Curriculum Book
and
Assessment and Evaluation Scheme

based on

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

in

Master of Science in Chemistry
M.Sc. (Chemistry)

4 Semester Degree Program

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

AKS University

Satna 485001, Madhya Pradesh, India

Faculty of Basic Science
Department of Chemistry

HEAD
Department of Chemistry
Basic Science, AKS University
Satna (M.P.) 485001

DEAN
Faculty of Basic Science
AKS University, Satna (M.P.)

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

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Curriculum
Of
M.Sc. Chemistry

(Revised as of 01 August 2023)
AKS University, Sherganj, Panna Road, Satna - 485001

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Foreword

As the Pro Chancellor of this esteemed institution, it is with great pleasure that I introduce the M.Sc. Chemistry Program to our academic community and beyond.

Chemistry, often referred to as the "central science," is at the heart of countless innovations and advancements that shape our world. From the molecules that make up the air we breathe to the complex compounds powering modern technology, the study of chemistry is indispensable to understanding the workings of our universe.

In today's rapidly evolving landscape, the demand for skilled chemists has never been greater. The M.Sc. Chemistry Program offered by our institution is designed to meet this demand by providing students with a comprehensive education that blends theoretical knowledge with practical skills.

Our dedicated faculty members, who are leading experts in their respective fields, are committed to fostering an environment of academic excellence and innovation. Through their mentorship, students will not only gain a deep understanding of core chemical principles but also develop the critical thinking and problem-solving abilities necessary to tackle the challenges of tomorrow.

Furthermore, our state-of-the-art laboratories and research facilities offer students the opportunity to engage in cutting-edge research across a variety of sub-disciplines, from organic and inorganic chemistry to materials science and analytical chemistry. By actively participating in research projects, students will have the chance to contribute to the advancement of scientific knowledge while honing their own research skills.

I am confident that graduates of our M.Sc. Chemistry Program will emerge as leaders in their field, equipped with the knowledge, skills, and passion to make meaningful contributions to society. Whether they choose to pursue careers in academia, industry, or government, they will be well-prepared to address the complex challenges facing our world through the transformative power of chemistry.

I extend my heartfelt congratulations to all the students who have chosen to embark on this journey of discovery and learning. May your pursuit of knowledge in the field of chemistry be both rewarding and fulfilling, and may you continue to strive for excellence in all your endeavors.

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

01 August 2023

From the Desk of the Vice-Chancellor

Dear Students, Faculty, and Stakeholders,

It gives me immense pleasure to announce the launch of the M.Sc. Chemistry Program at AKS University. As we embark on this new academic endeavor, I am filled with excitement and optimism for the opportunities it will provide for our students and the contributions it will make to the field of chemistry.

At AKS University, we are committed to excellence in education and research, and the introduction of the M.Sc. Chemistry Program is a testament to this commitment. This program has been meticulously designed to equip students with the knowledge, skills, and practical experience needed to excel in the dynamic and multifaceted field of chemistry.

Our esteemed faculty members, who are renowned experts in their respective fields, will guide and inspire students throughout their academic journey. Their dedication to teaching and research will ensure that students receive a world-class education that is both rigorous and relevant to the demands of the modern world.

Furthermore, AKS University boasts state-of-the-art laboratories and research facilities that provide students with hands-on experience in conducting experiments and engaging in scientific inquiry. Through experiential learning opportunities and research projects, students will have the chance to explore their interests, deepen their understanding of chemistry, and contribute to the advancement of knowledge in the field.

As Vice Chancellor, I am confident that the M.Sc. Chemistry Program at AKS University will empower students to become good academician and innovators in the field of chemistry. Whether they choose to pursue careers in academia, industry, or research, they will be well-prepared to make significant contributions to society and address the challenges of the 21st century.

I extend my best wishes to all the students who are considering joining the M.Sc. Chemistry Program at AKS University. Your decision to embark on this academic journey is commendable, and I am excited to see the impact you will make in the world of chemistry and beyond.

AKS University, Satna
01 August 2023

Professor B. A. Chopade
Vice-Chancellor

Preface

As the Head of the Department of Chemistry, it is my privilege to introduce the M.Sc. Chemistry curriculum, a comprehensive and dynamic program designed to cultivate the next generation of leaders and innovators in the field of chemistry.

Chemistry is a discipline that lies at the intersection of fundamental scientific principles and real-world applications. It is a subject of immense importance, influencing everything from the development of new pharmaceuticals to the design of sustainable energy solutions. As such, our M.Sc. Chemistry curriculum is built upon a strong foundation of core concepts while also incorporating the latest advancements and trends in the field.

Our curriculum is structured to provide students with a well-rounded education in all major sub-disciplines of chemistry, including organic, inorganic, physical, analytical, and green chemistry. Through a combination of lectures, laboratory work, seminars, and research projects, students will develop a deep understanding of principles on which chemistry is based and their applications in various contexts.

One of the distinguishing features of our program is its emphasis on hands-on learning and experiential education. Our state-of-the-art laboratories provide students with the opportunity to conduct experiments, analyze data, and solve problems in a real-world setting. Additionally, our faculty members, who are leading experts in their fields, are dedicated to providing mentorship and guidance to help students succeed both inside and outside the classroom.

Furthermore, our curriculum is designed to foster critical thinking, creativity, and communication skills, which are essential for success in today's rapidly evolving world. Whether students choose to pursue careers in academia, industry, government, or beyond, they will graduate from our program with the knowledge, skills, and confidence to excel in their chosen fields.

I am confident that the M.Sc. Chemistry curriculum will provide students with a transformative educational experience that prepares them for a lifetime of learning, discovery, and achievement. I extend my best wishes to all the students embarking on this academic journey, and I look forward to witnessing their growth and success in the years to come.

AKS University, Satna
01 August 2023

Dr. Shailendra Yadav
Head of Department

M.Sc.Chemistry

Scheme and Syllabus 2023-2024

Outcome Based Education System(OBES)/ Learning Outcomes based Curriculum Frame work(LOCF)

Choice Base Credit System (CBCS)

DEPARTMENTOF CHEMISTRY

FACULTY OF BASIC SCIENCE

Introduction

MSc in Chemistry is a two year postgraduate program divided in four semesters with 107 credits. This program is designed to provide in-depth knowledge and expertise in Chemistry with flexibility and options. The Chemistry is a fundamental science playing important role to improve human life by providing various needful materials and goods used in society with sustainability. There has been unprecedented development in chemistry in the last few decades. New branches of chemistry are emerging and gaining importance, such as green chemistry, materials chemistry, computational chemistry, supramolecular chemistry etc. The industrial practices which are based on chemistry are also undergoing sustainable changes and are increasing by adopting recently created knowledge in chemistry. Recently adopting Computer based techniques not only accelerated growth in chemistry but also revolutionized the practices of entire field of chemistry. A chemist is also related to other disciplines of science. Thus, after long duration greater specialization in undergraduate and graduate curricula interdisciplinary approach now more relevant

Vision

To provide trained & skilled human resources in the field of chemical science as researchers, educators, chemists and assist the chemical industries as well as stakeholders in the world

Mission

M01: To develop skilled educators, researchers and scientists in field of chemical science

M02: To develop skillful human resources for industries and businesses based on chemical science

M03: To develop complete personality of students by providing student centric teaching and research facilities.

M04: To achieve academic excellence in chemical science through an innovative teaching-learning process.

PROGRAM EDUCATIONAL OBJECTIVES (PEO)

PEO01: To develop skills in the students with practical knowledge work and able to solve problem inteaching, research and industrial area of chemistry

PEO02: To develop R&D temperament among the students for development, innovation and sustainable practices in chemical science

POE03: To develops ethical principles among the students and commitment of ulfilling international, national and local needs and social responsibilities with his/her professional excellence.

PEO04: Ability to understand the impact of professional chemistry base solutions in societal, economic and environmental contexts and demonstrate knowledge and need for sustainable development

Program Outcomes (PO) for M.Sc. Chemistry (CBCS)

After completion of program student will

PO_1	**Knowledge**	demonstrate broad disciplinary knowledge acquired during study
PO_2	**Research Aptitude**	ask relevant/ appropriate questions for identification formulation and analysis the research problems and to draw conclusion from the analysis.
PO_3	**Communication**	communicate effectively on general and scientific topics with the scientific community and with society at large.
PO_4	**Problem Solving**	apply knowledge to solve scientific and other chemistry related problems.
PO_5	**Individual and Team Work**	learn and work effectively as an individual, and as a member or leader of teams in diverse, multidisciplinary settings.
PO_6	**Investigation of Problems**	critically think and apply to analytical reasoning and research based knowledge including design of experiments, analysis and interpretation of data to provide conclusions.
PO_7	**Modern Tool usage**	use and learn techniques, skills and modern tools for scientific practices.
PO_8	**Science and Society**	apply reasoning to assess the different issues related to society and the consequent responsibilities relevant to the professional scientific practices.
PO_9	**Life-Long Learning**	apply knowledge and skills that are necessary for participating in learning activities throughout life.
PO_{10}	**Ethics**	identify and apply ethical issues related to one's work; avoid unethical behaviour such as fabrication of data, committing plagiarism and unbiased truthful actions in all aspects of work.
PO_{11}	**Project Management**	demonstrate knowledge and understanding of the scientific principles and apply these to manage projects.
PO_{12}	**Environment and sustainability**	solve environmental problems related to chemistry

Program Specific Outcomes(PSO's)

The program specific outcomes (PSO's) are the statement of competencies /abilities that describes the knowledge and capabilities of the post-graduate will have by the end of program studies.

After successful completionof M. Sc. Chemistry, the students will be able to

PSO_1	Deliver detailed functional knowledge of theoretical concepts and experimental aspects of chemistry.
PSO_2	integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.
PSO_3	understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon-based problems in chemical sciences.
PSO_4	Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science

Consistency/Mapping of PEOs with Mission of the Department

PEO	M1	M2	M3	M4
PEO1	3	2	3	2
PEO2	2	2	2	3
PEO3	2	3	2	1
PEO4	2	2	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) "-": No correlation

GENERAL COURSE STRUCTURE & THEME

Definition of Credit

1Hr.Lecture(L)per weekx15	1Credit
1Hr.Tutorial (T)per week	1Credit
2 Hours Practical (P) perweek	1 Credit

Range of Credits:

In the light of the fact that a typical Model Two-year Post Graduate degree program in Basic Science has about 100 credits, the total number of credits proposed for the M.Sc. in Chemistry is kept as 107 considering NEP-20 and UGC guidelines.

Structure of PG Program in Chemistry

The structure of M.Sc. program in Chemistry shall have essentially the following categories of courses with the breakup of credits as given:

Components of the Curriculum

(Program curriculum grouping based on course components)

SlNo	Course Component		% of total number of credits of the Program	Total number of Credits
1	Discipline Core Course (DCC)		81.31	87
2	Foundation Course (FC)	Chemistry Based	7.48	08
4	Elective course		7.48	08
5	Open elective course		3.73	04
6	Audit Course		0.00	0
7	MOOC**/NTPL/SWYAM		0	0
Total			100	107

General Course Structure and Credit Distribution (Curriculum of M.Sc. Chemistry)

Semester-I								
			Periods			Credit	Hours	Category Code
S. No.	**Course Code**	**Course**	**L**	**T**	**P**			
1	**76CH101**	Inorganic Chemistry-I	**3**	**1**	**-**	**4**	4	DCC
2	**76CH102**	Organic Chemistry-I	**3**	**1**	**-**	**4**	4	DCC
3	**76CH103**	Physical Chemistry-I	**3**	**1**	**-**	**4**	4	DCC
4	**76CH104**	Group theory and Spectroscopy I	**3**	**1**		**4**	4	DCC
5	**76MS105**	Mathematics for Chemist	**3**	**0**		**3**	3	FC
	76BI105	Biology for Chemist						FC
7	**76CH151**	Laboratory course-I(Inorganic Chemistry)		**-**	**4**	**2**	4	DCC
8	**76CH152**	Laboratory course-I (Organic Chemistry)	**-**	**-**	**4**	**2**	4	DCC
9	**76CH153**	Laboratory course-I (physical Chemistry)	**-**	**-**	**4**	**2**	4	DCC
Total						**25**	**31**	

DCC – Discipline Core Course; FC – Foundation Course; L – Lecture; T - Tutorial; P – Practical

Semester-II								
S.N.	**Course Code**	**Course**	**Period**			**Credit**	**Hours**	**Category Code**
			L	**T**	**P**			
1	**76CH201**	Inorganic Chemistry-II	**3**	**1**	**-**	**4**	4	DCC
2	**76CH202**	Organic Chemistry-II	**3**	**1**	**-**	**4**	4	DCC
3	**76CH203**	Physical Chemistry-II	**3**	**1**	**-**	**4**	4	DCC
4	**76CH204**	Differaction methods and Spectroscopy II	**3**	**1**		**4**	4	DCC
5	**76CA205**	Computer application in chemistry	**2**	**1**		**3**	3	FC
6	**76CH251**	Laboratory course-II (Inorganic Chemistry)	**-**	**-**	**4**	**2**	4	DCC
7-	**76CH252**	Laboratory course-II (Organic Chemistry)	**-**	**-**	**4**	**2**	4	DCC
8	**76CH253**	Laboratory course-II (physical Chemistry)			**4**	**2**	4	DCC
10	**XXXXX**	MOOC**/NTPL/SWYAM		**-**	**-**	**0**		
Total						**25**	**31**	

DCC – Discipline Core Course; FC – Foundation Course; L – Lecture; T - Tutorial; P - Practical

The student who will pass MOOC/NTPL/SWYAM course with 4-6 credits (12-16 weeks) awarded by an appreciation certificate from the department. Selection of MOOC course will be from list given on the Swayam portal or the list given by the Department/ University from 2nd semester to 3rd semesteras notified by the University

+

Semester III								
S.No.	**Course Code**	**Course**	**Period**			**Credit**	**Hours**	**Category Code**
			L	**T**	**Practical**			
1	**76CH301**	Applications of spectroscopy	3	1	-	4		DCC
2	**76CH302**	Photochemistry & solid state chemistry	3	1	-	4		DCC
3	**76CH303**	Analytical Chemistry	3	1	-	4		DCC
5	**76CH304**	Bio Inorganic, Bio Physical, Bio organic Chemistry	3	0	-	3		DCC
6	**76CH305**	Green Chemistry	1	-	1	2		DCC
7	**76CH351**	Instrumental Techniques in Chemical Analysis Lab	-	-	4	2		DCC
8	**76CH352**	Project Work	-	-		10		DCC
9	**xxxxxxx**	**Audit Course	1			0		AC
Total						29		

DCC – Discipline Core Course; AC= Audit Course
L – Lecture; T - Tutorial; P - Practical
**provided by the Department /University along with subject code and syllabus .Only passing of the Audit course is mandatory.

Audit Course*= Human Value, Professional Ethics& Scientific writing

Semester-IV						Credit	Category Code
S.No.	Course Code	Course	Period				
			L	T	P/Projrct		
1-	76CH401	Industrial Chemistry	3	1		4	DCC
2-	76CH401	Research Methodology, Research Ethics	2			2	FC
2	76CH40X	*E.C.1	3	1		4	E C
3	76CH40X	*E C 2	3	1		4	E C
5	XXXXX	*OEC	3	1		4	OEC
6-	76CH451	Project Work				10	DCC
Total						28	
Total Credit of Programme						107	

DCC – Discipline Core; *E.C. = Student will chose two elective courses provided by department

Elective Courses:

1 Polymer Chemistry (76CH403)
2 Heterocyclic Chemistry (76CH404)
3 Medicinal Chemistry & Natural product (76CH405)
4 Chemistry of materials (76CH406)
5 Advanced synthetic organic chemistry (76 CH407)

***OEC;** A student may choose open elective course offered by the other departments of University.

Course code and definition:

L **T** **PC**	= = =	Lecture Tutorial Practical Credit
PCC	=	Professional core courses
PEC	=	Professional Elective courses
OEC	=	Open Elective courses

AKSUniversity

Faculty of Basic Science, **Department of Chemistry**

Curriculum of M. Sc. In Chemistry Program (Revised as on 01 August 2023)

Courselevelcodingscheme:

76CH is prefix and 102…,201….,301…,401, are given for first, second, third and fourth semester.

Category-wiseCourses

Discipline Core Course

Sl.	CodeNo.	Subject	Semester	Credits
1	76CH101	Inorganic Chemistry-I	1	4
2	76CH102	Organic Chemistry-I	1	4
3	76CH103	Physical Chemistry-I	1	4
4	76CH104	Group theory and Spectroscopy I	1	4
5	76CH151	Laboratory course-I(Inorganic Chemistry)	1	2
6	76CH152	Laboratory course-I (Organic Chemistry)	1	2
7	76CH153	Laboratory course-I(physical Chemistry)	1	2
8	76CH201	Inorganic Chemistry-II	2	4
9	76CH202	Organic Chemistry-II	2	4
10	76CH203	Physical Chemistry-II	2	4
11	76CH204	Differaction methods and Spectroscopy II	2	4
12	76CH251	Laboratory course-II (Inorganic Chemistry)	2	2
13	76CH252	Laboratory course-II (Organic Chemistry)	2	2
14	76CH253	Laboratory course-II (physical Chemistry)	2	2
15	76CH301	Applications of spectroscopy	3	4
16	76CH302	Photochemistry & solid state chemistry	3	4
17	76CH303	Analytical Chemistry	3	4
18	76CH304	Bio Inorganic, Bio Physical, Bio organic Chemistry	3	4
19	76CH305	Green Chemistry	3	2
20	76CH351	Instrumental Techniques in Chemical Analysis Lab	3	2
21	76CH352	Project Work	3	10
22	76CH401	Industrial Chemistry	4	4
23	76CH451	Project Work	4	10
		Total		83

Foundation Courses

Sl.	CodeNo.	Subject	Semester	Credits
1	76MS105	Mathematics for Chemist	1	3
2	76BI105	Biology for Chemist		
3	76CA205	Computer application in chemistry	2	3
4	76CH402	ResearchMethodology, Research Ethics and	4	2
		Total		12

Elective courses (Only 2 shall be taken in 4th semester)

Sl.	CodeNo.	Subject	Semester	Credits
1	76CH404	Heterocyclic Chemistry(PEC)	4	4
2.	76CH406	Chemistry of materials(PEC)	4	4
3.	76CH403	Polymer Chemistry (PEC)	4	4
4.	76CH405	Medicinal Chemistry & Natural product(PEC)	4	4
5.	76CH407	Advanced synthetic organic chemistry	4	4
		Total		08

Audit Course

Sl.	CodeNo.	Subject	Semester	Credits
1	xxxxx	Human Value, Professional Ethics& Scientific writing	3	0

MOOC/NTPL/SWYAM**

Sl.	CodeNo.	Subject	Semester	Credits
1	xxxxx	**MOOC**/NTPL/SWYAM**	2-3	0

Induction Program

Induction program for students to be offered right at the start of the first year It is mandatory. AKS University has design an induction programfor1styear student, detailsare below:

1. Physical activity
2. Creative Arts
3. Universal Human Values
4. Literary
5. Proficiency Modules
6. Lectures by Eminent People
7. Visits to local Areas
8. Familiarization to Dept./Branch & Innovations

Mandatory Visits/ Workshop /Expert Lectures:

1. It is mandatory to arrange one industrial visit every semester for the students.
2. It is mandatory to conducta One-week workshop during the winter break after fifth semester on professional/industry/entrepreneurial orientation.
3. It is mandatory to organize at least one expert lecture persemester for each branch by inviting resource persons from industry.

<u>Semester wise Course Structure</u>

Semester wise Brief of total Cerits and Teaching Hours

Semester	L	T	P/ project	TotalHour	TotalCredit
Semester-I	15	04	6	31	25
Semester-II	15	04	6	31	25
Semester-III	13	3	3+ 10 hr project	32	29
Semester-IV	14	04	10hr (project)	28	28
Total				**122**	**107**

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Faculty of Basic Science, **Department of Chemistry**

Curriculum of M. Sc. In Chemistry Program (Revised as on 01 August 2023)

Semester I

Course Name: Inorganic Chemistry I

No. Of Credits: 4

L	T	P
3	1	0

Pre-requisite: Students must have fundamental knowledge of coordination complexes such as IUPAC nomenclature, Valence Bond Theory (VBT), Crystal Field Theory (CFT).

Rationale: The students studying inorganic chemistry should possess foundational understanding about VBT, CFT, structure, reactions and stereochemistry of inorganic compounds. This will provide applicable knowledge about Nature of bonding in inorganic compounds, stereochemistry of inorganic compounds, structure reactivity, and reaction mechanisms.

Course Outcomes:

After the completion of this course, the learner will

76CH101.1: Explain hybridization as well as dπ-pπ bonds and also compare the bond angle of molecules of main group compounds.

76CH101.2: Analyze metal ligand equilibrium in solution on the basis of factors affecting the stability of the complexes as well as determine the stability constant of complexes.

76CH101.3: Apply crystal field theory and molecular orbital theory for the stability of the complexes

76CH101.4:Applymechanisticdetails of reaction of transition metal complexes and inertness, liability of complexes.

76CH101.5: Explain π-metal complexes, their spectra, structure and reactions including dinitrogen and dioxygen complexes.

Unit- I

Stereochemistry and Bonding in Main Group Compounds: VSEPR Theory and its application for treating structures of inorganic molecules and ions containing lone pairs of electrons, shortcomings of VSEPR model., Walsh diagrams (tri- and penta- atomic molecules), dp-pp bonds. Bent rule and energetics of hybridization.

Unit-II

Metal-Ligand Equilibria in Solution: Stepwise and overall formation constants and their interaction, trends in stepwise constants, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, chelate effect and its thermodynamic origin, determination of binary formation constants by pH-metry and spectrophotometry.

Unit-III

Metal - Ligand Bonding: Applications & Limitations of Crystal field theory, Molecular orbital theory, octahedral, tetrahedral and square planer complexes, p bonding and molecular orbital theory (MOT).

Unit-IV

Reaction Mechanism of Transition Metal Complexes: Energy profile diagram of reaction, reactivity of metal complexes, Inert and labile complexes, interpretation of lability and inertness of transition metal complexeson the basis of valence bond and crystal field theories. Kinetics of octahedral substitution: acid hydrolysis, factors affecting acid hydrolysis.

Unit-V

Metal p-Complexes: Metal carbonyls, structure and bonding,Vibrational spectra of metal carbonyls for bonding and structural elucidation & important reactions of metal carbonyls; dinitrogen and di oxygen complexesMetal nitrosyls: preparation, bonding structure and important reactions of transition metal nitrosyl; Nitrosylating agents for synthesis of metal nitrosyls, vibrational spectra of metal nitrosyls for bonding and structure elucidation.

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)	
Program Core(PCC)	76CH101	Inorganic Chemistry-I	3	0	1	1	5	4

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, miniproject 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.

AKSUniversity

Faculty of Basic Science, **Department of Chemistry**

Curriculum of M. Sc. In Chemistry Program (Revised as on 01 August 2023)

Scheme of Assessment: Theory

Board of Study	Course Code	Course Title	**Scheme of Assessment (Marks)**						
			Progressive Assessment (RA)					**End Semester Assessment (ESA)**	**Total Marks** (PRA+ESA)
			Class/HomeAssignment5number 3 marks each (CA)	Class Test2 (2bestout of3) 10 marks each (CT)	Seminar one + Class activity	Class Attendance (AT)	Total Marks (CA+CT+SA +AT)		
PCC	76CH101	Inorganic Chemistry I	15	20	10	5	50	50	100

Course-Curriculum Detailing:

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

Unit- I

Stereochemistry and Bonding in Main Group Compounds: VSEPR Theory and its application for treating structures of inorganic molecules and ions containing lone pairs of electrons, shortcomings of VSEPR model., Walsh diagrams (tri- and penta- atomic molecules), dp-pp bonds. Bent rule and energetics of hybridization

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	LI	CI	SL
SO1.1 Students understood about the geometry and shape of molecules by using VSEPR theory SO1.2 Students understood about the short coming of VSEPR theory SO1.3 Students applied the knowledge of shape of molecule to compare the bond angle SO1.4 Understood about the hybridization and apply the same knowledge to calculate the pπ-dπ bonding patterns. SO1.5 Students understood that lone pair electrons occupy more space than that of bond pair electrons by using Bents rule.		1.Introduction to bobnding in ioorganic molecules 2.VSEPR Theory 3.Application of VSEPR Theory to decide the geometry and shape of inorganic molecules 4. Application of VSEPR Theory to decide the geometry and shape of inorganic ions 5. Limitations of VSEPR Theory 6. Bents Rule 7.Energetics of Hybridization 8. introduction and examples of dpi-p pi bonding 9. Walsh diagrams for tri atomic molecules T1. Walsh diagrams penta- atomic molecules T2 Geometry of inorganic molecules T3. Application of Bent rule	Dragos Rule

SW-1 Suggested Sessional Work(SW):
Assignments: Draw Wall's diagram of tri-atomic and Penta-atomic molecule
b. Mini Project: Make a model of shape of given molecules
c. Other Activities (Specify): Write short note Bents rule
Unit-II
Metal-Ligand Equilibria in Solution: Stepwise and overall formation constants and their interaction, trends in stepwise constants, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, chelate effect and its thermodynamic origin, determination of binary formation constants by pH-metry and spectrophotometry.

Activity	AppX Hrs
Cl	012
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 Students understood stepwise and overall formation constants and their interaction		1. Introduction to stepwise and overall formation constants 2. Interaction, trends in stepwise constants	Determination of binary formation constants by pH-metry method

SO2.2 Students understood different types of factors that affect the stability of metal complexes **SO2.3** Students leant the chelate effect to stabilize the metal complexes **SO2.4** Students understood about the determination of binary formation constants by pH-metry and spectrophotometry methods		3. Factors affecting the stability constant 4. Effect of metal ion on stability constant 5. Effect of nature of ligands on stability constant 6. Effcet of chelate effect on stability constat 7. Introduction to thermodynamical aspect of stability constant 8. Determination of binary formation constants by pH-metry 9. Determination of binary formation constants by spectrophotometry. Types of ligands and their staurcture Calculation of stability constant Principle of spectophotometry and pH metry	

SW-2 Suggested Sessional Work (SW):
Assignments: Discuss the factors affecting Stability of metal complexes
Mini Project:
Other Activities (Specify): Stepwise and formation constant

Unit-III (76CH101.3)
Metal - Ligand Bonding: Applications & Limitations of Crystal field theory, Molecular orbital theory, octahedral, tetrahedral and square planer complexes, p bonding and molecular orbital theory (MOT).

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Introduced to metal-ligand bonding in the coordination complexes **SO3.2** Understood and applied the knowledge of CFT in Oh and Td complexes **SO3.3** Understood and applied the concept of molecular orbital theory for octahedral, tetrahedral **SO3.4** Understood and applied the concept of molecular orbital theory for square planer complexes **SO3.5** Understood and applied the concept of molecular orbital theory for π-bonding metal complexes		1. Introduction to Metal - Ligand Bonding 2. Postulates of Crystal Field theory 3. Applications of CFT 4. Limitations of CFT 5. Introduction to Molecular orbital theory (MOT) 6. MOT for octahedral complexes 7. MOT for Tetrahedral complexes 8. MOT for square planer complexes 9. Pi-bonding molecular orbital theory (MOT). T1. Color of coordination complexes by CFT T2 Magnetic properties of complexes T3. Limitations of MOT	Werners Theory Limitation of VBT

SW-3 Suggested Sessional Work (SW):
Assignments: Hybridisation in coordination complexes
Mini Project: Pictorial presentation of complexes
Other Activities (Specify): Concept of molecular orbital theory
Unit-IV
Reaction Mechanism of Transition Metal Complexes: Energy profile diagram of reaction, reactivity of metal complexes, Inert and labile complexes, interpretation of lability and inertness of transition metal complexes on the basis of valence bond and crystal field theories. Kinetics of octahedral substitution: acid hydrolysis, factors affecting acid hydrolysis.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Students understood the energy profile diagram of reaction **SO4.2** Students understood inert and labile complexes and interpret the lability and inertness of transition metal complexes on the basis of VBT and CFT **SO4.3** Introduced to kinetics of octahedral substitution reaction **SO4.4** Introduced to acid hydrolysis **SO4.5** Understood the factors that affect acid hydrolysis.		**1.** Introduction to reaction of transition metal complexes **2.** Energy profile diagram of reaction **3.** Reactivity of metal complexes **4.** Introduction to Inert and labile complexes **5.** Interpretation of lability and inertness of transition metal complexes on the basis of valence bond theories. **6.** Interpretation of lability and inertness of transition metal complexes on the basis of crystal field theories. **7.** Introduction to substitution reaction in Oh Complexes **8.** Kinetics of octahedral substitution **9.** Introduction to acid hydrolysis. T1. Examples of acid hydrolysis. T2. Inertness of Oh complexes. T3. Lability of Oh Complexes.	Valence bond Theory

SW-4 Suggested Sessional Work (SW)
Assignment: Interpret the lability and inertness of transition metal complexes on the basis of VBT and CFT
Mini Project: Pictorial presentation of energy profile diagram of reaction.
Other Activities (Specify): Importance and applications of substitution reaction.

76CH101.5: **Metal p-Complexes**: Metal carbonyls, structure and bonding, Vibrational spectra of metal carbonyls for bonding and structural elucidation & important reactions of metal carbonyls; dinitrogen and di oxygen complexes Metal nitrosyls: preparation, bonding structure and important reactions of transition metal nitrosyl; Nitrosylating agents for synthesis of metal nitrosyls, vibrational spectra of metal nitrosyls for bonding and structure elucidation.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 Understood the structure and bonding pattern of metal carbonyl **SO5.2** Understood the concept of chemical reactions for the synthesis of homoleptic and heteroleptic compounds of metal carbonyls **SO5.3** Apply the concept of vibrational spectra of metal carbonyls for bonding and structural elucidation **SO5.**4 Understood the concept of bonding, structure and important reactions of transition metal nitrosyl **SO5.5** Applied the concept of vibrational spectra to elucidate the bonding and structure of metal nitrosyls.	.	**1.** **Introdution to metal pi-Complexes** **2.** Preparation and properties of metal carbonyls **3.** Structure and bonding of carbonyls **4.** Vibrational spectra of metal carbonyls for bonding and structural elucidation **5.** Dinitrogen complexes **6.** Dioxygen complexes **7.** Introduction to metal nitrosyls **8.** Preparation and properties of nytrosyls **9.** Bbonding structure of nytrosyls T1. Nitrosylating agents for synthesis of metal nitrosyls, T2. Vibrational spectra of metal nitrosyls T3. Bonding and structure elucidation metal nytrosyls	Principles of IR and Raman Spectroscopy

SW-5 Suggested Sessional Work (SW):
Assignments: Importance of metal nitrosyl compound
Mini Project: Structure elucidation of metal carbonyl
Other Activities (Specify): Stability of carbonyl and nitrosyl compounds

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
76CH101.1: explain hybridization as well as dπ-pπ bonds and also compare the bond angle of molecules of main group compounds.	12	02	01	15
76CH101.2: Analyze metal ligand equilibrium in solution on the basis of factors affecting the stability of the complexes as well as determine the stability constant of complexes.	12	02	01	15
76CH101.3: Apply crystal field theory and molecular orbital theory for the stability of the complexes	12	02	01	15
76CH101.4:Applymechanisticdetails of reaction of transition metal complexes and inertness, liability of complexes.	12	02	01	15
76CH101.5: Explain π-metal complexes, their spectra, structure and reactions including dinitrogen and dioxygen complexes.	12	02	01	15
Total Hours	60	10	05	75

Suggestion for End Semester Assessment

Suggested Specification Table(ForESA)

CO	UnitTitles	MarksDistribution			TotalMarks
		R	U	A	
CO-1	Stereochemistry and Bonding in Main Group Compounds	03	01	01	05
CO-2	Metal-Ligand Equilibria in Solution	02	06	02	10
CO-3	Metal - Ligand Bonding	03	07	05	15
CO-4	Reaction Mechanism of Transition Metal Complexes	-	10	05	15
CO-5	Metal p-Complexes	03	02	-	05
Total		11	26	13	50

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

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

Note.DetailedAssessmentrubricneedtobepreparedbythecoursewiseteachersforabovetasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

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

Suggested Learning Resources

(a) **Books:**

S. No.	Title	Author	Publisher	Edition& Year
1	Concise Inorganic Chemistry	J. D Lee	Wiley India Pvt Ltd.	4th edition
2	Organometallic & Bioinorganic Chemistry	Ajay Kumar	Paperback	2nd edition
3	Organometallic chemistry	BD Gupta	Universities Press	First Edition (1 January 2010)
4	Bioinorganic Chemistry	AK Das	Prentice-Hall	Revised edition
5	Inorganic chemistry	Gary L. Miessler	Pearson	5th edition
6	Inorganic chemistry	VK Jaiswal	Shri Balaji	Revised fifteenth edition-2022

SuggestedWebSources:

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

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

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

Course name: Inorganic Chemistry I　　　　Course Code: 76CH101

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Knowledge	Research Aptitude	Communication	Problem Solving	Individual and Team Work	Investigation of Problems	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and sustainability	The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry	To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.	understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon-based problems in chemical sciences.	Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science
CO1: Explain hybridization as well as dπ-pπ bonds and also compare the bond angle of molecules of main group compounds.	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO2: Analyze metal ligand equilibrium in solution on the basis of factors affecting the stability of the complexes as well as determine the stability constant of complexes.	2	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3: Apply crystal field theory and molecular orbital theory for the stability of the complexes	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO4: Apply mechanistic details of reaction of transition metal complexes and inertness, liability of complexes.	2	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
CO5: Explain π-metal complexes, their spectra, structure and reactions including dinitrogen and dioxygen complexes.	2	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

Ligand; Low = 1, Medium= 2, High=3

Course Curriculum Mapping:

POs	Course Outcome	SOs	LI	Class Instructipons	Self learning
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1:Explain hybridization as well as dπ-pπ bonds and also compare the bond angle of molecules of main group compounds.	SO1.1SO 1.2SO1.3 SO1.4 SO1.5		Unit-1. Stereochemistry and Bonding in Main Group Compounds 1.1,1.2,1.3,1.4,1.5,1.6,1.7	VSEPR theory & Bents rule
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO2: Analyze metal ligand equilibrium in solution on the basis of factors affecting the stability of the complexes as well as determine the stability constant of complexes.	SO2.1SO 2.2SO2.3 SO2.4 SO2.5		Unit-2 Metal-Ligand Equilibria in Solution 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9	Determination of binary formation constants by pH-metry method
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3 : Apply crystal field theory and molecular orbital theory for the stability of the complexes	SO3.1SO 3.2 SO3.3 SO3.4 SO3.5		Unit-3 :Metal - Ligand Bonding 3.1, 3.2,3.3,3.4,3.5,3.6,3.7	Molecular orbital theory for π-bonding metal complexes
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4: Apply mechanistic details of reaction of transition metal complexes and inertness, liability of complexes.	SO4.1SO 4.2SO4.3 SO4.4 SO4.5		Unit-4 : Reaction Mechanism of Transition Metal Complexes 4.1, 4.2,4.3,4.4,4.5,4.6,4.7	Kinetics of octahedral substitutions
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 5: Explain π-metal complexes, their spectra, structure and reactions including dinitrogen and dioxygen complexes.	SO5.1SO 5.2SO5.3 SO5.4 SO5.5		Unit 5: Metal p-Complexes 5.1,5.2,5.3,5.4,5.5,5.6,5.7	Vibrational spectra of metal carbonyl and metal nitrosyl

Course code: 76CH102
Course Title: Organic Chemistry I
No. of Credits: 4

L	T	P
3	1	0

Pre-requisite: Students should have basic knowledge of chemical bonding, structure, reactions of organic compounds.

Rationale: This course will provide applicable knowledge about Nature of bonding in organic compounds, stereochemistry of organic compounds, reaction mechanisms, structure and reactivity, aliphatic and aromatic nucleophilic substitution.

Course Outcomes:
After the completion of this course, the learner will

76CH102.1: Apply the concept of bonding and aromaticities on existed or newly synthesized organic molecules and explain structure of fullerenes as well as bonds weaker than covalent bond with related compounds

76CH102.2: Explain stereo-chemical terms and inter-convert to stereo-structural formulae of organic molecules analyze configurations, create stereo-structures as well as correlate configuration by applying the concept of chemical correlation.

76CH102.3: Apply mechanistic details of different type's reactioins with intermediates, thermodynamic & kinetic requirements and anlalyse the qualitative and quantitative structure& reactivity relationship in organic chemistry

76CH102.4: Apply mechanistic details of aliphatic nucleophilic substitution reactins and factors affecting reactivity in aliphatic nucleophilic substitution

76CH102.5: Apply the knowledge of the factors affecting reactivity in aromatic nucleophilic substitution to explain mechanisms of different type of aromatic nucleophilic reactions.

UNIT-I: Nature of Bonding in Organic Molecules
Delocalized chemical bonding, conjugation, resonance, hyper-conjugation, bonding in fullerenes, tautomerism. Aromaticity in benzenoid and non benzenoid compounds, alternant and non-alternant hydrocarbons, Huckel's rule, energy level of p-molecular orbitals, annulenes, anti-aromaticity, quasi aromaticity, hydrogen bonding, homo-aromaticity, PMO approach, Bonds weaker than covelent- addition compounds, crown ether complexes and cryptands, inclusion compounds, cyclodextrins.

UNIT II: Stereochemistry
Symmetry elements, D-L, R-S, E-Z and threo-erythro nomenclature, interconversion of Fischer, Newman, Sawhorse and flying wedge formulae. conformational analysis, enantiomerism and diastereomerism of simple, cyclic (chair and boat configuration) and acyclic systems. Axial and planer chirality, optical somerism in allenes, biphenyls (atropoisomerism), spiranes, hemispiranes.
Topicity of ligands and faces, their nomenclature and prostereoisomerism, stereogenecity, chirogenicity, pseudoasymmetry and prochiral centre. stereospecific and stereoselective reaction.

Elementary idea of principle categories of asymmetric synthesis, Cram's rule and its modification, Prelog rule and horeaus rule.

UNIT-III: Reaction Mechanism: Structure and Reactivity

Types of mechanisms, types of reactions, thermodynamic and kinetic requirements, Transition state and intermediate, Generation, structure, stability and reactivity of carbocations, carbanions, carbenes and nitrenes. effect of structure on reactivity - resonance and field effects, steric effect, quantitative treatment-The Hammett equation and linear free energy relationship, substituent and reaction constants and Taft equation.

UNIT IV: Aliphatic Nucleophilic Substitution

The SN2, SN1, mixed SN1 and SN2 and SET mechanisms. The neighbouring group-mechanism: neighbouring group participations by pi and sigma bonds, anchimeric assistance The SNi mechanism: Nucleophilic substitution at an allylic, aliphatic trigonal and a vinylic carbon. Reactivity: The effects of substrate structure, Attacking nucleophile, Leaving group and Reaction medium; Phase transfer catalysis.

UNIT IV: Aromatic Nucleophilic Substitution

The SNAr, SN1, benzyne and SRN1 mechanisms. Reactivity, effect of substrate structure, leaving group andattacking nucleophile. Bucherer reaction, alkylation, and amination. The Bamberger rearrangement. The von Richter rearrangement. Smiles rearrangement

SchemeofStudies:

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)	
Program Core(PCC)	76CH102	Organic Chemistry I	4	0	1	1	6	4

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 usingdifferent instructional strategies)
SW: Sessional Work (includesassignment,seminar,mini projectetc.),
SL:S elfLearning,
C: Credits.

Note: SW&SLhastobe planned and performe under the continuous guidance and feed back of teacher to ensure outcome of Learning.

Scheme of Assessment: Theory

Board of Study	Course Code	Course Title	SchemeofAssessment(Marks)						
			ProgressiveAssessment(PRAcontinous assessment 50)					EndSemester Assessment	Total Marks
			Class/ Home Assignmnt 5 number 3marks each (CA)	Class Test2 (2best out of3) 10 marks each (CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA +AT)	(ESA)	(PRA+ESA)
PCC	76CH102	Organic Chemistry I	15	20	10	5	50	50	100

Course-Curriculum Detailing:

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

76CH102.1: Apply the concept of bonding and aromaticities on existed or newly synthesized organic molecules and explain structure of fullerenes as well as bonds weaker than covalent bond with related compounds Approximate Hours

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self Learning (SL)
SO1.1 Eplain nature of bonding in aliphatic and aromatic compounds SO1.2 Apply resonance, hyperconjugation and aromaticity theory on compounds SO1.3 Explain different type of aromaticity by HMO,PMO theories SO1.4 Explain bonds weaker than covalent SO1.5 apply bonding in fullerenes, crown ether complexes, cryptands, inclusion compounds andcyclodextrins		Unit-1.0 Nature of Bonding in Organic Molecules 1.1Delocalized chemical bonding, conjugation, resonance, 1.2hyper-conjugation, tautomerism 1.3Aromaticity in benzenoid and non benzenoid compounds, alternant and non-alternant hdrocarbons, 1.4Huckel's rule, energy level of p-molecular orbitals, PMO approach anti-aromaticity, 1.5Quasi aromaticity 1.6.homo-aromaticity, annulenes, 1.7Hydrogen bonding, Bonds weaker than covelent 1.8.Addition compounds, crown ether complexes and cryptands, inclusion compounds, cyclodextrins. 1.9. fullerenes T1. Aromaticity in annulenes T2. Hyperconjugation and stability of alkenes T3. steric inhibition of resonance	V.B.T. and M.O.T.

SW-1SuggestedSessionalWork(SW):

a. **Assignments:**Discuss aromaticity, anatiaromaticity, homoaromaticity, quasiaromaticity on the basis of NMR spectroscopy with examples

b.Mini Project:
Frost diagram of monocyclic conjugated system

c.Other Activities (Specify):
Note on applications of crown ether and cryptands, fullerenes

76CH102.2: Explain stereo-chemical terms and inter-convert to stereo-structural formulae of organic molecules analyze configurations, create stereo-structures as well as correlate configuration by applying the concept of chemical correlation

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 Explain and apply symmetry elements, D-L, R-S, E-Z threo-erythro,nomenclature, interconversion of Fischer, Newman, Sawhorse and flying wedge formulae **SO2.2** Explain conformational analysis, enantiomerism and diastereomerism of simple, cyclic (chair and boat configuration) and acyclic systems **SO2.3** Explain axial and planer chirality, optical somerism in allenes, biphenyls (atropoisomerism), spiranes, hemispiranes **SO2.4** interpretate topicityofligandsandfaces,theirnomenclatureandprostereoisomerism,stereogenecity,chirogenicity,pseudoasymmetryandprochiralcentre.stereospecificandstereoselectivereaction **SO2.5** Explain and apply elementary idea of principle categories of asymmetric synthesis, Cram's rule and its modification,Prelogruleand horeaus rule		**Unit-2.0 Stereochemistry** 2.1Symmetry elements 2.2 D-L, R-S, E-Z and threo-erythro nomenclature 2.3 Conformational analysis acyclic & cyclic (chair and boat configuration) 2.4 Enantiomerism and diastereomerism of optical somerism in allenes, biphenyls (atropoisomerism), spiranes, hemispiranes. 2.5 Topicity of ligands and faces, their nomenclature Prostereoisomerism, 2.6.stereogenecity, chirogenicity, pseudoasymmetry and prochiral centre. 2.7Stereospecific and stereoselective reaction. 2.8Elementary idea of principle categories of asymmetric synthesis Cram's rule and its modification, 2.9 Prelog rule and horeaus rule. T1 Interconversion of Fischer, Newman, Sawhorse and flying wedge formulae. (practice) T2 Conformational analysis, simple acyclic systems. T3 Assign absolute and relative configuration	Interconversion of Fischer, Newman, Sawhorse and flying wedge formulae. (practice) Conformational analysis, simple, acyclic systems. Stereoisomerism, definition and classification Optical activity

SW-2 Suggested Sessional Work (SW):

a.Assignments: Apply RS nomencluatrue in allenes, biphenyls, spiranes, hemispiranes.

b. **Mini Project:**Conformational analysis with sturcture and energy level of cyclic and acyclic compounds

c.Other Activities (Specify): Write an eassy on medicinal values of specific stereoisomer camparble to concern stereoisomers.

