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	Class Test 2 (2 best out of 3)	Seminar one	Activity	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)		

			3 marks each (CA)	10 marks each (CT)	(SA)					
PC	**98BT404**	Biosafety, Bioethics and IPRs	**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	**98BT455**	Biosafety, Bioethics and IPRs	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	06	04	01	04	15

Course outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction(CI)	Self-Learning(SL)
CO1-98BT404.1: Familiarization with the basic concepts, key principles and regulations of biosafety in biotechnological research.	**SO1.1** Define and Describe concept of Biosafety	**LI1.1** Case study on Biosafety	**Unit-1** **CI1.1** Biosafety: Introduction	**SL1.1** Search various reference books and study material to start the learning of Biosafety
	SO1.2 Explain History of biosafety		**CI1.2** Historical prospective	
	SO1.3 Explain objectives of biosafety		**CI1.3** objectives,	**SL1.2** Examine biosafety in your institution's lab
	SO1.4 Study of risk assessment and its regulation	**LI1.2** To do the Case study on risk assessment of lab	**CI1.4,** risk assessment in biotechnological research and their regulation	
	SO1.5 Study the concept of containment		**CI1.5** physical and biological contaminants	**SL1.3** Classify your lab based on biosafety level
	SO1.6 Study planned introduction of GMOs		**CI1.6** field trial and planned introduction of GMOs,	**SL1.4** To implement guideline in biotech laboratory.

Suggested Sessional Work (SW):*anyone*	**SW1.1** Assignments	Describe in detail biosafety guidelines for regulation of RDT research in India.
	SW1.2 Mini Project	Prepare biosafety symbols and implement in your laboratory.
	SW1.3 Other Activities (Specify)	Preparation of biosafety manual for biotechnology laboratory.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	04	01	05	16

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO2-98BT404.2: Acquired Skills to analyze and address ethical, legal, and socioeconomic, health and safety implications of biotechnology.	**SO2.1** Explore the concept bioethics	**LI2.1** Case Study on Women Health Ethics	**Unit-II** **CI2.1** Bioethics: Introduction	**SL2.1** Search various books and resources for study the bioethics.
	SO2.2 Describe the ethical issue of biotechnology	**LI2.2** Case Study on Medical Negligence	**CI2.2** Ethical issues related to biotechnology	**SL2.2** study about failure of biotech products- case study
	SO2.3 Reflecting impact of biotech research in society		**CI2.3** legal and socioeconomic impacts of biotechnology	
	SO2.4 Explain health and safety issues of biotech		**CI2.4** health and safety issues	**SL2.3** to learn about control measures for biotech research
	SO2.5 Assessing the benefits of cloning		**CI2.5** possible benefits of successful cloning	**SL2.4** standardize the protocol for successful cloning
	SO2.6 Explaining the ethical concern of cloning		**CI2.6** Ethical concerns of gene cloning	**SL2.5** to learn hazards of cloning

Suggested Sessional Work (SW):*anyone*	**SW2.1** Assignments	Assess the impact on RDT research on human and environment.
	SW2.2 Mini Project	Designing of poster for showing benefits of cloning
	SW2.3 Other Activities (Specify)	To perform case studies on GMOs and their impact.

Course Outcome (CO)	**Session Outcomes(Sos)**	**Laboratory Instruction(LI)**	**Class room Instruction (CI)**	**Self-Learning(SL)**
CO3-98BT404.3: Equipped to comprehend the fundamentals of IPRs, including the legal frameworks and laws.	**SO3.1** Explain the role of IPRs.	**LI3.1** Case Study on clinical trial of drugs	**Unit-III** **CI3.1** Intellectual Property Rights-: Introduction	**SL3.1** Collection of books and study materials for IPRs
	SO3.2 Assessing the concept of Intellectual Property		**CI3.2** intellectual property: trade secret	**SL3.2** Study different types of intellectual property
	SO3.3 Explaining concept of Patent and copy right	**LI3.2** preparation of business plan	**CI3.3** patent, copyright	**SL3.3** categorization of different types of intellectual property
	SO3.4 Assessing different plant varieties		**CI3.4** plant variety protection	
	SO3.5 Describe about WIPO GATT and Trips		**CI3.5** WIPO, GATT, TRIPs,:	**SL3.4** Study of role of WIPO for IPR protection
	SO3.6 Assessing the concept of PBR act		**CI3.6** plant breeder's rights	**SL3.5** Assess law and legislation for IPRs

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Describe in detail about different types of intellectual properties.
	SW3.2 Mini Project	Describe the role of different Laws for protection of intellectual property.
	SW3.3 Other Activities (Specify)	Prepare a list of plant varieties protected through PBR Act and PPVFR Act.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	06	04	01	05	16

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Classroom Instruction(CI)	Self-Learning(SL)
CO4-98BT404.4: Recognize various methods related to patents and the patenting process law and regulations in India.	**SO4.1** Exploring the concept of Patents and Patenting process	**LI4.1** Proxy Filling of Process Patent	**Unit-IV** **CI4.1** Patents and patent processing: Introduction	**SL4.1** Learn about different categories of Patents
	SO4.2 Assessing role of Patenting	**LI4.2** Proxy filling of Product Patent	**CI4.2** Essential requirements	
	SO4.3 Explaining the concept of patent law		**CI4.3** International scenario of patents	**SL4.2** Compare Rules of different countries
	SO4.4 Explaining the role of patent for biologics.		**CI4.4** patenting of biological materials	**SL4.3** Learn about various criteria for patentnig
	SO4.5 Evaluate impact of patent in india		**CI4.5** significance of patents in India	**SL4.4** Case studies related to patenting in India
	SO4.6 evaluate impact of patenting` of biological items		**CI4.6** protection of biotechnological inventions	**SL4.5** Case studies related to biological patents

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Explain about patent and patent processing procedure.
	SW4.2 Mini Project	Study the silent features of different law of patenting worldwide
	SW4.3 Other Activities (Specify)	Prepare one article on international status of patenting.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	06	04	01	04	15

Course Outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Classroom Instruction(CI)	Self-Learning(SL)
CO5-98BT404.5: Explore role of regulatory framework for recombinant DNA research, Biotechnology and food safety laws.	**SO5.1** Define the concept of regulation of RDNA research	**LI5.1** Demonstration of regulation of GM Products	**Unit-V** **CI5.1** Regulatory framework in Biotechnology	**SL5.1** learn about basic concept & requirement of GMOs development
	SO5.2 Able to execute role of Regulation of RDT Research		**CI5.2** Regulation of RDT research;	**SL5.2**Review concept of RDT research
	SO5.3 Apply the role of Regulation of Food products	**LI5.2** case study on Regulation of food	**CI5.3** Regulation of food and food ingredients	**SL5.3**learn how to apply Law to regulate food products
	SO5.4 Apply the Role of Regulatory framework of RDT		**CI5.4** Regulatory framework in India governing GMOs	
	SO5.5 Study the Recombinant DNA Guideline 1990		**CI5.5** Recombinant DNA Guidelines (1990)	
	SO5.6 Elaborate Revised Guideline for Research in Transgenic Plants (1998)		**CI5.6** Revised Guidelines for Research in Transgenic Plants (1998)	**SL5.4** Learn about novel characters of GM Plants

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Explain general characteristics and silent features of RDNA laws.
	SW5.2 Mini Project	Describe the role of Law and legislations for development of new varieties.
	SW5.3 Other Activities (Specify)	Prepare a detail document on international Food law and regulations

Course duration (in hours) to attain Course Outcomes:

Course Title: Biosafety, Bioethics and IPRs **Course Code:**98BT404

Course Outcomes(COs)	Class lecture (CI)	Laboratory Instruction(LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1-98BT404.1: Familiarization with the basic concepts, key principles and regulations of biosafety in biotechnological research.	6	4	4	1	15
CO2-98BT404.2: Acquired Skills to analyze and address ethical, legal, and socioeconomic, health and safety implications of biotechnology	6	4	5	1	16
CO3-98BT404.3: Equipped to comprehend the fundamentals of IPRs, including the legal frameworks and laws.	6	4	5	1	16
CO4-98BT404.4: Recognize various methods related to patents and the patenting process law and regulations in India	6	4	5	1	16
CO5-98BT404.5: Explore role of regulatory framework for recombinant DNA research, Biotechnology and food safety laws.	6	4	4	1	15
Total Hours	30	20	23	05	78

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

Course Title: Biosafety, Bioethics and IPRs **Course Code:**98BT404

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
CO1-98BT404.1: Familiarization with the basic concepts, key principles and regulations of biosafety in biotechnological research.	2	1	1	1	5
CO2-98BT404.2: Acquired Skills to analyze and address ethical, legal, and socioeconomic, health and safety implications of biotechnology	2	4	2	2	10

CO3-98BT404.3: Equipped to comprehend the fundamentals of IPRs, including the legal frameworks and laws.	2	3	3	2	10
CO4-98BT404.4: Recognize various methods related to patents and the patenting process law and regulations in India	3	5	5	2	15
CO5-98BT404.5: Explore role of regulatory framework for recombinant DNA research, Biotechnology and food safety laws.	5	4	1	0	10
Total Marks	**14**	**17**	**12**	**07**	**50**

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

Suggested learning Resources:

(d) Books:

(e)

S.No.	Title/Author/Publisher details
1	Sateesh MK (2010) Bioethics and Bio safety, I. K. International Pvt Ltd.
2	Sree Krishna V (2007) Bioethics and Bio safety in Biotechnology, New age international publishers
3	The law and strategy of Biotechnological patents by Sibley. Butterworth publications.
4	Intellectual property rights – Ganguli – Tat McGraw-Hill
5	Biotechnology-B. D. Singh- Kalyani Publications

(f) Online Resources:

Suggested instructions/Implementation strategies:

10. Improved lecture
11. Tutorial
12. Case method

13. Group Discussion
14. Role play
15. Visit to virology lab (BSL-3)
16. Demonstration
17. ICT Based teaching Learning
18. Brainstorming

CO, PO and PSO Mapping

Program Name: B.Tech. Biotechnology

Semester: 4th Semester

Course Title: Biosafety, Bioethics and IPRs

Course Code: 98BT404

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
CO1-98BT404.1: Familiarization with the basic concepts, key principles and regulations of biosafety in biotechnological research.	1	1	2	2	3	1	2	3	2	1	2	3	2	2	3
CO2-98BT404.2: Acquired Skills to analyze and address ethical, legal, and socioeconomic, health and safety implications of biotechnology	1	1	1	1	2	1	2	2	1	2	2	2	2	3	3
CO3-98BT404.3: Equipped to comprehend the fundamentals of IPRs, including the legal frameworks and laws.	1	1	2	2	2	1	3	2	2	1	2	2	1	2	3
CO4-98BT404.4: Recognize various methods related to patents and the patenting process law and regulations in India	1	1	2	1	3	1	3	3	2	2	1	3	1	2	3
CO5-98BT404.5: Explore role of regulatory framework for recombinant	1	1	2	1	3	1	3	3	1	2	2	3	1	2	2

DNA research, Biotechnology and food safety laws.															

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	**CO1-98BT404.1:** Familiarization with the basic concepts, key principles and regulations of biosafety in biotechnological research.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6	**LI1** **LI2**	1.1,1.2,1.3,1.4,1.5, 1.6	1SL-1,2,3,4
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	**CO2-98BT404.2:** Acquired Skills to analyze and address ethical, legal, and socioeconomic, health and safety implications of biotechnology	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6	**LI1** **LI2**	2.1, 2.2, 2.3, 2.4, 2.5, 2.6	2SL-1,2,3,4,5
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	**CO3-98BT404.3:** Equipped to comprehend the fundamentals of IPRs, including the legal frameworks and laws.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6	**LI1** **LI2**	3.1,3.2,3.3,3.4,3.5, 3.6	3SL-1,2,3,4,5
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	**CO4-98BT404.4:** Recognize various methods related to patents and the patenting process law and regulations in India	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6	**LI1** **LI2**	4.1,4.2,4.3,4.4, 4.5, 4.6	4SL-1,2,3,4,5
PO 1,2,3,4,5, 6, 7,8,9,10,11, 12 PSO 1,2,3	**CO5-98BT404.5:** Explore role of regulatory framework for recombinant DNA research, Biotechnology and food safety laws.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6	**LI1** **LI2**	5.1,5.2,5.3,5.4,5.5, 5.6	5SL-1,2,3,4

Program Name	**B. Tech. Biotechnology**	
Semester	IV	
Course Code:	98BT406	
Course title:	Industrial Fermentation	**Curriculum Developer**: Sonal Gupta
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):	**CO1-98BT406.1.** Describe the fundamentals of Industrial Microbiology and Fermentation Technology **CO2-98BT406.2.** Define the role of microbiology for the production of desired bioproducts **CO3-98BT406.3.** Derive the working mechanism of upstream and downstream processing **CO4-98BT406.4.** Interpretate the mechanism of fermentation process in industry **CO5-98BT406.5.** 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=2:0:1)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Common (PC)	98BT405	Industrial Fermentation	2	2	1	3	8	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	Total Marks

			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)	(ESA)	(PRA+ ESA)
PC	98BT405	Industrial Fermentation	**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)		
PC	98BT456	Industrial Fermentation lab	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	06	04	01	05	16

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-98BT406.1. Describe the fundamentals of Industrial Microbiology and Fermentation Technology	**SO1.1** Explain the concept of Fermentation	**LI1.1** To Demonstrate the working of a Bench Top bioreactor	**Unit-1** **CI1.1** Introduction, fermentation and fermenters	**SL1.1** Search various reference books and study material to start the learning of microorganisms
	SO1.2 Elaborate the historical perspective of fermentation	**LI1.2** To perform the isolation of microorganisms from different kinds of samples	**CI1.2** Brief history and developments in industrial microbiology	**SL1.2** Find out the literature showing use of fermentation technology in ancient India
	SO1.3 Differentiate between Solid-state and liquid-state (stationary and submerged) fermentations		**CI1.3** Solid-state and liquid-state (stationary and submerged) fermentations	**SL1.3** Derive the equation representing various mode of fermentations
	SO1.4 Derive the equations based on Batch, fed-batch and continuous fermentations		**CI1.4** Batch, fed-batch and continuous fermentations	**SL1.4** Explore different bioproducts manufacture in laboratory
	SO1.5 Explain & compare the components of a typical bioreactor, types of bioreactors-Laboratories, pilot- scale and production fermenters		**CI1.5** Components of a typical bioreactor, types of bioreactors-Laboratories, pilot-scale and production fermenters	**SL1.5** Draw a well labelled diagram of a bioreactor

	SO1.6 Examine the difference and working of various types of reactors		**CI1.6** Continuous stirred tank fermenter, tower fermenter, fixed bed, fluidized bed bioreactors and air-lift fermenter	

Item	Cl	LI	SW	SL	Total
Approx. Hrs	6	06	01	05	18

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

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-98BT405.2. Define the role of microbiology for the production of desired bioproducts	**SO2.1** Explain the role of industrial scope of fermentation	**LI2.1** To Demonstrate the working of a pH electrode	**Unit-1** **CI2.1** Overview on industrial fermentation-measurement of parameters	**SL2.1** Search various reference books and study material to start the learning of microorganisms
	SO2.2 Derive the roles of Isolation of strains, media and ingredients: pH, temperature, dissolved oxygen, foaming and aeration	**LI2.2** To perform the primary and secondary of microorganisms from different kinds of samples	**CI2.2** Isolation of strains, media and ingredients: pH, temperature, dissolved oxygen, foaming and aeration	**SL2.2** Find out the literature showing use of fermentation technology in ancient India
	SO2.3 Compare different identification, screening & preservation techniques	**LI2.3** To prepare the different kinds of nutrient media for microbial culture	**CI2.3** Primary and secondary screening, strain development, preservation and maintenance of industrial strains	**SL2.3** Derive the equation representing various mode of fermentations
	SO2.4 Differentiate among different kinds of media used in industrial microbiology		**CI2.4** Crude and synthetic media; molasses, corn-steep liquor, sulphite waste liquor, whey and yeast extract	**SL2.4** Explore different bioproducts manufacture in laboratory

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	06	01	05	17

	SO2.5 Describe the Downstream processing: Filtration, centrifugation		**CI2.5** Downstream processing: Filtration, centrifugation	**SL2.5** Draw a well labelled diagram of a bioreactor
	SO2.6 Examine the difference and working of various types of reactors		**CI2.6** Cell disruption, solvent extraction, precipitation and ultrafiltration	

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

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-98BT405.3 Derive the working mechanism of upstream and downstream processing	**SO3.1** Explain the role of Metabolic pathways	**LI3.1** To Demonstrate the working of a pH electrode	**Unit-3** **CI3.1** Metabolic pathways and metabolic control mechanisms	**SL3.1** Search various reference books and study material to start the learning of microorganisms
	SO3.2 Define the concept of biological product production	**LI3.2** To perform the primary and secondary Screening of microorganisms from different kinds of samples	**CI3.2** Industrial production of citric acid, lactic acid	**SL3.2** Find out the literature showing use of Lactic Acid in industries

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	04	01	05	16

	SO3.3 Understand the steps of ABE fermentation	**LI3.3** To prepare the different kinds of nutrient media for microbial culture	**CI3.3** Industrial production of Enzymes (alpha-amylase, lipase, xylase, pectinases, proteases)	**SL3.3** Derive the mechanism for fermentation of ethanol
	SO3.4 Comprehend the concept of microbial production of enzymes		**CI3.4** ABE Fermentation	**SL3.4** Write about different bioproducts manufacture in laboratory
	SO3.5 Examine the role of metabolic pathways in prokaryotes and eukaryotes		**CI3.5** Microbial Production of Lysine and Glutamic acid	**SL3.5** Find out the applications of enzymes in industries
	SO3.6 Revision and assessment		**CI3.6** Revision and assessment	

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”

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

CO4-98BT405.4 Interpretate the mechanism of fermentation process in industry	**SO4.1** Define the Microbial production of therapeutic compounds	**LI4.1** To perform the antibiotic production using fungi	**Unit-4** **CI4.1** Importance and production of Beta-lactam, aminoglycosides, (Rifamycin)	**SL4.1** Find out more antibiotics and their production process
	SO4.2 Understand the production of antibiotics	**LI4.2** To perform the microbial growth kinetics by observing the biomass produced and representation on graph	**CI4.2** Microbial production of Peptide antibiotics Quinolinones	**SL4.2** List out the role of Antibiotic Resistance Genes
	SO4.3 Classify the difference between different classes of antibiotics		**CI4.3** Biotransformation of steroids and its microbial production	**SL4.3** Explore the medical applications of Steroids
	SO4.4 Recognize the various applications of Lactamase enzyme		**CI4.4** Vitamin B12 and Riboflavin production through fermentation	**SL4.4** Make a flowchart showing metabolic pathway for Vitamin B_{12} and Vitamin B_2
	SO4.5 Derive the production of Vitamins through microbes		**CI4.5** Production of Biogas; Anaerobic digestion	**SL4.5** Explore how Biogas is produced in rural areas of India
	SO4.6 revision and discussion		**CI4.6** revision and discussion	

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”

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	02	01	03	12

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO5-98BT405.5 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** Modern trends in microbial production of bioplastics (PHA, PHB)	**SL5.1** Explore the various kinds of biopolymers and their applications
	SO5.2 Recognize the production mechanism of different polymer		**CI5.2** Production of bioinsectices (Thuricide), Biopolymer (Dextran, Alginate, Xanthan, Pullulan)	**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** Microbial production of Single Cell Protein	
	SO5.5 Production mechanism and importance of Single cell protein		**CI5.5** Production of biological weapons with reference to anthrax	
	SO4.6 Revision and discussion		**CI5.6** Revision and discussion	

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 Fermentation **Course Code:** 98BT405

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1-98BT405.1: Describe the fundamentals of Industrial Microbiology and Fermentation Technology	6	4	5	1	16
CO2-98BT405.2: Define the role of microbiology for the production of desired bioproducts	6	6	5	1	18
CO3-98BT405.3: Elaborate the working mechanism of upstream and downstream processing	6	4	5	1	16
CO4-98BT405.4: Interpretate the mechanism of fermentation process in industry	6	4	5	1	16
CO5-98BT405.5: Examine the mechanism of biological product development using microbes	6	2	3	1	12
Total Hours	30	20	18	05	78

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

Course Title: Industrial Fermentation **Course Code:** 98BT405

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
CO1-98BT405.1: Describe the fundamentals of Industrial Microbiology and Fermentation Technology	2	1	1	1	5
CO2-98BT405.2: Define the role of microbiology for the production of desired bioproducts	2	4	2	2	10
CO3-98BT405.3: Elaborate the working mechanism of upstream and downstream processing	3	5	5	2	15
CO4-98BT405.4: Interpretate the mechanism of fermentation process in industry	2	3	3	2	10
CO5-98BT405.5: 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:

19. Improved lecture
20. Tutorial
21. Case method
22. Group Discussion
23. Role play
24. Visit to Industrial plant of Biotech-based organizations
25. Demonstration
26. ICT Based teaching Learning
27. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Tech. Biotechnology

Semester: IV Semester

Course Title: Industrial Fermentation

Course Code: 98BT405

CO/PO/PSO Mapping								
Course Outcome (Cos)	**Program Outcomes (POs)**					**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**
CO1-98BT405.1: Describe the fundamentals of Industrial Microbiology and Fermentation Technology	2	-	-	1	2	2	2	1
CO2-98BT405.2: Define the role of microbiology for the production of desired bioproducts	-	1	1	-	-	1	1	2
CO3-98BT405.3: Elaborate the working mechanism of upstream and downstream processing	1	1	1	1	-	1	1	1
CO4-98BT405.4: Interpretate the mechanism of fermentation process in industry	1	1	1	-	2	1	1	3
CO5-98BT405.5: Examine the mechanism of biological product development using microbes	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	**CO1-98BT405.1:** 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 PSO 1,2,3	**CO2-98BT405.2:** 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 PSO 1,2,3	**CO3-98BT405.3:** 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 PSO 1,2,3	**CO4-98BT405.4:** 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 PSO 1,2,3	**CO5-98BT405.5:** 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	**Bachelor of Technology - Biotechnology**	
Semester	IV	
Course title:	Genetic Engineering and Molecular Diagnostics	**Curriculum Developer**: Shaily Mishra, Assistant Professor
Pre-requisite:	Students should have basic knowledge of biology, biochemistry of nucleic acids, immune system related biological processes.	
Rationale:	The paper on Molecular biology and diagnostic techniques in a B.Sc. Biotechnology program provides students with an understanding of the basic principles and clinical significance of laboratory testing in the field of molecular diagnostics. Students will gain insights about the basic principles of DNA replication and how to perform basic molecular diagnostic techniques and their applications in the identification of genetic diseases and diseases caused by microorganisms.	
Course Outcomes (COs):	**CO1-:** Understand the basic structure of DNA and RNA, modes of DNA replication and its damage and repair mechanism. **CO2-:** Students are able to understand the chemical and molecular processes that occur in and between cells. **CO3-:** Gain knowledge about the protein synthesis mechanism and regulation of gene expression in prokaryotes. **CO4-:** Demonstrate an understanding of basic molecular diagnostic techniques. **CO5-:** Apply molecular diagnostic techniques to the identification and diagnosis of diseases.	

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme ofstudies (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)	98BT403	Genetic Engineering and Molecular Diagnostics	3	2	1	3	9	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)	Class Activity (CAT)	Seminar (SA)	Class Attendance (AT)	Total Marks (CA+CT+CAT+SA+AT)			

PC	**98Bt403**	Genetic Engineering and Molecular Diagnostics	**15**	**20**	**05**	**05**	**05**	**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	98BT453	Genetic Engineering and Molecular Diagnostics	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	9	04	01	3	17

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1- Understand the basic structure of DNA and RNA, modes of DNA replication and its damage and repair mechanism.	**SO1.1** Learn about DNA as genetic material	**LI1.1** Preparation of solutions for Molecular biology experiments.	**Unit-1 DNA structure and replication** **CI1.1** DNA as genetic material,	**SL1.1** Study experiments that proves DNA as genetic material
	SO1.2 Understand the structure of DNA		**CI1.2** Structure of DNA	
	SO1.3 Study about different forms of DNA		**CI1.3** Types of DNA	
	SO1.4 Understand the experimental proof of semi conservative DNA replication.	**LI1.2** DNA isolation from different sources	**CI1.4** Semi conservative nature of DNA replication	**SL1.2** Understand the role of proteins and enzymes in DNA replication
	SO1.5 Role of replicon and polymerases in prokaryotes		**CI1.5** Replicon and DNA polymerases in prokaryotes	
	SO1.6 Role of replicon and polymerases in eukaryotes		**CI1.6** Replicon and DNA polymerases in eukaryotes	
	SO1.7 Study the process of replication in prokaryotes		**CI1.7** Replication of DNA in prokaryotes	
	SO1.8 Role of telomere in termination of replication		**CI1.8** Telomere and end replication problem	
	SO1.9 Study the process of replication in eukaryotes		**CI1.9** Replication of DNA in eukaryotes	**SL1.3** Study about various factors responsible for DNA Damage

Suggested Sessional Work (SW):*anyone*	**SW1.1** Assignments	Describe in detail the function of machinery involved in DNA replication.
	SW1.2 Mini Project	Diagrammatic representation of repair mechanism of damaged DNA.
	SW1.3 Other Activities (Specify)	Search research papers related to DNA damage.

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)
CO2- Students are able to understand the chemical and molecular processes that occur in and between cells.	**SO2.1** Understand the structure of RNA	**LI2.1** Isolation of bacterial plasmid and their separation to confirm the coiling.	**Unit-2 Transcription** **CI2.1** RNA structure	**SL2.1** Function of different types of RNA.
	SO2.2 Types of RNA		**CI2.2** Types of RNA	
	SO2.3 Study the role of RNA polymerase enzyme in transcription	**LI2.2** Agarose gel electrophoresis	**CI2.3** Transcription in prokaryotes: Prokaryotic RNA polymerase	**SL2.2** Study the interaction of DNA and proteins.
	SO2.4 Learn about importance of different promoters		**CI2.4** Role of sigma factor and promoter	
	SO2.5 Understand the mechanism of transcription in prokaryotes		**CI2.5** Initiation, elongation and termination of RNA chains in prokaryotes	
	SO2.6 Study the role of RNA polymerase enzyme in eukaryotes		**CI2.6** Transcription in eukaryotes: Eukaryotic RNA polymerases,	**SL2.3** Understand the role of regulatory proteins.
	SO2.7 Study the role of transcription factors, promoters and enhancers		**CI2.7** Transcription factors, promoters, enhancers	
	SO2.8 Understand the mechanism of DNA replication in prokaryotes		**CI2.8** Mechanism of transcription in eukaryotes	

	SO2.9 Learn about RNA processing		**Cl2.9** RNA splicing and processing	

Item	Cl	LI	SW	SL	Total
Approx.Hrs	9	04	01	03	17

Suggested Sessional Work (SW):*anyone*	**SW1.1** Assignments	Differentiate between structure of RNA polymerase in prokaryotes and eukaryotes.
	SW1.2 Mini Project	Diagrammatic representation of mechanism of different types of RNA splicing.
	SW1.3 Other Activities (Specify)	Make a PowerPoint presentation on mechanism of transcription in prokaryotes.

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO3- Gain knowledge about the protein synthesis mechanism and regulation of gene expression in prokaryotes.	**SO3.1** Study about genetic code	**LI3.1** Demonstration of AMES test or reverse mutation for carcinogenicity	**Unit-3 Translation & Gene Expression** **CI3.1** Genetic code and its characteristics	**SL4.1** Structure of protein (primary, secondary and tertiary)
	SO3.2 Study the role of ribosome in translation.	**LI3.2** Kirby-Bauyer method (disc-diffusion method) to study antibiotic sensitivity of a bacterial culture	**CI3.2** Prokaryotic translation: ribosome structure and assembly,	**SL4.2** Role of protein in biological activities.
	SO3.3 Role of charging of aminoacyl tRNA in translation		**CI3.3** Charging of tRNA, aminoacyl tRNA synthetases	

	SO3.4 Structure and function of mRNA		**CI3.4** Polycistronic and monocistronic mRNA	
	SO3.5 Steps involved in process of protein synthesis in prokaryotes		**CI3.5** Mechanism of initiation, elongation and termination of polypeptides	**SL4.3** Understand the role of molecular chaperones
	SO3.6 Steps involved in process of protein synthesis in eukaryotes		**CI3.6** Mechanism of initiation, elongation and termination of polypeptides	**SL4.3** Understand the role of molecular chaperones
	SO3.7 Post-translational modifications		**CI3.7** Post-translational modifications of proteins	**SL4.4** Study the role of regulatory proteins in gene regulation.
	SO3.8 Learn about types of post-translational modifications		**CI3.8** Types of Post-translational modifications of proteins	
	SO3.9 Understand the mechanism of protein modifications		**CI3.9** Mechanism of protein modifications	

Suggested Sessional Work (SW):*anyone*	**SW3.1** Assignments	Describe the importance of post translation modification of proteins.
	SW3.2 Mini Project	Diagrammatic representation of *lac* and *trp* operon.
	SW3.3 Other Activities (Specify)	Draw a chart of genetic code and watch you tube videos of models of protein structures.

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)
CO4- Demonstrate an understanding of basic molecular diagnostic techniques.	**SO4.1** Understand about molecular diagnostic techniques.	**LI4.1** A kit-based detection of a microbial infection (Widal test).	**Unit-4** **Molecular Diagnostics Techniques-I** **CI4.1** Introduction to molecular Diagnostics	**SL4.1** Study different molecular techniques
	SO4.2 Explain PCR and DNA sequencing	**LI4.2** Demonstration of PCR	**CI4.2** PCR and its applications	**SL4.2** Gain insights of DNA replication mechanism
	SO4.3 Learn about the function of different types of PCR		**CI4.3** Types of PCR	
	SO4.4 Application of DNA sequencing		**CI4.4** DNA sequencing and its method	
	SO4.5 Different types of DNA sequencing methods		**CI4.5** Types of DNA sequencing	
	SO4.6 Understand difference among different blotting technique		**CI4.6** Blotting Techniques- Southern Blotting	**SL4.3** Learn about DNA,RNA and protein
	SO4.7		**CI4.7**	

	Concept of Blotting Techniques		Northern Blotting	
	SO4.8 Applications of blotting techniques		**CI4.8** Southern Blotting	
	SO4.9 Demonstrate about the diagnosis of genetic diseases.		**CI4.9** Diagnosis of genetic diseases,	**SL4.4** Study about molecular basis of genetic diseases.

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Differentiate between different blotting techniques used in molecular biology.
	SW4.2 Mini Project	Diagrammatic representation of PCR and DNA sequencing methods.
	SW4.3 Other Activities (Specify)	Find out some you tube videos related to detection of genetic diseases and mutation in DNA.

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)**
CO5- Apply molecular diagnostic techniques to the identification and diagnosis of diseases.	**SO5.1** Describe the techniques for testing microbial susceptibility	**LI5.1** Perform any one immune-diagnostic test (Typhoid, Malaria, and Dengue).	**Unit-5** **Molecular Diagnostics Techniques-II** **CI5.1** Susceptibility tests- Micro-dilution and macro-dilution broth procedures	**SL5.1** Study about effect of different antibiotics on microbial cell
	SO5.2 Learn about types and applications of susceptibility test		**CI5.2** Diffusion test procedures.	
	SO5.3 Study the tests for bactericidal activity.	**LI5.2** Demonstration of ELISA	**CI5.3** Tests for bactericidal activity	**SL5.2** List out antibiotics that have bactericidal effect
	SO5.4 Understand the application of bactericidal activity		**CI5.4** Application of bactericidal activity	
	SO5.5 Elucidate enzyme immuno assay technique		**CI5.5** Enzyme Immuno assay	**SL5.3** Learn about role of enzyme-substrate complex in immunological diagnostics.
	SO5.6		**CI5.6**	

	Recognize the application of enzyme in immunodiagnostic tests		Applications of enzyme immunoassays in diagnostic microbiology	
	SO5.7 Learn about Immunodiagnostic tests		**CI5.7** Immunodiagnostic tests	
	SO5.8 Understand the application of immunodiagnostic tests		**CI5.8** Application of immunodiagnostic tests	
	SO5.9 Explain different immune assays techniques		**CI5.9** Immuno florescence	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Draw a ray diagram to show different immuno assay methods used in molecular diagnostics.
	SW5.2 Mini Project	Make a power point presentation on immune fluorescence.
	SW5.3 Other Activities (Specify)	Search research paper on microbial susceptibility test.

Course duration (in hours) to attain Course Outcomes:

Course Title: Genetic Engineering and M D

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 structure of DNA and RNA, modes of DNA replication and its damage and repair mechanism.	9	04	03	01	17
CO2- Students are able to understand the chemical and molecular processes that occur in and between cells.	9	04	03	01	17
CO3- Gain knowledge about the protein synthesis mechanism and regulation of gene expression in prokaryotes.	9	04	03	01	17
CO4- Demonstrate an understanding of basic molecular diagnostic techniques.	9	04	03	01	17
CO5- Apply molecular diagnostic techniques to the identification and diagnosis of diseases.	9	04	03	01	17
Total Hours	45	20	15	05	85

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

Course Title: Molecular biology and diagnostic techniques

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
CO1- Understand the basic structure of DNA and RNA, modes of DNA replication and its damage and repair mechanism.	2	1	1	0	4
CO2- Students are able to understand the chemical and molecular processes that occur in and between cells.	2	4	2	0	08
CO3- Gain knowledge about the protein synthesis mechanism and regulation of gene expression in prokaryotes.	3	5	4	1	13
CO4- Demonstrate an understanding of basic molecular diagnostic techniques.	2	3	3	2	10
CO5- Apply molecular diagnostic techniques to the identification and diagnosis of diseases.	4	4	2	2	12
Total Marks	**13**	**17**	**12**	**05**	**47**

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

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1	Genes V by Benjamin Lewin, Oxford University Press, New York, 1994.
2	Gene IX, Benjamin Lewin Oxford University Press, New York, 2006.
3	Principles of Genetics, Snustad and Simmons, Seventh Edition, John Wiley and Sons, Inc.,2015.
4	Molecular Cell Biology, Lodish et.al., W. H. Freeman and Company,Eighth Edition,2016.
5	Genomes 5 by T.A. Brown, John Wiley and sons (Asia)PTE LTD, New York, Fifth Edition2023
6	Genes V by Benjamin Lewin, Oxford University Press, New York, 1994.

(b) Online Resources:

Suggested instructions/Implementation strategies:

28. Improved lecture
29. Tutorial
30. Case method
31. Group Discussion
32. Role play
33. Visit to Industrial plant of fermentation industries
34. Demonstration
35. ICT Based teaching Learning
36. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Tech. Biotechnology

Semester: IV Semester

Course Title: Genetic Engineering and Molecular Diagnostics

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-	-	-	-	-	2	2	3	-	3	3	3	3	2	2	1

Understand the basic structure of DNA and RNA, modes of DNA replication and its damage and repair mechanism.															
CO2- Students are able to understand the chemical and molecular processes that occur in and between cells.	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**3**	**2**	**3**	**3**	**2**	**1**	**2**
CO3- Gain knowledge about the protein synthesis mechanism and regulation of gene expression in prokaryotes.	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**3**	**1**	**3**	**3**	**1**	**1**	**3**
CO4- Demonstrate an understanding of basic molecular diagnostic techniques.	**-**	**-**	**-**	**-**	**2**	**2**	**3**	**3**	**-**	**1**	**3**	**3**	**1**	**1**	**3**
CO5- Apply molecular diagnostic techniques to the identification and diagnosis of diseases.	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**3**	**-**	**2**	**3**	**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-** Understand the basic structure of DNA and RNA, modes of DNA replication and its damage and repair mechanism.	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**
PO 1,2,3,4,5, 6, 7, 8, 9 10, 11, 12 PSO 1,2,3	**CO2-** Students are able to understand the chemical and molecular processes that occur in and between cells.	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**
PO 1,2,3,4,5, 6, 7, 8, 9 10, 11, 12 PSO 1,2,3	**CO3-** Gain knowledge about the protein synthesis mechanism and regulation of gene expression in prokaryotes.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8	**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**

		SO3.9			
PO 1,2,3,4,5, 6, 7, 8, 9 10, 11, 12 PSO 1,2,3	**CO4-** Demonstrate an understanding of basic molecular diagnostic techniques.	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**
PO 1,2,3,4,5, 6, 7, 8, 9 10, 11, 12 PSO 1,2,3	**CO5-** Apply molecular diagnostic techniques to the identification and diagnosis of diseases.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9	**LI 1** **LI2**	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 Technology (B.Tech.)- Biotechnology**	
Semester	IV	
CourseCode:	98BT401	
Coursetitle:	Molecular Biology	**Curriculum Developer**: Shaily Mishra, Assistant Professor
Pre-requisite:	Students should have basic knowledge of genetics, biochemistry of nucleic acids, chromosomes and gene structure.	
Rationale:	The paper on Molecular Biology in a B.Tech Biotechnology program seeks to understand the molecular basis of genetic processes. The students will acquire basic knowledge and explore skills in molecular biology an become aware of the complexity and harmony of cell. The course enlightens the students about the various processes such as DNA replication, transcription, translation, regulation, repair and advances in the topics in recent research. The students will be able design and implement experimental procedures using relevant techniques.	
CourseOutcomes (COs):	**CO1-98BT401.1.** Understand the composition, structure and characteristics of nucleic acids. **CO2-98BT401.2.** Understand molecular phenomena of DNA copying and transmission of information, its damage and repair mechanism. **CO3-98BT401.3.** Students are able to understand the chemical and molecular processes that occur in and between cells. **CO4-98BT401.4.** Gain knowledge about the protein synthesis mechanism and its localization in and between the cells. **CO5-98BT401.5.** The regulation of gene function, respond to environment and associated phenomena.	

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)**	
ProgramCommon(PC)	98BT401	Molecular Biology	3	2	1	3	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

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	98BT401	Molecular Biology	**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	98BT451	Molecular 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.	**ApproximateHours**

Item	Cl	LI	SW	SL	Total
Approx.Hrs	09	04	01	03	17

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-98BT401.1 Understand the composition, structure and characteristics of nucleic acids.	**SO1.1** Understand the chemical nature and structure of genetic material.	**LI1.1** Isolation of bacterial genomic DNA.	**Unit-1** **Genetic Material** **CI1.1** Chemical nature,	**SL1.1** Study about prokaryotic and eukaryotic cells.
	SO1.2 Study the structure & properties of genetic material		**CI1.2** Structure & properties of genetic material	
	SO1.3 Explain experimental evidences to show DNA as genetic material.	**LI1.2** Isolation of plant genomic DNA.	**CI1.3** DNA as the genetic material-experimental evidences	**SL1.2** Learn about experimental evidences of genetic material.
	SO1.4 Understand structure and forms of DNA		**CI1.4** Structure of DNA,	**SL1.3** Study the Watson and Crick model of DNA.
	SO1.5 Alternative forms of DNA		**CI1.5** Alternative forms of DNA	
	SO1.6 Explain RNA as genetic material		**CI1.6** RNA as genetic material	
	SO1.7 Organization of genetic material into the cell.		**CI1.7** Genomic organization/ packaging of genetic material,.	
	SO1.8 Organization of DNA-Nucleosome model		**CI1.8** Nucleosome model	
	SO1.9 revision and discussion		**CI1.9** revision and discussion	

Suggested Sessional Work (SW):*anyone*	**SW1.1** Assignments	Diagrammatic representation of experiments to prove DNA as genetic material.
	SW1.2 Mini Project	Differentiate between prokaryotic and eukaryotic genome organization.
	SW1.3 Other Activities (Specify)	Find out some you tube videos based on working model of biological activity associated with DNA.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	9	04	01	04	18

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO2-98BT401.2. Understand molecular phenomena of DNA copying and transmission of information, its damage and repair mechanism.	**SO2.1** Understand about the origin site of DNA replication.	**LI2.1** Isolation of bacterial plasmid and their separation to confirm the coiling.	**Unit-2** **DNA replication and repair** **CI2.1** Origin of DNA replication,.	**SL2.1** Study the structure of DNA and its functions.
	SO2.2 Understand about the model of DNA replication in prokaryotes	**Li2.2** To Prepare the setup for gel electrophoresis and PCR	**CI2.2** Replication of bacterial chromosomes- Theta model	
	SO2.3 Understand about the model of DNA replication in eukaryotes		**CI2.3** Replication of eukaryotic chromosomes-Linear model	
	SO2.4 Rolling circle mechanism of DNA replication.		**CI2.4** Rolling circle replication	**SL2.2** Learn the functions of telomere
	SO2.5 Understand the function of DNA polymerases		**CI2.5** DNA polymerases	**SL2.3** Study the fundamentals of cell division
	SO2.6 Explain the enzymes and mechanism involved in DNA replication.		**CI2.6** Mechanism of DNA replication and its regulation	
	SO2.7 Define the concept of telomere		**CI2.7** Telomere replication	**SL2.4** Find out the different kinds of DNA damage in the cell
	SO2.8 Explain the role of different repair mechanism of DNA damage		**CI2.8** DNA repair mechanisms: photo reactivation, excision, mismatch, post replication recombination repair, SOS repair	
	SO2.9 Revision and discussion		**CI2.9** Revision and discussion	

Suggested Sessional Work (SW):*anyone*	**SW2.1** Assignments	Write the mechanism of DNA replication in both prokaryotes and eukaryotes.
	SW2.2 Mini Project	Find some research paper on causes of DNA damage in the cell.
	SW2.3 Other Activities (Specify)	Draw a neat labelled diagram of various repair mechanism in the cell

Item	Cl	LI	SW	SL	Total
Approx.Hrs	09	04	01	03	17

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO3-98BT401.3 Students are able to understand the chemical and molecular processes that occur in and between cells.	**SO3.1** Understand the process involved in synthesis of RNA molecules from DNA.	**LI3.1** Competent cell preparation using bacterial *E.coli* strain.	**Unit-3** **Gene Expression I - Transcription** **CI3.1:** Transcriptional unit	**SL3.1** DNA binding proteins and their interaction with DNA.
	SO3.2 Study the role of bacterial and eukaryotic RNA polymerases		**CI3.2** Bacterial and eukaryotic RNA polymerases	
	SO3.3 Learn the role of sigma factor. Cis-regulatory sequence, enhancers/silencers		**CI3.3** Role of sigma factor. Cis-regulatory sequence, enhancers/silencers	
	SO3.4 Factors and enzymes involved in RNA synthesis.	**LI3.2** Bacterial transformation	**CI3.4** Cognate transcription factors	**SL3.2** Functions of different types of RNAs.
	SO3.5 Steps involved in process of transcription		**CI3.5** Initiation, elongation & termination of transcription	
	SO3.6 Role of regulatory proteins in RNA synthesis.		**CI3.6** Role of transcription factors, promoters and enhancers.	**SL3.3** Study the importance of Central Dogma.
	SO3.7 Post transcriptional modification in synthesized RNA.		**CI3.7** Processing of rRNA , tRNA and mRNA, poly-A tailing, 5' capping,	
	SO3.8 Understand the function of RNA editing		**CI3.8** RNA editing	
	SO3.9 Revision and discussion		**CI3.9** Revision and discussion	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Describe mechanism of transcription in prokaryotes and eukaryotes.
	SW3.2 Mini Project	Diagrammatic representation of process of RNA processing in different types of RNAs.
	SW3.3 Other Activities (Specify)	Write the role of various proteins and enzyme involved in transcription process and RNA processing.

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)**
CO4-98BT401.4 Gain knowledge about the protein synthesis mechanism and its localization in and between the cells.	**SO4.1** Study of genetic code and wobble hypothesis.	**LI4.1** Restriction digestion of plant genomic DNA	**Unit-4** **Gene Expression II - Translation** **CI4.1:** Genetic code, wobble hypothesis.	**SL4.1** Structure of protein (primary, secondary and tertiary)
	SO4.2 Role of ribosome and different RNAs	**LI4.2** Restriction digestion of bacterial genomic DNA	**CI4.2:** Ribosomal RNA and ribosome organization, transferRNA,	**SL4.2** Role of protein in biological activities.
	SO4.3 Steps involved in process of protein synthesis in prokaryotes		**CI4.3:** Translation process-initiation, elongation, termination in prokaryotes	**SL4.3** Understand the role of molecular chaperones
	SO4.4 Steps involved in process of protein synthesis in eukaryotes		**CI4.4:** Translation process-initiation, elongation, termination in eukaryotes	
	SO4.5 Comparison of eukaryotic and prokaryotic protein synthesis systems.		**CI4.5:** Comparison of eukaryotic and prokaryotic protein synthesis systems.	
	SO4.6 Importance Post- translational modifications.		**CI4.6:** Post- translational modifications	**SL4.4** Interaction of proteins in and between the cell.
	SO4.7 Translocation of proteins in and between the cells.		**CI4.7:** Translocation of proteins across ER membrane, protein modifications and folding in ER, transport into mitochondria, chloroplast, nucleus and peroxisomes	
	SO4.8 Learn about role of molecular chaperones		**CI4.8:** Molecular chaperones	

	SO4.9 Revision and discussion		**CI4.9** Revision and discussion	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Describe the importance of post translation modification.
	SW4.2 Mini Project	Diagrammatic representation of translation process in both prokaryotes and eukaryotes.
	SW4.3 Other Activities (Specify)	Draw a chart of genetic code and watch you tube videos of models of protein structures.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	09	04	01	03	17

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO5-98BT401.5 The regulation of gene function, respond to environment and associated phenomena.	**SO5.1** Learn about role of gene regulation in prokaryotes	**LI5.1** Demonstration of DNA amplification using thermal cycler.	**Unit-5** **Regulation of Gene Expression** **CI5.1:** Regulation in prokaryotes	**SL5.1** Concept of gene and unit of gene.
	SO5.2 Types of gene regulation	**LI5.2 t**o check the gene expression using RTPCR	**CI5.2:** Positive and negative gene regulation	
	SO5.3 Understand the operon concept.		**CI5.3:** Operon concept	
	SO5.4 Study the concept of lac and trp operons in prokaryotes.		**CI5.4:** *lac* and *trp operon*	**SL5.2** Study of operon model and structural genes
	SO5.5 Understand ara operon and glucose effect		**CI5.5:** *ara* operon, catabolite repression, attenuation	
	SO5.6 Control of gene expression in eukaryotes.		**CI5.6:** Regulation in eukaryotes-methylation & acetylation	**SL5.3** Study the role of regulatory proteins in gene regulation.
	SO5.7 Hormonal regulation of gene expression		**CI5.7:** Hormonal control of gene expression	
	SO5.8 Mechanism of RNA silencing		**CI5.8:** RNA silencing	
	SO5.9 Revision and discussion		**CI5.9** Revision and discussion	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Describe mechanism of gene regulation in prokaryotic and eukaryotic organism.
	SW5.2 Mini Project	Diagrammatic representation of positive and negative regulation in prokaryotes.
	SW5.3 Other Activities (Specify)	Read research paper related to gene regulation in both prokaryotic and eukaryotic organisms.

Course duration (in hours)to attain Course Outcomes:

Course Title: Molecular Biology **Course Code:**98BT401

Course Outcomes(COs)	**Class lecture (CI)**	**Laboratory Instruction(LI)**	**Self-Learning (SL)**	**Sessional work (SW)**	**Total Hours (Li+CI+SL+SW)**
CO1-98BT401.1. Understand the composition, structure and characteristics of nucleic acids.	9	4	3	1	17
CO2-98BT401.2. Understand molecular phenomena of DNA copying and transmission of information, its damage and repair mechanism.	9	4	4	1	18
CO3-98BT401.3. Students are able to understand the chemical and molecular processes that occur in and between cells.	9	4	3	1	17
CO4-98BT401.4. Gain knowledge about the protein synthesis mechanism and its localization in and between the cells.	9	4	4	1	18
CO5-98BT401.5. The regulation of gene function, respond to environment and associated phenomena.	9	4	3	1	17
Total Hours	45	20	17	5	87

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

Course Title: Molecular Biology **Course Code:**98BT401

Course Outcomes	**Marks Distribution**				**Total Marks**
	A	**An**	**E**	**C**	
CO1-98BT401.1. Understand the composition, structure and characteristics of nucleic acids.	2	1	1	1	5
CO2-98BT401.2. Understand molecular phenomena of DNA copying and transmission of information, its damage and repair mechanism.	2	4	5	1	12
CO3-98BT401.3. Students are able to understand the chemical and molecular processes that occur in and between cells.	3	5	5	1	14

CO4-98BT401.4. Gain knowledge about the protein synthesis mechanism and its localization in and between the cells.	2	3	5	1	11
CO5-98BT401.5. The regulation of gene function, respond to environment and associated phenomena.	5	4	1	0	10
Total Marks	**14**	**17**	**17**	**04**	**52**

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

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1	Genes V by Benjamin Lewin, Oxford University Press, New York, 1994.
2	Gene IX, Benjamin Lewin Oxford University Press, New York, 2006.
3	Principles of Genetics, Snustad and Simmons, Seventh Edition, John Wiley and Sons, Inc.,2015.
4	Molecular Cell Biology, Lodish et.al., W. H. Freeman and Company,Eighth Edition,2016.
5	Genomes 5 by T.A. Brown, John Wiley and sons (Asia)PTE LTD, New York, Fifth Edition2023

(b) Online Resources:

Suggested instructions/Implementation strategies:

37. Improved lecture
38. Tutorial
39. Case method
40. Group Discussion
41. Role play
42. Visit to Waste water/Effluent Treatment plant and downstream pharmaceutical plants
43. Demonstration
44. ICT Based teaching Learning
45. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Tech. Biotechnology

Semester: IV Semester

Course Title: Molecular Biology

Course Code: 98BT401

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**
CO1-98BT401.1. Understand the composition, structure and characteristics of nucleic acids.	-	-	-	-	2	2	3	-	3	3	3	3	2	2	1
CO2-98BT401.2. Understand molecular phenomena of DNA copying and transmission of information, its damage and repair mechanism.	-	-	-	-	-	-	3	-	3	2	3	3	2	1	2
CO3-98BT401.3. Students are able to understand the chemical and molecular processes that occur in and between cells.	-	-	-	-	-	-	3	-	3	1	3	3	1	1	3
CO4-98BT401.4. Gain knowledge about the protein synthesis mechanism and its localization in	-	-	-	-	2	2	3	3	-	1	3	3	1	1	3

and between the cells.															
CO5-98BT401.5. The regulation of gene function, respond to environment and associated phenomena.	-	-	-	-	-	2	3	3	-	2	3	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	**CO1-98BT401.1.** Understand the composition, structure and characteristics of nucleic acids.	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**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO2-98BT401.2.** Understand molecular phenomena of DNA copying and transmission of information, its damage and repair mechanism.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9	**LI 1** **LI2**	2.1, 2.2, 2.3, 2.4, 2.5,2.6,2.7,2.8, 2.9	**2SL-1,2,3,4**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO3-98BT401.3.** Students are able to understand the chemical and molecular processes that occur in and between cells.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9	**LI 1** **LI2**	3.1,3.2,3.3,3.4,3.5, 3.6,3.7,3.8, 3.9	**3SL-1,2,3**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO4-98BT401.4.** Gain knowledge about the protein synthesis mechanism and its localization in and between the cells.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7 SO4.8 SO4.9	**LI 1** **LI2**	4.1,4.2,4.3,4.4.4.5, 4.6,4.7,4.8, 4.9	**4SL-1,2,3,4**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO5-98BT401.5.** The regulation of gene function, respond to environment and associated phenomena.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9	**LI 1** **LI2**	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 Technology (B. Tech) Biotechnology**	
Semester	IV	
CourseCode:	**98BT404**	
Coursetitle:	Immunology and Immuno Technology	Developer: Mr. PARAS KOSHE
Pre-requisite:	Student should have basic knowledge about Physiology and biology and various system of our body	
Rationale:	The paper on "Immunology and Immuno Technology" in B.tech. Biotechnology program allow predicting the working principle and application of numerous cells involved in defense responses. This subject will build up the basic and advanced mechanism of immune responses during the different stresses. This subject offers the students the opportunity to advance their knowledge of immunology.	
CourseOutcomes (COs):	**98BT404.1:** The immune system, including its organs, cells, and receptors, will be covered in class. **98BT404.2:** Comparative study of immunogen and antigen and descriptive study of structure of antibody and its production. **98BT404.3:** Understand the mechanism of generation of B and T cell responses and study the their relationship with MHC, Cytokines and complement system **98BT404.4:** The molecular foundations of antigen recognition, hypersensitivity reactions, and antigen-antibody interactions will be thoroughly understood by the students. **98BT404.5:** The student gains an understanding of the fundamentals of immunology and how it can be used to treat diseases of humans as a result of the course.	