76CH102.3: Describe mechanistic details of different type's reactioins with intermediates, thermodynamic & kinetic requirements and anlalyse the qualitative and quantitative structure& reactivity relationship in organic chemistry

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Restate and apply typesofmechanisms,typesofreactions,thermodynamicandkineticrequirements of reactions **SO3.2** Explain Transition state and intermediates **SO3.3** Explain Generation, structure, stability andreactivity of carbocations, carbanions, carbenesandnitrenes **SO3.4** Apply effectofstructureonreactivity-resonanceandfieldeffects,stericeffect **SO3.5** Explain and apply quantitativetreatment-TheHammett equation and linear free energy relationship, substituent and reaction constants		3.1Typesofmechanisms,typesofreactions 3.2 Thermodynamicandkineticrequirements, 3.3Transition state and intermediate 3.4 Generation, structure, stability andreactivity of carbenes and nitrenes. 3.5 Generation, structure, stability andreactivity of carbocations, carbanions 3.6 Effectofstructureonreactivity-resonanceandfieldeffects 3.7 Effectofstructureonreactivity stericeffect, 3.8 Quantitativetreatment-TheHammett equation and linear free energy relationship, Substituent and reaction constants 3.9 Taftequation. **T1** Carbocations and rearrangement T2. Structure of Benzyne T3. Applications of Hammett equation	Modes of bond breaking, Electron displacement Effects

SW-3 Suggested Sessional Work (SW):

a.Assignments:

Rearrangment in carbocation and other intermediates

b.Mini Project:

Pictorial presentation of reactions and their mechanisms.

c.Other Activities (Specify):

Explanatory note on impotance of Hammett and Taft equations.

76CH102.4: Explain mechanistic details of aliphatic nucleophilic substitution reactions and factors affecting reactivity in aliphatic nucleophilic substitution

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Explain and apply The S_N^2, S_N^1, mixed S_N^1 and S_N^2 and SET mechanisms **SO4.2** Explainneighbouring group-mechanism: neighbouring group participations by pi and sigma bonds, anchimeric assistance **SO4.3** Explain the S_{Ni} mechanism **SO4.4**Explain and apply nucleophilic substitution at an allylic, aliphatic trigonal and a vinylic carbon **SO4.5** Explain and apply the effects of substrate structure, Attacking nucleophile, Leaving group and Reaction medium; Phase transfer catalysis		**Unit-4.0 Aliphatic Nucleophilic Substitution** 4.1The S_N^2, S_N^1, mixed S_N^1 and S_N^2 and SET mechanisms. 4.2The neighbouring group-mechanism: neighbouring group participations by pi and sigma bonds, 4.3 Anchimeric assistance 4.4The S_{Ni} mechanism 4.5Nucleophilic substitution at an allylic carbon. 4.6 5Nucleophilic substitution at aliphatic trigonal and vinylic carbon. 4.7.Reactivity: The effects of substrate structure, attacking nucleophile, 4.8.leaving group and Reaction medium 4.9.Phase transfer catalysis T1 SN1', SN2' mechanism T2. SNi' Mecanism T3. Factors affecting reactivity in SN reaction	Nucleophiles, Basicity & nucleophilicity

T1, T2, T3 = Tutorials, involve quiz, Discussion etc

SW-4 Suggested Sessional Work (SW):
a.Assignments: Acnhimeric assisted reactions and mechanisms
b.Mini Project: Pictorial presentation of Factors affecting reactivity of SN reactions..
c.Other Activities (Specify): Impotance and applications of phase tranfer catalysts.

76CH102.5: Apply the knowledge of the factors affecting reactivity in aromatic nucleophilic substitution to explain mechanisms of different type of aromatic nucleophilic reactions

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	10

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 Explain and apply the aromatic nucleophilic SNAr, SN1 reactions. **SO5.2** Explain benzyne and SRN1 mechanisms **SO5.3** Explain and apply effect of substrate structure, leaving group andattacking nucleophile in aromatic nucleophilic reactions. **SO5.4**Explain and apply Bucherer reaction, alkylation, and amination **SO5.5** Explain and apply The Bamberger rearrangement. The von Richter rearrangement	.	**Unit-5.0: Aromatic Nucleophilic Substitution.** 5.1 The SNAr 5.2 Ar SN1 5.3 Benzyne mechanism 5.4 Reactivity, effect of substrate structure, Effect of leaving group 5.5 Effect of attacking nucleophile. 5.6 Bucherer reaction 5.7bThe Bamberger rearrangement. 5.8 The von Richter rearrangement 5.9 SRN1 Mechanism T1 Aromatic substrate and their reactivity for nucleophile T2. ArsN2 mechanism T3. Smiles rearrangement	Sommelet –hauser rearrangement

SW-5 Suggested Sessional Work (SW):
a.Assignments:
Importance of Bucherer reaction, Bamberger rearrangement, Von Richter rearrangement

b.Mini Project:
Pictorial diagram of benzyne intermediate structure and stability
c.Other Activities (Specify):
Stabiltiy of Intermediates occur in aromatic nucleophilic reactions.

ModeofDelivery:Lecture,demonstration,E-tutoring,discussion,assignments,quizzes, case study, power point;

LMS/ICT Tools: Digital Classrooms, DLMS, ZOOM, G-Suite,MSPower-Point, Online Resources **Brief of Hours suggested for the Course Outcome**

Course Outcomes	Class Instruction (L+T) (CI)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
76CH102.1: Apply the concept of bonding and aromaticities on existed or newly synthesized organic molecules and explain structure of fullerenes as well as bonds weaker than covalent bond with related compounds	12	02	01	15
76CH102.2: Explain stereo-chemicalterms and inter-convert to stereo-structuralformulaeoforganicmolecules analyze configurations, create stereo-structures as well as correlate configuration byapplyingtheconcept ofchemical correlation.	12	02	01	15
76CH102.3: Describe mechanistic detailsofdifferenttype's reactioins with intermediates, thermodynamic & kinetic requirements and anlalyse the qualitative and quantitative structure& reactivity relationship in organic chemistry	12	02	01	15
76CH102.4:Explain mechanistic details of aliphatic nucleophilic substitution reactins and factors affecting reactivity in aliphatic nucleophilic substitution	12	02	01	15
76CH102.5: Apply the knowledge of the factors affecting reactivity in aromatic nucleophilic substitution to explain mechanisms of different type of aromatic nucleophilic reactions.	12	02	01	14

Total Hours	60	10	05	75

Suggestion for End Semester Assessment

Suggested Specification Table(For ESA)

CO	UnitTitles	MarksDistribution			Total Marks
		R	U	A	
CO-1	Nature of bonding in organic molecules	03	01	01	05
CO-2	Stereochemistry	02	06	02	10
CO-3	Reaction Mechanism: Structure and Reactivity	03	07	05	15
CO-4	Aliphatic Nucleophilic Substitution	-	10	05	15
CO-5	Aromatic Nucleophilic Substitution.	03	02	-	05
Total		11	26	13	50

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

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

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

Suggested Instructional /Implementation Strategies:

10. ImprovedLecture
11. Tutorial
12. CaseMethod
13. GroupDiscussion
14. RolePlay
15. Visitto NCL, CSIR laboratories
16. Demonstration
17. ICTBasedTeachingLearning(VideoDemonstration/TutorialsCBT,Blog,Facebook,Twitter,Whatsapp,Mobile,Onlinesources)
18. Brain storming

Suggested Learning Resources:

(b) **Books:**

S. No.	Title	Author	Publisher	Edition& Year
1	Advanced Organic Chemistry Reactions, Mechanism and Structure	Jerry March	John Wiley.	Revised editionedition2020
2	Advanced OrganicChemistry	F.A.CareyandR.J.Sundberg	Plenum	New edition, 2021
3	AGuideBooktoMechanisminOrganicChemistry	PeterSykes	Longman	1985
4	OrganicChemistry	R.T.MorrisonandR.N.Boyd	Prentice-Hall	Revised edition
5	Advanced organic chemistry	Dr. Jagdamba singh, Dr. LDS Yadav	Pragati prakashan	Revised edition 2016
6	OrganicChemistry	J.Clayden	OxfordPress	Revised edition

SuggestedWebSources:

4. https://nptel.ac.in/course.html
5. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5

urse Title: Organic Chemistry I

AKSUniversity

Faculty of Basic Science, **Department of Chemistry**

Curriculum of M. Sc. In Chemistry Program (Revised as on 01 August 2023)

Course Title: Organic ChemistryI **Course Code : 76CH102**

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Knowled ge	Resea rch Aptitu de	Commu nication	Proble m Solving	Individu al and Team Work	Investi gation of Proble ms	Modern Tool usage	Science and Society	Life-Long Learnin g	Ethics	Project Managem ent	Environme nt and sustainabili ty	The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry	To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.	understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon-based problems in chemical sciences.	Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science
CO1 : Apply the concept of bonding and aromaticities on existed or newly synthesized organic molecules and explain structure of fullerenes as well as bonds weaker than covalent bond with related compounds	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO 2 : Explain stereo-chemicalterms and inter-convert to stereo-structuralformulaeoforganicmolecules analyze configurations, create stereo-structures as well as correlate configuration byapplyingtheconcept ofchemical correlation	2	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3 : Describe mechanistic detailsofdifferenttype's reactioins with intermediates, thermodynamic & kinetic requirements and anlalyse the qualitative and quantitative structure& reactivity relationship in organic chemistry	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO 4: Explain mechanistic details of aliphatic nucleophilic substitution reactins and factors affecting reactivity in aliphatic nucleophilic substitution	2	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
CO 5: Apply the knowledge of the factors affecting reactivity in aromatic nucleophilic substitution to explain mechanisms of different type of aromatic nucleophilic reactions.	2	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

Legend:1–Low,2–Medium, 3–High

Course Curriculum Map:

POs &PSOsNo.	COsNo.&Titles	SOsNo.	LaboratoryInstruction(LI)	Classroom Instruction(CI)	Self Learning(SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1:Apply the concept of bonding and aromaticities on existed or newly synthesized organic molecules and explain structure of fullerenes as well as bonds weaker than covalent bond with related compounds	SO1.1SO 1.2SO1.3 SO1.4 SO1.5		Unit-1.0 Nature of bonbing in organic molecules 1.1,1.2,1.3,1.4,1.5,1.6,1.7	Aromaticity in annulenes,Inclusion Compounds
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 2 : Explain stereo-chemicalterms and inter-convert to stereo-structuralformulaeoforganicmolecules analyze configurations, create stereo-structures as well as correlate configuration byapplyingtheconcept ofchemical correlation	SO2.1SO 2.2SO2.3 SO2.4 SO2.5		Unit-2 Stereochemistry 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9	Interconversion of Fischer, Newman, Sawhorse and flying wedge formulae. (practice) Conformational analysis, simple, acyclic systems.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3 : Describe mechanistic detailsofdifferenttype's reactioins with intermediates, thermodynamic & kinetic requirements and anlalyse the qualitative and quantitative structure& reactivity relationship in organic chemistry	SO3.1SO3 .2 SO3.3 SO3.4 SO3.5		Unit-3 : Reaction mechanism structure and reactivity 3.1, 3.2,3.3,3.4,3.5,3.6,3.7	Generation, structure, stability andreactivity of carbocations, carbanions Taftequation
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4: Explain mechanistic details of aliphatic nucleophilic substitution reactins and factors affecting reactivity in aliphatic nucleophilic substitution	SO4.1SO 4.2SO4.3 SO4.4 SO4.5		Unit-4 : Aliphatic nucleophilic substitution 4.1, 4.2,4.3,4.4,4.5,4.6,4.7	Nucleophilic substitution at an aliphatic trigonal carbon. Phase transfer catalysis
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 5: : Apply the knowledge of the factors affecting reactivity in aromatic nucleophilic substitution to explain mechanisms of different type of aromatic nucleophilic reactions.	SO5.1SO 5.2SO5.3 SO5.4 SO5.5		Unit 5: Aromatic nucleophilic substitution 5.1,5.2,5.3,5.4,5.5,5.6,5.7	Alkylation,amination SRN1 mechanism

COURSE NAME: PHYSICAL CHEMISTRY I
NO. OF CREDITS: 4

L	T	P
3	1	0

Pre-requisite: Students must have fundamental knowledge of quantum mechanics, molecular orbital theory, thermodynamic of chemical process, electrochemical process, catalytic activity and surface chemistry.

Rationale: The students studying physical chemistry will understand and apply foundational thermodynamics of chemical process and basic concept of quantum mechanics. This will provide applicable knowledge about basic concept of quantum mechanics, thermodynamic of chemical process, catalytic activity and surface chemistry and electrochemical aspects to related process.

Course Outcomes:
Afterthe completionofthiscourse, thelearner will

76CH103.1: Explain and apply the basic concept of quantum mechanics.

76CH103.2: Apply molecular orbital theory to simple organic molecule.
76CH103.3: Explain and apply thermodynamic of chemical process.
76CH103.4: Explain catalytic activity and surface chemistry
76CH103.5: Apply electrochemical aspects to related process

Unit- I: Quantum Chemistry

The postulates of quantum mechanics, Linear and Hermitian operators.Commutation of operators and Uncertainty Principle. Schrödinger equation, Eigen function and Eigen values, free particle, Schrödinger equation for a particle in a box, the degeneracy, particle in a box with a finite barrier, Schrödinger equation for linear harmonic oscillator and its solution, zero-point energy, Energy levels and wave-functions of Rigid rotator.

Unit- II: Molecular Orbital Theory

Introduction and rule of HMO (Huckel Molecular Orbital) theory, Huckel theory of conjugated systems, bond order and charge density calculations. Applications to ethylene, butadiene, cyclopropenyl radical, cyclobutadiene etc.

Unit- III:

Classical Thermodynamics: Brief resume of concepts of laws of thermodynamics, free energy, chemical potential and entropies. Partial molar properties, partial molar free energy, partial molar volume and partial molar heat content and their significance. Determination of these quantities. Concept of fugacity and determination of fugacity Non-ideal systems: Excess functions for non ideal solutions. Activity and activity coefficient, Debye-Huckel theory for activity coefficient of electrolytic solutions; determination of activity and activity coefficients; ionic strength.

Unit- IV

Surface Chemistry: Surface tension, capillary action, pressure difference across curved surface (Laplace euqation), vapour pressure of droplets (Kelvin equation), Gibbs adsorption isotherm, estimation of surface area (BET equation) surface films on liquids (Electro-kinetic phenomenon), catalytic activity at surfaces.

Unit-V

Electrochemistry: Electrochemistry of solution. Debye-Huckel. Onsagar treatment and its extension, ion solvent interactions. Dye-Huckel- Jerum mode. Thermodynamics of electrified interface equations. Derivation of electro-capillarity. Lippmann equations (surface excess), Over potentials, exchange current density, derivation of butler-Volmer equation, Tafel plot. Eolectrocatalysis, Bioelectrochemistry.

Scheme of Studies:

Board of Study	CourseCode	CourseTitle	Scheme of studies(Hours/Week)					Total Credits(C)
			CI	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
ProgramCore(PCC)	76CH103	Physical Chemistry-I	3	0	1	1	5	4

Legend : **CI:**Class room Instruction (Includes different instructional strategiesi.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 (includesassignment,seminar, miniprojectetc.),
SL: Self Learning,
C: Credits.

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

Scheme of Assessment: Theory

Board ofStudy	CourseCode	CourseTitle	SchemeofAssessment(Marks)						
			Progressive Assessment(RA)					End Semester Assessment (ESA)	Total Marks (PRA+ESA)
			Class/HomeAssignment5number 3 markseach (CA)	Class Test2 (2bestout of3) 10 marks each(CT)	Seminarone + Class activity(SA)	Class Attendance (AT)	TotalMarks (CA+CT+SA +AT)		
PCC	76CH103	Physical Chemistry I	15	20	10	5	50	50	100

Course-Curriculum Detailing:

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

Unit- I (76CH103.1):

Quantum Chemistry;

The postulates of quantum mechanics, Linear and Hermitian operators. Commutation of operators and Uncertainty Principle. Schrödinger equation, Eigen function and Eigen values, free particle, Schrödinger equation for a particle in a box, the degeneracy, particle in a box with a finite barrier, Schrödinger equation for linear harmonic oscillator and its solution, zero-point energy, Energy levels and wave-functions of Rigid rotator.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO1.1 Explain postulates of quantum mechanics SO1.2 Apply Eigen function and Eigen values, free particle SO1.3 Explain Schrödinger equation for linear harmonic oscillator. SO1.4 Explain Energy levels and wave-functions of Rigid rotator SO1.5Expalin and apply Schrödinger equation for a particle in a box		1.1- Introduction Quantum mechanics 1,2--The postulates of quantum mechanics, 1.3--Linear and Hermitian operators. Commutation of operators and Uncertainty Principle. 1.4--Schrödinger equation derivation 1.5-Eigen function and Eigen values, free particle, 1.7Schrödinger equation for linear harmonic oscillator and its solution 1.8-Schrödinger equation for a particle in a box, the degeneracy8 wave-functions of Rigid rotator. 1.9-Zero-point energy and Energy levels. T1. Applications Schrodinger wave equation T2 Schrödinger equation for particle in a box with a finite barrier, T3 Applications of Schrodinger wave equation	Origin of quamntum mechanics

SW-1Suggested Sessional Work (SW):

Assignments: Discuss postulates of quantum mechanics, Schrödinger Wave equation, Energy levels and wave-functions of rigid rotator.

76CH102.2: **Unit- II**

Molecular Orbital Theory:

Introduction and rule of HMO (Huckel Molecular Orbital) theory, Huckel theory of conjugated systems, bond order and charge density calculations. Applications to ethylene, butadiene, cyclopropenyl radical, cyclobutadiene etc.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 Explain and apply HMO (Huckel Molecular Orbital) theory **SO2.2** Explain Huckel theory of conjugated systems, **SO2.3** Explain bond order and charge density calculations **SO2.4** Explain and apply ethylene, and butadiene, ethylene, butadiene, **SO2.5** Explain Applications to cyclopropenyl radical, and cyclobutadiene.		2.1-Introduction and rule of HMO (Huckel Molecular Orbital) theory, 2.2-Huckel theory of conjugated systems, 2.3-Bond order 2.4. Charge density calculations. 2.5-Applications to ethylene by HMO theory. 2.6-Applications to butadiene by HMO theory. 2.7-Applications of HMO theory on cyclopropenyl 2.8- Applications of HMO theory on cyclobutadiene 2.9.Other applications of HMO T T1Structure of butadiene T2 Struvture of cyclopentadiene T3 Concept of Zero point energy	Explain energy level diagram of organic molecule by HMO theory.

SW-2 Suggested Sessional Work (SW):

a- **Assignments:**

Discuss HMO Theory with examples,

b. Mini Project:

Applications to cyclopropenyl radical, and cyclobutadiene.

c. Other Activities (Specify):

Unit- III 76CH103.3: **Classical Thermodynamics**

Brief resume of concepts of laws of thermodynamics, free energy, chemical potential and entropies. Partial molar properties, partial molar free energy, partial molar volume and partial molar heat content and their significance. Determination of these quantities. Concept of fugacity and determination of fugacity Non-ideal systems: Excess functions for non ideal solutions.Activity and activity coefficient, Debye-Huckel theory for activity coefficient of electrolytic solutions; determination of activity and activity coefficients; ionic strength.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

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

SO3.1 Understand brief resume of concepts of laws of thermodynamics **SO3.2** Explainfree energy, chemical potential and entropies **SO3.3** Explain Partial molar properties, partial molar free energy, partial molar volume and partial molar heat content and their significance **SO3.4**Apply of activity and activity coefficients; ionic strength. **SO3.5** Concept of fugacity and determination of fugacity		**3.1-**Brief resume of concepts of laws of thermodynamics, 3,2-Free energy and chemical potential and entropies. 3.3-Partial molar properties, partial molar free energy, 3.4-partial molar volume and partial molar heat content and their significance. 3.5-Concept of fugacity 3.6. Determination of fugacity 3,7-Debye-Huckel theory for activity coefficient of electrolytic solutions; 8-3.8-Determination of activity and activity coefficients; 3.9-Ionic strength. T1- Concept of free energy T2- Determination of partial molar volume T3 -Determination of partial molar heat content	Non-ideal systems and Excess functions for non ideal solutions.

SW-3 Suggested Sessional Work (SW):

a.Assignments:

Concepts of laws of thermodynamics,

b. Mini Project:

Determination of fugacity Non-ideal systems

c.Other Activities (Specify):

Explanatory note on free energy, chemical potential and entropies

Unit-4.0 Surface Chemistry: Surface tension, capillary action, pressure difference across curved surface (Laplace euqation), vapour pressure of droplets (Kelvin equation), Gibbs adsorption isotherm, Estimation of surface area (BET equation) surface films on liquids (Electro-kinetic phenomenon), catalytic activity at surfaces.

Activity	AppX Hrs
Cl	07
LI	0
SW	2
SL	1
Total	10

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Understandsurface chemistry **SO4.2** Explainpressure difference across curved surface (Laplace euqation), **SO4.3** Explain Gibbs adsorption isotherm **SO4.4**Explain vapour pressure of droplets (Kelvin equation) **SO4.5** Explain estimation of surface area (BET equation)		4.1-Surface tension, capillary action, 4.2-Pressure difference across curved surface (Laplace euqation), 4.2-Vapour pressure of droplets (Kelvin equation), 4.4-Gibbs adsorption isotherm, 4.5-Postulates of BET equation 4.6-Estimation of surface area (BET equation) 4.7-Surface films on liquids (Electro-kinetic phenomenon), 4.8-limitation of BET equation 4.9- Application of BET T1- Gibs adsorption isother application T2- Surface tension determination T3 - Longmuir adsorption isotherm	Catalytic activity at surfaces.

SW-4 Suggested Sessional Work (SW):

a.Assignments:

Estimation of surface area (BET equation)

b.Mini Project:

c.Other Activities (Specify):

76CH102.5: **Electrochemistry:** Electrochemistry of solution. Debye-Huckel. Onsagar treatment and its extension, ion solvent interactions. Dye-Huckel- Jerum mode. Thermodynamics of electrified interface equations. Derivation of electro-capillarity. Lippmann equations (surface excess), Over potentials, exchange current density, derivation of butler-Volmer equation, Tafel plot. Eolectrocatalysis, Bioelectrochemistry.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 Understand Electrochemistry of solution **SO5.2** Explain Debye-Huckel. Onsagar treatment and its extension **SO5.3** Explain Dye-Huckel- Jerum mode. Thermodynamics of electrified interface equations. **SO5.4** Explain butler-Volmer equation and Tafel plot. **SO5.5** Explain Over potentials, exchange current density	.	5.1-introduction to electrochemistry 5.2.-Electrochemistry of solution. 5.3. Debye-Huckel. theory 5.4-Onsagar treatment and its extension, 5.5-Ion solvent interactions and 5.6-Derivation of electro-capillarity. 6-Lippmann equations (surface excess), 5.7-Over potentials, 5.8-Exchange current density, 5.9-Derivation of butler-Volmer equation and Tafel plot. T1- Debye-Huckel. Theory application T2- Lippmann equations application T3- Overvoltage	Electro catalysis,

SW-5 Suggested Sessional Work (SW):

a.Assignments:

Debye-Huckel. Onsagar treatment and its extension

c.Other Activities (Specify):

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
76CH103.1: Explain and apply the basic concept of quantum mechanics.	12	02	01	15
76CH103.2: Apply molecular orbital theory to simple organic molecule.	12	02	01	15
76CH103.3: Explain and apply thermodynamic of chemical process.	12	02	01	15
76CH103.4:Explain catalytic activity and surface chemistry	12	02	01	15
76CH103.5: Apply electrochemical aspects to related process	12	02	01	15
Total	60	15	05	75

Suggestion for End Semester Assessment

Suggested Specification Table(For ESA)

CO	UnitTitles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Quantum Chemistry	03	01	01	05
CO-2	Molecular orbital theory	02	06	02	10
CO-3	Classical thermodynamics	03	07	05	15
CO-4	Surface chemistry	-	10	05	15
CO-5	Electro chemistry**.**	03	02	-	05
Total		11	26	13	50

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

The end of semester assessment for physical chemistryI will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the cours ewise teachers for above tasks.Teacher s can alsodesign 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. Visitto NCL, CSIR laboratories
7. Demonstration
8. ICT Based Teaching Learning (VideoDemonstratio n/TutorialsCBT,Blog,Facebook,Twitter,Whatsapp,Mobile,Online sources)
9. Brainstorming

Suggested Learning Resources:

(c) **Books:**

S. No.	Title	Author	Publisher	Edition& Year
1	Physical Chemistry	P. W. Atkins,	ELBS	2012
2	Introduction to Quantum	A.K. Chandra,	Tata McGraw Hill.	2022
3	Quantum Chemistry,	Eyring and Kimball	Tata McGraw Hill.	1999
4	Quantum Chemistry,	Ira N. Levine, Prentce Hall.	Ira N. Levine, Prentce Hall.	2003
5				
6				

SuggestedWebSources:

6. https://nptel.ac.in/course.html
7. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
8. https://swayam.gov.in/explorer?category=Chemistry

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

LMS/ICT Tools: Digital Classrooms, DLMS, ZOOM, G-Suite,MSPower-Point, Online Resource

Course Title: Physical Chemistry I **Course Code : 76CH103**

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Knowledge	Research Aptitude	Communication	Problem Solving	Individual and Team Work	Investigation of Problems	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and sustainability	The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry	To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.	understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon-based problems in chemical sciences.	Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science
76CH103.1: Explain and apply the basic concept of quantum mechanics.	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
Explain and apply thermodynamic of chemical process.	2	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
76CH103.3: Apply molecular orbital theory to simple organic molecule.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
76CH103.4: Explain and apply thermodynamic of chemical process.	2	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
76CH103.5:Explain catalytic activity and surface chemistry	2	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

Legend:1–Low,2–Medium, 3–High

Course Curriculum Map:

POs &PSOsNo.	COsNo.&Titles	SOsNo.	LaboratoryInstruction(LI)	Classroom Instruction(CI)	Self Learning(SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	**76CH103.1**: Explain and apply the basic concept of quantum mechanics.	SO1.1S O1.2S O1.3S O1.4 SO1.5		Unit-1.0 Quantum chemistry 1.1,1.2,1.3,1.4,1.5,1.6,1.7,8,9	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	**76CH103.2**: Apply molecular orbital theory to simple organic molecule.	SO2.1S O2.2S O2.3 SO2.4 SO2.5		Unit-2 Molecular orbital theory 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	**76CH103.3**: Explain and apply thermodynamic of chemical process.	SO3.1S O3.2 SO3.3 SO3.4 SO3.5		Unit-3 : Clasical thermodynamics 3.1, 3.2,3.3,3.4,3.5,3.6,3.7.8,9	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	**76CH103.4**:Explain catalytic activity and surface chemistry	SO4.1S O4.2S O4.3S O4.4 SO4.5		Unit-4 : Surface chemistry 4.1, 4.2,4.3,4.4,4.5,4.6,4.78,9	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	**76CH103.5:** Apply electrochemical aspects to related process	SO5.1S O5.2S O5.3S O5.4 SO5.5		Unit 5: electro chemistry 5.1,5.2,5.3,5.4,5.5,5.6,5.7,8,9	

CODE: 76CH104

COURSE NAME: Group theory and Spectroscopy I

NO. OF CREDITS: 4

L	T	P
3	1	0

Pre-requisite: Students should have basic knowledge of symmetry and group theory, electromagnetic radiation, interaction of electromagnetic radiation with matter and spectroscopy.

Rationale: The students studying group theory and spectroscopy should possess foundational understanding about, symmetry, EMR, NMR,PES.

Course Outcomes:

After the completion of this course, the learner will

76CH104.1: Explain and apply the basic concept symmetry and group theory.

76CH104.2: Describe fundamental aspects of spectroscopy and apply the knowledge these aspects on solving problem related to these.

76CH104.3: Apply the basic concept of microwave and its principle

76CH104.4:Explain and apply the principle of atomic spectroscopy and photo electron spectroscopy**.**

76CH104.5: Apply the knowledge of NMR principle, instrumentation and applications. And apply the knowledge to solve issues related to NMR spectroscopy

Unit-I: Symmetry and Group Theory

Symmetry elements and Symmetry operations, definitions of group, subgroups, relationship between orders of a finite group and its subgroup. Conjugacy relation and classes.

Unit-II: Unifying Principles

Electromagnetic radiation, interaction of electromagnetic radiation with matter –Absorption, emission, transmission, reflection, refraction, dispersion, polarization and scattering. Uncertainty relation and natural line width and natural line broadening, transition probability, results of time dependent perturbation theory, transition moment, selection rules, Intensity of spectral lines, Born Oppenheimer approximation, rotational, Vibrational and electronic levels.

Unit-III: Microwave Spectroscopy

Classification of molecules, rigid rotor model, effect of isotopic substitution on the transition frequencies, intensities, non rigid rotors . Stark effect, nuclear and electron spin interaction and effect of external field.

Unit-IV: Electronic Spectroscopy

A-Atomic Spectroscopy: Energies of atomic orbitals, vector representation of momenta and vector coupling, spectra of hydrogen atoms and alkali metal atoms.

Photo electron spectroscopy: Basic principles, photo-electric effect, ionization process, Koopman's theorem, photo electron spectra of simple molecules.

Unit-V: Nuclear Magnetic Resonance Spectroscopy

Nuclear spin, nuclear resonance, saturation, shielding of magnetic nuclei, chemical shift and its measurements, factors influencing chemical shift, deshielding, spin-spin interactions, factor influencing coupling constant"J".Classification(ABX,AMX,ABC,A2B2,etc.),spin decoupling,basic ideas about instrument..

Scheme of Studies:

Board ofStudy	CourseCode	CourseTitle	Scheme ofstudies(Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
ProgramCore(PCC)	76CH104	Group theory and spectroscopy	4	0	1	1	6	4

Legend: **CI:**Class room 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 locates using different instructional strategies)
SW: Sessional Work(includesassignment,seminar,miniprojectetc.),
SL: Self Learning,
C: Credits.

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

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title	Scheme ofAssessmen t(Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ESA)
			Class/Home Assignment 5 number 3marks each (CA)	Class Test2 (2best out of3) 10 marks each(CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA +AT)		
PCC	76CH104	Group theory and spectroscopy	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.

76CH104.1: Explain and apply the basics concept symmetry and group theory.

Approximate Hours

Activity	Apex Hrs
CI	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO1.1Restate the concept of symmetry and symmetry elements. SO1.2 Apply concept of symmetry operation on compounds SO1.3 Describe different types of symmetry elements. SO1.4 Discuss about plane of symmetry and its types. SO1.5 Explain and apply the group , sub group and classes of symmetry elements of a molecule.		**Unit-1 symmetry and group theory** 1.1 Introduction of symmetry 1.2 symmetry elements 1.3 identity 1.4 proper axis of symmetry 1.5 improper axis of symmetry 1.6 plane of symmetry 1.7 in version centre 1.8 symmetry operation 1.9 group and sub group T1 Order of group T2 class of group T3 prediction of symmetry elements of molecules	Prediction of symmetry elements in benzene, $PtCl_4$.

SW-1SuggestedSessionalWork(SW):

a. Assignments:

Discuss the Symmetry elements and Symmetry operations of various types of molecules.

b. Mini Project:

group, subgroups, order of group of symmetry elements.

c. Other Activities (Specify):

Note on relationship between orders of a finite group and its subgroup.

76CH104.2: Describe fundamental aspects of spectroscopy and apply the knowledge these aspects on solving problem related to these.

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Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 Restate the term electromagnetic radiation. **SO2.2** Describe the interaction of electromagnetic radiation with matter with different phenomenon. **SO2.3** Discuss transmission, reflection, refraction **SO2.4** Explain and apply the phenomenon of scattering and polarization of light, its types and uses. **SO2.5** Explain elementary idea Uncertainty relation and natural line width and natural line broadening, transition probability.		**Unit-2.0 Unifying Principles** 2.1 Introduction of EMR 2.2 discovery, properties of EMR. 2.3 Types of electromagnetic radiation. 2.4 Born Oppenheimer approximation. 2.5 Interaction of electromagnetic radiation with matter 2.6absorption and emission 2.7Phenomenon's of transmission, reflection and refraction of light 2.8The phenomenon of scattering and polarization of light, its types and uses. 2.9 Uncertainty relation and natural line width T1-Natural line broadening, transition probability. T2-Selection rule T3- factors affecting band width broadening.	interaction of electromagnetic radiation with matter

SW-2 Suggested Sessional Work (SW):

A .Assignments:

Discussion of different phenomenon's of electromagnetic radiation interaction with matter.

b. Mini Project:

Natural line width and natural line broadeningand factors affecting band width broadening.

c. Other Activities (Specify):

Write an essay on electromagnetic radiation, interaction of electromagnetic radiation with matter.

76CH104.3: Describe details ofclassification of molecules, classical model of rigid rotator and analyses effect of isotopic substitution on the transition frequencies, intensities and stark effect.

Activity	AppX Hrs
Cl	15
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Restate classification of molecules, homo and hetroatomic microwave activity. **SO3.2** Explain, moment of inertia, kinetic energy and rotational energyof rigid rotator by classical model. **SO3.3** Explain selection rule and spectral intensities of rigid rotator. **SO3.4** Describe the effectof isotopic substitution on the transition frequencies**.** **SO3.5** Explain and apply stark effect, nuclear and electron spin interaction and effect of external field.		**Unit-3.0 Microwave Spectroscopy** 3.1 Classification of molecules 3.2 homo and hetroatomic molecules 3.3 microwave activity microwave activity. 3.4Moment of inertia of rigid rotator. 3.5kinetic energy of rigid rotator. 3.6rotational energyof rigid rotator by classical model 3.7 Mathematical derivation of rigid rotator by classical model 3.8 selection rule and spectral intensities of rigid rotator. 3.9 effect of isotopic substitution on the transition frequencies. T1 stark effect T2 Types of stark effect, T3nuclear and electron spin interaction and effect of external field.	Microwave activity of different molecules.

SW-3 Suggested Sessional Work (SW):

a. Assignments:
Isotopic substitution on the transition frequencies**.**
b. Mini Project:
Stark effect, nuclear and electron spin interaction and effect of external field.
c. Other Activities (Specify):
Explanatory note on importance of Microwave Spectroscopy

76CH104.4: Explain energies of atomic orbital's, vector representation of momenta and vector coupling, spectra of hydrogen atoms and Photo electron spectroscopy

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Explain and apply about Atomic Spectroscopy, Energies of atomic orbital's**,** vibronic transition. **SO4.2** Restate vector coupling of electron of atom andvector representation of momenta **SO4.3** Describe the spectra of hydrogen atoms with spectral lines and importance. **SO4.4** Discuss Photo electron spectroscopy**-** Basic principles, mechanism of photoelectric effect. **SO4.5** Explain and apply instrumentation of photo electron spectrometer and its application		**Unit-4.0 Atomic Spectroscopy** 4.1 Energies of atomic orbital's 4.2 electronic transition, 4.3 frank Condon principle. 4.4 vector representation of momenta 4.5 vector coupling of electron of atom. 4.6The spectra of hydrogen atoms with spectral lines and importance. 4.7 Photo electron spectroscopy**-** 4.8 Types of PES, Basic principles, 4.9 mechanism of photoelectric effect, ionization process. T1 Instrumentation of photo electron spectrometer T2 its application. T3 PES Spectra of molecules	Types of electronic transition and vibronic transition.

Suggested Sessional Work (SW):

a. **Assignments:**

Spectra of hydrogen atom and spectral line with importance.

b. Mini Project:

Vector representation of momenta and vector coupling of electron of atom.

b. **Other Activities (Specify):**

Importance and applications of photo electron spectroscopy.

76CH104.5: Apply the knowledge of the Nuclear Magnetic Resonance Spectroscopy, NMR activity,chemical shift and its measurements, factors influencing chemical shift, spin-spin interactions, basic ideas about instrument.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 Explain and apply the introduction of NMR ,Nuclear spin, nuclear resonance **SO5.2** Describe shielding and deshielding of magnetic nuclei. **SO5.3** Restatechemical shift , delta value and its measurements and factors influencing chemical shift, **SO5.4** Discuss spin-spin interactions, factor influencing coupling constant. **SO5.5** Restate spins decoupling and basic ideas about instrumentation of NMR spectrophotometer.	.	**Unit-5.0 Nuclear Magnetic Resonance Spectroscopy.** 5.1 introduction of NMR. 5.2Nuclear spin quantum number 5.3 NMR activity, nuclear resonance 5.4Shielding and deshielding of magnetic nuclei. 5.5 chemical shift, delta value and TMS scale. 5.6 delta value and its measurements 5.7factors influencing chemical shift. 5.8 spin-spin interactions, 5.9Factor influencing coupling constant "J" T1-Classification (ABX, AMX, ABC, A2B2 etc.) T2 Spin decoupling and basic ideas about it. T3-Instrumentation of NMR spectrophotometer.	Chemical shift and its measurements of different organic compound.

SW-5 Suggested Sessional Work (SW):

a. **Assignments:**
Chemical shift and its measurements of different organic compound.

c. **Mini Project:**
Spin-spin interactions and coupling constant "J" for (ABX,AMX,ABC,A2B2,etc.),

d. **Other Activities (Specify):**

Basic ideas about instrumentation of NMR spectrophotometer.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
76CH104.1: Explain and apply the basic concept symmetry and group theory.	12	02	01	15
76CH104.2: Describe fundamental aspects of spectroscopy and apply the knowledge these aspects on solving problem related to these	12	02	01	15
76CH104.3: Apply the basic concept of microwave and its principle.	12	02	01	15
76CH104.4 Explain and apply the principle of atomic spectroscopy and photo electron spectroscopy .	12	02	01	15
76CH104.5: Explain of NMR principle, instrumentation and applications. And apply the knowledge to solve issues related to NMR spectroscopy.	12	10	05	15
Total Hours	60	10	05	75

Suggestion for End Semester Assessment

Suggested Specification Table(For ESA)

CO	UnitTitles	MarksDistribution			Total Marks
		R	U	A	
CO-1	Symmetry and Group Theory	03	01	01	05
CO-2	Unifying Principles	02	06	02	10
CO-3	Microwave Spectroscopy	03	07	05	15
CO-4	Electronic Spectroscopy	-	10	05	15
CO-5	Nuclear Magnetic Resonance Spectroscopy	03	02	-	05
Total		11	26	13	50

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

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

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

Suggested Instructional/Implementation Strategies:

10. Improved Lecture
11. Tutorial
12. Case Method
13. Group Discussion
14. Role Play
15. Visit to NCL, CSIR laboratories
16. Demonstration
17. ICT Based Teaching Learning (Video Demonstration /Tutorials CBT,Blog,Facebook,Twitter,Whatsapp,Mobile,Online sources)
18. Brain storming

Suggested Learning Resources:

(d) **Books:**

S. No.	Title	Author	Publisher	Edition& Year
1	Modern Spectroscopy	J. M. Hoilas	John Wiley.	Revised editionedition2020
2	Applied Electron Spectroscopy for Chemical Analysis	Ed. H. Windawi and F. L. HO	Wiley Interscience.	New edition, 2021
3	NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry	R. V. Parish	Ellis Harwood.	New edition, 2021
4	Physical Mehtods in Chemistry	R. S. Drago	Saunders	Revised edition
5	Chemical Applications of Group Theory	F. A. Cotton.	--	Revised edition
6	Introduction to Molacular Spectroscopy	G. M. Barrow	McGRraw Hill.	2020Revised edition

SuggestedWebSources:

9. https://nptel.ac.in/course.html
10. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
11. https://swayam.gov.in/explorer?category=Chemistry

ModeofDelivery:Lecture,demonstration,E-tutoring,discussion,assignments,quizzes, case study, power point;

AKSUniversity

FacultyofBasic Science, **DepartmentofChemistry**

CurriculumofM. Sc. In Chemistry Program (Revisedason01August2023)

Title: Group Theory and SpectroscopyI **Course Code : 76CH102**

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Knowledge	Research Aptitude	Communication	Problem Solving	Individual and Team Work	Investigation of Problems	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and sustainability	The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry	To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.	understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon-based problems in chemical sciences.	Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science
CO1: Explain and apply the basic concept symmetry and group theory.	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO 2 Describe fundamental aspects of spectroscopy and apply the knowledge these aspects on solving problem related to these	2	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3 Apply the basic concept of microwave and its principle	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO 4: Explain and apply the principle of atomic spectroscopy and photo electron spectroscopy	2	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
CO 5 Explain of NMR principle, instrumentation and applications. And apply the knowledge to solve issues related to NMR spectroscopy	2	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

Legend:1–Low,2–Medium, 3–High

Course Curriculum Map:

POs & PSOsNo.	COsNo.&Titles	SOsNo.	LaboratoryInstruction(LI)	Classroom Instruction(CI)	Self Learning(SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1: : Explain and apply the basic concept symmetry and group theory.	SO1.1SO 1.2SO1.3 SO1.4 SO1.5		Unit-1.0 group theory and spectroscopy 1.1,1.2,1.3,1.4,1.5,1.6,1.7	Prediction of symmetry elements in benzene, PtCI4.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 2 : Describe fundamental aspects of spectroscopy and apply the knowledge these aspects on solving problem related to these	SO2.1SO 2.2SO2.3 SO2.4 SO2.5		Unit-2 Unifying Principles 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9	interaction of electromagnetic radiation with matter
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3 : Apply the basic concept of microwave and its principle	SO3.1SO3 .2 SO3.3 SO3.4 SO3.5		Unit-3 : Microwave Spectroscopy 3.1, 3.2,3.3,3.4,3.5,3.6,3.7	Microwave activity of different molecules.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4: Explain and apply the principle of atomic spectroscopy and photo electron spectroscopy	SO4.1SO 4.2SO4.3 SO4.4 SO4.5		Unit-4 : Electronic Spectroscopy 4.1, 4.2,4.3,4.4,4.5,4.6,4.7	Types of electronic transition and vibronic transition
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 5: Explain of NMR principle, instrumentation and applications. And apply the knowledge to solve issues related to NMR spectroscopy	SO5.1SO 5.2SO5.3 SO5.4 SO5.5		Unit 5: Nuclear Magnetic Resonance Spectroscopy 5.1,5.2,5.3,5.4,5.5,5.6,5.7	Chemical shift and its measurements of different organic compound

CODE: 76CH105
COURSE NAME: Mathematics for Chemist
NO. OF CREDITS: 3

L	T	P
1	3	0

Pre-requisite: Students must have fundamental knowledge of mathematical aspects, vectors, Differential Calculus,Permutation, Probability,Logarithm & Integral calculus, Elementary Differential equations, Matrices and Determinants.

Rationale: The students studying Mathematics for Chemist should possess foundational understanding about mathematical aspects, vectors, Differential Calculus,Permutation, Probability,Logarithm & Integral calculus, Elementary Differential equations, Matrices and Determinants.

COURSE OUT COMES:

Afterthe completion of this course, the learner will

76CH105.1: Explain Matrix and Vectors Algebra.

76CH105.2: Apply Differential Calculus.

7676CH105.3: Apply Integral calculus.

7676CH105.4: DiscussDifferentialequations.

7676CH105.5: Explain Fundamentals of Permutation and Probability with applications.

Unit I: Vectors:

Examples of scalar and vectors, definitions of vectors in two, three spaces, representation and simple properties of vectors, addition and subtraction of vectors, vector addition by the method of triangles, resolution of vectors into rectangular components, addition of vectors by components, multiplication and differentiation of vectors. Scalar product of vectors, vector product.

Matrices: Definition of matrix, types of matrices, viz. row matrix, column matrix, null matrix, square matrix, diagonal matrix, addition, subtraction and multiplication by a number, matrix multiplication. Transpose and adjoint of matrix,

Unit II: Differential Calculus

Functions, continuity and differentiability, rules for differentiation, applications of differential calculus including maxima and minima (examples related to maximally populated rotational energy levels, Bohr's radius and most probable velocity from Maxwell's distribution etc.).

Unit III: Logarithm & Integral calculus.

Logarithm, Graphical Representation of Equations, formulas for integration, integration by parts, partial fractions and substitution. Reduction formulae, applications of integral calculus. Functions of several variables, partial differentiation, co-ordinate transformations (e.g. Cartesian to spherical polar).

Unit IV: Elementary Differential equations

First-order and first degree differential equations, homogenous, exact and linear equations. Applications to chemical kinetics, secular equilibria, quantum chemistry etc. second order differential equation and their applications.

Unit V: Permutation and Probability

Permutations and combinations, probability and probability theorems average, variance and root means square deviation. Examples from the kinetic theory of gases including least squares fit .

Scheme of Studies:

Board ofStudy	CourseCode	CourseTitle	Scheme ofstudies (Hours/Week)					Total Credits(C)
			CI	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
ProgramCore(ECC)	76CH105	Mathematics for Chemist	3	0	1	1	5	4

Legend : CI: Class room Instruction (Includesdifferentinstructionalstrategiesi.e.Lecture(L)andTutorial (T)andothers),

LI: Laboratory Instruction (IncludesPracticalperformancesinlaboratory workshop, field or other locations using differentinstructionalstrategies)

SW: Sessional Work(includesassignment,seminar,miniprojectetc.),

SL: Self Learning,

C: Credits.

Note:

SW&SLhastobeplannedandperformedunderthecontinuousguidanceandfeedbackofteacherto ensure outcome ofLearning.

Scheme of Assessment: Theory

Board ofStudy	CourseCode	CourseTitle	SchemeofAssessment(Marks)						
			ProgressiveAssessment(RA)					EndSemester Assessment (ESA)	TotalMarks (PRA+ESA)
			Class/HomeAssignment5number 3 markseach (CA)	Class Test2 (2bestout of3) 10 markseach(CT)	Seminarone + Class activity	ClassAttendance (AT)	TotalMarks (CA+CT+SA +AT)		
BCC	76CH105	Mathematics for Chemist	15	20	10	5	50	50	100

Course-Curriculum Detailing:

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

Unit- I (76CH105.1):

Vectors: Examples of scalar and vectors, definitions of vectors in two, three spaces, representation and simple properties of vectors, addition and subtraction of vectors, vector addition by the method of triangles, resolution of vectors into rectangular components, addition of vectors by components, multiplication and differentiation of vectors. Scalar product of vectors, vector product.
Matrices: Definition of matrix, types of matrices, viz. row matrix, column matrix, null matrix, square matrix, diagonal matrix, addition, subtraction and multiplication by a number, matrix multiplication. Transpose and adjoint of matrix,

Activity	AppX Hrs
Cl	07
LI	0
SW	2
SL	1
Total	10

Session Outcomes (SOs)	LI	CI	SL
SO1.1 Students understood about the Vectors. SO1.2 Students understood about the Matrices. SO1.3 Students applied the knowledge of addition and subtraction of vectors, vector addition by the method of triangles, SO1.4 Discuss about the types of matrices with examples SO1.5 Students understood Transpose and adjoint of matrix,		1.1-Definitions of vectors in two, three spaces, representation and simple properties of vectors, 1,2-Addition and subtraction of vectors, 1,3-resolution of vectors into rectangular components, addition of vectors by components, 1.4-Multiplication and differentiation of vectors. Scalar product of vectors, vector product. 1.5-Definition of matrix with types 1.6-Addition, subtraction and multiplication by a number, matrix multiplication. 1.7- Inverse matrices with examples	Examples of scalar and vectors, Transpose and adjoint of matrix,

SW-1Suggested SessionalWork(SW):
Assignments: Draw Wall's diagram of tri-atomic and Penta-atomic molecule
b. Mini Project: Make a model of shape of given molecules
c. Other Activities (Specify): Write short note Bents rule

Unit-II (76CH105.2)

Differential Calculus. Functions, continuity and differentiability, rules for differentiation, applications of differential calculus including maxima and minima (examples related to maximally populated rotational energy levels, Bohr's radius and most probable velocity from Maxwell's distribution etc.).

Activity	AppX Hrs
Cl	07
LI	0
SW	2
SL	1
Total	10

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 Students understood Functions, continuity and differentiability **SO2.2** Students understood applications of differential calculus including maxima and minima **SO2.3** Discussrotational energy levels, **SO2.4** Bohr's radius and most probable velocity from Maxwell's distribution etc. **SO2.5** DiscussExamples of partial differentiation rotational energy levels,		2.1-Functions, continuity and differentiability, 2.2-Rules for differentiation with examples 2.3-Applications of differential calculus including maxima and minima 2.4-Examples related to maximally populated rotational energy levels, 2.5- Examples related to maximally populated Bohr's radius 2.6-Examples related to maximally populated most probable velocity from Maxwell's distribution etc. 2.7-Examples of partial differentiation	Applications of differentiation with examples

SW-2 Suggested Sessional Work (SW):
Assignments: Applications of differential calculus including maxima and minima

Mini Project:
Other Activities (Specify): explain partial differentiation .

Unit-III (76CH105.3)

Logarithm & Integral calculus.

Logarithm, Graphical RepresentationofEquations, formulas for integration, integration by parts, partial fractions and substitution. Reduction formulae, applications of integral calculus. Functions of several variables, partial differentiation, co-ordinate transformations (e.g. Cartesian to spherical polar).

Activity	AppX Hrs
Cl	07
LI	0
SW	2
SL	1
Total	10

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Introduced Logarithm, GraphicalRepresentationofEquations **SO3.2** Understood and applied the formulas for integration **SO3.3** Understood and applied the integration by parts, partial fractions and substitution **SO3.4** Explainapplications of integral calculus **SO3.5** Understood and applied the partial differentiation		3.1-Logarithm, GraphicalRepresentationofEquations, 3.2-Formulas for integration, integration by parts, partial fractions and substitution. 3.3-Reduction formulae, 3.4-Applications of integral calculus. 3.5-Functions of several variables, 3.6-Partial differentiation, 3.7-Coordinate transformations (e.g. Cartesian to spherical polar).	Applications of integral calculus

SW-3 Suggested Sessional Work (SW):
Assignments: Applications of integral calculus
Mini Project:
Other Activities (Specify): Applications of integral in chemistry

Unit-IV (76CH101.4)

Elementary Differential equations. First-order and first degree differential equations, homogenous, exact and linear equations. Applications to chemical kinetics, secular equilibria, quantum chemistry etc. second order differential equation and their applications.

Activity	AppX Hrs
Cl	07
LI	0

SW	2
SL	1
Total	10

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Students understood the order of reaction **SO4.2** Students understood second order differential equation and their applications **SO4.3** Introduced first degree differential equations **SO4.4** Applications to chemical kinetics **SO4.5** Understood the secular equilibria.		4.1-First-order and first degree differential equations, 4.2-Homogenous, exact and linear equations. 4.3-Applications to chemical kinetics, 4.4- Homogenous, exact and linear equations with examples. 4.5-Secularequilibria, quantum chemistry etc. 4.6-Second order differential equation and their applications. 4.7-Second order differential equation with examples.	First-order and second order differential equations with applications

SW-4 Suggested Sessional Work (SW)
Assignment: First-order and second order differential equations with applications

Mini Project:
Other Activities (Specify): Discuss in chemical kinetics

76CH101.5: **Permutation and Probability.**Permutations and combinations, probability and probability theorems average, variance and root means square deviation. Examples from the kinetic theory of gases including least squares fit .

Activity	AppX Hrs
Cl	07
LI	0
SW	2
SL	1
Total	10

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 Explain Permutations with examples **SO5.2** Understood the concept of Combinations with examples **SO5.3** Apply the concept of Average, variance and root mean square deviation **SO5.**4 Understood the concept of Probability theorem. **SO5.5** Applied Examples from the kinetic theory of gases including least squares fit	.	5.1-Permutations with examples and 5.2-Combinations with examples, 5.3-Probability and probability theorems 5.4-Average, variance and root mean square deviation. 5.5-Examples from the kinetic theory of gases including least squares fit . 5.6- Applications of Probability theorem. 5.7- Examples of Probability	Relation between Permutations & Combinations

SW-5 Suggested Sessional Work (SW):
Assignments: Applications of Probability theorem.

Mini Project:
Other Activities (Specify): Examples from the kinetic theory of gases including least squares fit

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
76CH105.1: ExplainMatrixand VectorsAlgebra.	07	02	01	10
76CH105.2: Understand & Apply DifferentialCalculus.	09	02	01	12
7676CH105.3: Understand & Apply Integral calculus.	07	02	01	10
7676CH105.4: Discuss Differential equations.	07	02	01	10

7676CH105.5: Fundamentals of Permutation and Probability with applications.	07	02	01	10
Total Hours	37	15	05	52

Suggestion for End Semester Assessment
Suggested Specification Table (For ESA)

CO	UnitTitles	MarksDistribution			TotalMarks
		R	U	A	
CO-1	Vectors & Matrices	03	01	01	05
CO-2	Differential Calculus	02	06	02	10
CO-3	Logarithm & Integral calculus	03	07	05	15
CO-4	Elementary Differential equations	-	10	05	15
CO-5	Permutation and Probability	03	02	-	05
Total		11	26	13	50

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

The written examination of 50 marks will be held at theendofsemesterfor Inorganic Chemistry

Note.DetailedAssessmentrubricneedtobepreparedbythecoursewiseteachersforabovetasks.
Teacherscanalsodesigndifferenttasksasperrequirement,forendsemesterassessment.
Suggested Instructional/Implementation Strategies:

19. Improved Lecture
20. Tutorial
21. Case Method
22. Group Discussion
23. Role Play
24. Visitto NCL, CSIR laboratories
25. Demonstration
26. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT,Blog,Facebook,Twitter,Whatsapp,Mobile,Onlinesources)
27. Brainstorming

SuggestedLearningResources:

Books:

S. No.	Title	Author	Publisher	Edition& Year
1	The chemistry Mathematics Book	E.Steiner	Oxford University Press	Revised Edition

2	Chemical Mathematics	D.M. Hirst	Longman	Revised Edition
3	Applied Mathematics for Physical Chemistry	J.R. Barante	Prentice Hall	Revised Edition
4	Basic Mathematics for Chemists	Tebbutt,	Wiley	Revised Edition
5	Mathematics for Chemists	Bhupendra Singh	Pragati Prakashan	Revised Edition
6	Mathematical for Physical chemistry	F. Daniels	Mc. Graw Hill	Revised Edition

SuggestedWebSources:

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

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

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

Course Title: Mathematics for Chemist **Course Code : 76CH105**

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Knowledge	Research Aptitude	Communication	Problem Solving	Individual and Team Work	Investigation of Problems	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and sustainability	The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry	To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.	understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon-based problems in chemical sciences.	Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science
CO1: Explain Matrix and Vectors Algebra	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO 2 Understand & Apply DifferentialCalculus	2	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3 Understand & Apply Integral calculus	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO 4: Discuss Differential equations	2	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
CO 5 Fundamentals of Permutation and Probability with applications	2	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

Legend:1–Low,2–Medium, 3–High

Course Curriculum Map:

POs &PSOsNo.	COsNo.&Titles	SOsNo.	LaboratoryInstruction(LI)	Classroom Instruction(CI)	Self Learning(SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1: Explain Matrix and Vectors Algebra	SO1.1SO 1.2SO1.3 SO1.4 SO1.5		Unit-1.0 Vectors & Matrices 1.1,1.2,1.3,1.4,1.5,1.6,1.7	Examples of scalar and vectors, Transpose and adjoint of matrix,
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 2 : Understand & Apply Differential Calculus	SO2.1SO 2.2SO2.3 SO2.4 SO2.5		Unit-2 Differential Calculus 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9	Applications of differentiation with examples
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3 : Understand & Apply Integral calculus	SO3.1SO3 .2 SO3.3 SO3.4 SO3.5		Unit-3 : Logarithm & Integral calculus 3.1, 3.2,3.3,3.4,3.5,3.6,3.7	Applications of integral calculus
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4: Discuss Differential equations	SO4.1SO 4.2SO4.3 SO4.4 SO4.5		Unit-4 Elementary Differential equations 4.1, 4.2,4.3,4.4,4.5,4.6,4.7	First-order and second order differential equations with applications
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 5: : Fundamentals of Permutation and Probability with applications	SO5.1SO 5.2SO5. 3SO5.4 SO5.5		Unit 5: Permutation and Probability 5.1,5.2,5.3,5.4,5.5,5.6,5.7	Relation between Permutations & Combinations

AKSUniversity

***FacultyofBasic Science*, DepartmentofChemistry**

CurriculumofM. Sc. In Chemistry Program (Revisedason01August2023)

CODE: 76CH105

COURSE NAME:Biology for Chemist

NO. OF CREDITS: 3

L T P
3 0 0

Pre-requisite: Students should have basic knowledge of Introduction to metabolic processes, cycleof livingbeings , carbohydrates and their impotance protein structure, Lipids, genetic enginreeing.

Rationale: The students studying biology chemistry should possess foundational understanding about metabolism processes, protein structure, carbohydrates and their impotance. This will provide applicalbe knoweledge about metabolism and energy cycle of living beings , Predict biochemistryof anymetabolism, protein structure and amino acid, genetic code.

COURSEOUTCOMES:

Afterthe completionofthiscourse, thelearner will:

76CH105.1:Explain the metabolism and energy cycle of living beings.
76CH105.2: Explain carbohydrates and their impotance for leaving beings
76CH105.3: Predict biochemistry of any metabolism
76CH105.4:Solve problems related protein structure and amino acid sequence in protein
76CH105.5: Solve problem related genetic enginreeing.

UNIT: I

Introduction to metabolic processes: Origin of life – unique properties of carbon, chemical evolution and rise of living systems, structure of prokaryotic and eukaryotic cells, and cell organells, catabolism and anabolism, ATP, currency of biological energy, energy rich and energy poor phosphates, role of NADH, NADPH, FADH2, TPP, coenzyme A, lipoic acid and biotin. Introduction to photosynthesis.

UNIT: II

Carbohydrates

Structure (excluding conformational analysis) and biological functions of monosaccharides (glucose, fructose and galactose) and their derivatives like glycosides, deoxy sugars, myoinositol. Disaccharides- sucrose, lactose and maltose.

Structure and biological functions of Structural polysaccharides (cellulose and chitin) and Storage polysaccharides (starch and glycogen) Heteropolysaccharides-Glucosaminoglycans / mucopolysaccharides.

UNIT: III

Lipids: Fatty acids, essential fatty acids, structure and function of triacylglycerols, glycerophospholipids, sphingolipids, cholesterol, bile acids, prostaglandins. Lipoproteins - composition and function, role in atherosclerosis.

Lipid metabolism - β-oxidation of fatty acids.

UNIT IV

Amino acids, Peptides and Proteins Chemical and enzymatic hydrolysis of proteins to peptides, amino and sequencing. Secondary structure of proteins, forces responsible for holding of secondary structures, a -helix, b -

sheets , super secondary structure, triple helix structure of collagen. Tertiary structures of proteins- folding and domain structures.. Amino acid metabolism – degradation and biosynthesis of amino acids, sequence determination: chemical / enzymatic / mass spectral , racemization/ detection.

UNIT V

Nucleic Acids and Genetic Code: Structure of nucleotides, nucleosides, DNA (Watson-Crick model) and RNA, Replication of DNA (semi-conservative, conservative and dispersive replication Maselson-Stahl experiment), transcription, translation of genetic material, genetic code, universality of the code, codon, anticodon pairing.

1. PrinciplesofBiochemistry,A.L. Lehninger,WorthPublishers.
2. Biochemistry,L.Stryer,W.H.Freeman.
3. Biochemistry,J.DavidRawn,NeilPatterson.
4. Biochemistry,Voet andVoet,JohnWiley.
5. OutlinesofBiochemistry,E.E.ConnandP.K. Stumpf,JohnWiley.

SchemeofStudies:

Board of Study	CourseCode	CourseTitle	Scheme ofstudies(Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
ProgramCore(PCC)	76CH105	Biology for Chemist	3	0	1	1	5	3

Legend: **CI:**ClassroomInstruction(Includesdifferentinstructionalstrategies i.e.Lecture(L)andTutorial(T)andothers),
SW: Sessional Work(includesassignment,seminar,miniprojectetc.),
SL: SelfLearning,
C:Credits.

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

Scheme of Assessment: Theory

Board of Study	CouseCode	CourseTitle	SchemeofAssessment(Marks)						
			ProgressiveAssessment(PRA)					EndSemesterAssessment (ESA)	TotalMarks (PRA+ESA)
			Class/HomeAssignment5number 3 markseach (CA)	Class Test2 (2bestoutof3) 10 markseach(CT)	Seminarone (SA)	ClassAttendance (AT)	TotalMarks (CA+CT+SA +AT)		
PCC	**76CH105**	**Biology for chemist**	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.

76CH105.1: Explain themetabolism andenergycycleof livingbeings.

Activity	AppX Hrs
Cl	07
LI	0
SW	2
SL	1
Total	10

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO1.1 Explain Origin of life and rise of living system. SO1.2 Apply , catabolism and anabolism SO1.3 Explain different between prokaryotic and eukaryotic cells. SO1.4 Explain photosynthesis. SO1.5 currency of biological energy.	.	1.Origin of life – unique properties of carbon, chemical evolution and rise of living systems, 2. Structure of prokaryotic and eukaryotic cells, and cell organells, 3 Catabolism and anabolism, 4 ATP, currency of biological energy, 5 Energy rich and energy poor phosphates, 6 Role of NADH, NADPH, FADH2, TPP, coenzymeA, 7 lipoic acid and biotin. Introduction to photosynthesis.	Biogenesis,Plant cell and animal cell,evolution photosynthesis.

SW-1SuggestedSessionalWork(SW):

a.Assignments:

Discuss metabolic processes: Origin of life – unique properties of carbon, chemical evolution and rise of living systems, structure of prokaryotic and eukaryotic cells, and cell organells, catabolism and anabolism**,** ATP, currency of biological energy, energy rich and energy poor phosphates, role of NADH, NADPH, FADH2, TPP, coenzyme A, lipoic acid and biotin. Introduction to photosynthesis.

b.Mini Project:

diagram of prokaryotic and eukaryotic cell, diagram of plant cell and animal cell

c.Other Activities (Specify):

chromosome, mitochondriya, genes, etc.

76CH105.2, Explain carbohydrates and their impotance for leaving beings.

Activity	**AppX Hrs**
Cl	07
LI	0
SW	2
SL	1
Total	10

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 Understand Carbohydrates Structure and biological functions . **SO2.2** Explain structure of prokaryotic and eukaryotic **SO2.3** Explain photosynthesis. **SO2.4** Understand and apply energy rich and energy poor phosphates, **SO2.5** Explain catabolism and anabolism.		1 Carbohydrates Structure and biological functions 2 Monosaccharides derivatives like glycosides, deoxy sugars, myoinositol. 3 Disaccharides- sucrose, lactose and maltose. 4 Structure and biological functions of Structural polysaccharides 5 cellulose and chitin and 6 Storage polysaccharides (starch 7Heteropolysaccharides-Glucosaminoglycans / muco polysaccharides.	Carbohydrates Structure (glucose, fructose , sucrose, lactose and maltose. Structure and biological functions of Structural polysaccharides

SW-2 Suggested Sessional Work (SW):

a.Assignments:

list some importance biological roles of glucose in human body

b.Mini Project: type of blood group

c.Other Activities (Specify): fermentation ,sweetening index

76CH105.3, Predict biochemistryof anymetabolism.

Activity	AppX Hrs
Cl	07
LI	0
SW	2
SL	1
Total	10

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Explain fluid mosaic model **SO3.2** differentiate between LDL and HDL **SO3.3** Explain bile acid . How are synthesized in liver **.** **SO3.4** Explain Beta oxidation . **SO3.5** Explain CoAs enter Mitochondrial matrix.		1 Lipids, Fatty acids, essential fatty acids, 2 Structure , function triacylglycerols, glycerophospholipids, sphingolipids, 3 cholesterol, bile acids, 4 prostaglandins. 5 Lipoproteins - composition 6 function, role in atherosclerosis. 7 Lipid metabolism - β-oxidation of fatty acids	Types of lipids and function Lipid metabolism - β-oxidation of fatty acids

SW-3 Suggested Sessional Work (SW):

a.Assignments:

Rearrangment in carbocation and other intermediates

b.Mini Project: beta oxidation , carnatine transporter system **.**

c.Other Activities (Specify):

Impotance and applications of lipoproteins and function .

76CH105.4: Solveproblemsrelated prrotein structure and amino scid sequence in proteins.

Activity	AppX Hrs
Cl	07
LI	0
SW	2
SL	1
Total	10

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Explain Amino acids, Peptides and Proteins Chemical and enzymatic hydrolysis of proteins to peptides **SO4.2** Explain a -helix, b -sheets , super secondary structure **SO4.3** Explain Amino acid metabolism **SO4.4**Explain parlell and anti parllel **SO4.5** Explain biosynthesis of giycine .		1Amino acids, Peptides and Proteins Chemical 2 Enzymatic hydrolysis of 3 proteins to peptides amino and sequencing. 4 Secondary structure of proteins, 5forces responsible for holding of secondary structures, a -helix, b -sheets , 6 super secondary structure, triple helix structure of collagen. Tertiary structures of proteins- folding and domain structures.. 7 Amino acid metabolism – degradation and biosynthesis of amino acids,.	degradation and biosynthesis of amino acids , enzymatic , mass spectral , racemization, biosynthesis

SW-4 Suggested Sessional Work (SW):

a.Assignments: degradation and biosynthesis of amino acids

b.Mini Project:glycolysis and krebs cycle

c.Other Activities (Specify):

Impotance and applications of phase tranfer catalysts.

76CH105.5: Solve problem related genetic enginreeing.

Activity	AppX Hrs
Cl	07
LI	0
SW	2
SL	1
Total	10

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 Explain Replication of DNA. **SO5.2** Explain Nucleic Acids and Genetic Code **SO5.3** Explain Watson-Crick model of DNA and duscuss its special features . **SO5.4**Explain anticodon pairing. **SO5.5** Explain chargaff rules with the help of suitable diagrams .	.	**1.** Nucleic Acids and Genetic Code 2. Structure of nucleotides, nucleosides, 3.DNA Watson-Crick model and RNA, 4.Replication of DNA transcription 5. Translation of genetic material 6. Genetic code, 7. Universality of the code, codon, anticodon pairing.	Ribose and Deoxyribose sugars structure Types of phosphodiester bonds

SW-5 Suggested Sessional Work (SW):
a.Assignments:

Importance of DNA ,types of DNA,

b.Mini Project: DNA double helix structure
c.Other Activities (Specify):mechanism of DNA replication .

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
76CH105.1: Explain the metabolism and energy cycle of living beings.	07	02	01	10
76CH105.2: Explain carbohydrates and their impotance for leaving beings.	09	02	01	12
76CH105.3: Predict biochemistry of any metabolism.	07	02	01	10
76CH105.4:Solve problems related protein structure and amino acid sequence in protein.	07	02	01	10
Total Hours	37	15	05	52

Suggestion for End Semester Assessment

Suggested Specification Table (ForESA*)*

CO	Unit Titles	MarksDistribution			Tota lMar ks
		R	U	A	
CO-1	Introduction to metabolic processes	03	01	01	05
CO-2	Carbohydrates and metabolism	02	06	02	10
CO-3	Lipids and Lipid metabolism	03	07	05	15
CO-4	Amino acid and metabolism	-	10	05	15
CO-5	Nucleic Acids and Genetic Code	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 rubricneed 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. **ImprovedLecture**
2. Tutorial
3. CaseMethod
4. GroupDiscussion
5. RolePlay
6. Visitto NCL, CSIR laboratories
7. Demonstration
8. ICTBasedTeachingLearning(VideoDemonstration/TutorialsCBT,Blog,Facebook,Twitter,Whatsapp,Mobile,Onlinesources)

Brainstorming

Suggested LearningResources:

(a) **Books:**

S. No.	Title	Author	Publisher	Edition& Year
1	PrinciplesofBiochemistry	A.L. Lehninger,	WorthPublishers	Revised edition1993
2	Biochemistry,	L.Stryer	W.H.Freeman	Revised edition2020
3	Biochemistry,J.David Rawn,NeilPatterson	J.David Rawn,	NeilPatterson	Revised edition1980
4	Biochemistry	Voet andVoet,.	JohnWiley.	Revised edition1983
5	Biochemistry,E.	E.E.ConnandP.K. Stumpf	JohnWiley	New edition2020

SUGGESTED WEB SOURCES:

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

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

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

course Title: Biology for Chemist **Course Code : 76CH105**

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Knowl edge	Research Aptitude	Communication	Problem Solving	Individual and Team Work	Investigation of Problems	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and sustainability	The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry	To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.	understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon-based problems in chemical sciences.	Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science
CO1: Explain the metabolism andenergycycleof livingbeings.	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO 2 : Explain carbohydrates and their impotance for leaving beings	2	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3 : Predict biochemistryof anymetabolism	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO 4: Solveproblemsrelated protein structure and amino acid sequence in protein	2	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
CO 5:.: Solve problem related genetic enginreeing.	2	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

Legend:1–Low,2–Medium, 3–High

Course Curriculum Maping

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	CO-1: Explain the metabolism and energy cycle of living beings.	SO1.1SO1.2SO1.3SO 1.4 SO1.5		Unit-1. Introduction to metabolic processes 1.1,1.2,1.3,1.4,1.5,1.6,1.7	Biogenesis,Plant cell and animal cell,evolution photosynthesis
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 2 : Explain carbohydrates and their impotance for leaving beings	SO2.1SO2.2SO2.3 SO2.4 SO2.5		Unit-2. Carbohydrates 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9	Carbohydrates Structure (glucose, fructose , sucrose, lactose and maltose. Structure and biological functions of Structural polysaccharides
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3 : Predict biochemistryof anymetabolism	SO3.1SO3.2 SO3.3 SO3.4 SO3.5		Unit-3 :Lipids and metabolism 3.1, 3.2,3.3,3.4,3.5,3.6,3.7	Types of lipids and function Lipid metabolism - β-oxidation of fatty acids
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4: Solveproblemsrelated protein structure and amino acid sequence in protein	SO4.1SO4.2SO4.3SO 4.4 SO4.5		Unit-4 : Amino acids and metabolism 4.1, 4.2,4.3,4.4,4.5,4.6,4.7	degradation and biosynthesis of amino acids , enzymatic , mass spectral , racemization, biosynthesis
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 5: : Solve problem related genetic enginreeing.	SO5.1SO5.2SO5.3SO 5.4 SO5.5		Unit 5: Nucleic Acids and Genetic Code 5.1,5.2,5.3,5.4,5.5,5.6,5.7	Ribose and Deoxyribose sugars structure Types of phosphodiester bonds

AKSUniversity

FacultyofBasic Science, **DepartmentofChemistry**

CurriculumofM. Sc. In Chemistry Program (Revisedason01August2023)

CODE: 76CH-151

Course Name: Inorganic Chemistry Lab-

No. Of Credits:2

L	T	P
0	0	2

Pre-requisite: Students should have basic knowledge of Laboratory safety as well as inorganic mixture analysis.

Rationale: This course provides skill in synthesis of inorganic compounds and inorganic mixture analysis.

COURSEOUTCOMES

After the completion of this course, the learner will:

CO1: Analyze inorganic mixture qualitatively
CO2: Analyze inorganic mixture containing less common salts
CO3: Analyse inorganic mixture containing insoluble salts
CO4: Synthesize simple inorganic complex compounds.
CO5. Estimate metallic ions in solution volumetrically

Unit I: Qualitative Analysis I: Inorganic mixture analysis (without insoluble and less common salts)
Unit II: Qualitative Analysis II: Inorganic mixture analysis with less common salts
Unit III: Qualitative Analysis III: Separation of inorganic mixture using chromatography
Unit IV: Inorganic Complex Synthesis I: $[Cu(NH_3)_4]SO_4$, $[Ni(NH_3)_6]Cl_2$
Unit V: Quantitative Analysis: Volumetric Analysis (Estimation of Cu and Ni)

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 (2hr) + SW + SL)	
ProgramCore(PCC)	76CH-151	Inorganic Chemistry I	0	2	1	1	6	2

Legend: **CI:** Class room Instruction (Includes different instructional strategies i.e. Lecture(L)and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional trategies)
SW: Sessional Work(include assignment, seminar, miniproject 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: Practical

Course Categeory	Couse Code	Course Title	Scheme of Assessment (Marks)					
			Progressive Assessment (PRA)				End Semester Assessment (ESA)	Total Marks
			Class/Home Assignment 5 number 7marks each (CA)	Viva voice 1X10	Class Attendance (AT)	Total Marks (CA+CT+SA +AT)	35(Exexcise)+10(viva)+5(for record file)	(PRA+ESA)
DCC	76CH-151	Inorganic Chemistry I	35	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, 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.

76CH151.1: Analyze inorganic mixture qualitatively

Activity	AppX Hrs
LI	2
SW	1
SL	1
Total	4

Session Outcomes (SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self Learning (SL)
SO1 Analyse three radicals mixture of inorganic compounds SO2 Analyse five radicals mixture of inorganic compounds	Unit 1.1Identify the given radicals of inorganic compounds qualitatively. 1.2 Identify the given radical mixture of inorganic compounds.		Safety measurement of chemicals

SW-1 Suggested Sessional Work (SW):

a. **Assignments:** Separatration of binary mixture of inorganic compounds by paper chromatography
b. **Mini Project:** Preparation of inorganic complexes

c. **Other Activities (Specify)**: NA

76CH151.2: Inorganic mixture analysis with less common salt

Activity	AppX Hrs
LI	2
SW	1
SL	1
Total	4

Session Outcomes (SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self Learning (SL)
SO1 Analyse three radicals mixture of inorganic compounds with less common salts SO2 Analyse five radicals mixture of inorganic compounds with less common salts	Unit2.1. Identify the given inorganic compounds containing atleast three radicals. 2.2. Identify the given inorganic compounds containing atleast three radicals.		Basics to identify acid and basic radicals

SW-2 Suggested Sessional Work(SW):
a. Assignments: Identify radicals containing common salts
b. Mini Project:
c. Other Activities (Specify):
76CH151.3: Separation of inorganic mixture using chromatography

Activity	AppX Hrs
LI	2 (2hr.each)
SW	1
SL	1
Total	4

Session Outcomes (SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self Learning (SL)
SO1 Identify binary mixture of inorganic compounds using chromatography SO2 Identify tertiary mixture of inorganic compounds using chromatogrphy	Unit3.1 Identify binary mixture of inorganic compounds (Pb^{2+} and Ag^{+}) using TLC 3.2. Identify tertiary mixture of inorganic compounds (Pb^{2+}, Ni^{2+} and Ag^{+}) using TLC		Basics of chromatography

SW-3 Suggested Sessional Work(SW):

a. **Assignments:** Discuss principle of chromatoghrphy
b. **Mini Project:** Development of chromatogram
c. **Other Activities (Specify)**: NA

76CH151.4: Synthesize simple inorganic complex compounds

Activity	AppX Hrs
LI	2 (2hr each)
SW	1
SL	1
Total	4

Session Outcomes (SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self Learning (SL)
SO1 Synthesize inorganic complexe such as $[Cu(NH_3)_4]\ SO_4$ SO2 Synthesize inorganic complexe such as $[Ni(NH_3)_6]\ Cl_2$	**Unit4**. 1 Synthesize inorganic complexe such as $[Cu(NH_3)_4]\ SO_4$ 4.2 Synthesize inorganic complexe such as $[Ni(NH_3)_6]\ Cl_2$		Synthesis and calculations of % yield

SW-4 Suggested Sessional Work(SW): $[Cu(NH_3)_4]\ SO_4$, $[Ni(NH_3)_6]\ Cl_2$
a. Assignments: Discuss mechanistic approach of synthesis of reaction
B. Mini Project: Determination of boiling point of synthesize compounds
c. Other Activities (Specify): NA

76CH151.5: Estimation of Cu and Ni quantitatively from their mixture

Activity	AppX Hrs
LI	2 (2hr each)
SW	1
SL	1
Total	6

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

SO1 Estimation of Cu and Ni quantitatively from their mixture	Unit5. 1 Estimation of Cu and Ni quantitatively from their mixture		Basics of separation of complexes

SW-4 Suggested Sessional Work (SW):

a. **Assignments:** Discuss percentage error
b. **Mini Project:**
c. **Other Activities (Specify**):

(b) **Books:**

S. No.	Title	Author	Publisher	Edition& Year
1	A Text Book of Macro and Semi-micro Quantitative Analysis	A.I. Vogel,	Orient Longman.	Rrvised 2021
2	A Vogel's Text Book of Quantitative Inorganic Analysis	. Bassett, R.C. Denney, G.B. Jaffery and J. Menaham	Longman, London	Revised 2022
3	Synthesis and Characterization of Inorganic Compounds	W.B. Jolly	Prentice Hall Englewood.	Revised
5	.			

SUGGESTEDWEBSOURCES:

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

Course Title: Inorganic Chemistry Lab I **Course Code : 76CH152**

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Knowledge	Research Aptitude	Communication	Problem Solving	Individual and Team Work	Investigation of Problems	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and sustainability	The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry	To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.	understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon-based problems in chemical sciences.	Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science
CO1 Analyze inorganic mixture qualitatively	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO2. Inorganic mixture analysis with less common salt	2	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3. Separation of inorganic mixture using chromatography	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO4. Synthesize simple inorganic complex compounds	2	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
CO5. Estimation of Cu and Ni quantitatively from their mixture	2	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

Legend:1–Low,2–Medium, 3–High

Course Curriculum Mapping

POs & 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	CO1 Analyze inorganic mixture qualitatively	SO 1,SO2	Unit 1.1Identify the given radicals of inorganic compounds qualitatively. 1.2 Identify the given radical mixture of inorganic compounds.		Safety measurement of chemicals
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO2. Inorganic mixture analysis with less common salt	SO1,SO2	Unit2.1. Identify the given inorganic compounds containing atleast three radicals. 2.2. Identify the given inorganic compounds containing atleast three radicals.		Basics to identify acid and basic radicals
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3. Separation of inorganic mixture using chromatography	SO 1,SO2	Unit3.1 Identify binary mixture of inorganic compounds (Pb^{2+} and Ag^{+}) using TLC 3.2. Identify tertiary mixture of inorganic compounds (Pb^{2+}, Ni^{2+} and Ag^{+}) using TLC		Basics of chromatography
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO4. Synthesize simple inorganic complex compounds	SO 1,SO2	**Unit4**. 1 Synthesize inorganic complexe such as $[Cu(NH_3)_4) SO_4$ 4.2 Synthesize inorganic complexe such as $[Ni(NH_3)_6] Cl_2$		Synthesis and calculations of % yield
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO5. Estimation of Cu and Ni quantitatively from their mixture	SO 1,SO2	**Unit5**. 1 Estimation of Cu and Ni quantitatively from their mixture		Basics of separation of complexes

Course Code: 76ch152
Course Title: Organic Chemistry Lab I
No. Of Credits: 2

P	L	T
2	0	0

Pre-requisite: Students should have basic knowledge of Laboratory safety as well as qualitative and quantitaive analysis.

Rationale: This course provide skill in synthesisof organic compounds and qualitative and quantitave organic analyasis.

CourseOutcomes: Afterthe completionofthiscourse, thelearner will:
76CH152.1: Analyse a given mixture of mono functional organic compounds qualitatively in laboratory.
76CH152.2:. Analyse the mixture of bi functional organic compounds
76CH152.3: Synthesise various organic compounds via single step in laboratory
76CH152.4: Synthesize organic compounds via two steps.
76CH152.5: Analyse the given oil fat quantitaviley and qualitatively

Unit1 Qualitative Organic analysisI
Qualitativeanalysis of mixture of mono functional compounds
Unit2 Qualitative Organic analysis II
Qualitative analysis of mixture of bifunctional compounds
Unit3 Synthesis I
Synthesis of organic compounds involving some of the following reactions: acylation reaction, aldol condensation
Unit 4 Synthesis II
Condensation reaction,Diazotization reactions.
Unit5 Quantitaive analysis
Analysis of oil and fat

Scheme of Studies:

Board ofStudy	CourseCode	CourseTitle	Scheme ofstudies(Hours/Week)					Total Credits(C)
			CI	LI	SW	SL	Total Study HoursCI+LI(2hr)+SW+SL)	
Program Core(PCC)	76CH102	Organic Chemistry I	0	2	1	1	6	2

Legend: **CI:** Class room Instruction (Includes different instructional strategies i.e. Lecture(L)and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional trategies)
SW: Sessional Work(include assignment, seminar, miniproject 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: Practical

Course Categeory	Couse Code	Course Title	Scheme of Assessment (Marks)					
			Progressive Assessment (PRA)				**End Semester Assessment (ESA)**	**Total Marks**
			Class/Home Assignment 5 number 7marks each (CA)	Viva voice 1X10	Class Attendance (AT)	Total Marks (CA+CT+SA +AT)	**35(Exexcise)+10(viva)+5(for record file)**	**(PRA+ESA)**
PCC	76CH102	Organic Chemistry I	35	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 inncluding, 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.

76CH152.1: Analyse a given mixture of mono functional organic compounds qualitatively in laboratory

Activity	AppX Hrs
LI	2
SW	1
SL	1

Total	4

Session Outcomes (SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self Learning (SL)
SO1 Analyse binary mixture of organic compounds SO2 Analyse binary mixture of organic compounds by utilizing different solvents	Unit 1.1Separte and identify the given binary mixture of organic compounds (with mono functional group or Hydrocarbons) **(separation by water)** 1.2 Separte and identify the given binary mixture of organic compounds(with mono functional group or Hydrocarbons) (**separation by utilizing different solvents)**		Purification of organic comp[ounds by crystallization Prepartaion of Required reagent for qualitative organc analysis

SW-1SuggestedSessionalWork(SW):

a.Assignments:

Separatration of binary mixture of organic compounds by column chromatography

b.Mini Project:

Preparation of derivatives of organic compounds (with mono functional group or Hydrocarbons)

c.Other Activities (Specify):

Verification of identified compounds by mixed melting point method. (with mono functional group or Hydrocarbons)

76CH152.2: Analyse the mixture of bi functional organic compounds

Activity	AppX Hrs
LI	2
SW	1
SL	1
Total	4

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

SO1 Analyse binary mixture of organic compounds with bifunctional groups SO2 Analyse binary mixture of organic compounds bifunctional by utilizing different solvents	Unit2.1Separte and identify the given binary mixture of organic compounds (with bi functional group) (separation by water) 2.2Separte and identify the given binary mixture of organic compounds(with bi functional group) (separation by utilizing different solvents)		Purification of organic compounds(with bi functional group) by crystallization Prepartaion of Required reagent for qualitative organc analysis

SW-2SuggestedSessionalWork(SW):

a.Assignments:
Separate and idetify binary mixture of two aromatic compounds (with bi functional group)
b.Mini Project:
Preparation of derivatives of organic compounds (with bi functional group)
c.Other Activities (Specify):
Verification of identified compounds by mixed melting point method (with bi functional group)

76CH152.3: Synthesise various organic compounds via single step in laboratory

Activity	**AppX Hrs**
LI	2 (2hr.each)
SW	1
SL	1
Total	4

Session Outcomes (SOs)	**Laboratory Instruction(LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO1 Synthesize organic compounds via acylation. SO2 Synthesize organic compounds via aldol condensation	Unit3.1Synthesize Aspirin from salicylic acid. without acetic anhydride 3.2Synthesize dibenzal acetone from benzaldehyde		Purification of synthesized compounds via methods other than crystalization

SW-3SuggestedSessionalWork(SW):

a.Assignments:
Discuss mechanistic approach of synthesis of dibenzalacetone
b.Mini Project:
Purification of aspirin
c.Other Activities (Specify):

NMR Study of purified compound

76CH152.4: Synthesize organic compounds via two step.

Activity	**AppX Hrs**
LI	2 (2hr each)
SW	1
SL	1
Total	4

Session Outcomes (SOs)	**Laboratory Instruction(LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO1 Synthesize organic compounds via two steps SO2 Synthesize organic compounds by acetoacetic ester condensation	**Unit4**. 1Synthesize p chlorotoluene from p-toluidine 4.2Synthesize ethyl n butylacetoacetate from acetoacetic ester		Purification by distillation under reduced pressure

SW-4 Suggested Sessional Work(SW):

a.Assignments:
Discuss mechanistic approach of sandmayer reaction
B.Mini Project:
Determination of boiling point of liquid organic compounds
c.Other Activities (Specify):
HNMR, C13 NMR Study of synthesized compounds

76CH152.5: Analyse the given oil fat quatitively and qualitatively

Activity	**AppX Hrs**
LI	2 (2hr each)
SW	1
SL	1
Total	6

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

SO1 Analyse acidity of given oil and fat SO2 Analyse saponification value of given oil and fat	**Unit5**. 1Determine acid value of given oil or fat 5.2 Determine saponification value of given oil and fat		Physical parameters of oil and fat analysis

SW-4Suggested Sessional Work(SW):

a.Assignments:
Discuss determination of Iodine value and its importance
B.Mini Project:
Determination of specific gravity of different edible oil
C.Other Activities (Specify):
Discuss determination of RM value and its

Learning Resources

(c) **Books:**

S. No.	Title	Author	Publisher	Edition& Year
1	Vogels qualitative organic analysis	A.I.Vogel,	OrientLongman.	Rrvised 2021
2	Advanced practical Chemistry	Jagdamba singh	Pragati prakashsan	Revised 2022
3	Advanced Organic Chemistry practical	N.K. Visnoi		

SUGGESTEDWEBSOURCES:

4. https://nptel.ac.in/course.html
5. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
6. https://swayam.gov.in/explorer?category=Chemistry
7. VirtualLab-https://vlab.amrita.edu

Title: Organic Chemistry Lab I **Course Code : 76CH152**

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Knowledge	Research Aptitude	Communication	Problem Solving	Individual and Team Work	Investigation of Problems	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and sustainability	The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry	To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.	understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon -based problems in chemical sciences.	Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science
CO1Analyse a given mixture of mono functional organic compounds qualitatively in laboratory.	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO2. Analyse the mixture of bi functional organic compounds	2	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO.3: Synthesise various organic compounds via single step in laboratory	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO.4: Synthesize organic compounds via two steps	2	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
CO5.5: Analyse the given oil fat quantitaviley and qualitatively	2	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

Legend:1–Low,2–Medium, 3–Hig

Course Curriculum Mapping

POs &PSOsNo.	COsNo.&Titles	SOsNo.	LaboratoryInstruction(LI)	Classroom Instruction(CI)	Self Learning(SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO1Analyse a given mixture of mono functional organic compounds qualitatively in laboratory.	SO1,SO2	Unit 1.1Separte and identify the given binary mixture of organic compounds (with mono functional group or Hydrocarbons) **(separation by water)** 1.2Separte and identify the given binary mixture of organic compounds(with mono functional group or Hydrocarbons) (**separation by utilizing different solvents)**		Purification of organic comp[ounds by crystallization Prepartaion of Required reagent for qualitative organc analysis
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO2. Analyse the mixture of bi functional organic compounds	SO1,SO2	Unit2.1Separte and identify the given binary mixture of organic compounds (with bi functional group) (separation by water) 2.2Separte and identify the given binary mixture of organic compounds(with bi functional group) (separation by utilizing different solvents)		Purification of organic compounds(with bi functional group) by crystallization Prepartaion of Required reagent for qualitative organc analysis
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO.3: Synthesise various organic compounds via single step in laboratory	SO1,SO2	Unit3.1Synthesize Aspirin from salicylic acid. without acetic anhydride 3.2Synthesize dibenzal acetone from benzaldehyde		Purification of synthesized compounds via methods other than crystalization
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO.4: Synthesize organic compounds via two steps	SO1,SO2	**Unit4**. 1Synthesize p chlorotoluene from p-toluidine 4.2Synthesize ethyl n butylacetoacetatefrom acetoacetic ester		Purification by distillation under reduced pressure
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO.5: Analyse the given oil fat quantitaviley and qualitatively	SO1,SO2	**Unit5**. 1Determine acid value of given oil or fat 5.2 Determine saponification value of given oil and fat		Physical parameters of oil and fat analysis

Course Code: 76ch153
Course Title: Physical Chemistry Lab I
No. Of Credits: 2

P	L	T
2	0	0

Pre-requisite: Students should have basic knowledge of Laboratory safety as well as Conductometry, pH-metry , Surface Chemistry and chemical kinetics.