Scheme of Studies:

Board of Study	**Course Code**	**Course Title**	**Scheme ofstudies (Hours/Week)**					**Total Credits(C)** (L: T: P=3:0:1)
			Cl	LI	SW	SL	**Total Study Hours(CI+LI+SW+SL)**	
Program Core(PCC)	98BT404	Immunology and Immuno Technology	3	2	1	1	7	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)	ClassActivityanyone (CAT)	Class Attendance (AT)	Total Marks (CA+CAT+CT+SA+AT)		
PCC	98BT404	Immunology and Immuno Technology	**15**	**20**	**5**	**5**	**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)		
PC	98BT454	Immunology and Immuno Technology	35	5	5	5	50	50	50

Scheme of Assessment: Practical

Course-Curriculum:

<table>
<tr>
<td>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.</td>
<td>Approximate Hours
<table><tr><td>Item</td><td>Cl</td><td>LI</td><td>SW</td><td>SL</td><td>Total</td></tr><tr><td>Approx.Hrs</td><td>09</td><td>04</td><td>01</td><td>04</td><td>18</td></tr></table></td>
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</table>

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

CO 1: Understand the essential of immune system cells to the organism	SO1.1: Able to define the immune system	LI1.1 Prepare a detailed report on the various components of the immune system	CI 1.1: **Introduction**: overview of the immune system	SL 1.1: Study about the basic of immune systems
	SO1.2: Understanding fundamental of immune system and Lymphatic system.	LI1.2 Dissect a model of the thymus and spleen to understand their structure and function.	CI 1.2: Lymphatic system	SL 1.2: Learn about defence mechanism in lower organism
	SO1.3: Understanding fundamental of lymphoid organs and their structure and functions.		CI 1.3: Lymphoid organs	SL 1.3: Read the working principle of the non-specific immune system
	SO1.4: In depth study about the specific immune systems and their cells.		CI 1.4: Cells of the immune system and their functions	SL 1.4: Compare the B-cells and T-cells
	SO1.5 Able to know innate and acquired immunity and their role in human life,		CI 1.5: Innate and Acquired immunity	
	SO1.6 Focus on the cells and processes of innate immunity.		CI 1.6: Cells and processes of Innate immunity	
	SO1.7: To know the cells and organs and their functions in acquired immunity.		CI 1.7: Cells and organs of the Acquired immunity**-**	
	SO1.8: Basic and advanced understanding of Anatomical and Physiological barriers of innate immunity.		CI 1.8: Anatomical and Physiological barriers;	
	SO1.9 Students will able to learn innate immune responses and their mechanism how these responses help in pathogen elimination.		CI 1.9 Innate immune response and their recognition structures; Pathogen elimination.	

Item	Cl	LI	SW	SL	Total
Approx.Hrs	09	06	01	03	19

Suggested Sessional Work (SW): *anyone*	SW1.1 Assignments	Describe in details about the immune system and lymphatic system.
	SW1.2 Mini Project	Draw well labelled diagram of different lymphoid organs and mention their functions.
	SW1.3 Other Activities (Specify)	Watch animation on mode of action of first line of defence. And various anatomical and physiological barriers,

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO 2: Know the fundamentals of immunoglobulins, antigens, and their classifications	SO2.1: Discuss the properties of antigens	LI 2.1: Demonstration of Antibody-antigen interaction	CI 2.1: Antigens: Properties and types, Haptens and Adjuvants	SL 2.1: Fundamental structure of immunoglobins
	SO2.2: Discuss the types of antigens	LI2.2 Determination of bleeding time of an individual	CI 2.2: Antigens: Properties and types, Haptens and Adjuvants	SL 2.2: Read the working principle of non-specific immune system
	SO2.3 explain Haptens and Adjuvants	LI2.3 Determination of Clotting time of an individual	CI 2.3: Haptens and Adjuvants	SL 2.3: Read in details about the monoclonal and polyclonal antibody
	SO2.4: Build up the concept about the antibody’s structures and classes		CI 2.4: Antibodies: Types, Molecular structure of Immuno-globulins, allotypes & idiotypes	

	SO2.5: Build up the concept about the antibody's structures and classes		CI 2.5: Antibodies: Types, Molecular structure of Immuno-globulins, allotypes & idiotypes	
	SO2.6: Summarizing the mode of monoclonal Antibody		CI 2.6: monoclonal Antibody	
	SO2.7: Learn how body functions under the pathogen attack		CI 2.7: organization and expression of immunoglobulin genes.	
	SO 2.8: Learn the concept of generation of antibody diversity and its importance.		CI 2.8: generation of Ab diversity	
	SO 2.9 Summarizing the mode of action and mechanism of class switching of antibodies.		CI 2.9 class switching	

Suggested Sessional Work (SW): *anyone*	SW1.1 Assignments	Discuss about cytokines and their role in immune responses
	SW1.2 Mini Project	Draw well labelled diagram of immunoglobin and mention their types
	SW1.3 Other Activities (Specify)	Watch animation on Antibody-antigen interaction mechanism

Item	Cl	LI	SW	SL	Total
Approx.Hrs	09	02	01	02	14

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO 3: In-depth study about action of immune responses and their genetic regulations	SO3.1: Discuss about how immune cell are activated and Summarizing the mode of action of B-cells and T-Cells in defence	LI3.1 Determination of Haemoglobin % of given human blood	CI 3.1: Generation of B-Cell and T-Cell Responses	SL3.1: Figure out the fundamental differences between humoral and cell-mediated immune responses
	SO3.2: Learn the structure and function of MHC molecules.		CI3.2: Major histocompatibility complex	SL 3.2: Advance the knowledge of the regulation of B & T cells on exposure to the antigens
	SO3.3: Able to visualize Activation of MHC I and II by peptide binding.		CI3.3: peptide binding by class I and class II molecules,	
	SO 3.4 Focus on antigen processing and presentation and their role in antibody production and immunity		CI 3.4: antigen processing and presentation	
	SO 3.5: Summarizing the mode of action of B-cells and T-Cells in defence.		CI 3.5: -Cell receptor, B- and T-cell activation and differentiation.	

	SO 3.6: Learn about various types of signalling pathways and molecules involved in it..		CI 3.6: signaling pathways	
	SO 3.7 Learn how body functions under the pathogen attack		CI 3.7 Cytokines: properties	
	SO 3.8 Elaborate and describe the role of T helper cells in cytokine production.		CI 3.8 Role of T- helper cells in cytokine production	
	SO 3.9 Describe about the pathways types functions and role of complement system in immunity.		CI 3.9 complement system	

Suggested Sessional Work (SW): *anyone*	Assignments:	Describe in detail about cytokines and their functions.
	Mini Project:	Elaborate the structure and function of MHC molecules.
	Other Activities (Specify):	Watch animation on explaining the functionality of cell mediated immune system.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	09	06	01	03	19

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO 4: Elaborate the various immunodeficiency related diseases and functionality of immune system	SO4.1: Discuss about principles and types of Antigen antibody Interactions	LI3.1 Determination of blood group of an individual	CI4.1: Antigen antibody Interactions	SL4.1: Study the MHCs
	SO 4.2: To know the mechanism and examples of precipitation reaction.	LI3.2 Determination of Rh factor of an individual	CI 4.2: Precipitation reaction	SL 4.2: Learn what are the CD4 & CD8
	SO4.3: Focus on the mechanism and examples of agglutination reaction	LI3.3 To perform ELISA test (KIT method)	CI4.3: agglutination reactions	SL 4.3: Study the nature of HIV and why is it not curable so far
	SO 4.4: Discus about Antibody affinity and activity		CI 4.4: Antibody affinity and activity	
	SO4.5: Explain isolation of lymphoid cells from blood and lymphoid organs,		CI4.5: isolation of lymphoid cells from blood and lymphoid organs,	
	SO4.6: Discuss principles types and applications of RIA		CI4.6: Radioimmunoassay	
	SO 4.7: Explain the procedure and applications of western blot.		CI 4.7: Western blot	
	SO 4.8: Discuss Immunoprecipitation – Immunoflouroscence , flow cytometry		CI 4.8: Immunoprecipitation – Immunoflouroscence , flow cytometry	

	SO 4.9 Describe various types of diagnostic method like ELISA and Rocket immunoelectrophoresis.		CI 4.9 Diagnostics methods: Immunodiffussion, immunoelectrophoresis. ELISA	

Suggested Sessional Work (SW): *anyone*	Assignments:	Elaborate the Principle and types of ELISA and RIA
	Mini Project:	Describe the mechanism and types of antigen antibody interactions
	Other Activities (Specify):	Make a poster explaining how pathogen make fool and escape from host immune machineries

Item	Cl	LI	SW	SL	Total
Approx.Hrs	09	02	01	02	14

Course outcome (COs)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO 5: Basic principles and applications of various immunization techniques as well as the various vaccinations	SO 5.1: Explain Vaccinology- Active immunization	Li5.1 to perform the antibiotic sensitive test of microbes	CI 5.1: Molecular Immunology	SL 5.1: Apply the idea of Infection to suppress the immunity to human health
	SO 5.2: Explain Vaccinology- passive immunization		CI 5.2: Preparation of vaccines	SL 5.2: Revise the ELSIA for several diseases' diagnosis.
	SO5.3: Illustrate thevaccine technology and application		CI 5.3: Vaccines & Vaccination	
	SO5.4 Explain application of recombinant DNA technology for the study of the immune systems		CI 5.4: application of recombinant DNA technology for the study of the immune systems	
	SO5.5 Explain the role and action of catalytic antibodies in -immunotherapy with genetically engineered		CI 5.5: catalytic antibodies-immunotherapy with genetically engineered antibodies	

	antibodies			
	SO5.6: Discuss about Hypersensitivity- Delayed hypersensitivity and immediate		CI 5.6 Hypersensitive reactions	
	SO5.7: Describe about Immune responses to infectious diseases		CI 5.7: Immune responses to infectious diseases	
	SO5.8: Demonstrate about Tumor Immunology with focusing the role of Vaccines		CI 5.8 Tumor Immunology-Vaccines	
	SO5.9Explain autoimmunity and their role in tissue and organ transplantation.		CI 5.9 Autoimmunity, tissue and organ transplant	

Suggested Sessional Work (SW): Anyone	Assignments:	Detail explanation of principle of vaccine production
	Mini Project:	Discuss about the western blotting techniques and it application in infection detection
	Other Activities (Specify):	How ELISA functioning differs from RIA.

Course duration (in hours) to attain Course Outcomes:

Course Title: Immunology and Immuno- Technology **Course Code:52BT201**

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
98BT404.1: The immune system, including its organs, cells, and receptors, will be covered in class.	9	4	4	1	18
98BT404.2: comprehensive understanding of innate immunity and the cell types involved.	9	6	3	1	19
98BT404.3: Understand the structure and operation of antibodies.	9	2	2	1	14

98BT404.4: The molecular foundations of antigen recognition, hypersensitivity reactions, and antigen-antibody interactions will be thoroughly understood by the students.	9	6	3	1	19
98BT404.5: The student gains an understanding of the fundamentals of immunology and how it can be used to treat diseases of humans as a result of the course.	9	2	2	1	14
Total Hours	45	20	14	05	84

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

Course Title: Immunology and Immuno- Technology **Course Code: 98BT404**

Course Outcomes	**Marks Distribution**				**Total Marks**
	A	**An**	**E**	**C**	
98BT404.1: The immune system, including its organs, cells, and receptors, will be covered in class.	2	1	1	1	5
98BT404.2: comprehensive understanding of innate immunity and the cell types involved.	2	4	2	2	10
98BT404.3: Understand the structure and operation of antibodies.	3	5	5	2	15
98BT404.4: The molecular foundations of antigen recognition, hypersensitivity reactions, and antigen-antibody interactions will be thoroughly understood by the students.	2	3	3	2	10
98BT404.5: The student gains an understanding of the fundamentals of immunology and how it can be used to treat diseases of humans as a result of the course.	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	Roitt I.M, Brostoff, J., Male D.K., Immunology (Illustrated Publisher, Mosby).
2	T. J. Kindt, R.A. G. B. A. Osborne, J. Kuby. Immunology (W.H. Freeman and Company, New York).

3	Paul, W.E. (2008). Fundamental immunology (Lippincott Williams & Wilkins).
4	T.G. Parslow, D.P. Stites, A.I. Terr. Medical immunology (Lange Medical Books/McGraw-Hill).

Suggested instructions/Implementation strategies:

46. Improved lecture
47. Tutorial
48. Case method
49. Group Discussion
50. Role play
51. Visit to virology lab (BSL-3)
52. Demonstration
53. ICT Based teaching Learning
54. Brainstorming

CO, PO and PSO Mapping

Program Name: B.Tech. Biotechnology

Semester: IV Semester

Course Title: Immunology and Immuno- Technology

Course Code: 98BT404

CO/PO/PSO Mapping		
Course Outcome (Cos)	**Program Outcomes (POs)**	**Program Specific Outcomes (PSOs)**

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3
98BT404.1: The immune system, including its organs, cells, and receptors, will be covered in class.	1	2	2	3	1	2	2	1
98BT404.2: comprehensive understanding of innate immunity and the cell types involved.	1	2	3	2	1	1	1	2
98BT4041.3: Understand the structure and operation of antibodies.	1	2	3	2	1	1	1	1
98BT404.4: The molecular foundations of antigen recognition, hypersensitivity reactions, and antigen-antibody interactions will be thoroughly understood by the students.	-	1	1	-	2	1	1	3
98BT404.5: The student gains an understanding of the fundamentals of immunology and how it can be used to treat diseases of humans as a result of the course.	1	1	1	-	-	1	3	2

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

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	**98BT404.1:** The immune system, including its organs, cells, and receptors, will be covered in class.	SO1.1, SO1.2 SO1.3, SO1.4SO1.5, 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,**
PO 1,2,3,4,5 PSO 1,2,3	**98BT404.2:** comprehensive understanding of innate immunity and the cell types involved.	SO2.1 SO2.2 SO2.3 SO2.4, SO2.5 SO2.6, SO2.7, SO2.8, SO2.9	**LI 1** **LI 2** **LI 3**	2.1, 2.2, 2.3, 2.4,2.5, 2.6,2.7,2.8,2.9	**2SL-1,2,3**
PO 1,2,3,4,5 PSO 1,2,3	**98BT404.3:** Understand the structure and operation of antibodies.	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**
PO 1,2,3,4,5 PSO 1,2,3	**98BT404.4:** The molecular foundations of antigen recognition, hypersensitivity reactions, and antigen-antibody interactions will be thoroughly understood by the students.	SO4.1 SO4.2 SO4.3 SO4.4, SO4.5, SO4.6, SO4.7 SO4.8, SO4.9	**LI 1** **LI 2** **LI 3**	4.1,4.2,4.3,4.4,4.5,4.5,4.6,4.7,4.8,4.9	**4SL-1,2,3**

PO 1,2,3,4,5 PSO 1,2,3	**98BT404.5:** The student gains an understanding of the fundamentals of immunology and how it can be used to treat diseases of humans as a result of the course.	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**

B. Tech. Biotechnology 5th Semester

Program name	Bachelor of Technology (B. Tech.)- Biotechnology	
Semester	Vth	
Course Code:	98BT503	
Course title:	Animal Biotechnology	**Curriculum Developer**: Dr. Monika Soni, Assistant Professor
Pre-requisite:	Students should have basic knowledge of animal biotechnology	
Rationale:	Animal Biotechnology explores genetic manipulation, reproductive technologies, and molecular biology applications in animals. The subject aims to enhance livestock production, develop disease-resistant breeds, and advance medical research through transgenic animals. It encompasses ethical considerations, environmental impact assessment, and regulatory frameworks. This multidisciplinary field contributes to food security, medical breakthroughs, and sustainable agriculture. The focus is on innovative techniques for genetic enhancement, disease prevention, and biopharmaceutical production in animals. As a dynamic field, Animal Biotechnology integrates biology, genetics, and technology to address global challenges while promoting responsible and sustainable practices in animal science.	
Course Outcomes (COs):	**CO1-98BT503.1**: To explain about fundamentals of animal biotechnology and define the role of tissue culture media and their constituents. **CO2-98BT503.2**: To understand the role of different cell lines in animal cell culture. **CO3-98BT503.3**: To study about cell cloning and cell selection process and analysis of cytotoxicity and viability of cells. **CO4-98BT503.4**: To study the method of monoclonal antibody production and its application. **CO5-98BT503.5**: To describe the recent research in the field of animal biotechnology.	

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)	
Program Common(PC)	98BT503	Animal Biotechnology	3	2	1	2	8	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	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)		
PC	98BT503	Animal Biotechnology	**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	98BT553	Animal Biotechnology	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	22

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO1-98BT503.1: To explain about fundamentals of animal biotechnology and define the role of tissue culture media and their constituents.			**Unit-1**	
	SO1.1 Explain in detail about history of animal biotechnology.		**CI1.1** Brief detail of animal biotechnology history.	**SL1.1** Search various reference books and other study material to start the learning about animal tissue culture and animal biotechnology.
	SO1.2 Explain in detail to specific goals & future of animal biotechnology.		**CI1.2** Describe the scope, and future of animal biotechnology.	
	SO1.3 Explain the basic requirements in laboratory.	**LI1.1** Demonstration of basic requirements (Instruments, Glasswares and others) in animal tissue culture laboratory.	**CI1.3** Basic requirements use in animal tissue culture laboratory.	**SL1.2** Learn about all requirements for animal biotechnology laboratory.
	SO1.4 Describe the application & function of basic requirements in ATC laboratory.		**CI1.4** Define the Application & function of requirements in laboratory.	
	SO1.5 Describe and define the cell culture media.		**CI1.5** Different components involves in cell culture media.	**SL1.3** Learn about all components involves to the preparation of cell culture media.
	SO1.6 Describe the different cell culture media & their components in ATC laboratory.		**CI1.6** Different cell culture media & their components.	

	SO1.7 Explain the general use of ingredients in cell culture media.		**CI1.7** Different ingredients like organic salts, vitamins, hormones etc. use in cell culture media for media preparation.	**SL1.4** Practice to the preparation of media.
	SO1.8 Explain the pros &cons of different ingredients in cell culture media.		**CI1.8** Study the Pros & cons of cell culture media's ingredients.	
	SO1.9 Describe about some growth factors use in cell culture media. Explain the advantages of sterilization of media. Explain the general process of preparation and sterilization of media. Describe the application of growth factors in cell culture media.	**LI1.2** Demonstration of media preparation and sterilization.	**CI1.9** Some growth factors like hormones, antibiotics etc. use in media. Study the advantage of Sterilization of media. Different sterilization techniques for sterilization of media. Application of different growth factors involves in cell culture media.	**SL1.5** Learn about different sterilization techniques to sterilize the cell culture media.

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignment	Describe in detail about animal tissue culture.
	SW1.2 Mini Project	Define cell culture medium & explain about various factors for the growth of animal cells/tissues.
	SW1.3 Other Activities (Specify)	Explain the process of media preparation and sterilization.

Item	CI	LI	SW	SL	Total
Approx. Hours	9	4	1	5	16

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO2-98BT503.2: To understand the role of different cell lines in animal cell culture.			**Unit-2**	
	SO2.1 Explain in detail about different types of tissue culture techniques.		**CI2.1** Brief details of different tissue culture technique.	**SL2.1** Search various reference books and other study material to start the learning about different cell/tissue culture techniques.
	SO2.2 Explain in detail about future prospects into tissue culture technique.		**CI2.2** Study the scope and application of tissue culture technique.	
	SO2.3 Define the primary cell culture and its types.		**CI2.3** Types of primary cell culture and methods for preparation of primary cells.	**SL2.2** Learn in detail types of primary and secondary cell culture.
	SO2.4 Explain the advantages of primary cell culture.		**CI2.4** Study the advantages of primary cell culture.	
	SO2.5 Describe different examples to culture chicken embryo fibroblast, liver and kidney.	**LI2.1** Demonstration of chicken embryo fibroblast culture.	**CI2.5** Preparation and culture of chicken embryo fibroblast, liver and kidney.	
	SO2.6 Explain in detail about application of fibroblast, liver, and kidney cells.		**CI2.6** Study the application of fibroblast, liver, and kidney cells.	
	SO2.7 Define the secondary cell culture and study about different cell lines.		**CI2.7** Types of secondary cell culture and preparation of cell lines.	**SL2.3** Practice to the preparation of cell lines.

	SO2.8 Explain in detail to application of secondary cell culture.		**CI2.8** Study the application of secondary cell culture.	**SL2.4** Learn about different cell separation techniques for the sorting of cells.
	SO2.9 Define the cell separation and explain its techniques. Explain in detail to application of cell separation techniques. Define the Organ culture and its application. Explain in detail to pros & cons of organ culture.	**LI2.2** To isolate the animal cells by using fluorescence activated cell shorter (FACs) technique.	**CI2.9** Isolation/ Separation of cells using different techniques. Study the application of cell separation techniques. Different methods using for culture of organ and its application and limitations. Study the pros & cons of organ culture.	**SL2.5** Learn in detail of organ culture and its development by using different methods.

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignment	Describe about different cell culture techniques.
	SW2.2 Mini Project	Detail study about cell lines.
	SW2.3 Other Activities (Specify)	Study one review article on cell separation using any techniques from animal cells.

Item	CI	LI	SW	SL	Total
Approx. Hours	9	4	1	6	23

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO3-98BT503.3: To study about cell cloning and cell selection process and analysis of cytotoxicity and viability of cells.			**Unit-3**	
	SO3.1 Explain in detail of contamination in cell culture.	**LI3.1** Demonstration of contaminants and decontaminants in animal tissue culture laboratory/medium.	**CI3.1** Brief details of different contaminants in cell culture.	**SL3.1** Search various reference books and other study material to start the learning about different contaminants.
	SO3.2 Explain in detail to removal of contamination in cell culture.		**CI3.2** Removal of contamination in cell culture.	
	SO3.3 Describe/Study about Cell cloning and selection.		**CI3.3** Various methods of cloning and selection of cell.	**SL3.2** Learn in detail cloning and selection of cell.
	SO3.4 Explain in detail to pros & cons of cell cloning.		**CI3.4** Study the pros & cons of cell cloning.	
	SO3.5 Explain in detail about scale up technique for development of cell culture.		**CI3.5** Different scale-up techniques for cell culture development.	**SL3.3** Learn about scale-up technique.
	SO3.6 Explain in detail to application of scale-up technique.		**CI3.6** Study the application of scale-up technique.	
	SO3.7 Describe the characterization and preservation of animal cells.	**LI3.2** To preserve the animal cells by using cryopreservation technique.	**CI3.7** Various techniques for characterization and preservation of animal cells.	**SL3.4** Learn in detail characterization and preservation of animal cells.
	SO3.8 Explain in detail to application of cryopreservation technique.		**CI3.8** Study the application of cryopreservation techniques.	

	SO3.9 Analysis of samples by cytotoxicity and viability test methods. Explain in detail to application of stem cells. Define the stem cells and explain about their properties. Explain in detail to application of cell cytotoxicity & viability.		**CI3.9** Various test methods of cytotoxicity and viability of cells. Study the application of stem cells. Types of stem cells and their properties. Study the application of cell cytotoxicity & viability.	**SL3.5** Learn in detail cytotoxicity and viability of cells. **SL3.6** Learn in detail stem cells.

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignment	Describe cloning and selection of cells and characterization and preservation methods for animal cells.
	SW3.2 Mini Project	Describe the methods to scale up of animal cell culture.
	SW3.3 Other Activities (Specify)	Prepare one review article on cytotoxicity and viability of cells.

Item	CI	LI	SW	SL	Total
Approx. Hours	9	4	1	5	22

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO4-98BT503.4: To study the method of monoclonal antibody production and its application.			**Unit-4**	
	SO4.1 Describe and define the transgene and transgenic animal production.		**CI4.1** Brief details of transgenic animal production.	**SL4.1** Search various reference books and other study material to start the learning about transgenic animals.

	SO4.2 Explain in detail to scope & application of transgenic animal production.		**CI4.2** Study the scope and application of transgenic animal production.	
	SO4.3 Explain in detail the methods of foreign gene transfer and their validation.	**LI4.1** Demonstration of foreign gene transfer in animal cells by using any method.	**CI4.3** Various methods of gene transfer.	
	SO4.4 Explain in detail to advantage & disadvantage of gene transfer methods.		**CI4.4** Study the advantage & disadvantage of gene transfer methods.	
	SO4.5 Explain in detail about transgenesis and organ transplantation.		**CI4.5** Different steps of transgenesis and organ transplantation.	**SL4.2** Learn in detail organ transplantation.
	SO4.6 Explain in detail to application, advantage, & disadvantage of transgenesis & organ transplantation.		**CI4.6** Study the application, advantage, & limitation of transgenesis & organ transplantation.	
	SO4.7 Describe in detail about gene therapy.		**CI4.7** Various methods and application of gene therapy.	**SL4.3** Learn in detail gene therapy.
	SO4.8 Explain in detail to pros & cons of gene therapy and Explain in detail In Vitro Fertilization and embryo transfer technique.		**CI4.8** Study the pros & cons of gene therapy and Detail in IVF and embryo transfer technique.	**SL4.5** Learn to the methods of monoclonal antibody production.
	SO4.9 Explain in detail to application & limitation of IVF & embryo transfer technique and Detail about monoclonal antibody, & methods of their production and application	**LI4.2** To prepare monoclonal antibody from animal cells.	**CI4.9** Study the application & limitation of IVF & embryo transfer technique and Detail about monoclonal antibody, & methods of their production and application	**SL4.4** Learn to the process of IVF and embryo transfer in animal cells. **SL4.5** Learn to the methods of monoclonal antibody production.

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignment	Describe the transgenesis process and production of transgenic animal.
	SW4.2 Mini Project	Describe in the detail of gene therapy and its application.
	SW4.3 Other Activities (Specify)	Study one research article on IVF and embryo transfer technique.

Item	CI	LI	SW	SL	Total
Approx. Hours	9	4	1	4	21

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO5-98BT503.5: To describe the recent research in the field of animal biotechnology.			**Unit-5**	
	SO5.1 Describe and define the vaccine.		**CI5.1** Brief details of vaccine.	**SL5.1** Search various reference books and other study material to start the learning about vaccine production.
	SO5.2 Explain in detail to scope of vaccine in animal biotechnology.		**CI5.2** Study the scope of vaccine.	
	SO5.3 Explain in detail the vaccine production.	**LI5.1** Demonstration of cell culture based vaccine to control of various diseases.	**CI5.3** Detail the vaccine production, & their methods.	

	SO5.4 Explain in detail to application & limitation of vaccine production.	**LI5.2** prepare the media and culture the bacterial cells	**CI5.4** Study the application, & limitation of vaccine production.	
	SO5.5 Explain in detail about cell culture use for diagnosis and treatment of disease.		**CI5.5** Detail of cell culture in diagnosis and treatment of disease.	**SL5.2** Learn in detail about cell culture for disease diagnosis.
	SO5.6 Explain in detail to application of cell culture diagnosis methods.		**CI5.6** Study the application of cell culture diagnosis methods.	
	SO5.7 Explain in detail to pros & cons of cell culture diagnosis methods.		**CI5.7** Study the pros & cons of cell culture diagnosis methods.	
	SO5.8 Describe in detail recent research in animal biotechnology.		**CI5.8** Detail in recent research in the field of animal biotechnology.	**SL5.3** Learn in detail current research in animal biotechnology to solve the problems.
	SO5.9 Describe in detail scope of recent research in animal biotechnology and application & limitation of recent research in animal biotechnology field.		**CI5.9** Study the scope of current research in animal biotechnology field and the application & limitation of recent research in animal biotechnology field.	SL5.4 Learn to the challenges in animal biotechnology field.

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignment	Explain in detail about vaccine production and their application.
	SW5.2 Mini Project	Describe in the detail of cell culture to diagnosis and treatment of disease.
	SW5.3 Other Activities (Specify)	Study review articles on the current research in the field of biotechnology.

Course duration (in hours) to attain Course Outcomes:

Course Title: Animal Biotechnology **Course Code:** 98BT503

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1-98BT503.1: To explain about fundamentals of animal biotechnology and define the role of tissue culture media and their constituents.	9	4	5	1	19
CO2-98BT503.2: To understand the role of different cell lines in animal cell culture.	9	4	5	1	19
CO3-98BT503.3: To study about cell cloning and cell selection process and analysis of cytotoxicity and viability of cells.	9	4	6	1	20
CO4-98BT503.4: To study the method of monoclonal antibody production and its application.	9	4	5	1	19
CO5-98BT503.5: To describe the recent research in the field of animal biotechnology.	9	4	4	1	18
Total Hours	45	20	25	05	95

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

Course Title: Animal Biotechnology **Course Code:** 98BT503

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

Course Outcomes	Marks Distribution			Total Marks
	R	**U**	**A**	
CO1-98BT503.1: To explain about fundamentals of animal biotechnology and define the role of tissue culture media and their constituents.	2	3	4	9
CO2-98BT503.2: To understand the role of different cell lines in animal cell culture.	2	4	4	10

CO3-98BT503.3: To study about cell cloning and cell selection process and analysis of cytotoxicity and viability of cells.	3	4	4	11
CO4-98BT503.4: To study the method of monoclonal antibody production and its application.	3	3	4	10
CO5-98BT503.5: To describe the recent research in the field of animal biotechnology.	3	4	3	10
Total Marks	**13**	**18**	**19**	**50**

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1.	Ranga M.M., Animal Biotechnology. Agrobios India Limited, 2002.
2.	Ramadass P, Meera Rani S., Text Book of Animal Biotechnology. Akshara Printers, 1997.
3.	R. Ian Freshney, Culture of Animal cells, A Manual of basic technique 4th Edition 2002.
4.	Masters J.R.W., Animal Cell Culture: Practical Approach. Oxford University Press,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
7. Demonstration
8. ICT Based teaching Learning
9. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Tech. Biotechnology

Semester: V^{th} Semester

Course Title: Animal Biotechnology

Course Code: 98BT503

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**
CO1-98BT503.1: To explain about fundamentals of animal biotechnology and define the role of tissue culture media and their constituents.	-	1	-	1	2	2	2	-	3	1	3	-	2	2	1
CO2-98BT503.2: To understand the role of different cell lines in animal cell culture.	-	1	-	-	-	-	3	-	3	2	3	2	1	1	2
CO3-98BT503.3: To study about cell cloning and cell selection process and analysis of cytotoxicity and viability of cells.	1	1	1	1	-	-	2	-	3	1	2	3	1	1	1
CO4-98BT503.4: To study the method of monoclonal antibody production and its application.	1	-	1	-	2	2	3	3	-	1	3	2	1	1	3
CO5-98BT503.5: To describe the recent research in the field of animal biotechnology.	1	-	1	-	-	2	2	3	-	2	2	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)
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO1-98BT503.1**: To explain about fundamentals of animal biotechnology and define the role of tissue culture media and their constituents.	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	**CO2-98BT503.2**: To understand the role of different cell lines in animal cell culture.	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	**CO3-98BT503.3**: To study about cell cloning and cell selection process and analysis of cytotoxicity and viability of cells.	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-1,2,3,4,5,6
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO4-98BT503.4**: To study the method of monoclonal antibody production and its application.	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
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO5-98BT503.5**: To describe the recent research in the field of animal biotechnology.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9	LI 1 LI2	5.1,5.2,5.3,5.4,5.5, 5.6,5.7,5.8,5.9	5SL-1,2,3,4

Program Name	**B. Tech. Biotechnology**	
Semester	V	
Course Code:	98BT504	
Course title:	Distillates and Fermentation	**Curriculum Developer**: Er. Arpit Srivastava, Assistant Professor
Pre-requisite:	Students should have basic knowledge of microbiology and fermentation	
Rationale:	Distillates and Fermentation study and solve problems related to industrial production processes. 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.	
Course Outcomes (COs):	**CO1-98BT504.1.** Describe the fundamentals of Distillates and Fermentation Technology **CO2-98BT504.2.** Define the role of microbiology for the production of desired bioproducts **CO3-98BT504.3.** Derive the working mechanism of upstream and downstream processing **CO4-98BT504.4.** Interpretate the mechanism of fermentation process in industry **CO5-98BT504.5.** 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)	98BT504	Distillates and Fermentation	3	2	1	3	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

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 (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)	(ESA)	(PRA+ ESA)
PC	98BT504	Distillates and Fermentation	**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)		
PC	98BT554	Distillates and Fermentation lab	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	05	19

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO1-98BT504.1. Describe the fundamentals of Distillates and Fermentation Technology	SO1.1: Understand microbial metabolic pathways	LI1: Study metabolic pathways in microorganisms	CI1.1: Lecture on metabolic pathways in microbes	SL1.1: Research recent advances in microbial metabolism
	SO1.2: Comprehend metabolic control mechanisms		CI1.2: Lecture on metabolic control mechanisms	
	SO1.3: Understand industrial production of citric acid		CI1.3: Lecture on industrial production of citric acid	
	SO1.4: Learn about lactic acid fermentation		CI1.4: Case study on lactic acid fermentation	SL1.2: Study the applications of lactic acid in industries
	SO1.5: Evaluate enzyme production processes	LI2: Enzyme extraction and activity assay	CI1.5: Lecture on microbial enzyme production (lipase, xylase, pectinases, proteases)	
	SO1.6: Analyze acetone-butanol fermentation		CI1.6: Group discussion on acetone-butanol fermentation	

	SO1.7: Study cheese fermentation process		CI1.7: Seminar on cheese fermentation	
	SO1.8: Compare different fermentation methods		CI1.8: Comparison of solid-state and submerged fermentation	
	SO1.9: Understand the role of fermentation in industrial applications		CI1.9: Industrial visit to enzyme production facility	

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

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)
CO1-98BT504.2. Define the role of microbiology for the production of desired bioproducts	SO2.1: Comprehend microbial production of insulin	LI1: Demonstrate insulin production	CI2.1: Lecture on microbial production of insulin	SL2.1: Research recent advances in microbial therapeutic production
	SO2.2: Understand production of interferons		CI2.2: Lecture on interferon production	

	SO2.3: Analyze production of amylase	LI2: Amylase activity assay	CI2.3: Lecture on microbial production of enzymes (amylase)	
	SO2.4: Evaluate microbial production of amino acids (EAA/N-EAA)		CI2.4: Lecture on amino acid production	
	SO2.5: Study vitamin B12 fermentation		CI2.5: Lecture on vitamin B12 and riboflavin fermentation	SL2.2: Study the health benefits of vitamin B12 and riboflavin
	SO2.6: Understand microbial production of riboflavin		CI2.6: Case study on riboflavin production	
	SO2.7: Learn about fermentation techniques for therapeutic compounds		CI2.7: Seminar on microbial production techniques	
	SO2.8: Compare different microbial production methods		CI2.8: Comparison of microbial and chemical production methods	
	SO2.9: Understand industrial applications of microbial therapeutic compounds		CI2.9: Industrial visit to a pharmaceutical production facility	

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

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)
CO1-98BT504.3 Derive the working mechanism of upstream and downstream processing	SO3.1: Understand microbial production of bioplastics	LI3.1: Study bioplastic production processes	CI3.1: Lecture on microbial production of bioplastics (PHB, PHA)	SL3.1: Research recent advances in bioplastic production
	SO3.2: Study bioinsecticides production	LI3.2: effect of bioinsecticide on plant growth	CI3.2: Lecture on bioinsecticides (thuricide) production	
	SO3.3: Analyze biopolymer production		CI3.3: Lecture on biopolymer production (dextran, alginate, xanthan, pullulan)	
	SO3.4: Understand the role of biofertilizers		CI3.4: Lecture on biofertilizers (nitrogen fixer Azotobacter, phosphate solubilizing microorganisms)	SL3.2: Study the benefits of biofertilizers in agriculture
	SO3.5: Study single cell protein production		CI3.5: Lecture on single cell protein production	

	SO3.6: Evaluate production of biological weapons		CI3.6: Lecture on biological weapons with reference to anthrax	
	SO3.7: Learn about microbial production techniques		CI3.7: Seminar on modern microbial production techniques	
	SO3.8: Compare different microbial production methods		CI3.8: Comparison of microbial production methods for different products	
	SO3.9: Understand industrial applications of modern microbial production		CI3.9: Industrial visit to a facility producing modern microbial products	

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"

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)**

CO4-98BT504.4 Interpretate the mechanism of fermentation process in industry	SO4.1: Comprehend the process of biogas production	LI4.1: Study biogas production process	CI4.1: Lecture on the substrate digester and microorganisms in biogas production	SL4.1: Research recent advances in biogas production
	SO4.2: Understand bioethanol production	LI4.2: to use sugarcane juice for bioethanol production	CI4.2: Lecture on bioethanol production from sugar, molasses, starch, and cellulosic materials	
	SO4.3: Analyze ethanol recovery techniques		CI4.3: Lecture on ethanol recovery methods	
	SO4.4: Study microbial production of hydrogen gas		CI4.4: Lecture on microbial production of hydrogen gas	SL4.2: Study the benefits of hydrogen gas as a biofuel
	SO4.5: Understand biodiesel production from hydrocarbons		CI4.5: Lecture on biodiesel production from hydrocarbons	
	SO4.6: Evaluate enzyme immobilization techniques		CI4.6: Lecture on immobilization of enzymes	
	SO4.7: Learn about the useful features of biofuels		CI4.7: Seminar on the advantages of biofuels	
	SO4.8: Compare different biofuel production methods		CI4.8: Comparison of different biofuel production methods	
	SO4.9: Understand industrial applications of biofuels		CI4.9: Industrial visit to a biofuel production facility	

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”

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)
CO5-98BT504.5 Examine the mechanism of biological product development using microbes	SO5.1: Comprehend the distillation process	LI5.1: Demonstrate distillation process	CI5.1: Lecture on the fundamentals of distillation	SL5.1: Research recent advances in distillation technology
	SO5.2: Understand types of mixtures in distillation	LI5.2 compare two column chromatography for two liquids	CI5.2: Lecture on types of mixtures	
	SO5.3: Analyze the laws of gases related to distillation		CI5.3: Lecture on the laws of gases	
	SO5.4: Study the role of atmospheric pressure in distillation		CI5.4: Lecture on the role of atmospheric pressure	SL5.2: Study the applications of distillation in various industries
	SO5.5: Understand Raoult's Law		CI5.5: Lecture on Raoult's Law	
	SO5.6: Evaluate different types of distillation units		CI5.6: Lecture on types of distillation units	
	SO5.7: Learn about the methods of distillation		CI5.7: Seminar on distillation methods	
	SO5.8: Compare different types of distillation columns		CI5.8: Comparison of different distillation columns	
	SO5.9: Understand industrial applications of distillation		CI5.9: Industrial visit to a distillation unit	

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: Distillates and Fermentation **Course Code:** 98BT504

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1-98BT504.1: Describe the fundamentals of Distillates and Fermentation Technology	9	4	5	1	19
CO2-98BT504.2: Define the role of microbiology for the production of desired bioproducts	9	4	5	1	19
CO3-98BT504.3: Elaborate the working mechanism of upstream and downstream processing	9	4	5	1	19
CO4-98BT504.4: Interpretate the mechanism of fermentation process in industry	9	4	5	1	19
CO5-98BT504.5: Examine the mechanism of biological product development using microbes	9	4	5	1	19
Total Hours	45	20	25	05	95

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

Course Title: Distillates and Fermentation **Course Code:** 98BT504

Course Outcomes	Marks Distribution				Total Marks
	A	**An**	**E**	**C**	
CO1-98BT504.1: Describe the fundamentals of Distillates and Fermentation Technology	2	1	1	1	5
CO2-98BT504.2: Define the role of microbiology for the production of desired bioproducts	2	4	2	2	10
CO3-98BT504.3: Elaborate the working mechanism of upstream and downstream processing	3	5	5	2	15
CO4-98BT504.4: Interpretate the mechanism of fermentation process in industry	2	3	3	2	10
CO5-98BT504.5: 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:

10. Improved lecture
11. Tutorial
12. Case method
13. Group Discussion
14. Role play
15. Visit to Industrial plant of Biotech-based organizations
16. Demonstration
17. ICT Based teaching Learning
18. Brainstorming

CO, PO and PSO Mapping

Program Name: M. Sc. Microbiology

Semester: III Semester

Course Title: Distillates and Fermentation Technology

Course Code: 98BT504

CO/PO/PSO Mapping								
Course Outcome (Cos)	**Program Outcomes (POs)**					**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**
CO1-98BT504.1: Describe the fundamentals of Distillates and Fermentation Technology	2	-	-	1	2	2	2	1
CO2-98BT504.2: Define the role of microbiology for the production of desired bioproducts	-	-	-	-	-	1	1	2
CO3-98BT504.3: Elaborate the working mechanism of upstream and downstream processing	-	1	1	1	-	1	1	1
CO4-98BT504.4: Interpretate the mechanism of fermentation process in industry	-	1	1	-	2	1	1	3
CO5-98BT504.5: Examine the mechanism of biological product development using microbes	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	**CO1-98BT504.1:** Describe the fundamentals of Distillates 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 PSO 1,2,3	**CO2-98BT504.2:** 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 PSO 1,2,3	**CO3-98BT504.3:** 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 PSO 1,2,3	**CO4-98BT504.4:** Interpretate the mechanism of fermentation process in industry	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5	**LI 1**	4.1,4.2,4.3,4.4, 4.5	**4SL-1,2,3,4,5**
PO 1,2,3,4,5 PSO 1,2,3	**CO5-98BT504.5:** 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	**Bachelor of Technology (B.Tech.)- Biotechnology**	
Semester	V	
Course Code:	98BT505	
Course title:	Bioseparations	**Curriculum Developer**: Er. Arpit Srivastava, Assistant Professor
Pre-requisite:	Students should have basic knowledge of fermentation and downstream processing	
Rationale:	Bioseparation is refers to the recovery and the purification of biosynthetic products. Downstream processing or bioseparation constitutes a critical step in manufacturing of pharmaceuticals such as antibiotics, hormones, antibodies and vaccines and enzymes with regards to product purity, cost, and environmental impact. This course offers the importance of downstream processing in biotechnology and its problems associated with product purification. The objective of this course is to impart knowledge and skills on different separation, purification, recovery and processing techniques.	
Course Outcomes (COs):	**CO1-98BT505.1.** Illustrate the basic mechanism of Bioseparations **CO2-98BT505.2.** Discuss the role of Downstream processing in bioprocessing **CO3-98BT505.3.** Comprehend & distinguish among the working mechanism of unit operators used in bioseparations **CO4-98BT505.4.** Interpretate the mechanism of isolation of products through analytical methods **CO5-98BT505.5.** Examine and demonstrate the mechanism of product purification	

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)	98BT505	Bioseparations	3	2	1	3	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

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)		

PE	98BT505	Bioseparations	**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)		
PE	98BT555	Bioseparations	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	02	16

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-98BT505.1 Illustrate the basic mechanism of Bioseparations	SO1.1: Understand the history and scope of downstream processing	LI1.1: Study the overview of a bioprocess	CI1.1: Lecture on the history and scope of downstream processing in biotechnology	SL1.1: Research recent advances in downstream processing
	SO1.2: Comprehend the problems and requirements of purification	LI1.2: demonstrate different processing units	CI1.2: Lecture on the problems and requirements of purification	
	SO1.3: Understand the overview of upstream and downstream processing		CI1.3: Lecture on upstream and downstream processing	
	SO1.4: Learn about the characteristics of biotechnology products		CI1.4: Lecture on the characteristics of biotechnology products	SL1.2: Study different classes of bioproducts
	SO1.5: Evaluate the physicochemical basis of bio-separation		CI1.5: Lecture on the physicochemical basis of bio-separation	
	SO1.6: Study the classes of bioproducts		CI1.6: Lecture on different classes of bioproducts	
	SO1.7: Learn about the importance of downstream processing		CI1.7: Seminar on the importance of downstream processing	
	SO1.8: Compare upstream and downstream processing methods		CI1.8: Comparison of upstream and downstream processing methods	

	SO1.9: Understand the industrial applications of downstream processing		CI1.9: Industrial visit to a downstream processing facility	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Describe in detail about the role of Bioseparation in Product development
	SW1.2 Mini Project	Differentiate between Upstream and Downstream processing
	SW1.3 Other Activities (Specify)	Draw a flowchart compiling all procedures used in bioseparation/downstream processing

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)**
CO2-98BT505.2. Discuss the role of Downstream processing in bioprocessing	SO2.1: Understand cell disruption for product release	LI2.1: Demonstrate cell disruption techniques	CI2.1: Lecture on mechanical, enzymatic, and chemical methods of cell disruption	SL2.1: Research recent advances in cell disruption techniques
	SO2.2: Comprehend the pretreatment and stabilization of byproducts	LI2.2: to perform quorum sensing of bacteria	CI2.2: Lecture on pretreatment and stabilization of byproducts	
	SO2.3: Analyze filtration principles		CI2.3: Lecture on conventional and cross flow filtration	
	SO2.4: Study filter media and membrane fouling		CI2.4: Lecture on filter media and membrane fouling	SL2.2: Study the applications of filtration in bioseparation
	SO2.5: Understand rotary vacuum filtration		CI2.5: Lecture on rotary vacuum filtration equipment	
	SO2.6: Evaluate different filtration methods		CI2.6: Comparison of different filtration methods	

	SO2.7: Learn about the principles of filtration		CI2.7: Seminar on filtration principles	
	SO2.8: Compare mechanical, enzymatic, and chemical cell disruption methods		CI2.8: Comparison of cell disruption methods	
	SO2.9: Understand the industrial applications of physical methods of separation		CI2.9: Industrial visit to a facility using physical methods of separation	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Describe Filteration and its application in bioseparation techniques
	SW2.2 Mini Project	Make a project on Rotatory Drum Vaccum Filter and its applications
	SW2.3 Other Activities (Specify)	Make Power point presentation on production of biomass

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)**
CO2-98BT505.3 Comprehend & distinguish among the working mechanism of unit operators used in bioseparations	SO3.1: Understand aqueous two-phase extraction principles	LI3.1: Demonstrate aqueous two-phase extraction	CI3.1: Lecture on aqueous two-phase extraction principles	SL3.1: Research recent advances in aqueous two-phase extraction
	SO3.2: Comprehend phase separation techniques		CI3.2: Lecture on phase separation	
	SO3.3: Analyze membrane separation methods	LI3.2: Demonstrate membrane separation	CI3.3: Lecture on membrane separation, ultrafiltration, and dialysis	

	SO3.4: Study protein precipitation methods		CI3.4: Lecture on precipitation of proteins by different methods	SL3.2: Study the applications of protein precipitation in bioseparation
	SO3.5: Understand sedimentation principles		CI3.5: Lecture on sedimentation principles and sedimentation coefficient	
	SO3.6: Evaluate centrifugation techniques		CI3.6: Lecture on tubular and disk centrifuges	
	SO3.7: Learn about ultracentrifugation		CI3.7: Lecture on ultracentrifugation and sedimentation at low accelerations	
	SO3.8: Compare flocculation principles		CI3.8: Lecture on flocculation principles	
	SO3.9: Understand the industrial applications of product isolation methods		CI3.9: Industrial visit to a facility using product isolation methods	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Derive the equations for Centrifugation using sedimentation, terminal velocity and gravity
	SW3.2 Mini Project	Describe the role of Ultracentrifuge in industries
	SW3.3 Other Activities (Specify)	Prepare one Power point presentation on "Different types of Centrifuge and their applications"

Item	Cl	LI	SW	SL	Total
Approx. Hrs	04	04	01	04	13

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO2-98BT505.4 Interpretate the mechanism of isolation of products through analytical methods	**SO4.1** Elucidate the application & working mechanism of Chromatography	**LI4.1** To perform the Column Chromatography process as Unit Operation for extraction of different compounds	**Unit-4 Product purification by chromatography** **CI4.1** Chromatography principles, chromatography equipment and detectors	**SL4.1** Find out the industrial applications of Chromatography
	SO4.2 Distinguish among Ion-exchange, size exclusion, hydrophobic interactions	**LI4.2** To perform the TLC of the amino acid presence in the given	**CI4.2** Ion-exchange, size exclusion, hydrophobic interaction	**SL4.2** List down various kinds of Chromatographic columns used in analysis
	SO4.3 Analyze the working of Bioaffinity chromatography		**CI4.3** Bioaffinity chromatography	**SL4.3** List down various kinds of Solvents used in Chromatographic technique
	SO4.4 Distinguish among the working mechanism of Pseudo affinity Chromatographic techniques		**CI4.4** Pseudo affinity Chromatographic techniques	**SL4.4** List down the various kinds of Detectors associated with chromatography

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Determine the working mechanism and applications of different kind of chromatographic techniques
	SW4.2 Mini Project	Derive the Qualitative and Quantitative data optimization and retrieval through chromatographic detectors and equations associated with it
	SW4.3 Other Activities (Specify)	Perform the extraction of different compounds and calculate the Retention time for each compound in laboratory

Item	Cl	LI	SW	SL	Total
Approx. Hrs	8	04	01	05	18

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO2-98BT505.5 Interpretate the mechanism of isolation of products through analytical methods	**SO5.1** Elucidate the application & working mechanism of Chromatography	**LI5.1** To determine the AA sequences comparison on the basis of peptide mapping using ProteoMapper (Server/tool)	**Unit-5 Final product formulation and finishing operations** **CI5.1** Analysis of the final product - Protein-based contaminants	**SL5.1** Find out the industrial applications of Chromatography
	SO5.2 Distinguish among Ion-exchange, size exclusion, hydrophobic interactions	**LI5.2** To determine the protein 3D structure, function and annotations using Protein Data Bank (PDB database)	**CI5.2** Removal of altered forms of the protein of interest from the product stream	**SL5.2** List down various kinds of Chromatographic columns used in analysis
	SO5.3 Analyze the working of Bioaffinity chromatography		**CI5.3** NMR and X-Ray Crystallography (protein structure determination)	**SL5.3** List down various kinds of Solvents used in Chromatographic technique
	SO5.4 Distinguish among the working mechanism of Pseudo affinity Chromatographic techniques		**CI5.4** Determination of protein concentration (all the major protein assays – principles)	**SL5.4** List down the various kinds of Detectors associated with chromatography
	SO5.5 Describe and draw Amnio acid’s structure and functions		**CI5.5** Amino acid analysis, Peptide mapping	**SL5.5** List down the various bioinformatics-based server/tool that assist in study of protein/proteomics
	SO5.6 Explain the process of Protein sequencing		**CI5.6** N-terminal sequencing, Analysis of secondary and tertiary structure	

	SO5.7 Define the protein-based product impurities		**CI5.7** Detection of protein-based product impurities	
	SO5.8 Explain the Rapid methods for detection of specific organisms and toxins (ELISA/RIA)		**CI5.8** Rapid methods for detection of specific organisms and toxins	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Explain general mechanism of ELISA and RIA
	SW5.2 Mini Project	Describe the RIPP model by giving an example from microbial production of any product from therapeutic domain
	SW5.3 Other Activities (Specify)	Prepare one article on the "Structure and Bonds associated with Proteins"

Course duration (in hours) to attain Course Outcomes:

Course Title: Bioseparations **Course Code:** 98BT505

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1-98BT505.1. Illustrate the basic mechanism of Bioseparations	9	4	2	1	16
CO2-98BT505.2. Discuss the role of Downstream processing in bioprocessing	9	4	2	1	16
CO3-98BT505.3. Comprehend & distinguish among the working mechanism of unit operators used in bioseparations	9	4	2	1	16
CO4-98BT505.4. Interpretate the mechanism of isolation of products through analytical methods	4	4	4	1	13
CO5-98BT505.5. Examine and demonstrate the mechanism of product purification	8	4	5	1	18
Total Hours	40	20	18	05	87

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

Course Title: Bioseparations **Course Code:** 98BT505

Course Outcomes	**Marks Distribution**				**Total Marks**
	A	**An**	**E**	**C**	
CO1-98BT505.1. Illustrate the basic mechanism of Bioseparations	2	1	1	1	5
CO2-98BT505.2. Discuss the role of Downstream processing in bioprocessing	2	4	5	1	12
CO3-98BT505.3. Comprehend & distinguish among the working mechanism of unit operators used in bioseparations	3	5	5	1	14
CO4-98BT505.4. Interpretate the mechanism of isolation of products through analytical methods	2	3	5	1	11
CO5-98BT505.5. Examine and demonstrate the mechanism of product purification	5	4	1	0	10
Total Marks	**14**	**17**	**17**	**04**	**52**

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

Suggested learning Resources:

(a) Books:

(b)

S.No.	**Title/Author/Publisher details**
1	Roger G.Harrison, Paul Todd, Scott R.Rudge and Demetri P. Pterides – Biosepartions Science and Engineering – Oxford University Press - 2003
2	R.O. Jenkins, (Ed.) – Product Recovery In Bioprocess Technology – Biotechnology By Open Learning Series, Butterworth-Heinemann (1992).
3	J.C. Janson And L. Ryden, (Ed.) – Protein Purification – Principles, High Resolution Methods And Applications, VCH Pub. 1989.
4	Fundamentals of Biochemistry. Author, JL Jain et al. Edition, reprint. Publisher, S. Chand Publishing, 2004.
5	Bioseparations: Principles and Techniques; Sivasankar, B; PHI Publications, 2009

(c) Online Resources:

Suggested instructions/Implementation strategies:

19. Improved lecture
20. Tutorial
21. Case method
22. Group Discussion
23. Role play
24. Visit to Waste water/Effluent Treatment plant and downstream pharmaceutical plants
25. Demonstration
26. ICT Based teaching Learning
27. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Tech. Biotechnology

Semester: V Semester

Course Title: Bioseparations

Course Code: 98BT505

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
CO1-98BT505.1. Illustrate the basic mechanism of Bioseparations	-	1	-	1	2	2	3	-	3	2	2	3	1	2	1
CO2-98BT505.2. Discuss the role of Downstream processing in bioprocessing	-	1	-	-	-	-	3	-	2	2	3	3	3	-	2
CO3-98BT505.3. Comprehend & distinguish among the working mechanism of unit operators used in bioseparations	-	1	1	1	-	-	3	-	3	1	1	2	1	2	-
CO4-98BT505.4. Interpretate the mechanism of isolation of products through analytical methods	-	-	1	-	2	2	3	3	-	1	3	3	2	1	3
CO5-98BT505.5. Examine and demonstrate the mechanism of product purification	1	-	1	-	-	2	3	3	1	2	2	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 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO1-98BT505.1.** Illustrate the basic mechanism of Bioseparations	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5SO1.6 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**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO2-98BT505.2.** Discuss the role of Downstream processing in bioprocessing	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5SO2.6 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**

PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO3-98BT505.3.** Comprehend & distinguish among the working mechanism of unit operators used in bioseparations	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**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO4-98BT505.4.** Interpretate the mechanism of isolation of products through analytical methods	SO4.1 SO4.2 SO4.3 SO4.4	**LI 1** **LI 2**	4.1,4.2,4.3,4.4	**4SL-1,2,3,4**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO5-98BT505.5.** Examine and demonstrate the mechanism of product purification	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8SO5.9	**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**

Program Name	**B. Tech. Biotech Semester-**	
Semester	**Vth**	
Course Code:	98BT506-C	
Course title:	**Molecular modeling and Drug designing (MMDD)**	**Curriculum Developer**: Mr. Piyush Kant Rai, Teaching associate
Pre-requisite:	Students must have knowledge of Molecular models and their structures which is important in drug designing.	
Rationale:	The paper on MMDD in B. Tech. Biotech Semester-Vth program explores the critical role of specialized mechanisms of protein 2D and 3D structure modeling and in analyzing microbial evolution and diversity. It delves into the use of tools for understanding mutation, evolution, and databases to learn more about how these data are generated and what biological mystery can be solved by using these data and tools.	