Rationale: This course provide skill in knowledge of Laboratory safety as well as Conductometry ,pH-metry , Surface Chemistry and chemical kinetics.

Course Outcomes: Afterthe completionofthiscourse, thelearner will:

76CH153.1**:** Handle electrodes and conductivity meter to perform physical property analysis.

76CH153.2: Determinerateandestimatemolecularmassofpolymer system.

76CH153.3: Determinerateconstantforvariouschemicalreactions.

76CH153.4: Analyze the viscosityofliquids using Ostwald viscometer.

76CH153.5: Handle pH meter to perform physical property analysis.

UnitI Conductometry I

1-Determine the strength of strongacid by conductometric titration with strong base.

2-Determine the strength of weak acid by conductometric titration with strong base.

Unit II Coductometry II

3- Study precipitation titration between KCl and $AgNO_3$ conductometrically.

4- Determine the basicity of mono-,di-,andtri-basic acid sconductometrically.

5- Determine the strength of strong acid and weak acid in amixture by conductometric titration with strong base.

6- Determine solubility and solubility product of sparingly solublesalts likePbSO4 ,$BaSO_4$.

Unit III pH-metry

7- Determinethe strength ofstrongacid bypH-metrictitration with strongbase.

8- Determinethestrength ofweakacidbypH-metric titration withstrongbase.

Unit IV Chemical Kinetics

8- Study the hydrolysis ofmethyl acetatein presence of hydrochloric acid.

9- Study saponification of ethylacetate by sodium hydroxide solution taking the initial concentration of ester and baseto be different.

Unit V
Surface Chemistry

10- Determine the viscosity of liquids(environment friendly) using Ostwald viscometer.

Study the variation of viscosity with concentration for a glycerol

Scheme of Studies:

Board ofStudy	CourseCode	CourseTitle	Scheme ofstudies(Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study HoursCI+LI(2hr)+ SW+SL)	
ProgramCore(PCC)	76CH153	Physical Chemistry I Lab	0	2	1	1	6	2

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

Note: SW& SL has to be planned and performe d under the continuous guidance and feedback of teacherto ensure outcome ofLearning.

Scheme of Assessment: Practical

Course Categeory	Couse Code	Course Title	Scheme of Assessment (Marks)					
			Progressive Assessment (PRA)				End Semester Assessment (ESA)	Total Marks
			Class/Home Assignment 5 number 7marks each (CA)	Viva voice 1X10	Class Attendance (AT)	Total Marks (CA+CT+SA +AT)	35(Exexcise)+ 10(viva)+5(for record file)	(PRA+ESA)
PCC	76CH153	Physical Chemistry I	35	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 inncluding, 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.

76CH 151 .1 Unit I Conductometry I

1-Determine the strength of strongacid by conductometric titration withstrongbase.
2-Determine the strength of weakacidbyconductometric titrationwithstrongbase.

Activity	AppX Hrs
LI	2
SW	1
SL	1
Total	4

Session Outcomes (SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self Learning (SL)
SO1 Analyse binary mixture of organic compounds SO2 Analyse binary mixture of organic compounds by utilizing different solvents	1.1-Determinethe strength of strongacid byconductometric titration withstrongbase. 1.2-Determinethestrengthof weakacidbyconductometric titrationwithstrongbase.		Determine solubility and solubility product of sparingly soluble salts likePbSO4,$BaSO_4$

SW-1Suggested Sessional Work(SW):

a.Assignments:

Determine the strength of mixture of acid by conductometric titration.

76CH153.2: **Unit II Coductometry II**

3-Study precipitation titration between KCland $AgNO_3$ conductometrically.
4-Determine the basicity of mono-,di-,andtri-basic acidsconductometrically.
5-Determine the strength of strong acid and weak acid in a mixture by conductometrictitration with strong base.
6-Determine solubility and solubility product of sparingly soluble salts likePbSO4,$BaSO_4$.

Activity	AppX Hrs
LI	2
SW	1
SL	1
Total	4

Session Outcomes (SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self Learning (SL)
SO1 Analyse precipitation titration between KCl and $AgNO_3$ conductometrically SO2 Analyse the strength of strong acid and weak acid in amixture by conductometric titration with strong base. Analyse solubility and solubility product of sparingly soluble salts like PbSO4, $BaSO_4$.	2.1-Study precipitation titration between KCl and $AgNO_3$ conductometrically. 2.2-Determine the basicity of mono-,di-,andtri-basic acids conductometrically. 2.3-Determine the strength of strongacid and weakacid in a mixture by conductometric titration with strongbase. 2.4-Determine solubility and solubility product of sparingly soluble salts likePbSO4, $BaSO_4$.		Caliboration of conductivity meter

SW-2SuggestedSessionalWork(SW):

a.Assignments:

Caliboration of conductivity meter

76CH153.3: Unit III pH-metry

7-Determine the strength of strong acid by pH-metric titration with strong base.

8-Determine the strength ofweak acid by pH-metric titration with strong base.

Activity	AppX Hrs
LI	2 (2hr.each)
SW	1
SL	1
Total	4

Session Outcomes (SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self Learning (SL)
SO1 Analyze the strength ofstrongacid bypH-metrictitration with strongbase SO2 Analyze the strength ofstrongacid bypH-metrictitration with strongbase.	.1-Determinethe strength ofstrong acid bypH-metric titration with strong base. 3.2-Determine thes trength of weak acid by pH-metric titration withstrongbase.		Approach Of Synthesis Of Dibenzalacetone

SW-3Suggested Sessional Work(SW):

a.Assignments:
Discuss mechanistic approach of synthesis of dibenzalacetone

76CH152.4: Unit IV
Chemical Kinetics

8- Study the hydrolysis of methyl acetatein presence of hydrochloric acid.
9Study saponification of ethyl acetate bysodiumhydroxide solution taking the initial concentration of ester and baseto be different

Activity	AppX Hrs
LI	2 (2hr each)
SW	1
SL	1
Total	4

Session Outcomes (SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self Learning (SL)
SO1 Synthesize organic compounds via two steps SO2 Synthesize organic compounds by aceto acetic ester condensation	4.1-Study the hydrolysis ofmethyl acetate in presence of hydrochloric acid. 4.2-Study saponification of ethylacetate by sodium hydroxide solution taking the initia lconcentration of esterand baseto be different.		Caliboration of Ph meter

SW-4SuggestedSessionalWork(SW):

a.Assignments:
Caliboration of Ph meter

76CH152.5: Unit V
Surface Chemistry

10-Determine the viscosity of liquids (environment friendly) using Ostwald viscometer.
Study the variation of viscosity with concentration for a glycerol

Activity	AppX Hrs
LI	2 (2hr each)
SW	1
SL	1

Total	6

Session Outcomes (SOs)	**Laboratory Instruction(LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO1 Determin e the viscosity of liquids (environment friendly) using Ostwald viscometer. SO2 Analyse Study the variation of viscosity with concentration for a glycerol	5.1-Determine the viscosity of liquids (environmentfriendly) using Ostwald viscometer. 5.2- Study the variation of viscosity with concentration for a glycerol		Different types of viscosity meter and their application

SW-4 Suggested Sessional Work (SW):

a.Assignments:
Discuss determination the viscosity of given liquids using Ostwald viscometer

LEARNING RESOURCES

(d) **Books:**

S. No.	**Title**	**Author**	**Publisher**	**Edition& Year**
1	Vogels qualitative organic analysis	A.I.Vogel,	OrientLongman.	Rrvised 2021
2	Advanced practical Chemistry	Jagdamba singh	Pragati prakashsan	Revised 2022
3	Advanced Organic Chemistry practical	N.K. Visnoi		

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

MODEOFTRANSACTION:Lecture,demonstration,E-tutoring,discussion,assignments,quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite,MSPower-Point, Online Resources.

AKSUniversity

FacultyofBasic Science, DepartmentofChemistry

CurriculumofM. Sc. In Chemistry Program (Revisedason01August2023)

Title: Physical Chemistry Lab I **Course Code : 76CH153**

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Knowledge	Research Aptitude	Communication	Problem Solving	Individual and Team Work	Investigation of Problems	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and sustainability	The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry	To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.	understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon -based problems in chemical sciences.	Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science
CO1:Handle electrodes and conductivity meter to perform physical property analysis	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO2:Determine rate and estimate molecular mass of polymer system.	2	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3:Determine rate constant for various chemical reactions.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO4: Analyze the viscosityofliquids using Ostwald viscometer	2	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
. CO5: Handle pH meter to perform physical property analysis	2	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

Legend:1–Low,2–Medium, 3–

AKSUniversity

FacultyofBasic Science, **DepartmentofChemistry**

CurriculumofM. Sc. In Chemistry Program (Revisedason01August2023)

Course curriculum mapping; **Course code: 76CH153**

POs &PSOsNo.	COsNo.&Titles	SOsNo.	LaboratoryInstruction(LI)	Classroom Instruction(CI)	Self Learning(SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	76CH153.1:Handle electrodes and conductivity meter to perform physical property analysis.	SO1,SO2	1.1-Determine the strength of strong acid by conductometric titration with strong base. 2.2-Determine the strength of weak acid by conductometric titration with strong base.		Determine solubility and solubility product of sparingly soluble salts likePbSO4,BaSO4s
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	76CH153.2: Determinerate and estimate molecular mass of polymer system.	SO1,SO2	Unit II 2.1-Study precipitation titration between KCland AgNO3 conductometrically. 2.2-Determine the basicity of mono-,di-,andtri-basic acids conductometrically. 2.3-Determine the strength of strong acid and weak acid in a mixture by conductometric titration with strong base. 2.4-Determine solubility and solubility product of sparinglysoluble salts like PbSO4,BaSO4.		Caliboration of conductivity meter
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	76CH153.3: Determinerate constant for various chemical reactions.	SO1,SO2	3.1-Determine the strength of strong acid by pH-metric titration with strong base. 3.2-Determine the strength of weak acid by pH-metric titration with strong base.		Approach Of Synthesis Of Dibenzalacetone
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	76CH153.4: Analyze the viscosityofliquids using Ostwald viscometer.	SO1,SO2	Unit IV 4.1-Study the hydrolysis of methyl acetatein presence of hydrochloric acid. 4.2-Study saponification of ethyl acetate by sodium hydroxides olutiontakingtheinitial concentration of ester and base to be different.		Caliboration of Ph meter
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	76CH153.5: Handle pH meter to perform physical property analysis.	SO1,SO2	5.1-Determine the viscosity of liquids(environment friendly) using Ostwald viscometer. 5.2- Study the variation of viscosity with concentration for a glycerol		Different types of viscosity meter and their application

M.Sc. Chemistry Semester II
Code: 76CH-201
Course Name: Inorganic Chemistry II

L	T	P
3	1	0

Pre-requisite: Students must have fundamental knowledge of coordination complexes such as IUPAC nomenclature, Valence Bond Theory (VBT), Crystal Field Theory (CFT), molecular orbital theory etc.

Rationale: The students studying inorganic chemistry should possess foundational understanding about VBT, CFT, molecular orbital theory, structure, reactions and stereochemistry of inorganic compounds. This will provide applicable knowledge about Nature of bonding in inorganic compounds, stereochemistry of inorganic compounds, structure reactivity, and reaction mechanisms**.**

Course Outcomes

After the completion of this course, the learner will:

76CH-201.1: Explain the correlation of spectroscopic terms and apply the knowledge to interpret the spectra and draw the Orgel energy level diagram for transition metal complexes.

76CH-201.2: Describe the mechanism of substitution reactions in square planner complexes and interprets them with different types of factors.

76CH-201.3: Apply the knowledge of electronic spectra to determine the crystal field splitting energy (Dq), Racah parameter (B) and Nephelauxetic ratio (β) for d^3, $d^7$and d^8 complexes.

76CH-201.4: Apply the knowledge of optical activity for optical rotator dispersion (ORD) and cotton effect.

76CH-201.5: Explain borane chemistry and structure and properties metal clusters.

Unit I (76CH-201.1): Electronic Spectra of Transition Metal Complexes

Spectroscopic term, terms and microstates for the p^2 and d^2 configurations, Hund'srules for ground state terms, the correlation of spectroscopic terms into Mulliken symbols, electronic transition selection rules, Orgel diagrams for transition metal complexes (d^1-d^9 states). Jahn-teller effect and electronic spectra of complexes.

UNIT II (76CH-201.2): ***Reaction Mechanism of Transition Metal Complexes***

Base hydrolysis, conjugate base mechanism, direct and indirect evidences in favor of conjugate mechanism. Substitution reactions in square planar complexes: The Trans effect and the *trans* influence: Polarization and p-Bonding theories, applications of Trans effect in synthesis, Kurnakove's test of distinguishing *cis* and *trans* isomers using the concept of trans effect, mechanism of substitution reactions in square planar complexes, factors affecting substitution reactions. Acquaintance of Trans effect in octahedral complexes

UNIT III (76CH-201.3): Metal-Ligand Bonding

Electronic Spectra and Magnetic Properties of Transition Metal Complexes Calculations of Dq, B (Racah parameter) and β (Nephelauxetic ratio) parameters for Cr(III), Co(II) and Ni(II) complexes using electronic spectral data. Charge transfer spectra: ligand to metal and metal to ligand.

UNIT IV (76CH-201.4): Circular Dichroism and Optical Rotatory Dispersion

Polarized light, fundamental symmetry requirements, for optical activity, interaction of polarized light with optically active matter, optical rotation, Cotton effect, configuration of Tris -chelated complexes.

UNIT V (76CH-201.5): Borane Chemistry Metal Clusters

Bonding and topology of boranes, 4-digit coding (s, t, y, x) numbers for B_2H_6, B_4H_{10}, B_5H_9, B_5H_{11} and B_6H_{10} and their utilities. Acquaintance with carboranes and metallocarboranes. Metal clusters: synthesis, reactivity and bonding.

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)	
Program Core(PCC)	76CH201	Inorganic Chemistry-II	3	0	1	1	5	4

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

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

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

SL: Self Learning,

C: Credits.

Note:

SW&SLhastobeplannedandperformedunderthecontinuousguidanceandfeedbackofteacherto ensure outcome ofLearning

Scheme of Assessment: Theory

Board of Study	CourseCode	CourseTitle	Scheme of Assessment (Marks)						
			Progressive Assessment (RA)					End Semester Assessment (ESA)	Total Marks (PRA+ESA)
			Class/HomeAssignment5 number 3 marks each (CA)	Class Test2 (2bestout of3) 10 marks each(CT)	Seminar one + Class activity	Class Attendance (AT)	Total Marks (CA+CT+SA+AT)		
PCC	76CH201	Inorganic Chemistry-II	15	20	10	5	50	50	100

Course-Curriculum Detailing:

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

Unit I (76CH-201.1): Electronic Spectra of Transition Metal Complexes

Spectroscopic term, terms and microstates for the p^2 and d^2 configurations, Hund'srules for ground state terms, the correlation of spectroscopic terms into Mulliken symbols, electronic transition selection rules, Orgel diagrams for transition metal complexes (d^1-d^9 states). Jahn-teller effect and electronic spectra of complexes.

Activity	AppX Hrs
CI	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	LI	CI	SL
SO1.1 Students understood about the microstate for p^2, d^2 and p^1d^1 configurations SO1.2 Students understood the ground state terms by applying the Hunds rule SO1.3 Students applied the knowledge to correlate the spectroscopic terms into Mulliken symbols SO1.4 Understood and apply the above knowledge to draw the Orgel diagrams for transition metal complexes (d^1-d^9 states) SO1.5 Students understood Jahn-teller effect and electronic spectra of transition metal complexes.		1.Introduction to electronic Spectra in relation to Transition Metal Complexes 2.Terms and Spectroscopic term 3.Introduction to microstates 4.Calculations of total microstates for the p2 and d2 configurations 5.Hund's rules for the determinations of ground state terms 6.Correlation of spectroscopic terms into Mulliken symbols 7.Electronic transition selection rules 8.Orgel diagrams for transition metal complexes (d1-d9 states) 9.Hole formalisms in orgel energy level diagram T1. Introduction to Jahn-teller distortion T2. Jahn Teller effect and electronic spectra of complexes. T3. Explanation of spectra of transition metal complesexes with the help of Orgel diagram	Draw Jahn-teller distortion of transition metal complexes

SW-1 Suggested Sessional Work(SW):

Assignments: Calculate the total microstates for the p^2, d^2 and p^1d^1 configurations

Mini Project: Draw the Orgel diagrams for transition metal complexes (d^1-d^9 states)

Other Activities (Specify): Write short note on spectroscopic terms

UNIT II (76CH-201.2)

Reaction Mechanism of Transition Metal Complexes*:* Base hydrolysis, conjugate base mechanism, direct and indirect evidences in favor of conjugate mechanism. Substitution reactions in square planar complexes: The Trans effect and the *trans* influence: Polarization and p-Bonding theories, applications of Trans effect in synthesis, Kurnakove's test of distinguishing *cis* and *trans* isomers using the concept of trans effect, mechanism of substitution reactions in square planar complexes, factors affecting substitution reactions. Acquaintance of Trans effect in octahedral complexes

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 Students understood base hydrolysis and conjugate base mechanism of complexes. **SO2.2** Students understood mechanism and factors affecting the substitution reaction in square planar complexes **SO2.3** Students leant the Kurnakove's test to distinguishing *cis* and *trans* isomers using the concept of trans effect, **SO2.4** Students understood acquaintance of Trans effect in octahedral complexes		1.Introduction to Reaction Mechanism of Transition Metal Complexes 2.Base hydrolysis 3.conjugate base mechanism 4.direct and indirect evidences in favor of conjugate mechanism 5.Substitution reactions in square planar complexes 6.Trans effect and the *trans* influence 7.Polarization and pi-Bonding theories 8.Applications of Trans effect in synthesis 9.Kurnakove's test to distinguishing *cis* and *trans* isomers using the concept of trans effect T1. Mechanism of substitution reactions in square planar complexes T2.Factors affecting substitution reactions T3.Acquaintance of Trans effect in octahedral complexes	Kurnakove's test of distinguishing *cis* and *trans* isomers using the concept of trans effect

SW-2 Suggested Sessional Work (SW):

Assignments: Discuss the factors affecting substitution reaction of square planar complexes
Mini Project: Kurnakove's test of distinguishing *cis* and *trans* isomers using the concept of trans effect
Other Activities (Specify): Base hydrolysis

UNIT III (76CH-201.3)

Metal-Ligand Bonding:. *Electronic Spectra and Magnetic Properties of Transition Metal Complexes* Calculations of Dq, B (Racah parameter) and β (Nephelauxetic ratio) parameters for Cr(III), Co(II) and Ni(II) complexes using electronic spectral data. Charge transfer spectra: ligand to metal and metal to ligand.

Activity	AppX Hrs
CI	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Introduced to metal-ligand bonding in the coordination complexes **SO3.2** Understood Electronic Spectra and Magnetic Properties of Transition Metal Complexes **SO3.3** Understood and applied the concept of electronic spectra to calculate crystal field splitting energy (Dq) of complexes. **SO3.4** Understood and applied the concept of B (Racah parameter) and β (Nephelauxetic ratio) parameters for Cr(III), Co(II) and Ni(II) complexes **SO3.5** Understood the concept of charge transfer spectra: ligand to metal and metal to ligand.		**1.**Introduction to metal-ligand bonding 2.Introduction to electronic Spectra 3.Magnetic Properties of Transition Metal Complexes 4.Calculations of Dq with B (Racah parameter) for Cr(III) complexes using electronic spectral data 5.Calculations of Dq with B (Racah parameter) for Co(II) and Ni(II) complexes using electronic spectral data 6.β (Nephelauxetic ratio) parameters for Cr(III) complexes using electronic spectral data 7.Introduction to charge transfer spectra 8.Ligand to metal charge transfer spectra 9.Metal to ligand charge transfer spectra T1. Calculations of Dq using β (Nephelauxetic ratio)	Magnetic Properties of Transition Metal Complexes

		parameters for Co(II) complexes using electronic spectral data T2. Calculations of Dq using β (Nephelauxetic ratio) parameters for Ni(II) complexes using electronic spectral data T3. Calculations of Dq with B (Racah parameter) for Ni(III) complexes using electronic spectral data	

SW-3 Suggested Sessional Work (SW):
Assignments: Calculation of B (Racah parameter) and β (Nephelauxetic ratio) parameters for Cr(III), Co(II) and Ni(II) complexes
Mini Project: Charge transfer spectra: ligand to metal and metal to ligand.
Other Activities (Specify):

UNIT IV (76CH-201.4): Circular Dichroism and Optical Rotatory Dispersion
Polarized light, fundamental symmetry requirements, for optical activity, interaction of polarized light with optically active matter, optical rotation, Cotton effect, configuration of Tris -chelated complexes.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Students understood the concept of Circular Dichroism and Optical Rotatory Dispersion **SO4.2** Students understood the concept of plane polarized light and its interaction with optically active matter **SO4.3** Students understood the concept of fundamental symmetry requirements for optical		1.Introduction to Plane polarized light 2.Optical activity 3.Fundamentals of symmetry requirements 4.interaction of polarized light with optically active matter 5.optical rotation 6.Cotton effect 7.Circular bireferengence 8. Configuration of Tris -chelated complexes 9. Circular Dichroism and Optical Rotatory Dispersion T1. Absolute configuration by ORD	Configuration of Tris - chelated complexes

activity **SO4.4** Introduced to Cotton effect **SO4.5** Understood the configuration of Tris -chelated complexes		curves T2. Absolute configuration by CD curves T3. Principles of polarimetry	

SW-4 Suggested Sessional Work (SW)

a. **Assignment**: Optical activity
b. **Mini Project:** configuration of Tris -chelated complexes.
c. **Other Activities (Specify):** Plane polarized light

UNIT V (76CH-201.5): ***Borane Chemistry Metal Clusters***

Bonding and topology of boranes, 4-digit coding (s, t, y, x) numbers for B_2H_6, B_4H_{10}, B_5H_9, B_5H_{11} and B_6H_{10} and theirutilities. Acquaintance with carboranes and metallo-carboranes. Metal clusters: synthesis, reactivity and bonding.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 Understood the Bonding and topology of boranes **SO5.2** Understood the concept of 4-digit coding (s, t, y, x) numbers for B_2H_6, B_4H_{10}, B_5H_9, B_5H_{11} and B_6H_{10}. **SO5.3** Apply the concept of isolobal analogy for carboranes and metallocaroranes **SO5.**4 Understood the synthesis of metal clusters **SO5.5** Applied the concept reactivity and bonding patterns of metal cluster	.	**1.**Bonding in boranes 2.topology in boranes 2.4-digit coding (s, t, y, x) numbers and bonding for B_2H_6 3.4-digit coding (s, t, y, x) numbers and bonding for B_4H_{10} 4.4-digit coding (s, t, y, x) numbers and bonding for B_5H_9 5. 4-digit coding (s, t, y, x) numbers and bonding for B_5H_{11} 6.4-digit coding (s, t, y, x) numbers and bonding for B_6H_{10} and their utilities 7.Acquaintance with carboranes 8.Acquaintance with metallo-	Metal clusters: synthesis, reactivity and bonding.

		carboranes 9.Synthesis of metal cluster T1. Reactivity and bonding of metal clusters T2. Applications of metal cluster T3. Synthetic applications of boranes	

SW-5 Suggested Sessional Work (SW):
Assignments: Importance of 4-digit coding (s, t, y, x) numbers for B_2H_6, B_4H_{10}, B_5H_9, B_5H_{11} and B_6H_{10} to dertermine the bonding patterns and structure
Mini Project: Metallocarboranes
Other Activities (Specify): Reactivity of metal cluster

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+ SW+ Sl)
76CH-201.1: Electronic Spectra of Transition Metal Complexes: Spectroscopic term, terms and microstates for the p^2 and d^2 configurations, Hund'srules for ground state terms, the correlation of spectroscopic terms into Mulliken symbols, electronic transition selection rules, Orgel diagrams for transition metal complexes (d^1-d^9 states). Jahn-teller effect and electronic spectra of complexes.	12	02	01	15
76CH-201.2: ***Reaction Mechanism of Transition Metal Complexes:*** Base hydrolysis, conjugate base mechanism, direct and indirect evidences in favor of conjugate mechanism. Substitution reactions in square planar complexes: The Trans effect and the *trans* influence: Polarization and p-Bonding theories, applications of Trans effect in synthesis, Kurnakove's test of distinguishing *cis* and *trans* isomers using the concept of trans effect, mechanism of substitution reactions in square planar complexes, factors affecting substitution reactions. Acquaintance of Trans effect in octahedral complexes	12	02	01	15

76CH-201.3: Metal-Ligand Bonding: *Electronic Spectra and Magnetic Properties of Transition Metal Complexes* Calculations of Dq, B (Racah parameter) and β (Nephelauxetic ratio) parameters for Cr(III), Co(II) and Ni(II) complexes using electronic spectral data. Charge transfer spectra: ligand to metal and metal to ligand.	12	02	01	15
76CH-201.4: Circular Dichroism and Optical Rotatory Dispersion: Polarized light, fundamental symmetry requirements, for optical activity, interaction of polarized light with optically active matter, optical rotation, Cotton effect, configuration of Tris -chelated complexes.	12	02	01	15
76CH-201.5: ***Borane Chemistry and Metal Clusters***:. Bonding and topology of boranes, 4-digit coding (s, t, y, x) numbers for B_2H_6, B_4H_{10}, B_5H_9, B_5H_{11} and B_6H_{10} and theirutilities. Acquaintance with carboranes and metallocarboranes. Metal clusters: synthesis, reactivity and bonding.	12	02	01	15
Total Hours	60	10	05	75

Suggestion for End Semester Assessment

Suggested Specification Table (ForESA)

CO	**Unit Titles**	**Marks Distribution**			**Total Marks**
		R	**U**	**A**	
CO-1	Electronic Spectra of Transition Metal Complexes	03	01	01	05
CO-2	Reaction Mechanism of Transition Metal Complexes	02	06	02	10
CO-3	Metal-Ligand Bonding	03	07	05	15
CO-4	Circular Dichroism and Optical Rotatory Dispersion	-	10	05	15
CO-5	Borane Chemistry and Metal Clusters	03	02	-	05
Total		11	26	13	50

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

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

Note.DetailedAssessmentrubricneedtobepreparedbythecoursewiseteachersforabovetasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

a. Improved Lecture
b. Tutorial
c. Case Method
d. Group Discussion
e. Role Play
f. Visit to NCL, CSIR laboratories
g. Demonstration
h. ICTBasedTeachingLearning(VideoDemonstration/TutorialsCBT,Blog,Facebook,Twitter,Whatsapp,Mobile,Onlinesources)
i. Brainstorming

Suggested Learning Resources:

(e) **Books:**

S. No.	Title	Author	Publisher	Edition& Year
1	Concise Inorganic Chemistry	J. D Lee	Wiley India Pvt Ltd.	4^{th} edition
2	Organometallic & Bioinorganic Chemistry	Ajay Kumar	Paperback	2^{nd} edition
3	Organometallic chemistry	BD Gupta	Universities Press	First Edition (1 January 2010)
4	BioinorganicChemistry	AK Das	Prentice-Hall	Revised edition
5	Inorganic chemistry	Gary L. Miessler	Pearson	5^{th} edition
6	Inorganic chemistry	VK Jaiswal	Shri Balaji	Revised fifteenth edition-2022

SuggestedWebSources:

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

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

LMS/ICT Tools: Digital Classrooms, DLMS, ZOOM, G-Suite, MSPower-Point, Online Resource

Title: Inorganic Chemistry II **Course Code : 76CH201**

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Knowledge	Research Aptitude	Communication	Problem Solving	Individual and Team Work	Investigation of Problems	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and sustainability	The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry	To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.	understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon-based problems in chemical sciences.	Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science
CO1: Explain the correlation of spectroscopic terms and apply the knowledge to interpret the spectra and draw the Orgel energy level diagram for transition metal complexes.	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO2: Describe the mechanism of substitution reaction in square planner complexes and interprets them with different types of factors.	2	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3: Apply the knowledge of electronic spectra to determine the crystal field splitting energy (Dq), Racah parameter (B) and Nephelauxetic ratio (β) for d^3, $d^7$and d^8 complexes.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO4: Apply the knowledge of optical activity for optical rotator dispersion (ORD) and cotton effect.	2	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
CO5: Explain borane chemistry and structure and properties metal clusters.	2	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

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

Course Curriculum Map:

POs &PSOsNo.	Cos No. & Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1:Explain the correlation of spectroscopic terms and apply the knowledge to interpret the spectra and draw the Orgel energy level diagram for transition metal complexes.	SO1.1SO 1.2SO1.3 SO1.4 SO1.5		Unit-1.Electronic Spectra of Transition Metal Complexes 1.1,1.2,1.3,1.4,1.5,1.6,1.7	Draw Jahn-teller distortion of transition metal complexes
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO2: Describe the mechanism of substitution reaction in square planner complexes and interprets them with different types of factors.	SO2.1SO 2.2SO2.3 SO2.4 SO2.5		Unit-2 Reaction Mechanism of Transition Metal Complexes 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9	Kurnakove's test of distinguishing *cis* and *trans* isomers using the concept of trans effect
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3: **A**pply the knowledge of electronic spectra to determine the crystal field splitting energy (Dq), Racah parameter (B) and Nephelauxetic ratio (β) for d^3, $d^7$and d^8 complexes.	SO3.1SO3 .2 SO3.3 SO3.4 SO3.5		Unit-3 :Metal - Ligand Bonding 3.1, 3.2,3.3,3.4,3.5,3.6,3.7	Magnetic Properties of Transition Metal Complexes
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO4: Apply the knowledge of optical activity for optical rotator dispersion (ORD) and cotton effect.	SO4.1SO 4.2SO4.3 SO4.4 SO4.5		Unit-4: Circular Dichroism and Optical Rotatory Dispersion 4.1, 4.2,4.3,4.4,4.5,4.6,4.7	Configuration of Tris - chelated complexes
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO5: Explain borane chemistry and structure and properties metal clusters.	SO5.1SO 5.2SO5.3 SO5.4 SO5.5		Unit 5: Borane Chemistry and Metal Clusters 5.1,5.2,5.3,5.4,5.5,5.6,5.7	Metal clusters: synthesis, reactivity and bonding.

CODE: 76CH-202

COURSE NAME: ORGANIC CHEMISTRY II

L	T	P
3	1	0

Pre-requisite: Students should have basic knowledge of aromaticity, reaction intermediates, types of reactions and their mechanisms.

Rationale: This course will provide applicable and creative knowledge about aromatic electrophilic, aliphatic substitution reaction, free radical substitution reactons, elimination reactions, pericyclic reactionsas well as reactivity of carbonyl compounds i various reactions

COURSEOUTCOMES:

Afterthe completionofthiscourse, thelearner will:

CO1: Explain and apply the concept of aromatic electrophilic and aliphatic substitution reactions.

CO2: Explain the concept of free radical substitution reactions with their mechanisms and create mechanistic path for newer free radical reactions

CO3: Explain the reactivity of carbonyl compounds in various reactions and apply these concepts for synthesizing new organic compounds

CO4:Explain mechanistic details of different types of elimination reactions, Saytzeff and Hoffman rules and apply these concepts in predictionofproduct formation in various elimination reactions

CO5: Explain pericyclic reactions, types, mechanisms and FMO and PMO approach in reference of pericyclic compounds and propose mechanistic path for newer r products obtained by pericyclic reactions.

Organic Chemistry-II

UNIT I

Aliphatic Electrophilic Substitution. Bimolecular mechanisms, SE2 and SEi mechanisms. The SE1 mechanism, electrophilic substitution accompaniedby double bond shifts. Effect of substrates, leaving group and solvent polarity on the reactivity.

Aromatic Electrophilic Substitution. The arenium ion mechanism, orientation and reactivity. The ortho/para ratio, ipso attack. Vilsmeier reaction, Friesrearrangement

UNIT II

Free Radical Reactions:

Types of free radical reactions and their detection. Free radical substitution mechanism, mechanism at aromatic substrates. Reactivity in the attacking radicals. The effect of solvents on reactivity. Allylic halogenations (NBS) oxidation of aldehydes to carboxylic acids, auto-oxidation, Radical coupling, arylation of aromatic compounds by diazonium salts. Sand Meyer reaction. Free radical rearrangement. Hunsdiecker reaction.

UNIT III

Addition to Carbon-Carbon Multiple Bonds: Mechanistic and stereochemical aspects of addition reactions.

Hydroboration. Michael reaction. Sharpless asymmetric epoxidation.

Addition to Carbon-Hetero atom Multiple Bonds: Mechanism of metal hydride reduction of carbonyl compounds, acids, esters and nitriles. Wittigreaction.Mechanism of condensation reactions involving enolates. Mannich, Benzoin, Perkin, and Stobbe reactions.

UNIT IV

Elimination Reactions

The E2,E1 And E1CB mechanisms,orientation of the double bond. Reactivity- effects of substrate structers,attacking base,the leaving group and the medium.Mechanism and orientation in pyrolytic Elimination

UNIT V

Pericyclic Reactions: Molecular orbitals and their symmetry. Molecular orbitals of ethylene, 1,3- butadiene, 1,3,5-hexatriene and allyl system, their symmetry properties.Characteristics and classification. Electrocyclic reactions: conrotatory and disrotatory motions, 4n, 4n+2 and allyl systems.Woodward-Hoffmann correlation diagrams. FMO and PMO approach.Cycloaddditions. Woodward-Hoffmann correlation diagrams. FMO and PMO approach. Antarafacial andsuprafacial additions. 4n and 4n+2 systems, 2+2 addition of ketenes. Ene synthesis.Sigmatropic Rearrangements. Suprafacial and antarafacial 1,3- and 1,5- shifts of H, sigmatropic shifts involving carbon moieties, 2,3-, and 3,3-sigmatropic rearrangements. Claisen, Cope, aza-Cope, Sommlet-Hauser, and Fisher Indole rearrangements.

Scheme of Studies:

Category of course	CourseCode	CourseTitle	Scheme ofstudies(Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
ProgramCore(PCC)	76CH202	Organic Chemistry II	4	0	1	1	6	4

Legend: **CI:**Class room Instruction (Includesdifferentinstructionalstrategiesi.e.Lecture(L)andTutorial (T)andothers),
LI: Laboratory Instruction (Includes Practica lperformances in laboratory workshop,field or other locations using different instructional strategies)
SW: Sessiona lWork (includesassignment,seminar,miniprojectetc.),
SL: Self Learning,
C: Credits.

Note: SW &SL has to be planned and performed unde rth e continuous guidance and feedback of teacherto ensure outcome ofLearning.

AKSUniversity

FacultyofBasic Science, **DepartmentofChemistry**

CurriculumofM. Sc. In Chemistry Program (Revisedason01August2023)

Scheme of Assessment: Theory

Board of Study	Couse Code	Course Title	SchemeofAssessment(Marks)						
			Progressive Assessment (PRA continous assessment 50)					End Semester Assessment	Total Marks
			Class/Home Assignment 5number 3 markseach (CA)	Class Test2 (2best out of3) 10 marks each(CT)	Seminar one (SA)	Class Attendance (AT)	Total Marks (CA+CT+SA +AT)	(ESA)	(PRA+ESA)
PCC	**76CH202**	**Organic Chemistry II**	15	20	10	5	50	50	100

Courrse-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.

76CH202.1: Explain and apply the concept of aromatic electrophilic and aliphatic substitution reactions.

Activity	AppX Hrs
CI	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self Learning (SL)
SO1.1 Explain aliphaticand aromatic electrophiilic substitution reactions with their mechanisms and factors affecting them		1.Aliphatic Electrophilic Substitution SE1 mechanism 2. Bimolecular mechanisms, SE2 and SEi mechanisms.	Electron displacement effects in organic molecules

SO1.2 Create mechanistic path for newer electrophilic substitution reactions SO1.3 Explain and apply orientation and reactivity of substituted aromatic compounds SO1.4 Explain and apply ortho/para ratio SO1.5 Explain Ipso attack and various types electrophilic substitution reactions.		3.Electrophilic substitution accompaniedby double bond shifts. 4.Effect of substrates, leaving group and solvent polarity on the reactivity. 5.Aromatic Electrophilic Substitution. 6.The arenium ion mechanism, 7. Orientation and reactivity. 8. The ortho/para ratio 9. Ipso attack. T1.Vilsmeier reaction, T2.Fries rearrangement T3.Nitration, sulphonation, acylation, alkylation, halogenation	

SW-1Suggested Sessional Work (SW):

a.Assignments: Discuss mechanistic paths of nitration and sulphnation of phenol and benzoic acid

b.Mini Project:
Draw reaction coordinate diagram of sulphonation, nitration, alkylation, acylation, halogenations of benzene
c.Other Activities (Specify):
Explain activators and deactivators groups with the help of electron displacement groups

76CH202.2: Explain the concept of free radical substitution reactions with their mechanisms and create mechanistic path for newer free radical reactions

Activity	AppX Hrs
CI	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 Explain types of free radical reaction and dectect their generation		1.Types of free radical reactions and their detection. 2.Free radical substitution mechanism	Generation of free racdical, their structure and stability

SO2.2 Create/ propose mechanistic path for newer free radical substitution reactions SO2.3 Explain and apply reactivity of attacking radicals SO2.4 Explain allylic halogenations, auto-oxiation SO2.5 Apply radical coupling and explain arylation of aromatic compound by dizonium salts.		3. Mechanism at aromatic substrates. 4. Reactivity in the attacking radicals. 5.The effect of solvents on reactivity. 6. Allylic halogenations (NBS) oxidation of aldehydes to carboxylic acids, 7.Auto-oxidation 8. Radical coupling, 9. Arylation of aromatic compounds by diazonium salts. T1.Sand Meyer reaction T2.Free radical rearrangement T3.Hunsdiecker reaction.	

SW-1SuggestedSessionalWork(SW):

a.Assignments: Discuss various methods for detection of free radicals.
b.Mini Project:
Applications **of** Allylic halogenations (NBS) oxidation of aldehydes to carboxylic acids
c.Other Activities (Specify):Explain importance of Sand Meyer reaction, Free radical rearrangement, Hunsdiecker reaction

76CH202.3: Explain the reactivity of carbonyl compounds in various reactions and apply these concepts for synthesizing new organic compounds

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Explain Mechanisticand stereochemical aspects of addition reactions		1.Mechanisticand stereochemical aspects of addition reactions.	General introductuion to Addition reaction

SO3.2 Create/ propose mechanistic path for newer addition reaction SO3.3 Explain and apply hydroboration, epoxidation SO3.4 Explain Mechanism of metal hydride reduction of carbonyl compounds, SO3.5 Explain and apply Reduction of acids, esters and nitriles.		2.Hydroboration 3.Michael reaction. 4.Sharplessasymmetric, epoxidation. **Addition to Carbon-Hetero atom Multiple Bonds.** *5.*Mechanism of metal hydride reduction of carbonyl compounds, 6.Reduction of acids, esters and nitriles. 7.Wittigreaction 8.Mechanism of condensation reactions involving enolates. 9.Mannich T1.Benzoin T2.Perkin T3. Stobbe reactions	

SW-1SuggestedSessionalWork(SW):

a.Assignments: What are enolates and Discuss reactions involving enolates
b.Mini Project:
Impotance of Mannich, benzoin and perkin reaction
c.Other Activities (Specify): Diagram of Significance of Hydroboration

76CH202.4: Explainmechanisticdetailsofdifferenttypesof elimination reactions, Saytzeff and Hoffman rules and apply these concepts in predictionofproduct formation in various elimination reactions

Activity	**AppX Hrs**
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	**Laboratory Instruction(LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO4.1 Explain Mechanistic and stereochemical aspects of eleminatio reaction reactions		1. The E2 reaction 2. E1 And E1CB mechanisms, 3.Orientation of the double bond	General introductuion to Elimination recation

SO4.2 Create/ propose mechanistic path for newer nlemination reactions SO4.3 Explain Pyrolytic elimination and double bond reactivity SO4.4 Explain Evidences in support of eleminatio reaction SO4.5 Explain Factors affecting elimination reaction		Reactivity- 4.Effects of substrate structers 5.Effects of attacking base, 6. Effects of the leaving group 7. Effects of the medium. 8. Pyrolytic elemination 9. Mechanism and orientation in pyrolytic Elimination T1 Double bond reactivity T2 Evidences in supports of E1,E2 T3 Evidences in supports of E1CB Mechanism	

SW-1SuggestedSessionalWork(SW):

a.Assignments: alpha and beta elimination, saytzeff rule
b.Mini Project:
Satzeff rule
c.Other Activities (Specify): Pictorial presentation of Pyrolytic elimination

76CH202.5: Explain pericyclic reactions, types, mechanisms and FMO and PMO approach in reference of pericyclic compounds and proposed mechanistic path for newer r products obtained by pericyclic reactions.

Activity	AppX Hrs
CI	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 Explain Mechanistic and stereochemical aspects of pericyclic reaction		1.Molecular orbitals and their symmetry. 2.Molecular orbitals of ethylene,	FMO and PMO theories

SO5.2 Create/ propose mechanistic path for newer pericyclic reaction SO5.3 Explain and apply symmetry of molecular orbitals SO5.4 Explain Evidences in support of pericyclic reaction SO5.5 Explain and apply Claisen, Cope, aza-Cope, Sommlet-Hauser, and Fisher Indole rearrangements.		1,3- butadiene, 1,3,5-hexatriene and allyl system, their symmetry properties. 3.Characteristics and classification. Electrocyclic reactions: conrotatory and disrotatory motions, 4n, 4n+2 and allyl systems. 4.Woodward-Hoffmann correlation diagrams. FMO and PMO approach. 5.Cycloaddditions. Woodward-Hoffmann correlation diagrams. FMO and PMO approach. Antarafacial andsuprafacial additions. 4n and 4n+2 systems, 2+2 addition of ketenes. Ene synthesis. 6.Sigmatropic Rearrangements. Suprafacial and antarafacial 1,3- and 1,5- shifts of H, sigmatropic shifts involving carbon moieties, 7.2,3-, and 3,3-sigmatropic rearrangements. 8.Claisen rearrangement 9.Coperearrangement T1aza-Cope rearrangement T2.SommletHauserrearrangement, T3 Fisher Indole rearrangements.	

SW-1SuggestedSessionalWork(SW):

a.Assignments: Types of pericyclic reactions with example
b.Mini Project: Discuss cyclo addition

c.Other Activities (Specify): Pictorial presentation of Sigmatropic rearrangement

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Instruction (L+T) (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)

76CH202.1: Explain and apply the concept of aromatic electrophilic and aliphatic substitution reactions.	12	02	01	15
76CH202.2: Explain the concept of free radical substitution reactions with their mechanisms and create mechanistic path for newer free radical reactions	12	02	01	15
76CH202.3: Explain the reactivity of carbonyl compounds in various reactions and apply these concepts for synthesizing new organic compounds	12	02	01	15
76CH202.4: Explain mechanistic details of different types of elimination reactions, Saytzeff and Hoffman rules and apply these concepts in prediction of product formation in various elimination reactions	12	02	01	15
76CH202.5: Explain pericyclic reactions, types, mechanisms and FMO and PMO approach in reference of pericyclic compounds and proposed mechanistic path for newer r products obtained by pericyclic reactions.	12	02	01	14
Total Hours	60	10	05	75

Suggestion for End Semester Assessment

Suggested Specification Table(ForESA)

CO	UnitTitles	MarksDistribution			Total Marks
		R	U	A	
CO-1	Aliphatic and Aromatic Elecrophilic Substitution	03	01	01	05
CO-2	Free radical Reactions	02	06	02	10
CO-3	Elemination Reaction	03	07	05	15
CO-4	Addition Recation	-	10	05	15
CO-5	Pericyclic reaction	03	02	-	05

Total	11	26	13	50

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

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

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

Suggested Instructional /Implementation Strategies:

28. Improved Lecture
29. Tutorial
30. Case Method
31. Group Discussion
32. RolePlay
33. Visitto NCL, CSIR laboratories
34. Demonstration
35. ICTBasedTeachingLearning(VideoDemonstration/TutorialsCBT,Blog,Facebook,Twitter,Whatsapp,Mobile,Onlinesources)
36. Brainstorming

Suggested Learning Resources:

(f) **Books:**

S. No.	Title	Author	Publisher	Edition& Year
1	Advanced Organic Chemistry Reactions, Mechanism and Structure	Jerry March	John Wiley.	Revised editionedition2020
2	Advanced OrganicChemistry	F.A.CareyandR.J.Sundberg	Plenum	New edition, 2021
3	AGuideBooktoMechanisminOrganicChemistry	PeterSykes	Longman	1985
4	OrganicChemistry	R.T.MorrisonandR.N.Boyd	Prentice-Hall	Revised edition
5	Advanced organic chemistry	Dr. Jagdamba singh, Dr. LDS Yadav	Pragati prakashan	Revised edition 2016
6	OrganicChemistry	J.Clayden	OxfordPress	Revised edition

SuggestedWebSources:

18. https://nptel.ac.in/course.html
19. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5

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

Course Title: Organic Chemistry II **Course Code : 76CH202**

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
	Knowledge	**Research Aptitude**	**Communication**	**Problem Solving**	**Individual and Team Work**	Investigation of Problems	**Modern Tool usage**	**Science and Society**	**Life-Long Learning**	**Ethics**	**Project Management**	**Environment and sustainability**	**The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry**	**To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.**	**understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon-based problems in chemical sciences.**	**Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science**
CO1 : Explain and apply the concept of aromatic electrophilic and aliphatic substitution reactions.	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO 2 : Explain the concept of free radical substitution reactions with their mechanisms and create mechanistic path for newer free radical reactions	2	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3 : Explain the reactivity of carbonyl compounds in various reactions and apply these concepts for synthesizing new organic compounds	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO 4: Explain mechanistic details of different types of elimination reactions, Saytzeff and Hoffman rules and apply these concepts in prediction of product formation in various elimination reactions	2	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
CO 5: Explain pericyclic reactions, types, mechanisms and FMO and PMO approach in reference of pericyclic compounds and proposed mechanistic path for newer r products obtained by pericyclic reactions	2	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

Legend:1–Low,2–Medium, 3–High

Course Curriculum Map:

POs &PSOsNo.	COsNo.&Titles	SOsNo.	LaboratoryInstruction(LI)	Classroom Instruction(CI)	Self Learning(SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO1 : Explain and apply the concept of aromatic electrophilic and aliphatic substitution reactions.	SO1.1SO1 .2SO1.3S O1.4 SO1.5		Unit-1.0 1.1,1.2,1.3,1.4,1.5,1.6,1.7.1.8, 1.9	Electron displacement effects in organic molecules
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 2 : Explain the concept of free radical substitution reactions with their mechanisms and create mechanistic path for newer free radical reactions	SO2.1SO2 .2SO2.3 SO2.4 SO2.5		Unit-2 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9	Generation of free racdical, their structure and stability
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3 : Explain the reactivity of carbonyl compounds in various reactions and apply these concepts for synthesizing new organic compounds	SO3.1SO3. 2 SO3.3 SO3.4 SO3.5		Unit-3 : 3.1, 3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9	General introductuion to Addition reaction
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4: Explain mechanistic details of different types of elimination reactions, Saytzeff and Hoffman rules and apply these concepts in prediction of product formation in various elimination reactions	SO4.1SO4 .2SO4.3S O4.4 SO4.5		Unit-4 4.1, 4.2,4.3,4.4,4.5,4.6,4.7,4.7,4,8,4.9	General introductuion to Elimination recation
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 5: Explain pericyclic reactions, types, mechanisms and FMO and PMO approach in reference of pericyclic compounds and proposed mechanistic path for newer r products obtained by pericyclic reactions	SO5.1SO5 .2SO5.3S O5.4 SO5.5		Unit 5 5.1,5.2,5.3,5.4,5.5,5.6,5.7, 5.8,5.9	FMO and PMO theories

CODE: 76CH203

COURSE NAME: PHYSICAL CHEMISTRY II,**NO. OF CREDITS: 4**

L T P
3 1 O

Pre- requisite: Students should have basic knowledge of electro chemistry, chemical dynamics, statistical thermodynamics, angular momentum and macromolecules.

Rationale: Up on completion of the course student shall be able to learn about system property analyzed using electro chemistry

After the completion of this course, the learner will –

76CH203.1: Explain the chemical kinetics of reactions through different approaches.
76CH203.2: Describe and apply the knowledge with helps of statistical thermodynamics.
76CH203.3: Aware about different types of polymeric materials, their synthesis and properties

76CH203.4: Understand approximate methods and angular momentum and its importance.

76CH203.5: Understand to handle different electrochemical process

UNIT I

Chemical Dynamics Methods of determining rate laws, collision theory of reaction rates, steric factor, activated complex theory, Arrhenius equation and the activated complex theory; ionic reactions, kinetic salt effects, steady state kinetics, kinetic and thermodynamic control of reactions, treatment of unimolecular reactions.Dymanics of unimolecular reactions; Lindemann-Hinshelwood and Rice-Ramsperger-Kassel-Marcus and Slater theories of unimolecular reactions.

UNIT II

Statistical Thermodynamics:

Aims of statistical thermodynamics – thermodynamic probability,Ensemble averaging, postulates of ensemble averaging. Microcanonical, canonical and grand canonical ensembles, corresponding distribution laws (using Lagrange‘s method of undetermined multipliers). Distinguishable and Indistinguishable/ Identical Particles. Maxwell-Boltzmann statistics, Boltzmann distribution, derivation of the Boltzmann distribution expression, determination of the Boltzmann constant, Maxwell distribution law of velocities from Boltzmann distribution expression. Quantum statistics: Bose-Einstein statistics and Fermi-Dirac statistics, Bose-Einstein condensation & distribution function. Derivation of Fermi-Dirac distribution function and its comparison.

UNIT III

Macromolecules. Polymers, types of polymers, kinetics of polymerization, mechanism of polymerization reactions. Molecular mass ofmacromolecues, number and mass average molecular mass; molecular mass determination (osmometry, viscometry, diffusion and light scattering methods),sedimentation, chain structures and their configuration.

UNIT IV

Approximate Methods

The variation theorem, linear variation principle. Perturbation theory (first order and non-degenerate). Applications of variation method and perturbation theory to the Helium atom

Angular Momentum. Ordinary angular momentum, generalized angular momentum, eigen functions for angular momentum, eigen values of angularmomentum, addition of angular momenta, spin, antisymmetry and Pauli exclusion principle.

UNIT V

Electrchemistry:

Ion size factor and ion-solvent interactions. Decomposition voltage and overvoltage. Consecutive electrode processes.

Exchange current density. Electrokinetic potential, its determination and significance. Butler-Volmer's equation. Tafel's plot. Theory of polarography. Ilkovic equation. Half wave potential and its significance.Introduction to corrosion. Forms of corrosion. Corrosion monitoring and prevention.Application of corrosion.

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)	
Program Core (PCC)	76CH203	Physical Chemistry-II	4	0	1	1	6	4

Legend:

(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 of teacher to ensure outcome of Learning.

Scheme of Assessment: Theory

Board ofStudy	Couse Code	CourseTitle	SchemeofAssessment(Marks)						
			ProgressiveAssessment(PRA)					EndSemesterAssessment	Total Marks
			Class/HomeAssignment 5number	Class Test2 (2bestout of3) 10	Seminarone (SA)	ClassAttendance (AT)	TotalMarks	**(ESA)**	(PRA+ESA)

			3 marksea ch (CA)	marks each(CT)			(CA+CT+SA +AT)		
PCC	76CH203	Physical Chemistry II	15	20	10	5	50	50	100

Course-Curriculum Detailing:

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

76CH203.1: **76CH203.1**: Explain the chemical kinetics of reactions through different approaches.

Activity	Apex Hrs
CI	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO1.1 Describe methods of determining rate laws SO1.2 Describe mathematical collision theory with applications SO1.3 Explain Arrhenius equation. SO1.4 Discuss activated complex theory SO1.5 Explain and apply		**UNIT I** **Chemical Dynamics** **1.1** Methods of determining rate laws, 1.2 Factors affecting rate of reactions 1.3 Collision theory of reaction rates	Applications of chemical kinetics

unimolecular and bimolecular reactions		1.4 Steric factor 1.5 activated complex theory, 1.6 Arrhenius equation 1.7 Transition state theory 1.8 ionic reactions, 1.9 kinetic salt effects, 1.11 steady state kinetics, 1.12kineticandthermodynamic control of reactions, T1-treatment of unimolecular reactions. T2 Dymanics of unimolecular reactions; T3 Uses of chemical kinetics 1.11-Lindemann-Hinshelwood and 1.12-Rice-Ramsperger-Kassel-Marcus and Slater theories of unimolecular reactions.	

SW-1 Suggested Sessional Work (SW):

a. Assignments:

Discuss the Unimolecular reaction &bimolecular reaction

76CH204.2: Describe and apply the knowledge with helps of statistical thermodynamics

Activity	**Apex Hrs**
CI	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO2.1 Restate Aims of statistical thermodynamics **SO2.2** Describe Ensemble averaging, postulates of ensemble averaging and thermodynamic probability. **SO2.3** Explain and apply Maxwell-Boltzmannstatistics **SO2.4** Explain and apply Bose and Fermy statistics. **SO2.5** 7 Determination of the Boltzmann constant,		**Statistical Thermodynamics**: 2.1 Aims of statistical thermodynamics – 2.2Thermodynamicprobability, 2.3 Ensemble averaging, postulates of ensemble averaging. 2.4 Microcanonical, canonical and grand canonical ensembles, corresponding distribution laws (using Lagrange's method of undetermined multipliers). Distinguishable and Indistinguishable/ Identical Particles. 2.5Maxwell-Boltzmannstatistics, 2.6 Boltzmann distribution, derivation of the Boltzmann distributionexpression, 2.7determination of the Boltzmann constant, 2.8Maxwell distribution law of velocities from Boltzmann distribution expression. 2.9Quantum statistics: Bose-Einstein statistics and Fermi-Dirac statistics, Bose-Einstein condensation & distribution function. Derivation of Fermi-Dirac distribution function and its comparison.	Explain fundamentals of statistical thermodynamics

SW-2 Suggested Sessional Work (SW):

A .Assignments:

Discussion of Morse potential energy diagrams, vibration-rotation spectroscopy, P,Q,R branch's.

b. Mini Project:

Problem-solving exercises involving TH

c. Other Activities (Specify):

Write an essay on Resonance Raman Spectroscopy, coherent anti-stokes Raman Spectroscopy (CARS

76CH204.3 Aware about different types of polymeric materials, their synthesis and properties

Activity	**Apex Hrs**
CI	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO3.1 Explain introduction and types of polymers **SO3.2** Discuss kinetics of polymerization, mechanism of polymerization reactions. **SO3.3** Explain and apply Molecular mass of macromolecues, **SO3.4** Determine molecular weigh of polymers by different theory method **SO3.5** Explain chain structures and their configuration.		3.1 *Introductions of* Polymers, 3.2 types of polymers, 3.3 kinetics of polymerization, mechanism of polymerization reactions. 3.4 Molecular mass of macromolecues, 3.5number and mass average molecular mass; molecular mass 3.6 osmometry method , 3.7 viscometry method, 3.8diffusion method 3.9light scattering methods), 3.10 Sedimentationvelocity method 3.11 chain structures and their configuration. 3.12 Examples of polymers T1 Condensation polymers T2Addition Polymers T3 Molecular weight of Polymer	Explain Polymers with examples

SW-3 Suggested Sessional Work (SW):

a. Assignments:

Classification of polymer

b. Mini Project:

Molecular weight of polymer

c. Other Activities (Specify):

Condensation polymers

76CH203.4: Understand approximate methods and angular momentum and its importance.

Activity	**Apex Hrs**
CI	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO4.1 Explain and apply variation theorem, **SO4.2** Describe Perturbation theory (first order and non-degenerate). **SO4.3** Discuss zero fields splitting and Kramer's degeneracy. **SO4.4** Explain and apply Angular Momentum **SO4.5** Discuss eigen values and Eigen Functions of angular momentum,		**4.1** Approximate Methods 4.2 The variation theorem, 4.3linear variation principle. 4.4 Perturbation theory (first order and non-degenerate). 4.5 Applications of variation method 4.6 perturbation theory to the Helium atom **4.7** Angular Momentum. 4.8 Ordinary angular momentum, 4.9 generalized angular momentum, 4.10 eigen functions for angular momentum, 4.11 eigen values of angular momentum, 4.12 addition of angular momenta, T2antisymmetry T3 Pauli exclusion principle.	Applications of Angular momentum

SW-4 Suggested Sessional Work (SW):

a. **Assignments:**

Applications of Angular Momentum

b. Mini Project:

Apply and uses of variation theorm

76CH203.5: Understand to handle different electrochemical process

Activity	**Apex Hrs**
CI	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self Learning**
SO5.1 Explain ion solvent interactions. **SO5.2** Describe overvoltage with applications **SO5.3** Explain Electrokinetic potential, its determination and significance **SO5.4** Explain and apply Butler-Volmer's equation. and Tafel's plot. **SO5.5** Explain and apply polarography with application	.	**Unit-V Electrchemistry:** 5.1 Ion size factor 5.2 Ion-solvent interactions. *5.3* Decomposition voltage 5.3 overvoltage. 5,4 Consecutive electrode processes. 5.5 Exchange current density. 5.6 Electrokinetic potential, its determination and significance. 5.7 Butler-Volmer's equation. 5.8 Tafel's plot. 5.9 Theory of polarography. 5.10 Ilkovic equation. 5.11 Application of Polarography 5.12Half wave potential and its significance. T1 Introduction to corrosion. Forms of corrosion. T2 Corrosion monitoring and prevention. T3Application of corrosion.	Application of electro chemistry

SW-5 Suggested Sessional Work (SW):

a. Assignments:

Identification of compounds by polarography theory

b. Mini Project:

Measurement technique, elucidation of polarographic method

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
76CH203.1: Explain the chemical kinetics of reactions through different approaches.	12	02	01	15
76CH203.2: Describe and apply the knowledge with helps of statistical thermodynamics.	12	02	01	15
76CH203.3: Aware about different types of polymeric materials, their synthesis and properties	12	02	01	15
76CH203.4: Understand approximate methods and angular momentum and its importance.	12	02	01	15
76CH203.5: Understand to handle different electrochemical process	12	02	01	15
Total Hours	60	10	05	75

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Chemical Kinetics	03	01	01	05

CO-2	Statistical Thermodynamics	02	06	02	10
CO-3	Macromolecules	03	07	05	15
CO-4	Approximate method & Angular Method	-	10	05	15
CO-5	Electro chemistry	03	02	-	05
Total		11	26	13	50

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

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

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

Suggested Instructional/Implementation Strategies:

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

Suggested Learning Resources:

(a) Books :

S. No.	Title	Author	Publisher	Edition & Year
1	Physical Mehtods in Chemistry	R. S. Drago	Saunders College.	Revised edition
2	Physical Chemistry.	D. A. McQuarrie and J. D. Simon	Saunders College --	Revised edition
3	Physical Chemistry	K. J. Laidler and J. H. Meiser	Houghton Mifflin Company	Revised edition

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.

Physical Chemistry: Course Code:76CH 203

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
	Knowledge	**Research Aptitude**	**Communication**	**Problem Solving**	**Individual and Team Work**	Investigation of Problems	**Modern Tool usage**	**Science and Society**	**Life-Long Learning**	**Ethics**	**Project Management**	**Environment and sustainability**	**The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry**	**To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.**	**understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon-based problems in chemical sciences.**	**Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science**
CO1: Explanation the symmetry and group theory provide a powerful framework to understand and analyze patterns, structures, and behaviors across various disciplines	**3**	**1**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**3**	**2**	**2**	**3**	**3**	**1**
CO2Describe and apply the knowledge with helps of statistical thermodynamics	**2**	**1**	**2**	**2**	**1**	**2**	**3**	**2**	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**1**
CO3 Collectively aim to provide students with a comprehensive discuss the theory, operation, data analysis, and applications of Raman spectroscopy.	**2**	**2**	**1**	**1**	**1**	**2**	**2**	**2**	**1**	**2**	**1**	**2**	**1**	**1**	**2**	**2**
CO 4 Students would gain a comprehensive apply of the theoretical foundations, practical aspects, and diverse applications of ESR spectroscopy.	**2**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**2**	**3**	**3**	**3**	**3**	**2**
CO 5 Collectively aim to equip students with a comprehensive explanation of the theoretical principles, practical methodologies, and diverse applications of diffraction techniques.	**2**	**-**	**-**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**3**	**1**	**3**

Legend: Low= 1, Medium= 2, High=3

Course Curriculum Map:

POs &PSOsNo.	Cos No. &Titles	SOsNo.	Laboratory instruction(LI)	Classroom Instruction(CI)	Self Learning(SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO1: Explanation the symmetry and group theory provide a powerful framework to understand and analyze patterns, structures, and behaviors across various disciplines	SO1.1SO1.2SO1.3SO1.4 SO1.5		Unit-1. 1.1,1.2,1.3,1.4,1.5,1.6,1.7	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO2Describe and apply the knowledge with helps of statistical thermodynamics	SO2.1SO2.2SO2.3 SO2.4 SO2.5		Unit-2 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9	.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	**CO3** Collectively aim to provide students with a comprehensive discuss the theory, operation, data analysis, and applications of Raman spectroscopy.	SO3.1SO3.2 SO3.3 SO3.4 SO3.5		Unit-3 3.1, 3.2,3.3,3.4,3.5,3.6,3.7	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	**CO 4** Students would gain a comprehensive apply of the theoretical foundations, practical aspects, and diverse applications of ESR spectroscopy.	SO4.1SO4.2SO4.3SO4.4 SO4.5		Unit-4 : : 4.1, 4.2,4.3,4.4,4.5,4.6,4.7	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	**CO 5** Collectively aim to equip students with a comprehensive explanation of the theoretical principles, practical methodologies, and diverse applications of diffraction techniques.	SO5.1SO5.2SO5.3SO5.4 SO5.5		5.1,5.2,5.3,5.4,5.5,5.6,5.7	

Course Name: Differaction Methods And Spectroscopy Ii

Code: 76CH204 No. Of Credits: 4

L	T	P
3	1	0

Pre-requisite: Students should have basic knowledge of symmetry, symmetry elements, and symmetry operation. They may also know about EMR, mode of vibration, M-L bond, coordination number, diffraction, Scattering and reflection.

Rationale: Up on completion of the course student shall be able to learn about system property analyzed using group theory. They reveal information on the hyperfine interactions and ESR, *acquainted with paramagnetic species.* Understand elucidation of the crystal structure by using x-ray.

CourseOutcomes:

Afterthe completionofthiscourse, thelearner will –

76CH204.1: Explain the symmetry and group theory provides a powerful framework to understand and analyze patterns, structures, and behaviors across various disciplines.

76CH204.2: Describe and apply the knowledge which helps in identifying and characterizing specific vibrational frequencies..

76CH204.3: Collectively aim to provide students with a comprehensive discussion of the theory, operation, data analysis, and applications of Raman spectroscopy.

76CH104.4:Students would gain a comprehensive apply the theoretical foundations, practical aspects, and diverse applications of ESR spectroscopy.

76CH204.5: Collectively aim to equip students with a comprehensive explanation of the theoretical principles, practical methodologies, and diverse applications of diffraction techniques.

UNIT-I

Symmetry and Group Theory: Schonflies symbols, representations of groups by matrices (representation for the C_n, C_{nv}, C_{nh}, etc groups to be worked out explicitly). Character of a representation. The great orthogonality theorem (without proof) and its importance. Character tables and their use in spectroscopy.

UNIT-II Vibrational Spectroscopy

A- **Infrared Spectroscopy:** Review of linear harmonic oscillator, vibration energies of diatomic molecules, Zero point energy, force constants and bond strengths, anharmonicity, Morse potential energy diagrams, vibration-rotation spectroscopy, P,Q,R branch's, breakdown of Oppenhimer approximation, vibration of poly atomic molecules, selection rules, normal modes of vibrations, group frequencies, overtones, hot bands, factors affecting band positions and intensities, far IR region, metal ligand vibrations,

UNIT-III

Raman Spectroscopy:

Classical and quantum theories of Raman effect. Pure vibrational- rotational Raman Spectra, mutual exclusion principle, Resonance Raman Spectroscopy, coherent anti-stokes Raman Spectroscopy (CARS).

UNIT-IV Magnetic Resonance Spectroscopy

a. Electron spin Resonance Spectroscopy

Basic principles, zero field splitting and Kramer's degeneracy, factors affecting the 'g' value. Isotropic and anisotropic hyperfine coupling constants, spin Hamiltonian, spin densities and McConnell relationship, measurement techniques, applications.

b. Nuclear Quadrupole Resonance Spectroscopy

Quadrupole nuclei, quadrupole moments, electric field gradient, coupling constant splitting. Applications.

UNIT-V

X-ray Diffraction

a. Bragg condition, Miller indices, Laue method, Bragg method, Debye-Scherrer method of X-ray structural analysis of crystals, index reflections, identification of unit cells from systematic absences in diffraction pattern..

b.Electron Diffraction

Scattering intensity vs. scattering angle, Wierl equation, measurement technique, elucidantion of structre of simple gas phase molecules. Low energy electron diffraction and structure of surfaces.

c. Neutron Diffraction

Scattering of neutrons by solids and liquieds, magnetic scattering, measurement techniques. Elucidation of structure of Magnetically ordered unit cell.

Scheme of Studies:

Board ofStudy	CourseCode	CourseTitle	Scheme ofstudies(Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
ProgramCore(PCC)	76CH204	Diffraction Methods And Spectroscopy II	4	0	1	1	6	4

Legend: **CI:**Class room Instruction(Includesdifferentinstructionalstrategiesi.e.Lecture(L)andTutorial (T)Andothers),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different in structional strategies)
SW: Sessional Work (includes assignment, seminar,miniprojectetc.),
SL: Self Learning,
C: Credits.

Note: SW& SL has to be planned and performed under the continuous guidance and feed back of teacher to ensure outcome ofLearning.

Scheme of Assessment: Theory

Board ofStudy	Couse Code	CourseTitle	SchemeofAssessment(Marks)						
			ProgressiveAssessment(PRA)					EndSemesterAssessment	Total Marks
			Class/HomeAssignment 5number 3 markseach (CA)	Class Test2 (2bestout of3) 10 marks each(CT)	Seminarone (SA)	ClassAttendance (AT)	TotalMarks (CA+CT+SA+AT)	(ESA)	(PRA+ESA)
PCC	76CH204	Diffraction Methods And Spectroscopy II	15	20	10	5	50	50	100

Course-Curriculum Detailing:

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

76CH204.1: Explain the symmetry and group theory provides a powerful framework to understand and analyze patterns, structures, and behaviors across various disciplines Approximate Hours

Activity	Apex Hrs
CI	12
LI	0
SW	2
SL	1

Total	15

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO1.1 Restate group operations, including, identity element, inverses, and their significance in defining groups. SO1.2 Describe mathematical representations of groups by matrices. SO1.3 Explain and apply the applications of group actions in permutation groups and geometry. SO1.4 Discuss the representation of character table for different point group. SO1.5 Explain and apply representation theory, character theory, and the relationship between groups and linear transformations		**Unit-1 Symmetry and Group Theory** 1.1 symmetry and symmetry elements 1.2 Schonflies symbols of symmetry elements, 1.3 Point group of molelcules. 1.4 Identification of point group. 1.5 Representations of groups by matrices 1.6 Matrices representation for the C_n, C_{nv}, C_{nh}, etc group's symmetry operation. 1.7 Irreversible reducible (IR) representation of point group 1.8 Formation of character table for C_n, C_{nv}, C_{nh}, etc group's. 1.9 Reversible reducible (RR) representation of point group by character table. T1-Explanation the great orthogonality theorem (without proof) and T2- its importance. T3- Character tables and their use in spectroscopy. .	Worked out C_n, C_{nv}, C_{nh}, etc groups.

SW-1Suggested Sessional Work(SW):

a. Assignments:
Discuss the Character table representation for C2V and C3V point group.

b. Mini Project:
The great orthogonality theorem (without proof) and its importance.

c. Other Activities (Specify):

Character tables and their use in spectroscopy.

76CH204.2: Describe and apply the knowledge which helps in identifying and characterizing specific vibrational frequencies.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO2. Restate the classification of different types of vibrational modes in molecules. **SO2.2** Describe the fundamental principles of vibrational spectroscopy, including the interaction of light with molecular vibrations, the concept of infrared (IR) **SO2.3** Explain and apply Zero point energy, force constants and bond strengths **SO2.4** Restate the concept of anharmonicity, Morse potential energy diagrams, vibration-rotation spectroscopy, P, Q, R branch's . **SO2.5** Discuss factors affecting band positions and intensities, Classical and quantum theories of Raman effect..		**Unit-2.0 Infrared Spectroscopy** 2.1 Classification of different types molecules 2.2 vibrational modes in molecules (stretching, bending, torsional, etc.). 2.3 degree of freedom 2.4 IR activity. 2.5 Review of linear harmonic oscillator, 2.6 vibrational energies of diatomic molecules. 2.7 Zero point energy, overtones, hot bands, 2.8 factors affecting band positions, 2.9 force constants and intensities, T1-Breakdown of Oppenhimer approximation, vibration of poly atomic molecules, selection rules. T2- Pure vibrational- rotational Raman Spectra, mutual exclusion principle. T3- factors affecting band positions and intensities, far IR region, metal ligand vibrations,	Resonance Raman Spectroscopy, coherent anti-stokes Raman Spectroscopy (CARS).

SW-2 Suggested Sessional Work (SW):

A .Assignments:
Discussion of Morse potential energy diagrams, vibration-rotation spectroscopy, P,Q,R branch's.

b. Mini Project:
Problem-solving exercises involving spectral interpretation, solving practical spectroscopic problems, and identifying unknown compounds from spectra.

c. Other Activities (Specify):
Write an essay on Resonance Raman Spectroscopy, coherent anti-stokes Raman Spectroscopy (CARS).

76CH204.3: Collectively aim to provide students with a comprehensive discussion of the theory, operation, data analysis, and applications of Raman spectroscopy

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Restate Classical and quantum theories of Raman effect **SO3.2** Discuss the Pure vibrational-rotational Raman Spectra. **SO3.3** Explain and apply mutual exclusion principle, Resonance **SO3.4** Discuss Raman Spectroscopy, coherent anti-stokes Raman Spectroscopy (CARS).		**Unit-3.0 Raman Spectroscopy**: 3.1Introduction of raman effect. 3.2 Cause of raman effect. 3.3 elastic collision. 3.4 inelastic collision. 3.5Classical theories of Raman effect. 3.6Quantum theories of Raman effect. 3.7 Pure vibrational- rotational Raman Spectra, 3.8 mutual exclusion principle, Resonance 3.9 Raman Spectroscopy, T1-coherent anti-stokes Raman Spectroscopy (CARS). T2-. apply mutual exclusion principle, Resonance T3- Application of Raman spectroscopy	(CARS). at

SW-3 Suggested Sessional Work (SW):

a. Assignments:

Classical and quantum theories of Raman effect.

b. Mini Project:

Coherent anti-stokes Raman Spectroscopy (CARS).

c. Other Activities (Specify):

Explanatory note on importance of Raman Spectroscopy

76CH204.4: Students would gain a comprehensive apply the theoretical foundations, practical aspects, and diverse applications of ESR spectroscopy**.**

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Explain and apply materials with unpaired electrons, Introduction of ESR, basic principles of ESR **SO4.2** Restate Theory/origin of an ESR Signal, Zeeman effect magnetic moment and spin quantum number. **SO4.3** Discuss zero fields splitting and Kramer's degeneracy. **SO4.4**Explain and apply Isotropic and anisotropic hyperfine coupling constants, spin densities and McConnell relationship. **SO4.5** Discuss valuable insights into the molecular structure, dynamics, and composition of materials containing nuclei with a non-zero quadrupole moment,		**Unit-4.0 Magnetic Resonance Spectroscopy**- **ESR Spectroscopy& NQR** **4.1**Local environment of the molecule, 4.2 Electron distribution within the molecule, **4.3** Magnitude of magnetic moment, Identification of free radicals **4.4**. Determination of structure of molecules. **4.5** Magnetic moment and spin quantum number, 4.6 gyromagnetic ratio Lande g factor, bohr magneton. **4.7** Factors affecting the 'g' value. **4.8** zero field splitting **4.9** Kramer's degeneracy, degeneracy of the electron spin states degeneracy of the electron spin states, **T1-** Hyperfine splitting: Selection Rule, Super hyperfine splitting , **T2-** Zero field splitting and Kremer degeneracy spin Hamiltonian, spin densities and McConnell relationship	Factors affecting the 'g' value. Isotropic and anisotropic hyperfine coupling constants

		T3-Quadrupole nuclei, quadrupole moments, electric field gradient, coupling constant splitting. Applications.	

SW-4 Suggested Sessional Work (SW):

e. Assignments:

Zero field splitting and Kramer's degeneracy

b. Mini Project:

Application of ESR and NQR

f. Other Activities (Specify):

Analysis of polynuclear hydrocarbons

76CH204.5: Collectively aim to equip students with a comprehensive explanation of the theoretical principles, practical methodologies, and diverse applications of diffraction techniques.

Activity	AppX Hrs
CI	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 Apply introduction of X-ray. Diffraction determination crystallographic structure of materials. **SO5.2** Describe identification of unit cells from systematic absences in diffraction pattern.. **SO5.3** Analyzing the diffraction pattern produced when electrons interact with a crystal, **SO5.4**Explain and apply Low energy electron diffraction and structure of		**Unit-5.0 X-ray Diffraction , Electron Diffraction, Neutron Diffraction** **5.1**Determination crystallographic structure of materials. 5.2 Bragg condition, 5.3 Miller indices, Laue method, Bragg method. **5.4** Debye-Scherrer method of X-ray structural analysis of crystals, index reflections,	magnetic scattering, measurement techniques

surfaces. **SO5.5** Explain and apply basic ideas about Neutron DiffractionScattering of neutrons by solids and liquids'		**5.5** Scattering intensity vs. scattering angle, 5.6 Wierl equation, measurement technique, 5.7deduction of positions of atoms in the crystal lattice **5.8**Measurement technique, elucidation of structure of simple gas phase molecules. 5.9 LEED and structure of surfaces. **T1-** Scattering of neutrons by solids and liquids, **T2-**magnetic scattering, measurement techniques. T3-Elucidation of structure of Magnetically ordered unit cell.	

SW-5 Suggested Sessional Work (SW):

a. **Assignments:**
   Identification of unit cells from systematic absences in diffraction pattern.

g. **Mini Project:**

Measurement technique, elucidation of structure of simple gas phase molecules

h. **Other Activities (Specify):**

Scattering of neutrons by solids and liquids, magnetic scattering

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
76CH204.1: Understand the symmetry and group theory provides a powerful framework to understand and analyze patterns, structures, and behaviors across various disciplines	12	02	01	15
76CH204.2: Describe and apply the knowledge which helps in identifying and characterizing specific vibrational frequencies.	12	02	01	15
76CH204.3: Collectively aim to provide students with a comprehensive understanding of the theory, operation, data analysis, and applications of Raman spectroscopy.	12	02	01	15
76CH104.4:Students would gain a comprehensive understanding of the theoretical foundations, practical aspects, and diverse applications of ESR spectroscopy.	12	02	01	15
76CH204.5: Collectively aim to equip students with a comprehensive understanding of the theoretical principles, practical methodologies, and diverse applications of diffraction techniques.	12	02	01	15
Total Hours	60	10	05	75

Suggestion for End Semester Assessment

Suggested SpecificationTable(ForESA)

CO	UnitTitles	MarksDistribution			Total Marks
		R	U	A	
CO-1	Symmetry and Group Theory	03	01	01	05
CO-2	Vibrational Spectroscopy	02	06	02	10
CO-3	Raman Spectroscopy	03	07	05	15
CO-4	Magnetic Resonance Spectroscopy	-	10	05	15
CO-5	X-ray Diffraction , Electron Diffraction Neutron Diffraction	03	02	-	05
Total		11	26	13	50

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

TheendofsemesterassessmentforOrganic Chemistry I willbeheldwithwrittenexaminationof50 marks

Note.DetailedAssessmentrubricneedtobepreparedbythecoursewiseteachersforabovetasks. Teacherscanalsodesigndifferenttasksasperrequirement,forendsemesterassessment.

Suggested Instructional/Implementation Strategies:

37. ImprovedLecture
38. Tutorial
39. CaseMethod
40. GroupDiscussion
41. RolePlay
42. Visitto NCL, CSIR laboratories
43. Demonstration
44. ICTBasedTeachingLearning(VideoDemonstration/TutorialsCBT,Blog,Facebook,Twitter,Whatsapp,Mobile,Onlinesources)
45. Brainstorming

Suggested Learning Resources:

(g) **Books:**

S. No.	Title	Author	Publisher	Edition& Year

1	Modern Spectroscopy	J. M. Hoilas	John Wiley.	Revised editionedition2 020
2	Applied Electron Spectroscopy for Chemical Analysis	Ed. H. Windawi and F. L. HO	Wiley Interscience.	New edition, 2021
3	NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry	R. V. Parish	Ellis Harwood.	New edition, 2021
4	Physical Mehtods in Chemistry	R. S. Drago	Saunders College.	Revised edition
5	Chemical Applications of Group Theory	F. A. Cotton.	--	Revised edition
6	Introduction to Molacular Spectroscopy	G. M. Barrow	McGRraw Hill.	Revised edition

SuggestedWebSources:

20. https://nptel.ac.in/course.html
21. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
22. https://swayam.gov.in/explorer?category=Chemistry

ModeofDelivery:Lecture,demonstration,E-tutoring,discussion,assignments,quizzes, case study, power point;

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

Course Title: Group theory and spectyroscvopy **Course Code : 76CH204**

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Knowledge	Research Aptitude	Communication	Problem Solving	Individual and Team Work	Investigation of Problems	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and sustainability	The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry	To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.	understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon-based problems in chemical sciences.	Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science
CO1: Explanation the symmetry and group theory provide a powerful framework to understand and analyze patterns, structures, and behaviors across various disciplines	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO2: Describe and apply the knowledge which helps in identifying and characterizing specific vibrational frequencies.	2	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3 Collectively aim to provide students with a comprehensive discuss the theory, operation, data analysis, and applications of Raman spectroscopy.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO 4 Students would gain a comprehensive apply of the theoretical foundations, practical aspects, and diverse applications of ESR spectroscopy.	2	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
CO 5 Collectively aim to equip students with a comprehensive explanation of the theoretical principles, practical methodologies, and diverse applications of diffraction techniques.	2	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

Legend:1–Low,2–Medium, 3–Hig

:

POs &PSOsNo.	Cos No. &Titles	SOsNo.	Laboratory instruction(LI)	Classroom Instruction(CI)	Self Learning(SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO1: Understand the symmetry and group theory provide a powerful framework to understand and analyze patterns, structures, and behaviors across various disciplines .	SO1.1SO1.2S O1.3SO1.4 SO1.5		Unit-1.0 Symmetry and Group Theory 1.1,1.2,1.3,1.4,1.5,1.6,1.7	Character tables and their use in spectroscopy.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	**CO2**: Describe and apply the knowledge which helps in identifying and characterizing specific vibrational frequencies.	SO2.1SO2.2S O2.3 SO2.4 SO2.5		Unit-2 **Vibrational Spectroscopy** 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9	Resonance Raman Spectroscopy, coherent anti-stokes Raman Spectroscopy (CARS).
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	**CO3** Collectively aim to provide students with a comprehensive understanding of the theory, operation, data analysis, and applications of Raman spectroscopy	SO3.1SO3.2 SO3.3 SO3.4 SO3.5		Unit-3 :**Mössbauer Spectroscopy** 3.1, 3.2,3.3,3.4,3.5,3.6,3.7	Nature of M-L bond, coordination number, structure and detection of oxidation state.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	**CO 4** Students would gain a comprehensive understanding of the theoretical foundations, practical aspects, and diverse applications of ESR spectroscopy.	SO4.1SO4.2S O4.3SO4.4 SO4.5		Unit-4 : :**Magnetic Resonance Spectroscopy** 4.1, 4.2,4.3,4.4,4.5,4.6,4.7	Quadrupole nuclei, quadrupole moments, electric field gradient, coupling constant splitting. Applications
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	**CO 5** Collectively aim to equip students with a comprehensive understanding of the theoretical principles, practical methodologies, and diverse applications of diffraction techniques.	SO5.1SO5.2S O5.3SO5.4 SO5.5		**Unit 5: X-ray Diffraction , Electron Diffraction Neutron Diffraction** 5.1,5.2,5.3,5.4,5.5,5.6,5.7	Low energy electron diffraction and structure of surfaces. ,

CODE: 76CH-205

COURSE NAME: COMPUTER APPLICATION IN CHEMISTRY

CREDIT 3

L	T	P
3	0	0

Pre-requisite: Student should have basic knowledgeof computer
Rationale: Student will be able to operate various types of softwares and programmes required for a chemist
Course Outcomes:

CO.1: Apply the basics of computers for Chemists.
CO.2: Explain and apply various theoretical and practical principles involved in the design and use of programming interface.
CO.3: apply the basic programming for chemist's requirement like Van der Waals equation.

CO.4: Design and implement Chart plotting using Excel and create the document using MS Word.

CO.5: Applythe Internet, SEO, PDF, JPG and RTF format.

UNIT I
Introduction to Computers and Computing. Basic structure and functioning of computer with a PC as illustrative example. Memory I/O devices. Secondary storage Computer languages. Operating systems with DOS as an example Introduction to UNIX and WINDOWS. Principles of programmingAlogrithms and flow-charts.

UNIT II
Computer Programming in FORTRAN/C/BASIC.(the language features are listed here with reference to FORTRAN. The instructor may choose another language such as BASIC or C the features may be replaced appropriately). Elements of the compute language. Constants and variables. Operations and symbols Expressions. Arithmetic assignment statement. Input and output Format statement. Termination statements. Branching statements as IF or GOTO statement. LOGICAL variables. Double precession variables. Subscripted variables and DIMENSION. DO statement FUNCTION AND SUBROUTINE.COMMON and DATA statement (Student learn the programming logic and these language feature by hands on experience on a personal computer from thebeginning of this topic.)

UNIT III
Programming in Chemistry. Developing of small computer codes using any one of the languages FORTRAN/C/BASIC involving simple formulae in Chemistry, such as Van der Waals equation. Chemical kinetics (determination of Rate constant) Radioactive decay (Half Life and Average Life). Determination Normality, Molarity nd Molality of solutions. Evaluation Electronegativity of atom and Lattice Energy from experimental determination of molecular weight and percentage of element organic compounds using data from experimental metal representation of molecules in terms of elementary structural features such as
bond lengths, bond angles.

UNIT IV

Use of Computer programmes. Operation of PC. Data Processing. Running of standard Programs and Packages such as MS WORD, MS EXCEL -special emphasis on calculations and chart formations. X-Y plot. Simpson's Numerical Integration method. Programmes with data preferably from physicalchemistry laboratory.

UNIT V

Internet. Application of Internet for Chemistry with search engines, various types of files like PDF, JPG, RTF and Bitmap. Scanning, OMR, Web camera.

SchemeofStudies:

Board ofStudy	CourseCode	CourseTitle	Scheme of studies(Hours/Week)					TotalCredits (C)
			CI	LI	SW	SL	Total StudyHours(CI+LI+SW+SL)	
		COMPUTERS FOR CHEMISTS	4	2	1	1	8	6

Legend:CI: Class room Instruction (Include sdifferent in structional strategies i.e.,Lecture (L)andTutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop ,field orother locations using different instructiona lstrategies)
SW: Sessional
Work (includesassignment,seminar,miniprojectetc.),**SL:**SelfLearning,**C:** Credits.
Note: SW&SL has to be lanned mand performed unde rthe continuou sguidanceandfeedbackofteacherto ensure outcome ofLearning.

SchemeofAssessment: Theory

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

Course-CurriculumDetailing:

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.

CO 1: Apply the basics of Computers and its Storage.

Approximate Hours

Item	Appx Hrs.
Cl	10
LI	0
SW	1
SL	1
Total	12

S2-COAPIT.1:Introduction to Computers and Computing. Basic structure and functioning of computer with a PC as illustrative example. Memory I/O devices. Secondary storage Computer languages. Operating systems with DOS as an example Introduction to UNIX and WINDOWS. Principles of programming Algorithms and flow-charts.

Session Outcomes (SOs)	(LI)	ClassroomInstruction (CI)	(SL)
SO1.1 Understand the concept of Computing. **SO1.2** Understand the concept of Memory I/O devices **SO1.3** Understand the concept Operating systems with DOS. **SO1.4** Preparation of UNIX and WINDOWS. **SO1.5** Preparation Programming Algorithms & Flow-charts.		**Unit-1.0 Theoretical Framework of Database** 1.1. Introduction to Computers and Computing. 1.2. Concepts of computer with a PC as illustrative example. 1.3. Memory I/O devices. 1.4. Secondary storage Computer languages. 1. 5. Operating systems with DOS. 1.6. Data base Administrator, ER model 1.7. Example Introduction to UNIX and WINDOWS. 1.8. Principles of programming, 1.9. Programming	1. Study working of the CRT monitor 2. Study of the inkjet printer.

		Algorithms 1.10. Flow-charts.	

S2-COAPIT.2: Explain various theoretical and practical principles involved in the design and use of programming interface.