Course Outcomes (COs):	98BT506-C1: Explain the various stages of drug discovery 98BT506-C2: Define the concept of receptor and ligand binding 98BT506-C3: Describe physicochemical Properties and the techniques involved in QSAR 98BT506-C4: Learn introduction to Bioinformatics and Cheminformatics 98BT506-C5: Learn methods in molecular and quantum mechanics and Explain various structure-based drug design methods

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 Elective (PE)	98BT506-C	**Molecular modeling and Drug designing (MMDD)**	3	2	1	1	7	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)		
Program Elective (PE)	98BT506-C	Molecular modeling and Drug designing (MMDD)	16	19	5	5	5	50	50

Scheme of Assessment: practical

			Scheme of Assessment (Marks)		
			Progressive Assessment (PRA)		

Board of Study	Course Code	Course Title	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)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Program Elective (PE)	98BT556-C	Molecular modeling and Drug designing (MMDD)-lab	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	02	16

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-98BT506C1: Explain the various stages of drug discovery	SO1.1: Understand bond length, bond angle, torsion angle, and non-covalent interactions	LI1.1: Study molecular structure using modeling software	CI1.1: Lecture on basic concepts of molecular structure	SL1.1: Research recent advances in molecular modeling
	SO1.2: Comprehend molecular structure and internal energy	LI1.2: Demonstrate energy minimization of small molecules	CI1.2: Lecture on molecular structure and internal energy	
	SO1.3: Learn energy minimization techniques		CI1.3: Lecture on energy minimization of small molecules	
	SO1.4: Evaluate empirical representation of molecular energies		CI1.4: Lecture on empirical representation of molecular energies	SL1.2: Study different force fields used in molecular mechanics
	SO1.5: Understand the use of force fields and molecular mechanics methods		CI1.5: Lecture on the use of force fields and molecular mechanics methods	
	SO1.6: Discuss global energy minimum		CI1.6: Lecture on the concept of global energy minimum	
	SO1.7: Learn molecular representation in graphics		CI1.7: Seminar on molecular representation in graphics	
	SO1.8: Compare different molecular modeling software		CI1.8: Comparison of molecular modeling software	

	SO1.9: Understand the industrial applications of molecular modeling		CI1.9: Industrial visit to a molecular modeling facility	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Write about the Schrodinger wave equation and its improvement
	SW1.2 Mini Project	Learn different types of force fields.
	SW1.3 Other Activities (Specify)	Which force field is the most stable and frequently used for biologically active molecule

Item	Cl	LI	SW	SL	Total
Approx. Hrs	**09**	4	1	2	**16**

Course Outcome (CO)	**Session Outcomes (SOs)**	**LaboratoryInstruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO2-98BT506-C2: Define the concept of receptor and ligand binding	O2.1: Understand the criteria for synthesizing drugs	LI2.1: Study drug synthesis techniques	CI2.1: Lecture on the rational basis of drug designing	SL2.1: Research recent advances in drug designing
	SO2.2: Comprehend pharmacophore-based drug design	LI2.2: Demonstrate pharmacophore modeling	CI2.2: Lecture on pharmacophore-based drug design	
	SO2.3: Analyze lead finding and lead optimization		CI2.3: Lecture on lead finding and lead optimization	
	SO2.4: Study receptor-based design		CI2.4: Lecture on receptor based design	SL2.2: Study different receptor structures used in drug design
	SO2.5: Understand the process of structure-based design		CI2.5: Lecture on the process of structure-based design	

	SO2.6: Evaluate design of energy inhibitors		CI2.6: Lecture on design of energy inhibitors	
	SO2.7: Learn about action and reaction in drug design		CI2.7: Seminar on action and reaction in drug design	
	SO2.8: Compare different drug designing approaches		CI2.8: Comparison of drug designing approaches	
	SO2.9: Understand the industrial applications of drug designing		CI2.9: Industrial visit to a drug designing facility	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Write about the Lipinski rule of five
	SW2.2 Mini Project	Write about lead and target optimization.
	SW2.3 Other Activities (Specify)	Find out some you tube videos based on how a drug works in the system.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	**09**	4	**1**	2	16

Course Outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO3-98BT506-C3: Describe physicochemical Properties and the techniques involved in QSAR	SO3.1: Understand the tools Ludi, Ludi/CAP, AutoDock, and GRAMM	LI3.1: Demonstrate the use of Ludi and AutoDock	CI3.1: Lecture on computer based tools for drug designing	SL3.1: Research recent advances in computer based drug designing tools
	SO3.2: Comprehend scoring and docking modes	LI3.2: Demonstrate docking simulations	CI3.2: Lecture on scoring and docking modes	

	SO3.3: Analyze QSAR principles and methods		CI3.3: Lecture on QSAR principles and methods	
	SO3.4: Study drug design by receptor site fit		CI3.4: Lecture on drug design by receptor site fit	SL3.2: Study the applications of QSAR in drug designing
	SO3.5: Understand active site simulations using PDB structure data		CI3.5: Lecture on active site simulations using PDB structure data	
	SO3.6: Evaluate homology modeling		CI3.6: Lecture on homology modeling techniques	
	SO3.7: Learn about perturbation free energy		CI3.7: Lecture on perturbation free energy and its practical applications	
	SO3.8: Compare different computer based drug designing tools		CI3.8: Comparison of computer based drug designing tools	
	SO3.9: Understand the industrial applications of computer based drug designing		CI3.9: Industrial visit to a computer based drug designing facility	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Write about the minimum and maximum range and its significance with respect to ADMET properties
	SW3.2 Mini Project	
	SW3.3 Other Activities (Specify)	Employ the virtual lab for docking basics.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	4	1	2	16

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO4-98BT506-C4: Learn introduction to Bioinformatics and Cheminformatics	SO4.1: Understand basic principles of molecular dynamics	LI4.1: Demonstrate molecular dynamics simulations	CI4.1: Lecture on basic principles of molecular dynamics	SL4.1: Research recent advances in molecular dynamics
	SO4.2: Comprehend Monte Carlo simulation for conformational analysis	LI4.2: Demonstrate Monte Carlo simulations	CI4.2: Lecture on Monte Carlo simulation for conformational analysis	
	SO4.3: Analyze ab initio and Density-Functional Theory		CI4.3: Lecture on ab initio and Density-Functional Theory	
	SO4.4: Study semiemperical methods		CI4.4: Lecture on semiemperical methods	SL4.2: Study the applications of semiemperical methods in drug discovery
	SO4.5: Understand organized drug discovery and development		CI4.5: Lecture on organized drug discovery and development	
	SO4.6: Evaluate pharmacology and screening systems		CI4.6: Lecture on pharmacology and screening systems	
	SO4.7: Learn about alternative strategies in lead identification		CI4.7: Seminar on alternative strategies in lead identification	
	SO4.8: Compare lead optimization strategies		CI4.8: Comparison of lead optimization strategies	
	SO4.9: Understand the industrial applications of		CI4.9: Industrial visit to a drug discovery facility	

	molecular dynamics and drug discovery			

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	prepare a flow chart of drug discovery and development.
	SW4.2 Mini Project	
	SW4.3 Other Activities (Specify)	Relate the force field and Newton equation of motion for a biological system

Item	Cl	LI	SW	SL	Total
Approx. Hrs	**09**	4	1	2	16

Course Outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO5-98BT506-C5: Learn methods in molecular and quantum mechanics and Explain various structure-based drug design methods.	SO5.1: Understand enzyme catalytic principles	LI5.1: Study enzyme catalytic principles	CI5.1: Lecture on enzyme catalytic principles	SL5.1: Research recent advances in enzyme inhibitors
	SO5.2: Comprehend affinity labels and suicide inactivation	LI5.2: Demonstrate affinity labeling techniques	CI5.2: Lecture on affinity labels and suicide inactivation	
	SO5.3: Analyze enzyme inhibition theories		CI5.3: Lecture on theories of enzyme inhibition	
	SO5.4: Study enzyme inhibition as a tool for drug development		CI5.4: Lecture on enzyme inhibition as a tool for drug development	SL5.2: Study the applications of enzyme inhibition in drug development
	SO5.5: Understand structure-based drug design		CI5.5: Lecture on structure-based drug design	

	SO5.6: Evaluate structural bioinformatics in drug discovery		CI5.6: Lecture on structural bioinformatics in drug discovery	
	SO5.7: Learn about illustrative examples of enzyme inhibitors		CI5.7: Seminar on illustrative examples of enzyme inhibitors	
	SO5.8: Compare different enzyme inhibition strategies		CI5.8: Comparison of enzyme inhibition strategies	
	SO5.9: Understand the industrial applications of enzyme inhibitors in drug development		CI5.9: Industrial visit to a facility using enzyme inhibitors in drug development	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	illustrate the theories of enzyme inhibition
	SW5.2 Mini Project	
	SW5.3 Other Activities (Specify)	Rewrite the Scope and limitations of Enzyme background

Course duration (in hours) to attain Course Outcomes:

Course Title: Molecular modeling and Drug designing (MMDD) **Course Code: 98BT506-C**

Course Outcomes (COs)	**Class lecture (CI)**	**Laboratory Instruction (LI)**	**Self-Learning (SL)**	**Sessional work (SW)**	**Total Hours (Li+CI+SL+SW)**
CO1-98BT506C1: Explain the various stages of drug discovery	9	4	2	1	16
CO2-98BT506-C2: Define the concept of receptor and ligand binding	9	4	2	1	16

CO3-98BT506-C3: Describe physicochemical Properties and the techniques involved in QSAR	9	4	2	1	16
CO4-98BT506-C4: Learn introduction to Bioinformatics and Cheminformatics	9	4	2	1	16
CO5-98BT506-C5: Learn methods in molecular and quantum mechanics and Explain various structure-based drug design methods.	9	4	2	1	16
Total Hours	45	20	10	5	80

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

Course Title: Computational biology and bioinformatics **Course Code: 98BT301**

Course Outcomes	**Marks Distribution**				**Total Marks**
	A	**An**	**E**	**C**	
CO1-98BT506-C1: Explain the various stages of drug discovery	02	03	04	1	10
CO2-98BT506-C2: Define the concept of receptor and ligand binding	02	05	02	1	10
CO3-98BT506-C3: Describe physicochemical Properties and the techniques involved in QSAR	04	04	01	1	10
CO4-98BT301-A.4 Learn Introduction to Bioinformatics and Cheminformatics	03	04	02	1	10
CO5-98BT301-A.5 Learn methods in molecular and quantum mechanics and Explain various structure-based drug design methods	04	03	02	1	11
Total Marks	15	19	11	05	51

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

Suggested learning Resources:

(c) Books:

(d)

S.No.	Title/Author/Publisher details
1	MOLECULAR MODELLING AND DRUG DESIGN K. Anand Solomon Mjp Publishers 2011
2	Guidebook On Molecular Modeling In Drug Design Cohen Claude Elsevier India 2014
3	Molecular Modeling in Drug Design Rebecca Wade and Outi Salo-Ahen MDPI 2019

(e) Online Resources:

Suggested instructions/Implementation strategies:

28. Improved lecture
29. Tutorial
30. Case method
31. Group Discussion
32. Role play
33. Visit to Research lab (BSL-1)
34. Demonstration
35. ICT Based teaching Learning
36. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Tech. Biotechnology

Semester: 5th Sem

Course Title: Molecular modeling and Drug designing (MMDD)

Course Code: 98BT506-C

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**
CO1-98BT506-C1: Explain the various stages of drug discovery	-	-	-	1	2	2	2	-	1	2	2	3	-	-	-
CO2-98BT506-C2: Define the concept of receptor and ligand binding	-	-	-	-	-	-	-	-	2	2	3	3	-	-	-
CO3-98BT506-C3:Describe physicochemical Properties and the techniques involved in QSAR	-	1	1	1	-	-	2	-	3	1	1	2	-	1	1
CO4-98BT301-A.4 Learn Introduction to Bioinformatics and Cheminformatics	1	1	1	-	2	2	2	3	-	1	-	-	1	1	1
CO5-98BT301-A.5 Learn methods in molecular and quantum mechanics and Explain various structure-based drug design methods	-	1	1	-	-	2	-	3	1	2	2	2	-	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 4,5,6 7,9,10,11,12 PSO 1,2, 3	**CO1-98BT506-C1: Explain the various stages of drug discovery**	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5SO1.6 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**
PO 9,10,11,12 PSO 1,2, 3	**CO2-98BT506-C2: Define the concept of receptor and ligand binding**	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5SO2.6 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**
PO 2,3,4,5, 7,9,10,11,12 PSO 1,2, 3	**CO3-98BT506-C3:Describe physicochemical Properties and the techniques involved in QSAR**	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**
PO 1,2,3,5,6 7,8,10 PSO 1,2, 3	**CO4-98BT301-A.4 Learn Introduction to Bioinformatics and Cheminformatics**	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	**4SL-1, 2**
PO 2,3,4,5,6 7,8,10,11,12 PSO 1,2, 3	**CO5-98BT301-A.5** **Learn methods in molecular and quantum mechanics and Explain various structure-based drug design methods**	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8	**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**

Program Name	**Bachelor of Technology (B.Tech.)- Biotechnology**	
Semester	V	
Course Code:	98BT506-A	
Course title:	Nanotechnology and Engineering	**Curriculum Developer**: Arpit Srivastava, Assistant Professor
Pre-requisite:	Students should have basic knowledge of Physical & Biological Science	
Rationale:	Nanotechnology is a rather young discipline, which came up in the nineties. Nevertheless, Nanotech has gained so much importance within the last years that universities at all rankings have introduced or are going to introduce Nanotechnology teaching programs. Predictions say that NT will change our lives and society more than computer technology and electricity have done together. The course will provide an overview over NT. It will show that the nano regime is so different from other regimes because both classical and quantum effects can be active thus leading to unique properties of nano devices. It is a highly interdisciplinary science, which will be reflected in the course by making reference to chemistry, physics, biology, pharmacy, and engineering. Applications of Nanotechnology, as they are already in use today or as they are planned for the future, will be discussed.	
Course Outcomes (COs):	**CO1-98BT506-A.1.** Explain fundamentals of Nanotechnology **CO2-98BT506-A.2.** Define the role of biotechnology in nanoscience **CO3-98BT506-A.3.** Comprehend the working mechanism of nanoparticles in cancer treatment **CO4-98BT506-A.4.** Interpretate the mechanism of drug delivery and designing **CO5-98BT506-A.5.** Examine the mechanism of nano-sensors & demonstrate the significance of biosensors in industries.	

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 Elective (PE)	98BT506-A	Nanotechnology and Engineering	3	2	1	1	7	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

			Scheme of Assessment (Marks)

Board of Study	Couse Code	Course Title	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)		
PE	98BT506-A	Nanotechnology and Engineering	15	20	5	5	5	50	50

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	Viva Voce I	Viva Voce II	Class Attendance (AT)	Total Marks (CA+VV1+VV2+SA+AT)		

			7 marks each (CA)						
PE	98BT556-A	Nanotechnology and Engineering	35	5	5	5	50	50	50

Course-Curriculum:

<table>
<tr>
<td>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.</td>
<td>Approximate Hours
<table>
<tr><td>Item</td><td>Cl</td><td>LI</td><td>SW</td><td>SL</td><td>Total</td></tr>
<tr><td>Approx. Hrs</td><td>09</td><td>04</td><td>01</td><td>02</td><td>16</td></tr>
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Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-56MB205.1: Explain fundamentals of Nanotechnology	SO1.1: Understand basic concepts and introduction to nanotechnology	LI1.1: Study the basic concepts of nanotechnology using simulations	CI1.1: Lecture on basic concepts and introduction to nanotechnology	SL1.1: Research recent advances in nanotechnology

	SO1.2: Comprehend nanomechanics and nanotribology	LI1.2: Demonstrate nanomechanics techniques	CI1.2: Lecture on nanomechanics and nanotribology	
	SO1.3: Analyze scanning probe microscopy		CI1.3: Lecture on scanning probe microscopy	
	SO1.4: Study nanomaterials and its handling		CI1.4: Lecture on nanomaterials and its handling	SL1.2: Study the applications of nanomaterials
	SO1.5: Understand nanobots and nanofuture		CI1.5: Lecture on nanobots and nanofuture	
	SO1.6: Evaluate nano-fying electronics		CI1.6: Lecture on nano-fying electronics	
	SO1.7: Learn about nanofibres		CI1.7: Seminar on nanofibres	
	SO1.8: Compare nanopores and nanotubes		CI1.8: Comparison of nanopores and nanotubes	
	SO1.9: Understand the industrial applications of nanotechnology		CI1.9: Industrial visit to a nanotechnology facility	

	SW1.1 Assignments	Describe in detail about the Nanoparticles
	SW1.2 Mini Project	Draw a well labelled diagram of a microscope

Suggested Sessional Work (SW): *anyone*	**SW1.3** Other Activities (Specify)	Write an article on "Latest research in the field of Nanotechnology"

I

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)
CO2-98BT506-A Define the role of biotechnology in nanoscience	SO2.1: Understand the introduction to nanoscience	LI2.1: Study the production of nanoparticles using simulations	CI2.1: Lecture on introduction to nanoscience	SL2.1: Research recent advances in nanoscience
	SO2.2: Comprehend optical microscopy	LI2.2: Demonstrate optical microscopy techniques	CI2.2: Lecture on optical microscopy	
	SO2.3: Analyze atomic force microscopy		CI2.3: Lecture on atomic force microscopy	
	SO2.4: Study SEM techniques		CI2.4: Lecture on SEM techniques	SL2.2: Study the applications of SEM in nanotechnology
	SO2.5: Understand the production of nanoparticles		CI2.5: Lecture on production of nanoparticles	
	SO2.6: Evaluate collision / coalescence mechanism		CI2.6: Lecture on collision / coalescence mechanism	

	SO2.7: Learn about nanoparticle agglomerates		CI2.7: Seminar on nanoparticle agglomerates	
	SO2.8: Compare aerogels and their properties		CI2.8: Comparison of aerogels and their properties	
	SO2.9: Understand the industrial applications of nanoparticles		CI2.9: Industrial visit to a nanoparticle production facility	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Make a table to distinguish different nanoparticles with their biological applications
	SW2.2 Mini Project	Write down the protocol for the production of Nanoparticle in laboratory
	SW2.3 Other Activities (Specify)	Attain at least one seminar or online talk on Nanotechnology and its applications

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	04	01	05	16

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
98BT506-A.3. Comprehend the working mechanism of nanoparticles in Cancer treatment	SO3.1: Understand cancer and current approaches to its cure through nanoparticles	LI3.1: Study the use of nanoparticles in cancer therapy	CI3.1: Lecture on cancer and current approaches to its cure through nanoparticles	SL3.1: Research recent advances in cancer drug delivery systems
	SO3.2: Comprehend characteristics of tumor tissues	LI3.2: Demonstrate tumor tissue characterization techniques	CI3.2: Lecture on characteristics of tumor tissues	
	SO3.3: Analyze drug delivery to tumors		CI3.3: Lecture on drug delivery to tumors	
	SO3.4: Study physio-chemical properties of		CI3.4: Lecture on physio-chemical properties of	SL3.2: Study the applications of

	nanoparticles in cancer therapy		nanoparticles in cancer therapy	nanoparticles in cancer therapy
	SO3.5: Understand site-specific delivery of chemotherapeutic agents		CI3.5: Lecture on site-specific delivery of chemotherapeutic agents	
	SO3.6: Evaluate the effectiveness of different nanoparticles		CI3.6: Lecture on the effectiveness of different nanoparticles in cancer therapy	
	SO3.7: Learn about nanoparticle-based imaging techniques		CI3.7: Seminar on nanoparticle-based imaging techniques	
	SO3.8: Compare different cancer drug delivery systems		CI3.8: Comparison of different cancer drug delivery systems	
	SO3.9: Understand the industrial applications of nanoparticles in cancer therapy		CI3.9: Industrial visit to a cancer drug delivery research facility	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Make a table to distinguish different nanoparticles with their biological applications
	SW3.2 Mini Project	Write down the protocol for the production of Nanoparticle in laboratory
	SW3.3 Other Activities (Specify)	Attain at least one seminar or online talk on Nanotechnology and its applications

Item	Cl	LI	SW	SL	Total
Approx. Hrs	08	02	01	05	16

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO4-98BT506-A.4: Interpretate the mechanism of drug delivery and nanoparticle-based designing	SO4.1: Understand the basics of non-viral gene therapy	LI4.1: Study non-viral gene therapy techniques	CI4.1: Lecture on non-viral gene therapy with nanoparticles	SL4.1: Research recent advances in gene therapy
	SO4.2: Comprehend hyperthermia in gene therapy	LI4.2: Demonstrate hyperthermia techniques	CI4.2: Lecture on hyperthermia in gene therapy	
	SO4.3: Analyze controlled delivery of chemotherapeutic drugs		CI4.3: Lecture on controlled delivery of chemotherapeutic drugs	
	SO4.4: Study nanoparticles to circumvent MDR		CI4.4: Lecture on nanoparticles to circumvent MDR	SL4.2: Study the applications of nanoparticles in overcoming MDR
	SO4.5: Understand potential problems using nanoparticles		CI4.5: Lecture on potential problems using nanoparticles	
	SO4.6: Evaluate the application of nanotechnology in agriculture		CI4.6: Lecture on the application of nanotechnology in agriculture	
	SO4.7: Learn about nanotechnology in medicine		CI4.7: Seminar on nanotechnology in medicine	

	SO4.8: Compare nanotechnology applications in different fields		CI4.8: Comparison of nanotechnology applications in different fields	
	SO4.9: Understand the industrial applications of nanotechnology in gene therapy		CI4.9: Industrial visit to a nanotechnology research facility	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Write an article on "Role of Nanoparticles in Non-Viral Gene Therapy"
	SW4.2 Mini Project	List down the conditions of MDR, XDR and TDR in microbes
	SW4.3 Other Activities (Specify)	Make a presentation on Non-Viral Gene therapy techniques

Item	Cl	LI	SW	SL	Total
Approx. Hrs	08	02	01	05	13

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
98BT506-A.5. To Examine the mechanism of nano-sensors & demonstrate the significance of biosensors in industries.	**SO5.1** Identify different classes of biosensors and describe their functioning principles	**LI5.1** To retrieve the oncological based data from Cancer Genome Atlas	**Unit-5** **Biosensors and Nanosensors** **CI5.1** Introduction to Biosensors, types and working of biosensors	**SL5.1** Find out the role of Biosensors

	SO5.2 Recognize limitations of biosensors in real-life applications		**CI5.2** Importance of biosensors, parts of biosensors and its function, Channel Gating Biomimetic Membranes	**SL5.2** Explore the various kinds of biosensors
	SO5.3 Analyze the principles and concepts of transducers and their application in biosensor design		**CI5.3** Membrane Biosensors Based on Ion Channel Gating	**SL5.3** Read research on advancement in biosensors
	SO5.4 Define the fundamentals of diagnostic devices and biomarker testing in biological fluids		**CI5.4** Nanofabrication, medicine-Potential Biomedical Applications	**SL5.4** Observe the natural biosensors around us
	SO5.5 Discover the technical and societal factors involved in point-of-care diagnostics and wearable sensors		**CI5.5** Applications of Polymer Nanostructures, Types of nanosensors, LAB-On-A-CHIP, Applications of Biosensors	**SL5.5** Find out the meaning of Biomimicry

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Write an article on "Role of Biosensors and its mechanism"
	SW5.2 Mini Project	List down the principles of biosensors and Nanosensors
	SW5.3 Other Activities (Specify)	Make a presentation on Lab-On-A-Chip technique with applications

Course duration (in hours) to attain Course Outcomes:

Course Title: Nanotechnology and Engineering **Course Code:** 98BT506.A

Course Outcomes (COs)	Class lecture	Laboratory Instruction (LI)	Sessional work	Self-Learning	Total Hours (Li+CI+SW+SL)

	(CI)		(SW)	(SL)	
CO1-98BT506-A.1: Explain fundamentals of Nanotechnology	8	2	1	5	16
CO2-98BT506-A.2: Define the role of biotechnology in nanoscience	8	4	1	5	18
CO3-98BT506-A.3: To Comprehend the working mechanism of nanoparticles in Cancer treatment	8	2	1	5	16
CO4-98BT506-A.4: Interpretate the mechanism of drug delivery and nanoparticle-based designing	8	2	1	5	16
CO4-98BT506-A.5: To Examine the mechanism of nano-sensors & demonstrate the significance of biosensors in industries.	8	2	1	5	16
Total Hours	40	12	05	25	82

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

Course Title: Nanotechnology and Engineering **Course Code:** 98BT506.A

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
CO1-98BT506-A.1: Explain fundamentals of Nanotechnology	2	1	1	1	5
CO2-98BT506-A.2: Define the role of biotechnology in nanoscience	3	4	2	1	10
CO3-98BT506-A.3: To Comprehend the working mechanism of nanoparticles in Cancer treatment	4	5	5	1	15
CO4-98BT506-A.4: Interpretate the mechanism of drug delivery and nanoparticle-based designing	3	4	3	0	10
CO4-98BT506-A.5: To Examine the mechanism of nano-sensors & demonstrate the significance of biosensors in industries.	5	4	1	0	10

Total Marks	17	18	12	03	50

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

Suggested learning Resources:

Books:

S.No.	Title/Author/Publisher details
1	Bharat Bhushan., Nanotribology and Nanomechanics - An introduction, Springer.
2	Mark, Ratner Daniel Ratner, Nanobiotechnology- next big idea.
3	Challa S.S.R.Kumar, Joseph Hornes, Carola Leuschner, Nanofabrication towards Biomedical applications.
4	Pharmaceutical Nanobiotechnology for Targeted Therapy, Hamed Barabadi, Ebrahim Mostafavi, Muthupandian Saravanan, Springer 2022
5	Charles P. Poole, Jr., Frank J. Owens; "Introduction to Nanotechnology", John Wiley& Sons, 2003,

(a) Online Resources:

Suggested instructions/Implementation strategies:

37. Improved lecture
38. Tutorial
39. Case method
40. Group Discussion
41. Role play
42. Demonstration
43. ICT Based teaching Learning
44. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Tech. Biotechnology

Semester: V Semester

Course Title: Nanotechnology and Engineering

Course Code: 98BT506-A

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
CO1-98BT506-A.1: Explain fundamentals of Nanotechnology	-	-	-	1	2	2	2	-	1	2	2	3	3	3	1
CO2-98BT506-A.2: Define the role of biotechnology in nanoscience	-	-	-	-	-	-	3	-	2	2	3	3	1	1	2
CO3-98BT506-A.3: To Comprehend the working mechanism of nanoparticles in Cancer treatment	-	1	1	1	-	-	2	-	3	1	1	2	1	1	1
CO4-98BT506-A.4: Interpretate the mechanism of drug delivery and nanoparticle-based designing	-	1	1	-	2	2	2	3	-	1	-	-	1	2	2
CO4-98BT506-A.5: To Examine the mechanism of nano-sensors &	1	1	1	-	-	2	3	3	1	2	2	2	1	1	2

demonstrate the significance of biosensors in industries.															

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	**CO1-98BT506-A.1:** Explain fundamentals of Nanotechnology	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5SO1.6 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**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO2-98BT506-A.2:** Define the role of biotechnology in nanoscience	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5SO2.6 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**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO3-98BT506-A.3:** To Comprehend the working mechanism of nanoparticles in Cancer treatment	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-1,2,3,4,5**
PO 1,2,3,4,5,6 7,8,9,10,11,12	**CO4-98BT506-A.4:** Interpretate the mechanism of drug delivery and nanoparticle-based designing	SO4.1 SO4.2 SO4.3 SO4.4	**LI 1** **LI 2**	4.1,4.2,4.3,4.4	**4SL-1,2,3,4,5**

PSO 1,2, 3					
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO4-98BT506-A.5:** To Examine the mechanism of nano-sensors & demonstrate the significance of biosensors in industries.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8SO5.9	**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**

Program Name	**B.Tech. Biotechnology**	
Semester	V	
Course Code:	**98BT506-B**	
Course title:	Pharmaceutical Biotechnology	**Curriculum Developer**: Mrs. Keerti Samdariya, Assistant Professor
Pre-requisite:	Students should have basic knowledge of pharmaceutical biotechnology	
Rationale:	The paper on Pharmaceutical Biotechnology in B.tech. Biotechnology program explores the role of biotechnology in drug discovery, development, and production, including the use of recombinant DNA technology and biopharmaceutical manufacturing. Students need to develop practical skills in laboratory techniques and methods used in producing, purifying, and analyzing pharmaceutical biotechnology products.	

Course Outcomes (COs):	**CO1-98BT506-B:** Understand the role of biotechnology in drug discovery, development, and production, including recombinant DNA technology and biopharmaceutical manufacturing.
	CO2-98BT506-B: Extend practical skills in laboratory techniques and methods used in producing, purifying, and analyzing pharmaceutical biotechnology products.
	CO3-98BT506-B: Evaluate knowledge of regulatory frameworks and quality control practices specific to pharmaceutical biotechnology.
	CO4-98BT506-B: Understand the application of biotechnology in the pharmaceutical industry. Apply regulatory aspects, ethical considerations, and safety requirements associated with pharmaceutical biotechnology.
	CO5-98BT506-B: Apply the knowledge of GLP and GMP in the Pharmaceutical laboratory.

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)	
Program Common (PC)	**98BT506-B**	Pharmaceutical Biotechnology	3	2	1	3	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

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)		
PE	**98BT506-B**	Pharmaceutical Biotechnology	**15**	**20**	**10**	**5**	**50**	**50**	**100**

Scheme of Assessment: Practical

			Scheme of Assessment (Marks)		
			Progressive Assessment (PRA)		

Board of Study	Course Code	Course Title	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)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
PE	**98BT556-B**	Pharmaceutical Biotechnology	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	05	19

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

CO1 -98BT506-B: Understand the role of biotechnology in drug discovery, development, and production, including recombinant DNA technology and biopharmaceutical manufacturing.	**SO1.1** Define and describe Antibiotics and synthetic antimicrobial agents.	**LI1.1** Demonstration of antibiotic action with bacterial strain.	**Unit 1** **CI1.1** A brief outline of the discovery of antibiotics.	**SL1.1** Explore the various kinds of biopolymers and their applications
	SO1.2 Define and describe synthetic antimicrobial agents.	**LI1.2** Diagrammatic presentation of types of antibiotics.	**CI1.2** Define and describe Antibiotics and synthetic antimicrobial agents.	
	SO1.3 Differentiate antifungal antibiotics, antitumor substances	.	**CI1.3** The general structure of beta-lactam antibiotics.	**SL1.2** Read research on advancement in the production of biofertilizers
	SO1.4 Differentiate Chemical disinfectants, antiseptics, and preservatives.		**CI1.4** Classification and Explanation of Antifungal antibiotics, antitumor substances, Peptide antibiotics, Chloramphenicol, Sulphonamides, and	**SL1.3** Find out different centers where Single Cell Proteins are used

			Quinolinone antimicrobial agents.	
	SO1.5 Classification and Explanation of Antifungal antibiotics		**CI1.5** Classification and mechanism of action of antimicrobial agents.	
	SO1.6 Classification and Explanation of antitumor substances,		**CI1.6** Classification and mechanism of action of antimicrobial agents	
	SO1.7 Classification and Explanation of Peptide antibiotics, Chloramphenicol, Sulphonamides, and Quinolinone antimicrobial agents.		**CI1.7** Classification and mechanism of action of antimicrobial agents	
	SO1.8 Classification and Explanation of Chloramphenicol, Sulphonamides, and Quinolinone antimicrobial agents.		**CI1.8** Classification and mechanism of action of antimicrobial agents	
	SO1.9 Revision and assessment		**CI1.9** Revision and assessment	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Describe in detail about Antibiotics and their classification.
	SW3.2 Mini Project	Describe the role of antibiotics in medical system
	SW3.3 Other Activities (Specify)	Prepare a diagrammatic poster for different antiviral ,antibacterial and antifungal drug and their role in health .

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	04	01	05	19

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO1 -98BT506-B: Extend practical skills in laboratory techniques and methods for producing, purifying, and analyzing pharmaceutical biotechnology products	**SO2.1** To explain the Mechanism of action of antibiotics inhibitors of cell wall synthesis.	**LI2.1** To perform the Mode of action of antibiotic antimicrobial agents.	**Unit 2** **CI2.1** Mechanism of action of antibiotics (inhibitors of cell wall synthesis, nucleic acid and protein synthesis)	**SL2.1** Read the Mode of action of antibiotics.
	SO2.2 Mechanism of action of antibiotics (inhibitors of nucleic acid synthesis)	**LI2.2** To perform the Mode of action of non-antibiotic antimicrobial agents. .	**CI2.2** Mechanism of action of antibiotics (inhibitors of cell wall synthesis, nucleic acid and protein synthesis)	**SL2.2** Various assays were used for bacterial susceptibility.
	SO2.3 Mechanism of action of antibiotics (inhibitors of protein synthesis		**CI2.3** Mechanism of action of antibiotics (inhibitors of cell wall synthesis, nucleic acid and protein synthesis)	**SL2.3** Learn Molecular principles of drug targeting.

	SO2.4 To describe Molecular principles of drug targeting.		**CI2.4** Molecular principles of drug targeting.	**SL2.3** Read about inhibitors of cell wall synthesis, nucleic acid, and protein synthesis.
	SO2.5 To describe the Mode of action of bacterial killing by quinolinones.		**CI2.5** Mode of action of bacterial killing by quinolinones, Bacterial resistance to quionolinones.	
	SO2.6 To explain the cellular permeability barrier.		**CI2.6** How the antimicrobial agents reach the targets (cellular permeability barrier, cellular transport system and drug diffusion	
	SO2.7 To elaborate on drug diffusion		**CI2.7** How the antimicrobial agents reach the targets (cellular permeability barrier, cellular transport system and drug diffusion	
	SO2.8 To explain the Drug delivery system in gene therapy.		**CI2.8** How the antimicrobial agents reach the targets (cellular permeability barrier, cellular transport system and drug diffusion	
	SO2.9 Revision and assessment		**CI2.9** Revision and assessment	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Describe in detail Mechanism of action of antibiotics .
	SW2.2 Mini Project	Various Mode of action of Bacterial resistance to quionolinones..
	SW2.3 Other Activities (Specify)	How the antimicrobial agents reach the targets (cellular permeability barrier, cellular transport)

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	04	01	05	19

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO3-98BT506-B: Evaluate knowledge of regulatory frameworks and quality control practices specific to pharmaceutical biotechnology.	**SO3.1** Explain the Microbial contamination.	**LI3.1** Demonstrate the sterilization process.	**Unit 3** **CI3.1** Microbial contamination and spoilage of pharmaceutical products and their sterilization.	**SL3.1** Discuss various types of vaccines involved in health system
	SO3.2	**LI3.2** Perform the production of	**CI3.2** Read about various Microbial contamination and spoilage of	**SL3.2** Read the sterilization

	Define and differentiate sterile injectibles, and non-injectibles.	microbial culture.	pharmaceutical products and their sterilization.	process in industrial production of drugs.
	SO3.3 Describe the sterilization process used in the pharmaceutical industry.		**CI3.3** Manufacturing procedures and in process control of pharmaceuticals	
	SO3.4 Describe Manufacturing procedures and in process control of pharmaceuticals		**CI3.4** pharmaceuticals produced by microbial fermentations (streptokinase, streptodornase).	
	SO3.5 Explain pharmaceuticals produced by microbial fermentations (streptokinase, streptodornase)		**CI3.5** New vaccine technology, DNA vaccines, synthetic peptide vaccines, multivalent subunit vaccines.	
	SO3.6 Explain pharmaceuticals produced by microbial fermentations (streptokinase, streptodornase)		**CI3.6** New vaccine technology, DNA vaccines, synthetic peptide vaccines, multivalent subunit vaccines.	

	SO3.7 illustrates New vaccine technology, DNA vaccines, synthetic peptide vaccines,		**CI3.7** New vaccine technology, DNA vaccines, synthetic peptide vaccines, multivalent subunit vaccines.	
	SO3.8 illustrates New vaccine technology, multivalent subunit vaccines.		**CI3.8** New vaccine technology, DNA vaccines, synthetic peptide vaccines, multivalent subunit vaccines.	
	SO3.9 Revision and assessment		**CI3.9** Revision and assessment	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Describe in detail on New vaccine technology, DNA vaccines, synthetic peptide vaccines.
	SW3.2 Mini Project	Describe the role of different vaccines.
	SW3.3 other activity	Prepare one article on different types of diseases and their vaccines.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	04	01	05	19

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO4-98BT506-B: Understand the application of biotechnology in the pharmaceutical industry. Apply regulatory aspects, ethical considerations, and safety requirements associated with pharmaceutical biotechnology	**SO4.1** Describe the classification of pharmacopeia.	**LI4.1** To analyze the Immobilization process.	**Unit-4** **CI4.1** Financing R&D capital and market outlook	**SL4.1** Learn about the Government regulatory practices and policies.
	SO4.2 Explain the Government regulatory practices and policies.	**LI4.2**To develop a model of the application of microbial enzymes in pharmaceuticals.	**CI4.2** IP, BP, USP. Government regulatory practices and policies, FDA perspective	**SL4.2** Learn about various types of Immobilization procedures for pharmaceutical applications. .

	SO4.3 Describe IP, BP, USP. Government regulatory practices and policies, FDA perspective		**CI4.3** IP, BP, USP. Government regulatory practices and policies, FDA perspective	
	SO4.4 Evaluate reimbursement of drugs and biologicals.		**CI4.4** Reimbursement of drugs and biologicals, legislative perspective. Rational drug design.	
	SO4.5 Define and describe Immobilization procedures for pharmaceutical applications.		**CI4.5** Immobilization procedures for pharmaceutical applications (liposomes). Macromolecular, cellular and synthetic drug carriers.	
	SO4.6 Explain pharmaceuticals produced by microbial fermentations streptokinase.		**CI4.6** Explain pharmaceuticals produced by microbial fermentations streptokinase	
	SO4.7 Explain pharmaceuticals produced by microbial fermentations streptodornase		**CI4.7** Explain pharmaceuticals produced by microbial fermentations streptokinase.	

	SO4.8 Biosensors in pharmaceuticals. Application of microbial enzymes in pharmaceuticals		**CI4.8** Biosensors in pharmaceuticals. Application of microbial enzymes in pharmaceuticals	
	SO4.9 Revision and assessment		**CI4.9** Revision and assessment	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Explain Biosensors and their application in the pharmaceutical industry.
	SW4.2 Mini Project	Describe the various types of Pharmacopeias.
	SW4.3 Other Activities (Specify)	Prepare one article on the IP, BP, USP. Government regulatory practices and policies, FDA perspective.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	04	01	05	19

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO5-98BT506-B: Apply the knowledge of Quality Assurance and	**SO5.1** Explain Good Manufacturing Practices	**LI5.1** Use of Good Laboratory	**Unit-5** **CI5.1**	**SL5.1** Find out the role of Good Manufacturing Practices (GMP) and

Validation, GLP, and GMP in the Pharmaceutical laboratory.	(GMP) in the pharmaceutical industry.	Practices (GLP)	Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in the pharmaceutical industry.	Good Laboratory Practices (GLP) in the pharmaceutical industry.
	SO5.2 Define quality control. in pharmaceuticals.	**LI5.2** To do the sterilization of glass wares	. **CI5.1** Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in the pharmaceutical industry.	.
	SO5.3 Define Quality assurance and quality management in pharmaceuticals.		**CI5.2** Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in the pharmaceutical industry.	
	SO5.3 Elaborate ISO, WHO, and US certification		**CI5.3** ISO, WHO and US certification	
	SO5.4 Evaluate the Sterilization control and sterility testing.		**CI5.4** Sterilization control and sterility testing (heat sterilization, D value, z value, survival curve, Radiation, gaseous and filter sterilization)	

	SO5.5 Elaborate Chemical and biological indicators		**CI5.5** Chemical and biological indicators.	
	SO5.6 Design and layout of sterile product manufacturing unit. (Designing of Microbiology laboratory), Safety in the microbiology laboratory.		**CI5.6** Design and layout of sterile product manufacturing unit. (Designing of Microbiology laboratory), Safety in the microbiology laboratory.	
	SO5.7 Design and layout of sterile product manufacturing unit. (Designing of Microbiology laboratory), Safety in the microbiology laboratory.		**CI5.7** Design and layout of sterile product manufacturing unit. (Designing of Microbiology laboratory), Safety in the microbiology laboratory.	
	SO5.8 Design and layout of sterile product manufacturing unit. (Designing of Microbiology laboratory), Safety in the microbiology laboratory.		**CI5.8** Design and layout of sterile product manufacturing unit. (Designing of Microbiology laboratory), Safety in the microbiology laboratory.	
	SO5.9 Revision and assessment		**CI5.9** Revision and assessment	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Explain Sterilization control and sterility testing.

	SW5.2 Mini Project	Describe the Design and layout of the sterile product manufacturing unit.
	SW5.3 Other Activities (Specify)	Prepare one article on ISO, WHO, and US certification.

Course duration (in hours) to attain Course Outcomes:

Course Title: Pharmaceutical Biotechnology **Course Code: 98BT506-BE**

Course Outcomes (COs)	**Class lecture (CI)**	**Laboratory Instruction (LI)**	**Self-Learning (SL)**	**Sessional work (SW)**	**Total Hours (Li+CI+SL+SW)**
CO1-98BT506-B: Understand the role of biotechnology in drug discovery, development, and production, including recombinant DNA technology and biopharmaceutical manufacturing.	9	4	5	1	19
CO2-98BT506-B: Extend practical skills in laboratory techniques and methods used in producing, purifying, and analyzing pharmaceutical biotechnology products.	9	4	5	1	19
CO3-98BT506-B: Evaluate knowledge of regulatory frameworks and quality control practices specific to pharmaceutical biotechnology.	9	4	5	1	19

CO4-98BT506-B: Understand the application of biotechnology in the pharmaceutical industry. Apply regulatory aspects, ethical considerations, and safety requirements associated with pharmaceutical biotechnology.	9	4	5	1	19
CO5-98BT506-B: Apply the knowledge of GLP and GMP in the Pharmaceutical laboratory.	9	4	5	1	19
Total Hours	45	20	25	05	95

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

Course Title: Pharmaceutical Biotechnology **Course Code: 98BT506-BE**

Course Outcomes	**Marks Distribution**				**Total Marks**
	A	**An**	**E**	**C**	
CO1-98BT506-B: Understand the role of biotechnology in drug discovery, development, and production, including recombinant DNA technology and biopharmaceutical manufacturing.	2	1	1	1	5

CO2-98BT506-B: Extend practical skills in laboratory techniques and methods used in producing, purifying, and analyzing pharmaceutical biotechnology products.	2	4	2	2	10
CO3-98BT506-B: Evaluate knowledge of regulatory frameworks and quality control practices specific to pharmaceutical biotechnology.	3	5	5	2	15
CO4-98BT506-B: Understand the application of biotechnology in the pharmaceutical industry. Apply regulatory aspects, ethical considerations, and safety requirements associated with pharmaceutical biotechnology.	2	3	3	2	10
CO5-98BT506-B: Apply the knowledge of GLP and GMP in the Pharmaceutical laboratory.	5	4	1	0	10
Total Marks	**14**	**17**	**12**	**07**	**50**

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

Suggested learning Resources:

(f) Books:

S.No.	Title/Author/Publisher details
1	Pharmaceutical Microbiology – Edt. By W.B.Hugo & A.D.Russell Sixth edition. Blackwell scientific Publications.
2	Analytical Microbiology –Edt by Frederick Kavanagh Volume I & II. Academic Press New York.
3	Quinolinone antimicrobial agents – Edt. by David C. Hooper, John S.Wolfson .ASM Washington DC.
4	Pharmaceutical Microbiology – Edt. By W.B.Hugo & A.D.Russell Sixth edition. Blackwell scientific Publications.
5	Analytical Microbiology –Edt by Frederick Kavanagh Volume I & II. Academic Press New York.