Approximate Hours

Item	Appx Hours
Cl	8
LI	
SW	1
SL	1
Total	10

SessionOutcomes (SOs)	**(LI)**	**ClassroomInstruction (CI)**	**(SL)**
SO2.1 Concept of Elements of the compute language. **SO2.2** Understanding about the Constants and variable. **SO2.3**Concept of Operations and symbols Expressions **SO2.4** Understanding theArithmetic assignment statement. **SO2.5** Preparation of FUNCTION AND SUBROUTINE.COMMON and DATA statement		**Unit 2.0Computer Programming in FORTRAN/C/BASIC.** 2.1 Elements of the compute language. 2.2Constants and variables. Operations and symbols Expressions. 2.3Arithmetic assignment statement. Input and output Format statement. Termination statements. 2.4Branching statements as IF or GOTO statement. 2.5LOGICAL variables. Double precession variables. 2.6 Subscripted variables and DIMENSION. 2.7 DO statement FUNCTION. 2.8 SUBROUTINE.COMMON and DATA statement.	1. Make programs of the functions. 2. Make programs of the structure and union.

S2-COAPIT.3: Learn the basic programming for chemist’s requirement like Van der Waals equation.

Approximate Hours

Item	Appx Hours
Cl	10
LI	0
SW	1
SL	1
Total	12

Session Outcomes (SOs)	(LI)	Classroom Instruction (CI)	(SL)
SO3.1 Meaning and concept of **Relational algebra:** **SO3.2** Practical problem related to select command, Project, cross product. **SO3.3** Understanding the different types of joins: Theta join, Equi join, Natural join and Outer Join. **SO3.4** Understanding about Set operations, definition of union & set difference. **SO3.5** Preparation of Cartesian product, Selection, Intersection & Relational query language.	.	**Unit-3.0:Programming in Chemistry.** 3.1 Developing of small computer codes using any one of the languages. 3.2 FORTRAN/C/BASIC involving simple formulae in Chemistry. 3.3 Van der Waals equation. 3.4 Chemical kinetics. 3.5 Determination of Rate constant. 3.6 Radioactive decay (Half Life and Average Life). 3.7 Determination Normality, Molarity and Molality of solutions. 3.8 Evaluation Electronegativity of atom and Lattice Energy from experimental determination of molecular weight. 3.9 Percentage of element organic compounds using data. 3.10 experimental metal representation of molecules in terms of elementary structural features such as bond lengths, bond angles	1.write a program on the Thermodynamics equation. 2. Write a program on the Boyel's equation.

S2-COAPIT.4: Design and implement Chart plotting using Excel and create the document using MS Word.

Approximate Hours

Item	Appx Hours
Cl	11
LI	
SW	1
SL	1
Total	13

SessionOutcomes (SOs)	(LI)	ClassroomInstruction (CI)	(SL)
SO4.1 Understanding about the concept Use of Computer Programmes. **SO4.2** Preparation of Operation of PC, Data Processing. **SO4.3** Understanding about the Running of standard Programs and Packages such as MS WORD, MS EXCEL:- **SO4.4** Understanding about the Special emphasis on calculations and chart formations. **SO4.5** Preparation of X-Y plot, Simpson's Numerical Integration method.		Unit 4.0 **Use of Computer Programmes**:- 4.1 Operation of PC, Data Processing, 4.2 Running of standard Programs and Packages 4.3 MS WORD, 4.4 MS EXCEL 4.5 MS PowerPoint. 4.6 formula of MS EXCEL 4.7 Macros in MS Word. 4.8Special emphasis on calculations and chart formations 4.9X-Y plot, Simpson's Numerical Integration method. 4.10Programmes with data preferably 4.11physical chemistry laboratory.	1. Make a Word document showing the advertisment of the AKS University. 2. Make a excel sheet using titration data.

S2-COAPIT.5: Learn the Internet, SEO, PDF, JPG and RTF format.

Approximate Hours

Item	Appx Hours
Cl	9
LI	0
SW	1
SL	1
Total	11

SessionOutcomes (SOs)	**(LI)**	**ClassroomInstruction (CI)**	**(SL)**
SO5.1 Understand about the concept of Application of Internet for Chemistry with search engines: **SO5.2** Preparation of various types of files like PDF. **SO5.3** Preparation of JPG, RTF. **SO5.4** Understanding about the Bitmap. Scanning. **SO5.5**Understanding about the OMR, Web camera.		**Unit 5.0:** Internet. 5.1**.** Application of Internet for Chemistry with search engines: 5.2 various types of files like PDF. 5.3 JPG, 5.4 RTF 5.5 mpeg 5.6 bitmap file format 5.7Bitmap. Scanning. 5.8OMR, 5.9. Web camera.	1. Study working of different image file formats. **2.** Study of the different audio file formats**.**

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
CO.1: Apply the basics of computers for Chemists.	10	1	1	12
CO.2: Explain and apply various theoretical and practical principles involved in the design and use of programming interface.	8	1	1	10

CO.3: apply the basic programming for chemist's requirement like Van der Waals equation.	10	1	1	12
CO.4: Design and implement Chart plotting using Excel and create the document using MS Word.	11	1	1	8
AC 101.5: Learn the Internet, SEO, PDF, JPG and RTF format.	9	1	1	7
Total Hours	48	05	05	58

Suggestion for End Semester Assessment

Suggested Specification Table (ForESA)

CO	UnitTitles	MarksDistribution			Total Marks
		R	U	A	
CO-1	Apply the basics of computers for Chemists.	01	01	03	05
CO-2	Explain and apply various theoretical and practical principles involved in the design and use of programming interface.	01	01	03	05
CO-3	apply the basic programming for chemist's requirement like Van der Waals equation.	-	03	10	13
CO-4	Design and implement Chart plotting using Excel and create the document using MS Word.	-	03	10	13
CO-5	Learn the Internet, SEO, PDF, JPG and RTF format.	01	03	10	14
Total		03	12	36	50

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

Theendofsemester assessmentforFinancial Accounting willbeheld with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wiseteachers for above tasks. Teachers can also design different tasks as per requirement, for endsemesterassessment.

SuggestedInstructional/ImplementationStrategies:

1. ImprovedLecture
2. Tutorial
3. CaseMethod
4. GroupDiscussion
5. Brainstorming

SuggestedLearningResources:

(a) **Books**:

S. No.	Title	Author	Publisher	Edition&Year
1	Computer Fundamentals	Raja Raman		
2	Computer Fundamentals	P. K. Sinha		
3	Fundamentals of Computers	E Balagurusamy	Black Book	

Suggested Web Sources:

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

Mode of transaction:Lecture,demonstration,E-tutoring,discussion,assignments,quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite,MSPower-Point, Online Resource

Title: Computer for Chemist **Course Code : 76CH205**

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Knowledge	Research Aptitude	Communication	Problem Solving	Individual and Team Work	Investigation of Problems	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and sustainability	The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry	To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.	understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon-based problems in chemical sciences.	Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science
CO.1: Apply the basics of computers for Chemists.	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO.2: Explain and apply various theoretical and practical principles involved in the design and use of programming interface.	2	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO.3: apply the basic programming for chemist's requirement like Van der Waals equation.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO.4: Design and implement Chart plotting using Excel and create the document using MS Word.	2	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
CO.5: Applythe Internet, SEO, PDF, JPG and RTF format.	2	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

Legend:1–Low,2–Medium, 3–High

CourseCurriculumMap:

POs &PSOsNo.	COsNo.&Titles	SOsNo.	Laboratory Instruction(LI)	Classroom Instruction(CI)	Self Learning(SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4		SO1.1SO1.2S O1.3SO1.4 SO1.5		Unit-1 1.1,1.2,1.3,1.4,1.5,1.6,1.7	1. Study working of the CRT monitor 2. Study of the inkjet printer.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4		SO2.1SO2.2S O2.3 SO2.4 SO2.5		Unit-2. 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9	1.Make programs of the functions. 2. Make programs of the structure and union
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4		SO3.1SO3.2 SO3.3 SO3.4 SO3.5		Unit-3 3.1, 3.2,3.3,3.4,3.5,3.6,3.7	1.Write a program on the Thermodynamics equation. 2. Write a program on the Boyel's equation
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4		SO4.1SO4.2S O4.3SO4.4 SO4.5		Unit-4 : 4.1, 4.2,4.3,4.4,4.5,4.6,4.7	1. Make a Word document showing the advertisment of the AKS University. 2.Make a excel sheet using titration data.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4		SO5.1SO5.2S O5.3SO5.4 SO5.5		Unit 5: 5.1,5.2,5.3,5.4,5.5,5.6,5.7	1. Study working of different image file formats. 2.Study of the different audio file formats

Code: 76CH251
Course Name: Inorganic Chemistry Lab-II
No. Of Credits: 2

L	T	P
0	0	2

Pre-requisite: Students should have basic knowledge of Laboratory safety as well as inorganic mixture analysis.
Rationale: This course provides skill in synthesis of inorganic compounds and inorganic mixture analysis.

Course Outcomes

Afterthe completionofthiscourse, thelearner will:

CO1: Analyze inorganic mixture qualitatively
CO2: Analyze inorganic mixture containing less common salts
CO3: Separation of inorganic mixture using chromatography
CO4: Synthesize simple inorganic complex compounds.
CO5. Estimate metallic ions in solution volumetrically

Unit I: **QualitativeAnalysis** I:
Inorganic mixture analysis (without insoluble and less common salts)

Unit II: QualitativeAnalysis II
Inorganic mixture analysis with less common salts

Unit III: Qualitative Analysis III
Separation of inorganic mixture of Ni(II), Co(II) and Zn(II) using chromatography
Separation of inorganic mixture of Ni(II), Co(II), Cu(II) and Zn(II) using chromatography

Unit IV: Inorganic Complex Synthesis I
Synthesis of bis(dimethylglyoximato) nickel (II) : [Ni(C4H7O2N2)2]
Synthesis of hexamine cobalt (III) chloride: [Co(NH3)6]Cl3
Synthesis of potassium trioxalato chromate (III) trihydrate: K3[Cr(C2O4)3].3H2O

Unit V: Quantitative Analysis
Separation and estimation of two metal ions like Barium and copper (Ba-Cu

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 (2hr) + SW + SL)	
ProgramCore(PCC)	76CH-251	Inorganic Chemistry II	0	2	1	1	6	2

Legend: **CI:** Class room Instruction (Includes different instructional strategies i.e.Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory

workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includesassignment,seminar,miniprojectetc.),
SL: Self Learning,
C: Credits.

Note:
SW&SLhastobeplannedandperformedunderthecontinuousguidanceandfeedbackofteacherto ensure outcome ofLearning.

Scheme of Assessment: Practical

Course Categeory	Couse Code	Course Title	Scheme of Assessment (Marks)					
			Progressive Assessment (PRA)				**End Semester Assessment (ESA)**	**Total Marks**
			Class/Home Assignment 5 number 7marks each (CA)	Viva voice 1X10	Class Attendance (AT)	Total Marks (CA+CT+SA +AT)	**35(Exexcise)+ 10(viva)+5(for record file)**	**(PRA+ESA)**
PCC	76CH-251	Inorganic ChemistryII	35	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, 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.

76CH151.1: Analyze inorganic mixture qualitatively

Activity	**AppX Hrs**
LI	2
SW	1
SL	1
Total	4

Session Outcomes (SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self Learning (SL)
SO1 Analyse five radicals mixture of inorganic compounds SO2 Analyse five radicals mixture of inorganic compounds	Unit 1.1Identify the given radicals of inorganic compounds qualitatively. dentify the given radical mixture of inorganic compounds.		Safety measurement of chemicals

SW-1 Suggested Sessional Work (SW):

a.Assignments:

Separatration of binary mixture of inorganic compounds by paper chromatography

d. Mini Project:

Preparation of inorganic complexes

c.Other Activities (Specify):

76CH151.2: Inorganic mixture analysis with less common salt

Activity	AppX Hrs
LI	2
SW	1
SL	1
Total	4

Session Outcomes (SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self Learning (SL)
SO1 Analyse seven radicals mixture of inorganic compounds with less common salts SO2 Analyse seven radicals mixture of inorganic compounds with less common salts	Unit2.1. Identify the given inorganic compounds containing atleast seven radicals. 2.2. Identify the given inorganic compounds containing atleast three radicals.		Basics to identify acid and basic radicals

SW-2 Suggested Sessional Work(SW):

a.Assignments:

Identify radicals containing common salts

b. Mini Project:

c. Other Activities (Specify):

76CH151.3: Separation of inorganic mixture using chromatography

Activity	AppX Hrs
LI	2 (2hr.each)
SW	1
SL	1
Total	4

Session Outcomes (SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self Learning (SL)
SO1 Identify tertiary mixture of inorganic compounds using chromatography SO2 Identify quaternary mixture of inorganic compounds using chromatogrphy	Unit3.1 Identify binary mixture of inorganic compounds (Ni^{2+}, Co^{2+} and Zn^{2+}) using TLC 3.2. Identify tertiary mixture of inorganic compounds (compounds (Ni^{2+}, Co^{2+}, Zn^{2+} and Cu^{2+}) using TLC		Basics of chromatography

SW-3 Suggested Sessional Work (SW):

4. **Assignments:** Discuss principle of chromatoghrphy
5. **Mini Project:** Development of chromatogram
6. **Other Activities (Specify)**: NMR Study of purified compound

76CH151.4: Synthesize simple inorganic complex compounds

Activity	AppX Hrs
LI	2 (2hr each)
SW	1
SL	1
Total	4

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

		(CI)	
SO1 Synthesis of bis(dimethylglyoximato) nickel (II) : [Ni(C4H7O2N2)2] SO2 Synthesis of hexamine cobalt (III) chloride: [Co(NH3)6]Cl3 SO3 Synthesis of potassium trioxalato chromate (III) trihydrate: K3[Cr(C2O4)3].3H2O	Unit4. 1 Synthesis of bis(dimethylglyoximato) nickel (II) : [Ni(C4H7O2N2)2] 4.2 Synthesis of hexamine cobalt (III) chloride: [Co(NH3)6]Cl3 4.3 Synthesis of potassium trioxalato chromate (III) trihydrate: K3[Cr(C2O4)3].3H2O		Synthesis and calculations of % yield

SW-4 Suggested Sessional Work (SW): [$Cu(NH_3)_4)$ SO_4, $[Ni(NH_3)_6]Cl_2$

a.Assignments: Discuss mechanistic approach of synthesis of reaction
B.Mini Project: Determination of boiling point of synthesize compounds
c. Other Activities (Specify):

76CH151.5: Separation and estimation of two metal ions like Barium and copper (Ba-Cu)

Activity	**AppX Hrs**
LI	2 (2hr each)
SW	1
SL	1
Total	6

Session Outcomes (SOs)	**Laboratory Instruction(LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO1 Estimation of Ba and Cu **quantitatively from their mixture**	**Unit5**. 1 Estimation of Ba and Cu **quantitatively from their mixture**		Basics of separation of complexes

SW-4Suggested Sessional Work (SW):

a.Assignments: Discuss percentage error
B.Mini Project:
C.Other Activities (Specify):

(a) **Books:**

S. No.	Title	Author	Publisher	Edition& Year
1	AText Book of Macro and Semi-micro QuantitativeAnalysis	A.I.Vogel	OrientLongman	4th edition
2	Synthesis and Characterization of Inorganic Compounds	W.B.Jolly	PrenticeHall,Englewood	2nd edition
3	Synthesis and Physical Studies of Inorganic Compounds	C.F.Bell	PergamonPress	

SUGGESTEDWEBSOURCES:

1. https://nptel.ac.in/course.html
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5

3.https://swayam.gov.in/explorer?category=Chemistry

ourse Title: Inorganic Chemistry Lab I I **Course Code : 76CH252**

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Knowledge	Research Aptitude	Communication	Problem Solving	Individual and Team Work	Investigation of Problems	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and sustainability	The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry	To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.	understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon -based problems in chemical sciences.	Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science
CO1 Analyze inorganic mixture qualitatively	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO2. Inorganic mixture analysis with less common salt	2	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3. Separation of inorganic mixture using chromatography	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO4. Synthesize simple inorganic complex compounds	2	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
CO5. Estimation of Ba and Cu quantitatively from their mixture	2	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

Legend:1–Low,2–Medium, 3–

Course Curriculum Mapping

POs &PSOsNo.	COsNo.&Titles	SOsNo.	LaboratoryInstruction(LI)	Classroom Instruction(CI)	Self Learning(SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO1 Analyze inorganic mixture qualitatively	SO1,SO2	Unit 1.1Identify the given radicals of inorganic compounds qualitatively. 1.2 Identify the given radical mixture of inorganic compounds.		Safety measurement of chemicals
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO2. Inorganic mixture analysis with less common salt	SO1,SO2	Unit2.1. Identify the given inorganic compounds containing atleast seven radicals. 2.2. Identify the given inorganic compounds containing atleast three radicals.		Basics to identify acid and basic radicals
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3. Separation of inorganic mixture using chromatography	SO1,SO2	Unit3.1 Identify binary mixture of inorganic compounds (Ni^{2+}, Co^{2+} and Zn^{2+}) using TLC 3.2. Identify tertiary mixture of inorganic compounds (compounds (Ni^{2+}, Co^{2+}, Zn^{2+} and Cu^{2+}) using TLC		Basics of chromatography
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO4. Synthesize simple inorganic complex compounds	SO1,SO2	Unit4. 1 Synthesis of bis(dimethylglyoximato) nickel (II) : [Ni(C4H7O2N2)2] 4.2 Synthesis of hexamine cobalt (III) chloride: [Co(NH3)6]Cl3 4.3 Synthesis of potassium trioxalato chromate (III) trihydrate: K3[Cr(C2O4)3].3H2O		Synthesis and calculations of % yield
PO1,2,3,4,5,6 7,8,9,10,11,12PSO 1,2, 3, 4	CO5. Estimation of Cu and Ni quantitatively from their mixture	SO1,SO2	Unit5. 1 Estimation of Ba and Cu quantitatively from their mixture		Basics of separation of complexes

Course Name: Organic Chemistry Lab-II

Code: 76 CH-252   No. Of Credits:2

L	T	P
0	0	2

Pre-requisite: Students should have basic knowledge of Laboratory safety as well as qualitative and quantitaive analysis.

Rationale: This course provide skill in synthesisof organic compounds and qualitative and quantitave organic analyasis.

CourseOutcomes: Afterthe completionofthiscourse, thelearner will:

76CH152.1: Analyse a given mixture of bi functional organic compounds qualitatively in laboratory.

76CH152.2: Estimate carbohydrate, Vitamin C, Aspirin by spectrophotometer

76CH152.3: Synthesise various organic compounds via green methods

76CH152.4: Synthesize organic compounds via two steps.

76CH152.5: Analyse Quantitaively: Iodine value of oil fat, BOD, COD, DO of water sample

Unit1 Qualitative Organic analysis

Qualitativeanalysisof bi functional compounds

Unit2 Quantitative analysis of organic compound

Estimatation of carbohydrate, Vitamin C, Aspirin by spectrophotometer

Unit3 Synthesis I

Synthesis of organic compounds involving some of the following reactions: Solvent free aldol condensation, Azomethine

Unit 4 Synthesis II

Two step synthesis: Thicarbahydrazide conventional and Microwave synthesis

Unit5 Quantitaive analysis

Analysis of oil and fat : Iodine value, R.M value of oil fat

Wtaer analysis: Ph, conductivity, TDS, BOD, COD, DO of water sample

Scheme of Studies:

Board ofStudy	CourseCode	CourseTitle	Scheme ofstudies(Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study HoursCI+LI(2hr)+ SW+SL)	
ProgramCore(PCC)	76CH252	Organic Chemistry II	0	2	1	1	6	2

Legend: **CI:**Class room Instruction (Includes different instructiona lstrategies i.e.Lecture(L)andTutorial

(T)andothers),
LI: Laboratory Instruction(Includes Practical performances in laboratory workshop,field or othe r location s using different in s tructional strategies)
SW: Sessional Work (includes assignment,seminar,miniprojectetc.),
SL: Self Learning,
C:Credits.

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

SchemeofAssessment: Practical

Course Categeory	Couse Code	Course Title	Scheme of Assessment (Marks)					
			Progressive Assessment (PRA)				**End Semester Assessment (ESA)**	**Total Marks**
			Class/Home Assignment 5 number 7marks each (CA)	Viva voice 1X10	Class Attendance (AT)	Total Marks (CA+CT+SA +AT)	**35(Exexcise)+ 10(viva)+5(for record file)**	**(PRA+ESA)**
PCC	76CH102	Organic Chemistry I	35	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 inncluding, 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.

76CH252.1: Analyse a given mixture of bi functional organic compounds qualitatively in laboratory

Activity	**AppX Hrs**
LI	2
SW	1
SL	1
Total	4

Session Outcomes (SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self Learning (SL)
SO1 Analyse binary mixture of organic compounds SO2 Analyse binary mixture of organic compounds by utilizing different solvents	Unit 1.1Separte and identify the given binary mixture of organic compounds (with BI functional group or Hydrocarbons) **(separation by water)** 1.2Separte and identify the given binary mixture of organic compounds(with BI functional group or Hydrocarbons) (**separation by utilizing different solvents)**		Purification of organic comp[ounds by crystallization Prepartaion of Required reagent for qualitative organc analysis

SW-1SuggestedSessionalWork(SW):

a.Assignments:
Preparation of Derivative and purification
b.Mini Project:
Poater of Separation Techniques for organic compounds
c.Other Activities (Specify):
Charaacterization of compounds biy I.R., NMR, MASS spectroscopy

76CH252.2: Estimate carbohydrate, Vitamin C, Aspirin by spectrophotometer

Activity	AppX Hrs
LI	2
SW	1
SL	1
Total	4

Session Outcomes (SOs)	**Laboratory Instruction(LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO1 Estimate of Vitamin C by spectrophotometer SO2 Estimate of Aspirin by spectrophotometer	Unit2.1. Estimation of Vitamin C by spectrophotometer 2. Estimation of Aspirin by spectrophotometer		Purification of organic compounds(with bi functional group) by crystallization Prepartaion of Required reagent for qualitative organc analysis

SW-2SuggestedSessionalWork(SW):

a.Assignments:
Limitations of Beer-Lambert law
b.Mini Project:
Differtialte between colourimetry and spectrophotometry
c.Other Activities (Specify):
Working of double beam Spectrophotometer

76CH252.3: Synthesise various organic compounds via green methods

Activity	**AppX Hrs**
LI	2 (2hr.each)
SW	1
SL	1
Total	4

Session Outcomes (SOs)	**Laboratory Instruction(LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO1 Apply green aldol condensation SO2 Synthesis of Azomethine via greener route	Unit3.1 Solvent free aldol condensation 3.2 Synthesis of Azomethine		Solvent free synthesis

SW-3SuggestedSessionalWork(SW):

a.Assignments:
Green and conventional menthod of synthesis
b.Mini Project:
Principal of Green Chemistry
c.Other Activities (Specify):

76CH252.4: Synthesize organic compounds via two steps.

Activity	AppX Hrs
LI	2 (2hr each)
SW	1
SL	1
Total	4

Session Outcomes (SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self Learning (SL)
SO1 Synthesize organic compounds by conventional method SO2 Synthesize organic compounds by Green route	**Unit4**. 1 Synthesis Thiocarbohydrazide by conventional route 4. 2Synthesis Thiocarbohydrazide by green route		Green methods of synthesis

SW-4SuggestedSessionalWork(SW):

a.Assignments:
Principle of microwave heating
B.Mini Project:
Conventional synthetic methods and limitations
c.Other Activities (Specify):
Tables of compounds synthesized by microwave and % Yield

76CH 252.5: Analyse Quantitaively: Iodine value of oil fat, BOD, COD, DO of water sample

Activity	**AppX Hrs**
LI	2 (2hr each)
SW	1
SL	1
Total	6

Session Outcomes (SOs)	**Laboratory Instruction(LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO1 Analyse value of given oil and fat SO2 DO of water sample	**Unit5**. 1 Iodine value of oil fat 5.2 DO of water sample		Water analysis parameters

SW-4 Suggested Sessional Work(SW):

a.Assignments:
R.M Value and its importance
B.Mini Project:
C.O.D., B.O.D.
C.Other Activities (Specify):
Physical parameters of Water analysis

(a) **Books:**

S. No.	**Title**	**Author**	**Publisher**	**Edition& Year**
1	Vogels qualitative organic analysis	A.I.Vogel,	OrientLongman.	Rrvised 2021
2	Advanced practical Chemistry	Jagdamba singh	Pragati prakashsan	Revised 2022
3	Advanced Organic Chemistry practical	N.K. Visnoi		
4.	AHand book of OrganicAnalysis-Qualitative and Quantitative	H.T. Clarke	London	1975

5	Experiments in Organic Chemistry	Louis,F.Fieser,D.C.Heath	Company Boston	1955
6	Systematic QualitativeOrganic Analysi	H.Middleton	Edward Arnold (Publishers)Limited	1959

SUGGESTEDWEBSOURCES:

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

MODEOFTRANSACTION:Lecture,demonstration,E-tutoring,discussion,assignments,quizzes,casestudy,powerpoint;**LMS/ICTTools:**DigitalClassrooms,DLMS,ZOOM,G-Suite, MSPower-Point, Online Resources

Course Title: Organic Chemistry Lab II **Course Code : 76CH252**

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Knowledge	Research Aptitude	Communication	Problem Solving	Individual and Team Work	Investigation of Problems	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and sustainability	The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry	To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.	understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon -based problems in chemical sciences.	Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science
CO1Analyse a given mixture of bi functional organic compounds qualitatively in laboratory.	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO2: Estimate carbohydrate, Vitamin C, Aspirin by spectrophotometer COD, DO of water sample	2	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
7CO3: Synthesise various organic compounds via green methods	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO4: Synthesize organic compounds via two steps.	2	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
CO5: Analyse Quantitaively: Iodine value of oil fat, BOD	2	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

Legend:1–Low,2–Medium, 3–High

Course Curriculum Map:

POs &PSOsNo.	COsNo.&Titles	SOsNo.	LaboratoryInstruction(LI)	Classroom Instruction(CI)	Self Learning(SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	. CO1Analyse a given mixture of bi functional organic compounds qualitatively in laboratory.	SO1,SO2	1, 2		Purification of organic compounds(with bi functional group) by crystallization Prepartaion of Required reagent for qualitative organc analysis
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO2: Estimate carbohydrate, Vitamin C, Aspirin by spectrophotometer COD, DO of water sample	SO1,SO2	1, 2		Purification of organic compounds(with bi functional group) by crystallization Prepartaion of Required reagent for qualitative organc analysis
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	7CO3: Synthesise various organic compounds via green methods	SO1,SO2	1, 2		Solvent free synthesis
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	Synthesize organic compounds via two steps.	SO1,SO2	1 ,2		Green methods of synthesis
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	Analyse Quantitaively: Iodine value of oil fat, BOD	SO1,SO2	1, 2		Water analysis parameters

M.Sc. Chemistry Semester II

Code: 76CH-253

Subject Name: Physical Chemistry Lab-II

L	T	P
0	0	2

Pre-requisite: Students should have basic knowledge of Laboratory safety as well as refractiveindex,refractivity, and molar refractivity properties of liquids in analysis.

Rationale: This course provides skill in knowledge of Laboratory safety as well as refractiveindex,refractivity, and molar refractivityproperties o fliquids in analysis.

CourseOutcomes: After the completion of this course, the learner will:

76CH253.1:Determine refractive index,refractivity, and molar Refractivity properties of liquids inanalysis.

76CH253.2: Determine rate and estimate molecular mass of polymer system.

76CH253.3: Solve wet-lab practical difficultiesrelated to kinetics of in version,

76CH253.4: Analyze distribution properties oftwo liquids.

76CH253.5:Handle electrode potential for various applications.

Unit-1 Colorimetry

1-Determination of Composition of a Complex by Jobs method

2-Colorimetric determination of Iron in potable water.

Unit-2 Refractometry

3- Determine the refractive index of simple organic liquids (environment friendly).

4- Study the variationof refractive index with concentration forKCl solution and thereafter determine the unknown concentration of given KCl solution.

Unit -3- Polarimetry

5-Studythevariation of angle ofopticalrotation with theconcentration ofany Optically active substance(sucroseorglucose)anddeterminetheunknownconcentrationofgivensolution.

6-Determine the specific and molecular rotation of sucrose or glucose at numberofconcentrations.

Unit-4- Potentiometry

7-Determine thestandardelectrodepotentialofCuand Zn.

8-Study the precipitationtitrationbetweenKClandAgNO_3potentiometrically.

Unit-5- Distribution Law

9-Determine distributioncoefficientofammoniabetweenchloroformandwater.

10-Determine theformulaofthecomplexformedbetweencopper(II)ionandammoniausingdistribution method.

AKS University

FacultyofBasic Science, **DepartmentofChemistry**

CurriculumofM. Sc. In Chemistry Program (Revisedason01August2023)

Scheme of Studies:

Board ofStudy	CourseCode	CourseTitle	Scheme ofstudies(Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study HoursCI+LI(2hr)+ SW+SL)	
ProgramCore(PCC)	76CH253	Physical Chemistry Lab	0	2	1	1	6	2

Legend: **CI:**ClassroomInstruction(Includesdifferentinstructionalstrategiesi.e.Lecture(L)andTutorial (T)andothers),
LI: LaboratoryInstruction(IncludesPracticalperformancesinlaboratoryworkshop,fieldorotherlocationsusingdifferentinstructionalstrategies)
SW: SessionalWork(includesassignment,seminar,miniprojectetc.),
SL: SelfLearning,
C:Credits.

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

Scheme of Assessment: Practical

Course Categeory	Couse Code	Course Title	Scheme of Assessment (Marks)					
			Progressive Assessment (PRA)				End Semester Assessment (ESA) 35(Exexcise)+ 10(viva)+5(for record file)	Total Marks (PRA+ESA)
			Class/Home Assignment 5 number 7marks each (CA)	Viva voic	Class Attendance (AT)	Total Marks (CA+CT+SA +AT)		
PCC	76CH153	Physical Chemistry I	35	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 inncluding, 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.

76CH 253.1 **Unit-1 Colorimetry**
1.1- Determination of Composition of a Complex by Jobs method
1.2-Colorimetric determination of Iron in potable water.

Activity	**AppX Hrs**
LI	2
SW	1
SL	1
Total	4

Session Outcomes (SOs)	**Laboratory Instruction(LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO1 Analyse Composition of a Complex by Jobs method SO2 Analyse Colorimetric determination of Iron in potable water.	**Unit-1 Colorimetry** 1.1- Determination of Composition of a Complex by Jobs method 1.2-Colorimetric determination of Iron in potable water.		Applications of Colorimeter

SW-1Suggested Sessional Work(SW):

a.Assignments:
Jobs method

76CH253.2: Unit-2 Refractometry
3- Determinetherefractive indexofsimpleorganicliquids(environmentfriendly).
4- Studythevariationof refractiveindex withconcentrationforKCl solutionandthereafterdeterminetheunknownconcentration ofgiven KCl solution.

Activity	**AppX Hrs**
LI	2
SW	1
SL	1

Total	4

Session Outcomes (SOs)	**Laboratory Instruction(LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO1 Analyze therefractive index of simple organic liquids (environment friendly). SO2 Analyze Study the variation of refractive index with concentration for KCl solution and the reafter determine the unknown concentration of given KCl solution. SO3 Analyse solubility and solubility product of sparingly soluble salts like PbSO4, BaSO4.	Unit-2 Refractometry 2.1-Determinetherefractive indexofsimpleorganicliquids(environmentfriendly). 2.2 - Studythe variationof refractiveindex withconcentrationforKCl solutionandthe reafterdeterminetheunknownconcentration ofgiven KCl solution.		Uses Of Refractometer

SW-2 Suggested Sessional Work(SW)

a.Assignments:

Separate and idetify binary mixture of two aromatic compounds (with bi functional group)

76CH153.3: **Unit-3**

3.1- Studythevariation of angle ofopticalrotation with theconcentration ofany opticallyactivesubstance(sucroseorglucose)anddeterminetheunknownconcentrationofgivensolution.

3.2- Determine the specific and molecular rotation of sucrose or glucose at numberofconcentrations.

Activity	**AppX Hrs**
LI	2 (2hr.each)
SW	1
SL	1
Total	4

Session Outcomes (SOs)	**Laboratory Instruction(LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO1 Analyze the strength ofstrongacid bypH-metrictitration with strongbase SO2 Analyze the strength ofstrongacid bypH-metrictitration	**Unit-3** Studythevariation of angle ofopticalrotation with theconcentration ofany opticallyactivesubstance(sucros		Uses of polarimeter

with strongbase.	eorglucose)anddeterminetheunknownconcentrationofgivensolution. Determine the specific and molecular rotation of sucrose or glucose at numberofconcentrations.		

SW-3SuggestedSessionalWork(SW):

a.Assignments:

Discuss mechanistic approach of synthesis of dibenzalacetone

76CH253.4: Unit-4- Potentiometry

4.1- DeterminethestandardelectrodepotentialofCuand Zn.

4.2- StudytheprecipitationtitrationbetweenKClandAgNO_3potentiometrically.

Activity	AppX Hrs
LI	2 (2hr each)
SW	1
SL	1
Total	4

Session Outcomes (SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self Learning (SL)
SO1 Synthesize organic compounds via two steps SO2 Synthesize organic compounds by aceto acetic ester condensation	Unit-4- Potentiometry Determine the standard electrodepotentialofCuand Zn. 4.2- Study the precipitation titration between KClandAgNO_3potentiometrically.		Discuss mechanistic approach of sandmayer reaction

SW-4 Suggested Sessional Work(SW)

a.Assignments:

Discuss mechanistic approach of sandmayer reaction

76CH253.5: Unit-5- Distribution Law

Determine distribution coefficientofammoniabetweenchloroformandwater.

Determine the formula of the comple x for med between copper(II)ionand ammonia using distribution method.

Activity	AppX Hrs
LI	2 (2hr each)
SW	1
SL	1
Total	6

Session Outcomes (SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self Learning (SL)
SO1 Determine the viscosity of liquids (environment friendly) using Ostwald viscometer. SO2 Analyse Study the variation of viscosity with concentration for a glycerol	Unit-5- 5.1Determine distribution coefficient of ammonia between chloroform and water. Determine the formula of the complex formed between copper(II)ion and ammonia using distribution method.		Discuss determination the viscosity of given liquids using Ostwald viscometer

SW-4 Suggested Sessional Work (SW):

a.Assignments:

Discuss determination the viscosity of given liquids using Ostwald viscometer

Suggested Web Sources:

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

Mode of transaction :Lab demonstration ,experimentation discussion, assignments, quizzes; **LMS/ ICTTools:** Virtual Labs, DLMS, ZOOM, G-Suite, MSPower-Point, Online Resources

Course Title: Physical Chemistry Lab II **Course Code : 76CH253**

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Knowledge	Research Aptitude	Communication	Problem Solving	Individual and Team Work	Investigation of Problems	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and sustainability	The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry	To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.	understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon-based problems in chemical sciences.	Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science
CO1Determine refractive index,refractivity, and molar Refractivity properties of liquids inanalysis	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
76CH253.2: Determinerateandestimatemolecularmassofpolymer system	2	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
76CH253.3: Solve wet-lab practical difficultiesrelated to kinetics ofinversion,	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
76CH253.4: Analyze distribution properties oftwo liquida	2	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
76CH253.5:Handle electrodepotentialforvariousapplications.	2	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

Legend:1–Low,2–Medium, 3–High

Course Curriculum Map:

POs &PSOsNo.	COsNo.&Titles	SOsNo.	LaboratoryInstruction(LI)	Classroom Instruction(CI)	Self Learning(SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	76CH253.1:Determine refractive index,refractivity, and molar Refractivity properties of liquids inanalysis. .	SO1,SO2	**Unit-1** 1.1- Determination of Composition of a Complex by Jobs method 1.2-Colorimetric determination of Iron in potable water.	Applications of Colorimeter	Purification of organic comp[ounds by crystallization Prepartaion of Required reagent for qualitative organc analysis
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	76CH253.2: Determinerate and estimate molecular mass of polymer system.	SO1,SO2	**Unit -2** Determine the refractive index of simple organic liquids (environment friendly). 2.2 - Studythe variationof refractiveindex with concentration forKCl solution and the determine the unknown concentration of given KCl solution.	Uses Of Refractometer	Purification of organic compounds(with bi functional group) by crystallization Prepartaion of Required reagent for qualitative organc analysis
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	76CH253.3: Solve wet-lab practical difficultiesrelated to kinetics ofinversion,	SO1,SO2	**Unit -3** the variation of angle of optical rotation with the concentration of any optically active substance (sucrose or glucose) and determine the unknown concentration of given solution.- Determine the specific and molecular rotation of sucrose or glucose at number of concentrations.	Uses of polarimeter	Purification of synthesized compounds via methods other than crystalization
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	76CH253.4: Analyze distribution properties of two liquids.	SO1,SO2	Unit -4 4.1 Determine the standard electro depotential of Cu and Zn. 4.2Study the precipitation titration between KCl and AgNO3 potentiometrically.	Discuss mechanistic approach of sandmayer reaction	Purification by distillation under reduced pressure
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	76CH253.5:Handle electrode potential for various applications	SO1,SO2	**Unit -5** Determine distribution coefficient of ammonia between chloroform and water. ermine the formula of the complex for med between copper(II)ion and ammonia using Distribution method	Discuss determination the viscosity of given liquidsusingOstwaldviscometer	Physical parameters of oil and fat analysis

M.Sc. Chemistry Semester III

CODE: 76CH-301

Course Name: Application Of Spectroscopy

L	T	P
3	1	0

Pre-requisite: Students should have basic knowledge of principles of uv-visible, IR, NMR spectroscopy.

Rationale: Upon completion of the course student shall be able to analyzing the pattern, intensity, and position of peaks of samples like medicine for elucidating molecular structures, determining purity, studying molecular dynamics, and investigating metabolic processes.

CourseOutcomes:

After the completion of this course, the learner will –

- 76CH-301: CO1 Applythe basic principle of UV- Visible Spectroscopy for qualitative analysis
- 76CH-301:CO2 Explain and apply the basic principle of I.R. Spectroscopy for the qualitative analysis specially forstructure elucidation
- 76CH-301 CO3 Explain and apply thebasic principles ofNMR spectroscopy (H1NMR,C13NMR)for the structure determination of organic compounds.
- 76CH-301: CO4 Explain the basic principle of Mossbauer spectroscopy for Qualiatative analysis
- 76CH-301 CO5 Applyspectral data obatiend from UV-Visible, I.R.,NMR, Mossbauer spectroscopy and Mass spectrometry for solving /determining the structure of organic compounds (compositeproblems)

Unit – 1 **Ultraviolet and Visible spectroscopy**

Principal and selection rule,types of transition,Effect of solvent polarity on electronic transitions, ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes, Fieser Woodward rules for conjugated dienes and carbonyl compounds, ultraviolet spectra of aromatic compounds. Steric effect in biphenyls.

Unit – 2 **Vibrational Spectroscopy**

Instrumentaition,and sampling technique,principle,selection rule,factors affecting Vibrational frequencies Characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams and conjugated carbonyl compounds). Effect of hydrogen bonding and solvent effect on vibrational frequencies, overtones, combination bands and fermi resonance.

Unit – 3 **Nuclear Magnetic Resonance Spectroscopy**

General introduction principle and definition, chemical shift, spin-spin interaction, shielding mechanism, , chemical shift values and correlation for protons bonded to carbon (aliphatic, olefinic, aldehydic and aromatic) and other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides & mercapto), chemical exchange, effect of deuteration, Stereochemistry, hindered rotation, Karplus curve-variation of coupling constant with disordered angle. NMR shift reagents, solvent effects. nuclear overhauser effect (NOE).XCarbon-13 NMR Spectroscopy General considerations, chemical shift (aliphatic olefinic , alkyne, aromatic, heteroaromatic and carboynl carbon), coupling constants..

Unit – 4 **Mössbauer Spectroscopy**

Basic principles,instrumentation. Application of the technique to the studies of bonding and structures of Fe^{+2} and Fe^{+3} compounds including those of intermediate spin, nature of M-L bond, coordination number, structure and detection of oxidation state.

Unit – 5 **Mass Spectrometry**

Introduction basic principle,instrumentation, ion production E1, C1 FD, ESI and FAB, factors affecting fragmentation, ion analysis, ion abundance Mass spectral fragmentation of organic compounds, common functional groups, molecular ion peak, metastable peak. Me Lafferty rearrangement. Nitrogen rule. High resolution mass spectrometry. Structure elucidation of simple molecules using UV – Visible, IR, NMR and mass spectral techniques.

Scheme of Studies:

Board ofStudy	CourseCode	CourseTitle	Scheme ofstudies(Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
ProgramCore(PCC)	76CH-25	APPLICATION OF SPECTROSCOPY	4	0	1	1	6	4

]

Legend: **CI:** Class room Instruction (Includes different instructional strategie si.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,miniprojectetc.),

SL: SelfLearning,**C:** Credits.

Note: SW& SL has to be planned and performed under the continuou sguidance and feedback of teacher to ensure outcome ofLearning.

Scheme of Assessment: Theory

Board ofStudy	Couse Code	CourseTitle	SchemeofAssessment(Marks)						
			ProgressiveAssessment(PRA)					EndSemesterAssessment (ESA)	Total Marks (PRA+ESA)
			Class/HomeAssignment5number 3 markse(CA)	Class Test2 (2bestout of3)10 markseach(CT)	Seminarone (SA)	ClassAttendance (AT)	TotalMarks (CA+CT+SA+AT)		
PCC	76CH-25	**APPLICATION OF SPECTROSCOPY**	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.

76CH-251: CO1:- Applythebasicprincipleofof UV- Visible Spectroscopy for qualitative analysis

Approximate Hours

Activity	Apex Hrs
CI	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self Learning (SL)
SO1.1 Explain Principal and selection rule, types of transition SO1.2 Describe Effect of solvent polarity on electronic transitions SO1.3 Explain and apply the ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds. SO1.4 Discuss the Fieser Woodward rules for conjugated dienes and carbonyl compounds SO1.5 Explain and apply ultraviolet spectra of aromatic compounds. Steric effect in biphenyls		**Ultraviolet and Visible spectroscopy** 1Principal and selection rule, 2.types of transition, 3.Effect of solvent polarity on electronic transitions, 4. Ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds 5.Dienes, conjugated polyenes, 6. Fieser Woodward rules for conjugated dienes 7. Fieser Woodward rules for carbonyl compounds, 8. Ultraviolet spectra of aromatic compounds. 9. Steric effect in biphenyls T1. Simple application of Uv visible spectroscopy T2 Application of woodward fieser rule on carbonayl compounds T3 Application of woodward fieser rule on conjugated dienes	Ultraviolet bands for various dienes, conjugated polyenes

SW-1Suggested Sessional Work(SW):

a. Assignments:

Discuss the various types of solvents used in UV visible spectroscopy.

b. Mini Project:
Joblanski diagaram
c. Other Activities (Specify):
Identification of Unknown compounds by UV visible spectroscopy

76CH251-CO2: Explain and apply thebasicprinciple of I.R. Spectroscopyforthe qualitative analysis especially forstructure elucidation

.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 Explain types of vibrational modes and apply instrumentation and sampling techniques. **SO2.2** Describe the fundamental principle and factors affecting Vibrational frequencies Characteristic vibrational frequencies. **SO2.3** Explain and apply vibrational frequencies of aromatic compounds, alcohols, ethers, phenols and amines. **SO2.4** Discuss the vibrational frequencies of carbonyl compounds, lactones, lactams and conjugated carbonyl compounds. **SO2.5** Discuss effect of hydrogen bonding and solvent effect on vibrational frequencies		**Unit – 2 Vibrational Spectroscopy** 2.1Instrumentation 2.2 Sampling technique, principle, selection rule. 2.3 Factors affecting Vibrational frequencies Characteristic vibrational frequencies of alkanes, alkenes, alkynes, 2.4 Aromatic compounds, alcohols, ethers, phenols and amines. 2.5 Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams and conjugated carbonyl compounds). 2.6.Effect of hydrogen bonding on vibrational frequencies 2.7 Effect of bond angle on vibrational frequencies and overtones, 2.8Combination bands and fermi resonance. 2.9 Vibrational frequencies of anhydrides and lactones T1 Application of Vibrational	Number of fundamental bands for linear and non linear molecules.

		Spectroscopy T2. Structure elucidation by IR Spectroscopy T3. Application of IR Spectroscopy for Quantitative analysis	

SW-2 Suggested Sessional Work (SW):

A .Assignments:

Discussion of effect of hydrogen bonding and solvent effect on vibrational frequencies.

b. Mini Project:

Problem-solving exercises involving spectral interpretation, solving practical spectroscopic problems, and identifying unknown compounds from spectra.

c. Other Activities (Specify):

Write an Instrumentation, and sampling technique, principle, selection rule.

76CH251CO3:Explain and apply thebasicprinciples ofNMRspectroscopy (H1NMR,C13NMR)forthe structure determination of organic compounds

.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Explain principle of NMR, chemical shift, spin-spin interaction, chemical shift values. **SO3.2** Apply correlation for protons bonded to carbon (aliphatic, olefinic, aldehydic and aromatic) **SO3.3** Explain and apply Stereochemistry, hindered rotation, Karplus curve-variation of coupling constant with disordered angle **SO3.4** Explain and apply nmr spectral data of for qualitative analysis **SO3.5** Determine structure of organic compounds on the basis of Carbon-13 NMR Spectroscopy		**Unit – 3Nuclear Magnetic Resonance Spectroscopy** 3.1. General introduction principle and definition] 3.2. Chemical shift, spin-spin interaction, shielding mechanism, , chemical shift values 3.3Correlation for protons bonded to carbon (aliphatic, olefinic, aldehydic and aromatic) and other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides & mercapto), 3.4. Chemical exchange 3.5. Effect of deuteration,	Karplus curve-variation of coupling constant with disordered angle

		Stereochemistry 3.6. Hindered rotation, Karplus curve-variation of coupling constant with disordered angle. 3.7NMR shift reagents, solvent effects. nuclear overhauser effect (NOE). 3.8 Carbon-13 NMR Spectroscopy General considerations 3.9 chemical shift (aliphatic olefinic , alkyne, aromatic, heteroaromatic and carboynl carbon), coupling constants T1Qualitative Application of NMR Spectroscopy T2 Quantitative Application of NMR T3 Structure elucidation by NMR Spectroscopy	

SW-3 Suggested Sessional Work (SW):
a. Assignments:
Nuclear overhauser effect (NOE **)**
b. Mini Project:
Carbon-13 NMR Spectroscopy General considerations, chemical shift.
c. Other Activities (Specify):
Principle and definition, chemical shift, spin-spin interaction, shielding mechanism.
76CH251 CO4:Explain the basic principle of Mossbauer spectroscopy for Qualiatative analysis
.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

SW-4

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Restate Mossbauer effect: "Recoilless nuclear resonance absorption of γ-ray **SO4.2** Discuss the Mossbauer Active Elements, Mössbauer nuclide 57Fe. **SO4.3** Explain and apply Experimental Resonance Conditions,Transition energy **SO4.4**DiscussMean lifetime of excited state and natural line width **SO4.5** Apply Nuclear parameters for selected Mossbauer isotopes		**Unit-4.0 Mossbauer Spectroscopy** 4.1 Introduction and Basic principles. 4.2 Instrumentation. 4.3Recoil less Nuclear Resonance Absorption –Radiation γ 4.4 Recoil Effect substitution on the transition frequencies. 4.5 Structures of Fe^{+2} and Fe^{+3} compounds including those of intermediate spin . 4.6Sharpness of resonance Γ/Eγ in Mossbauer effect with nuclear transition 4.7 Nature of M-L bond, coordination number, 4.8 Structure and detection of oxidation state. 4.9 Isotropic and anisotropic hyperfine coupling constants T1 Application of Mossbauer Spectroscopy T2 Structure determination of co-ordination compounds T3 Study of reaction mechanism	Recoil Effect substitution on the transition frequencies. Factors affecting the 'g' value. Isotropic and anisotropic hyperfine coupling constants

Suggested Sessional Work (SW):
a.Assignments: Different types ofMossbauer nucleotides
b. Mini Project:
Sharpness of resonance Γ/Eγ in Mossbauer effect with nuclear transition
Other Activities (Specify):
Stark effect, nuclear and electron spin interaction and effect of external field.
76CH-25 CO5 Applyspectral data obatiend from UV-Visible, I.R.,NMR, Mossbauer spectroscopy and Mass spectrometryforsolving/determiningthestructureof organic compounds (compositeproblems)

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 Apply introduction basic principle, Instrumentation Mass Spectrometer. SO5.2 Describe ion production E1, C1 FD, ESI and FAB, factors affecting fragmentation. SO5.3 Analyzing ion abundance mass spectral fragmentation of organic compounds. SO5.4 Explain and apply Me Lafferty rearrangement. Nitrogen rule. High resolution mass spectrometry. SO5.5 Explain and apply Structure elucidation of simple molecules using mass spectral techniques.	.	Unit – 5 Mass Spectrometry 5.1 Introduction basic principle 5.2 Instrumentation, 5.3 Ion production E1, C1 FD, ESI and FAB, 5.4 Factors affecting fragmentation, ion analysis, 5.5 Ion abundance mass spectral fragmentation of organic compounds, common functional groups, 5.6 Molecular ion peak, metastable peak .5.7 Me Lafferty rearrangement. Nitrogen rule. 5.8High resolution mass 5.9 factors affecting fragmentation T1 Quantitative and Qualitative Application of Mass Spectrometry T2 Study of mechanism of reaction T3Structure elucidation by Mass spectrometry	Me Lafferty rearrangement. Nitrogen rule. High resolution mass spectrometry.

SW-5 Suggested Sessional Work (SW):

b. **Assignments:**

Structure elucidation of simple molecules using mass spectral techniques.

i. Mini Project:

Ion production E1, C1 FD, ESI and FAB, factors affecting fragmentation, ion analysis

j. Other Activities (Specify):

High resolution mass spectrometry.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
76CH-25:1- Apply the basic principle of all kinds of spectroscopic technique used inorganic chemistry for structural elucidation of organic compounds.	12	02	01	15
76CH-25:2-explain the basic concept behind NMR spectroscopy and its application for the structure elucidation.	12	02	01	15
76CH-25:3 Explain the chemical shift and coupling constant in relation to stereochemical structure of the organic compound, C13-NMR spectroscopic techniques	12	02	01	15
76CH-25:4- Explain and aply the theory, operation, data analysis, and applications of Mossbauer spectroscopy	12	02	01	15
76CH-25:5- apply various spectroscopic techniques discussed above for solving/determining the structure of organic compounds (compositeproblems)	12	02	01	15
Total Hours	60	10	05	75

Suggestion for End Semester Assessment

Suggested Specification Table(For ESA)

CO	UnitTitles	MarksDistribution			Total Marks
		R	U	A	

CO-1	Ultraviolet and Visible spectroscopy	03	01	01	05
CO-2	Vibrational Spectroscopy	02	06	02	10
CO-3	Nuclear Magnetic Resonance Spectroscopy	03	07	05	15
CO-4	Mössbauer Spectroscopy	-	10	05	15
CO-5	Mass Spectrometry	03	02	-	05
Total		11	26	13	50

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

The end of semesterassessment for Applicationof Spectroscopy will be held with written examination of 50 marks

Note.Detailed Assessmen trubric 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. RolePlay
6. Visitto NCL, CSIR laboratories
7. Demonstration
8. ICTBasedTeachingLearning(VideoDemonstration/TutorialsCBT,Blog,Facebook,Twitter,Whatsapp,Mobile,Onlinesources)
9. BrainstormingSuggestedLearningResources:

(h) **Books:**

S. No.	Title	Author	Publisher	Edition& Year
1	Modern Spectroscopy	J. M. Hoilas	John Wiley.	Revised editionedition2020
2	Applied Electron Spectroscopy for Chemical Analysis	Ed. H. Windawi and F. L. HO	Wiley Interscience.	New edition, 2021
3	NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry	R. V. Parish	Ellis Harwood.	New edition, 2021

4	Physical Mehtods in Chemistry	R. S. Drago	Saunders College.	Revised edition
5	Chemical Applications of Group Theory	F. A. Cotton.	--	Revised edition
6	Introduction to Molacular Spectroscopy	G. M. Barrow	McGRraw Hill.	Revised edition

SuggestedWebSources:

23. https://nptel.ac.in/course.html
24. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
25. https://swayam.gov.in/explorer?category=Chemistry

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

LMS/ICT Tools: Digital Classrooms, DLMS, ZOOM, G-Suite, MSPower-Point, Online Resource

Course Title: Application of Spectroscopy — CODE: 76CH-301

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Knowl edge	Rese arch Apti tude	Com munic ation	Probl em Solvin g	Indivi dual and Team Work	Inve stiga tion of Prob lems	Moder n Tool usage	Scienc e and Societ y	Life-Long Learni ng	Ethics	Project Manage ment	Environ ment and sustaina bility	The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry	To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutica l etc.	understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon -based problems in chemical sciences.	Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science
CO1.Applythebasicprincipleofallkindsofspectroscopictechniquesusedinorganicchemistryforstructural elucidation oforganiccompounds.	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
Co2. explain the basic concept behind NMR spectroscopy and its application for the structure elucidation.	2	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3. Explain and apply thebasic principles ofNMR spectroscopy (H1NMR,C13NMR)for the structure determination of organic compounds	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO4.– Explain and aply the theory, operation, data analysis, and applications of Mossbauer spectroscopy	2	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
Co5. apply various spectroscopic techniques discussed above for solving/determining thestructure of organic compounds (compositeproblems)	2	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

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

Course Curriculum Map:

POs &PSOsNo.	Cos No. & Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO1.Applythebasicprincipleofallkindsofspectroscopictechniquesused inorganicchemistryforstructural elucidation oforganiccompounds.	SO1.1SO 1.2SO1. 3SO1.4 SO1.5		Unit1 1.1-1.9,T1, T2,T3	Ultraviolet bands for various dienes, conjugated polyenes
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	Co2. explain the basic concept behind NMR spectroscopy and its application for the structure elucidation.	SO2.1SO 2.2SO2. 3 SO2.4 SO2.5		Unit2 2.1-2.9,T1, T2,T3	Number of fundamental bands for linear and non linear molecules
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3. Explain and apply thebasic principles ofNMR spectroscopy (H1NMR,C13NMR)for the structure determination of organic compounds	SO3.1SO 3.2 SO3.3 SO3.4 SO3.5		Unit3 3.1-3.9,T1, T2,T3	Karplus curve-variation of coupling constant with disordered angle
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	**CO4.**– Explain and aply the theory, operation, data analysis, and applications of Mossbauer spectroscopy	SO4.1SO 4.2SO4. 3SO4.4 SO4.5		Unit4 4.1-4.9,T1, T2,T3	Recoil Effect substitution on the transition frequencies.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	**Co5.** apply various spectroscopic techniques discussed above for solving/determining thestructure of organic compounds (compositeproblems)	SO5.1SO 5.2SO5. 3SO5.4 SO5.5		Unit 5 5.1-5.9,T1, T2,T3	Me Lafferty rearrangement. Nitrogen rule. High resolution mass spectrometry.

M.Sc. CHEMISTRY SEMESTER III

CODE: 76CH-302

COURSE NAME: PHOTOCHEMISTRY AND SOLID STATE

L	T	P
3	1	0

COURSE OUTCOMES:

Afterthe completionofthiscourse, thelearner willbeableto:

CO1: Understand theoretical aspect of photochemistry .

CO2: Apply the principle of photochemistyry in photochemical process

CO3: Understand the principle of solid state reaction .

CO4: solvetheproblem related solid state and photochemistry

CO5: Apply the knoledge of solid state for preparing semiconcductor.

PHOTOCHEMISTRY & SOLID STATE CHEMISTRY

Unit - 1

Photochemical Reactions Interaction of electromagnetic radiation with matter, types ofexcitations, fate of excited molecule, quantum yield, transfer of excitation energy, actinometry.

Determination of Reaction Mechanism Classification, rate constants and life times ofreactive energy state determination of rate constants of reactions. Effect of light intensity on the rate of photochemical reactions. Types of photochemical reactions-photo dissociation, gas-phase photolysis. Photo chemical formation of smog, photochemistry of vision

Unit - 2

Photochemistry of Alkene Intramolecular reactions of the olefinic bond-geometricalisomerism, cyclisation reactions, rearrangement of 1,4- and 1,5-dienes. **Photochemistry of Aromatic Compounds** Isomerisations, additions and substitutions.

Photochemistry of Carbonyl Compounds Intramolecular reactions of carbonylcompounds-saturated, cyclic and acyclic, b,g unsaturated and a, b unsaturated compounds, Intermolecular cyloaddition reactions-dimerisations and oxetane formation. Singlet molecular Oxygen reaction.

Unit - 3

Solid State Reactions General principles, experimental procedure, co-precipitation as aprecursory to solid state reactions, kinetics of solid state reactions.

Crystal Defects and Non-Stoichiometry Perfect and imperfect crystals, intrinsic andextrinsic defects-point defects, line and plane defects, vacancies-Schottky detects and Frenkel defects. Thermodynamics of Schottky and Frenkel defect formation, colour centres, non-stoichiometry and defects.

Unit - 4

Electronic Properties and Band Theory Metal,s insulators and semiconductors, electronicstructure of solidsband theory band structure of metals, insulators and semiconductors, Intrinsic and extrinsic semiconductors, doping semiconductors, p-n junctions, super conductors.

Unit – 5 Organic Solids

Electrically conducting solids. organic charge transfer complex, organic metals, new superconductors. Liquid Crystals: Types of liquid crystals: Nematic, Smectic, Ferroelectric, Antiferroelectric, Various theories of LC, Liquid crystal display, Newmaterials.

Board of Study	CourseCode	CourseTitle	Scheme ofstudies(Hours/Week)					Total Credits(C)
			CI	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
ProgramCore(PCC)	76CH407	**Photochemistry & Solid State Chemistry**	4	0	1	1	5	4

Legend: **CI:**Class room Instruction (Includes different in structional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop ,field or other locations using different in structional strategies)
SW: Sessional Work(includesassignment,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 ofLearning.

Scheme of Assessment: Theory

Board of Study	Course Code	Course Title	SchemeofAssessment(Marks)						
			ProgressiveAssessment(PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ESA)
			Class/Home Assignment number 3 marks each (CA)	Class Test2 (2best out of 3) 10 marks each(CT)	Seminarone (SA)	ClassAttendance (AT)	TotalMarks (CA+CT+SA +AT)		
PCC	76CH407	**PHOTOCHEMISTRY & SOLID STATE CHEMISTRY**	15	20	10	5	50	50	100

Course-Curriculum Detailing:

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

76CH102.1: Apply the concept of Explain the Basic concepts of **Photochemical Reactions**

Activity	**AppX Hrs**
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO1.1 Explain the Interaction of electromagnetic radiation with matter SO1.2 Expain the types excitation, fate of excited molecule, quantum yield, transfer of excitation energy, actinometry. SO1.3 Explain the Classification, rate constants and life times ofreactive energy state determination of rate constants of reactions. SO1.4 Explain the Effect of light intensity on the rate of photochemical reactions. SO1.5 Explain the Types of photochemical reactions-photo dissociation, gas-phase photolysis. Photo chemical formation of smog, photochemistry o f vision.		Unit – 1 Photochemical Reactions . 1.1 Interaction of electromagnetic radiation with matter, 1.2 types excitation, fate of excited molecule, 1.3Quantum yield, transfer of excitation energy, actinometry. **1.4Determination of Reaction Mechanism** Classification, rate constants and life times ofreactive energy state. 1.5 determination of rate constants of reactions. 1.6 Effect of light intensity on the rate of photochemical reactions. 1.7Types of photochemical reactions 1.8photo dissociation, gas-phase photolysis. 1.9 Photo chemical formation of smog, photochemistry of vision. T-1 rate of photochemical	Discuss the Types of excitations, fate of excited molecule.

		reactions T-2 rate constants and life times T-3 light intensity on the rate of photochemical reactions. .	

SW-1SuggestedSessionalWork(SW):

a.Assignments: Effect of light intensity on the rate of photochemical reactions.
b.Mini Project: rate constants and life times.
c.Other Activities (Specify):
Note on applications of Photo chemical reactions.
76CH102.2: Explain reactions of the olefinic bond-geometricalisomerism, cyclisation reactions, rearrangement of 1,4- and 1,5-dienes.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 Explain the Intramolecular reactions of the olefinic. bond- **SO2.**2Explain thegeometrical isomerism, cyclisation reactions, rearrangement of 1,4- and 1,5-dienes. Photochemistry of Aromatic Compounds **SO2.3** Explain the Isomerisations, additions and substitutions. **SO2.**3 Apply the concept of Photochemistry of Carbonyl CompoundsIntramolecular reactions of carbonyl compounds-saturated, **SO2.4** Explain the cyclic and acyclic, b,g unsaturated and a, b unsaturated compounds,.		**2.0 Determination of Reaction Mechanism.** 2.1 Classification, rate constants and life times of reactive. 2.2 energy state determination of rate constants of reactions. 2.3 Effect of light intensity on the rate of photochemical reactions. 2.4 Effect of light intensity on the rate of photochemical reactions. 2.5 chemical formation of smog, photochemistry of vision. 2.6 Intramolecular reactions of carbonylcompounds-saturated, cyclic and acyclic, b,g unsaturated 2.7 unsaturated compounds, Intermolecular cyloaddition reactions-dimerisations 2.8 oxetane formation. Singlet molecular Oxygen reaction. 2.9 reactions, rearrangement of 1,4- and 1,5-dienes. Photochemistry of Aromatic Compounds T-1 Explain the cyclisation reactions	Explain chemical formation of smog, photochemistry of vision.

SO2.5 Explain theIntermolecular cyloaddition reactions-dimerisations and oxetane formation. Singlet molecular Oxygen reaction.		T-2 Explain the cyclic and acyclic T-3 Explain the additions and substitutions.	

SW-2 Suggested Sessional Work (SW):

a. **Assignments:**
   Classification, rate constants and life times of reactive.
b. **Mini Project:**
Effect of light intensity on the rate of photochemical reactions.
c. **Other Activities (Specify):**
Write an eassy on explain chemical formation of smog, photochemistry of vision

76CH102.3: Describe the analysis solid state reactions, crystal defects and non-stoichiometry.

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Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Explain the General principles **SO3.2** Apply the experimental procedure, co-precipitation as aprecursory . **SO3.3** Explain the solid state reactions, kinetics of solid state reactions. **SO3.4** Explain the Perfect and imperfect crystals, intrinsic andextrinsic defects-point defects, line. **SO3.5** Explain the plane		Unit -3 3.1Solid State Reaction General principles. 3.2 experimental procedure. 3.3 kinetics of solid state reactions.Crystal Defects and Non-Stoichiometry 3.4 Perfect and imperfect crystals,intrinsic defects-point defects ,3.5 line and plane defects, vacancies-Schottky detects and Frenkel defects.	Explain line and plane defects, vacancies-Schottky detects and Frenkel defects.

defects, vacancies-Schottky detects and Frenkel defects. Thermodynamics of Schottky and Frenkel defect formation, colour centres, non-stoichiometry and defects.		3.6 Thermodynamics of Schottky and Frenkel defect 3.7 co-precipitation as aprecursory to solid state reactions. 3.8, line and plane defects 3.9 detects the Frenkel defects. T-1 Thermodynamics of Schottky T-2 Frenkel defect formation, colour centres, non-stoichiometry and defects. T-3 Perfect and imperfect crystals.	

SW-3 Suggested Sessional Work (SW):

a. Assignments:

analysis kinetics of solid state reactions.Crystal Defects and Non-Stoichiometry

b. Mini Project:

Explains kinetics of solid state reactions

c. Other Activities (Specify):

Explain and apply Thermodynamics of Schottky and Frenkel defect formation, colour centres, non-stoichiometry and defects.

76CH102.4: Explain Electronic Properties and Band Theory**.**

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Explain the Metal,s insulators and semiconductors, **SO4.2** Explain the electronic structure of solidsband theory band **SO4.3Explain the** structure of metals. **SO4.4** Explain the insulators and semiconductors, Intrinsic and extrinsic semiconductors, **SO4.5** Explain the doping semiconductors, p-n junctions, super conductors.		**Unit - 4** **4.1Electronic Properties and Band Theory** 4.2Metal,s insulators and semiconductors, 4.3electronicstructure of solids band 4.4theory band structure of metals, 4.5insulators and semiconductors, 4.6Intrinsic and extrinsic semiconductors, 4.7 doping semiconductors, 4.8 p-n junctions, 4.9super conductors. T-1 insulators and semiconductors T-2 semiconductors T-3 band theory band .	. Explain the electronic Structure of solids band theory band.

SW-4 Suggested Sessional Work (SW):

a. Assignments:

Explain and apply the Electronic Properties and Band Theory.

b. Mini Project:

thesilicone's polymetalloxanes and polymetallosiloxanes, silazanes.

c. Other Activities (Specify):

Explain and apply the silicone's polymetalloxanes and polymetallosiloxanes, silazanes.

76CH102.5: Apply the knowledge of the Structure, Properties and Application of Polymers based on Phosphorous-Phosphazenes, Polyphosphates.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 Explain the Electrically conducting solids. **SO5.2** Explain the organic charge transfer complex. **SO5.3** Explain the organic metals, new superconductors. **SO5.4** Explain the Liquid Crystals : Types of liquid crystals: **SO5.5** Explain the Nematic, Smectic, Ferroelectric, Antiferroelectric, Various theories of LC, Liquid crystal display, New materials.	.	**Unit – 5 Organic Solids** 5.1Electrically conducting solids. 5.2 organic charge transfer complex, 5.3 organic metals, 5.4 new superconductors. Liquid Crystals: 5.5 Types of liquid crystals: 5.6 Nematic, Smectic, 5.7Ferroelectric,Antiferroelectric, 5.8Various theories of LC, 5.9 Liquid crystal display, Newmaterials. T-1 Define the Ferroelectric, Anti ferroelectric,. T-2 Various theories of LC. T-3 Explain the New materials	Explain the Liquid Crystals : Types of liquid crystals:

SW-5 Suggested Sessional Work (SW):

a. **Assignments:**

Explain the organic metals, new superconductors.

b. **Mini Project:** Describe the Liquid Crystals : Types of liquid crystals:

c. **Other Activities (Specify):**

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
76CH102.1: Explain the Basic concepts of photochemical Reactions.	12	02	01	15
76CH102.2: Explain determination of reaction mechanism, photochemistry of alkene, aromatic compounds, carbonyl compounds.	12	02	01	15
76CH102.3: Describe the analysis solid state reactions, crystal defects and non-stoichiometry	12	02	01	15
76CH102.4:Explain the electronic properties and band theory.	12	02	01	15

76CH102.5: Explain andApply the Electrically conducting solids. organic charge transfer complex, organic metals, new superconductors knowledge of organic solids. .	12	02	01	15
Total Hours	60	10	05	75

Suggestion for End Semester Assessment

Suggested Specification Table(ForESA)

CO	UnitTitles	MarksDistribution			TotalM arks
		R	U	A	
CO-1	Explain the Basic concepts of photochemical Reactions.	03	01	01	05
CO-2	Explain determination of reaction mechanism, photochemistry of alkene, aromatic compounds, carbonyl compounds.	02	06	02	10
CO-3	Describe the analysis solid state reactions, crystal defects and non-stoichiometry	03	07	05	15
CO-4	Explain the electronic properties and band theory.	-	10	05	15
CO-5	Explain andApply the Electrically conducting solids. organic charge transfer complex, organic metals, new superconductors knowledge of organic solids.	03	02	-	05
Total		11	26	13	50

Legend: R:Remember, E: Explain A:Apply

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

Note.Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks.Teachers can also design different tasks as per r equirement ,for end semester rassessment. Suggested Instructional /Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. RolePlay
6. Visitto NCL, CSIR laboratories
7. Demonstration
8. ICTBased TeachingLearning (Video Demonstration /TutorialsCBT,Blog,Facebook,Twitter,Whatsapp,Mobile, Onlinesources)
9. Brainstorming

Suggested Learning Resources:

(a) **Books:**

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

ModeofDelivery: Lecture, demonstration,E-tutoring, discussion, assignments, quizzes, case study, power point;

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

Course Title: Photochemistry & solid state chemistry

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Knowledge	Research Aptitude	Communication	Problem Solving	Individual and Team Work	Investigation of Problems	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and sustainability	The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry	To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.	understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon-based problems in chemical sciences.	Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science
CO1: Explain the Basic concepts of photochemical Reactions.	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO2: Explain determination of reaction mechanism, photochemistry of alkene, aromatic compounds, carbonyl compounds.	2	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3 : Describe the analysis solid state reactions, crystal defects and non-stoichiometry.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO 4: Explain the electronic properties and band theory.	2	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
CO5: Explain andApply the Electrically conducting solids. organic charge transfer complex, organic metals, new superconductors knowledge of organic solids.	2	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

Course Curriculum Map:

POs &PSOsNo.	COsNo.&Titles	SOsNo.	LaboratoryInstruction(LI)	Classroom Instruction(CI)	Self Learning(SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1 Explain the Basic concepts of photochemical Reactions.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8 SO1.9		Unit-1.0 Photochemical Reaction 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9	Discuss the Types of excitations, fate of excited molecule.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 2 : Explain determination of reaction mechanism, photochemistry of alkene, aromatic compounds, carbonyl compounds.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2. 9		Unit-2 Photochemistry of Alkene and Aromatic compounds .1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9	Explain chemical formation of smog, photochemistry of vision.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3 Describe the analysis solid state reactions, crystal defects and non-stoichiometry	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9		Unit-3 :Solid State Reactions 3.1, 3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO4: Explain the electronic properties and band theory.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4. 7 SO4. 8 SO4.9		Unit-4 : Electronic Properties and Band Theory 4.1, 4.2,4.3,4.4,4.5,4.6,4.7 ,4.8,4.9	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 5: Explain andApply the Electrically conducting solids. organic charge transfer complex, organic metals, new superconductors knowledge of organic solids..	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6 SO5.7 SO5.8 SO5.9		Unit 5: Organic Solids 5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,5.9	Explain the Liquid Crystals : Types of liquid crystals:

AKSUniversity

***FacultyofBasic Science,* DepartmentofChemistry**

CurriculumofM. Sc. In Chemistry Program (Revisedason01August2023)

M.Sc. Chemistry Semester III

Code: 76CH-303

Course Name: Analytical Chemistry

No. Of Credits: 4

L	T	P
3	1	0

Pre-requisite: Student should have basic knowledge of Role of analytical chemistry, Errors and Evalution, Origin of water pollutants and their effects, Fuel analysis.

Rationale: The Course will provide applicable knowledge about General survey of instrumental techniques for the analysis of heavy metals in aqueous systems. drug analysis

COURSE OUTCOMES:

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

CO1 Explain and apply theoretical aspect of analytical chemistry.
CO2: Analyse water, soil and biological fluid sample
CO3: Explain and identify the errors occurred during chemical analysis
CO4: Handle glass ware and reagent in scientific way
CO5: Expertise in laboratory saftey

Unit I

Introduction - Role of analytical chemistry. Classification of analytical methods –classsical and instrumental. Types of instrumental analysis. Selecting an analytical method.Neatness and cleanliness.Laboratory operations and practices.Analytical balance.Techniques of weighing,errors. Volumetric glassware cleaning and calibration of glassware.Sample preparations-dissolution and decomposition.Gravimetric techniques.Selecting and handling of reagents.Laboratory notebooks.Safety in the analytical laboratory.

UNIT II

Errors and Evalution-Definition of terms in mean and median.Precision-standard deviation,relatives standard deviation.Accuracy-absolute error.Types of error in experimental data-determinate(systmatic), indeterminate(or random)and gross.

UNITIII

Analysis of water pollutionp- Origin of water pollutants and their effects. Sources of water pollution domestic, industrial, agricultural soil and radioactive wastes as sources of pollution objectives of analysis-parameter for analysis-colour,turbidity,total solids,conductvity,acidity,alkalinity,hardness,chloride,sulphate,fluoride,silica,phosphates and different forms of nitrogen.Heavy metal pollution-public health significance of cadmium,chromium,copper,lead,zinc,manganese,mercury and arsenic. General survey of instrumental techniques for the analysis of heavy metals in aqueous systems. Measurements of DO,BOD&COD. Pesticides as water pollutants and analysis. Water pollution laws and standards.

UNIT IV

Analysis of Soil, Fuel, Body Fluids and Drugs- (a) Analysis of soil: moisture,pH, total nitrogen , phosphorus, silica, lime, magnesia, manganese, sulphur and alkali salts.

(b) Fuel analysis: solid, liquid and gas.Ultimate and proximate analysis-heating values- grading coal. Liquid fuels-flash point, aniline point, octane number and carbon residue. Gaseous fuels-producer gas and water gas –calorific values

UNIT V

Analysis of Soil, Fuel, Body Fluids and Drugs

(a) Clinical chemistry: Composition of blood collection and preservation of samples. Clinical analysis .Serum electrolytes , blood glucose , blood urea nitrogen, uric acid, albumin,globulins, barbiturates, acid and alkaline phosphateses. Immunoassay principles of ratio immunoassay (RIA) and applications.The blood gas analysis trace elements in the body.

(b) Drug analysis: Narcotics and dangerous grug.Classification of drugs.Screening by gas and thin-layar chromatography and spectrophotometric measurement.

Scheme of Studies:

Board ofStudy	CourseCode	CourseTitle	Scheme ofstudies(Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
ProgramCore(PCC)	76CH-303	Analytical Chemistry	4	0	1	1	5	4

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

Note: SW& SL has to be planned and performed under the continuous guidance and feed back of teacher to ensure outcome ofLearning.

SchemeofAssessment: Theory

Board ofStudy	Couse Code	Course Title	SchemeofAssessment(Marks)						
			ProgressiveAssessment(PRA)					EndSemesterAssessment	Total Marks
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test2 (2bestout of3) 10 marks each(CT)	Seminarone (SA)	ClassAttendance (AT)	TotalMarks (CA+CT+SA+AT)	(ESA)	(PRA+ESA)
PCC	76CH103	Analytical Chemistry	15	20	10	5	50	50	100

Course-Curriculum Detailing:

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

76CH303.1: Explain and apply theoretical aspect of analytical chemistry

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO1.1 Explain Role of analytical chemistry. Classification of analytical methods –classsical and instrumental		Unit-1.0 Role of analytical chemistry. 1.1Classification of analytical methods –classsical and instrumental	Techniques of weighing, errors.

SO1.2 Explain Types of instrumental analysis. Selecting an analytical method.Neatness and cleanliness.Laboratory operations and practices.Analytical balance. SO1.3 Explain Techniques of weighing,errors. Volumetric glassware cleaning and calibration of glassware. SO1.4 Explain Sample preparations-dissolution and decomposition.Gravimetric techniques. SO1.5 Understand and explain Selecting and handling of reagents.Laboratory notebooks.Safety in the analytical laboratory.		1.2 Explain Types of instrumental analysis. 1.3 Selecting an analytical method. 1.4 Neatness and cleanliness. 1.5 Laboratory operations and practices. 1.6 Analytical balance. 1.7 Techniques of weighing,errors. 1.8 Volumetric glassware cleaning and calibration of glassware. 1.9 Sample preparations-dissolution and decomposition.Gravimetric techniques. T1-Selecting and handling of reagents. T2-Laboratory notebooks. T3-Safety in the analytical laboratory.	

SW-1SuggestedSessionalWork(SW):

a.Assignments:

Discuss Techniques of weighing,errors. Volumetric glassware cleaning and calibration of glassware.

b.Mini Project:

Sample preparations-dissolution and decomposition.Gravimetric techniques.

c.Other Activities (Specify):

Note on applications of selecting and handling of reagents.laboratory notebooks.safety in the analytical laboratory.

76CH303.2: Analyse water, soil and biological fluid sample.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1

Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 Understand Errors and Evalution-Definition of terms in mean and median.Precision-standard deviation. **SO2.2** Explain relatives standard deviation. **SO2.3**Explain Accuracy-absolute error. **SO2.4** Explain types of error in experimental data determinate(systmatic). **SO2.5** Understand and apply indeterminate(or random)and gross.		**Unit-2.0 Errors and Evalution**- 2.1Introduction of errors and evalution. 2.2 Introduction of terms in mean and median.Precision. 2.3 Properties of the terms in mean and median.Precision. 2.4Definition of terms in mean and median.Precision-standard deviation. 2.5 Introduction of relatives standard deviation. 2.6 Properties of the relatives standard deviation. 2.7 Importance of relatives standard deviation. 2.8 Introduction of accuracy-absolute error. 2.9 Mechanism of the accuracy-absolute error. T1- Types of error in experimental data determinate(systmatic). T2- Indeterminate(or random)and gross. T3-Importance of Indeterminate(or random)and gross.	Properties and types of error in experimental data determinate.

SW-2 Suggested Sessional Work (SW):

a.Assignments:

Apply Errors and Evalution-Definition of terms in mean and median.Precision-standard deviation,

b.Mini Project:

Types of error in experimental data-determinate(systmatic)

c.Other Activities (Specify):

Write an eassy on relatives standard deviation.Accuracy-absolute error.

76CH303.3: Explain and identify the errors occurred during chemical analysis

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Understand and apply Origin of water pollutants and their effects. Sources of water pollution domestic, industrial, agricultural soil and radioactive wastes as sources of pollution. **SO3.2** Explain objectives of analysis- parameter for analysis- colour,turbidity,total solids,conductvity,acidity,alkalinity, hardness,chloride,sulphate,fluoride, silica,phosphates and different forms of nitrogen. **SO3.3** Explain Heavy metal pollution-public health significance of cadmium, chromium, copper, lead,zinc,manganese,mercury and arsenic. **SO3.4** Explain General survey of instrumental techniques for the analysis of heavy metals in aqueous systems. Measurements of DO,BOD&COD. **SO3.5** Explain Pesticides as water pollutants and analysis. Water		Unit-3. **Analysis of water pollution** 3.1 Origin of water pollutants and their effects. 3.2Sources of water pollution domestic, industrial, agricultural. 3.3 soil and radioactive wastes as sources of pollution. 3.4 objectives of analysis- parameter for analysis- colour,turbidity,total solids. 3.5 objectives of analysis- conductvity,acidity. 3.6 objectives of analysis- alkalinity,hardness,chloride,sulphate. 3.7 objectives of analysis- fluoride,silica,phosphates and different forms of nitrogen. 3.8 Introduction and properties of heavy mketals. 3.9 Heavy metal pollution-public health significance of cadmium, chromium, copper, lead,zinc,manganese,mercury and arsenic. T1-General survey of instrumental techniques for the	. General survey of instrumental techniques for the analysis of heavy metals in aqueous systems.

pollution laws and standards.		analysis of heavy metals in aqueous systems. T2-Measurements of DO,BOD&COD. T3-Pesticides as water pollutants and analysis. Water pollution laws and standards.	

SW-3 Suggested Sessional Work (SW):

a.Assignments:

Origin of water pollutants and their effects. Sources of water pollution domestic, industrial, agricultural soil and radioactive wastes as sources of pollution.

b.Mini Project:

Explain Heavy metal pollution-public health significance of cadmium, chromium, copper, lead,zinc,manganese,mercury and arsenic.

c.Other Activities (Specify):

Explain Pesticides as water pollutants and analysis. Water pollution laws and standards.

76CH303.4: Handle glass ware and reagent in scientific way.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Explain and apply The Analysis of soil: moisture,pH, total nitrogen , phosphorus, silica, lime, magnesia, manganese, sulphur and alkali salts. **SO4.2** Explainanalysis of Fuel analysis: solid, liquid and gas. **SO4.3** Explain the Ultimate		Unit-4.0 Drug design, Pharmacokinetics & Pharmacodynamics 4.1 The Analysis of soil: moisture,pH, total nitrogen. 4.2 The Analysis of soil: phosphorus, silica, lime, magnesia. 4.3 The Analysis of soil: manganese, sulphur and alkali salts. 4.4Introduction of Fuel analysis.	The Analysis of soil: moisture,pH, total nitrogen , phosphorus.

and proximate analysis- heating values- grading coal. SO4.4Explain and apply Liquid fuels-flash point, aniline point, octane number and carbon residue. SO4.5 Explain and apply Gaseous fuels-producer gas and water gas –calorific values. chemistry.		4.5 Properties of fuel analysis. 4.6 Fuel analysis.solid. 4.7 liquid and gas. 4.8 The Ultimate and proximate analysis. 4.9 heating values- grading coal. T1- Liquid fuels-flash point, aniline point, T2- octane number and carbon residue. T3-Gaseous fuels-producer gas and water gas –calorific values. chemistry.	

SW-4 Suggested Sessional Work (SW):

a.Assignments:

Explain and apply The Analysis of soil: moisture,pH, total nitrogen , phosphorus, silica, lime, magnesia, manganese, sulphur and alkali salts.

b.Mini Project:

Explainanalysis of Fuel analysis: solid, liquid and gas.

c.Other Activities (Specify):

Explain and apply Liquid fuels-flash point, aniline point, octane number and carbon residue.

76CH303.5: Expertise in laboratory safety.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 Explain and apply the Clinical chemistry: Composition of blood collection and preservation of samples **SO5.2** Explain Clinical analysis .Serum electrolytes , blood glucose , blood urea nitrogen, uric acid,	.	**5. Clinical Chemistry:** 5.1 Composition of blood collection and preservation of samples. 5.2 Introduction of Clinical analysis . 5.3 blood urea nitrogen.	Properties of Barbiturates, acid and alkaline phosphateses.

albumin,globulins. **SO5.3** Explain and apply effect of substrate structure, leaving group andattacking nucleophile in aromatic nucleophilic reactions. **SO5.4**Explain and apply The blood gas analysis trace elements in the body. **SO5.5** Explain and apply The **Drug analysis**: Narcotics and dangerous grug.Classification of drugs.Screening by gas and thin-layar chromatography and spectrophotometric measurement		5.4 barbiturates, acid and alkaline phosphateses. 5.5 Immunoassay principles of ratio immunoassay (RIA) and applications. 5.6 The blood gas analysis trace elements in the body. **5.**7 Drug analysis: Narcotics and dangerous grug. 5.8 Clinical analysis uric acid, 5.9 Screening by gas and thin-layar chromatography and spectrophotometric measurement T1- Clinical analysis .Serum electrolytes , blood glucose. T2- Classification of drugs. T3-Properties of chromatography.	

SW-5 Suggested Sessional Work (SW):
a.Assignments:
Explain and apply effect of substrate structure, leaving group andattacking nucleophile in aromatic nucleophilic reactions.
b.Mini Project:
Clinical chemistry: Composition of blood collection and preservation of samples.
c.Other Activities (Specify):
Drug analysis: Narcotics and dangerous grug.Classification of drugs.Screening by gas and thin-layar chromatography and spectrophotometric measurement.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
76CH303.1: Explain and apply theoretical aspect of analytical chemistry.	12	02	01	15
76CH303.2 Analyse water, soil and biological fluid sample	12	02	01	15

76CH303.3: Explain and identify the errors occurred during chemical analysis	12	02	01	15
76CH303.4:Handle glass ware and reagent in scientific way	12	02	01	15
76CH303.5:Expertise in laboratory saftey	12	02	01	15
Total Hours	60	15	05	75

Suggestion for End Semester Assessment

Suggested Specification Table(ForESA)

CO	UnitTitles	MarksDistribution			Total Marks
		R	U	A	
CO-1	Introduction of analytical chemistry	03	01	01	05
CO-2	Errors and Evalution	02	06	02	10
CO-3	Analysis of water pollution	03	07	05	15
CO-4	Analysis of Soil, Fuel, Body Fluids and Drugs –I	-	10	05	15
CO-5	Analysis of Soil, Fuel, Body Fluids and Drugs -II	03	02	-	05
Total		11	26	13	50

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

The end of semester assessment for Medicinal Chemistry and Natural Product I will be held with written examination of 50 marks

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

Suggested Instructional/ImplementationStrategies:

10. ImprovedLecture
11. Tutorial
12. CaseMethod
13. GroupDiscussion
14. RolePlay
15. Visitto NCL, CSIR laboratories
16. Demonstration
17. ICTBasedTeachingLearning(VideoDemonstration/TutorialsCBT,Blog,Facebook,Twitter,Whatsapp,Mobile,Onlinesources)
18. Brainstorming

Suggested Learning Resources:

(i) **Books:**

S. No.	Title	Author	Publisher	Edition& Year
1	A Textbook of Quantitative Inorganic Analysis	A. I. Vogel	Longman,	Edition,1966
2	Fundamentals of Analytical Chemistry	Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch	Cengage Learning, 2021	Edition, 2021
3	Physical methods in chemistry.	Drago, Russell S. ,MNB	Ft. Worth : Saunders College Pub.	Edition,2021
4	Introduction to magnetic resonance with applications to chemistry and chemical physics	Carrington, Alan	New York : Harper & Row	Edition,2019
5	Instrumentalmethodsо fAnalysis	L. L.Merrit, R.H. Willard and J.A. Dean;VanNostrand-Reinhold.	D. Van Nostrand & Co.	Edition,2023

SuggestedWebSources:

26. https://nptel.ac.in/course.html
27. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
28. https://swayam.gov.in/explorer?category=Chemistry

ModeofDelivery:Lecture,demonstration,E-tutoring,discussion,assignments,quizzes, case study, power point;

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

Title: Organic Analytical ChemistryI **Course Code : 76CH303**

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Know ledge	Rese arch Apti tude	Com munic ation	Probl em Solvin g	Indivi dual and Team Work	Inve stiga tion of Prob lems	Moder n Tool usage	Scienc e and Societ y	Life-Long Learni ng	Ethics	Project Manage ment	Environ ment and sustaina bility	The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry	To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutica l etc.	understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon -based problems in chemical sciences.	Provide opportunitie s to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science
CO1:Explain and apply theoretical aspect of analytical chemistry.	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO2:Analyse water, soil and biological fluid sample.	2	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3 Explain and identify the errors occurred during chemical analysis	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO4: Handle glass ware and reagent in scientific way	2	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
CO5: Expertise in laboratory saftey	2	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

Legend:1–Low,2–Medium, 3–High

Course Curriculum Mapping

POs &PSOsNo.	Cos No.&Titles	SOsNo.	LaboratoryInstruction(LI)	Classroom Instruction(CI)	Self Learning(SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO1: Explain and apply theoretical aspect of analytical chemistry.	SO1.1SO 1.2SO1.3 SO1.4 SO1.5		Unit-1. 1.1,1.2,1.3,1.4,1.5,1.6,1.7 , 1.8, 1.9 T1, T2,T3	Techniques of weighing, errors.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO2:Analyse water, soil and biological fluid sample	SO2.1SO 2.2SO2.3 SO2.4 SO2.5		2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9 T1, T2,T3	Properties and types of error in experimental data determinate.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3:Explain and identify the errors occurred during chemical analysis	SO3.1SO3 .2 SO3.3 SO3.4 SO3.5		Unit-3 : 3.1, 3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9 T1, T2,T3	General survey of instrumental techniques for the analysis of heavy metals in aqueous systems.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO4: Handle glass ware and reagent in scientific way	SO4.1SO 4.2SO4.3 SO4.4 SO4.5		Unit-4 : 4.1, 4.2,4.3,4.4,4.5,4.6,4.7,4.8 ,4.9 T1,T2,T3	The Analysis of soil: moisture,pH, total nitrogen , phosphorus.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO5: Expertise in laboratory saftey	SO5.1SO 5.2SO5.3 SO5.4 SO5.5		Unit 5: 5.1,5.2,5.3,5.4,5.5,5.6,5.7, 5.8,5.9. T1,T2, T3	Properties of Barbiturates, acid and alkaline phosphateses.