Suggested instructions/Implementation strategies:

45. Improved lecture
46. Tutorial
47. Case method
48. Group Discussion
49. Role play
50. Visit to virology lab (BSL-3)
51. Demonstration
52. ICT Based teaching Learning
53. Brainstorming

CO, PO and PSO Mapping

Program Name: B.Tech. Biotechnology

Semester: V Semester

Course Title: Pharmaceutical Biotechnology

Course Code:

CO/PO/PSO Mapping								
Course Outcome (Cos)	**Program Outcomes (POs)**					**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**
CO1-98BT506-B: Understand the role of biotechnology in drug discovery, development, and production, including recombinant DNA technology and biopharmaceutical manufacturing.	1	2	2	3	1	2	2	1
CO298BT506-B-: Extend practical skills in laboratory techniques and methods used in producing, purifying, and analyzing pharmaceutical biotechnology products.	1	2	3	2	1	1	1	2
CO3-98BT506-B: Evaluate knowledge of regulatory frameworks and quality control practices specific to pharmaceutical biotechnology.	1	2	3	2	1	1	1	1

CO4-98BT506-B: Understand the application of biotechnology in the pharmaceutical industry. Apply regulatory aspects, ethical considerations, and safety requirements associated with pharmaceutical biotechnology.	-	1	1	-	2	1	1	3
CO5-98BT506-B: Apply the knowledge of GLP and GMP in the Pharmaceutical laboratory.	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	**CO1-98BT506-B**: Understand the role of biotechnology in drug discovery, development, and production, including recombinant DNA technology and biopharmaceutical manufacturing.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5SO1.6 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**
PO 1,2,3,4,5 PSO 1,2,3	**CO2-98BT506-B**: Extend practical skills in laboratory techniques and methods used in producing, purifying, and analyzing pharmaceutical biotechnology products.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5SO2.6 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**
PO 1,2,3,4,5 PSO 1,2,3	**CO3-98BT506-B**: Evaluate knowledge of regulatory frameworks and quality control practices specific to pharmaceutical biotechnology.	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**

PO 1,2,3,4,5 PSO 1,2,3	**CO498BT506-B -**: Understand the application of biotechnology in the pharmaceutical industry. Apply regulatory aspects, ethical considerations, and safety requirements associated with pharmaceutical biotechnology.	SO4.1 SO4.2 SO4.3 SO4.4	**LI 1** **LI 2**	4.1,4.2,4.3,4.4	**4SL-1,2**
PO 1,2,3,4,5 PSO 1,2,3	**CO5-98BT506-B**: Apply the knowledge of GLP and GMP in the Pharmaceutical laboratory.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8SO5.9	**LI 1** **LI 2**	5.1,5.2,5.3,5.4,5.5, 5.6, 5.7, 5.8,5.9	**5SL-1**

Program Name	**Bachelor of Technology (B.Tech.)- Biotechnology**	
Semester	V	
Course Code:	**98BT501-A**	
Course title:	Plant Biotechnology	**Curriculum Developer**: Kamlesh Kumar Soni
Pre-requisite:	Student should have basic knowledge of Molecular Biology and Biotechnology	
Rationale:	The paper on Plant Biotechnology in B. Tech. Biotech Semester-V program is a rather most important discipline. Nevertheless, the subject Plant Biotechnology has become demanding subject for the last few years that universities at all rankings have introduced or are going to introduce Plant Biotechnology teaching programs. The course will provide an overview over Plant Biotechnology. It will in understanding the basic and advance application in tissue culture and transgenic based plant development. Applications of Plant Biotechnology, as they are already in use today or as they are planned for the future, will be discussed	
Course Outcomes (COs):	**98BT501-A.1.** Explain fundamentals of Plant Biotechnology **98BT501-A.2.** Define the role of tissue culture media and its constituents in micropropagation of ex-plants **98BT501-A.3.** Understand the working mechanism of callus culture **98BT501-A.4.** Interpretate the mechanism of plant-based vector and plasmids **98BT501-A.5.** Examine the mechanism of gene transfer in plants	

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)	**98BT501**	Plant Biotechnology	3	2	1	3	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

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	98BT501	Plant Biotechnology	**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	98BT551	Plant Biotechnology-lab	35	5	5	5	50	50	50

Course-Curriculum:

Unit-I: Basics of Plant tissue culture	
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)**
CO1-98BT501-A.1: Explain fundamentals of Plant Biotechnology	SO1.1: Understand the introduction and historical perspective of plant tissue culture	LI1.1: to perform the plant tissue culture of bamboo	CI1.1: Lecture on the introduction and historical perspective of plant tissue culture	SL1.1: Research recent advances in plant tissue culture
	SO1.2: Comprehend the organization of a tissue culture lab	LI1.2: Demonstrate tissue culture lab organization	CI1.2: Lecture on tissue culture lab organization	
	SO1.3: Analyze preparation of stock solution and sterilization techniques		CI1.3: Lecture on preparation of stock solution and sterilization techniques	
	SO1.4: Study types of nutrient media and media composition		CI1.4: Lecture on types of nutrient media and media composition	SL1.2: Study the applications of different nutrient media
	SO1.5: Understand sterilization and preparation of explants		CI1.5: Lecture on sterilization and preparation of explants	
	SO1.6: Evaluate initiation of culture		CI1.6: Lecture on initiation of culture	

	SO1.7: Learn about the importance of aseptic techniques		CI1.7: Seminar on aseptic techniques in plant tissue culture	
	SO1.8: Compare different methods of culture initiation		CI1.8: Comparison of different methods of culture initiation	
	SO1.9: Understand the industrial applications of plant tissue culture		CI1.9: Industrial visit to a plant tissue culture facility	

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	4	01	02	16

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Briefly explain "Sterilization menthids: why it is important"
	SW1.2 Mini Project	Preparation of different types of media
	SW1.3 Other Activities (Specify)	Look the animated video about agrobacterium transformation from internet sources

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO2-98BT501-A.2: Define the role of tissue culture media and its constituents in micropropagation of ex-plants	O2.1: Understand the concept of totipotency	LI2.1: Study totipotency in plant tissue culture	CI2.1: Lecture on totipotency	SL2.1: Research recent advances in totipotency
	SO2.2: Comprehend tissue and organ culture	LI2.2: Demonstrate tissue and organ culture techniques	CI2.2: Lecture on tissue and organ culture	

	SO2.3: Analyze establishment and maintenance of callus culture		CI2.3: Lecture on establishment and maintenance of callus culture	
	SO2.4: Study organogenesis		CI2.4: Lecture on organogenesis	SL2.2: Study the applications of organogenesis
	SO2.5: Understand cell suspension cultures		CI2.5: Lecture on cell suspension cultures	
	SO2.6: Evaluate single cell clones and methods of single cell culture		CI2.6: Lecture on single cell clones and methods of single cell culture	
	SO2.7: Learn about embryo culture and embryo rescue		CI2.7: Seminar on embryo culture and embryo rescue	
	SO2.8: Compare different tissue culture methods		CI2.8: Comparison of different tissue culture methods	
	SO2.9: Understand the industrial applications of plant tissue culture methods		CI2.9: Industrial visit to a tissue culture research facility	

Suggested Sessional Work (SW): *anyone*	SW1.1 Assignments	Write about the totipotency and pluripotency
	SW1.2 Mini Project	Use leaf as explant to make callus
	SW1.3 Other Activities (Specify)	Some text book to understand about the embryo and its culture: applications

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)
CO3-98BT501-A.3: Understand the working mechanism of callus culture	SO3.1: Understand protoplast isolation and culture regeneration	LI3.1: To Study protoplast isolation techniques	CI3.1: Lecture on protoplast isolation and culture regeneration	SL3.1: Research recent advances in protoplast culture
	SO3.2: Comprehend protoplast fusion and somatic hybrids	LI3.2: Demonstrate protoplast fusion techniques	CI3.2: Lecture on protoplast fusion and somatic hybrids	
	SO3.3: Analyze production of haploid plants		CI3.3: Lecture on production of haploid plants	
	SO3.4: Study somoclonal variations and somatic embryogenesis		CI3.4: Lecture on somoclonal variations and somatic embryogenesis	SL3.2: Study the applications of somatic embryogenesis
	SO3.5: Understand production of virus-free plants		CI3.5: Lecture on production of virus-free plants	
	SO3.6: Evaluate germplasm conservation and cryopreservation		CI3.6: Lecture on germplasm conservation and cryopreservation	
	SO3.7: Learn about hardening and transfer of whole plants to soil		CI3.7: Seminar on hardening and transfer of whole plants to soil	
	SO3.8: Compare different protoplast culture methods		CI3.8: Comparison of different protoplast culture methods	
	SO3.9: Understand the industrial applications of protoplast culture		CI3.9: Industrial visit to a protoplast culture facility	

Suggested Sessional Work (SW): *anyone*	SW1.1 Assignments	Write 5 applications protoplasts in plant biotechnology
	SW1.2 Mini Project	How somatic hybrid is different from cytoplasmic hybrid; their applications in plant biotechnology
	SW1.3 Other Activities (Specify)	Find out hardening methods and why is important

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	04	01	05	16

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO4-98BT501-A.4: Interpretate the mechanism of plant-based vector and plasmids	SO4.1: Understand transformation vectors and Agrobacterium tumefaciens	LI4.1: Study transformation vector techniques	CI4.1: Lecture on transformation vectors and Agrobacterium tumefaciens	SL4.1: Research recent advances in plant genetic engineering
	SO4.2: Comprehend the structure of T-DNA and Ti plasmid	LI4.2: Demonstrate T-DNA and Ti plasmid structure	CI4.2: Lecture on T-DNA and Ti plasmid structure	
	SO4.3: Analyze Ti plasmid derived vector systems		CI4.3: Lecture on Ti plasmid derived vector systems	
	SO4.4: Study physical methods of transferring genes to plants		CI4.4: Lecture on physical methods of transferring genes to plants	SL4.2: Study the applications of gene transfer methods
	SO4.5: Understand microprojectile bombardment		CI4.5: Lecture on microprojectile bombardment	
	SO4.6: Evaluate electroporation techniques		CI4.6: Lecture on electroporation techniques	

	SO4.7: Learn about viral vector systems		CI4.7: Seminar on viral vector systems	
	SO4.8: Compare different recombinant selection methods		CI4.8: Comparison of different recombinant selection methods	
	SO4.9: Understand the industrial applications of genetic engineering in plants		CI4.9: Understand the industrial applications of genetic engineering in plants	

Suggested Sessional Work (SW): *anyone*	SW1.1 Assignments	Details on *Agrobacterium tumefaciens* and Ti-Plasmid
	SW1.2 Mini Project	Selection of transformed plant; how is it done?
	SW1.3 Other Activities (Specify)	Look some videos on *Agrobacterium* mediated plant transformation

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	04	01	02	16

Course outcome (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO5-98BT501-A.5: Socioeconomic importance of transgenics	SO5.1: Understand the development of new qualities in transgenic plants	LI5.1: Study transgenic plant development techniques	CI5.1: Lecture on development of new qualities in transgenic plants	SL5.1: Research recent advances in transgenic technology
	SO5.2: Comprehend herbicide tolerance and insect/pest resistance	LI5.2: Demonstrate herbicide tolerance techniques	CI5.2: Lecture on herbicide tolerance and insect/pest resistance	
	SO5.3: Analyze disease resistance and drought resistance		CI5.3: Lecture on disease resistance and drought resistance	
	SO5.4: Study bt-cotton and its applications		CI5.4: Lecture on bt-cotton and its applications	SL5.2: Study the applications of bt-cotton
	SO5.5: Understand the production of therapeutic proteins and compounds		CI5.5: Lecture on production of therapeutic proteins and compounds	
	SO5.6: Evaluate oral vaccines and their development		CI5.6: Lecture on oral vaccines and their development	
	SO5.7: Learn about improvement in seed quality		CI5.7: Seminar on improvement in seed quality	

	SO5.8: Compare different genetic marker techniques		CI5.8: Comparison of different genetic marker techniques	
	SO5.9: Understand the industrial applications of transgenic technology		CI5.9: Industrial visit to a transgenic technology research facility	

Suggested Sessional Work (SW): *anyone*	SW1.1 Assignments	Briefly explain Bt-Cotton, mode of action and its application
	SW1.2 Mini Project	Treat plant with salt and drought stress and record some physiology parameters and morphology of the plant
	SW1.3 Other Activities (Specify)	Application of various markers: read in depth to understand the differences among the biomarkers

Course duration (in hours) to attain Course Outcomes **(Course Title:** Plant Biotechnology) (**Course Code: 98BT501-A**)					
Course Outcomes (COs)	**Class lecture (CI)**	**Laboratory Instruction (LI)**	**Self-Learning (SL)**	**Sessional work (SW)**	**Total Hours (Li+CI+SL+SW)**
CO1-98BT501-A.1: Explain fundamentals of Plant Biotechnology	9	4	2	1	16
CO2-98BT501-A.2: Define the role of tissue culture media and its constituents in micropropagation of ex-plants	9	4	2	1	16
CO3-98BT501-A.3: Understand the working mechanism of callus culture	9	4	2	1	16
CO4-98BT501-A.4: Interpretate the mechanism of plant-based vector and plasmids	9	4	2	1	16
CO5-98BT501-A.5. Examine and demonstrate the mechanism of product purification	9	4	2	1	16
Total Hours	45	20	10	05	80

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome: **(Course Title:** Plant Biotechnology) (**Course Code: 98BT501-A**)					
Course Outcomes	**Marks Distribution**				**Total Marks**
	A	**An**	**E**	**C**	
CO1-98BT501-A.1: Explain fundamentals of Plant Biotechnology	2	1	1	1	5
CO2-98BT501-A.2: Define the role of tissue culture media and its constituents in micropropagation of ex-plants	2	4	5	1	12
CO3-98BT501-A.3: Understand the working mechanism of callus culture	3	5	5	1	14
CO4-98BT501-A.4: Interpretate the mechanism of plant-based vector and plasmids	2	3	5	1	11
CO5-98BT501-A.5. Examine and demonstrate the mechanism of product purification	5	4	1	0	10
Total Marks	**14**	**17**	**17**	**04**	**52**
***Legend*: A,** Apply; **An,** Analyze; **E,** Evaluate; **C,** Create					

Suggested learning Resources:

(a) Books:

S.no.	Title	Author	Publisher	Edition & Year
1	Plant Tissue Culture	K.K. De	New Central Book Agency	1 & 2018 (reprint)
2	Plant Biotechnology: The Genetic manipulation of plants	Adrian Slater, Nigel Scott, and Mark Fowler	Oxford University Press	2 & 2008
3	Plant Biotechnology	B.D. Singh	Kalyani Publication	4 & 2022
4	Principle of Plant Biotechnology	S.S. Purohit	Agrobios (India)	1 & 2015

(b) Online Resources:

Suggested instructions/Implementation strategies:

54. Improved lecture
55. Tutorial
56. Case method
57. Group Discussion
58. Role play
59. Visit to Waste water/Effluent Treatment plant and downstream pharmaceutical plants
60. Demonstration
61. ICT Based teaching Learning
62. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Tech. 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**
CO1-98BT501-A.1: Explain fundamentals of Plant Biotechnology	1	1	1	-	-	-	1	-	-	2	1	2	2	2	-
CO2-98BT501-A.2: Define the role of tissue culture media and its constituents in micropropagation of ex-plants	1	1	1	2	2	-	1	1	-	2	3	2	2	2	1
CO3-98BT501-A.3: Understand the working mechanism of callus culture	-	1	1	1	-	-	2	-	3	1	1	2	1	1	1
CO4-98BT501-A.4: Interpretate the mechanism of plant-based vector and plasmids	3	3	3	2	2	3	2	2	1	2	-	1	2	2	3
CO5-98BT501-A.5. Examine and demonstrate the mechanism of product purification	2	2	2	-	-	2	3	3	1	2	1	2	2	1	3
Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3															

Semester: V Semester

Course Title: Plant Biotechnology

Course Code: 98BT501-A

Program Name: B. Tech. Biotechnology

Semester: V Semester

Course Title: Plant Biotechnology

Course Code: 98BT501-A

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	**CO1-98BT501-A.1:** Explain fundamentals of Plant Biotechnology	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5SO1.6 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**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO2-98BT501-A.2:** Define the role of tissue culture media and its constituents in micropropagation of ex-plants	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5SO2.6 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**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO3-98BT501-A.3:** Understand the working mechanism of callus culture	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-1,2,3,4,5**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO4-98BT501-A.4:** Interpretate the mechanism of plant-based vector and plasmids	SO4.1 SO4.2 SO4.3 SO4.4	**LI 1** **LI 2**	4.1,4.2,4.3,4.4	**4SL-1,2,3,4,5**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO5-98BT501-A.5.** Examine and demonstrate the mechanism of product purification	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8SO5.9	**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**

Program Name	**Bachelor of Technology (B.Tech.)- Biotechnology**	
Semester	V	
Course Code:	**98BT502**	
Course title:	Enzyme Engineering and Technology	**Curriculum Developer**: Piyush Kant Rai, Assistant professor
Pre-requisite:	Student should have basic knowledge of Molecular Biology and Biotechnology	
Rationale:	The paper on Plant Biotechnology in B. Tech. Biotech Semester-V program is a rather most important discipline. Nevertheless, the subject Plant Biotechnology has become demanding subject for the last few years that universities at all rankings have introduced or are going to introduce Plant Biotechnology teaching programs. The course will provide an overview over Plant Biotechnology. It will in understanding the basic and advance application in tissue culture and transgenic based plant development. Applications of Plant Biotechnology, as they are already in use today or as they are planned for the future, will be discussed	
Course Outcomes (COs):	**98BT502-CO1. Explain relationship between the structure and function of enzymes** **98BT502CO2. Define the speed of a biochemical reaction in sense of thermodynamics, kinetics and molecular interactions.** **98BT502CO3. Interpretate the significant mechanisms of regulation of enzymatic action and specifies importance of enzymes in regulation of metabolism;** **98BT502CO4. Apply appropriate methods for determination of catalytic parameters and activity of enzymes and resolve problems.**	

	98BT502-CO5. Validate the considering kinetics and thermodynamics of enzymatic reactions

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C) (L:T:P=2:0:1)
			CI	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Common (PC)	**98BT502**	Enzyme Engineering and Technology	2	2	1	2	7	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 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)		
Program Common (PC)	**98BT502**	Enzyme Engineering and Technology	**15**	**20**	**5**	**5**	**5**	**50**	**50**	**100**

Scheme of Assessment: Practical

			Scheme of Assessment (Marks)		
			Progressive Assessment (PRA)		

Board of Study	Course Code	Course Title	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)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
Program Common (PC)	**98BT552**	Enzyme Engineering and Technologylab	35	5	5	5	50	50	50

Course-Curriculum:

Unit-I:	
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 (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
98BT502-CO1. Explain relationship between the structure and function of enzymes	SO1.1: Understand enzyme nomenclature and classification	LI1.1: Experiment on enzyme activity measurement	CI1.1: Introduction to enzymes and their significance	SL1.1: Research different enzyme classes

	SO1.2: Learn about factors affecting enzyme activity	LI1.2: Demonstration of factors affecting enzyme activity	CI1.2: Lecture on factors affecting enzyme activity	SL1.2: Study various factors affecting enzyme activity
	SO1.3: Comprehend theories of enzyme-substrate complex formation		CI1.3: Theories of enzyme-substrate complex formation	
	SO1.4: Understand catalytic RNA and its role		CI1.4: Catalytic RNA and its significance	
	SO1.5: Study metal-activated enzymes and metalloenzymes		CI1.5: Lecture on metal-activated enzymes and metalloenzymes	
	SO1.6: Learn about coenzymes used in biological reactions		CI1.6: Coenzymes and their roles in biological reactions	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Write a report on enzyme nomenclature
	SW1.2 Mini Project	Mini Project: Analysis of Michaelis-Menten plot
	SW1.3 Other Activities (Specify)	Assignment on Briggs-Haldane modification

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	4	01	02	13

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
98BT502CO2. Define the speed of a biochemical reaction in sense of thermodynamics, kinetics and molecular interactions.	SO2.1: Learn kinetics of uncatalyzed reactions	LI2.1: Kinetics experiment on uncatalyzed reaction	CI2.1: Introduction to enzyme kinetics	SL2.1: Study kinetics of uncatalyzed reactions

	SO2.2: Understand Michaelis-Menten equation	LI2.2: Michaelis-Menten kinetics experiment	CI2.2: Michaelis-Menten equation and its significance	SL2.2: Research on Michaelis-Menten kinetics
	SO2.3: Learn about Briggs-Haldane modification		CI2.3: Briggs-Haldane modification	
	SO2.4: Study Lineweaver-Burk and Eadie-Hofstee plots		CI2.4: Lineweaver-Burk and Eadie-Hofstee plots	
	SO2.5: Understand classification of BiBi reactions		CI2.5: Classification of BiBi reactions	
	SO2.6: Learn about multisubstrate kinetics and allosteric enzymes		CI2.6: Multisubstrate kinetics and allosteric enzymes	

Suggested Sessional Work (SW): *anyone*	SW1.1 Assignments	Write a report on uncatalyzed reaction kinetics
	SW1.2 Mini Project	Mini Project: Analysis of Michaelis-Menten plot
	SW1.3 Other Activities (Specify)	Assignment on Briggs-Haldane modification

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	04	01	02	13

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
98BT502CO3. Interpretate the significant mechanisms of regulation of enzymatic action and specifies importance of enzymes in regulation of metabolism	SO3.1: Learn about types of enzyme inhibition	LI3.1: Experiment on enzyme inhibition	CI3.1: Introduction to enzyme inhibition	SL3.1: Study types of enzyme inhibition
	SO3.2: Understand kinetics of enzyme inhibition	LI3.2: Kinetics of enzyme inhibition experiment	CI3.2: Kinetics of enzyme inhibition	SL3.2: Research on enzyme inhibition kinetics
	SO3.3: Study mechanism of enzyme catalysis		CI3.3: Mechanism of enzyme catalysis	
	SO3.4: Understand protein-ligand binding and cooperativity		CI3.4: Protein-ligand binding and cooperativity	
	SO3.5: Learn about Hill and Adair equations		CI3.5: Hill and Adair equations	
	SO3.6: Study enzyme catalysis examples like chymotrypsin and ribonuclease		CI3.6: Enzyme catalysis examples	

Suggested Sessional Work (SW): *anyone*	SW1.1 Assignments	Write a report on enzyme inhibition types
	SW1.2 Mini Project	Mini Project: Analysis of enzyme inhibition kinetics
	SW1.3 Other Activities (Specify)	Assignment on enzyme catalysis mechanism

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	04	01	02	13

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
98BT502CO4. Apply appropriate methods for determination of catalytic parameters and activity of enzymes and resolve problems.	SO4.1: Learn methods of enzyme immobilization	LI4.1: Experiment on enzyme immobilization	CI4.1: Introduction to enzyme immobilization	SL4.1: Study methods of enzyme immobilization
	SO4.2: Understand applications of immobilized enzymes	LI4.2: Demonstration of immobilized enzyme applications	CI4.2: Applications of immobilized enzymes	SL4.2: Research applications of immobilized enzymes
	SO4.3: Study design of immobilized enzyme reactors		CI4.3: Design of immobilized enzyme reactors	
	SO4.4: Learn about packed bed reactors		CI4.4: Packed bed reactors	

	SO4.5: Understand fluidized-bed membrane reactors		CI4.5: Fluidized-bed membrane reactors	
	SO4.6: Study extraction and purification of enzymes		CI4.6: Extraction and purification of enzymes	

Suggested Sessional Work (SW): *anyone*	SW1.1 Assignments	Write a report on enzyme immobilization methods
	SW1.2 Mini Project	Mini Project: Application of immobilized enzyme
	SW1.3 Other Activities (Specify)	Assignment on immobilized enzyme reactors

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)**
98BT502-CO5. Validate the considering kinetics and thermodynamics of enzymatic reactions	SO5.1: Learn concepts of enzyme engineering	LI5.1: Study enzyme engineering techniques	CI5.1: Introduction to enzyme engineering	SL5.1: Research enzyme engineering concepts
	SO5.2: Understand prediction of enzyme structure	LI5.2: Demonstration of enzyme structure prediction	CI5.2: Prediction of enzyme structure	SL5.2: Study methods of enzyme structure prediction
	SO5.3: Study site-directed mutagenesis		CI5.3: Site-directed mutagenesis	
	SO5.4: Learn about protein engineering techniques		CI5.4: Protein engineering techniques	
	SO5.5: Understand genetic engineering techniques for enzyme technology		CI5.5: Genetic engineering for enzyme technology	

	SO5.6: Study applications of enzyme engineering		CI5.6: Applications of enzyme engineering	

Suggested Sessional Work (SW): *anyone*	SW1.1 Assignments	Write a report on enzyme engineering
	SW1.2 Mini Project	Mini Project: Predicting enzyme structure
	SW1.3 Other Activities (Specify)	Assignment on site-directed mutagenesis

Course duration (in hours) to attain Course Outcomes **(Course Title:** Enzyme Engineering and Technology (**Course Code: 98BT502**)					
Course Outcomes (COs)	**Class lecture (CI)**	**Laboratory Instruction (LI)**	**Self-Learning (SL)**	**Sessional work (SW)**	**Total Hours (Li+CI+SL+SW)**
98BT502-CO1. Explain relationship between the structure and function of enzymes	6	4	2	1	13
98BT502CO2. Define the speed of a biochemical reaction in sense of thermodynamics, kinetics and molecular interactions.	6	4	2	1	13
98BT502CO3. Interpretate the significant mechanisms of regulation of enzymatic action and specifies importance of enzymes in regulation of metabolism;	6	4	2	1	13
98BT502CO4. Apply appropriate methods for determination of catalytic parameters and activity of enzymes and resolve problems.	6	4	2	1	13
98BT502-CO5. Validate the considering kinetics and thermodynamics of enzymatic reactions	6	4	2	1	13
Total Hours	30	20	10	05	65

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

(**Course Title:** Enzyme Engineering and Technology (**Course Code: 98BT502**)					
Course Outcomes	**Marks Distribution**				**Total Marks**
	A	**An**	**E**	**C**	
98BT502-CO1. Explain relationship between the structure and function of enzymes	2	1	1	1	5
98BT502CO2. Define the speed of a biochemical reaction in sense of thermodynamics, kinetics and molecular interactions.	2	4	5	1	12
98BT502CO3. Interpretate the significant mechanisms of regulation of enzymatic action and specifies importance of enzymes in regulation of metabolism;	3	5	5	1	14
98BT502CO4. Apply appropriate methods for determination of catalytic parameters and activity of enzymes and resolve problems.	2	3	5	1	11
98BT502-CO5. Validate the considering kinetics and thermodynamics of enzymatic reactions	5	4	1	0	10
Total Marks	**14**	**17**	**17**	**04**	**52**
Legend: **A,** Apply; **An,** Analyze; **E,** Evaluate; **C,** Create					

Suggested learning Resources:

(c) Books:

S.no.	**Title**	**Author**	**Publisher**	**Edition & Year**
1	Enzymes	Palmer	Horwood Publishing Series.	2001

2	Fundamentals of Enzymology	Price and Stevens	Oxford University Press	2002
3	Enzyme Technology	Helmut uhling	John Wiley	1998
4	Introduction to Proteins Structure	Branden and Tooze	Garland Publishing Group.	1998

(d) Online Resources:

Suggested instructions/Implementation strategies:

63. Improved lecture
64. Tutorial
65. Case method
66. Group Discussion
67. Role play
68. Visit to Waste water/Effluent Treatment plant and downstream pharmaceutical plants
69. Demonstration
70. ICT Based teaching Learning
71. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Tech. Biotechnology

Semester: V Semester

Course Title: Enzyme Engineering and Technology

Course Code: 98BT502

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**
98BT502-CO1. Explain relationship between the structure and function of enzymes	1	1	1	-	-	-	1	-	-	2	1	2	2	2	-
98BT502CO2. Define the speed of a biochemical reaction in sense of thermodynamics, kinetics and molecular interactions.	1	1	1	2	2	-	1	1	-	2	3	2	2	2	1
98BT502CO3. Interpretate the significant mechanisms of regulation of enzymatic action and specifies importance of enzymes in regulation of metabolism;	-	1	1	1	-	-	2	-	3	1	1	2	1	1	1
98BT502CO4. Apply appropriate methods for determination of catalytic parameters and activity of enzymes and resolve problems.	3	3	3	2	2	3	2	2	1	2	-	1	2	2	3

98BT502-CO5. Validate the considering kinetics and thermodynamics of enzymatic reactions	2	2	2	-	-	2	3	3	1	2	1	2	2	1	3
Legends: CO/PO/PSO Mapping Range: Low, 1; Medium, 2; High, 3															

Program Name: B. Tech. Biotechnology

Semester: V Semester

Course Title: Enzyme Engineering and Technology

Course Code: 98BT502

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	**98BT502-CO1.** Explain relationship between the structure and function of enzymes	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5SO1.6	**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**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**98BT502CO2.** Define the speed of a biochemical reaction in sense of thermodynamics, kinetics and molecular interactions.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5SO2.6	**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**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**98BT502CO3.** Interpretate the significant mechanisms of regulation of enzymatic action and specifies importance of enzymes in regulation of metabolism;	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6	**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**

PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**98BT502CO4.** Apply appropriate methods for determination of catalytic parameters and activity of enzymes and resolve problems.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6	**LI 1** **LI 2**	4.1,4.2,4.3,4.4, 4.5, 4.6	**4SL-1,2**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**98BT502-CO5.** Validate the considering kinetics and thermodynamics of enzymatic reactions	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6	**LI 1** **LI 2**	5.1,5.2,5.3,5.4,5.5, 5.6	**5SL-1,2**

B. Tech. Biotechnology 6^{th} Semester

Program Name	**B. Tech. Biotech Semester-**	
Semester	**VIth**	
Course Code:	98BT606-C	
Course title:	**Bio-programming and Soft Computing Techniques**	**Curriculum Developer**: Mr. Piyush Kant Rai, Teaching associate
Pre-requisite:	Students must have knowledge of Bio-programming and Soft Computing Techniques.	
Rationale:	The paper on Bio-programming and Soft Computing Techniques in B. Tech. Biotech Semester-VIth program explores the Bio-programming and soft computing techniques integrate principles from biology and computer science to develop innovative solutions for complex problems. By mimicking biological processes such as evolution, neural networks, and genetic algorithms, these techniques offer efficient ways to model, analyze, and optimize systems in various fields such as healthcare, bioinformatics, and robotics. They enable advancements in personalized medicine, biomolecular engineering, and adaptive systems, contributing to interdisciplinary research and technological innovation.	
Course Outcomes (COs):	**CO1 98BT606-C. Understand about the biocomputing methods, principles and practices.** **CO2 98BT606-C. Outline the advanced genomics, transcriptomics and proteomics methods** **CO3 98BT606-C. Apply web-based methods and tools for simulation of biological problems** **CO4 98BT606-C. Analyse vaccine designing and protein-ligand interactions for drug discovery** **CO5 98BT606-C. Compare various databases and softwares used in Bio-computing**	

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)	
ProgramElective (PE)	98BT606-C	**Bio-programming and Soft Computing Techniques**	3	2	1	1	7	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

	Couse Code	Course Title	Scheme of Assessment (Marks)		
					Total Marks

Board of Study			Progressive Assessment (PRA)					End Semester Assessment (ESA)	(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)		
Program Elective (PE)	**98BT606-C**	**Bio-programming and Soft Computing Techniques**	15	20	5	5	5	50	50

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)		
Program Elective (PE)	**98BT656-C**	**Bio-programming and Soft Computing Techniques**	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	9	04	01	03	17

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
98BT656CO1. Understand about the biocomputing methods, principles and practices.	Explain Introduction to R Programming Overview of the R Language	**LI1.1** Installation of R program via R project installer	Introduction to R Programming Overview of the R Language	Vectors and array in R.
	Defining R Project; Obtaining R, where to get help Generating R Code –Basic Programming Concepts, Scripts, Text editors for R	**LI1.2** To install and run R program	Defining R Project; Obtaining R, where to get help Generating R Code –Basic Programming Concepts, Scripts, Text editors for R	What is script?
	Features of Graphical User Interfaces (GUI’s) for R; Vectors and Matrices, Data Frames and tests works		Graphical User Interfaces (GUI’s) for R; Vectors and Matrices, Data Frames and tests	How many R-packages are there for biological sequence analysis
	Can answer datasets included in R Packages		Datasets included in R Packages	

	How to Manipulate objects in R, Graphics (Basics) Mathematical Operations,		Manipulating objects, Graphics (Basics) Mathematical Operations	
	Basic Matrix computation Regular Sequences		Basic Matrix computation Regular Sequences	
	Basic Matrix computation Regular Sequences		Basic Matrix computation Regular Sequences	
	Apply strings and Pattern matching on any dataset		Strings and Pattern matching	
	Hypothesis testing and data handling; t-tests		Hypothesis testing and data handling; t-tests	
	ANNOVA basics		ANNOVA basics	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Write about the R packages
	SW1.2 Mini Project	Learn different types of libraries in R
	SW1.3 Other Activities (Specify)	What is annova do a thorough searching

Item	Cl	LI	SW	SL	Total
Approx. Hrs	**09**	4	1	3	17

Course Outcome (CO)	Session Outcomes (SOs)	LaboratoryInstruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
98BT656 CO2. Outline the advanced genomics, transcriptomics and proteomics methods	Introduction to MATLAB	To learn Basics of MATLAB	Introduction to MATLAB	Make a 2d simulation of any arbitrary program.
	How to use MATLAB as calculator	To explore various tools of MATLAB	MATLAB as calculator	Explore MATLAB uses
	Standard MATLAB windows		Standard MATLAB windows	Remember steps of calling MATLAB tools
	Understanding the operations with variables		operations with variables	
	Understanding the operations with arrays		Understanding the operations with arrays	
	writing script files		writing script files	
	Can writing functions, simple graphics		writing functions, simple graphics	

	what are the Data types, File Input-output in MATLAB		Data types, File Input-output in MATLAB	
	Communication with external devices		Communication with external devices	

Item	Cl	LI	SW	SL	Total
Approx. Hrs	**09**	4	**1**	3	17

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Write about the basics of MATLAB
	SW2.2 Mini Project	List a various operations and array used in MATLAB
	SW2.3 Other Activities (Specify)	Find out some you tube videos based on how to getting started with MATLAB

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
98BT656 CO3. Apply web-based methods and tools for simulation of biological problems	Introduction to Python	Write First python program using PyCharm	Introduction to Python	Remember basics of python
	Remember the features of Python	**Li3.2** To learn the data input and output of the R	Features of Python	Understand how python works
	Data types, Variables operators		Th Data types, Variables operators	Write the features of PyCharm

	What are the Data types, Variables, operators and expressions-1		Data types, Variables, operators and expressions-1	
	Data types, Variables, operators and expressions-2		Data types, Variables, operators and expressions-2.	
	Understand functions, Data structures		Understand functions, Data structures	
	What is Input and Output,		Input and Output	
	Introduction to object-oriented programming CSS and Zope-1		Introduction to object-oriented programming CSS and Zope-1	
	Introduction to object-oriented programming		Introduction to object-oriente	

	CSS and Zope-2		d programming CSS and Zope-2	

Item	Cl	LI	SW	SL	Total
Approx. Hrs	**09**	4	1	1	15

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Write about the Objected oriented CSS
	SW3.2 Mini Project	
	SW3.3 Other Activities (Specify)	Employ the python programming skill to make a DNA base counter

Course Outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
98BT656 CO4. Analyse vaccine designing and protein-ligand interactions for drug discovery	Remember Soft Computing Techniques and Algorithms	Make first algorithm for biological sequences.	Soft Computing Techniques and Algorithms	Learn basic of soft computing
	Introduction to Soft computing	**LI4.2** To search for the gene gene network in KEGG database	Introduction to Soft computing	

	Hidden Markov Models: Application in Bioinformatics		Hidden Markov Models: Application in Bioinformatics ANN (Artificial Neural Networks)	
	ANN (Artificial Neural Networks)-1		ANN (Artificial Neural Networks)-1	
	Types of ANN (Artificial Neural Networks)		Types of ANN (Artificial Neural Networks)	
	How to do Identification – Lead optimization.		Identification – Lead optimization.	
	Lead optimization.		Lead optimization.	
	Apply Basic concepts and Applications of Genetic Algorithms-1		Basic concepts and Applications of Genetic Algorithms	
	Apply Basic concepts and Applications of Genetic Algorithms-2		Basic concepts and Applications of Genetic Algorithms	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	prepare a flow chart of classical case of ANN
	SW4.2 Mini Project	
	SW4.3 Other Activities (Specify)	Relate The genetic algorithm with ANN

item	Cl	LI	SW	SL	Total
Approx. Hrs	**09**	4	1	2	16

Course Outcome (CO)	Session Outcomes (SOs)	LaboratoryInstruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
98BT656 CO5. Compare various databases and software's used in Bio-computing	Understand Introduction to VB	How to make HTML using VB	Introduction to VB	Revise Basic of VB
	What introduction to Client/Server Technology	**LI5.2** to make first program using Visual basics	Introduction to Client/Server Technology	Remember Client/server technology
	Evaluate Data types, Strings		Data types, Strings	
	Apply Variant, Constant, Data Arrays		Variant, Constant, Data Arrays	
	Looping and Interactive statements Functions in VB		Looping and Interactive statements Functions in VB	
	Understand the working with controls and procedures		Working with controls and procedures	

	Introduction to Data Connectivity-1		Introduction to Data Connectivity-1	
	Introduction to Data Connectivity-2		Introduction to Data Connectivity-2	
	Different Database Connectivity.		Different Database Connectivity.	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	illustrate the theories of DATA types
	SW5.2 Mini Project	
	SW5.3 Other Activities (Specify)	Rewrite the Scope and limitations of VB

Course duration (in hours) to attain Course Outcomes:
Course Title: Bio-programming and Soft Computing Techniques **Course Code: 98BT656**

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
98BT656 CO1. Understand about the biocomputing methods, principles and practices.	9	4	3	1	17
98BT656 CO2. Outline the advanced genomics, transcriptomics and proteomics methods	9	4	3	1	17
98BT656 CO3. Apply web-based methods and tools for simulation of biological problems	9	4	3	1	17
98BT656 CO4. Analyse vaccine designing and protein-ligand interactions for drug discovery	9	4	1	1	15

98BT656 CO5. Compare various databases and software's used in Bio-computing	9	4	2	1	13
Total Hours	45	20	12	5	79

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

Course Title: Bio-programming and Soft Computing Techniques **Course Code:**

Course Outcomes	**Marks Distribution**				**Total Marks**
	A	**An**	**E**	**C**	
98BT656 CO1. Understand about the biocomputing methods, principles and practices.	03	02	04	1	10
98BT656 CO2. Outline the advanced genomics, transcriptomics and proteomics methods	03	04	02	1	10
98BT656 CO3. Apply web-based methods and tools for simulation of biological problems	03	04	02	1	10
98BT656 CO4. Analyse vaccine designing and protein-ligand interactions for drug discovery	03	03	03	1	10
98BT656 CO5. Compare various databases and software's used in Bio-computing	03	02	04	1	10
Total Marks	15	15	15	05	50

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

Suggested learning Resources:

Books:

S.No.	**Title/Author/Publisher details**
1	Nathan Yan The Art of R Programming No Starch Press,US; 7 edition 2016
2	Rudra Prathap –Getting started with MATLAB oxford 2019

3	**Soft Computing: Fundamentals and Applications**	**Alpha Science International Ltd**	2015

Online Resources:

Suggested instructions/Implementation strategies:

Improved lecture
Tutorial
Case method
Group Discussion
Role play
Visit to bioinformatics lab
Demonstration
ICT Based teaching Learning
Brainstorming

CO, PO and PSO Mapping

Program Name: B. Tech. Biotechnology

Semester: 6th Sem

Course Title: Bio-programming and Soft Computing Techniques

Course Code: 98BT656

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**
98BT656 CO1. Understand about the biocomputing methods, principles and practices.	-	1	-	1	2	2	3	-	3	3	3	3	-	1	-
98BT656 CO2. Outline the advanced genomics, transcriptomics and proteomics methods	-	-	-	-	-	-	3	-	3	2	3	3	-	-	-
98BT656 CO3. Apply web-based methods and tools for simulation of biological problems	-	-	1	1	-	-	3	-	3	1	-	-	-	-	1
98BT656 CO4. Analyse vaccine designing and protein-ligand interactions for drug discovery	1	-	1	-	2	-	3	3	-	1	-	1	1	-	1
98BT656 CO5. Compare various databases and software's used in Bio-computing	1	1	1	-	-	2	3	3	1	2	3	3	1	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 2,4,5,6 7,9,10,11,12 PSO 2	**98BT656 CO1. Understand about the biocomputing methods, principles and practices.**	SO1.1 SO1.2 SO1.3 SO1.4,SO1.5, SO1.6, SO1.7, SO1.8,SO1.9 SP1.10	**IL 1** **IL 2**	1.1,1.2,1.3,1.4 ,1.5,1.6, 1.7, 1.8, 1.9	**1SL-1,2,3**
PO 7,9,10,11,12	**98BT656 CO2. Outline the advanced genomics, transcriptomics and proteomics methods**	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5,SO2.6SO2.7 SO2.8 SO2.9	**IL 1** **IL 2**	2.1, 2.2, 2.3, 2.4,2.5,2.6, 2.7, 2.8, 2.9	**2SL-1,2,3**
PO 3,4,5, 7,9,10 PSO 3	**98BT656 CO3. Apply web-based methods and tools for simulation of biological problems**	SO3.1 SO3.2 SO3.3 SO3.4 ,3.5,SO3.6,SO3.7, SO3.8 SO3.9	**IL 1** **IL 2**	3.1,3.2,3.3,3.4.3.5,3.6,3.7, 3.8, 3.9	**3SL-1,2,3**
PO 1,3,5, 7,8,10,12 PSO 1,3	**98BT656 CO4. Analyse vaccine designing and protein-ligand interactions for drug discovery**	SO4.1 SO4.2 SO4.3 SO4.4 ,SO4.5,SO4.6,SO4.7 SO4.8 SO4.9	**IL 1** **IL 2**	4.1,4.2,4.3,4.4,4.5,4.6,4.7, 4.8, 4.9	**4SL-1**
PO 1, 2,3,6 7,8,10,11,12 PSO 1,2, 3	**98BT656 CO5. Compare various databases and software's used in Bio-computing**	SO5.1 SO5.2 SO5.3 SO5.4 ,SO5.5,SO5.6,SO5.7 SO5.8 SO5.9	**IL 1** **IL 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 Technology (B.Tech.)- Biotechnology**	
Semester	VI	
Course Code:	98BT602	
Course title:	Metabolic Engineering	**Curriculum Developer**: Er. Arpit Srivastava, Assistant Professor
Pre-requisite:	Students should have basic knowledge of biochemistry and metabolism	
Rationale:	Metabolic engineering is an emerging field of biotechnology/bioprocess engineering which aims towards purposeful modification of cellular (metabolic, gene regulatory, and signaling) processes/networks to achieve desirable goals such as enhanced production of metabolites including pharmaceuticals, biofuels and biochemicals and other biotechnology products. This course aims to provide fundamental and advanced knowledge in the development of microbial strain for bio production through metabolic engineering	
Course Outcomes (COs):	**CO1-98BT602.1.** Explain the basic principles and fundamentals of metabolic engineering **CO2-98BT602.2.** Discuss the role of comprehensive cellular reaction models **CO3-98BT602.3.** Design and describe metabolic flux analysis to determine metabolic pathway utilization **CO4-98BT602.4.** Design effective strategies to implement metabolic flux to determine metabolic pathways **CO5-98BT602.5.** Describe combinatorial metabolic engineering strategies to illustrate metabolic control analysis	

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)	98BT602	Metabolic Engineering	2	2	1	3	8	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	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)		

			(CA)							
PC	98BT602	Metabolic Engineering	**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	98BT652	Metabolic Engineering	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	06	06	01	05	18

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-98BT602.1. Explain the basic principles and fundamentals of metabolic engineering	**SO1.1** Explain concept of metabolic engineering	**LI1.1** Draw the steps followed in prokaryotic /eukaryotic glycolysis metabolic pathways	**Unit-1** **CI1.1** Metabolic Engineering and its importance	**SL1.1** Find out some examples of metabolic engineering
	SO1.2 Define Basic terminology, scope and application for ME	**LI1.2** Draw the steps followed in prokaryotic /eukaryotic TCA metabolic pathways	**CI1.2** Terminologies of Metabolic Engineering	**SL1.2** Explore conventional papers on metabolic engineering
	SO1.3 Elaborate the scientific Flux, Flux Split Ratio, flux analysis	**LI1.3** To understand the production and consumption of ATPs involve in glycolysis and TCA cycle	**CI1.3** Flux, Flux Split Ratio, flux analysis	**SL1.3** Write down few points on applications of metabolic engineering
	SO1.4 Define metabolism and types		**CI1.4** Overview of Cellular Metabolism, Ana/Catabolism	**SL1.4** Write down few points on flux
	SO1.5 Describe types of cellular reactions		**CI1.5** Polymerization, Fuel reactions, Assembling Reactions with examples	**SL1.5** Collect information on career in metabolic engineering field
	SO5.6 Revision and Assessment		**CI1.6** Revision and Assessment	

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	04	01	04	15

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Describe in detail about the role of "Metabolic Engineering in synthesis of bioproduct"
	SW1.2 Mini Project	Elaborate the role of Flux and Fluxomics
	SW1.3 Other Activities (Specify)	Draw a flowchart compiling all procedures used in performing metabolic engineering

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO2-98BT602.2.	**SO2.1** Explain concept of downstream processing	**LI2.1** Demonstrate the working of Cell Disruption technique	**Unit-2** **CI2.1**	**SL2.1** Find out more conventional cell disruption techniques

Discuss the role of comprehensive cellular reaction models			Anapleoritic, Mixed Fermentation, Fermentative Metabolism of yeast	
	SO2.2 Relate the concept of how physical and biological separation can be done	**LI2.2** To perform the experiment of production of microbial biomass	**CI2.2** Stoichiometry of Cellular Reactions, (Glucose to Acetate)	**SL2.2** Read the latest research in bioseparations methods
	SO2.3 Outline the steps of coverting glucose to ethanol		**CI2.3** Glucose to Ethanol, Metabolic products	**SL2.3** Write down few points on biological product's properties
	SO2.4 Define the mechanism of biomass		**CI2.4** Biomass Constituents, Intracellular Metabolites	**SL2.4** Find out the different kinds of filter aids and their role
	SO2.5 Explain the role of Modelling Metabolism		**CI2.5** Modelling Metabolism (Graph Theory)	
	SO2.6 Revision and assessment		**CI2.6** Revision and assessment	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Describe the role of Biomass in metabolism
	SW2.2 Mini Project	Make a project on bioconversion of Glucose to Ethanol
	SW2.3 Other Activities (Specify)	Make Power point presentation on Metabolism modelling

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	04	01	03	14

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO3-98BT602.3. Design and describe metabolic flux analysis to determine metabolic pathway utilization	**SO3.1** Define the Regulation of Enzymatic Activity, Models of Feedback inhibition	**LI3.1** To perform the Centrifugation process as Unit Operation	**Unit-3** **CI3.1** Regulation of Enzymatic Activity, Models of Feedback inhibition	**SL3.1** Find out the process of Enzyme inhibition in human metabolism
	SO3.2 Derive the mathematical expression for Enzyme Kinetics, Inhibition system	**LI3.2** To do the enzyme assay using spectrophotometric method	**CI3.2** Overview of Enzyme Kinetics, Inhibition system with slopes, Steady state approach, BH equation	**SL3.2** Read the process of how Michalis Menten equation was derived
	SO3.3 Analyze the Substrates, Competitive Inhibition with slopes		**CI3.3** Substrates, Competitive Inhibition with slopes	**SL3.3** Write down the steps followed in Lac operon model
	SO3.4 Distinguish among the working mechanism of Regulation of Enzyme concentration & Operon		**CI3.4** Regulation of Enzyme concentration; Transcription: Lac Operon Model	
	SO3.5		**CI3.5**	

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	02	01	04	13

	Explain the role of Global control and Enzyme Substrate binding		Global Control at Whole Cell Level, Enzyme Substrate Binding theory	
	SO3.6 Revision and assessment		**CI3.6** Revision and assessment	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Derive the equations for Michalis Menten theory of Enzyme Substrate complex
	SW3.2 Mini Project	Write an article on Global Control at whole Cell level
	SW3.3 Other Activities (Specify)	Prepare one Power point presentation on "Different types of Centrifuge and their applications"

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO2-98BT602.4 Design effective strategies to implement metabolic flux to determine metabolic pathways	**SO4.1** Distinguish among different nodes and branches in MFA	**LI4.1** To perform the Column Chromatography process as Unit Operation for	**Unit-4** **CI4.1** Branch Point Classification, Nodes Analysis (Weak, Strong and Rigid),	**SL4.1** Find out the the types of classifications of nodes in MFA

Item	Cl	LI	SW	SL	Total
Approx. Hrs	6	04	01	05	16

		extraction of different compounds	Introduction to Metabolic Flux Analysis	
	SO4.2 Distinguish among different theories of MFA		**CI4.2** Theories of MFA, Tissue Dynamics, Sensitivity Analysis	**SL4.2** Write down some more examples of Tissue dynamics
	SO4.3 Analyze the working of isotopic labelling and fractional labelling		**CI4.3** Isotope Labelling; Fractional Label enrichment in MFA	**SL4.3** List down the role of MFA in metabolism
	SO4.4 Derive the metabolism reaction for lysine biosynthesis and carbon balancing		**CI4.4** Lysine Biosynthesis; Carbon balancing	**SL4.4** List down the steps involve in Lysine biosynthesis
	SO4.5 Derive the Atom mapping metrices based equations		**CI4.5** Atom mapping matrices	
	SO4.6 Revision and assessment		**CI4.6** Revision and assessment	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Determine the working mechanism and applications of Tissue Dynamics
	SW4.2 Mini Project	Derive the Qualitative and Quantitative data optimization and retrieval through MFA in isotopic labelling
	SW4.3 Other Activities (Specify)	Make a presentation on Lysine biosynthesis and its importance in metabolism

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO2-98BT602.5 Describe combinatorial metabolic engineering strategies to illustrate metabolic control analysis	**SO5.1** Elucidate Amino Acid Metabolism	**LI5.1** To determine the AA sequences comparison on the basis of peptide mapping using	**Unit-5** **CI5.1** Amino Acid Metabolism; Metabolism types in biomolecules	**SL5.1** Explore amino acid metabolism in eukaryotes

		ProteoMapper (Server/tool)		
	SO5.2 Distinguish among different metabolic core carbon pathways with glycolysis	**LI5.2** To determine the protein 3D structure, function and annotations using Protein Data Bank (PDB database)	**CI5.2** Glycolysis and Core Carbon metabolism	**SL5.2** Write down the enzymes associated in glycolysis
	SO5.3 Analyze the metabolism of aromatic amino acids		**CI5.3** Aromatic amino acid metabolism	**SL5.3** List down various kinds of amino acids and their structures
	SO5.4 Describe the entire role of CRISPR and its mechanism		**CI5.4** CRISPR-CAS9; Introduction; fundamentals and mechanism	**SL5.4** List down the applications of CRISPR
	SO5.5 Describe metabolic reconstruction		**CI5.5** Metabolic Reconstruction and Remodelling	**SL5.5** List down the various bioinformatics-based server/tool that assist in study of metabolism
	SO5.6 Explain the mechanism of MCA and network modelling of MCA		**CI5.6** MCA (metabolic Control analysis); fundamentals and mechanism; Metabolic networks	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Explain general mechanism of negative Charge Amino acids
	SW5.2 Mini Project	Describe the applications of CRISP-Cas9 in detail
	SW5.3 Other Activities (Specify)	Prepare one article on the "Metabolic Control Analysis"

Course duration (in hours) to attain Course Outcomes:

Course Title: Metabolic Engineering **Course Code:** 98BT602

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1-98BT602.1. Explain the basic principles and fundamentals of metabolic engineering	6	6	5	1	18
CO2-98BT602.2. Discuss the role of comprehensive cellular reaction models	6	4	4	1	15

CO3-98BT602.3. Design and describe metabolic flux analysis to determine metabolic pathway utilization	6	4	3	1	14
CO4-98BT602.4. Design effective strategies to implement metabolic flux to determine metabolic pathways	6	2	4	1	13
CO5-98BT602.5. Describe combinatorial metabolic engineering strategies to illustrate metabolic control analysis	6	4	5	1	16
Total Hours	30	20	21	05	76

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

Course Title: Metabolic Engineering **Course Code:** 98BT602

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
CO1-98BT602.1. Explain the basic principles and fundamentals of metabolic engineering	2	1	1	1	5
CO2-98BT602.2. Discuss the role of comprehensive cellular reaction models	2	4	5	1	12
CO3-98BT602.3. Design and describe metabolic flux analysis to determine metabolic pathway utilization	3	5	5	1	14
CO4-98BT602.4. Design effective strategies to implement metabolic flux to determine metabolic pathways	2	3	5	1	11
CO5-98BT602.5. Describe combinatorial metabolic engineering strategies to illustrate metabolic control analysis	5	4	1	0	10
Total Marks	**14**	**17**	**17**	**04**	**52**

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

Suggested learning Resources:

Books:

S.No.	Title/Author/Publisher details
1	Gregory N. Stephanopoulos, Aristos A. Aristidou, Jens Nielsen; Metabolic Engineering; Academic Press 1998
2	R.O. Jenkins, (Ed.) – Product Recovery in Bioprocess Technology – Biotechnology By Open Learning Series, Butterworth-Heinemann (1992).
3	J.C. Janson And L. Ryden, (Ed.) – Protein Purification – Principles, High Resolution Methods And Applications, VCH Pub. 1989.
4	Fundamentals of Biochemistry. Author, JL Jain et al. Edition, reprint. Publisher, S. Chand Publishing, 2004.
5	Nielsen, J., Eggeling, L., Dynesen, J., Gárdonyi, M., Gill, R. T., de Graaf, A. A., van Zyl, W. H. (Eds.). (2001). Metabolic Engineering. Advances in Biochemical Engineering/Biotechnology.

Online Resources:

Suggested instructions/Implementation strategies:

Improved lecture
Tutorial
Case method
Group Discussion
Role play
Visit to Waste water/Effluent Treatment plant and downstream pharmaceutical plants
Demonstration
ICT Based teaching Learning
Brainstorming

CO, PO and PSO Mapping

Program Name: B. Tech. Biotechnology

Semester: VI Semester

Course Title: Metabolic Engineering

Course Code: 98BT602

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**
CO1-98BT602.1. Explain the basic principles and fundamentals of metabolic engineering	-	1	-	1	2	2	3	-	3	2	2	3	1	2	1
CO2-98BT602.2. Discuss the role of comprehensive cellular reaction models	-	1	-	-	1	-	3	1	2	2	3	3	2	-	2
CO3-98BT602.3. Design and describe metabolic flux analysis to determine metabolic pathway utilization	-	1	1	1	-	-	1	-	2	1	1	2	3	2	-
CO4-98BT602.4. Design effective strategies to implement metabolic flux to determine metabolic pathways	-	-	1	-	2	2	3	3	-	1	3	3	2	1	3

CO5-98BT602.5. Describe combinatorial metabolic engineering strategies to illustrate metabolic control analysis	1	-	1	2	-	2	3	3	1	2	2	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 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO1-98BT602.1.** Explain the basic principles and fundamentals of metabolic engineering	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6	**LI 1** **LI 2** **LI 3**	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	**CO2-98BT602.2.** Discuss the role of comprehensive cellular reaction models	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6	**LI 1** **LI 2**	2.1, 2.2, 2.3, 2.4, 2.5, 2.6	**2SL-1,2,3,4**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO3-98BT602.3.** Design and describe metabolic flux analysis to determine metabolic pathway utilization	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6	**LI 1** **LI 2**	3.1,3.2,3.3,3.4,3.5, 3.6	**3SL-1,2,3**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO4-98BT602.4.** Design effective strategies to implement metabolic flux to determine metabolic pathways	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6	**LI 1**	4.1,4.2,4.3,4.4, 4.5, 4.6	**4SL-1,2,3,4**

PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO5-98BT602.5.** Describe combinatorial metabolic engineering strategies to illustrate metabolic control analysis	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6	**LI 1** **LI 2**	5.1,5.2,5.3,5.4,5.5, 5.6	**5SL-1,2,3,4,5**

Program Name	**Bachelors of Technology (B. Tech.)- Biotechnology**	
Semester	VI	
Course Code:	98BT603	
Course title:	Bioreactor Design	**Curriculum Developer**: Er. Arpit Srivastava, Assistant Professor
Pre-requisite:	Students should have basic knowledge of fermentation and biochemical engineering	
Rationale:	Bioreactor Design covers a wide range of topics, from the design and research of bioreactors (including their physical architecture, instrumentation, and operational mode) to the development of kinetic models. Across a range of industries, biochemical engineers can find work. They work in the food industry, nuclear industry, healthcare industry, chemical manufacturing firms, pharmaceutical industry, research labs, and other sectors. This course gives us information on various living things, including bacteria, fungus, plants, and animals. However, bioprocess engineering aids in the development of the necessary abilities needed to use these living things for the benefit of both humans and the natural world.	
Course Outcomes (COs):	**CO1-98BT603.1.** Illustrate the terminologies associated with Bioreactor Design **CO2-98BT603.2.** Explain the kinetics and mechanism of various types of reactors **CO3-98BT603.3.** Interpretate the different experimental data on reaction rate related to reactor engineering principles **CO4-98BT603.4.** Analyse the Transfer of Heat and Mass with its kinetics **CO5-98BT603.5.** Evaluate & Design numerical values for development of heterogenous reaction	

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)	98BT603	Bioreactor Design	2	2	1	3	8	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	98BT603	Bioreactor Design	**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	98BT653	Bioreactor Design	35	5	5	5	50	50	50

Course-Curriculum:

<table>
<tr><td>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.</td>
<td>Approximate Hours
<table>
<tr><td>Item</td><td>Cl</td><td>LI</td><td>SW</td><td>SL</td><td>Total</td></tr>
<tr><td>Approx. Hrs</td><td>06</td><td>08</td><td>01</td><td>03</td><td>18</td></tr>
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Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-98BT603.1 Illustrate the terminologies associated with Bioreactor Design	**SO1.1** Explain concept of Basic design and construction, materials of construction of reactor's vessels	**LI1.1** To Demonstrate the working of a Bench Top bioreactor with all its parts	**CI1.1** Basic design and construction, materials of construction	**SL1.1** Find out some examples of bioprocess technique used in ancient India
	SO1.2 Determine the basic Vessel geometry, Bearing assemblies	**LI1.2** To perform the isolation of microorganisms from different kinds of samples	**CI1.2** Vessel geometry, Bearing assemblies	**SL1.2** Search various reference books and study material to start the learning of microorganisms
	SO1.3 Elaborate the working mechanism of Motor drives, Aseptic seals, flow measuring device	**LI1.3** To evaluate the theoretical and observable yield of biological products from fermentation process	**CI1.3** Motor drives, Aseptic seals, flow measuring device	**SL1.3** Draw a flow chart showing upstream and fermentation processing

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	06	01	03	16

	SO1.4 Define the Fundamental mechanism of Valves, Agitator, and Sparger Design	**LI1.4** To evaluate the numerical data on overall mass transfer associated with bioprocessing in a given reactor	**CI1.4** Valves, Agitator & Numerical Problems	
	SO1.5 Define Sparger Design & types		**CI1.5** Sparger Design & types	
	SO1.6 Revision and assessment		**CI1.6** Revision and assessment	

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 and parts
	SW1.3 Other Activities (Specify)	Make a power point presentation on "Role of Fermentations in Ancient India"

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO2-98BT603.2.	**SO2.1**	**LI2.1**	**CI2.1**	**SL2.1**

Explain the kinetics and mechanism of various types of reactors	Explain the Operational Mode of Reactors: Batch, Fed batch, Continuous cultivation	To perform the experiment on the microbial production of Acetic Acid	Operational Mode of Reactors: Batch, Fed batch, Continuous cultivation	Find out more conventional cell disruption techniques
	SO2.2 Explain the working mechanism of Stirred Tank, Airlift Bioreactor, Airlift Pressure, cycle Bioreactor, Loop Bioreactor, Bubble column Bioreactor, Packed bed and hollow fibre membrane bioreactor	**LI2.2** To perform the experiment of microbial production of Amino acids	**CI2.2** Novel Bioreactor Stirred Tank, Airlift Bioreactor, Airlift Pressure, cycle Bioreactor, , Packed bed and hollow fibre membrane bioreactor	**SL2.2** Read the latest research in bioseparations methods
	SO2.3 Explain the working mechanism of CSTRs fermenter, Monod equation for chemostat, Monod Kinetics	**LI2.3** To perform the cell disruption technique using physical, chemical and biological methods	**CI2.3** Design equation for CSTRs fermenter	**SL2.3** Write down few points on biological product's properties
	SO2.4 Explain Monod equation for chemostat		**CI2.4** Monod equation for chemostat	
	SO2.5 Explain Monod Kinetics		**CI2.5** Monod Kinetics	
	SO2.6 Explain Loop Bioreactor, Bubble column Bioreactor		**CI2.6** Loop Bioreactor, Bubble column Bioreactor	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Describe Biosynthetic pathway for Acetone, Butanol and Ethanol derived fermentation
	SW2.2 Mini Project	Make a project on different kinds of Amino acids, their structure and functions
	SW2.3 Other Activities (Specify)	Make Power point presentation on Distillation as Unit operations

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	06	01	02	15

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO2-98BT603.3 Interpretate the different experimental data on reaction rate related to reactor engineering principles	**SO3.1** Elucidate the application of various kinds of separation process	**LI3.1** To perform the microbial production of Secondary metabolites using shake flask fermentation method	**CI3.1** Law of mass action, Rate equation, elementary, non elementary reaction and their mechanism	**SL3.1** Derive the numerical problems associated with Elementary and Non-Elementary reactions
	SO3.2 Derive the mathematical expression for centrifugal sedimentation	**LI3.2** To observe the growth of microbial biomass and calculate its kinetics using graph	**CI3.2** Theories of reaction rate and temperature dependency	**SL3.2** Derive the numerical problems associated with experimental reactor data
	SO3.3 Analyze the partition coefficient associated with phase extraction	**LI3.3** To determine the production of weak organic acids through fermentation	**CI3.3** Analysis of experimental reactor data	
	SO3.4 Evaluation of rate equation, Integral and differential analysis for constant and variable volume system		**CI3.4** Evaluation of rate equation, Integral and differential analysis for constant and variable volume system	
	SO3.5 Evaluate Numerical problem associated with rate of reaction		**CI3.5** Fitting of data to complex reaction mechanism, Numerical problems	

Item	Cl	LI	SW	SL	Total
Approx. Hrs	05	00	01	03	9

	SO3.6 Revision and assessment		**CI3.6** Revision and assessment	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Derive the equations for Rate of Reaction and 1st Order, 2nd Order reactions
	SW3.2 Mini Project	Describe the role of mass and heat transfer and its kinetics
	SW3.3 Other	Prepare one Power point presentation on "Reaction Kinetics of Various Fermentation Operations"

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO2-98BT603.4 Analyse the Transfer of Heat and Mass with its kinetics	**SO4.1** Elucidate the Mechanism of heat transfer, Equipment of heat transfer		**CI4.1** Mechanism of heat transfer, Equipment of heat transfer	**SL4.1** List down the different kinds of equipment used in heat exchangers
	SO4.2 Derive the Conduction, Heat transfer between fluids, Heat transfer coefficients, Overall Hear transfer coefficients		**CI4.2** Conduction, Heat transfer between fluids, Heat transfer coefficients, Overall Hear transfer coefficients	**SL4.2** Read the process of Heat transfer
	SO4.3		**CI4.3**	**SL4.3**

Item	Cl	LI	SW	SL	Total
Approx. Hrs	6	00	01	05	12

	Analyze the Design equation for Heat transfer, Calculations of Heat transfer coefficients		Design equation for Heat transfer, Calculations of Heat transfer coefficients	Find out the role of oxygen transfer in reactors
	SO4.4 Describe the Oxygen transfer methodologies in fermenter, Determination of oxygen transfer coefficient (Kla) Liquid –Liquid Mass transfer		**CI4.4** Oxygen transfer methodologies in fermenter, Determination of oxygen transfer coefficient (Kla) Liquid –Liquid Mass transfer	
	SO4.5 Interpretate the Factor affecting mass transfer and oxygen transfer		**CI4.5** Factor affecting mass transfer and oxygen transfer	
	SO4.6 Revision and assessment		**CI4.6** Revision and assessment	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Determine the working mechanism and applications of different kind of Vectors used in RDT
	SW4.2 Mini Project	Derive the Plant and Animal Cell Culture based metabolites having therapeutic applications
	SW4.3 Other Activities (Specify)	Make a Power point presentation for description of “Role of Host-vector system” in RDT for Bioprocessing

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO5-98BT603.5. Evaluate & Design numerical values for development of homogeneous reaction	**SO5.1** Elucidate the Internal mass transfer and steady state shell mass balance (assumption and derivation)		**CI5.1** Internal mass transfer and steady state shell mass balance (assumption and derivation)	**SL5.1** Find out the industrial applications of Chromatography
	SO5.2 Describe the Concentration profile for first order kinetics and spherical geometry		**CI5.2** Concentration profile for first order kinetics and spherical geometry	**SL5.2** Solve the numerical problems associated with Thiele Modulus
	SO5.3 Analyze the Concentration profile for zero order kinetics and spherical geometry		**CI5.3** Concentration profile for zero order kinetics and spherical geometry	**SL5.3** Solve the numerical problems associated with rate of reactions
	SO5.4 Analyze the Concentration profile for Michles-menten kinetics and spherical geometry		**CI5.4** Concentration profile for Michles-menten kinetics and spherical geometry	**SL5.4** Solve the numerical problems associated with Michalis-Menton kinetics
	SO5.5 Evaluate the Thiele modulus and effectiveness factor for first order, Zero order		**CI5.5** Thiele modulus and effectiveness factor for first order, Zero order	**SL5.5** Solve the numerical problems associated with heterogeneous reactions
	SO5.6 Evaluate the Michles-menten Kinetics, External mass transfer, Minimizing		**CI5.6** , External mass transfer, Minimizing mass transfer effect (internal and external	

	mass transfer effect (internal and external			

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Derive the numerical problems for Thiele modulus
	SW5.2 Mini Project	Describe the Michalis-Menton kinetics
	SW5.3 Other Activities (Specify)	Prepare one article on the "Heterogeneous Reactions and its Significance"

Course duration (in hours) to attain Course Outcomes:

Course Title: Bioreactor Design **Course Code:** 98BT603

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1-98BT603. Illustrate the terminologies associated with Bioreactor Design	6	8	3	1	18
CO2-98BT603. Explain the kinetics and mechanism of various types of reactors	6	6	3	1	16
CO3-98BT603.3. Interpretate the different experimental data on reaction rate related to reactor engineering principles	6	6	2	1	15
CO4-98BT603.4. Analyse the Transfer of Heat and Mass with its kinetics	6	0	3	1	10
CO5-98BT603.5. Evaluate & Design numerical values for development of heterogenous reaction	6	0	5	1	12
Total Hours	39	20	16	05	71

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

Course Title: Bioreactor Design **Course Code:** 98BT603

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
CO1-98BT603.1. Illustrate the terminologies associated with Bioreactor Design	2	1	1	1	5
CO2-98BT603.2. Explain the kinetics and mechanism of various types of reactors	2	4	5	1	12
CO3-98BT603.3. Interpretate the different experimental data on reaction rate related to reactor engineering principles	3	5	5	1	14
CO4-98BT603.4. Analyse the Transfer of Heat and Mass with its kinetics	2	3	5	1	11
CO5-98BT603.5. Evaluate & Design numerical values for development of heterogenous reaction	2	4	1	1	10
Total Marks	**11**	**17**	**17**	**05**	**50**

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

Suggested learning Resources:

Books:

S.No.	Title/Author/Publisher details
1	Pauline M. Doran, "Bioprocess engineering principles" : Acedemic press
2	James E. Bailey & David F. Ollis- Biochemical engineering fundamentals
3	J.C. Janson And L. Ryden, (Ed.) – Protein Purification – Principles, High Resolution Methods and Applications, VCH Pub. 1989.
4	Peter F. Stanbury, Allan Whitekar, "Principles for fermentation technology"

Online Resources:

Suggested instructions/Implementation strategies:

Improved lecture

Tutorial
Case method
Group Discussion
Role play
Visit to Beverage producing plants & Distillery/Fermenter units
Demonstration
ICT Based teaching Learning
Brainstorming

CO, PO and PSO Mapping

Program Name: B. Tech. Biotechnology

Semester: 6th Semester

Course Title: Bioreactor Design

Course Code: 98BT603

CO/PO/PSO Mapping			
Course Outcome (Cos)	**Program Outcomes (POs)**		**Program Specific Outcomes (PSOs)**

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1-56MB303.1: Describe the fundamentals of Industrial Microbiology and Fermentation Technology	2	-	-	1	2	1	2	2	1
CO2-56MB303.2: Define the role of microbiology for the production of desired bioproducts	-	-	1	1	-	1	1	1	2
CO3-56MB303.3: Elaborate the working mechanism of upstream and downstream processing	1	1	1	1	-	1	1	1	1
CO4-56MB303.4: Interpretate the mechanism of fermentation process in industry	-	1	1	-	2	1	1	1	3
CO5-56MB303.5: Examine the mechanism of biological product development using microbes	1	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 1,2,3,4,5,6 PSO 1,2, 3	**CO1-98BT603.1.** Illustrate the terminologies associated with Bioreactor Design	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6	**LI 1** **LI 2** **LI 3** **LI 4**	1.1,1.2,1.3,1.4,1.5, 1.6	**1SL-1,2,3**

PO 1,2,3,4,5,6 PSO 1,2, 3	**CO2-98BT603.2.** Explain the kinetics and mechanism of various types of reactors	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6	**LI 1** **LI 2** **LI 3**	2.1, 2.2, 2.3,2.4,2.5,2.6	**2SL-1,2,3**
PO 1,2,3,4,5,6 PSO 1,2, 3	**CO3-98BT603.3.** Interpretate the different experimental data on reaction rate related to reactor engineering principles	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6	**LI 1** **LI 2** **LI 3**	3.1,3.2,3.3,3.4,3.5, 3.6	**3SL-1,2**
PO 1,2,3,4,5,6 PSO 1,2, 3	**CO4-98BT603.4.** Analyse the Transfer of Heat and Mass with its kinetics	SO4.1 SO4.2 SO4.3 SO4.4 SO5.5 SO5.6		4.1,4.2,4.3,4.4, 4.5, 4.6	**4SL-1,2,3**
PO 1,2,3,4,5,6 PSO 1,2, 3	**CO5-98BT603.5.** Evaluate & Design numerical values for development of heterogenous reaction	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-1,2,3,4,5**

Program Name	**Bachelor of Technology (B.Tech.)- Biotechnology**	
Semester	VI	
Course Code:	98BT604	
Course title:	Waste Treatment	**Curriculum Developer**: Er. Arpit Srivastava, Assistant Professor
Pre-requisite:	Students should have basic knowledge of environmental science	
Rationale:	The course content aims to make the student understand how biotechnology can help in monitoring or removing the pollutants and developing an understanding of new trends such as biofuels, renewable energy sources, or development of stress-tolerant plants which can minimize the harmful impact of pollutants thereby making the planet earth a better dwelling place. Students will gain knowledge about how to maintain the environment. They will also gain the knowledge to use biotechnology for waste management, bioremediation, and green energy.	
Course Outcomes (COs):	**CO1-98BT604.1.** Identify different strategies of Waste treatment and its management **CO2-98BT604.2.** Apply technical methods to get best out of waste **CO3-98BT604.3.** Analyze various equipment used in anaerobic waste treatment **CO4-98BT604.4.** Design effective strategies to implement metabolic flux to determine metabolic pathways **CO5-98BT604.5.** Describe, design and develop systematic approach to remediate waste using technical advancement	

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)	98BT604	Waste Treatment	2	2	1	3	8	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	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)		

			(CA)							
PC	98BT604	Waste Treatment	**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	98BT654	Waste Treatment	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	6	06	01	05	18

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO1-98BT604.1. Identify different strategies of Waste treatment and its management	**SO1.1** Explain concept of waste treatment	**LI1.1** To make a report on Waste treatment and management plan for any district of your choice	**Unit-1** **CI1.1** Waste; Treatment of waste and its importance	**SL1.1** Find out some examples of waste
	SO1.2 Define Basic terminology, scope and application for waste	**LI1.2** Identify the types of pollutants present in drinking water	**CI1.2** Types and Sources of solid and hazardous wastes	**SL1.2** Explore conventional papers on waste management
	SO1.3 Elaborate the scientific applications of hazardous waste	**LI1.3** Prepare a report on different types of agricultural waste produces in your surrounding	**CI1.3** hazardous wastes, and biomedical wastes; other types of waste	**SL1.3** Write down few points on applications of waste treatment
	SO1.4		**CI1.4**	**SL1.4**

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	04	01	04	15

	Define waste generation rates		Waste generation rates, Composition; Characteristics	Write down few points on recycle
	SO1.5 Elaborate the process of waste generation in food industries		**CI1.5** Waste generation from food industries	**SL1.5** Collect information on career in waste treatment
	SO1.6 Revision and assessment		**CI1.6** Revision and assessment	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Describe in detail about the role of "Generation of Waste in India"
	SW1.2 Mini Project	Elaborate the role of 3Rs
	SW1.3 Other Activities (Specify)	Draw a flowchart compiling all procedures used in waste management

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO2-98BT604.2. Apply technical methods to get best out of waste	**SO2.1** Explain concept of downstream processing	**LI2.1** Demonstrate the working of waste segregation and handling	**Unit-2** **CI2.1** Handling, Segregation, Storage and collection of waste	**SL2.1** Find out the process followed in your district for waste handling and segregation
	SO2.2	**LI2.2**	**CI2.2**	**SL2.2**

	Relate the concept of how physical and biological separation can be done	To perform the experiment of production of microbial biomass	Treatment of biomedical waste	Read the latest research in innovations in composting
	SO2.3 Outline the steps of converting glucose to ethanol		**CI2.3** Composting, thermal conversion technologies, energy recovery	**SL2.3** Write down few points on energy recovery from waste
	SO2.4 Define the mechanism of biomass		**CI2.4** Incineration, solidification and stabilization of hazardous wastes	**SL2.4** Find out the different kinds of incinerators and write about them
	SO2.5 Explain the role of Modelling Metabolism		**CI2.5** Biological and chemical conversion technologies	
	SO2.6 Revision and assessment		**CI2.6** Revision and assessment	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Describe the role of agricultural Biomass in Energy recovery
	SW2.2 Mini Project	Make a project on bioconversion of agricultural waste for the production of waste
	SW2.3 Other Activities (Specify)	Make a Power point presentation on Composting and Thermal conversion of waste

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	04	01	03	14

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO3-98BT604.3. Analyz various equipment used in anaerobic waste treatment	**SO3.1** Define the the role of landfills	**LI3.1** To design a landfill with all details and labelling	**Unit-3** **CI3.1** Design and operation of sanitary landfills, secure landfills and landfill bioreactors	**SL3.1** Find out how many landfills are present in your district and of which type they are
	SO3.2 Derive the process of landfill monitoring	**LI3.2** To determine the BOD of various water samples	**CI3.2** Landfill closure and environmental monitoring; remediation	**SL3.2** Read the process of BOD is calculated for a given sample
	SO3.3 Distinguishes the types of landfills and its working		**CI3.3** Landfills; types; mechanism; site selection	**SL3.3** Write down the steps followed in Effluent Treatment Plant
	SO3.4 Derive the mathematical modelling of BOD		**CI3.4** Mathematical modelling of BOD & kinetics	
	SO3.5 Explain the treatment process in ETP		**CI3.5** Waste Water Treatment (ETP)	
	SO3.6 Revision and assessment		**CI3.6** Revision and assessment	

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	02	01	04	13

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Derive the equations for Michalis Menten theory of Enzyme Substrate complex
	SW3.2 Mini Project	Write an article on Global Control at whole Cell level
	SW3.3 Other Activities (Specify)	Prepare one Power point presentation on "Effluent Treatment Plant"

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO4-98BT604.4 Design effective strategies to implement waste management	**SO4.1** Distinguish among different types of waste water	**LI4.1** To perform the Oil separation method using aqueous two-phase extraction method	**Unit-4** **CI4.1** Sources and types of industrial wastewater, Environmental impacts	**SL4.1** Find out the methods to separate oil from water
	SO4.2 Distinguish among different methodologies used in waste treatment		**CI4.2** Neutralization, Oil separation, Flotation, Precipitation	**SL4.2** Write down some more examples of Heavy metals contamination
	SO4.3		**CI4.3** Heavy metal Removal, adsorption, Chemical oxidation	**SL4.3**

Item	Cl	LI	SW	SL	Total
Approx. Hrs	6	04	01	05	16

	Analyze the working of Heavy metal Removal, adsorption, Chemical oxidation			List down the different organic pollutants present in natural substances
	SO4.4 Derive the process of ozonation, evaporation and other methods		**CI4.4** Ozonation, Photocatalysis, Wet Air Oxidation – Evaporation	**SL4.4** List down the steps involve in membrane separations
	SO4.5 Derive the mechanism of ion exchange, membrane processing		**CI4.5** Ion Exchange, Membrane Technologies	
	SO4.6 Revision and assessment		**CI4.6** Revision and assessment	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Determine the working mechanism and applications of Photocatalysis
	SW4.2 Mini Project	Derive the working mechanism of membrane separation technologies
	SW4.3 Other Activities (Specify)	Make a presentation on heavy metal contamination and its bioremediation processing

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO5-98BT604.5. Describe, design and develop systematic approach to remediate waste using technical advancement	**SO5.1** Elucidate Anaerobic process of digestion	**LI5.1** To perform the process of anaerobic digestion	**Unit-5** **CI5.1** Fundamentals of anaerobic treatments; Anaerobic digestion	**SL5.1** Explore Anaerobic digestion
	SO5.2 Distinguish among Sedimentation and thickening in waste treatment	**LI5.2** To remediate the contaminations from water sample using natural adsorbents	**CI5.2** Sedimentation and Thickening	**SL5.2** Write a report on gravity-based separation of waste
	SO5.3		**CI5.3**	**SL5.3**

	Analyz the working of anaerobic lagoons		Anaerobic lagoons	Prepare a report on air pollution in your locality and the air quality index
	SO5.4 Describe the Waste generation from different industries		**CI5.4** Waste generation from different industries	**SL5.4** List down the surrounding industries and type of waste they generate
	SO5.5 Interpret design considerations of Anaerobic reactors		**CI5.5** General design considerations, of Anaerobic reactors	**SL5.5** List down the various types of anaerobic lagoons found in India
	SO5.6 Revision and assessment		**CI5.6** Revision and assessment	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Explain general mechanism of Anaerobic digestion and products associated with it
	SW5.2 Mini Project	Describe the applications of Anaerobic reactors and its design
	SW5.3 Other Activities (Specify)	Prepare one article on the "Biogas Production mechanism and its distribution in India"

Course duration (in hours) to attain Course Outcomes:

Course Title: Waste Treatment **Course Code:** 98BT604

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1-98BT604.1. Identify different strategies of Waste treatment and its management	6	6	5	1	18
CO2-98BT604.2. Apply technical methods to get best out of waste	6	4	4	1	15
CO3-98BT604.3. Analyze various equipment used in anaerobic waste treatment	6	4	3	1	14
CO4-98BT604.4. Design effective strategies to implement waste management	6	2	4	1	13

CO5-98BT604.5. Describe, design and develop systematic approach to remediate waste using technical advancement	6	4	5	1	16
Total Hours	30	20	21	05	76

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

Course Title: Waste Treatment **Course Code:** 98BT604

Course Outcomes	**Marks Distribution**				**Total Marks**
	A	**An**	**E**	**C**	
CO1-98BT604.1. Identify different strategies of Waste treatment and its management	2	1	1	1	5
CO2-98BT604.2. Apply technical methods to get best out of waste	2	4	5	1	12
CO3-98BT604.3. Analyze various equipment used in anaerobic waste treatment	3	5	5	1	14
CO4-98BT604.4. Design effective strategies to implement waste management	2	3	5	1	11
CO5-98BT604.5. Describe, design and develop systematic approach to remediate waste using technical advancement	5	4	1	0	10
Total Marks	**14**	**17**	**17**	**04**	**52**

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

Suggested learning Resources:

Books:

S.No.	**Title/Author/Publisher details**
1	S.K.Garg (2004) Environmental Engineering (Vol I & II) Khanna publishers
2	Marcos Von Sperling (2007), Waste Water Characteristics, Treatment and Disposal, Biological Waste Water Treatment, Serie I, Iwa Publishing (Intl water Association).
3	Eckenfelder, W.W., (1999). Industrial Water Pollution Control, (3rd Ed) McGraw-Hill.

Online Resources:

Suggested instructions/Implementation strategies:

Improved lecture
Tutorial
Case method
Group Discussion
Role play
Visit to Waste water/Effluent Treatment plant and downstream pharmaceutical plants
Demonstration
ICT Based teaching Learning
Brainstorming

CO, PO and PSO Mapping

Program Name: B. Tech. Biotechnology

Semester: VI Semester

Course Title: Waste Treatment

Course Code: 98BT604

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**
CO1-98BT604.1. Identify different strategies of Waste treatment and its management	-	1	-	1	2	2	3	-	3	2	2	3	1	1	2
CO2-98BT604.2. Apply technical methods to get best out of waste	-	1	-	-	1	-	3	1	2	2	3	3	2	-	2
CO3-98BT604.3. Analyze various equipment used in anaerobic waste treatment	-	1	1	1	-	1	1	-	2	1	1	2	3	2	-
CO4-98BT604.4. Design effective strategies to implement waste management	1	-	1	-	2	2	2	3	-	1	3	3	2	1	3
CO5-98BT604.5. Describe, design and develop systematic approach to remediate waste using technical advancement	1	-	1	2	-	2	3	2	1	2	2	2	1	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 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO1-98BT604.1.** Identify different strategies of Waste treatment and its management	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6	**LI 1** **LI 2** **LI 3**	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	**CO2-98BT604.2.** Apply technical methods to get best out of waste	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6	**LI 1** **LI 2**	2.1, 2.2, 2.3, 2.4, 2.5, 2.6	**2SL-1,2,3,4**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO3-98BT604.3.** Analyze various equipment used in anaerobic waste treatment	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6	**LI 1** **LI 2**	3.1,3.2,3.3,3.4,3.5, 3.6	**3SL-1,2,3**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO4-98BT604.4.** Design effective strategies to implement waste management	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5,SO4.6	**LI 1**	4.1,4.2,4.3,4.4, 4.5,4.6	**4SL-1,2,3,4**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO5-98BT604.5.** Describe, design and develop systematic approach to remediate waste using technical advancement	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6	**LI 1** **LI 2**	5.1,5.2,5.3,5.4,5.5,5.6	**5SL-1,2,3,4,5**

Program Name	**Bachelor of Technology (B.Tech.)- Biotechnology**	
Semester	VI	
Course Code:	**98BT605**	
Course title:	Genomics and Proteomics	**Curriculum Developer**: Sonal Gupta, Assistant Professor
Pre-requisite:	Students should have basic knowledge of biochemistry, molecular biology and bioinformatics	
Rationale:	Genomics is an entry point for looking at the other 'omics' sciences. Genomics provides an overview of the complete set of genetic instructions provided by the DNA, while transcriptomics looks into gene expression patterns. Proteomics studies dynamic protein products and their interactions. An application of proteomics is known as protein "expression profiling" where proteins are identified at a certain time in an organism as a result of the expression to a stimulus. Proteomics can also be used to develop a protein-network map where interaction among proteins can be determined for a particular living system.	
Course Outcomes (COs):	**CO1 98BT605**. Understand about the fundamentals of genomics and proteomics **CO2 98BT605** Outline the next-generation sequencing techniques **CO3 98BT605**. Apply analytical approach to identify protein structures **CO4 98BT605**. Analyse vaccine designing and protein-ligand interactions for drug discovery **CO5 98BT605**. Compare various databases and software used in proteomics	

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)	
ProgramCommon (PC)	98BT605	Genomics and Proteomics	3	2	1	3	9	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 (CAT)	Class Attendance (AT)	Total Marks (CA+CT+CAT+SA+AT)		

PC	98BT605	Genomics and Proteomics	**15**	**20**	**5**	**5**	**5**	**50**	**50**	**100**

Course-Curriculum:

<table>
<tr>
<td>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.</td>
<td>Approximate Hours
<table>
<tr><td>Item</td><td>Cl</td><td>LI</td><td>SW</td><td>SL</td><td>Total</td></tr>
<tr><td>Approx. Hrs</td><td>09</td><td>04</td><td>01</td><td>05</td><td>19</td></tr>
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Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-98BT605.1 Understand about the fundamentals of genomics	**SO1.1** An introduction of genomics	**LI1.1** List the basic software used for genomic study	**Unit-1** **Introduction of genomics** **CI1.1** Genomics: History, types and scope in modern biotechnology	**SL1.1** Find out some examples softwares used for genome assembly
	SO1.2 Describe various DNA sequencing methods: Manual methods	**LI1.2** Make a comparative chart of various DNA sequencing methods	**CI1.2** Elaborate Sanger and Maxam Gilbert method of DNA sequencing	**SL1.2** Explain the manual methods of DNA sequencing
	SO1.3		**CI1.3** Study pyrosequencing and other next generation	**SL1.3** Write down stepwise methodology of shotgun

	Elaborate the automated methods of DNA sequencing		platforms of automated DNA sequencing	sequencing method of genome sequencing
	SO1.4 Define the shot gun method of genome sequencing		**CI1.4** Explain the detailed principle and methodology of shot gen method of whole genome sequencing	**SL1.4** Write an overview on genomics and its types
	SO1.5 Describe hierarchical method of genome sequencing		**CI1.5** Explain the principle and stepwise methodology of hierarchical method of genome sequencing	**SL1.5** Collect information on next generation sequencing methods
	SO1.6 Elaborate various computational tool used for genome sequencing		**CI1.6** Study the software or computational platform used for genome sequencing	
	SO1.7 Explain Genome sequence assembly software		**CI1.7** Study various software used for alignment of genome sequences during whole genome projects	
	SO1.8 Revision		**CI1.8** Revision	
	SO1.9 Assessment		**CI1.9** Assessment	

	SW1.1 Assignments	Describe the role of bioinformatics and computational biology in genomics

Suggested Sessional Work (SW): *anyone*	**SW1.2** Mini Project	Differentiate between shot gun and hierarchical method of genome sequencing
	SW1.3 Other Activities (Specify)	Draw a flowchart compiling all steps of Sanger and Maxam Gilbert methods of DNA sequencing

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)**
CO2-98BT605.2. Outline the next-generation sequencing techniques	**SO2.1** Explain web-based server	**LI2.1** Make a list of various browsers used for genome analysis	**Unit-2** **Managing and Distributing Genome Data**	**SL2.1** Find out all the browser used to search genomic database

			CI2.1 Describe web-based servers and softwares used for genome analysis: ENSEMBL, VISTA, UCSC	
	SO2.2 Describe various browser used for genome analysis	**LI2.2** Make a chart of first, second and next generation sequencing platforms	**CI2.2** Explain different Genome Browser, NCBI genome	**SL2.2** Read the latest research in genome sequencing
	SO2.3 Describe various genomic database		**CI2.3** Biological database: definition, types, databases for genomic studies	**SL2.3** Write down a note on genome database
	SO2.4 Define the model organisms used for genomic studies		**CI2.4** Elaborate various model organisms	**SL2.4** Find out the different kinds of platforms used for genome sequencing projects
	SO2.5 Explain the first-generation sequencing platforms		**CI2.5** Describe different platforms used for first generation sequencing: Sanger DNA sequencing	
	SO2.6 Explain second generation sequencing platforms		**CI2.6** Elaborate second generation sequencing platform: Roche 454 FLX system – Illumina Solexa and SoLiD	
	SO2.7		**CI2.7**	

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	04	01	03	17

	Describe Next generation sequencing platforms		Explain next generation sequencing and various platforms used for NGS	
	SO2.8 different types of NGS platforms		**CI2.8** different types of NGS platforms	
	SO2.9 Revision and assessment		**CI2.9** Revision and assessment	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Describe browsers and servers used for genomic studies
	SW2.2 Mini Project	Make a comparative chart on genomic databases
	SW2.3 Other Activities (Specify)	Make a power point presentation on "Next Generation Sequencing".

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO3-98BT505.3 Apply analytical approach to identify protein structures	SO3.1: Understand the basic structure of proteins	LI3.1: SDS-PAGE for Protein Size Determination	CI3.1: Introduction to Protein Structure	SL3.1: Study of protein structures
	SO3.2: Learn about the chemical properties of proteins	LI3.2: Native PAGE for Protein Structure Analysis	CI3.2: Chemical Properties of Proteins	SL3.2: Research on chemical properties of proteins

	SO3.3: Understand the role of physical interactions in proteins		CI3.3: Physical Interactions in Proteins	SL3.3: Study of protein physical interactions
	SO3.4: Learn about short-range interactions in proteins		CI3.4: Short-Range Interactions in Proteins	
	SO3.5: Understand electrostatic forces in proteins		CI3.5: Electrostatic Forces in Proteins	
	SO3.6: Study Van der Waals interactions in proteins		CI3.6: Van der Waals Interactions in Proteins	
	SO3.7: Learn about hydrogen bonds in proteins		CI3.7: Hydrogen Bonds in Proteins	
	SO3.8: Understand hydrophobic interactions in proteins		CI3.8: Hydrophobic Interactions in Proteins	
	SO3.9: Learn methods for determining protein sizes		CI3.9: Methods for Determining Protein Sizes	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Describe the properties of proteins
	SW3.2 Mini Project	Describe the role of SDS PAGE in proteomic studies
	SW3.3 Other Activities (Specify)	Prepare one Power point presentation on “Proteomics”

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	04	01	03	17

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO4-98BT605.4 Compare various databases and software used in proteomics	SO4.1: Understand the introduction and scope of proteomics	LI4.1: Two-dimensional PAGE for Proteome Analysis	CI4.1: Introduction and Scope of Proteomics	SL4.1: Study of various applications of proteomics
	SO4.2: Learn about ion-exchange chromatography	LI4.2: Isoelectric Focusing (IEF) of Proteins	CI4.2: Protein Separation Techniques: Ion-Exchange Chromatography	SL4.2: Research on ion-exchange chromatography
	SO4.3: Understand size-exclusion chromatography		CI4.3: Protein Separation Techniques: Size-Exclusion Chromatography	SL4.3: Study of size-exclusion chromatography
	SO4.4: Learn about affinity chromatography techniques		CI4.4: Protein Separation Techniques: Affinity Chromatography	
	SO4.5: Understand polyacrylamide gel electrophoresis		CI4.5: Polyacrylamide Gel Electrophoresis (PAGE)	
	SO4.6: Learn about isoelectric focusing (IEF)		CI4.6: Isoelectric Focusing (IEF)	
	SO4.7: Study two-dimensional PAGE for proteome analysis		CI4.7: Two-Dimensional PAGE for Proteome Analysis	
	SO4.8: Understand image analysis of 2D gels		CI4.8: Image Analysis of 2D Gels	

	SO4.9: Learn about in-silico analysis of proteins		CI4.9: In-Silico Analysis of Proteins	

Item	Cl	LI	SW	SL	Total
Approx. Hrs	9	04	01	05	19

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Describe the working principle of chromatographic techniques and their applications in protein studies
	SW4.2 Mini Project	Read research articles on recent advancements in proteomics
	SW4.3 Other Activities (Specify)	Make a presentation on 2D PAGE

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO5-98BT605.5 Design novel proteins and predict their annotative functionality through NMR	**SO5.1** Introduction to mass spectrometry.	**LI5.1** Make a list of protein databases used for proteomic studies	**Unit-5** **CI5.1** Mass spectrometery: principle, instrumentation and application in proteome study	**SL5.1** Find out the industrial applications of functional proteomics
	SO5.2 Explain strategies for protein identification	**LI5.2** To perform the SDS-PAGE analysis of the given protein	**CI5.2** Describe various techniques used for protein identification	**SL5.2** List down various steps of protein engineering
	SO5.3 Explain Protein sequencing		**CI5.3** Describe different methods of protein sequencing	**SL5.3** An overview on Mass spectrometery
	SO5.4 Elaborate Protein modifications		**CI5.4**	**SL5.4** Explain different kinds of protein modifications
	SO5.5 Elaborate Protein-protein interaction (Two hybrid interaction screening)		**CI5.5** Describe protein-protein interaction and two hybrid method to detect protein-protein interaction	**SL5.5** List down the various bioinformatics-based server/tool and databases

				that assist in study of protein/proteomics
	SO5.6 Proteomics and Applications of proteomics		**CI5.6** Define functional proteomics; Clinical and biomedical application of proteomics, proteome analysis for drug designing	
	SO5.7 Describe different proteome database		**CI5.8** Study the various databases used for proteomic studies	
	SO5.8 Describe Protein engineering		**CI5.8** Elaborate detailed strategy of protein engineering	
	SO5.9 What is protein chip and its role in proteomic studies		**CI5.9** Explain Protein chips	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Explain general strategy of protein engineering
	SW5.2 Mini Project	Describe various applications of proteomic studies
	SW5.3 Other Activities (Specify)	Prepare one article on the "Mass spectrometery"

Course duration (in hours) to attain Course Outcomes:

Course Title: Genomics and Proteomics **Course Code:** 98BT605

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1 98BT605. Understand about the fundamentals of genomics and proteomics	9	04	05	01	19
CO2 98BT605 Outline the next-generation sequencing techniques	9	04	04	01	18
CO3 98BT605. Apply analytical approach to identify protein structures	9	04	03	01	17
CO4 98BT605. Analyse vaccine designing and protein-ligand interactions for drug discovery	9	04	03	01	17
CO5 98BT605. Compare various databases and software used in proteomics	9	04	03	01	17
Total Hours	45	20	18	5	88

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

Course Title: Genomics and Proteomics **Course Code:** 98BT605

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
CO1 98BT605. Understand about the fundamentals of genomics and proteomics	2	1	1	1	5
CO2 98BT605 Outline the next-generation sequencing techniques	2	4	5	1	12
CO3 98BT605. Apply analytical approach to identify protein structures	3	5	5	1	14
CO4 98BT605. Analyse vaccine designing and protein-ligand interactions for drug discovery	2	3	5	1	11
CO5 98BT605. Compare various databases and software used in proteomics	5	4	1	0	10
Total Marks	**14**	**17**	**17**	**04**	**52**

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

Suggested learning Resources:

Books:

S.No.	Title/Author/Publisher details
1	Genes IX by Benjamin Lewin, Johns and Bartlett Publisher, 2006.
2	Modern Biotechnology, 2nd Edition, S.B. Primrose, Blackwell Publishing, 1987.
3	Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition, B.R. Glick, J.J. Pasternak and C.L. Patten, 2010.
4	Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III, 1989.
5	Principles of Gene Manipulation 6th Edition, S.B.Primrose, R.M.Twyman and R.W. Old. Blackwell Science, 2001.
6	Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
7	Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.

Online Resources:

Suggested instructions/Implementation strategies:

Improved lecture
Tutorial
Case method
Group Discussion
Role play
Visit to Waste water/Effluent Treatment plant and downstream pharmaceutical plants
Demonstration
ICT Based teaching Learning
Brainstorming

CO, PO and PSO Mapping

Program Name: B. Tech. Biotechnology

Semester: VI Semester

Course Title: Genomics and Proteomics

Course Code: 98BT605

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 98BT605. Understand about the fundamentals of genomics and proteomics	-	1	-	1	2	2	3	-	3	3	3	3	1	2	1
CO2 98BT605 Outline the next-generation sequencing techniques	-	-	-	-	-	-	2	-	3	2	3	3	3	-	2

CO3 98BT605. Apply analytical approach to identify protein structures	-	-	1	1	-	-	3	-	3	1	-	-	1	2	-
CO4 98BT605. Analyse vaccine designing and protein-ligand interactions for drug discovery	1	-	1	-	2	-	2	3	-	1	-	1	2	1	3
CO5 98BT605. Compare various databases and software used in proteomics	1	1	1	-	-	2	3	3	1	2	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 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO1 98BT605**. Understand about the fundamentals of genomics and proteomics	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**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO2 98BT605** Outline the next-generation sequencing techniques	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9	**LI 1** **LI2**	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9	**2SL-1,2,3,4**

PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO3 98BT605**. Apply analytical approach to identify protein structures	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO2.7 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**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO4 98BT605**. Analyse vaccine designing and protein-ligand interactions for drug discovery	SO4.1 SO4.2 SO4.3 SO4.4 SO 4.5 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**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO5 98BT605**. Compare various databases and software used in proteomics	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**

Program Name	**Bachelor of Technology (B.Tech.)- Biotechnology**	
Semester	VI	
Course Code:	98BT606-B	
Course title:	Vaccine Technology	**Curriculum Developer**: Er. Arpit Srivastava, Assistant Professor
Pre-requisite:	Students should have basic knowledge of immunology and vaccines	

Rationale:	Vaccines are one of the most important discoveries in the history of Medicine. These biological preparations have been highly successful in preventing infectious diseases, significantly reducing the incidence of childhood diseases and mortality. Importance of Designing New Vaccine - Vaccine "teach" your body to defend itself from pathogens like viruses and bacteria. There are numerous viruses and bacteria discovered which can be potential disease-causing agents to Humans. To tackle these potential threats effective vaccines are required. This course will help students to explore new horizons of innovations in Vaccine designing domain.
Course Outcomes (COs):	**CO1-98BT606-B.1.** Explain fundamental principles of vaccine science and its role in biotechnology **CO2-98BT606-B.2.** Outline the effects of Vaccine over immunity **CO3-98BT606-B.3.** Identify novel strategies for vaccine design and preservation **CO4-98BT606-B.4.** Examine methods to test the concentration of vaccine **CO5-98BT606-B.5.** Predict, Design and Compare different vaccines the basis of its production

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)**	
ProgramElective (PE)	98BT606-B	Vaccine Technology	3	2	1	3	9	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	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)		

			(CA)							
PE	98BT606-B	Vaccine Technology	**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)		
PE	98BT656-B	Vaccine Technology	35	5	5	5	50	50	50

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)
CO1-98BT606-B.1. Explain fundamental principles of vaccine science and its role in biotechnology	**SO1.1** Explain the concept of Vaccines	**LI1.1** Draw the steps followed in prokaryotic /eukaryotic glycolysis pathways	**Unit-1** **CI1.1** Introduction to Vaccines	**SL1.1** Find out some conventional examples of Indian vaccines
	SO1.2 Define Basic terminology, scope and application for Vaccines	**LI1.2** Draw the steps followed in prokaryotic /eukaryotic TCA pathway	**CI1.2** Terminologies associated with Vaccines	**SL1.2** Explore conventional papers on Vaccines
	SO1.3 Elaborate the Historical Aspects of Vaccines	**LI1.3** To understand the production and consumption of ATPs involve in glycolysis and TCA cycle	**CI1.3** Historical Aspects of Vaccine	**SL1.3** Write down few points on applications of Vaccine deign
	SO1.4 Observe the Applications associated with vaccines		**CI1.4** Importance and Applications: Vaccines	**SL1.4** Write down few points on Applications of Vaccines
	SO1.5 Describe types of VAccines		**CI1.5** Vaccines and its types	**SL1.5** Collect information on career in “Vaccinomics”
	SO1.6 Discuss Role of Vaccines in today’s medical world		**CI1.6** Role of Vaccines in today’s medical world	
	SO1.7		**CI1.7**	

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	04	01	05	19

	Illustrate the Improvisations in Vaccines development		Improvisations in Vaccines development	
	SO1.8 Discuss the Indian scenario with respect to Vaccines		**CI1.8** Vaccines – Indian Scenario	
	SO1.9 Revision and assessment		**CI1.9** Revision and assessment	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Describe in detail about "Significance of Indian Vaccines"
	SW1.2 Mini Project	Elaborate the role of Innate Immunity
	SW1.3 Other Activities (Specify)	Draw a flowchart of Adaptive immunity

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO2-98BT606-B.2. Outline the effects of Vaccine over immunity	**SO2.1** Explain concept of Bacterial and Viral vaccines	**LI2.1** Demonstrate the working of Cell Disruption technique	**Unit-2** **CI2.1**	**SL2.1** Find out more conventional cell disruption techniques

			Overview of bacterial and viral vaccines and their importance to public health	
	SO2.2 Illustrate the mechanism behind Diphtheria based Vaccines	**LI2.2** To perform the experiment of production of microbial biomass	**CI2.2** Epidemiology and pathophysiology of vaccine preventable diseases with special emphasis on Diphtheria	**SL2.2** Read the latest research in bioseparations methods
	SO2.3 Illustrate the mechanism behind Titanus based Vaccines		**CI2.3** Epidemiology and pathophysiology of vaccine preventable diseases with special emphasis on Titanus	**SL2.3** Write down few points on biological product's properties
	SO2.4 Illustrate the mechanism behind Pertussis based Vaccines		**CI2.4** Epidemiology and pathophysiology of vaccine preventable diseases with special emphasis on Pertussis	**SL2.4** Find out the different kinds of filter aids and their role
	SO2.5 Explain the role of QC in Vaccine design		**CI2.5** Consistency approach for vaccine quality improvement	
	SO2.6 Discuss Role Antigens in Vaccine development		**CI2.6** Antigens used for immunizations of Equines and storage of antigens	
	SO2.7		**CI2.7**	

	Illustrate the Improvisations in Vaccines development by Adjuvants		Adjuvants used in immunization of Equines. Storage of adjuvants	
	SO2.8 Discuss dose preparation mechanisms		**CI2.8** Dose preparation for immunization of equines and immunization of equines for production of antisera	
	SO2.9 Revision and assessment		**CI2.9** Revision and assessment	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Describe the role of Macrophages and Autophagy
	SW2.2 Mini Project	Make a project on Indian Vaccines
	SW2.3 Other Activities (Specify)	Make Power point presentation on Immunoinformatic

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	04	01	03	17

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO3-98BT606-B.3. Identify novel strategies for vaccine design and preservation	**SO3.1** Define the Regulation of Enzymatic Activity, Models of Feedback inhibition	**LI3.1** To perform the Centrifugation process as Unit Operation	**Unit-3** **CI3.1** Manufacturing bleeding of equines for production therapeutic antisera, collection and separation of plasma	**SL3.1** Find out the process of Enzyme inhibition in human metabolism
	SO3.2 Derive the mechanism for Reinfusion of RBC's in equines	**Li3.2** To prepare the RBC plate for CFU	**CI3.2** Reinfusion of RBC's in equines	**SL3.2** Read the process of how Michalis Menten equation was derived
	SO3.3 Analyze the Processing of plasma for the production of therapeutic antisera		**CI3.3** Processing of plasma for the production of therapeutic antisera	**SL3.3** Write down the steps followed in Lac operon model
	SO3.4 Distinguish among the working mechanism of		**CI3.4** Antiserum Filtration: Important in Vaccine Development	

	different Antiserum Filtration techniques			
	SO3.5 Explain the role of Testing of venoms (in vivo & in vitro)		**CI3.5** Testing of venoms (in vivo & in vitro)	
	SO3.6 Discuss Testing of toxoid (in vivo & in vitro)		**CI3.6** Testing of toxoid (in vivo & in vitro)	
	SO3.7 Illustrate the Abnormal Toxicity testing mechanism		**CI3.7** Abnormal Toxicity testing: Important factor in vaccine development	
	SO3.8 Illustrate the Abnormal Sterility testing mechanism		**CI3.8** Sterility testing: Important factor in vaccine development	
	SO3.9 Revision and assessment		**CI3.9** Revision and assessment	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Describe the role of Adjuvants in Vaccines
	SW3.2 Mini Project	Make a project on RBC Infusion Protocol: Vaccine Development
	SW3.3 Other Activities (Specify)	Make Power point Different Testings used in Vaccine Development

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)**
CO4-98BT606-B.4. Examine methods to test the concentration of vaccine	**SO4.1** Distinguish among different nodes and branches in MFA	**LI4.1** To perform the Column Chromatography & Filtration process as Unit Operation for extraction of different compounds	**Unit-4** **CI4.1** Production of Proteus agglutinating suspension for Weil Felix Test	**SL4.1** Find out the types of classifications of nodes in MFA
	SO4.2 Distinguish among different theories of MFA	**LI4.2** to perform Weil Felix test	**CI4.2** Production of Vibrio cholera antisera	**SL4.2** Write down some more examples of Tissue dynamics
	SO4.3 Analyze the Preparation of absorbing suspension of V. Cholera		**CI4.3** Preparation of absorbing suspension of V. Cholera	**SL4.3** List down the role of MFA in metabolism
	SO4.4 Discuss the Filtration, preservation, labelling and storage of antisera		**CI4.4** Filtration, preservation, labelling and storage of antisera	**SL4.4** List down the steps involve in Lysine biosynthesis
	SO4.5 Interpret the mechanism for Immunization of rabbits		**CI4.5** Immunization of rabbits	
	SO4.6 Discuss Typhoid Antigen preparation		**CI4.6** Typhoid Antigen preparation	

	SO4.7 Illustrate the Production of *Salmonella* antisera		**CI4.7** Production of *Salmonella* antisera	
	SO4.8 Illustrate the Preparation of absorbing suspension of *Salmonella*		**CI4.8** Preparation of absorbing suspension of *Salmonella*	
	SO4.9 Revision and assessment		**CI4.9** Revision and assessment	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Determine the working mechanism and applications of Tissue Dynamics
	SW4.2 Mini Project	Derive the Qualitative and Quantitative data optimization and retrieval through MFA in isotopic labelling
	SW4.3 Other Activities (Specify)	Make a presentation on Lysine biosynthesis and its importance in metabolism

Item	Cl	LI	SW	SL	Total
Approx. Hrs	9	02	01	05	17

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO5-98BT606-B.5. Predict, Design and Compare different vaccines the basis of its production	**SO5.1** Elucidate the protocol for testing of Vaccines	**LI5.1** To determine the AA sequences comparison on the basis of peptide mapping using ProteoMapper (Server/tool)	**Unit-5** **CI5.1** Maintenance and use of national reference standards for testing of vaccines	**SL5.1** Explore amino acid metabolism in eukaryotes
	SO5.2 Interpret the role of animals in the quality control testing of vaccines		**CI5.2** Role of animals in the quality control testing of vaccines	**SL5.2** Write down the enzymes associated in glycolysis
	SO5.3 Describe the maintenance and handling of small laboratory animals during quality control testing		**CI5.3** Maintenance and handling of small laboratory animals during quality control testing	**SL5.3** List down various kinds of amino acids and their structures
	SO5.4		**CI5.4**	**SL5.4**

	Describe the Ethical Aspects and Issues in vaccine Design and Development		Ethical Aspects and Issues in vaccine Design and Development	List down the applications of CRISPR
	SO5.5 Describe Active viable air sampling of classified areas		**CI5.5** Active viable air sampling of classified areas by HI-AIR PETRITM AIR SAMPLING SYSTEM	**SL5.5** List down the various bioinformatics-based server/tool that assist in study of metabolism
	SO5.6 Explain the different types of reporting methods		**CI5.6** Preparation of results, documentation, reporting and maintenance of records	
	SO5.7 Discuss Quality control tests of antisera: Potency test.		**CI5.7** Quality control tests of antisera: Potency test.	
	SO5.8 Illustrate the Production of *COVID-19 Vaccine*		**CI5.8** Production of *COVID-19 Vaccine*	
	SO5.9 Illustrate the Preparation COVID-19 Vaccines – Indian Scenario. Discuss Immunoinformatics and Epitope Design		**CI5.9** COVID-19 Vaccines – Indian Scenario Immunoinformatics and Epitope Design: Dry Lab method in Vaccine designing	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Explain general mechanism behind Preparation of COVID-19 Vaccines
	SW5.2 Mini Project	Describe the applications of Vaccines
	SW5.3 Other Activities (Specify)	Prepare one article on the "Immunological Response of COVID-19 Vaccines"

Course duration (in hours) to attain Course Outcomes:

Course Title: Vaccine Technology **Course Code:** 98BT606-B

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)

CO1-98BT606-B.1. Explain fundamental principles of vaccine science and its role in biotechnology	9	6	5	1	21
CO2-98BT606-B.2. Outline the effects of Vaccine over immunity	9	4	5	1	19
CO3-98BT606-B.3. Identify novel strategies for vaccine design and preservation	9	4	3	1	17
CO4-98BT606-B.4. Examine methods to test the concentration of vaccine	9	4	4	1	18
CO5-98BT606-B.5. Predict, Design and Compare different vaccines the basis of its production	9	2	5	1	19
Total Hours	45	20	22	05	94

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

Course Title: Vaccine Technology **Course Code:** 98BT606-B

Course Outcomes	**Marks Distribution**				**Total Marks**
	A	**An**	**E**	**C**	
CO1-98BT606-B.1. Explain fundamental principles of vaccine science and its role in biotechnology	2	1	1	1	5
CO2-98BT606-B.2. Outline the effects of Vaccine over immunity	2	4	5	1	12
CO3-98BT606-B.3. Identify novel strategies for vaccine design and preservation	3	5	5	1	14
CO4-98BT606-B.4. Examine methods to test the concentration of vaccine	2	3	5	1	11
CO5-98BT606-B.5. Predict, Design and Compare different vaccines the basis of its production	5	4	1	0	10
Total Marks	**14**	**17**	**17**	**04**	**52**

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

Suggested learning Resources:

Books:

S.No.	Title/Author/Publisher details
1	Vaccines. 6th Edition, Stanley Plotkin Walter Orenstein Paul Offit.
2	New Generation Vaccines. Fourth Edition, Myrone M. Levine, Myron M. Levine, Gordon Dougan , Michael F. Good , Margaret A. Liu , Gary J. Nabel , James P. Nataro, Rino Rappuoli.
3	J.C. Janson And L. Ryden, (Ed.) – Protein Purification – Principles, High Resolution Methods And Applications, VCH Pub. 1989.
4	Fundamentals of Biochemistry. Author, JL Jain et al. Edition, reprint. Publisher, S. Chand Publishing, 2004.
5	Kuby Immunology. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis Kuby
6	"Biotechnology – Questioning The Reasons" – 2nd Edition, Arpit Srivastava, (2024), Book Rivers Publication - India

Online Resources:

Suggested instructions/Implementation strategies:

Improved lecture
Tutorial
Case method
Group Discussion
Role play
Visit to Waste water/Effluent Treatment plant and downstream pharmaceutical plants
Demonstration
ICT Based teaching Learning
Brainstorming

CO, PO and PSO Mapping

Program Name: B. Tech. Biotechnology

Semester: VI Semester

Course Title: Vaccine Technology

Course Code: 98BT606-B

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
CO1-98BT606-B.1. Explain fundamental principles of vaccine science and its role in biotechnology	-	1	-	1	2	2	3	-	3	2	2	3	1	2	1
CO2-98BT606-B.2. Outline the effects of Vaccine over immunity	-	1	-	-	1	-	3	1	2	2	3	3	2	-	2
CO3-98BT606-B.3. Identify novel strategies for vaccine design and preservation	-	1	1	1	-	-	1	-	2	1	1	2	3	2	-
CO4-98BT606-B.4. Examine methods to test the concentration of vaccine	-	-	1	-	2	2	3	3	-	1	3	3	2	1	3

CO5-98BT606-B.5. Predict, Design and Compare different vaccines the basis of its production	**1**	**-**	**1**	**2**	**-**	**2**	**3**	**3**	**1**	**2**	**2**	**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 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO1-98BT606-B.1.** Explain fundamental principles of vaccine science and its role in biotechnology	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8	**LI 1** **LI 2** **LI 3**	1.1,1.2,1.3,1.4,1.5, 1.6, 1.7, 1.8	**1SL-1,2,3,4,5**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO2-98BT606-B.2.** Outline the effects of Vaccine over immunity	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8	**LI 1** **LI 2**	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8	**2SL-1,2,3,4**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO3-98BT606-B.3.** Identify novel strategies for vaccine design and preservation	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8	**LI 1**	3.1,3.2,3.3,3.4,3.5, 3.6, 3.7, 3.8	**3SL-1,2,3**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO4-98BT606-B.4.** Examine methods to test the concentration of vaccine	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO1.7 SO1.8	**LI 1**	4.1,4.2,4.3,4.4, 4.5, 4.6, 4.7, 4.8	**4SL-1,2,3,4**
PO 1,2,3,4,5,6 7,8,9,10,11,12	**CO5-98BT606-B.5.** Predict, Design and Compare different vaccines the basis of its production	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6	**LI 1** **LI 2**	5.1,5.2,5.3,5.4,5.5, 5.6, 5.7, 5.8, 5.8, 5.9, 5.10	**5SL-1,2,3,4,5**

PSO 1,2, 3		SO5.7 SO5.8 SO5.9 SO5.10			

Program Name	**Bachelor of Technology (B. Tech)- Biotechnology**	
Semester	VI	
Course Code:	98BT607	
Course title:	Advance Bioanalytical Techniques	**Curriculum Developer**: Dr. Ashwini A. Waoo, Professor
Pre-requisite:	Student should have foundational knowledge in biology, chemistry, and analytical instrumentation. Additionally, familiarity with basic bioanalytical methods	
Rationale:	Students have acquired fundamental knowledge in biotechnology and related sciences. Introducing advanced bioanalytical techniques in the 6th semester allows students to deepen their understanding of analytical methods crucial for biotechnological research and industry applications. It equips them with practical skills necessary for addressing complex biological challenges and fosters their readiness for professional roles in biotechnology, pharmaceuticals, and research.	
Course Outcomes (COs):	**98BT607CO1-.1:** Students will be proficient in employing various microscopy techniques for detailed sample analysis and understand the principles behind high-throughput screening methods, **98BT607CO1-.2:** Students will grasp sequencing technology evolution and gain proficiency in diverse genomics research applications. **98BT607CO1-.3:** Students will master a diverse range of spectroscopic techniques, enhancing their analytical capabilities across scientific disciplines. **98BT607CO1-.4:** Students will develop expertise in chromatographic techniques, specifically GCMS and LCMS, enabling precise separation and analysis of complex mixtures in various fields **98BT607CO1-.5:** Students will grasp flow cytometry fundamentals, including fluorochromes, experimental design, and fluorescence quantitation. They will also learn electrophoresis techniques	

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)**	
ProgramCore (PCC)	98BT607	Advance Bioanalytical Techniques	3	2	1	1	7	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)		

ProgramCore (PCC)	98BT607	Advance Bioanalytical Techniques	**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)		
ProgramCore (PCC)	98BT657	Advance Bioanalytical Techniques lab	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	05	19

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO1-.1: Students will be proficient in employing various microscopy techniques for detailed sample analysis and understand the principles behind high-throughput screening methods,	Understand working of live cell imaging		**Unit-1** **CI1.1** Live cell imaging,	Study videos on live cell imaging
	Illustrate the mechanism of confocal microscopy		**CI1.2** Confocal microscopy and	What are various components of confocal Microscope
	Understand fluorescence microscopy		**CI1.3** sample preparation for fluorescence microscopy	Write applications of fluorescence microscopy
	Understand need of High content/throughput screening		**CI1.4** High content/throughput screening -	Study videos of High content/throughput screening
	Describe basics of SEM	**LI1.1** Virtual demonstration of SEM	**CI1.5** Basics of SEM &	
	Illustrate the technique of Specimen preparation for SEM		**CI1.6** Specimen preparation for SEM -	

	Learn Basics of TEM	**LI1.2** Virtual demonstration of TEM	**CI1.7** Basics of TEM &	
	Knowledge about Specimen preparation for TEM		**CI1.8** Specimen preparation for TEM.	
	Revision and assessment		**CI1.9** Revision and assessment	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Enlist differences between SEM and TEM
	SW1.2 Mini Project	Describe mode of action of High content/throughput screening .
	SW1.3 Other Activities (Specify)	Find out DNA extraction protocol for insect cell.

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)**
CO1-.2: Students will grasp sequencing technology evolution and gain proficiency in diverse genomics research applications.	**SO2.1** Illustration of High-Throughput Next generation sequencing (HT-NGS) platforms	**LI2.1** To perform Sanger DNA sequencing and analyze the results.	**Unit-II** **CI2.1** High-Throughput Next generation sequencing (HT-NGS) platforms-	**SL2.1** Learn High-Throughput Next generation sequencing (HT-NGS) platforms
	SO2.2 Illustration of DNA Sequencing	**LI2.2** To demonstrate Illumina Solexa sequencing and analyze the output.	**CI2.2** First generation sequencing platform:	**SL2.2** Explain Sanger DNA sequencing
	SO2.3 Understand working of Sanger DNA sequencing		**CI2.3** Sanger DNA sequencing-	**SL2.3** Learn mechanism and applications of Roche 454

	SO2.4 Acquire knowledge about Illumina Solex		**CI2.4** Illumina Solexa and	**SL2.4** Discuss the Illumina Solex
	SO2.5 Assessing the need of Solid next generation genome sequencing		**CI2.5** SoLiD next generation genome sequencing	
	SO2.6 Explaining he Third generation sequencing platforms		**CI2.6** Third generation sequencing platforms: Single molecular sequencing:	
	SO2.7 Explaining Helico high speed genome sequencing		**CI2.7** Helico high speed genome sequencing	**SL2.5** Give Helico high speed genome sequencing -
	SO2.8 high speed sequencing platform		**CI2.8** high speed sequencing platform	
	SO2.9 Revision and assessment		**CI2.9** Revision and assessment	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Describe High-Throughput Next generation sequencing (HT-NGS) platforms
	SW2.2 Mini Project	Explain the Sanger DNA sequencing.
	SW2.3 Other Activities (Specify)	Prepare chart on Helico high speed genome sequencing

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-.3: Students will master a diverse range of spectroscopic techniques, enhancing their analytical capabilities across scientific disciplines.	Demonstrate the UV-Visible light spectroscopy	**LI3.1** Demonstration of Beer Lambert Law	**Unit-III** Introduction to UV, Visible light spectroscopy,	Read about types of spectroscopy
	SO3.2 Illustration of Fluorescence spectroscopy,	**LI 3.2** Demonstration of UV visible spectrophotometer	Flouroscence spectroscopy,	Draw a fluorescence spectroscopy
	SO3.3 Apply and analyze CD spectroscopy and luminometry		luminometry, CD spectroscopy,	Explain luminometry and CD spectroscopy
	SO3.4 Evaluate Light scattering, Atomic spectroscopy,		Light scattering, Atomic spectroscopy,	
	SO3.5 Describe IR and Raman spectroscopy,		IR and Raman spectroscopy,	
	SO3.6 Demonstrate the use of surface plasmone resonance ,		surface plasmone resonance ,	Write a note on CI3.6 surface plasmone resonance
	SO3.7 Describe Electron paramagnetic resonance,		Electron paramagnetic resonance,	
	SO3.8 Describe		X-ray diffraction	Diagrammatically explain X ray

	X-ray diffraction techniques		techniques.	diffraction
	SO3.9 Revision and assessment		Revision and assessment	

Item	**Item** Cl	LI	SW CI	LI SL	SW Total SL	Total
Approx. Hrs	**Approx. Hrs** 09	06	01 09	04 05	02 11 05	19

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Describe principles and types of spectroscopies
	SW3.2 Mini Project	Describe the significance of UV visible spectroscopy
	SW3.3 Other Activities (Specify)	Prepare list of compounds analysed by NMR, IR and UV Visible spectrophotometer

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO1-.4: Students will develop expertise in chromatographic techniques, specifically GCMS and LCMS, enabling precise separation and analysis of complex mixtures in various fields	Develop understanding of GCMS	LI 4.1 Virtual Demonstration of GCMS	Gas chromatography with mass spectrometric detection (GC-MS),	Learn about GC MS
	Illustrate mechanism of LC MS	LI4.2 Virtual Demonstration of LCMS	liquid chromatography with mass spectrometric detection (LC-MS),	Discuss challenges LC MS
	Ananlyze key features ICPMS	LI4.3 Virtual Demonstration of ICPMS	inductively coupled plasma with mass spectrometric detection (ICP-MS).	Video for ICPMS
	Evaluate strategies and analysis of HPLC data		Metal analysis by ICP-MS; Analysis of data: HPLC chromatograms,	**SL4.4** Study heavy metals and its Metal analysis
	Evaluate the need of Adsorption Chromatography, partition chromatography		Chromatographic performance parameters, Adsorption Chromatography,	
	Evaluate the need of partition chromatography		partition chromatography,	**SL4.5** Evaluate the technique of adsorption and partition chromatography
	Apply Ion exchange chromatography in appropriate samples		Ion exchange chromatography,	
	Explain Molecular exclusion chromatography		Molecular exclusion chromatography	
	Revision and assessment		Revision and assessment	

Suggested Sessional Work (SW): *anyone*		
	SW4.1 Assignments	Describe principles and strategies of GC MS and LC MS
	SW4.2 Mini Project	Describe the techniques of heavy metal analysis
	SW4.3 Other Activities (Specify)	Prepare list of samples and their state for analysis in GC MS, LC MS, ICP MS

Item	Cl	LI	SW	SL	Total
Approx. Hrs	09	2	01	05	18

Course Outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO1-.5: Students will grasp flow cytometry fundamentals, including fluorochromes, experimental design, and fluorescence quantitation. They will also learn electrophoresis techniques	Demonstrate working of flow cytometer		**Unit-V** Flow Cytometer: Introduction to flow cytometry-	**SL5.1** learn about principle of flow cytometer
	Illustrate the basics of Fluorochromes and fluorescence		Fluorochromes and fluorescence	**SL5.2** learn about CI5.2 Fluorochromes and fluorescence
	Evaluate the need of fluorescence quantitation		Experimental design and fluorescence quantitation-	**SL5.3** Give role of fluorescence quantitation in research
	Illustrate Compensation and gating, Normalization Probability Binning		Compensation and gating, Normalization Probability Binning -	**SL5.4** Learn about Compensation and gating, Normalization Probability Binning
	Analyze the advantages of electrophoresis of proteins	LI5.1 Electrophoresis of DNA	Electrophoresis of proteins and nucleic acids,	**SL5.5** Give precautions during electrophoretic run
	Describe capillary electrophoresis,		capillary electrophoresis,	
	Evaluate the need of Microchip electrophoresis.		Microchip electrophoresis	

	Types of microchips		Types of microchips	
	Revision and assessment		Revision and assessment	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Describe principles and mechanism of flow cytometry
	SW5.2 Mini Project	Describe the applications of electrophoresis
	SW5.3 Other Activities (Specify)	Describe PAGE and SDS PAGE

Course duration (in hours) to attain Course Outcomes:

Course Title: Advance Bioanalytical Techniques **Course Code:** 98BT607

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1-.1: Students will be proficient in employing various microscopy techniques for detailed sample analysis and understand the principles behind high-throughput screening methods,	9	4	5	1	19
CO1-.2: Students will grasp sequencing technology evolution and gain proficiency in diverse genomics research applications.	9	4	5	1	19
CO1-.3: Students will master a diverse range of spectroscopic techniques, enhancing their analytical capabilities across scientific disciplines.	9	4	5	1	19
CO1-.4: Students will develop expertise in chromatographic techniques, specifically GCMS and LCMS, enabling precise separation and analysis of complex mixtures in various fields	9	6	5	1	21
CO1-.5: Students will grasp flow cytometry fundamentals, including fluorochromes, experimental design, and fluorescence quantitation. They will also learn electrophoresis techniques	9	2	5	1	17

Total Hours	45	20	25	05	83

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

Course Title: Advance Bioanalytical Techniques **Course Code:98BT607**

Course Outcomes					
	A	**A**	**E**	**C**	**Total Marks**
98BT607CO1-.1: Students will be proficient in employing various microscopy techniques for detailed sample analysis and understand the principles behind high-throughput screening methods,	03	01	01	01	06
98BT607CO1-.2: Students will grasp sequencing technology evolution and gain proficiency in diverse genomics research applications.	02	04	02	02	10
98BT607CO1-.3: Students will master a diverse range of spectroscopic techniques, enhancing their analytical capabilities across scientific disciplines.	03	05	05	01	14
98BT607CO1-.4: Students will develop expertise in chromatographic techniques, specifically GCMS and LCMS, enabling precise separation and analysis of complex mixtures in various fields	02	03	05	00	10
98BT607CO1-.5: Students will grasp flow cytometry fundamentals, including fluorochromes, experimental design, and fluorescence quantitation. They will also learn electrophoresis techniques	05	04	00	01	10
Total Marks	15	17	13	05	50

Legend: A: Apply, A: Analyze E: Evaluate, C: Create

Suggested learning Resources:

Books:

S. No.	Title
1	Skoog, D.A., Crouch, S.R., and Holler, F.J. *"Principles of Instrumental Analysis",* 6th edition, Brooks/Cole, USA, 2006.
2	Williams, D. and Fleming, I. "*Spectroscopic Methods in Organic Chemistry",* 6th edition, McGraw-Hill Higher Education, Maidenhead, UK, 2008.

3	Freifelder D., Physical Biochemistry, "*Application to Biochemistry and Molecular Biology*", 2nd Edition, W.H. Freeman & Company, San Fransisco, 1982.
4	Keith Wilson and John Walker, "Principles and Techniques of Practical Biochemistry", 5th Edition, Cambridge University Press, 2000.

Online Resources:

Suggested instructions/Implementation strategies:

Improved lecture
Tutorial
Case method
Group Discussion
Role play
Visit to virology lab (BSL-3)
Demonstration
ICT Based teaching Learning
Brainstorming

CO, PO and PSO Mapping

Program Title: B. Tech. Biotechnology

Semester: VI

Course Code: 98BT607

Course Title: Advance Bioanalytical Techniques

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-.1: Students will be proficient in employing various microscopy techniques for detailed sample analysis and understand the principles behind high-throughput screening methods,	-	-	1	2	2	2	2	-	2	2	2	3	3	-	-
CO1-.2: Students will grasp sequencing technology evolution and gain proficiency in diverse genomics research applications.	-	-	-	-	-	-	-	-	2	2	3	3	2	-	1
CO1-.3: Students will master a diverse range of spectroscopic techniques, enhancing their analytical capabilities across scientific disciplines.	-	1	2	2	-	2	2	-	3	3	3	1	2	2	1
CO1-.4: Students will develop expertise in chromatographic techniques, specifically GCMS and LCMS, enabling precise separation and analysis of complex mixtures in various fields	-	1	2	2	2	2	2	3	-	2	2	2	2	2	2
CO1-.5: Students will grasp flow cytometry fundamentals, including fluorochromes, experimental design, and fluorescence quantitation. They will also learn electrophoresis techniques	1	1	1	-	-	3	3	3	1	2	3	2	2	2	1

Legend: **(1) Low (2) Medium (3) High**

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:** Students will be proficient in employing various microscopy techniques for detailed sample analysis and understand the principles behind high-throughput screening methods,	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, 1.7, 1.8,1.9	1SL-1,2,3,4,5

		SO1.7 SO1.8 SO1.9			
PO 1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2,3	**CO1-.2:** Students will grasp sequencing technology evolution and gain proficiency in diverse genomics research applications.	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
PO 1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2,3	**CO1-.3:** Students will master a diverse range of spectroscopic techniques, enhancing their analytical capabilities across scientific disciplines.	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-1,2,3,4,5
PO 1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2,3	**CO1-.4:** Students will develop expertise in chromatographic techniques, specifically GCMS and LCMS, enabling precise separation and analysis of complex mixtures in various fields	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
PO 1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2,3	**CO1-.5:** Students will grasp flow cytometry fundamentals, including fluorochromes, experimental design, and fluorescence quantitation. They will also learn electrophoresis techniques	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9	LI1	5.1,5.2,5.3,5.4,5.5, 5.6, 5.7, 5.8, 5.9	5SL-1,2,3,4,5

Curriculum Development Team

Prof. Kamlesh Choure
Prof Ashwini A. Waoo
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Er. Arpit Srivastava

Program Name	**B. Tech. Biotech Semester-**	
Semester	**VIth**	
Course Code:	**98BT606-A**	
Course title:	**Food Biotechnology**	**Curriculum Developer**: Mrs. Maahi choure
Pre-requisite:	A foundational knowledge of molecular biology, microbiology, and biochemistry is necessary to understand and apply biotechnological techniques in food science.	
Rationale:	Food biotechnology is essential for enhancing food quality, safety, and nutritional value, while also increasing agricultural productivity and sustainability to meet the demands of a growing global population.	
Course Outcomes (COs):	**98BT656 CO1. Explain fundamental principles of food science and chemistry** **98BT656CO2. Outline beneficial and harmful effects of microorganisms.** **98BT656CO3. Identify microbes for development of functional food** **98BT656CO4. Examine methods that increase shelf life and food quality** **98BT656CO5. Compare the microbes on the basis of their morphological characteristics**	

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 elective (PE)	98BT606-A	Food Biotechnology	3	2	1	1	7	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)		

Program elective (PE)	**98BT606-A**	**Food Biotechnology**	16	19	5	5	5	50	50

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)		
Program elective (PE)	**98BT656-A**	**Food Biotechnology**	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	02	16

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
98BT656 CO1. Explain the fundamental principles of food science and chemistry	SO1.1 Factors Affecting Microbial Growth	LI1.1 Observe effects of temperature, pH, and moisture on microbial growth in food samples.	CI1.1 Introduction to factors affecting microbial growth in food.	SL1.1 Research on intrinsic and extrinsic factors influencing microbial growth in food.
	SO1.2 Microbial Spoilage of Milk	LI1.2 Identify microorganisms involved in spoilage of milk through culture techniques.	CI1.2 Study microbial spoilage mechanisms in milk.	SL1.2 Read articles on microbial spoilage of milk and its prevention.
	SO1.3 Microbial Spoilage of Meat		CI1.3 Analyze microbial spoilage processes in meat.	
	SO1.4 Microbial Spoilage of Plant Products		CI1.4 Understand microbial spoilage in plant products.	
	SO1.5 Methods to Prevent Microbial Spoilage		CI1.5 Discuss methods to prevent microbial spoilage in food.	

	SO1.6 Comparison of Spoilage in Different Foods		CI1.6 Compare microbial spoilage across different food types.	
	SO1.7 Review of Key Concepts		CI1.7 Recap on key factors and methods for preventing spoilage.	
	SO1.8 Case Studies on Spoilage		CI1.8 Analyze real-world cases of food spoilage.	
	SO1.9 Advances in Spoilage Prevention		CI1.9 Study recent advancements in food preservation.	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Design mini-project research a specific microbial spoilage problem in a food product of choice and present findings, including the microorganism involved, spoilage mechanisms, and prevention strategies.
	SW1.2 Mini Project	Group Assignment – microbial spoilage
	SW1.3 Other Activities (Specify)	Evaluate students based on their technique, accuracy, and lab equipment skills.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	**09**	4	1	2	16

Course Outcome (CO)	**Session Outcomes (SOs)**	**LaboratoryInstruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**

98Bt606CO2. Outline the beneficial and harmful effects of microorganisms.	SO2.1 Bacterial Agents of Foodborne Illness	LI2.1 Isolate and identify bacterial pathogens from food samples.	CI2.1 Overview of bacterial pathogens causing foodborne illnesses.	SL2.1 Study the characteristics of major bacterial foodborne pathogens.
	SO2.2 Clostridium and Listeria	LI2.2 Perform tests to detect Clostridium and Listeria in food samples.	CI2.2 Detailed study of Clostridium and Listeria-related foodborne illnesses.	SL2.2 Read about outbreaks and case studies involving Clostridium and Listeria.
	SO2.3 Salmonella and Shigella		CI2.3 Explore Salmonella and Shigella in foodborne illness cases.	
	SO2.4 Staphylococcus and Vibrio		CI2.4 Study the effects of Staphylococcus and Vibrio on food safety.	
	SO2.5 Yersinia and Non-Bacterial Agents		CI2.5 Investigate Yersinia and non-bacterial agents affecting foodborne illnesses.	
	SO2.6 Toxigenic Algae and Fungi		CI2.6 Study the role of toxigenic algae and fungi in foodborne illnesses.	
	SO2.7 Foodborne Viruses		CI2.7 Explore the impact of foodborne viruses on health and safety.	
	SO2.8 Review of Foodborne Pathogens		CI2.8 Summarize key concepts related to foodborne pathogens.	
	SO2.9 Case Studies on Foodborne Illnesses		CI2.9 Discuss real-world cases of foodborne illnesses.	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Write about the Staphylococcus: Characteristics, toxins (enterotoxins), diseases (staphylococcal food poisoning), sources, and prevention.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	**09**	4	**1**	2	16

	SW2.2 Mini Project	Prepare a case studies on food borne pathogen
	SW2.3 Other Activities (Specify)	Find out some you tube videos based on the pathogens, clinical manifestations,.

Course Outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
98BT606CO3. Identify microbes for development of functional food	SO3.1 Fermented Milk Products	LI3.1 Prepare and analyze fermented milk samples.	CI3.1 Study the fermentation processes in milk products.	SL3.1 Learn about the health benefits and production methods of fermented milk.
	SO3.2 Cheese and Sauerkraut	LI3.2 Produce cheese and sauerkraut and test for microbial activity.	CI3.2 Explore the production processes of cheese and sauerkraut.	SL3.2 Research the microbial cultures used in cheese and sauerkraut production.
	SO3.3 Fermented Meat Products		CI3.3 Analyze the role of fermentation in meat preservation.	
	SO3.4 Beer and Vinegar Production		CI3.4 Understand the microbial processes involved	

			in beer and vinegar production.	
	SO3.5 Mold Fermentation		CI3.5 Study the role of molds in fermentation processes.	
	SO3.6 Benefits of Fermented Foods		CI3.6 Discuss the nutritional and health benefits of fermented foods.	
	SO3.7 Microbial Cultures in Fermentation		CI3.7 Examine the role of specific microbial cultures in fermentation.	
	SO3.8 Review of Fermentation Processes		CI3.8 Summarize the key concepts of fermentation in food production.	
	SO3.9 Case Studies on Fermented Foods		CI3.9 Discuss real-world applications of fermentation in food industry.	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Remember fermentation
	SW3.2 Mini Project	To do the case studies on fermented foods
	SW3.3 Other Activities (Specify)	Explore online tutorials and resources on meat processing.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	**09**	4	1	2	16

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
98BT606CO4. Examine methods that increase shelf life and food quality	SO4.1 Direct Microscopic Examination	LI4.1 Perform direct microscopic examination of food samples.	CI4.1 Introduction to direct microscopic techniques for food examination.	SL4.1 Review methods for direct microscopic examination in food microbiology.
	SO4.2 Culture Techniques	LI4.2 Apply various culture techniques to isolate microorganisms from food.	CI4.2 Study the principles of culture techniques in food microbiology.	SL4.2 Learn about different culture media and their applications.
	SO4.3 MPN Count		CI4.3 Understand the MPN method for microbial quantification.	
	SO4.4 Dye Reduction Assay		CI4.4 Discuss the use of dye reduction assays in evaluating microbial growth.	
	SO4.5 Immunological Methods		CI4.5 Explore immunological techniques for foodborne pathogen detection.	

	SO4.6 Advanced Techniques		CI4.6 Introduction to advanced microbiological techniques for food testing.	
	SO4.7 Review of Examination Methods		CI4.7 Summarize key methods for microbiological examination of foods.	
	SO4.8 Case Studies in Microbiological Testing		CI4.8 Discuss real-world applications and challenges in microbiological testing.	
	SO4.9 Innovations in Microbiological Techniques		CI4.9 Study recent advancements in microbiological techniques for food analysis.	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Various culture techniques
	SW4.2 Mini Project	To list out the various microbial examination
	SW4.3 Other Activities (Specify)	Understand dye reduction assay

Item	Cl	LI	SW	SL	Total
Approx. Hrs	**09**	4	1	2	16

Course Outcome (CO)	Session Outcomes (SOs)	LaboratoryInstruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO5. Compare the microbes on the basis of their morphological characteristics	SO5.1 Physical Preservation Methods	LI5.1 Test the effectiveness of physical preservation methods (e.g., heat, freezing).	CI5.1 Overview of physical methods for food preservation.	SL5.1 Research different physical preservation techniques and their impacts.
	SO5.2 Chemical Preservation Methods	LI5.2 Apply chemical preservatives to food samples and assess their effectiveness.	CI5.2 Study chemical preservation methods and their safety implications.	SL5.2 Learn about the use and regulations of chemical preservatives in food.
	SO5.3 Biological Preservation Methods		CI5.3 Discuss biological preservation methods and their mechanisms.	
	SO5.4 Quality Control in Preservation		CI5.4 Introduction to quality control and microbiological criteria for food preservation.	
	SO5.5 Cleaning and Disinfection Practices		CI5.5 Discuss the importance of cleaning and disinfection in food safety.	
	SO5.6 Good Manufacturing Practices (GMP)		CI5.6 Study the principles and applications of GMP in food production.	
	SO5.7 Hazard Analysis and Critical Control Points (HACCP)		CI5.7 Introduction to HACCP and its role in food safety.	

	SO5.8 Record Keeping in Food Safety		CI5.8 Discuss the importance of record keeping in food safety management.	
	SO5.9 Review and Innovations in Preservation		CI5.9 Summarize key preservation methods and discuss innovations.	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	illustrate the role of quality control for Industrial Bioproducts
	SW5.2 Mini Project	Prepare a list of innovations of preservation
	SW5.3 Other Activities (Specify)	Rewrite the HACCP rule

Course duration (in hours) to attain Course Outcomes:
Course Title: Food Biotechnology **Course Code: 98BT606**

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
98BT606CO1. Explain fundamental principles of food science and chemistry	9	4	2	1	16
98BT606CO2. Outline beneficial and harmful effects of microorganisms.	9	4	2	1	16
98BT606CO3. Identify microbes for development of functional food	9	4	2	1	16
98BT606CO4. Examine methods that increase shelf life and food quality	9	4	2	1	16
98BT606CO5. Compare the microbes on the basis of their morphological characteristics	9	4	2	1	16
Total Hours	45	20	10	5	80

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

Course Title: **Food Biotechnology** **Course Code:** 98BT606

Course Outcomes	**Marks Distribution**				**Total Marks**
	A	**An**	**E**	**C**	
98BT606CO1. Explain fundamental principles of food science and chemistry	02	03	04	1	10
98BT606CO2. Outline beneficial and harmful effects of microorganisms.	02	05	02	1	10
98BT606CO3. Identify microbes for development of functional food	04	04	01	1	10
98BT606CO4. Examine methods that increase shelf life and food quality	03	04	02	1	10
98BT606CO5. Compare the microbes on the basis of their morphological characteristics	04	03	02	1	11
Total Marks	15	19	11	05	51

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

Suggested learning Resources:

Books:

S.No.	**Title/Author/Publisher details**
1	Prescott, Harley and Klein, ‘ Microbiology’, MC Graw Hill, International Edition.
2	Willian C. Fraizier and Dennis C. Westhoff, ‘Food Microbiology’, Tata McGraw Hill Publishing Company , New Delhi.
3	Willian C. Fraizier and Dennis C. Westhoff, ‘Food Microbiology’, Tata McGraw Hill Publishing Company , New Delhi.

Online Resources:

Suggested instructions/Implementation strategies:

Improved lecture
Tutorial
Case method
Group Discussion
Role play
Visit to Research lab (BSL-1)
Demonstration
ICT Based teaching Learning
Brainstorming

CO, PO and PSO Mapping

Program Name: B. Tech. Biotechnology

Semester: 6th Sem

Course Title: Food Biotechnology

Course Code: 98BT606

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. Explain fundamental principles of food science and chemistry	-	1	-	1	1	2	1	-	3	1	3	1	-	1	-
CO2. Outline beneficial and harmful effects of microorganisms.	-	1	-	-	-	-	3	-	3	2	3	3	-	1	-
CO3. Identify microbes for development of functional food	-	2	1	1	-	-	3	-	3	1	3	3	-	2	1
CO4. Examine methods that increase shelf life and food quality	1	1	1	-	2	2	2	3	-	1	3	3	1	1	1

CO5. Compare the microbes on the basis of their morphological characteristics	**1**	**1**	**2**	**-**	**-**	**2**	**3**	**3**	**-**	**2**	**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 2,4,5,6,7,9,10,11,12 PSO 2	**CO1. Explain fundamental principles of food science and chemistry**	SO1.1 SO1.2 SO1.3 SO1.4,SO1.5, SO1.6 SO1.7, SO1.8, SO1.9	**IL 1** **IL 2**	1.1,1.2,1.3,1.4 ,1.5,1.6, 1.7, 1.8, 1.9	**1SL-1,2**
PO 2,7,9,10,11,12 PSO 2,	**CO2. Outline beneficial and harmful effects of microorganisms.**	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5,SO2.6 SO2.7 SO2.8 So2.9	**IL 1** **IL 2**	2.1, 2.2, 2.3, 2.4,2.5,2.6,2.7, 2.8, 2.9	**2SL-1,2**
PO 2,3,4, 7,9,10,11,12 PSO 2, 3	**CO3. Identify microbes for development of functional food**	SO3.1 SO3.2 SO3.3 SO3.4 ,3.5,SO3.6 SO3.7 SO3.8 SO3.9	**IL 1** **IL 2**	3.1,3.2,3.3,3.4.3.5,3.6,3.7, 3.8 ,3.9	**3SL-1,2**
PO 1,2,3,5,6 7,8,10,11,12	**CO4. Examine methods that increase shelf life and food quality**	SO4.1 SO4.2 SO4.3 SO4.4 ,SO4.5,SO4.6	**IL 1** **IL 2**	4.1,4.2,4.3,4.4,4.5,4.6, 4.7, 4.8, 4.9	**4SL-1,2**

PSO 1,2, 3		SO4.7 SO4.8 SO4.9			
PO 1,2,3,4,5,6 7,9,10,11,12 PSO 1,2, 3	**CO5. Compare the microbes on the basis of their morphological characteristics**	SO5.1 SO5.2 SO5.3 SO5.4 ,SO5.5,SO5.6 SO5.7 SO5.8 SO5.9	**IL 1** **IL 2**	5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8, 5.9	**5SL-1,2**

B. Tech. Biotechnology 7th Semester

Program name	Bachelor of Technology (B. Tech.)- Biotechnology	
Semester	VIIth	
Course Code:	98BT701	
Course title:	Stem Cell & Tissue Engineering	**Curriculum Developer**: Dr. Monika Soni, Assistant Professor
Pre-requisite:	Students should have basic knowledge of stem cell & tissue engineering	
Rationale:	The subject aims to provide an overview of stem cells & tissue engineering, and describe the current progress with stem cell research in tissue engineering, and the potential implications on medical treatment.	
Course Outcomes (COs):	**CO1-98BT701.1**: To explain about fundamentals of tissue engineering and define the role in stem cell research. **CO2-98BT701.2**: To study about the biomaterials for tissue engineering. **CO3-98BT701.3**: To understand the biological study of different cell types. **CO4-98BT701.4**: To understand the principle and practice of gene therapy. **CO5-98BT701.5**: To study about the development of artificial tissues by tissue engineering.	

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)	
Program Common(PC)	98BT701	Stem Cell & Tissue Engineering	3	2	1	2	8	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	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)		
PE	98BT701	Stem Cell & Tissue Engineering	**15**	**20**	**5**	**5**	**5**	**50**	**50**	**100**

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)		
PE	98BT751	Stem Cell & Tissue Engineering-lab	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.	

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)
CO1-98BT701.1: To explain about fundamentals of tissue engineering and define the role in stem cell research.			**Unit-1**	
	SO1.1 Explain in detail about introduction to tissue engineering.		**CI1.1** Brief details of introduction to tissue engineering.	**SL1.1** Search various reference books and other study material to start the learning about stem cell & tissue engineering.
	SO1.2 Explain in detail to sources of cells for tissue engineering.		**CI1.2** Describe the sources of cells for tissue engineering.	
	SO1.3 Describe & define the culture methods in tissue engineering.		**CI1.3** Study the culture methods in tissue engineering.	**SL1.2** Learn about the cell therapies in stem cell & tissue engineering.
	SO1.4 Explain in detail to the maturation of tissue constructs.	**LI1.1** To understand the basics of tissue engineering and practice cell culture techniques for tissue construct formation.	**CI1.4** Study the maturation of tissue constructs.	**SL1.3** Learn about the tissue construction & creation.
	SO1.5 Explain in detail to the musculoskeletal tissue engineering.		**CI1.5** Study the musculoskeletal tissue engineering.	
	SO1.6 Describe the modifications of tissue rings.		**CI1.6** Understand the modifications of tissue rings.	
	SO1.7 Explain in detail to the receptor-ligand interactions in tissue engineering.	**LI1.2** To investigate receptor-ligand interactions using a biochemical assay.	**CI1.7** Understand the receptor-ligand interactions in tissue engineering.	**SL1.4** Learn about different receptors & their ligand interaction in tissue engineering.
	SO1.8 Describe the receptor engineering in tissue engineering.		**CI1.8** Study the receptor engineering in tissue engineering.	
	SO1.9 Describe the cosmetics measures in tissue engineering. Explain in detail		**CI1.9** Study the cosmetics measures in tissue engineering. Study the future directions in tissue	**SL1.5** Learn about advanced topics in tissue engineering.

	to the future directions in tissue engineering. Describe the regulatory considerations in tissue engineering. Explain in detail to the organ modules in tissue engineering.		engineering. Study the organ modules in tissue engineering. Study the regulatory considerations in tissue engineering.	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignment	Describe in detail to tissue creation & construction.
	SW1.2 Mini Project	Describe the receptors & their ligand interaction in tissue engineering.
	SW1.3 Other Activities (Specify)	Explain the cell therapies in stem cell & tissue engineering.

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)
CO2-98BT701.2: To study about the biomaterials for tissue engineering.			**Unit-2**	
	SO2.1 Explain in detail introduction to tissue engineering related to biomaterials and bioreactors.		**CI2.1** Brief details of introduction to tissue engineering related to biomaterials and bioreactors.	**SL2.1** Search various reference books and other study material to start the learning about biomaterials.
	SO2.2 Explain in detail the biomaterials in tissue engineering.		**CI2.2** Study the biomaterials in tissue engineering.	
	SO2.3 Describe & define the polymeric scaffolds and cell seeding.	**LI2.1** To fabricate degradable polymeric scaffolds and seed cells	**CI2.3** Study the polymeric scaffolds and cell seeding.	**SL2.2** Understanding of degradable polymeric scaffolds in tissue engineering.

		onto the fabricated scaffolds.		
	SO2.4 Explain in detail to cell sources in tissue engineering.		**CI2.4** Brief details to cell sources in tissue engineering.	**SL2.3** Explore the role of acellular bio-matrices in tissue engineering.
	SO2.5 Explain in detail to the stem cells in tissue engineering.		**CI2.5** Study the stem cells in tissue engineering.	**SL2.4** Explore the role of stem cells as cell sources in tissue engineering.
	SO2.6 Explain in detail to bioreactors in tissue engineering.		**CI2.6** Brief details to bioreactors in tissue engineering.	
	SO2.7 Describe the nail naughton's bioreactor.	**LI2.2** To operate Nail Naughton's bioreactor and culture cells within the bioreactor under controlled conditions.	**CI2.7** Brief details to nail naughton's bioreactor.	
	SO2.8 Describe the pulsatile bioreactors.		**CI2.8** Brief details to pulsatile bioreactors.	
	SO2.9 Describe the scaffold fabrication techniques. Explain in detail on emerging trends and future directions. Explain in detail the tissue engineering applications. Describe the regulatory considerations		**CI2.9** Study the scaffold fabrication techniques. Study the regulatory considerations. Understand the tissue engineering applications. Discussion on emerging trends and future directions.	**SL2.5** Learn about natural and synthetic biological-derived polymers used in tissue engineering.

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignment	Describe in detail about biomaterials used in tissue engineering.
	SW1.2 Mini Project	Describe the biological derived polymers & their function & mechanism.
	SW1.3 Other Activities (Specify)	Explain the parts of bioreactors.

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)
CO3-98BT701.3: To understand the biological study of different cell types.			**Unit-3**	
	SO3.1 Explain in details to cell lines and cell culture.		**CI3.1** Brief details of cell lines and cell culture.	**SL3.1** Search various reference books and other study material to start the learning about cell lines.
	SO3.2 Explain in details to establishment of cell lines.		**CI3.2** Brief details to establishment of cell lines.	**SL3.2** Understand the process of establishing cell lines and its importance in research and medicine.
	SO3.3 Explain in detail to endothelial cells.	**LI3.1** To learn the techniques for establishing primary cell cultures from different cell types.	**CI3.3** Study the endothelial cells.	
	SO3.4 Explain in detail to fibroblast cells.	**LI3.1** To identify and characterize different cell types in primary cell cultures.	**CI3.4** Study the fibroblast cells.	
	SO3.5 Explain in detail to epithelial cells.		**CI3.5** Study the epithelial cells.	
	SO3.6 Explain in detail to myoblast cells.		**CI3.6** Study the myoblast cells.	
	SO3.7 Explain in detail to chromaffin cells.		**CI3.7** Study the chromaffin cells.	

	SO3.8 Explain in detail to smooth muscle cells.		**CI3.8** Study the smooth muscle cells.	
	SO3.9 Explain in detail to plasma cells. Explain in detail the applications of cell lines. Explain in detail the pros & cons to cell lines. Discussion on findings of specific cell types.		**CI3.9** Study the plasma cells. Study the applications of cell lines. Study the pros & cons to cell lines. Study the findings of specific cell types.	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignment	Describe in details to cell lines.
	SW3.2 Mini Project	Explain in details of different cell types & its function, and application.
	SW3.3 Other Activities (Specify)	Prepare one review article on cell lines.

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)
CO4-98BT701.4: To understand the principle and practice of gene therapy.			**Unit-4**	
	SO4.1 Describe and define the gene therapy.		**CI4.1** Brief details to introduction to gene therapy.	**SL4.1** Search various reference books and other study material to start the learning about transgenic animals.
	SO4.2 Explain in detail to requirements of gene therapy.		**CI4.2** Study the requirements of gene therapy.	**SL4.2** Understand the essential components and considerations for successful gene therapy interventions.

	SO4.3 Describe the genetic defects.		**CI4.3** Study the genetic defects.	**SL4.3** Study the genetic diseases on the basis of molecular level and their implications for gene therapy.
	SO4.4 Explain in detail to targeted cells for gene therapy.	**LI4.1** To understand gene delivery methods and evaluate transduction efficiency in target cells.	**CI4.4** Study the targeted cells for gene therapy.	
	SO4.5 Explain in detail to process of gene therapy.	**LI4.2** To investigate target cell specificity and regulate gene expression in vitro.	**CI4.5** Study the process of gene therapy.	
	SO4.6 Describe in detail to the factors responsible for effective gene therapy.		**CI4.6** Brief in details the factors responsible for effective gene therapy.	
	SO4.7 Describe the recent developments in gene therapy research.		**CI4.7** Study the recent developments in gene therapy research.	**SL4.4** Stay updated on the latest advancements and breakthroughs in the field of gene therapy.
	SO4.8 Explain in detail ethical considerations of gene therapy.		**CI4.8** Study the ethical considerations of gene therapy.	**SL4.5** Explore the ethical implications surrounding the development and application of gene therapy.
	SO4.9 Explain in detail the applications of gene therapy. gene therapy. concepts and their implications for healthcare and society.		**CI4.9** Study the applications of gene therapy. the gene therapy concepts and their implications for healthcare and society.	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Describe the genetic defects.
	SW4.2 Mini Project	Describe in the detail of gene therapy and its application.
	SW4.3 Other Activities (Specify)	Study one research article on gene therapy.

Item	CI	LI	SW	SL	Total
Approx. Hours	9	4	1	1	15

Course outcomes (COs)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CIs)	Self-Learning (SL)
CO5-98BT701.5: To study about the development of artificial tissues by tissue engineering.			**Unit-5**	
	SO5.1 Describe in details to tissue engineering and artificial tissues.		**CI5.1** Brief details of introduction to tissue engineering and artificial tissues.	**SL5.1** Search various reference books and other study material to start the learning about tissue engineering & transplantation biology.
	SO5.2 Explain in detail the basic concepts in transplantation biology.		**CI5.2** Study the basic concepts in transplantation biology.	
	SO5.3 Explain in detail the tissue typing.		**CI5.3** Brief in details the tissue typing.	
	SO5.4 Explain in detail the techniques of tissue typing.	**LI5.1** To familiarize students with the techniques used in tissue typing for transplantation.	**CI5.4** Brief in details the techniques of tissue typing.	
	SO5.5 Explain in detail the minor histocompatibility antigens.		**CI5.5** Study the minor histocompatibility antigens.	
	SO5.6 Explain in detail the immunosuppression in transplantation.	**LI5.2** To investigate the effects of immunosuppressive drugs on immune cell function.	**CI5.6** Study the immunosuppression in transplantation.	
	SO5.7 Explain in detail to types of immunosuppression.		**CI5.7** Study the types of immunosuppression.	

	SO5.8 Describe in detail the side effects of immunosuppression.		**CI5.8** Study the side effects of immunosuppression.	
	SO5.9 Describe in detail the alternative approaches to immunosuppression. clinical applications of tissue engineering.		**CI5.9** Study the alternative approaches to immunosuppression. clinical applications of tissue engineering.	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Explain in detail about transplantation biology.
	SW5.2 Mini Project	Describe in the detail of tissue typing & its techniques.
	SW5.3 Other Activities (Specify)	Study review articles on the minor histocompatibility antigens.

Course duration (in hours) to attain Course Outcomes:

Course Title: Stem cell & tissue engineering **Course Code:** 98BT701

Course Outcomes (COs)	**Class lecture (CI)**	**Laboratory Instruction (LI)**	**Self-Learning (SL)**	**Sessional work (SW)**	**Total Hours (Li+CI+SL+SW)**
CO1-98BT701.1: To explain about fundamentals of tissue engineering and define the role in stem cell research.	9	4	5	1	19
CO2-98BT701.2: To study about the biomaterials for tissue engineering.	9	4	5	1	19
CO3-98BT701.3: To understand the biological study of different cell types.	9	4	2	1	16
CO4-98BT701.4: To understand the principle and practice of gene therapy.	9	4	5	1	19
CO5-98BT701.5: To study about the development of artificial tissues by tissue engineering.	9	4	1	1	15
Total Hours	45	20	18	05	88

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

Course Title: Stem cell & tissue engineering **Course Code:** 98701

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

Course Outcomes	Marks Distribution				Total Marks
	R	U	A	A	
CO1-98BT701.1: To explain about fundamentals of tissue engineering and define the role in stem cell research.	2	2	3	2	9
CO2-98BT701.2: To study about the biomaterials for tissue engineering.	2	3	3	3	11
CO3-98BT701.3: To understand the biological study of different cell types.	2	3	3	2	10
CO4-98BT701.4: To understand the principle and practice of gene therapy.	2	3	3	2	10
CO5-98BT701.5: To study about the development of artificial tissues by tissue engineering.	2	2	3	3	10
Total Marks	**10**	**13**	**15**	**12**	**50**

Suggested learning Resources:

(a) Books:

S.No.	Title/Author/Publisher details
1.	Robert Lanza, Robert Langer, Joseph P. Vacanti, and Antonios G. Mikos., Principles of Tissue Engineering. Academic Press.
2.	Jonathan Slack., Stem Cells: A Very Short Introduction. New York Oxford University Press, 2016.
3.	Robert Lanza, Anthony Atala, and Helen M. Blau., Essentials of Stem Cell Biology. Academic Press, 2014
4.	Eapen Cherian, G Nandhini, Anil Kurian., Stem Cells. Jaypee Brothers Medical Publishers (P) Ltd. 2011.

(b) Online Resources:

Suggested instructions/Implementation strategies:

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

CO, PO and PSO Mapping

Program Name: B. Tech. Biotechnology

Semester: VII[th] Semester

Course Title: Stem cell & tissue engineering

Course Code: 98BT701

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**
CO1-98BT701.1: To explain about fundamentals of tissue engineering and define the role in stem cell research.	-	1	-	1	2	2	2	-	3	1	3	-	2	2	1
CO2-98BT701.2: To study about the biomaterials for tissue engineering.	-	1	-	-	-	-	3	-	3	2	3	2	1	1	2
CO3-98BT701.3: To understand the biological study of different cell types.	1	1	1	1	-	-	2	-	3	1	2	3	1	1	1
CO4-98BT701.4: To understand the principle and practice of gene therapy.	1	-	1	-	2	2	3	3	-	1	3	2	1	1	3
CO5-98BT701.5: To study about the development of artificial tissues by tissue engineering.	1	-	1	-	-	2	2	3	-	2	2	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)
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO1-98BT701.1:** To explain about fundamentals of tissue engineering and define the role in stem cell research.	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	**CO2-98BT701.2**: To study about the biomaterials for tissue engineering.	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	**CO3-98BT701.3**: To understand the biological study of different cell types.	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	**CO4-98BT701.4**: To understand the principle and practice of gene therapy.	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
PO1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2,3	**CO5-98BT701.5**: To study about the development of artificial tissues by tissue engineering.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9	LI1 LI2	5.1,5.2,5.3,5.4,5.5, 5.6,5.7,5.8,5.9	5SL-1

Program Name	**Bachelor of Technology (B.Tech.)- Biotechnology**	
Semester	VII	
Course Code:	**98BT704**	
Course title:	Proteomics & Protein Engineering	**Curriculum Developer**: Sonal Gupta, Assistant Professor
Pre-requisite:	Students should have basic knowledge of biochemistry and bioanalytical techniques.	
Rationale:	Proteomics is the large-scale study of the structure and function of proteins in complex biological sample. Such an approach has the potential value to understand the complex nature of the organism. Current proteomic tools allow large-scale, high-throughput analyses for the detection, identification, and functional investigation of proteome. Protein engineering is the process by which a researcher modifies a protein sequence through substitution, insertion, or deletion of nucleotides in the encoding gene, with the goal of obtaining a modified protein that is more suitable for a particular application or purpose than the unmodified protein.	

Course Outcomes (COs):	**CO1 98BT704.** Explain the classification and construction of proteins **CO2 98BT704.** Analyse and compare the amino acid sequences and structures of proteins and relate this information to function **CO3 98BT704**. Modify a protein purification scheme to a specific application. **CO4 98BT704**. Understand the different systems of recombinant protein expression with advantages and disadvantages of each one. **CO5 98BT704**. Comprehend the difficulties in working with proteomics compare to genomics. **CO6 98BT704**. Gain thinking and analysis skills in protein biochemistry, Protein 3-D Structure and Protein folding.

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)	
Program Common (PC)	**98BT703**	Proteomics & Protein Engineering	2	2	1	3	8	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	**98BT703**	Proteomics & Protein Engineering	**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)		
PE	**98BT753**	Proteomics & Protein Engineering	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	06	04	01	04	15

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-98BT704.1 Architecture of Proteins	**SO1.1** Introduction of amino acids	**LI1.1** Basic instruments used for the study of proteomics.	**Unit-1** **Introduction and Overview CI1.1** Basic structure, classification and properties of amino acids.	**SL1.1** Classification of amino acids and proteins
	SO1.2 Basic classification of proteins	**LI1.2** To Demonstrate various qualitative and quantitative analysis used for proteins.	**CI1.2** Classify protein on various basis and their biological significance.	**SL1.2** Explore mechanism of protein folding
	SO1.3 Explain the structural organization of proteins		**CI1.3** Overview on various levels (primary, secondary, tertiary and quaternary) levels of the protein structure.	**SL1.3** Write a note on protein structural organization
	SO1.4 Define the kinetics and thermodynamics of protein folding.		**CI1.4** Mechanism of protein folding. Kinetics and thermodynamic behind the protein folding process.	**SL1.4** Write down an overview on proteomics
	SO1.5 Describe the stability of proteins		**CI1.5** Explain the various factors affect the stability of proteins	
	SO1.6 Identification and quantification of amino acids and proteins and Explain In-silico protein modelling		**CI1.6** Describe the various methods to analyse amino acids and protein qualitatively and quantitatively and various computational methods to	

			study protein 3D structure.	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Describe the structural organization of protein in detail.
	SW1.2 Mini Project	Explain protein folding and its biological significance.
	SW1.3 Other Activities (Specify)	Elaborate in silico methods of protein modelling

Item	Cl	LI	SW	SL	Total
Approx. Hrs	6	04	01	04	15

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO2-98BT704.2. Control of Protein Function	**SO2.1** Explain various mechanism of protein regulation	**LI2.1** Demonstrate the denaturation of protein by using temperature	**CI2.1** Describe protein interaction domains	**SL2.1** Find out various mechanism to regulate protein functions.
	SO2.2 Describe the regulation of protein function by its location	**LI2.2** To perform the cell transformation experiment	**CI2.2** How proteins regulate their functions by intracellular location.	**SL2.2** Read the latest research articles on regulatory mechanisms of protein functions.
	SO2.3 Regulation of proteins by conformational change: Allostery		**CI2.3** Allostery: Effector ligand and Cooperativity	**SL2.3** Write down a note on protein kinase and its significance in cell signaling
	SO2.4		**CI2.4**	**SL2.4**

	Protein switches based on nucleotide hydrolysis		G-protein: Types and mechanism of action	An overview on protein trafficking
	SO2.5 Explain the motor protein switches		**CI2.5** Describe various switches to regulate motor proteins.	
	SO2.6 Explain protein synthesis And Various mechanisms of protein degradation to control its activity, Protein kinase and their role in regulation of various biological activities like cell signaling, cell cycle, two components signaling system, mechanisms of protein trafficking		**CI2.6** Various steps of protei9n synthesis: Transcription and Translation and Various mechanisms of protein degradation to control its activity, Protein kinase and their role in regulation of various biological activities like cell signaling, cell cycle, two components signaling system, mechanisms of protein trafficking	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Make a diagrammatic presentation on two components signaling
	SW2.2 Mini Project	Make a project on role of protein kinase in cell signaling
	SW2.3 Other Activities (Specify)	Make Power point presentation on protein synthesis

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	4	01	03	14

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO2-98BT704.3 Protein-Protein Interactions	**SO3.1** Describe protein-protein interactions	**LI3.1:** To use string database for the given protein	**Unit-3** **CI3.1** Study the protein-protein interactions	**SL3.1** Study the protein-protein interaction and its significance
	SO3.2 Elaborate Topoisomerase based gene cloning	**LI3.2:** To use ensemble genome browser for gene ontology	**CI3.2** Describe single step gene cloning method: TOPO Cloning (Topoisomerase based gene cloning).	**SL3.2** Read the various advanced methods of single step gene cloning.
	SO3.3 Explain Univector plasmid fusion system		**CI3.3** Elaborate single step gene cloning methos: UPS (Univector plasmid fusion system).	**SL3.3** Explain the various methods to find out protein-protein interactions
	SO3.4 Study two hybrid analysis in yeast, bacteria and virus		**CI3.4** How to study protein-protein interaction by two hybrid analysis.	
	SO3.5 Explain the Phage display method		**CI3.5** Describe phage display method to study protein-protein interactions.	
	SO3.6 Elaborate protein fragment complementation assay		**CI3.6** Protein fragment complementation assay to explain protein- protein interaction.	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Make a chart of various methods to study protein-protein interactions.
	SW3.2 Mini Project	Describe the Univector plasmid fusion system in detail.
	SW3.3 Other Activities (Specify)	Prepare one Power point presentation on "phage display method".

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	04	01	04	15

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO2-98BT704.4 Protein Engineering & Protein Design	**SO4.1** Bioengineering of macromolecules	**LI4.1** Make a chart of various steps involved in protein engineering	**Unit-4 Protein Engineering & Protein Design** **CI4.1** Explain biomolecular engineering as a multidisciplinary science	**SL4.1** Find out the industrial significance of protein engineering
	SO4.2 Describe the methods used to alter the primary structure of proteins	**LI4.2** to use the homology modelling using modeller	**CI4.2** Study the detailed mechanism of site directed mutagenesis and its role in protein alteration	**SL4.2** List down various steps of protein designing and engineering.
	SO4.3 Principle of protein designing		**CI4.3** Describe the principle behind protein design and modelling	**SL4.3** An overview on various methods used to characterize a protein
	SO4.4 Elaborate various steps of protein engineering		**CI4.4** Elaborate the multistep process of protein engineering to create protein with desired needs	**SL4.4** Describe site directed mutagenesis

	SO4.5 Various methods of protein characterization: Amino acid sequencing		**CI4.5** Explain various methods of amino acid sequencing	
	SO4.6 Various methods of protein characterization: Mass peptide fingerprinting and Mass intact protein. Define glycan analysis		**CI4.6** Elaborate Mass peptide fingerprinting and Mass intact protein techniques of protein identification. glycan analysis of proteins in detail	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Make a flow chart of various steps of protein engineering
	SW4.2 Mini Project	Write an overview on Mass peptide fingerprinting.
	SW4.3 Other Activities (Specify)	Prepare a PowerPoint presentation on site directed mutagenesis

Item	Cl	LI	SW	SL	Total
Approx. Hrs	6	04	01	04	15

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO2-98BT704.5 Techniques used in Protein engineering	**SO5.1** Physical methods of determining the three-dimensional structure of proteins by various optical spectroscopic techniques: i) X-ray crystallography	**LI5.1** To perform SDS PAGE to separate given mixture of proteins.	**Unit-5** Techniques used in Protein engineering **CI5.1** How to elaborate protein structure by X-ray crystallography.	**SL5.1** Find out the principles of various spectroscopic methods used in proteomics.

	SO5.2 ii) Nuclear magnetic resonance spectroscopy,	**LI5.2** To perform the spectroscopy method of protein detection	**CI5.2** Describe NMR: Principle, instrumentation and mechanism.	**SL5.2** Write down various steps of 2D PAGE.
	SO5.3 iii) Neutron diffraction		**CI5.3** Describe Neutron diffraction: principles, instrumentation and mechanism.	**SL5.3** Explain principle of cryo electron microscopy and its sample preparation.
	SO5.4 iv) Vibrational spectroscopy, (Raman spectroscopy)		**CI5.4** Explain principle, instrumentation and mechanism of Raman spectroscopy.	**SL5.4** Explain mechanism of X-ray crystallography
	SO5.5 v) Circular dichroism		**CI5.5** Explain Circular dichroism in detail.	
	SO5.6 Describe 2D PAGE, Cryo electron microscopy		**CI5.6** Describe 2D PAGE: Sensitivity, resolution and representation 2D PAGE. Cryo electron microscopy	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Explain general mechanism of NMR (Nuclear Magnetic Resonance)
	SW5.2 Mini Project	Describe the circular dichroism and its role in protein study
	SW5.3 Other Activities (Specify)	Prepare one article on the “Raman Spectroscopy”

Course duration (in hours) to attain Course Outcomes:

Course Title: Proteomics and Protein Engineering **Course Code:** 98BT505

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO198BT704. Explain the classification and construction of proteins	6	2	4	1	13
CO2 98BT704. Analyse and compare the amino acid sequences and structures of proteins and relate this information to function	6	2	4	1	13
CO3 98BT704. Modify a protein purification scheme to a specific application.	6	2	3	1	12
CO4 98BT704. Understand the different systems of recombinant protein expression with advantages and disadvantages of each one.	6	2	4	1	13
CO5 98BT704. Comprehend the difficulties in working with proteomics compare to genomics.	6	2	4	1	13
Total Hours	30	20	19	05	66

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

Course Title: Proteomics and Protein Engineering **Course Code:** 98BT507

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
CO1 98BT704. Explain the classification and construction of proteins	2	1	1	1	5
CO2 98BT704. Analyse and compare the amino acid sequences and structures of proteins and relate this information to function	2	4	5	1	12
CO3 98BT704. Modify a protein purification scheme to a specific application.	3	5	5	1	14

CO4 98BT704. Understand the different systems of recombinant protein expression with advantages and disadvantages of each one.	2	3	5	1	11
CO5 98BT704. Comprehend the difficulties in working with proteomics compare to genomics.	5	4	1	0	10
Total Marks	**14**	**17**	**17**	**04**	**52**

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

Suggested learning Resources:

(c) **Books:**
(d)

S.No.	**Title/Author/Publisher details**
1	TE Creighton. Protein Function A Practical Approach, 2005. W.H. Freeman & Company. New Edition.
2	Thomas E Creighton , Creighton. Proteins: Structures and Molecular Properties, W.H. Freeman & Company. New Edition
3	N J Darby, T E Creighton. Protein Structure (In Focus), W.H. Freeman & Company. New Edition.
4	TE Creighton. Protein Function A Practical Approach, 2005. W.H. Freeman & Company. New Edition.
5	Thomas E Creighton , Creighton. Proteins: Structures and Molecular Properties, W.H. Freeman & Company. New Edition

(e) Online Resources:

Suggested instructions/Implementation strategies:

10. Improved lecture
11. Tutorial
12. Case method
13. Group Discussion
14. Role play
15. Visit to Waste water/Effluent Treatment plant and downstream pharmaceutical plants
16. Demonstration
17. ICT Based teaching Learning
18. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Tech. Biotechnology

Semester: V Semester

Course Title: Bioseparations

Course Code: 98BT505

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 98BT704. Explain the classification and construction of proteins	**-**	**-**	**-**	**1**	**2**	**2**	**1**	**-**	**3**	**1**	**3**	**1**	**-**	**-**	**-**
CO2 98BT704. Analyse and compare the amino acid sequences and structures of proteins and relate this information to function	**-**	**1**	**-**	**-**	**1**	**-**	**3**	**-**	**3**	**2**	**3**	**3**	**-**	**1**	**-**
CO3 98BT704. Modify a protein purification scheme to a specific application.	**-**	**2**	**1**	**1**	**-**	**-**	**3**	**-**	**3**	**1**	**2**	**3**	**-**	**2**	**1**
CO4 98BT704. Understand the different systems of recombinant protein expression with advantages and disadvantages of each one.	**1**	**1**	**1**	**-**	**2**	**2**	**2**	**3**	**-**	**1**	**2**	**3**	**1**	**1**	**1**
CO5 98BT704. Comprehend the difficulties in working	**1**	**-**	**2**	**1**	**-**	**2**	**3**	**3**	**-**	**2**	**2**	**3**	**1**	**-**	**2**

with proteomics compare to genomics.														

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 98BT704**. Explain the classification and construction of proteins	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,**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO2 98BT704**. Analyse and compare the amino acid sequences and structures of proteins and relate this information to function	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6	**LI 1** **LI 2**	2.1, 2.2, 2.3, 2.4, 2.5, 2.6	**2SL-1,2,3,4**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO3 98BT704.** Modify a protein purification scheme to a specific application.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6	**LI 1** **LI 2**	3.1,3.2,3.3,3.4,3.5, 3.6	**3SL-1,2,3**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO4 98BT704**. Understand the different systems of recombinant protein expression with advantages and disadvantages of each one.	SO4.1 SO4.2 SO4.3 SO4.4 SO2.5 SO2.6	**LI 1** **LI 2**	4.1,4.2,4.3,4.4, 4.5, 4.6	**4SL-1,2,3,4**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO5 98BT704**. Comprehend the difficulties in working with proteomics compare to genomics.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6	**LI 1** **LI 2**	5.1,5.2,5.3,5.4,5.5, 5.6	**5SL-1,2,3,4,**

Program Name	**Bachelor of Technology (B.Tech.)- Biotechnology**	
Semester	VII	
Course Code:	98BT704-B	
Course title:	Bioremediation	**Curriculum Developer**: Dr. Ashwini A. Waoo, Professor
Pre-requisite:	Student should have basic knowledge of environmental factors and pollution	
Rationale:	Bioremediation, integral to a BTech Biotechnology curriculum, offers a crucial understanding of eco-friendly solutions to environmental pollution. Its inclusion cultivates interdisciplinary skills, aligning students with sustainable practices and equipping them with applied biotechnological expertise for addressing real-world environmental challenges effectively.	
Course Outcomes (COs):	**CO1-98BT704-B.1**: Identify the different types of bioremediation techniques, mechanism and microbes for bioremediation **CO2-98BT704-B.2**: Differentiate criteria of types of bioremediations and its detail process. **CO3-98BT704-B.3**: Evaluate the roles Bio sorption & Bioleaching and phytoremediation. **CO4-98BT704-B.4**: Use of Bioremediation of phenols, cyanides, dyes, understand biodegradation through pathway engineering. **CO5-98BT704-B.5**: Case study and demonstration of bioremediation plan for industrial waste.	

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)	
ProgramElective (PE)	98BT704-B	Bioremediation	2	2	1	5	10	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)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)		

				10 marks each (CT)					
PE	98BT704-B	Bioremediation	**15**	**20**	**10**	**5**	**50**	**50**	**100**

Scheme of Assessment: Practical

			Scheme of Assessment (Marks)		
			Progressive Assessment (PRA)		

Board of Study	Course Code	Course Title	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)	End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
PE	**98BT754-B**	Bioremediation-lab	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	CI	LI	SW	SL	Total
Approx. Hrs	06	00	01	05	14

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO1-98BT704-B.1: Identify the different types of bioremediation techniques, mechanism and microbes for bioremediation	**SO1.1** Understand scope, types and need of bioremediation	**LI1.1:** To demonstrate the process of bioremediation using microbial cultures.	**Unit-1** **CI1.1** Types of Bioremediations	**SL1.1** Study of biotic and abiotic factors of environment
	SO1.2 Understand factors affecting bioremediation	**LI1.2:** To evaluate the factors affecting bioremediation efficiency in controlled environments.	**CI1.2** Factors affecting Bioremediation.	**SL1.2** Factors affecting growth of microbes
	SO1.3 Illustration of and mechanism of bioremediation		**CI1.3** Bioremediation Mechanisms,	**SL1.3** Mechanism of Bioremediation in algae, fungi, bacteria
	SO1.4 Evaluate limitations of bioremediation		**CI1.4** Limitations of Bioremediations	
	SO1.5 Analyze microbial diversity for use in bioremediation experiment.		**CI1.5** Microbes for Bioremediation	**SL1.4** List out microorganisms used for bioremediation
	SO1.6 Study characteristics of microbes for bioremediation. adptations for bioremediation		**CI1.6** Essential Characteristics of Microbes for Bioremediation. adptations for bioremediation	**SL1.5** List out adaptations for bioremediation

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Enlist types of Bioremediation techniques.
	SW1.2 Mini Project	Prepare list of microorganisms and respective pollutants used for bioremediation
	SW1.3 Other Activities (Specify)	Prepare chart on mechanism of bioremediation.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	04	01	05	16

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO2-98BT704-B.2: Differentiate criteria of types of bioremediations and its detail process.	**SO2.1** Explore types of bioremediation technique	LI 1 Isolation of pollutant degrading bacteria from various contaminated sits	**Unit-II** **CI2.1** Insitu & Exsitu bioremediation techniques	**SL2.1** Search various techniques of bioremediation
	SO2.2 Describe the Land farming technique	LI 2 Strain improvement for bioremediation	**CI2.2** Application, specific advantages and disadvantages of bioremediation technologies - land farming	**SL2.2** Write a note on land farming
	SO2.3 Study advantages, disadvantages and applications of Biopiles		**CI2.3** prepared beds, biopiles	**SL2.3** Learn about contents prepared bed and biopiles

	SO2.4 Explain Study advantages, disadvantages and applications of composting		**CI2.4** composting	**SL2.3** Searching online about ongoing composting plants
	SO2.5 Assessing advantages, disadvantages and applications of Bioventing		**CI2.5** Bioventing	
	SO2.6 Explaining the steps of Biosparging		**CI2.6** Biosparging	**SL2.5** Prepare design of biosparging implementation plan
	SO2.7 Explaining the stages of execution of constructed wet land		**CI2.7** constructed wet lands,	
	SO2.8 explain about Bioreactor used in bioremediation	LI 1 Demonstration of bioreactor for bioremediation	**CI2.8** use of bioreactors for bioremediation.	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Describe principles of types of bioremediation techniques
	SW2.2 Mini Project	Prepare complete draft on mechanism, advantages and disadvantages of each type
	SW2.3 Other Activities (Specify)	Prepare a bioremediation plan using bioreactor for industry waste.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	04	01	04	15

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO3-98BT704-B.3: Evaluate the roles Bio sorption & Bioleaching and phytoremediation.	**SO3.1** Explain the role of Bioleaching in bioremediation	**LI3.1** To perform the phytostablization	**Unit-III** **CI3.1** Microorganisms involved in Bioleaching of ores	**SL3.1** Read about Bioleaching and applications
	SO3.2 Assessing efficiency of Mechanism		**CI3.2** mechanisms of bioleaching	**SL3.2** Collection of research data on bioleaching
	SO3.3 Understand metal recovery in mines		**CI3.3** metal recovery.	**SL3.3** Illustration about different techniques of metal recovery
	SO3.4 Study microbial transformation		**CI3.4** Microbial transformation	
	SO3.5 Describe phytoremediation	**LI3.2** Demonstration of phytoremediation of waste water	**CI3.5** Phytoremediation, mechanisms	
	SO3.6 Assessing the role of phytoextraction, phytostabilization, phytovolatilaztion, rhizodegradation, rhizofiltration, Phytoremediation of contaminated sites		**CI3.6** phytoextraction, phytostabilization, phytovolatilaztion, rhizodegradation, rhizofiltration, Phytoremediation of contaminated sites	**SL3.4** Write a note on Phytoextraction

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Describe principles of biosorption, bioleaching and phytoremediation
	SW3.2 Mini Project	Prepare complete draft on mechanism, advantages and disadvantages of each type of phytoremediation

	SW3.3 Other Activities (Specify)	Prepare a phytoremediation plan for industry waste.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	04	01	05	16

Course Outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO4-98BT704-B.4: Use of Bioremediation of phenols, cyanides, dyes, understand biodegradation through pathway engineering.	**SO4.1** Understand process of bioremediation of phenols dyes and cynaides	Li4.1To demonstrate the process of bioremediation using microbial cultures.	**Unit-IV** **CI4.1** Bioremediation of phenols	**SL4.1** Learn about phenol health hazards
	SO4.2 Assessing the bioremediation of cyanides		**CI4.2** cyanides,	**SL4.2** Discuss health hazards and sources of Cyanide pollution
	SO4.3 Illustration of Dye bioremediation	LI 4.2 Isolation of dye degrading bacteria and dye degradation.	**CI4.3** dyes;	**SL4.3** Learn about various types of dyes in textile industry
	SO4.4 Illustrate mechanism and applications of Rhizoremediation		**CI4.4** Rhizoremediation: a beneficial plant-microbe interaction;	**SL4.4** Case studies related to rhizoremediation
	SO4.5 Understand Enhanced biodegradation through pathway engineering		**CI4.5** Molecular techniques in bioremediation	
	SO4.6 Learn pathway engineering strategies.		**CI4.6** Enhanced biodegradation through pathway engineering;	**SL4.5** Evaluate the need of GMOs for bioremediation

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Describe health effects of cyanides, dyes and phenols and their need for remediation.
	SW4.2 Mini Project	Describe the rhizoremediation detail and its applications
	SW4.3 Other Activities (Specify)	Prepare list of experiments done for pathway engineering for bioremediation

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	04	01	05	16

Course Outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO5-98BT704-B.5: Case study and demonstration of bioremediation plan for industrial waste.	**SO5.1** Illustrate technique of Bioremediation of industrial wastes.	**LI5.1:** To demonstrate the process of bioremediation using microbial cultures.	**Unit-V** **CI5.1** Bioremediation of industrial wastes.	**SL5.1** learn about basic concept of Bioremediation of industrial wastes.
	SO5.2 Illustrate the use of bioindicators,	**LI5.2:** To evaluate the factors affecting bioremediation efficiency in controlled environments.	**CI5.2** Bioindicators	**SL5.2** Review different bioindicators
	SO5.3 Apply the biomarkers for bioremediation		**CI5.3** Biomarkers	**SL5.3** learn how biomarkers help in

				bioremediation
	SO5.4 Understand the mechanism and types of biosensors		**CI5.4** Biosensors in waste treatment.	**SL5.4** Learn about types of biosensors and give examples
	SO5.5 Understand the process of Bioconversion of agricultural, Sewage		**CI5.5** Bioconversion of agricultural	
	SO5.6 Describe sewage sludge treatment, waste bioremediation, conversion of sugar waste to fertilizers		**CI5.6** Sewage sludge, waste bioremediation., conversion of sugar waste to fertilizers	**SL5.5** Learn about sugar mill waste products

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Describe short term plan for bioremediation of industry.
	SW5.2 Mini Project	Describe the applications of bioremediation.
	SW5.3 Other Activities (Specify)	Prepare a detail document on biosensors available commercially.

Course duration (in hours) to attain Course Outcomes:

Course Title: Bioremediation **Course Code:** 98BT704-B

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
CO1-98BT704-B.1: Identify the different types of bioremediation techniques, mechanism and microbes for bioremediation	6	4	5	1	16
CO2-98BT704-B.2: Differentiate criteria of types of bioremediations and its detail process.	6	4	5	1	16

CO3-98BT704-B.3: Evaluate the roles Bio sorption & Bioleaching and phytoremediation.	6	4	4	1	15
CO4-98BT704-B.4: Use of Bioremediation of phenols, cyanides, dyes, understand biodegradation through pathway engineering.	6	4	5	1	16
CO5-98BT704-B.5: Case study and demonstration of bioremediation plan for industrial waste.	6	4	5	1	16
Total Hours	30	20	24	05	79

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

Course Title: Bioremediation **Course Code:** 98BT704-B

Course Outcomes	**A**	**An**	**E**	**Total Marks**
CO1-98BT704-B.1: Identify the different types of bioremediation techniques, mechanism and microbes for bioremediation	02	02	01	05
CO2-98BT704-B.2: Differentiate criteria of types of bioremediations and its detail process.	03	05	02	10
CO3-98BT704-B.3: Evaluate the roles Bio sorption & Bioleaching and phytoremediation.	05	05	05	15
CO4-98BT704-B.4: Use of Bioremediation of phenols, cyanides, dyes, understand biodegradation through pathway engineering.	04	03	03	10
CO5-98BT704-B.5: Case study and demonstration of bioremediation plan for industrial waste.	05	04	01	10
Total Marks	19	19	12	50

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

Suggested learning Resources:

(f) Books:

(g)

S. No.	Title	Author	Publisher	Edition & Year
1	Microbial Biodegradation and Bioremediation,	Surajit Das,	Elsevier,	2017
2	Bioremediation Technology: Recent Advances,	M. H. Fulekar,	Springer Science & Business Media	2012
3	Biodegradation and Bioremediation, , ,	Martin Alexander	Academic Press	1994,
4	Bioremediation: Principles and Applications	Ronald L. Crawford, Don L. Crawford	Cambridge University Press	2005
5	Applied Bioremediation and Phytoremediation, ,	Ajay Singh, Owen P. Ward	Springer Berlin Heidelberg,	2011

(h) Online Resources:

Suggested instructions/Implementation strategies:

19. Improved lecture
20. Tutorial

21. Case method
22. Group Discussion
23. Role play
24. Visit to virology lab (BSL-3)
25. Demonstration
26. ICT Based teaching Learning
27. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Tech. Biotechnology

Semester: VII

Course Title: Bioremediation

Course Code: 98BT704-B

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

CO1-98BT704-B.1: Identify the different types of bioremediation techniques, mechanism and microbes for bioremediation	-	-	1	2	2	2	2	-	1	2	2	3	3	-	-
CO2-98BT704-B.2: Differentiate criteria of types of bioremediations and its detail process.	-	-	-	-	-	-	-	-	2	2	3	3	2	-	1
CO3-98BT704-B.3: Evaluate the roles Bio sorption & Bioleaching and phytoremediation.	-	1	1	1	-	2	2	-	3	3	3	2	2	2	1
CO4-98BT704-B.4: Use of Bioremediation of phenols, cyanides, dyes, understand biodegradation through pathway engineering.	-	1	1	2	2	2	2	3	-	1	2	2	2	2	2
CO5-98BT704-B.5: Case study and demonstration of bioremediation plan for industrial waste.	1	1	1	-	-	3	3	3	1	2	3	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 1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2,3	**CO1-98BT704-B.1:** Identify the different types of bioremediation techniques, mechanism and microbes for bioremediation	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	**CO2-98BT704-B.2:** Differentiate criteria of types of bioremediations and its detail process.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6	Li 1, LI 2	2.1, 2.2, 2.3, 2.4, 2.5, 2.6	2SL-1,2,3,4,5

PO 1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2,3	**CO3-98BT704-B.3:** Evaluate the roles Bio sorption & Bioleaching and phytoremediation.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6	Li 1, LI 2	3.1,3.2,3.3,3.4,3.5, 3.6	3SL-1,2,3,4
PO 1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2,3	**CO4-98BT704-B.4:** Use of Bioremediation of phenols, cyanides, dyes, understand biodegradation through pathway engineering.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6	Li 1, LI 2	4.1,4.2,4.3,4.4, 4.5, 4.6	4SL-1,2,3,4,5
PO 1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2,3	**CO5-98BT704-B.5:** Case study and demonstration of bioremediation plan for industrial waste.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6	Li 1, LI 2	5.1,5.2,5.3,5.4,5.5, 5.6	5SL-1,2,3,4,5

Program Name	**B. Tech. Biotech Semester-**	
Semester	**VIIth**	
Course Code:	**98BT704-C**	
Course title:	**Metagenomics**	**Curriculum Developer**: Mr. Piyush Kant Rai, Assistant professor
Pre-requisite:	Proficiency in bioinformatics and molecular biology techniques.	
Rationale:	Equipping students with skills to analyze and manage metagenomic data, interpret phylogenetic trees, utilize protein databases, and contribute to scientific knowledge sharing and collaboration.	
Course Outcomes (COs):	**98BT704-C-CO1. Conduct appropriate quality control and decontamination of metagenomic data** **98BT704-C-CO2. Discuss and interpret phylogenetic tree construction models** **98BT704-C-CO3. Utilize protein databases and tools for analysis of annotated structures and functions** **98BT704-C-CO4. Apply relevant tools in the analysis of metagenomic data** **98BT704-C-CO5. Submit metagenomic data to online repositories for sharing and future analysis**	

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)	
Program elective (PE)	98BT704-C	Metagenomics	2	2	1	1	6	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	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)
Program elective (PE)	**98BT704-C**	**Metagenomics**	16	19	5	5	5	50	50

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)		
Program elective (PE)	**98BT754-C**	**Metagenomics**	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	06	04	01	03	14

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
98BT704-C-CO1. Conduct appropriate quality control and decontamination of metagenomic data	**SO5.1** Metagenomic Analysis of Soil Microbial Communities	**LI1.1** Introduction to Experimental Setup of DNA Isolation	**CI1.1** Metagenomic Analysis of Soil Microbial Communities	**SL1.1** Independent research on soil microbial community
	SO5.2 Metagenomic Analysis of Marine Microbial Communities	**LI1.2** to isolate the genomic DNA from environmental sample	**CI1.2** Metagenomic Analysis of Marine Microbial Communities	**SL1.2** Self-paced learning to understand the workflow and differences between these sequencing approaches.
	SO5.3 Metagenome of the Microbial Community in Acid Mine Drainage		**CI1.3** Metagenome of the Microbial Community in Acid Mine Drainage	**SL1.3** Revise Microbial Community in Acid Mine Drainage
	SO5.4 Understand Metagenomic Analysis of Bacteriophages		**CI1.4** Metagenomic Analysis of Bacteriophages	

	SO5.5 Metagenomics and Its Applications to the Study of the Human Microbiome		**CI1.5** Metagenomics and Its Applications to the Study of the Human Microbiome	
	SO5.6 Archaeal Metagenomics: Bioprospecting Novel Genes and Exploring New Concepts		**CI1.6** Archaeal Metagenomics: Bioprospecting Novel Genes and Exploring New Concepts	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Design a mini-project comparing different metagenomics approaches
	SW1.2 Mini Project	Group Assignment - Genome Sequencing Project
	SW1.3 Other Activities (Specify)	Evaluate students based on their technique, accuracy, and data interpretation skills.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	**06**	4	1	3	14

Course Outcome (CO)	**Session Outcomes (SOs)**	**LaboratoryInstruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
98BT704-C-CO2. Discuss and interpret phylogenetic tree construction models	**SO2.1** Overview of Phylogenetic Tree Construction	**LI2.1** To learn Basics of analysis platforms	**CI2.1** Phylogenetic Tree Construction	**SL2.1** Practice phylogenetic tree reconstruction method
	SO2.2 What are Web-based Servers and Software	**LI2.2** To search and explore various genomes using metagenome analysis	**CI2.2** Construction of a Metagenomic Library	**SL2.2** Explore Phylip
	SO2.3 Analysis of Metagenomic Libraries		**CI2.3** Analysis of Metagenomic Libraries	**SL2.3** Remember steps of metagenome analysis

	SO2.4 Sequence-based Metagenomics Analysis		**CI2.4** Sequence-based Metagenomics Analysis	
	SO2.5 Function-based Metagenomics Analysis.		**CI2.5** Function-based Metagenomics Analysis	
	SO2.6 Phylogenetic Analysis and Comparative Genomics		**CI2.6** Phylogenetic Analysis and Comparative Genomics	

Item	Cl	LI	SW	SL	Total
Approx. Hrs	**06**	4	**1**	3	14

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Write about the comparative genomics
	SW2.2 Mini Project	Write about web-based tools.
	SW2.3 Other Activities (Specify)	Find out some you tube videos based on how to do genome analysis.

Course Outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
98BT704-C-CO3. Utilize protein databases and tools for analysis of annotated structures and functions	**SO3.1** Protein Separations Before Digestion	**LI3.1** Apply ADMET properties to any lead compound	**CI3.1** Protein Separations Before Digestion	**SL3.1** Remember HPLC process
	SO3.2 High-Performance Liquid Chromatography (HPLC)	LI3.2 to perform the HPLC for the given sample	**CI3.2** High-Performance Liquid Chromatography (HPLC)	**SL3.2** Understand the role of protein-protein interactions using SDS
	SO3.3 Protein Separations After Digestion		**CI3.3** Protein Separations After	**SL3.3** Write Develop an experimental design for

			Digestion	protein separation
	SO3.4 MALDI-TOF-MS: The TOF Mass Analyzer		**CI3.4** MALDI-TOF-MS: The TOF Mass Analyzer	
	SO3.5 Problems with 2D-SDS-PAGE		**CI3.5** Problems with 2D-SDS-PAGE	
	SO3.6 Pros and Cons of MALDI		**CI3.6** Pros and Cons of MALDI.	

Item	Cl	LI	SW	SL	Total
Approx. Hrs	**06**	4	1	1	12

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Remember MALDI TOF
	SW3.2 Mini Project	
	SW3.3 Other Activities (Specify)	Explore online tutorials and resources on SDS PAGE.

Course Outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
98BT704-C-CO4. Apply relevant tools in the analysis of metagenomic data	**SO4.1** Answer Introduction to Environmental Metagenomics	**LI4.1** Safety instructions and laboratory protocols for handling Raw data of metagenome	**CI4.1** Introduction to Environmental Metagenomics	**SL4.1** learn Interpretation of Metagenomics
	SO4.2 Pure Culture and Consortium in Environmental Metagenomics	**LI4.2** To prepare the recombinant DNA using E.coli	**CI4.2** Pure Culture and Consortium in Environmental Metagenomics	
	SO4.3 Cultivable and Non-Cultivable Microbial Analysis		**CI4.3** Cultivable and Non-Cultivable Microbial Analysis	

	SO4.4 Recombinant DNA Technology and DNA Cloning		**CI4.4** Recombinant DNA Technology and DNA Cloning	
	SO4.5 Molecular Fingerprinting Techniques		**CI4.5** Molecular Fingerprinting Techniques	
	SO4.6 Stable Isotope Probing (SIP) and Suppressive Subtractive Hybridization		**CI4.6** Stable Isotope Probing (SIP) and Suppressive Subtractive Hybridization	

Item	Cl	LI	SW	SL	Total
Approx. Hrs	**06**	4	1	3	14

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Stable Isotope Probing (SIP) and Suppressive Subtractive Hybridization.
	SW4.2 Mini Project	
	SW4.3 Other Activities (Specify)	Relate the Molecular finger printing

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
98BT704-C-CO5. Submit metagenomic data to online repositories for sharing and future analysis	**SO5.1** What is Application of Metagenomics to Bioremediation	**LI5.1** How to do the DNA sequencing of uncultured microbes	**CI5.1** Application of Metagenomics to Bioremediation.	**SL5.1** Revise Application of Metagenomics to Bioremediation
	SO5.2 Able to apply Applications of Metagenomics for Industrial Bioproducts.	**LI5.2** to understand the Raw data came from NGS	**CI5.2** Applications of Metagenomics for Industrial Bioproducts.	**SL5.2** Recall Metagenomic Enzyme Discovery.
	SO5.3 Escherichia coli Host Engineering for Efficient Metagenomic Enzyme Discovery		**CI5.3** Escherichia coli Host Engineering for Efficient Metagenomic Enzyme Discovery	**SL5.3** Remember Next-Generation Sequencing Approaches to Metagenomics
	SO5.4 Next-Generation		**CI5.4** Next-Generation	

	Sequencing Approaches to Metagenomics		Sequencing Approaches to Metagenomics	
	SO5.5 Stable Isotope Probing: Uses in Metagenomics		**CI5.5** Stable Isotope Probing: Uses in Metagenomics	
	SO5.6 DNA Sequencing of Uncultured Microbes from Single Cells		**CI5.6** DNA Sequencing of Uncultured Microbes from Single Cells	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	illustrate the Applications of Metagenomics for Industrial Bioproducts
	SW5.2 Mini Project	Make a flow chart of approaches to metagenomics
	SW5.3 Other Activities (Specify)	Rewrite the Next-Generation Sequencing Approaches to Metagenomics

Course duration (in hours) to attain Course Outcomes:

Course Title: Metagenomics **Course Code: 98BT704-C**

Course Outcomes (COs)	Class lecture (CI)	Laboratory Instruction (LI)	Self-Learning (SL)	Sessional work (SW)	Total Hours (Li+CI+SL+SW)
98BT704-C-CO1. Conduct appropriate quality control and decontamination of metagenomic data	6	4	3	1	14
98BT704-C-CO2. Discuss and interpret phylogenetic tree construction models	6	4	3	1	14
98BT704-C-CO3. Utilize protein databases and tools for analysis of annotated structures and functions	6	4	3	1	14
98BT704-C-CO4. Apply relevant tools in the analysis of metagenomic data	6	4	1	1	12
98BT704-C-CO5. Submit metagenomic data to online repositories for sharing and future analysis	6	4	3	1	14
Total Hours	30	20	13	5	68

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

Course Title: Metagenomics **Course Code: 98BT704-C**

Course Outcomes	Marks Distribution				Total Marks
	A	An	E	C	
98BT704-C-CO1. Conduct appropriate quality control and decontamination of metagenomic data	02	03	04	1	10
98BT704-C-CO2. Discuss and interpret phylogenetic tree construction models	02	05	02	1	10
98BT704-C-CO3. Utilize protein databases and tools for analysis of annotated structures and functions	04	04	01	1	10
98BT704-C-CO4. Apply relevant tools in the analysis of metagenomic data	03	04	02	1	10
98BT704-C-CO5. Submit metagenomic data to online repositories for sharing and future analysis	04	03	02	1	11
Total Marks	15	19	11	05	51

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

Suggested learning Resources:

(i) Books:

(j)

S.No.	Title/Author/Publisher details
1	Genes IX by Benjamin Lewin, Johns and Bartlett Publisher, 2016
2	Metagenomics: Methods and Protocols, Wolfgang R. Streit, Rolf Daniel, Springer New York, 2016
3	Metagenomics: Perspectives, Methods, and Applications, Muniyandi Nagarajan, ACADEMIC PRESS, 2017

(k) Online Resources:

Suggested instructions/Implementation strategies:

28. Improved lecture
29. Tutorial
30. Case method
31. Group Discussion

32. Role play
33. Visit to Research lab (BSL-1)
34. Demonstration
35. ICT Based teaching Learning
36. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Tech. Biotechnology

Semester: 7th Sem

Course Title: Metagenomics

Course Code: 98BT704-C

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
98BT704-C-CO1. Conduct appropriate quality control and decontamination of metagenomic data	-	1	-	1	1	2	1	-	3	1	3	1	-	1	-
98BT704-C-CO2. Discuss and interpret phylogenetic tree construction models	-	1	-	-	-	-	3	-	3	2	3	3	-	1	-

98BT704-C-CO3. Utilize protein databases and tools for analysis of annotated structures and functions	-	2	1	1	-	-	3	-	3	1	3	3	-	2	1
98BT704-C-CO4. Apply relevant tools in the analysis of metagenomic data	1	1	1	-	2	2	2	3	-	1	3	3	1	1	1
98BT704-C-CO5. Submit metagenomic data to online repositories for sharing and future analysis	1	1	2	-	-	2	3	3	-	2	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 2,4,5,6,7,9,10,11,12 PSO 2	**98BT605-CO1. Understand about the fundamentals of genomics and proteomics**	SO1.1 SO1.2 SO1.3 SO1.4,SO1.5, SO1.6	**IL 1** **IL 2**	1.1,1.2,1.3,1.4 ,1.5,1.6	**1SL-1,2,3**
PO 2,7,9,10,11,12 PSO 2,	**98BT605-CO2. Outline the next-generation sequencing techniques**	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5,SO2.6	**IL 1** **IL 2**	2.1, 2.2, 2.3, 2.4,2.5,2.6	**2SL-1,2,3**
PO 2,3,4, 7,9,10,11,12 PSO 2, 3	**98BT605-CO3. Apply analytical approach to identify protein structures**	SO3.1 SO3.2 SO3.3 SO3.4 ,3.5,SO3.6	**IL 1** **IL 2**	3.1,3.2,3.3,3.4.3.5,3.6	**3SL-1,2,3**
PO 1,2,3,5,6 7,8,10,11,12 PSO 1,2, 3	**98BT605-CO4. Analyse vaccine designing and protein-ligand interactions for drug discovery**	SO4.1 SO4.2 SO4.3 SO4.4 ,SO4.5,SO4.6	**IL 1** **IL 2**	4.1,4.2,4.3,4.4,4.5,4.6	**4SL-1**
PO 1,2,3,4,5,6 7,9,10,11,12 PSO 1,2, 3	**98BT605-CO5. Compare various databases and software used in proteomics**	SO5.1 SO5.2 SO5.3 SO5.4 ,SO5.5,SO5.6	**IL 1** **IL 2**	5.1,5.2,5.3,5.4,5.5,5.6	**5SL-1,2,3**

Program Name	B.Tech. in Biotechnology	
Semester	VII	
CourseCode:	98BT706	
Coursetitle:	Research Methodology	**Curriculum Developer**: Dr. Deepak Mishra, Professor
Pre-requisite:	Student should have basic and advanced knowledge of Biotechnology and practical as well as research skills.	
Rationale:	The paper on Research Methodology in an BTech Biotechnology program explores the critical role of specialized research and scientific tools in analyzing Biotechnological research. It delves into the use of precise instruments for monitoring and analyzing data and literature, development of research skills and scientific aptitudes. This study enables students to understand how systematic research process helps us for doing any research in a systematic manner along with data publication. It also explore the publication ethics and plagiarism knowledge.	
Course Outcomes (COs):	**CO1-98BT706.1:** Students are being knowledgeable with essentials of research methodology through various tools available. **CO2-98BT706.2:** Development of critical thinking skills for evaluating scientific literature and identifying research problems. **CO3-98BT706.3:** Proficiency in communicating research findings through various written forms. **CO4-98BT706.4:** Recognize various issues related to research ethics, data processing and integrity, research commercialization. **CO5-98BT706.5:** Proficiency in report writing, plagiarism rectification, making deliberations and presentation.	

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)	
Program Common(PC)	98BT706	Research Methodology	2	-	1	5	8	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 Assessmen t	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)
PC	**98BT706**	Research Methodology	**15**	**20**	**10**	**5**	**50**	**50**	**100**

Course-Curriculum:

<table>
<tr>
<td>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.</td>
<td>Approximate Hours
<table>
<tr><td>Item</td><td>Cl</td><td>LI</td><td>SW</td><td>SL</td><td>Total</td></tr>
<tr><td>Approx.Hrs</td><td>06</td><td>00</td><td>01</td><td>05</td><td>12</td></tr>
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Course outcome (CO)	Session Outcomes(SOs)	Laboratory Instruction(LI)	Class room Instruction(CI)	Self-Learning(SL)
CO1-98BT706.1: Students are being knowledge-able with essentials of research methodology through various tools available	**SO1.1** Define and Describe concept of scientific writing and research, its types		**Unit-1** **CI1.1** Scientific Writing & Research- meaning, types,	**SL1.1** Search various reference books and study material to start the learning of research and scientific writing
	SO1.2 Describe about objectives and approaches of research		**CI1.2** objectives, and approaches	**SL1.2** Differentiation of research problems based on objective
	SO1.3 Explain about methods and sources of literature		**CI1.3** Literature collection: Different sources,	**SL1.3** Searching and literature on different online resources.
	SO1.4 Describe about biological online database		**CI1.4** Biological online databases,	
	SO1.5 Study of sampling techniques		**CI1.5** Determining sample design,	**SL1.4** Use of sampling methods for collection of scientific data related to different research problems
	SO1.6 Study of data collection methods, hypothesis testing		**CI1.6** collecting data, hypothesis testing	**SL1.5** Setting up the Hypothesis and their application in research

Suggested Sessional Work (SW):*anyone*	**SW1.1** Assignments	Describe in detail research and its types
	SW1.2 Mini Project	Collection of data and literature related to any biotechnological research problem
	SW1.3 Other Activities (Specify)	Searching of online database available on internet and their application in research

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	00	01	05	12

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO2-98BT706.2: Development of critical thinking skills for evaluating scientific literature and identifying research problems	**SO2.1**Explore the concept and techniques of writing reviews		**Unit-II** **CI2.1** Writing review articles,	**SL2.1** Search various contents for writing a review article
	SO2.2 Describe the contents of research article		**CI2.2** Writing Journal articles, bibliography	**SL2.2** designing of a research article
	SO2.3 Reflecting about the concept and contents of books and monograph		**CI2.3** books, and monographs-	**SL2.3** Learn about contents of an ideal book
	SO2.4 Explain about contents of an ideal thesis		**CI2.4**Structure of thesis;	**SL2.3** Searching and literature on different online resources.
	SO2.5 Assessing the role of manuscript and proof correction in research		**CI2.5**Manuscript and proof correction,	

	SO2.6 Explaining the steps of research process, execution of research, types of research designs.		**CI2.6**Research Process: selection of problems, execution of research, types of research designs.	**SL2.5** Use of research process to solve different research problems

Suggested Sessional Work (SW):*anyone*	**SW2.1** Assignments	Describe in detail about different stages of execution of research by using research process.
	SW2.2 Mini Project	Designing of a research thesis.
	SW2.3 Other Activities (Specify)	Take a research problem a select a specific research design for solving it.

Item	Cl	LI	SW	SL	Total
Approx.Hrs	06	00	01	05	12

Course Outcome (CO)	**Session Outcomes(SOs)**	**Laboratory Instruction(LI)**	**Class room Instruction (CI)**	**Self-Learning(SL)**
CO3-98BT706.3: Proficiency in communicating research findings through various written forms.	**SO3.1** Explain the role of different types of data in research.		**CI3.1** Data Collection: Secondary Data, Primary Data	**SL3.1** Read about various types of data and their applications in research
	SO3.2 Assessing different methods used in data collection		**CI3.2** Methods of collection	**SL3.2** Collection of research data using different tools

	SO3.3 Explaining concept and types of scales		**CI3.3** Scaling Techniques Concepts and types,	**SL3.3** Illustration about different scaling techniques
	SO3.4 Assessing different scaling methods used in research		**CI3.4** Rating scales and Ranking scales, Scale Construction techniques	
	SO3.5 Describe about multi-dimensional scaling		**CI3.5** Multi-Dimensional Scaling.	**SL3.4** Collection of different research journals
	SO3.6 Assessing the role of research journals in research and their standards, concept of impact factor and citation index		**CI3.6** Journals: Standard of research Journals, Impact factor, citation index	**SL3.5** Assess role of impact factor and citation index in research

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Describe in detail different categories of data and its collection methods.
	SW3.2 Mini Project	Describe the role of scaling methods in research and their application for data validation
	SW3.3 Other Activities (Specify)	Prepare a list of research journal and checking their standard parameters.

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	00	01	05	12

Course Outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO4-98BT706.4: Recognize various issues related to research ethics, data processing and integrity, research commercialization	**SO4.1** Exploring the concept of data processing		**CI4.1** Data processing	**SL4.1** Learn about data processing approaches and its implementation.
	SO4.2 Explaining the analytical/ statistical methods involved in research		**CI4.2** Qualitative and Quantitative analytical / statistical methods involved in research.	**SL4.2** Learn about analytical and scientific methods of research.
	SO4.3 Assessing the sources of ethical issues in science and biotechnology		**CI4.3** Research Ethics- The source of ethical issues in science and biotechnology	**SL4.3** Discuss ethical concern of research in science and biotechnology
	SO4.4 Explaining the concept of objectivity and integrity		**CI4.4** research and reporting objectivity and integrity,	**SL4.4** Learn about various types of reports
	SO4.5 Explaining the plagiarism and related issues		**CI4.5** the problem of plagiarism and related issues	**SL4.5** SL4.4 Case studies related to plagiarism
	SO4.6 Evaluate impact of international norms and standards.		**CI4.6** international norms and standards, the impact of scientific temper and virtues ethical issues and environmental impact and commercializing research.	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Explain about Qualitative and Quantitative analytical / statistical methods involved in research.
	SW4.2 Mini Project	Describe the various ethical issues related to biotechnological research.
	SW4.3 Other Activities (Specify)	Prepare one article on commercialization of research

Item	Cl	LI	SW	SL	Total
Approx.Hrs	6	00	01	05	12

Course Outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
CO5-98BT706.5: Proficiency in report writing, plagiarism rectification, making deliberations and presentation	**SO5.1** Define the concept and types and components of scientific reports		**CI5.1** Structure, Types and components of scientific reports	**SL5.1** learn about basic concept & requirement of research report
	SO5.2 Able to execute steps layout and structure of research.		**CI5.2** Steps, Layout and structure; Illustrations and tables	**SL5.2**Review different layouts of report
	SO5.3 Apply the role of Bibliography, referencing and footnotes		**CI5.3** Bibliography, referencing and footnotes	**SL5.3**learn how prepare a report
	SO5.4 Evaluate the concept of plagiarism in research		**CI5.4** Reproduction of published material Plagiarism,	**SL5.4** Learn about plagiarism checking
	SO5.5 Evaluate the citation and bibliography, reproducibility and accountability		**CI5.5** Citation and acknowledgement, Reproducibility and accountability	
	SO5.6 Describe about Seminars; Symposia;		**CI5.6** General idea about: Seminars;	**SL5.5** Learn about role of deliberation.

	Workshops, Conferences and Elaborate the role of deliberations in research methods of presentation preparation, visual aids in effective communication		Symposia; Workshops, Conferences Making deliberations (Oral presentation) Planning - Preparation and Making presentation, visual aids in effective communication	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Explain general characteristics and components of research report
	SW5.2 Mini Project	Describe the role of deliberation in research
	SW5.3 Other Activities (Specify)	Prepare a detail document on Use of visual aids- Importance of effective communication

Course duration (in hours)to attain Course Outcomes:

Course Title: Research Methodology **Course Code:**98BT706

Course Outcomes(COs)	**Class lecture (CI)**	**Laboratory Instruction(LI)**	**Self-Learning (SL)**	**Sessional work (SW)**	**Total Hours (Li+CI+SL+SW)**
CO1-98BT706.1: Students are being knowledgeable with essentials of research methodology through various tools available.	6	0	5	1	12
CO2-98BT706.2: Development of critical thinking skills for evaluating scientific literature and identifying research problems.	6	0	5	1	12

CO3-98BT706.3: Proficiency in communicating research findings through various written forms.	6	0	5	1	12
CO4-98BT706.4: Recognize various issues related to research ethics, data processing and integrity, research commercialization.	6	0	5	1	12
CO5-98BT706.5: Proficiency in report writing, plagiarism rectification, making deliberations and presentation.	6	0	5	1	12
Total Hours	30	00	25	05	60

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

Course Title: Research Methodology **Course Code:**98BT706

Course Outcomes	**Marks Distribution**				**Total Marks**
	A	**An**	**E**	**C**	
CO1-98BT706.1: Students are being knowledgeable with essentials of research methodology through various tools available.	2	1	1	1	5
CO2-98BT706.2: Development of critical thinking skills for evaluating scientific literature and identifying research problems.	2	4	2	2	10
CO3-98BT706.3: Proficiency in communicating research findings through various written forms.	2	3	3	2	10
CO4-98BT706.4: Recognize various issues related to research ethics, data processing and integrity, research commercialization.	3	5	5	2	15
CO5-98BT706.5: Proficiency in report writing, plagiarism rectification, making deliberations and presentation.	5	4	1	0	10
Total Marks	**14**	**17**	**12**	**07**	**50**

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

Suggested learning Resources:

(l) Books:

(m)

S.No.	Title/Author/Publisher details
1	Beier, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent protection-Oxford and IBH Publishing Co. New Delhi.
2	Singh K, Intellectual Property rights on Biotechnology, BCIL, New Delhi
3	Writing the doctoral dissertation. Barrons Educational series, 2nd edition, Davis, G.B. and C.A. Parker, 1997. pp 160.
4	Authoring a PhD, thesis: how to plan, draft, write and finish a doctoral dissertation, Duncary, P. 2003.
5	Beier, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent protection-Oxford and IBH Publishing Co. New Delhi.

(n) Online Resources:

Suggested instructions/Implementation strategies:

37. Improved lecture
38. Tutorial
39. Case method
40. Group Discussion
41. Role play
42. Visit to virology lab (BSL-3)
43. Demonstration
44. ICT Based teaching Learning
45. Brainstorming

CO, PO and PSO Mapping

Program Name: B.Tech. Microbiology

Semester: VII Semester

Course Title: Research Methodology

Course Code: 98BT706

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
CO1-98BT706.1: Students are being knowledgeable with essentials of research methodology through various tools available.	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3
CO2-98BT706.2: Development of critical thinking skills for evaluating scientific literature and identifying research problems.	2	2	3	2	3	2	2	3	2	2	3	2	2	3	3
CO3-98BT706.3: Proficiency in communicating research findings through various written forms.	2	2	3	2	3	2	2	3	2	2	3	2	2	3	3
CO4-98BT706.4: Recognize various issues related to research ethics, data processing and	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3

integrity, research commercialization.															
CO5-98BT706.5: Proficiency in report writing, plagiarism rectification, making deliberations and presentation.	3	3	3	3	2	3	3	3	3	3	3	3	3	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	**CO1-98BT706.1:** Students are being knowledgeable with essentials of research methodology through various tools available.	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-1,2,3,4,5
PO 1,2,3,4,5 PSO 1,2,3	**CO2-98BT706.2:** Development of critical thinking skills for evaluating scientific literature and identifying research problems.	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-1,2,3,4,5
PO 1,2,3,4,5 PSO 1,2,3	**CO3-98BT706.3:** Proficiency in communicating research findings through various written forms.	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-1,2,3,4,5

PO 1,2,3,4,5 PSO 1,2,3	**CO4-98BT706.4:** Recognize various issues related to research ethics, data processing and integrity, research commercialization.	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-1,2,3,4,5
PO 1,2,3,4,5 PSO 1,2,3	**CO5-98BT706.5:** Proficiency in report writing, plagiarism rectification, making deliberations and presentation.	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-1,2,3,4,5

Program Name	**Bachelor of Technology (B.Tech.)- Biotechnology**	
Semester	VII	
Course Code:	98BT702	
Course title:	Bioprocess Engineering and Unit Operation	**Curriculum Developer**: Er. Arpit Srivastava, Assistant Professor
Pre-requisite:	Students should have basic knowledge of fermentation and biochemical engineering	
Rationale:	Bioprocess engineering is a conglomerate of mathematics, biology and industrial design, and consists of various spectrums like the design and study of bioreactors (operational mode, instrumentation, and physical layout) to the creation of kinetic models. Biochemical engineers find employment opportunities in various industries. They provide their services in the food sector, nuclear sector, healthcare industry, pharmaceuticals, chemical manufacturing companies, research laboratories and other areas. This course provides us about the knowledge about the living organisms such as plants, animals, bacteria and fungi but the bioprocess engineering helps in development of the essential skills required to utilize the living organisms for the betterment of the human beings and the nature itself.	
Course Outcomes (COs):	**CO1-98BT702.1. Recall the basic fundamentals of bioprocess engineering** **CO2-98BT702.2. Explain the production process of industrial fermented products** **CO3-98BT702.3. Apply unit operations to isolate biological products** **CO4-98BT702.4. Analyse the purity of products isolated through unit operations** **CO5-98BT702.5. Evaluate & Design numerical values for development of biomass and product formation by downstream processing**	

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)	
Program Common (PC)	98BT702	Bioprocess Engineering and Unit Operation	2	2	1	3	8	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	Class Test 2 (2 best out of 3)	Seminar one	Class Activity (CAT)	Class Attendance (AT)	Total Marks (CA+CT+CAT+SA+AT)		

			3 marks each (CA)	10 marks each (CT)	(SA)					
PC	98BT702	Bioprocess Engineering and Unit Operation	**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	98BT752	Bioprocess Engineering and Unit Operation	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	06	04	01	03	14

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
CO1-98BT505.1 Illustrate the basic mechanism of Bioprocess engineering	**SO1.1** Explain concept of Bioprocess engineering	**LI1.1** To Demonstrate the working of a Bench Top bioreactor with all its parts	**Unit-1** **Introduction and Overview** **CI1.1** A historical overview of industrial fermentation process - traditional and modern biotechnology	**SL1.1** Find out some examples of bioprocess technique used in ancient India
	SO1.2 Determine the basic and advanced terminology, scope and application	**LI1.2** To perform the isolation of microorganisms from different kinds of samples	**CI1.2** Brief survey of organisms, processes, products relating to modern biotechnology	**SL1.2** Search various reference books and study material to start the learning of microorganisms
	SO1.3 Elaborate the scientific applications of Bioseparation		**CI1.3** Process flow sheeting – block diagrams, pictorial representation	**SL1.3** Draw a flow chart showing upstream and fermentation processing
	SO1.4 Define the Fundamental		**CI1.4** Fundamental mechanism of Fermentation	
	SO1.5 mechanism of Fermentation		**CI1.5** mechanism of Fermentation	
	SO1.6 Revision and assessment		**CI1.6** Revision and assessment	

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 and parts
	SW1.3 Other Activities (Specify)	Make a power point presentation on “Role of Fermentations in Ancient India”

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	06	01	03	16

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO2-98BT752.2. Explain the production process of industrial fermented products	**SO2.1** Explain the production mechanism of multiple weak organic acids	**LI2.1** To perform the experiment on the microbial production of Acetic Acid	**CI2.1** Production of some commercially important organic acids (e.g. citric acid, lactic acid, acetic acid	**SL2.1** Find out more conventional cell disruption techniques
	SO2.2 Explain the production mechanism of Amino acids	**LI2.2** To perform the experiment of microbial production of Amino acids	**CI2.2** Microbial production of amino acids (Glutamic acid, Phenyalanine, Aspartic acid)	**SL2.2** Read the latest research in bioseparations methods
	SO2.3 Explain the production mechanism of ABE fermentation	**LI2.3** To perform the cell disruption technique using physical, chemical and biological methods	**CI2.3** ABE Fermentation (Acetone, Butanol and Ethanol)	**SL2.3** Write down few points on biological product's properties
	SO2.4: Study the commercial importance of these compounds		**CI2.4**: Commercial Importance of Organic Acids, Amino Acids, and Alcohols	
	SO2.5: Learn about the fermentation conditions for these products		**CI2.5:** Fermentation Conditions for Bioproducts	
	SO2.6: Explore the role of microorganisms in these processes		**CI2.6:** Microorganisms in Production Processes	

Suggested Sessional Work (SW): *anyone*	**SW2.1** Assignments	Describe Biosynthetic pathway for Acetone, Butanol and Ethanol derived fermentation
	SW2.2 Mini Project	Make a project on different kinds of Amino acids, their structure and functions
	SW2.3 Other Activities (Specify)	Make Power point presentation on Distillation as Unit operations

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	06	01	03	16

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO2-98BT505.3 Apply unit operations to isolate biological products using bioprocessing	**SO3.1** Elucidate the application of various kinds of separation process	**LI3.1** To perform the microbial production of Secondary metabolites using shake flask fermentation method	**Unit-3** **CI3.1** Study of production processes for various classes of secondary metabolites	**SL3.1** Find out the process of Aqueous two-phase extraction, instrument setup
	SO3.2 Derive the mathematical expression for centrifugal sedimentation	**LI3.2** To observe the growth of microbial biomass and calculate its kinetics using graph	**CI3.2** Production processes for Beta-lactams (penicillin, cephalosporin etc.),	**SL3.2** Read the process of protein precipitation and its application in healthcare
	SO3.3 Analyze the partition coefficient associated with phase extraction	**LI3.3** To determine the production of weak organic acids through fermentation	**CI3.3** Production processes for aminoglycosides (streptomycin etc.,) macrolides (erythromycin	**SL3.3** Find out the process of Ultracentrifugation and its application
	SO3.4 Distinguish among the working mechanism of Precipitation of proteins by different methods sedimentation		**CI3.4** Microbial production of vitamins and Steroids	
	SO3.5 Examine the role of microorganisms in secondary metabolite production		**CI3.5:** Microorganisms in Secondary Metabolite Production	
	SO3.6: Discuss the commercial significance of secondary metabolites		**CI3.6:** Commercial Significance of Secondary Metabolites	

Suggested Sessional Work (SW): *anyone*	**SW3.1** Assignments	Derive the equations for Centrifugation using sedimentation, terminal velocity and gravity
	SW3.2 Mini Project	Describe the role of Ultracentrifuge in industries
	SW3.3 Other Activities (Specify)	Prepare one Power point presentation on “Different types of Centrifuge and their applications”

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	02	01	03	12

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO2-98BT505.4 Analyse the purity of products isolated through unit operations	**SO4.1** Elucidate the application of various kinds of separation process	**LI4.1** To perform the production of Antibiotics using fungi in a Shake Flask reactor.	**Unit-4 Role of RDT in Bioprocessing** **CI4.1** Production of recombinant proteins having therapeutic and diagnostic applications	**SL4.1** List down the different kinds of vaccine produced through RDT process in India
	SO4.2 Derive the mathematical expression for centrifugal sedimentation		**CI4.2** Production of vaccines (Recombinant)	**SL4.2** Read the process of MoAb production and its application in healthcare
	SO4.3 Analyze the partition coefficient associated with phase extraction		**CI4.3** Production of monoclonal antibodies (MoAb), types and mechanism	**SL4.3** Find out the size of genome of various important microorganisms
	SO4.4 Distinguish among the working mechanism of Precipitation of proteins by different methods sedimentation		**CI4.4** Products of plant and animal cell culture which can be produced through Bioprocess	
	SO4.5 Interpretate and analyze various host vector system for recombinant cell cultivation		**CI4.5** Different host vector system for recombinant cell cultivation strategies and advantages	
	SO4.6 Interpretate and analyze E. coli, yeast, Pichia pastoris / Saccharomyces cereviseae		**CI4.6** Recombinant cell cultivation strategies using E. coli, yeast, Pichia pastoris / Saccharomyces cereviseae	

Suggested Sessional Work (SW): *anyone*	**SW4.1** Assignments	Determine the working mechanism and applications of different kind of Vectors used in RDT
	SW4.2 Mini Project	Derive the Plant and Animal Cell Culture based metabolites having therapeutic applications
	SW4.3 Other Activities (Specify)	Make a Power point presentation for description of “Role of Host-vector system” in RDT for Bioprocessing

Item	Cl	LI	SW	SL	Total
Approx. Hrs	6	02	01	05	14

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO5-98BT752.5. Evaluate & Design numerical values for development of biomass and product formation by downstream processing	**SO5.1** Elucidate the application & working mechanism of Chromatography	**LI5.1** To perform the Column Chromatography process as Unit Operation for extraction of different compounds	**Unit-5 Chromatography and Electrophoresis** **CI5.1** Introduction, Principle and Working fundamentals of Chromatography	**SL5.1** Find out the industrial applications of Chromatography
	SO5.2 Distinguish among Ion-exchange, size exclusion, hydrophobic interactions		**CI5.2** Types of Chromatography (Gel filtration, Reversed-phase, Hydrophobic interaction, Ion exchange; IEC)	**SL5.2** List down various kinds of Chromatographic columns used in analysis
	SO5.3 Analyze the working of Bioaffinity chromatography		**CI5.3** IMAC and bio-affinity chromatography	**SL5.3** List down various kinds of Solvents used in Chromatographic technique
	SO5.4 Distinguish among the working mechanism of Pseudo affinity Chromatographic techniques		**CI5.4** Design and selection of chromatographic matrices modes of operation	**SL5.4** List down the various kinds of Detectors associated with chromatography
	SO5.5 Describe and draw Amnio acid's structure and functions		**CI5.5** Introduction, Principle and Working fundamentals of Electrophoresis; Electrophoretic Mobility and equations	**SL5.5** Find out the role of different tracking dyes used in Electrophoresis
	SO5.6 Explain the process of Protein sequencing		**CI5.6** Agarose Gel Electrophoresis, Working mechanisms. Capillary Gel Electrophoresiws and application of Gel Electrophoresis	

Suggested Sessional Work (SW): *anyone*	**SW5.1** Assignments	Explain the working and Application of Ion Exchange Chromatography
	SW5.2 Mini Project	Describe the working mechanism and role of Agarose in Gel Electrophoresis
	SW5.3 Other Activities (Specify)	Prepare one article on the "Types of Bioinstrumentation and their applications in Bioprcess Engineeirng"

Course duration (in hours) to attain Course Outcomes:

Course Title: Bioprocess Engineering and Unit Operations **Course Code:** 98BT702

Course Outcomes (COs)	**Class lecture (CI)**	**Laboratory Instruction (LI)**	**Self-Learning (SL)**	**Sessional work (SW)**	**Total Hours (Li+CI+SL+SW)**
CO1-98BT702.1. Recall the basic fundamentals of bioprocess engineering	6	4	3	1	14
CO2-98BT702.2. Explain the production process of industrial fermented products	6	6	3	1	16
CO3-98BT702.3. Apply unit operations to isolate biological products	6	6	3	1	16
CO4-98BT702.4. Analyse the purity of products isolated through unit operations	6	2	3	1	12
CO5-98BT702.5. Evaluate & Design numerical values for development of biomass and product formation by downstream processing	6	2	5	1	14
Total Hours	30	20	17	05	72

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

Course Title: Bioprocess Engineering and Unit Operations **Course Code:** 98BT702

Course Outcomes	**Marks Distribution**				**Total Marks**
	A	**An**	**E**	**C**	
CO1-98BT702.1. Recall the basic fundamentals of bioprocess engineering	2	1	1	1	5
CO2-98BT702.2. Explain the production process of industrial fermented products	2	4	5	1	12
CO3-98BT702.3. Apply unit operations to isolate biological products	3	5	5	1	14
CO4-98BT702.4. Analyse the purity of products isolated through unit operations	2	3	5	1	11

CO5-98BT702.5. Evaluate & Design numerical values for development of biomass and product formation by downstream processing	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:

(b)

S.No.	Title/Author/Publisher details
1	Pauline M. Doran, "Bioprocess engineering principles" : Acedemic press
2	James E. Bailey & David F. Ollis- Biochemical engineering fundamentals
3	J.C. Janson And L. Ryden, (Ed.) – Protein Purification – Principles, High Resolution Methods and Applications, VCH Pub. 1989.
4	Peter F. Stanbury, Allan Whitekar "Principles fo fermentation technology"
5	Bioseparations: Principles and Techniques; Sivasankar, B; PHI Publications, 2009

(c) Online Resources:

Suggested instructions/Implementation strategies:

46. Improved lecture
47. Tutorial
48. Case method
49. Group Discussion
50. Role play
51. Visit to Beverage producing plants & Distillery/Fermenter units
52. Demonstration
53. ICT Based teaching Learning
54. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Tech. Biotechnology

Semester: VII Semester

Course Title: Bioprocess Engineering and Unit Operations

Course Code: 98BT702

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**
CO1-98BT702.1. Recall the basic fundamentals of bioprocess engineering	-	1	-	1	2	2	1	-	3	1	3	1	1	2	1
CO2-98BT702.2. Explain the production process of industrial fermented products	-	1	-	-	-	-	3	-	3	2	3	3	3	-	2
CO3-98BT702.3. Apply unit operations to isolate biological products	-	2	1	1	-	-	3	-	3	1	3	3	1	1	1

CO4-98BT702.4. Analyse the purity of products isolated through unit operations	**1**	**-**	**1**	**-**	**2**	**2**	**2**	**3**	**-**	**1**	**3**	**3**	**2**	**2**	**3**
CO5-98BT702.5. Evaluate & Design numerical values for development of biomass and product formation by downstream processing	**1**	**-**	**2**	**-**	**-**	**2**	**3**	**3**	**-**	**2**	**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 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO1-98BT702.1.** Recall the basic fundamentals of bioprocess engineering	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**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO2-98BT702.2.** Explain the production process of industrial fermented products	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6	**LI 1** **LI 2** **LI 3**	2.1, 2.2, 2.3, 2.4, 2.5, 2.6	**2SL-1,2,3**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO3-98BT702.3.** Apply unit operations to isolate biological products	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6	**LI 1** **LI 2** **LI 3**	3.1,3.2,3.3,3.4, 3.5, 3.6	**3SL-1,2,3**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO4-98BT702.4.** Analyse the purity of products isolated through unit operations	SO4.1 SO4.2 SO4.3 SO4.4 SO5.5 SO5.6	**LI 1**	4.1,4.2,4.3,4.4, 4.5, 4.6	**4SL-1,2,3**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO5-98BT702.5.** Evaluate & Design numerical values for development of biomass and product formation by downstream processing	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6	**LI 1**	5.1,5.2,5.3,5.4,5.5, 5.6	**5SL-1,2,3,4,5**

Program Name	**Bachelor of Technology (B.Tech.)- Biotechnology**	
Semester	V	
Course Code:	**98BT704-A**	
Course title:	Biofuels and Bioenergy	**Curriculum Developer**: Kamlesh Kumar Soni
Pre-requisite:	Student should have basic knowledge of life sciences and Biotechnology	
Rationale:	The paper on Biofuels and Bioenergy in B. Tech. Biotech Semester-VII program, Biofuels is a rather young discipline, which came up in the nineties. Nevertheless, Biofuels has gained so much importance within the last years that universities at all rankings have introduced or are going to introduce Biofuels and Bioenergy teaching programs. Predictions say that Biofuels and Bioenergy will change our lives and society more than computer technology and electricity have done together. The course will provide an overview over Biofuels and Bioenergy. Biofuels and Bioenergy is a highly interdisciplinary science, which will be reflected in the course by making reference to chemistry, physics, biology, pharmacy, and engineering. Applications of biosensors, as they are already in use today or as they are planned for the future, will be discussed	
Course Outcomes (COs):	**98BT704-A.1.** Understand the different generations of biofuels and discuss the steps involve in their production. **98BT704-A.2.** Compare different energy based, starch-based crops for the production of biofuel **98BT704-A.3.** Explain the role of bioleaching in metallurgy **98BT704-A.4.** Identify the types of resources and their application in day-to-day life **98BT704-A.5.** Develop the prototype of the Microbial Fuel Cell and demonstrate its working principle	

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)	
Program Common (PC)	98BT704-A	Biofuels and Bioenergy	2	2	1	3	8	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	Class Test 2 (2 best out of 3)	Seminar one (SA)	Class Activity (CAT)	Class Attendance (AT)	Total Marks (CA+CT+CAT+SA+AT)		

			3 marks each (CA)	10 marks each (CT)						
PC	98BT704-A	Biofuels and Bioenergy	**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	**98BT752-A**	Biofuels and Bioenergy	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	06	04	01	02	13

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO1-98BT704-A Understand the different generations of biofuels and discuss the steps involve in their production.	SO1.1: Understand the production mechanisms of bioethanol by microbes	LI1.1: To demonstrate the fermentation process for bioethanol production.	CI1.1: Production Mechanisms of Bioethanol	SL1.1: Study the microbial pathways involved in bioethanol production
	SO1.2: Learn about the production mechanisms of methane and hydrogen as second-generation biofuels	LI1.2: To set up a bioreactor for methane and hydrogen production.	CI1.2: Production Mechanisms of Methane and Hydrogen	SL1.2: Research on the microbial processes involved in methane and hydrogen production
	SO1.3: Study the factors affecting biogas yields		CI1.3: Factors Affecting Biogas Yields	
	SO1.4: Understand the production mechanisms of biobutanol		CI1.4: Production Mechanisms of Biobutanol	
	SO1.5: Learn about biodiesel production from algae		CI1.5: Biodiesel Production from Algae	
	SO1.6: Explore the differences between first, second, and third-generation biofuels		CI1.6: Comparison of Biofuel Generations	

Suggested Sessional Work (SW): *anyone*	**SW1.1** Assignments	Write the difference in the aerobic respiration and anaerobic respiration
	SW1.2 Mini Project	Case study: algae being utilize for the production of biodiesel
	SW1.3 Other Activities (Specify)	Find the interesting videos explaining the pathways involve in ethanol production from yeast

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	04	01	02	13

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO2-98BT704-A.2: Compare different energy based, starch-based crops for the production of biofuel	SO2.1: Understand the degradation of lignocellulose by microorganisms	LI2.1: To isolate and characterize microorganisms involved in lignocellulose degradation.	CI2.1: Degradation of Lignocellulose by Microorganisms	SL2.1: Study the microbial pathways for lignocellulose degradation
	SO2.2: Learn about the degradation of sugar and starch crops by microorganisms	LI2.2: To set up an experiment to study the microbial degradation of sugar and starch crops.	CI2.2: Degradation of Sugar and Starch Crops by Microorganisms	SL2.2: Research on the biochemical pathways involved in sugar and starch degradation
	SO2.3: Study the degradation of oilseed crops by microorganisms		CI2.3: Degradation of Oilseed Crops by Microorganisms	
	SO2.4: Understand the degradation of hydrocarbon-producing crops by microorganisms		CI2.4: Degradation of Hydrocarbon-Producing Crops by Microorganisms	
	SO2.5: Explore the microbial pathways involved in the degradation of various energy crops		CI2.5: Microbial Pathways for Energy Crop Degradation	
	SO2.6: Learn about the commercial significance of microbial degradation of energy crops		CI2.6: Commercial Significance of Microbial Degradation	

Suggested Sessional Work (SW): *anyone*	SW1.1 Assignments	List the oil seed crops and their processing for the fuel production
	SW1.2 Mini Project	Hydrocarbon: is it a better energy than others? How?
	SW1.3 Other Activities (Specify)	Read into details about the recombinant microbe to enhance the degradation of lignocellulosic crop: a case study

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	04	01	02	13

Course outcome (CO)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO3-98BT704-A.3: Explain the role of bioleaching in metallurgy	SO3.1: Understand the principles of microbial metal leaching	LI3.1: To demonstrate the basic principles of microbial metal leaching.	CI3.1: Principles of Microbial Metal Leaching	SL3.1: Study the theoretical background of microbial metal leaching
	SO3.2: Learn about leaching mechanisms and models	LI3.2: To analyze different models of leaching mechanisms.	CI3.2: Leaching Mechanisms and Models	SL3.2: Research on the various models of leaching mechanisms
	SO3.3: Study the factors influencing bioleaching		CI3.3: Factors Influencing Bioleaching	
	SO3.4: Understand bacterial attachment on mineral surfaces		CI3.4: Bacterial Attachment on Mineral Surfaces	
	SO3.5: Learn about microbial diversity in bioleaching environments		CI3.5: Microbial Diversity in Bioleaching Environments	
	SO3.6: Understand the principles of microbial metal leaching		CI3.6: Principles of Microbial Metal Leaching	

Suggested Sessional Work (SW): *anyone*	SW1.1 Assignments	Bacterial attachment for the bioleaching
	SW1.2 Mini Project	A short report on the application of bioleaching at commercial scale
	SW1.3 Other Activities (Specify)	NA

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	4	01	02	13

Course outcome (CO)	Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
CO4-98BT704-A.4: Identify the types of resources and their application in day-to-day life	O4.1: Understand the classification of resources	LI4.1: To categorize and classify various resources in a lab setting.	CI4.1: Classification of Resources	SL4.1: Study the different types of resources and their classification
	SO4.2: Learn about renewable and non-renewable resources	LI4.2: To analyze the properties and uses of renewable and non-renewable resources.	CI4.2: Renewable and Non-Renewable Resources	SL4.2: Research on the characteristics of renewable and non-renewable resources
	SO4.3: Study the use and overexploitation of resources		CI4.3: Use and Overexploitation of Resources	
	SO4.4: Understand the classification and sources of energy		CI4.4: Classification and Sources of Energy	
	SO4.5: Learn about the problems relating to the demand and supply of energy		CI4.5: Problems Relating to Demand and Supply of Energy	
	SO4.6: Explore the energy sources like coal and petroleum		CI4.6: Energy Sources: Coal and Petroleum	

Suggested Sessional Work (SW): *anyone*	SW1.1 Assignments	How overexploitation can affect the future; Make detail report on it
	SW1.2 Mini Project	A short report on the fossil fuels and their availability
	SW1.3 Other Activities (Specify)	Find the recent discovery of green technology

Suggested Sessional Work (SW): *anyone*	SW1.1 Assignments	What is nanocarbon and its application
	SW1.2 Mini Project	How Biosensors are playing important role in biotechnology, write an article for the same
	SW1.3 Other Activities (Specify)	Find out some you tube videos explaining Nano-aerosols for waste water treatments

Item	Cl	LI	SW	SL	Total
Approx. Hrs	06	4	01	02	13

Course outcome (COs)	**Session Outcomes (SOs)**	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
CO5-98BT704-A.5: Develop the prototype of the Microbial Fuel Cell and demonstrate its working principle	SO5.1: Understand the types and working principles of microbial fuel cells	LI5.1: To construct and evaluate a microbial fuel cell.	CI5.1: Types and Working Principles of Microbial Fuel Cells	SL5.1: Study the different types of microbial fuel cells and their principles
	SO5.2: Learn about the applications of microbial fuel cells	LI5.2: To demonstrate the applications of microbial fuel cells in a lab setting.	CI5.2: Applications of Microbial Fuel Cells	SL5.2: Research on the various applications of microbial fuel cells
	SO5.3: Study the theory and applications of biofilms		CI5.3: Theory and Applications of Biofilms	
	SO5.4: Understand the theory and applications of biosensors		CI5.4: Theory and Applications of Biosensors	
	SO5.5: Learn about environmental nanobiotechnology applications		CI5.5: Environmental Nanobiotechnology Applications	
	SO5.6: Understand the significance of nanobiotechnology in waste management		CI5.6: Nanobiotechnology in Waste Management	

Course duration (in hours) to attain Course Outcomes (**Course Title:** Biofuels & Bioenergy) (**Course Code: 98BT704-A)**					
Course Outcomes (COs)	**Class lecture (CI)**	**Laboratory Instruction (LI)**	**Self-Learning (SL)**	**Sessional work (SW)**	**Total Hours (Li+CI+SL+SW)**
CO1-98BT704-A.1: Understand the different generations of biofuels and discuss the steps involve in their production	6	4	2	1	13
CO2-98BT704-A.2: Compare different energy based, starch-based crops for the production of biofuel	6	4	2	1	13
CO3-98BT704-A.3: Explain the role of bioleaching in metallurgy	6	4	2	1	13
CO4-98BT704-A.4: Identify the types of resources and their application in day-to-day life	6	4	2	1	13
CO5-98BT704-A.5. Examine and demonstrate the mechanism of product purification	6	4	2	1	13
Total Hours	30	20	10	05	65

End semester Assessment Scheme for setting up question paper and assessment to evaluate the Course Outcome: (**Course Title:** Biofuels & Bioenergy) (**Course Code: 98BT704-A)**					
Course Outcomes	**Marks Distribution**				**Total Marks**
	A	**An**	**E**	**C**	
CO1-98BT704-A.1: Understand the different generations of biofuels and discuss the steps involve in their production	2	1	1	1	5
CO2-98BT704-A.2: Compare different energy based, starch-based crops for the production of biofuel	2	4	5	1	12
CO3-98BT704-A.3: Explain the role of bioleaching in metallurgy	3	5	5	1	14
CO4-98BT704-A.4: Identify the types of resources and their application in day-to-day life	2	3	5	1	11
CO5-98BT704-A.5. Examine and demonstrate the mechanism of product purification	5	4	1	0	10
Total Marks	**14**	**17**	**17**	**04**	**52**
***Legend*: A,** Apply; **An,** Analyze; **E,** Evaluate; **C,** Create					

Suggested learning Resources:

(a) Books:

S.no.	Title	Author	Publisher	Edition & Year
1	Biofuels and Bioenergy	John Love, John A. Bryant John	Wiley & Sons	1 & 2017
2	Biofuels and Bioenergy: Processes and Technologies	Sunggyu Lee, Y.T. Shah	CRC Press	1 & 2012
3	Bioenergy and Biofuels	Ozcan Konur	CRC Press	1 & 2018
4	Bioenergy: Biomass to Biofuels	Anju Dahiya	Academic Press	1 & 2014
5	Biofuels and Bioenergy	Robbie Larkin	Syrawood Publishing House	1 & 2016

(b) Online Resources:

Suggested instructions/Implementation strategies:

55. Improved lecture
56. Tutorial
57. Case method
58. Group Discussion
59. Role play
60. Visit to Waste water/Effluent Treatment plant and downstream pharmaceutical plants
61. Demonstration
62. ICT Based teaching Learning
63. Brainstorming

CO, PO and PSO Mapping

Program Name: B. Tech. Biotechnology

Semester: VII Semester

Course Title: Biofuels and Bioenergy

Course Code: 98BT704-A

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**
CO1-98BT704-A.1: Understand the different generations of biofuels and discuss the steps involve in their production	1	1	1	-	2	2	2	-	1	2	2	2	2	3	2
CO2-98BT704-A.2: Compare different energy based, starch-based crops for the production of biofuel	-	-	-	2	-	-	2	-	2	2	3	1	2	2	2
CO3-98BT704-A.3: Explain the role of bioleaching in metallurgy	-	2	1	-	1	-	2	-	2	1	1	2	2	1	1
CO4-98BT704-A.4: Identify the types of resources and their application in day-to-day life	-	1	-	1	2	2	2	3	-	1	-	-	1	2	3
CO5-98BT704-A.5. Examine and demonstrate the mechanism of product purification	-	-	1	1	-	2	2	2	1	2	2	2	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 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO1-98BT704-A.1:** Explain fundamentals of Plant Biotechnology	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6	**LI 1** **LI2**	1.1,1.2,1.3,1.4, 1.5, 1.6	**1SL-1,2**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO2-98BT704-A.2:** Define the role of tissue culture media and its constituents in micropropagation of ex-plants	SO2.1 SO2.2 SO2.3 SO2.4 SO25 SO2.6	**LI 1** **LI2**	2.1, 2.2,2.3,2.4, 2.5, 2.6	**2SL-1,2**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO3-98BT704-A.3:** Understand the working mechanism of callus culture	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6	**LI 1** **LI2**	3.1,3.23.3,3.4, 3.5, 3.6	**3SL-1,2**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO4-98BT704-A.4:** Interpretate the mechanism of plant-based vector and plasmids	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6	**LI 1** **LI2**	4.1,4.2,4.3,4.4, 4.5, 4.6	**4SL-1,2**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3	**CO5-98BT704-A.5.** Examine and demonstrate the mechanism of product purification	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6	**LI 1** **LI2**	5.1,5.2,5.3,5.4, 5.5, 5.6	**5SL-1,2**

B. Tech. Biotechnology 8th Semester

AKS UNIVERSITY

DEPARTMENT OF BIOTECHNOLOGY

Guidelines for BSc/MSC/BTECH/MTECH Thesis Preparation

For internal use only

April, 2022

TABLE OF CONTENT

PART 1: MUST-KNOW ISSUES

1. Enrolment and Pre-requisites

Your research project begins in your last semester. The project is considered as a credit course which must be completed within the same semester to qualify for graduation/post graduation. Other important courses such as Biostatistics, Scientific Writing Workshop and Research Methodology should be taken prior to the start of your thesis project.

2. Goals and Objectives

The aim of the research project is to provide students with practice on how to undertake an original research in the major fields of biotechnology. The results will be presented to examiners set up by the University. By the end of the research project students will have gained experience in conducting an independent research and should be capable in it.

3. Duration and workload

The research project comprises a credit module equivalent to 45 days-six months working months. Students are expected to devote regular time in preparing the research proposal, commencing the research project, writing the thesis and presenting it before an Evaluation Committee.

4. Scope

Projects should be original laboratory, field-based or survey research on a topic proposed a internal adviser at University or any outside relevant organization/research lab or industry. You could also conduct their thesis project outside the University given that your proposal is approved with adequate supervision by external supervisor.

5. Choice of projects

Department of Biotechnology and its faculty members will offer a list of possible projects for students' consideration. The proposed projects are closely related to the supervisor's expertise and considered feasible given the current conditions of the University laboratory system or alternatives elsewhere. Students can select the project they are most interested in and discuss with the faculty member proposing the project. Competition may exist when more than one student are interested in the same project. The supervisor has the right to select the most suitable student but criteria for selection should be publicized.

It is possible for students to propose and arrange these projects themselves, but the topic and scientific content must be endorsed by an Advisor of the Department of the University. For project that will be conducted outside the University and supervised by non-University employer, students are requested to provide evidence for such an arrangement by completing Form BT01 along with a CV of your supervisor.

6. Assessment

The thesis will be evaluated by an anonymous examiner assigned by the University. Students are allowed to present his/her thesis only if the examiner approved the same.

8. Progress report

About four weeks after the start of your research you are required to submit a progress report to the Department using Form BT02. This progress report must becertified by the supervisor. Change of the initial research title and/or objectives, if

well justified, are possible and should be officially approved by the Department.

9. Thesis submission and revision

- The date for submission of completed theses is set by the Department (i.e. 45 days to six months depending on the course scheme and commencement of the research) and will be confirmed before the beginning of the semester.
- Two copies of thesis (soft-bounded) should be submitted to the Department two weeks before the date set for thesis defence.
- After a successful defence, the student revises his/her thesis according to the comments and amendments required by the Examiner. The adviser should make sure that all corrections are followed by the student by approving the revised thesis using Form BT03.
- The revised thesis is finally checked and approved by the Department.
- Students are required to submit two copies of thesis (no binding is required) and a and the electronic versions of the thesis (in both .doc and /pdf formats) and the presentation in PowerPoint. The Pen Drive should be labelled with student name, ID and year of graduation/post graduation.

PART 2: THESIS CONTENT

From 2022 onwards students are required to write theses in the form of an extended paper. This new requirement is not only to train students with manuscript preparation, but also to facilitate later publication of good research by the Department. For your thesis the following sections are required in the order shown below. Start each section on a new page.

- Cover page: use the format issued by the Department
- Acknowledgment
- Main body: paper-styled, including
  - *Title, author name(s) and affiliation*
  - *Abstract*
  - *Introduction*
  - *Materials and Methods*
  - *Results*
  - *Discussion*
  - *Conclusion*
  - *References*
- Appendix (if needed only)

ACKNOWLEDGMENT

This section is to recognize the people, and institutions who have helped you in completing your research project. The page is very informal and you can write in any style that you want. It is best to keep this section short. List here those individuals who provided help during the research (e.g., providing funding, language help, writing assistance or proof reading the article, etc.).

ABSTRACT

The abstract is a very brief overview of your entire study. It must come immediately after the title page. The abstract should briefly state the purpose of the research (introduction), how the problem was studied (methods), the important findings (results), and what the findings mean (conclusion). It is important to be descriptive but concise and to say only what are essential, using no more than 200 words. The author should also suggest some keywords that well represent the content of the research.

INTRODUCTION

This section is short (about 2 - 3 pages) and should be comprehensible to an informed lay person and give enough background to enable the reader to place the particular research problem in a context of common knowledge. It is important to state (i) the research problems (ii) a snap-shot literature review on what have been known or not known yet in relation to relevant hypotheses or assumptions suggested by you, (iii) the purposes of your research, (iv) scope and limitation and (v) expected outcomes.

More specifically, all problem elements, including the variables to be studied, should be expressed in an orderly system of relationships. Research questions must be clear, consistent, and measurable. They guide the research design process. Indicate "why" the study is being proposed.

Provide an adequate background (literature review) and clearly state the objectives of the work, avoiding a detailed literature survey or a summary of the results. Try to answer the question: "what potential impact will the results of the study have on the current body of knowledge?

MATERIALS & METHODS

This section should provide an accurate description of all methods and materials used in your study. It should be written in the past tense in the passive voice. Provide sufficient detail to allow the work to be reproduced, with details of supplier and catalogue number when appropriate. Methods already published should be indicated by a reference: only relevant modifications should be described. See Appendix 2 for an example of this section.

Recommended structure of the section:

2.1 Research object and location (information about the object of your research and where it was conducted)

2.2 Experimental design: describe the experimental design, methods adopted or developed to collect data. Relevant instruments and materials should be mentioned along with their description. Do not just simply list all the chemicals, instruments or devices used in the research. If you use standard methods(published and used by many similar studies, for example Kjeldall method to determine crude protein concentration), just mention the name of the methods and cite the reference that describe the method. In case the method should be described but too long, detailed information can be presented in the Appendix.

2.3 Data analysis: describe statistical methods used for data analysis with enough details so that the reliability of your research can be assessed. Data should be analyzed using statistics, either descriptive or inferential or both. Raw data are never included in your thesis unless they are needed to give evidence for specific conclusions which cannot be obtained by looking at an analysis, or summation, of the data.

If your study includes more than one experiment, describe one by one.

RESULTS

Summarize the findings without interpretation. Results should be clear and concise. Only analyzed data should be presented in forms of figures, graphs, tables and/or text descriptions of observations. When presenting statistically summarised data, you should state whether the number is a mean or median and clearly state how the data spread is expressed (± standard deviation, ± standard error of the mean, or inter-quartile range). When claiming a statistically significant result, you must support such a statement with a declaration of the probability (p) value and the test that was used to generate that value. Consult a statistician if you feel you need help in doing your statistical test and seek his advice in presenting your results.

All Figures and Tables should be numbered chronologically as they appear in your thesis. All Figures and Tables must be referred to in the text to facilitate reading. See furtherguidelines for constructing tables and figures in Part 3.

DISCUSSION

This should explore the significance of the results of the work, not repeat them. Discuss all the significant outcomes of your research; see how they fit with our current understanding of the research areas or what implications it implies for future studies or industrial application. Any limitation or weakness of the research should also be discussed and ended up with recommendations for possible improvement.

CONCLUSION

This section should state the conclusions and recommendations that you have drawn from your work (in relation to the research question or tested hypothesis) and relate the findings of your study to previously published work. Students should avoid to state the key results here instead of conclusions. Recommendations should be relevant to your research findings in order to provide the readers with tips, suggestions or modes of action so that they can follow if interested.

REFERENCES

This must contain complete list of **all** references cited in the text (see Section 5.2 on referencing).

APPENDIX

Any other relevant information that cannot be appropriately accommodated elsewhere can be placed in an Appendix (or Appendices) at the end of the dissertation. Try not to use them unless you absolutely have to. They are considered useful for listing raw data or details of experimental protocols if you feel it is necessary to do so

PART 3: THESIS FORMAT

From 2022 onwards students at the Department of Biotechnology are required to write their theses in the form of an extended paper. The format of your thesis is, therefore, a blended design of a traditional thesis, i.e. with the cover page, followed by Acknowledgment and ended up with an Appendix. The main body of the thesis is, however, a paper which is allowed to be a bit longer than the standard. In order to facilitate professional writing the format of Journal of Innovation in Applied Research (jiar.in). You are advised to strictly follow the instructions below.

THESIS LAYOUT

- The thesis must be word-processed in English (American or British usage is accepted, but not a mixture of these) using TIME NEW ROMAN font 12 point size with 1.5 line spacing. The text should be fully justified and leave 1 space between sentences. Content Font Size = 12; Heading = 14.
- Page set-up: use A4 paper with the left margin of 4.0 cm to allow binding. All the other margins are 2.5 cm.
- Each page of the main body must be numbered, starting with the page that has the title of your research and the abstract. Place the number in the centre of the bottom of the page. No header/footer is allowed.
- Binding will be arranged by the Department once you submit the final version of your thesis.

NUMBER OF PAGES

- Keep your writing short, informative and as concise as possible.
- No page number is required for the Cover page, Acknowledgment, References and Appendix.
- The length of the main body of your thesis should be ideally between 15 and 20 pages. When needed the addition of few more pages are allowed, but the total number of pages of the main body should not exceed 25.
- Your supervisor will advise you on the length of each section and the level of details required.

COVER PAGE

- The cover page is designed to highlight your research title while providing important information such as the name of the educational provider, name of student and adviser(s) and year of publication.
- Use the standard format provided by the Department (see Appendix 1).

HEADINGS

The appropriate use of headings is a great assistance to the reader, breaking the text into logical blocks. Divide your thesis into clearly defined and numbered sections. Subsections should be numbered 1.1 (then 1.1.1, 1.1.2, ...), 1.2, etc. Any subsection may be given a brief heading. Each heading should appear on its own separate line. The recommended structure and headings of the main body is as follows:

Title

Author name(s) and affiliation

Abstract

Keywords

1. Introduction
2. Materials & Methods
    - 2.1 Research object and location
    - 2.2 Experimental design
    - 2.3 Data analysis
3. Results
    - 3.1 sub-headline 1
    - 3.2 sub-headline 2
    - 3.n sub-headline n
4. Discussion
5. Conclusion

References

- Constructed molecular sensor to enhance metal detection by bacterial ribosomal switch–ion channel protein interaction

  Raul Cuero[a,*], J. Lilly[a], David S. McKay[b]

  [a] Prairie View A&M University, CARC, Prairie View, TX 77446, USA
  [b] NASA Johnson Space Center, Houston, TX 77058, USA

TITLE PAGE INFORMATION (see the example above)

- The title should be concise and informative as it will be used in information- retrieval systems. Avoid abbreviations and formulae where possible.

- Author names and affiliations: where the family name may be ambiguous (e.g., a double name), please indicate this clearly. Your official affiliation address is "Department of Biotechnology, AKS University, Satna". Indicate all affiliations with a lower-case superscript letter immediately after the author's name and in front of the appropriate address if your adviser/co-worker is from another institution. Provide the e-mail address of the corresponding author, i.e. yours in most cases.

ABSTRACT

- Not more than 200 words and should be as a single paragraph.
- Keywords: immediately after the abstract. Provide a maximum of 6 keywords, using American spelling and avoiding general and plural terms and multiple concepts (avoid, for example, 'and', 'of'). Be sparing with abbreviations: only abbreviations firmly established in the field may be eligible. These keywords will be used for indexing purposes.

A B S T R A C T

Molecular biosensors are useful tools that detect metal ions or other potentially toxic chemicals. However, the efficiency of conventional sensors is limited in mixed metals substrates, which is the common way they are found in nature. The use of biosensors constructed from genetically modified living microbial systems has the potential of providing sensitive detection systems for specific toxic targets. Consequently, our investigation was aimed at assembling different genetic building blocks to produce a focused microbial biosensor with the ability to detect specific metals. This objective was achieved by using a synthetic biology approach. Our genetic building blocks, including a synchronized ribosomal switch–iron ion channel, along with sequences of promoters, metal-binding proteins (Fe, Pb), ribosomal binding sites, yellow fluorescence reporter protein (YFRP), and terminators, were constructed within the same biobrick in *Escherichia coli*. We used an rpoS ribosomal switch containing an aptamer, which responds to the specific metal ligands, in synchronization with an iron ion channel, TonB. This switch significantly stimulates translation, as expressed by higher fluorescence, number of colonies, and concentration of RNA in *E. coli*. The positive results show the effectiveness of using genetically tailored synchronized ribosomal switch–ion channels to construct microbial biosensors to detect specific metals, as tested in iron solutions.

Keywords:
Biosensor
Ribosomal switch
Ion channel

TABLES

- Number tables consecutively in accordance with their appearance in the text.
- Place footnotes to tables below the table body and indicate them with superscript lowercase letters. Avoid vertical rules.
- Be sparing in the use of tables and ensure that the data presented in tables do not duplicate results described elsewhere in the article.

Examples:

•

Table 1
First central composite design 2^2 coded for the study of the effect of pH, enzyme concentration and glutaraldehyde concentration on the immobilization process of glucosyltransferase onto Celite, for conversion of sucrose into isomaltulose; the statistical analyses were carried out only in the first batch of 2.5 h, at 33 °C and 130 rpm.

Assay	Variables			Conversion of sucrose into isomaltulose (%)		
	pH	Enzyme (U/g of Celite)	Glutaraldehyde (%)	1° batch	2° batch	3° batch
1	−1 (5.6)	−1 (32.6)	−1 (0.10)	7.38	7.38	9.03
2	+1 (7.4)	−1 (32.6)	−1 (0.10)	0.00	0.00	0.00
3	−1 (5.6)	+1 (87.0)	−1 (0.10)	21.92	21.92	23.63
4	+1 (7.4)	+1 (87.0)	−1 (0.10)	1.34	1.34	1.59
5	−1 (5.6)	−1 (32.6)	+1 (0.40)	1.51	0.00	1.59
6	+1 (7.4)	−1 (32.6)	+1 (0.40)	0.00	0.00	0.00
7	−1 (5.6)	+1 (87.0)	+1 (0.40)	12.75	8.73	10.64
8	+1 (7.4)	+1 (87.0)	+1 (0.40)	0.00	1.52	1.15
9	−1.68 (5.0)	0 (59.8)	0 (0.25)	19.81	18.09	20.32
10	+1.68 (8.0)	0 (59.8)	0 (0.25)	0.00	0.00	0.09
11	0 (6.5)	−1.68 (14.1)	0 (0.25)	0.00	0.00	0.00
12	0 (6.5)	+1.68 (105.5)	0 (0.25)	7.23	8.00	7.19
13	0 (6.5)	0 (59.8)	−1.68 (0.00)	16.94	14.12	11.54
14	0 (6.5)	0 (59.8)	+1.68 (0.50)	3.25	2.87	3.77
15	0 (6.5)	0 (59.8)	0 (0.25)	4.31	6.33	4.62
16	0 (6.5)	0 (59.8)	0 (0.25)	6.18	5.96	4.29

FIGURE CAPTION

Ensure that each illustration has a caption. A caption should comprise a brief title and a description of the illustration. Keep text in the illustrations themselves to a minimum but explain all symbols and abbreviations used.

Example:

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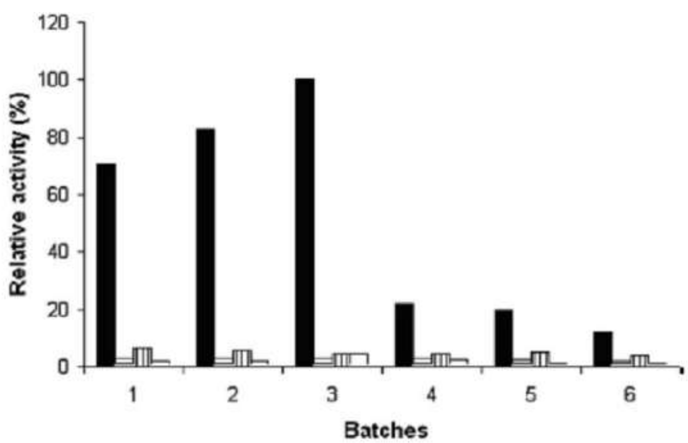

Fig. 5. Relative glucosyltransferase activity of the different low methoxyl pectin microcapsules containing glucosyltransferase after six batches of 30 min each of conversion of sucrose into isomaltulose. (■) Microcapsules with fat; (⊟) microcapsules without fat; (◘) lyophilized microcapsules with fat; and (□) lyophilized microcapsules without fat.

CITATION IN TEXT

Please ensure that every reference cited in the text is also present in the reference list and vice versa. Any references cited in the abstract must be given in full. Unpublished results and personal communications are not recommended in the reference list, but may be mentioned in the text. If these references are included in the reference list they should follow the standard reference style as follows and should include a substitution of the publication date with either 'Unpublished results' or 'Personal communication'. Citation of a reference as 'in press' implies that the item has been accepted for publication.

All citations in the text should refer to:

- *Single author:* the author's name (without initials, unless there is ambiguity) and the year of publication;
- *Two authors:* both authors' names and the year of publication;
- *Three or more authors:* first author's name followed by 'et al.' and the year of publication.

Citations may be made directly (or parenthetically). Groups of references should be listed first alphabetically, then chronologically.

> There are several works in the literature reporting bacterial cell immobilization in isomaltulose production (Kawaguti et al., 2006; Oliva-Neto and Menão, 2009). However, few studies are focused on the immobilization of extracted glucosyltransferase, which converts sucrose into isomaltulose. The immobilization of the enzyme presents some advantages compared to cell immobilization, such as lower risk of microbial contamination of the product, the former prevents the risk of unwanted catalytic activity; whole cells bring along further resistance to mass transfer due to the presence of the cell wall, which drastically reduces reaction rates (Chen, 2007). Thus, this work aimed to immobilize the glucosyltransferase from *Erwinia* sp. D12, in two different supports by adsorption (Celite) and entrapment (low-methoxyl pectin

WEB REFERENCE

As a minimum, the full URL should be given and the date when the reference was last accessed. Any further information, if known (DOI, author names, dates, reference to a source publication, etc.), should also be given. Web references can be listed separately (e.g., after the reference list) under a different heading if desired, or can be included in the reference list. Avoid using websites as reference unless absolutely necessary.

REFERENCE LIST

References should be arranged first alphabetically and then further sorted chronologically if necessary. More than one reference from the same author(s) in the same year must be identified by the letters 'a', 'b', 'c', etc., placed after the year of publication. Journal name must be written in full name.

Examples:

Reference to a journal publication:

Van der Geer, J., Hanraads, J.A.J., Lupton, R.A., 2010. The art of writing a scientificarticle. Journal of Science Communication 163, 51–59.

Reference to a book:

Strunk Jr., W., White, E.B., 2000. The Elements of Style, fourth ed. Longman, New York.

Reference to a chapter in an edited book:

Mettam, G.R., Adams, L.B., 2009. How to prepare an electronic version of your article,in: Jones, B.S., Smith , R.Z. (Eds.), Introduction to the Electronic Age. E-Publishin.

- **References**

Andrianantoandro, E., Basu, S., Karig, D.K., Weiss, R., 2006. Synthetic biology: new engineering rules for an emerging discipline. Molecular Systems Biology 2 (28), 1–14.

Breaker, R.R., 2010. RNA second messengers and riboswitches: relics from the RNA world. Microbe American Society for Microbiology 5 (1), 13–20.

Cuero, R., Ouellett, T., Yu, J., Mogongwa, N., 2003. Metal ion enhancement of fungal growth, gene expression, and aflatoxin synthesis in *Aspergillus flavus*: RT-PCR characterization. Journal of Applied Microbiology 94 (6), 953–961.

Cuero, R., Ouellett, T., 2005. Metal ions modulate gene expression, and accumulation of the mycotoxins aflatoxin and zearalenone. Journal of Applied Microbiology 98 (3), 598–605.

Failla, M.L., 1977. Zinc Functions and Transport in Microorganisms, 4th ed. Weinberg, New York.

Grundy, F.J., Henkin, T.M., 2006. From ribosome to riboswitch: control of gene expression in bacteria by RNA structural rearrangements. Critical Reviews in Biochemistry and Molecular Biology 41 (6), 329–338.

Hengge-Aronis, R., 2002. Signal transduction and regulation mechanisms involved in control of the sigma (s) RpoS subunit of RNA polymerase. Microbiology and Molecular Biology Review 66 (3), 373–395.

Hille, B., 2001. Ion Channels of Excitable Membranes, 3rd ed. Sinauer, Sunderland.

Ito, M., Xu, H., Gufanti, A.A., Wei, Y., Zvi, L., Clapham, D.E., Krulwich, T.A., 2004. The voltage-gated Na+ channel NavBP has a role in motility, chemotaxis, and pH homeostasis of an alkalinophilic *Bacillus*. Proceedings of the National Academy of Sciences 101 (29), 10566–10571.

Kauffman, S., 2000. Investigations. Oxford University Press, New York.

Lei, Y., Chen, W., Mulchandani, A., 2006. Microbial biosensors. Analytica Chimica Acta 568 (1), 200–210.

Mijakovic, I., 2010. Protein phosphorylation in bacteria. Microbe ASM News 5 (1), 21–25.

Nudler, E., Mironov, A.S., 2004. The riboswitch control of bacterial metabolism. Trends in Biochemical Science 29 (1), 11–17.

APPENDIX

All materials placed in the appendix must be directly relevant to the paper. The material must be cross-referenced to the development of the research in the text of the paper using an explanatory note or a parenthetical reference. Avoid the temptation to use the appendix to bulk up the paper.

LANGUAGE AND GRAMMAR

- Use simple but clear language
- Take time to check your work for misspelled words, typographical error, mislabelled figures, tables or photos.
- If you need help in grammar, seek the help of an editor before submitting your work to your adviser. Your adviser is not expected to correct errors in spelling, punctuation, grammar, and formatting.

ABBREVIATION

Define abbreviations that are not standard in this field in a footnote to be placed on the first page of the article. Such abbreviations that are unavoidable in the abstract must be defined at their first mention there, as well as in the footnote. Ensure consistency of abbreviations throughout the article.

ACKNOWLEDGING THE WORK OF OTHERS

Plagiarism

Plagiarism is copying another person's idea or written work and claiming it as your own. This is an academic offence and you are strictly prohibited from doing this. Make sure that all information, photos, figures and tables are properly acknowledged

Citations

You must always acknowledge your sources of factual information and diagrams you wish to use. This is known as a *citation*.

PART 4: THESIS DEFENCE

PRESENTATION

- Presentation should last up to 15 minutes with another 15 minutes for questions and answers
- Slides should be prepared using Microsoft PowerPoint and presented from a disk.
- Rehearse your presentation and anticipate questions that may be asked by the Evaluation Committee.
- If you are not sure about the pronunciation of certain terminologies, be sure to ask a knowledgeable person before your defence.
- Try not to read from your slides and maintain eye contact with your audience
- Use pointers or laser devices properly
- Ask your supervisor for advice on the content and structure of your presentation.
- Even a successful defense is generally followed by certain minor adjustments in your document, and a some final paperwork amendments. You should take notes during the Q&A session, and contact the Secretary of the Evaluation Committee for a detailed request for thesis improvement.

CONTENT OF PRESENTATION

- The presentation should be a brief introduction of your topic, purpose of your study; description of the methods used and the results.
- It is advisible that your presentation has enough important details in order to avoid misunderstanding or excessive questions. Also, keep it short as time is limited.
- Make sure your answers are relevant to the questions of the Evaluation Committee.

APPENDIX 1: FORMAT OF THESIS COVER PAGE

AKS University, Satna

(5 lines from logo)

TITLE OF THESIS

(3 lines)

A thesis submitted to

The Department of Biotechnology, AKS University In partial fulfillment of the requirements for the degree of

B.Sc. (Hons.) in ……………………..

(6 lines)

Student name: Full name of student – ID No.

Supervisor: Title and full name of supervisor(s)

(7 lines)

Month/Year

APPENDIX 2: RELEVANT FORMS

(proposal development, proposal defense, midway progress report, evaluation, etc.)

Content	Page

Form **BT01**

THESIS REGISTRATION

1. (Student's name) .... (ID) ....
2. (Department) ....
3. (Thesis title) ....

....

....

4. (Objectives) ....

....

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5. (Research content) ....

....

....

....

6.(Research location) ....

....

7. (Duration) (from): .... (to): ....
8. (Supervisor):

   (Full name).......................................

   (Address)..

   ....

   Email: ....

(Supervisor)

(Department)

Form **BT02**

THESIS PROGRESS REPORT

1. Student name: .... Student's ID...................................
2. Supervisor ....
3. Thesis title ....

....

SECTION A: to be completed by student

Thesis processing management

Content	**Status**		**Tentative completion time**
	Complete	On going	
1.	.	.	
2.	.	.	
3.	.	.	
n.	.	.	

Presence of obstacles to thesis completion, if any,

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Important note: Date to submit the completed thesis:

Date:....................................

Signature of student

SECTION B: to be completed by the principal Supervisor

Has the student:	Yes	No
(i) Shown relevant knowledge and understanding toward specific project field?	·	·
(ii) Shown initiative consistent with the requirements of the research program?	·	·
(iii) Made satisfactory progress in the research program?	·	·
(iv) Shown the ability to complete the research program by the due date?	·	·

If no, please recommend extension for completion or cut some parts of the proposal

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Date:.....................................

Signature of supervisor

Form **BT03**

Evaluation Form

Academic Adviser

Name of Student .... ID: ....

Criteria	Maximum marks	Your mark
Independence in work	10	
Creativity	10	
Level of commitment	20	
Writing skill	20	
Overall quality of thesis *	40	
Total	**100**	

* The maximum mark should not exceed 30 unless the student produced a manuscript for possible publication. A hard copy of the manuscript should be enclosed with this evaluation form.

____
Name of Adviser

____
Date Signed

Evaluation Form

Thesis Reviewer

Name of Student____ID: ______________________

Criteria	Maximum mark	Your mark
Project goal and objectives (clear, achievable)	15	
Quality of Literature Review *(comprehensive, relevant)*	15	
Materials and Methods *(sound methods, appropriate materials and supporting equipment)*	25	
Results and Significant contribution *(please evaluated against the specific objectives of the project)*	30	
Writing skill and format (including compliance do thesis guidelines)	15	
Total	**100**	

Comments and recommendations for improvement/ correction (blank section is not acceptable)

....

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....

____
Name of Examiner (Signature and Date)

____
Date Signed

Form **BT05**

Evaluation Form

For examiner of the Scientific Committee

Name of Student .... ID: ....

Criteria	Maximum mark	Your mark
Introduction *(research problem well stated, clear objectives)*	10	
Good understanding of the research field	10	
Methodology *(sound, appropriate or creative)*	20	
Quality of results *(evaluated against the research objectives)*	20	
Presentation skills *(quality of slides, speaking skills, timing)*	20	
Quality of answers *(relevant to questions, satisfied by the committee members)*	20	
Total	**100**	

Additional comments/suggestions for improvement:

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Name of Examiner

Date Signed