M.Sc. Chemistry Semester III
Code: 76CH-304
Course Name: Bio Inorganic, Bio Physical, Bio Organic Chemistry
No. Of Credits: 4

L	T	P
4	0	0

Pre-requisite: Students must have fundamental knowledge of bio-molecules such as enzymes, vitamins, carbohydrates, nucleotides etc to understand the concept of bio-inorganic, bio-physical, bio-organic chemistry.

Rationale: The students studying bio-inorganic, bio-physical, bio-organic chemistry should possess foundational understanding about basic knowledge of standard free energy change in biological processes, exergonic and endergonic reactions etc to understand the basic principle of reactions involving biochemical processes.

CourseOutcomes
After the completion of this course, the learner will able to
76CH-304**.1**: Explain structure and function of metal complexes or metallo-proteins involved in storage & transportation of oxygen as well in transmission of energy.
76CH-304**.2**: Explain structure and function of metalloproteins like cytochrome and iron-sulphur proteins involved in electron transport processes and also describe various reactions calalysed by enzymes.
76CH-304**.3**: Explain the concept of enzymes and apply its production, purification and applications in various areas.
76CH-304**.4**: Describe mechanisticdetails of chemical reactions of various co-enzymic form of vitamins and also describe structure and function of proteins.
76CH-304**.5:** Explain standard free energy change in biochemical reactions and apply the same concept to hydrolysis and synthesis of ATP.

Unit-I (76CH-304**.1): Metal ions in Biological System**
A] Structure and Function of hemoglobin, myoglobin, hemocyanins and hemerythrin,
B] Metal compexes in transmission of energy: chlorophylls, photosystem I and photosystem II in cleavage of water

Unit-II (76CH-304**.2): Electron transfer in Biological System**
Structure and function of metalloproteins in electron transport processes-cytochromes and ion-sulphur proteins
Kinds of Reactions Catalysed by Enzymes
Nucleophilic displacement on a phosphorus atom. Isomerization and rearrangement reactions, enolic intermediates in iomerization reactions. Enzyme catalyzed carboxylation and decarboxylation reaction.

Unit-III (76CH-304**.3): Enzymes and their biotechnological applications**

Introduction of bioorganic chemistry and Enzymes, coenzymes, prosthetic groups, apoenzymes. Properties of enzymes like catalytic power, specificity and regulation. Proximity effects and molecular adaptation. Transition-state theory and orientation

Nomenclature and classification of enzymes. Fischer's lock and key and Koshland's induced fit hypothesis.

Large-scale production and purification of enzymes, techniques and methods of immobilization of enzymes, effect of immobilization on enzyme activity, enzymes and recombinant DNA technology.

Unit-IV (76CH-304**.4): Co- Enzyme Chemistry and Biopolymer Interaction**

A] Cofactors as derived from vitamins. Structure and biological functions of coenzyme A, thiamine pyrophosphate (TPP), pyridoxal phosphate, NAD+, NADP+ , FMN, FAD, lipoic acid, vitamin B12. Mechanisms of reactions catalyzed by the above cofatctors.

B] Biomimetic chemistry, crown ethers, cryptates.

C] Polypeptide and protein structures, introduction to protein folding problem. Forces involved in biopolymer interactions.

Unit-V (76CH-304**.5): Cell membrane and transport of Ions**

Structure and functions of biological cell membrane, ion transport through cell membrane, Structure and functions of DNA and RNA in living systems.

Bioenergetics

Standard free energy change in biochemical reactions, exergonic, endergonic. Hydrolysis of ATP, synthesis of ATP from ADP.

Biopolymer and their molecular weight

Evaluation of size, shape, molecular weight Methods for determination of molar mass of biopolymers (a) Viscosity method (b) Sedimentation methods (c) Osmotic pressure methods

SchemeofStudies:

Board ofStudy	CourseCode	CourseTitle	Scheme ofstudies (Hours/Week)					Total Credits(C)
			CI	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
ProgramCore(PCC)	76CH-304	Bioinorganic, biophysical, bioorganic chemistry	4	0	1	1	6	4

Legend : CI: Class room Instruction(Includesdifferentinstructionalstrategiesi.e.Lecture(L)andTutorial (T)andothers),

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

SW: Sessional Work(includesassignment,seminar,miniprojectetc.),
SL: Self Learning,
C: Credits.

Note:

SW&SLhastobeplannedandperformedunderthecontinuousguidanceandfeedbackofteacherto ensure outcome ofLearning.

SchemeofAssessment: Theory

Board ofStudy	CourseCode	CourseTitle	**SchemeofAssessment(Marks)**						
			ProgressiveAssessment(RA)					**EndSemesterAssessment (ESA)**	**TotalMar** (PRA+ESA
			Class/HomeAssignment5number 3 markseach (CA)	Class Test2 (2bestout of3) 10 markseach(CT)	Seminarone + Class activity	ClassAttendance (AT)	TotalMarks (CA+CT+SA +AT)		
PCC	76CH-304	Bioinorganic, biophysical, bioorganic chemistry	15	20	10	5	50	50	100

Course-Curriculum Detailing:

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

Unit-I (76CH-304.1)**: Metal ions in Biological System**

A] Structure and Function of hemoglobin, myoglobin, hemocyanins and hemerythrin,

B] Metal compexes in transmission of energy: chlorophylls, photosystem I and photosystem II in cleavage of water

Activity	**AppX Hrs**
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	**LI**	**CI**	**SL**

After the completion of topics students will be able to SO1.1 understand the function of metal or metal ions in biological system SO1.2 describe the structure and restate the functions of hemoglobin and myoglobin, SO1.3 describe the structure and restate the functions of hemocyanins and hemerythrin SO1.4 understand metal complexes in transmission of energy such as chlorophylls SO1.5 explain photosystem I and photosystem II in cleavage of water		**Unit-I** (76CH-304.1)**: Metal ions in Biological System** 1.1 Introduction to m**etal ions in Biological System** 1.2 Structure and Function of hemoglobin 1.3 Structure and Function of myoglobin 1.4 Structure and Function of hemocyanins 1.5 Structure and Function of hemerythrin 1.6 Metal compexes in transmission of energy 1.7 Chlorophylls 1.8 Chlorophylls 1.9 Photosystem I 1.10 Photosystem II in cleavage of water 1.11 Class test 1.12 Class test	• Chlorophyll a • Chlorophyll b

SW-1Suggested Sessional Work (SW):
Assignments: Structure and Function of hemoglobin
Mini Project:
Other Activities (Specify): Structure and Function of hemerythrin

Unit-II (76CH-304.2)**: Electron transfer in Biological System**

[A] Structure and function of metalloproteins in electron transport processes-cytochromes and ion-sulphur proteins [B] **Kinds of Reactions Catalysed by Enzymes:** Nucleophilic displacement on a phosphorus atom. Isomerization and rearrangement reactions, enolic intermediates in iomerization reactions. Enzyme catalyzed carboxylation and decarboxylation reaction.

Activity	**AppX Hrs**
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
After the completion of topics students will be able to		**Unit-II** (76CH-304.**2**)**: Electron transfer in Biological System**	• Metalloproteins

SO2.1 describe the structure and function of metalloproteins **SO2.2** describe structure and function of metalloproteins in electron transport processes-cytochromes **SO2.3 explain s**tructure and function of metalloproteins in electron transport processes-ion-sulphur proteins **SO2.4** understand the kinds of reactions Catalysed by Enzymes such as nucleophilic displacement on a phosphorus atom **SO2.5** explain enzyme catalyzed carboxylation and decarboxylation reaction		2.1 Electron transfer in Biological System 2.2 Structure and function of metalloproteins in electron transport processes-cytochromes 2.3 Structure and function of metalloproteins in electron transport processes-ion-sulphur proteins 2.4 Structure and function of metalloproteins in electron transport processes-ion-sulphur proteins 2.5 Kinds of Reactions Catalysed by Enzymes 2.6 Nucleophilic displacement on a phosphorus atom 2.7 Isomerization and rearrangement reactions 2.8 enolic intermediates in iomerization reactions. 2.9 Enzyme catalyzed carboxylation 2.10Enzyme catalyzed decarboxylation reaction 2.11Test 2.12Test	

SW-2 Suggested Sessional Work (SW):
Assignments: ion-sulphur proteins
Mini Project:
Other Activities (Specify): Nucleophilic displacement on a phosphorus atom

Unit-III (76CH-304.**3): Enzymes and their biotechnological applications**

Introduction of bioorganic chemistry and Enzymes, coenzymes, prosthetic groups, apoenzymes. Properties of enzymes like catalytic power, specificity and regulation. Proximity effects and molecular adaptation. Transition-state theory and orientation

Nomenclature and classification of enzymes. Fischer’s lock and key and Koshland’s induced fit hypothesis.

Large-scale production and purification of enzymes, techniques and methods of immobilization of enzymes, effect of immobilization on enzyme activity, enzymes and recombinant DNA technology.

Activity	**AppX Hrs**
Cl	12
LI	0
SW	2
SL	1
Total	15

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

After the completion of topics students will be able to **SO3.1** understand bioorganic chemistry and its applications **SO3.2** understand the properties of enzymes and transition state **SO3.3** explain nomenclature and classification of enzymes. **SO3.4** describe production and purification of enzymes **SO3.5** describe recombinant DNA technology		**Unit-III (**76CH-304**.3): Enzymes and their biotechnological applications** 3.1 understand bioorganic chemistry and its applications 3.2 coenzymes, prosthetic groups, apoenzymes 3.3 Properties of enzymes like catalytic power, specificity and regulation. 3.4 Proximity effects and molecular adaptation. 3.5 Transition-state theory and orientation 3.6 Nomenclature and classification of enzymes. 3.7 Fischer's lock and key and Koshland's induced fit hypothesis. 3.8 Large-scale production and purification of enzymes 3.9 Techniques and methods of immobilization of enzymes 3.10 Effect of immobilization on enzyme activity, enzymes 3.11 Recombinant DNA technology. 3.12 Test	• Nucleotide • Nucleoside • DNA

SW-3 Suggested Sessional Work (SW):
Assignments: recombinant DNA Technology
Mini Project:
Other Activities (Specify):

Unit-IV (76CH-304**.4): Co- Enzyme Chemistry and Biopolymer Interaction**

A] Cofactors as derived from vitamins. Structure and biological functions of coenzyme A, thiamine pyrophosphate (TPP), pyridoxal phosphate, NAD+, NADP+ , FMN, FAD, lipoic acid, vitamin B12. Mechanisms of reactions catalyzed by the above cofatctors.

B] Biomimetic chemistry, crown ethers, cryptates.

C] Polypeptide and protein structures, introduction to protein folding problem. Forces involved in biopolymer interactions.

Activity	**AppX Hrs**
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
After the completion of topics		**Unit-IV (**76CH-304**.4): Co- Enzyme Chemistry and**	• Amino acid

students will be able to **SO4.1 understand** the terms of coenzyme and cofactors **SO4.2 explain structure** and biological functions of coenzyme A **SO4.3 explain structure** and biological functions of coenzyme of Vitamin B-complex **SO4.4** Biomimetic chemistry, crown ethers, cryptates. **SO4.5** Explain structure and functions of polypeptides and proteins structures		**Biopolymer Interaction** 4.1 Cofactors as derived from vitamins 4.2 Structure and biological functions of coenzyme A 4.3 Structure and biological functions of coenzyme of Thiamine pyrophosphate (TPP) 4.4 Structure and biological functions of coenzyme like pyridoxal phosphate 4.5 Structure and biological functions of coenzyme like NAD+, NADP+ 4.6 Structure and biological functions of coenzyme such as FMN, FAD 4.7 Structure and biological functions of coenzyme lipoic acid and vitamin B12 4.8 Biomimetic chemistry 4.9 crown ethers 4.10 cryptates 4.11 Structure and functions of polypeptide and protein 4.12 Forces involved in biopolymer interactions.	• Physic-chemical properties • Vitamins

SW-4 Suggested Sessional Work (SW)
Assignment: Vitamins and cofactors
Mini Project:
Other Activities (Specify): Enzymes and coenzymes

Unit-V (76CH-304.5): Cell membrane and transport of Ions
Structure and functions of biological cell membrane, ion transport through cell membrane, Structure and functions of DNA and RNA in living systems.
Bioenergetics
Standard free energy change in biochemical reactions, exergonic, endergonic. Hydrolysis of ATP, synthesis of ATP from ADP.
Biopolymer and their molecular weight
Evaluation of size, shape, molecular weight Methods for determination of molar mass of biopolymers (a) Viscosity method (b) Sedimentation methods (c) Osmotic pressure methods

Activity	**AppX Hrs**
Cl	12
LI	0
SW	2
SL	1
Total	15

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

After the completion of topics students will be able to **SO5.**1 understand structure and functions of biological cell membrane and ion transportation through cell membrane **SO5.2** explains structure and functions of DNA and RNA in living systems **SO5.3** apply the concept of bioenergetics to describe the hydrolysis of ATP **SO5.**4 explains the viscosity and sedimentation methods to evaluate the the size, shape and molecular weight of biopolymers **SO5.5** explains the osmotic pressure methods to evaluate the the size, shape and molecular weight of biopolymers	.	**Unit-V (**76CH-304.**5): Cell membrane and transport of Ions** 5.1 Structure and functions of biological cell membrane 5.2 ion transport through cell membrane 5.3 Structure and functions of DNA and RNA in living systems 5.4 **Bioenergetics** 5.5 Standard free energy change in biochemical reactions 5.6 Exergonic and endergonic 5.7 Hydrolysis of ATP 5.8 synthesis of ATP from ADP 5.9 **Biopolymer and their molecular weight** 5.10 Evaluation of size, shape, molecular weight Methods for determination of molar mass of biopolymers by Viscosity method 5.11 By sedimentation methods 5.12 By osmotic pressure methods	• Molar mass • Gibbs free energy

SW-5 Suggested Sessional Work (SW):
Assignments: Structure and functions of DNA and RNA in living systems.
Mini Project:
Other Activities (Specify): Synthesis of ATP from ADP.

Brief of Hours suggested for the Course Outcome

Course Outcomes	**Class Lecture (Cl)**	**Sessional Work (SW)**	**Self Learning (Sl)**	**Total hour (Cl+SW+Sl)**
76CH-304.**1**: explain structure and function of metal complexes or metallo-proteins involved in storage & transportation of oxygen as well in transmission of energy.	12	02	01	15
76CH-304.**2**: explain structure and function of metalloproteins like cytochrome and iron-sulphur proteins involved in electron transport processes and also describe various reactions calalysed by enzymes.	12	02	01	15

76CH-304.**3**: understand the concept of enzymes and describe its production, purification and applications in various areas.	12	02	01	15
76CH-304.**4**:Describe mechanisticdetails of chemical reactions of various co-enzymic form of vitamins and also describe structure and function of proteins.	12	02	01	15
76CH-304.**5:** Explain standard free energy change in biochemical reactions and apply the same concept to hydrolysis and synthesis of ATP.	12	02	01	15
Total Hours	60	10	05	75

Suggestion for End Semester Assessment
Suggested Specification Table(ForESA)

CO	**UnitTitles**	**MarksDistribution**			**TotalMarks**
		R	**U**	**A**	
CO-1	**Metal ions in Biological System**	03	01	01	05
CO-2	**Electron transfer in Biological System**	02	06	02	10
CO-3	**Enzymes and their biotechnological applications**	03	07	05	15
CO-4	**Co- Enzyme Chemistry and Biopolymer Interaction**	-	10	05	15
CO-5	**Cell membrane and transport of Ions**	03	02	-	05
Total		11	26	13	50

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

The written examination of 50 marks will be held at theendofsemesterfor Inorganic Chemistry

Note.Detailed Assessmentrubricneedtobepreparedbythecoursewiseteachersforabovetasks. Teacherscanalsodesigndifferenttasksasperrequirement,forendsemesterassessment.

SuggestedInstructional/ImplementationStrategies:

19. ImprovedLecture
20. Tutorial
21. CaseMethod
22. GroupDiscussion
23. RolePlay
24. Visitto NCL, CSIR laboratories
25. Demonstration
26. ICTBasedTeachingLearning(VideoDemonstration/TutorialsCBT,Blog,Facebook,Twitter,Whatsapp,Mobile,Onlinesources)
27. Brainstorming

SuggestedLearningResources:

(j) **Books:**

S. No.	Title	Author	Publisher	Edition& Year
1	Principles of Biochemistry,	A.L. Lehninger	Worth Publishers	4th edition
2	Principles of Bioinorganic Chemistry	S. J Lippard	Paperback	2nd edition
3	Biochemistry	L. Stryer, W.H.Freeman.	Universities Press	First Edition (1 January 2010)

SuggestedWebSources:

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

ModeofDelivery:Lecture,demonstration,E-tutoring,discussion,assignments,quizzes, case study, power point;

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

ourse Title: Bioinorganic **Course Code : 76CH101**

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
		Research Aptitude	Communication	Problem Solving	Individual and Team Work	Investigation of Problems	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and sustainability	The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry	To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.	understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon-based problems in chemical sciences.	Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science
CO1: explain structure and function of metal complexes or metallo-proteins involved in storage & transportation of oxygen as well in transmission of energy.	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO2:explain structure and function of metalloproteins like cytochrome and iron-sulphur proteins involved in electron transport processes and also describe various reactions calalysed by enzymes.	2	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3:understand the concept of enzymes and describe its production, purification and applications in various areas.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO4: Describe mechanisticdetails of chemical reactions of various co-enzymic form of vitamins and also describe structure and function of proteins.	2	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
CO5: Explain standard free energy change in biochemical reactions and apply the same concept to hydrolysis and synthesis of ATP.	2	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

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

Curriculum Map:

POs &PSOsNo.	Cos No. & Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1: explain structure and function of metal complexes or metallo-proteins involved in storage & transportation of oxygen as well in transmission of energy.	SO1.1SO 1.2SO1.3 SO1.4 SO1.5		Unit-1.**Metal ions in Biological System** 1.1,1.2,1.3,1.4,1.5,1.6,1.7	• Chlorophyll a • Chlorophyll b
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO2: explain structure and function of metalloproteins like cytochrome and iron-sulphur proteins involved in electron transport processes and also describe various reactions calalysed by enzymes.	SO2.1SO 2.2SO2.3 SO2.4 SO2.5		Unit-2 **Electron transfer in Biological System** 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9	• Metalloproteins
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3: understand the concept of enzymes and describe its production, purification and applications in various areas.	SO3.1SO3 .2 SO3.3 SO3.4 SO3.5		Unit-3 :**Enzymes and their biotechnological applications** 3.1, 3.2,3.3,3.4,3.5,3.6,3.7	• Nucleotide • Nucleoside • DNA
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4: Describe mechanisticdetails of chemical reactions of various co-enzymic form of vitamins and also describe structure and function of proteins.	SO4.1SO 4.2SO4.3 SO4.4 SO4.5		Unit-4 : **Co- Enzyme Chemistry and Biopolymer Interaction** 4.1, 4.2,4.3,4.4,4.5,4.6,4.7	• Amino acid • Physic-chemical properties • Vitamins
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 5: Explain standard free energy change in biochemical reactions and apply the same concept to hydrolysis and synthesis of ATP.	SO5.1SO 5.2SO5.3 SO5.4 SO5.5		Unit 5: **Cell membrane and transport of Ions** 5.1,5.2,5.3,5.4,5.5,5.6,5.7	• Molar mass • Gibbs free energy

M.Sc. CHEMISTRY III

CODE: 76CH-305

Subject Name: Green Chemistry No. Ofcredits: 2

L	T	P
2	0	0

Pre-requisite: Students should have basic knowledge of chemistry

Rtional: After completion of course student will promote, develop and design environment benign chemical process and products.

COURSEOUTCOMES:

Afterthe completionofthiscourse, thelearner will

CO1: Explain and apply concept and principle of green chemistry

CO2: Design environmentsustainableand economicalroute ofasynthesis.

CO3: Adoptrenewable andalternate resourcesof energy in various processes

CO4: Solve environmental issues by adopting the principle of green chemistry

UNITI

PRINCIPLES & CONCEPT OF GREEN CHEMISTRY: Introduction, Concept and Principles, development of Green Chemistry,Atomeconomyreactions–rearrangementreactions, addition reactions, atomuneconomic-sublimation, elimination,Wittig reactions,toxicity measures,Need of GreenChemistry in our day-to-daylife.

UNITII

EMERGINGGREENTECHNOLOGYANDALTERNATIVEENERGYSOURCES: Designfor Energy efficiency, Photochemical reactions, Advantages & Challenge faced by photochemical process.Microwave technology on Chemistry,Microwave heating,Microwave assisted reactions,Sonochemistry and Green Chemistry,Electrochemical Synthesis, Examples of Electrochemical synthesis.

UNITIII

RENEWABLE RESOURCES: Biomass, Renewable energy, Fossil fuels, Energy from Biomass, SolarPower, Otherformsofrenewableenergy,FuelCells,Alternativeeconomics,Syngaseconomy,hydrogeneconomy, Someothernaturalchemical resources.

UNITIV

INDUSTRIAL CASE STUDIES: Methyl Methacrylate (MMA), Greening of Acetic acid manufacture,Dyeing, Application, Polyethylene, Ziegler-Natta Catalysis, Metallocene Catalysis, Eco friendlyPesticides-Insecticides.

Scheme of Studies:

Board ofStudy	CourseCode	CourseTitle	Scheme ofstudies(Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
ProgramCore(PCC)	76CH305	Green Chemistry	2	0	1	1	6	2

Legend: **CI:** Class room Instruction (Includes different in structional strategies i.e. Lecture (L) andTutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop,field or other location susing different in structional strategies)
SW: Sessional Work (includes assignment,seminar, miniproject etc.),
SL: Self Learning,
C: Credits.

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

Scheme o fAssessment: Theory

Board ofStudy	Couse Code	CourseTitle	SchemeofAssessment(Marks)						
			ProgressiveAssessment(PRA)					EndSemesterAssessment	Total Marks
			Class/HomeAssignment5number 3 markseach (CA)	Class Test2 (2bestout of3) 10 marks each(CT)	Seminarone (SA)	ClassAttendance (AT)	TotalMarks (CA+CT+SA +AT)	(ESA)	(PRA+ESA)
PCC	**76CH305**	**Green Chemistry**	15	20	10	5	50	50	100

Course-Curriculum Detailing:

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

76CH305.1: explain and apply concept and principle of green chemistry

Activity	**AppX Hrs**
CI	06
LI	0
SW	2
SL	1
Total	09

Session Outcomes (SOs)	**Laboratory Instruction(LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO1.1 understand basics of green chemistry SO1.2 explain basic principles of green chemistry SO1.3 understand rearrangements reactions SO1.4 Explain addition reactions, atom uneconomic- sublimation , elimination,witting reactions SO1.5 Understand need of green chemistry in our day to day life		Unit-1 1.1Introduction, Concept and Principles, 1.2DevelopmentofGreenChemistry, 1.3Atomeconomyreactions–rearrangementreactions, 1.4 Additionreactions, atomuneconomic-sublimation, elimination, 1.5 Wittig reactions T-1Toxicity measures, T2NeedofGreenChemistryin our day-to-daylife.	Understand need of green chemistry day to day life.

SW-1SuggestedSessionalWork(SW):

a. Assignments: Discuss the principle of green chemistry and their synthesis

b. Mini Project:

chart on uses of green chemistry in day to day life

c. Other Activities (Specify):

Note on green synthesis reactions

76CH305: 2: design environmentsustainableand economicalroute ofasynthesis.

Activity	AppX Hrs
Cl	07
LI	0
SW	2
SL	1
Total	10

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 Understand green synthesis techniques **SO2.2** Explain alternative energy sources **SO2.3** Understand photochemical reactions and advantages and challenges faced by photochemical process **SO2.4** Explain Microwave technology , microwave heating and microwave assisted reactions **SO2.5** Understand sono chemistry ,Green chemistry & Electrochemical synthesis with example		**Unit-2:** 2.1Designfor Energy efficiency, 2.2 Photochemical reactions, 2.3 Advantages & Challenge faced by photochemical process. 2.4MicrowavetechnologyonChemistry, 2.5 Microwave heating,and Microwaveassistedreactions, T-1SonochemistryandGreenChemistry, T-2 ElectrochemicalSynthesis,ExamplesofElectrochemicalsynthesis.	Studied different type of green synthesis techniques.

SW-2 Suggested Sessional Work (SW):

a. **Assignments:**
   Apply different type of green synthesis techniques.
b. **Mini Project:**
Prepare chart on green synthesis techniques.
c. **Other Activities (Specify):**
Write an essay on sono chemistry and green chemistry

76CH305.3:Adoptrenewable andalternate resourcesof energy in various processes

Activity	AppX Hrs
Cl	07
LI	0
SW	2
SL	1
Total	10

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Describe basics of Renewable resources **SO3.2** Explain Biomass ,Renewable energy & Fossil fuels **SO3.3** Explain Solar power & other forms of renewable energy and fuels **SO3.4** Understand alternative economics ,syngas economy and hydrogen economy **SO3.5** Explain some other natural chemical resources		**Unit-3** **3.1** Biomass, Renewable **3.2** energy from Fossil fuels, Energy from Biomass **3.3** SolarPower, **3.4** Otherformsofrenewableenergy,FuelCells, 3.5 Alternativeeconomics, T-1Syngaseconomy,hydrogeneconomy, T-2 Someothernaturalchemical resources.	Learn some other natural chemical resources

SW-3 Suggested Sessional Work (SW):

a. **Assignments:** Discuss the renewable energy resources

b. **Mini Project:** Pictorial presentation of renewable energy

c. **Other Activities (Specify):**

Explanatory note on importance of renewable resources

76CH305.4: Solve environmental issues which can be solved by adopting the principle of green chemistry

Activity	AppX Hrs
Cl	07
LI	0
SW	2
SL	1
Total	10

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Discuss basics of industrial case studies **SO4.2** Explain MethylMethacrylate & greening of acetic acid **SO4.3** Explain and apply dyeing and its application **S04.4** Explain polyethylene , Ziegler Natta Catalysis ,Metallocene catalysis, Eco friendly pesticides-insecticides		**Unit-4** 4.1Methyl Methacrylate (MMA), 4.2 Greening of Acetic acid manufacture, 43Dyeing, Application, 4.4 Polyethylene, 4.5 Ziegler-Natta Catalysis, T-1 Metallocene Catalysis, T-2 Eco friendlyPesticides-Insecticides.	Eco friendly pesticides & insecticides

SW-4 Suggested Sessional Work (SW):

a. **Assignments:**
   Note on natural dyes
b. **Mini Project:**

Prepare chart on Ziegler-Natta catalysis.

c. **Other Activities (Specify):**

Importance and applications of greening of acetic acid manufacture.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
76CH305.1: Explain and apply concept and principle of green chemistry .	07	02	01	10
76CH305.2 Design environmentsustainableand economicalroute ofasynthesis	09	02	01	12
76CH305.3: Adoptrenewable andalternate resourcesof energy in various processes	07	02	01	10
76CH305.4: Solve environmental issues which can be solved by adopting the principle of green chemistry	07	02	01	10
Total Hours	37	10	05	52

Suggestion for End Semester Assessment

Suggested SpecificationTable(ForESA)

CO	UnitTitles	MarksDistribution			Total Marks
		R	U	A	
CO-1	Principle & Concept of Green Chemistry	03	01	01	05
CO-2	Emerging Green Technology and Alternative Energy sources	02	06	02	10
CO-3	Renewable resources	03	07	05	15
CO-4	Industrial case studies	-	10	05	15
Total		11	26	13	50

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

TheendofsemesterassessmentforOrganic Chemistry I willbeheldwithwrittenexaminationof50 marks

Note.DetailedAssessmentrubricneedtobepreparedbythecoursewiseteachersforabovetasks. Teacherscanalsodesigndifferenttasksasperrequirement,forendsemesterassessment.

Suggested Instructional/Implementation Strategies:

28. Improved Lecture
29. Tutorial
30. Case Method
31. Group Discussion
32. RolePlay
33. Visitto NCL, CSIR laboratories
34. Demonstration
35. ICTBasedTeaching Learning(VideoDemonstration/TutorialsCBT,Blog,Facebook,Twitter,Whatsapp,Mobile,Onlinesources)
36. Brainst

SuggestedLearningResources:

(k) **Books:**

S. No.	Title	Author	Publisher	Edition& Year
1	GreenChemistryandIntroductorytext,	MikeLancaster,		IIEdition
2	P.T.AnastasandJ.C Warner,GreenChemistrytheoryandPractice	V Kumar	OxfordUniversitypress,Oxford	OxfordUniversitypress,Oxford(1988)
3	ATextBookofGreen Chemistry	Sankar P. Dey Nayim Sepay	ProttiD.Dondi*et.al.,* GreenChemistry	
4	Green Chemistry A Text Book	V.K. Abdullah		
5	An Introductory Text on Green Chemistry	Indu Tucker Sidhwani Rakesh K. Sharma	Wiley	Blaclwell ,London (2007)

SuggestedWebSources:

32. https://nptel.ac.in/course.html
33. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
34. https://swayam.gov.in/explorer?category=Chemistry

ModeofDelivery:Lecture,demonstration,E-tutoring,discussion,assignments,quizzes, case study, power point;

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

Title: Green Chemistry **Course Code : 76CH305**

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Knowledge	Research Aptitude	Communication	Problem Solving	Individual and Team Work	Investigation of Problems	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and sustainability	The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry	To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.	understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon -based problems in chemical sciences.	Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science
CO1 Explain and apply concept and principle of green chemistry .	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO 2 Design environmentsustainableand economicalroute ofasynthesis	2	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3 Adopt renewable and alternate resources of energy in various process	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO 4: Solve environmental issues which can be solved by adopting the principle of green chemistry	2	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2

Legend:1–Low,2–Medium, 3–Hig

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Curriculum Map:

POs &PSOsNo.	COsNo.&Titles	SOsNo.	Laboratory Instruction(LI)	Classroom Instruction(CI)	Self Learning(SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1Explain and apply concept and principle of green chemistry	SO1.1SO 1.2SO1.3 SO1.4 SO1.5		Unit-1.0 Principle & Concept of Green Chemistry 1.1,1.2,1.3,1.4,1.5,T-1,T-2	Understand need of green chemistry day to day life
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 2: Design environmentsustainableand economicalroute ofasynthesis	SO2.1SO 2.2SO2.3 SO2.4 SO2.5		Unit-2 Emerging Green Technology and Alternative Energy sources 2.1,2.2,2.3,2.4,2.5,T-1,T-2	. Studied different type of green synthesis techniques
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3 : Adopt renewable and alternate resources of energy in various process	SO3.1SO3 .2 SO3.3 SO3.4 SO3.5		Unit- 3Renewable resources 3 3.1, 3.2,3.3,3.4,3.5,T-1,T-2	Understand natural chemical resources
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4: : Solve environmental issues which can be solved by adopting the principle of green chemistry	SO4.1SO 4.2SO4.3 SO4.4 SO4.5		Unit-4 : Industrial case studies 4.1, 4.2,4.3,4.4,4.5,T-1,T-2	Eco friendly pesticides & insecticides

AKSUniversity

FacultyofBasic Science, **DepartmentofChemistry**

CurriculumofM. Sc. In Chemistry Program (Revisedason01August2023)

CODE: 76CH-351

Course Name: Instrumental Techniques in Chemical Analysis Lab

No. Of Credits: 2

L	T	P
0	0	2

Pre – requisite: students should have basic knowledge of laboratory safety as well as qualitative analysis and quantative analysis

Rationale : This course provide skill in synthesis of organic & inorganic compound and qualitative & quantative analysis.

Course Out Comes:

Afterthe completionofthiscourse, thelearner will

CO1: Explain and apply chromatography techniques.
CO2: Apply spectroscopic techniques and characterize chemical compounds.
CO3: Analyse sample by conductivitymeter, ph meter and potentiometery.
CO4: Analyse qualitatively or quantitively inorganic/organic compound.
CO5: Apply microwave & ultra sound organic synthesis techniques.
.

Unit -1 Chromatography

1.1 Paper chromatographic separation
   a. Separation Ag(I),Pb(II) and Hg(II) ions by chromatography method
   b. Separation Bi(III),Cu(II) and Cd(II) ions by chromatography method

1.2 Column chromatography
   a. Separation of Zn(II) and Mg(II) in the given unknown solution by anaion exchange Resin (Amberlitre IRA-400) column followed by their estimation with N/100 EDTA and Eriochrome Black-T as an indicator.
   b. Separation of Ni and Co in the given unknown sample solution by Anion exchange column followed by tbheir estimation by back titration using EDTA and xylenol orange as an indicator.

1.3 Thin layer chromatography
   a. To separate a mixture of amino acid by Thin layer chromatography (TLC) and identify the test amino acids by measuring their Rf values.
   b. Separation Ni(II),Co(II) and Zn(II) ions by thin layer chromatography method.

Unit -2 Spectrophotometery And Colorimetery

2.1. Verification of Beer's Law and concentration of KMnO4 by digital double beam Spectrophotometer.
2.2 Spectrophotometric determination of fluoride, iron,
2.3. Spectrophotometric determination of carbohydrate, ascorbic acid

Unit -3 Conductometry, Ph Metry & Potentiometry

3.1 To determine the solubility of the given sparingly soluble salt by conductance measurements.
3.2 Determine the composition of mixture of Acetic acid and HCl by conductometric titration.
3.3 Determination of Hammett equation of o, m, p amoino / nitro benzoic acid by ph measurement method
3.4 Determination of pk values of maleic acid/ malonic acid by potentiometric titration with sodium hydroxide

UNIT 4 Inorganic Qualitative Analysis-

4.1 Insoluble residue, Rare metal analysis
4.1.1 white residue, yellow residue and green residue
4.1.2 Analysis of mixture containing rare elements like molybdenum,tellurium,zirconium
Organic qualitative analysis
4.2 Separation and identification of ternary mixture of organic compounds

Unit 5 Sustainable Synthesis And Isolation

Two step Micro wave/ ultrasound assisted synthesis of organic compounds/inorganic compounds
Microwave / ultrasound assisted extraction of natural products

Reference Books:

1. Advanced practical chemistry, Jagdamba Singh,R.K.P. Singh, Jaya Singh,LDS Yadav,IR Siddiqui,Jaya Shrivastava . A Pragati edition
2.

SchemeofStudies:

Board ofStudy	CourseCode	CourseTitle	Scheme ofstudies(Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
ProgramCore(PCC)	76CH351	Techniques in Chemical Analysis Lab	0	2	0	1	6	2

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

Note:

SW&SLhastobeplannedandperformedunderthecontinuousguidanceandfeedbackofteacherto ensure outcome ofLearning.

Schemeof Assessment: Practical

Course Category	Course Code	Course Title	Scheme of Assessment (Marks)					
			Progressive Assessment (PRA)				End Semester Assessment (ESA) 35(Exercise)+ 10(viva)+5(for record file)	Total Marks (PRA+ESA)
			Class/Home Assignment 5 number 7marks each (CA)	Viva voice 1X10	Class Attendance (AT)	Total Marks (CA+CT+SA +AT)		
PCC	76CH351	Techniques in Chemical Analysis Lab	35	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, 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.

76CH351.1: Explain and apply chromatography techniques

1.1 Paper chromatographic separation

a. Separation Ag(I),Pb(II) and Hg(II) ions by chromatography method
b. Separation Bi(III),Cu(II) and Cd(II) ions by chromatography method
c. Separation Ni(II),Co(II) and Zn(II) ions by chromatography method

1.2 Column chromatography

a. Separation of Zn(II) and Mg(II) in the given unknown solution by anaion exchange Resin (Amberlitre IRA-400) column followed by their estimation with N/100 EDTA and Eriochrome Black-T as an indicator.

c. Separation of Ni and Co in the given unknown sample solution by Anion exchange column followed by their estimation by back titration using EDTA and xylenol orange as an indicator.

1.23 Thin layer chromatography

d. To separate a mixture of amino acid by Thin layer chromatography (TLC) and identify the test amino acids by measuring their Rf values.

Activity	AppX Hrs
LI	2
SW	1
SL	1
Total	4

Session Outcomes (SOs)	**Laboratory Instruction(LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO1 separate different ions and compounds by chromatographic techniques SO2 Apply principles of different chromatographic techniques	1.1 Paper chromatographic separation Separation Ag(I),Pb(II) and Hg(II) ions by chromatography method Separation Bi(III),Cu(II) and Cd(II) ions by chromatography method Separation Ni(II),Co(II) and Zn(II) ions by chromatography method `1.2 Column chromatography Separation of Zn(II) and Mg(II) in the given unknown solution by anaion exchange Resin (Amberlitre IRA-400) column followed by their estimation with N/100 EDTA and Eriochrome Black-T as an indicator. Separation of Ni and Co in the given unknown sample solution by Anion exchange column followed by tbheir estimation by back titration using EDTA and xylenol orange as an indicator. 1.3 Thin layer chromatography To separate a mixture of amino acid by Thin layer chromatography (TLC) and identify the test amino acids by measuring their Rf values.		1. Principles of different chromatography techniques.

SW-1SuggestedSessionalWork(SW):

a. Assignments:

Separatration of binary mixture of organic compounds by column chromatography

b. Mini Project: Separation of pigment in green leaves by paper chromatography method.

c. Other Activities (Specify):

Prepare chart on chromatographic techniques.

76CH351.2 apply spectroscopic techniques and characterize chemical compounds

2.1. Verification of Beer's Law and concentration of KMnO4 by digital double beam Spectrophotometer.
2.2 Spectrophotometric determination of fluoride, iron,
2.3. Spectrophotometric determination of carbohydrate, ascorbic acid

Activity	**AppX Hrs**
LI	2
SW	1
SL	1
Total	4

Session Outcomes (SOs)	**Laboratory Instruction(LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO1 Explain and apply principles of spectrophotometric techniques and Beer'lambert law. SO2 Determine concentration of unknown solution by spectrophotometer techniques.	Unit2.Spectrophotometry and Conductometry 2.1. Verification of Beer's Law and concentration of KMnO4 by digital double beam Spectrophotometer. 2.2 Spectrophotometric determination of fluoride, iron, 2.3. Spectrophotometric determination of carbohydrate, ascorbic acid		More about spectroscopy techniques

SW-2SuggestedSessionalWork(SW):

a.Assignments:Write principle of Beer's Lambert law and derive it .
b.Mini Project:
Explain instrumentation of spectrophotometer.
c.Other Activities (Specify):
Verification of Beer'sLambert law

76CH351.3: Analyse sample by conductivitymeter, ph meter and potentiometery

Activity	AppX Hrs
LI	2 (2hr.each)
SW	1
SL	1
Total	4

Session Outcomes (SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self Learning (SL)
SO1. Understand conductometric and potentiometric techniques. SO2 apply and understand ph meter instrument	Unit3. 3.1 Conductometric determination of sparingly soluble salt, 3.2Conductometyric determination of composition of muixture of Acetic acid and HCl 3.3 Determination of Hammett equation of o, m, p amoino / nitro benzoic acid by ph measurement method 3.4 Determination of pk values of maleic acid/ malonic acid by potentiometric titratiobn with sodium hydroxide		More about conductometric ,pH and potentiometric techniques

SW-3SuggestedSessionalWork(SW):

a. Assignments:
Discuss mechanistic approach of synthesis of dibenzalacetone
b.Mini Project:
Purification of aspirin
c.Other Activities (Specify):
NMR Study of purified compound

76CH351: analyse qualitatively or quantitively inorganic/organic compound.

Activity	AppX Hrs
LI	2 (2hr each)
SW	1
SL	1
Total	4

Session Outcomes (SOs)	**Laboratory Instruction(LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO1 Apply inorganic and organic qualitative analysis techniques SO2 separate and identify of ternary organic mixture	**Unit4**. Inorganic qualitative analysis Insoluble residue, Rare metal analysis white residue, yellow residue and green residue analysis of mixture containing rare elements like molybdenum,tellurium,zirconium organic qualitative analysis Separation and identification of ternary mixture of organic compounds		More about analysis techniques

SW-4SuggestedSessionalWork(SW):

a.Assignments:
Discuss separation and identification of ternary organic mixture.
B.Mini Project:
Determination of boiling point of liquid organic compounds
c.Other Activities (Specify):
study more about qualitative and quantative analysis

76CH351: 5: apply microwave & ultra sound organic synthesis techniques

Activity	AppX Hrs
LI	2 (2hr each)
SW	1
SL	1
Total	6

Session Outcomes (SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self Learning (SL)
SO1 learn synthesis of organic compound by microwave /ultrasound techniques SO2 learn synthesis of inorganic compound by microwave/ultrasound techniques	**Unit5**. Two step Micro wave/ ultrasound assisted synthesis of organic compounds/inorganic compounds Microwave / ultrasound assisted extraction of natural products		Synthesis of organic and inorganic compounds

SW-4SuggestedSessionalWork(SW):

a.Assignments:
Discuss determination of Iodine value and its importance
B.Mini Project:
Determination of specific gravity of different edible oil
C.Other Activities (Specify):
Discuss determination of RM value and its importance

BOOK SUGGESTED:

S. No.	Title	Author	Publisher	Edition& Year
1	ATextbookofQuantitativeInorganicAnalysi	A.I.Vogel,	ELBS,London.	Revised edition

2	Fundamentalso fAnalyticalChe mistry;	D.A.Skoog,O.M. WestandF	Saunders.	Revised edition)
3	Instrumentalmeth odsofAnalysi	L. L.Merrit, R.H. Willard		
4	Green Chemistry A Text Book	V.K. Abdullah		
5	An Introductory Text on Green Chemistry	Indu Tucker Sidhwani Rakesh K. Sharma	Wiley	Blaclwell ,London (2007)

SUGGESTEDWEBSOURCES:

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

MODEOFTRANSACTION:Lecture,demonstration,E-tutoring,discussion,assignments,quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite,MSPower-Point, Online Resources.

Course Title: Techniques in Chemical Analysis Lab **Course Code : 76CH351**

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Knowledge	Research Aptitude	Communication	Problem Solving	Individual and Team Work	Investigation of Problems	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and sustainability	The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry	To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.	understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon-based problems in chemical sciences.	Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science
CO1 Explain and apply chromatography techniques	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO2. understand and apply spectroscopic techniques	2	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO.3 Analyse samples by conductivitymeter,ph meter, and potentiometery	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO.4: analyze inorganic & organic qualitative analysis techniques	2	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
CO5. apply and understand microwave & ultra sound organic synthesis techniques	2	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

Legend:1–Low,2–Medium, 3– High

AKSUniversity

FacultyofBasic Science, **DepartmentofChemistry**

CurriculumofM. Sc. In Chemistry Program (Revisedason01August2023)

Course Curriculum mapping

POs &PSOsNo.	COsNo.&Titles	SOsNo.	Laboratory Instruction(LI)	Classroom Instruction(CI)	Self Learning(SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO1. Explain and apply chromatography techniques	SO1,SO2	Unit 1. aper chromatographic separation Separation Ag(I),Pb(II) and Hg(II) ions by chromatography method Separation Bi(III),Cu(II) and Cd(II) ions by chromatography method 1.2 Column chromatography Separation of Zn(II) and Mg(II) in the given unknown solution by anaion exchange Resin (Amberlitre IRA-400) column followed by their estimation with N/100 EDTA and Eriochrome Black-T as an indicator. Separation of Ni and Co in the given unknown sample solution by Anion exchange column followed by tbheir estimation by back titration using EDTA and xylenol orange as an indicator. 2 Thin layer chromatography To separate a mixture of amino acid by Thin layer chromatography (TLC) and identify the test amino acids by measuring their Rf values. Separation Ni(II),Co(II) and Zn(II) ions by thin layer chromatography method		Purification of organic comp[ounds by crystalliza Prepartaion of Required reagent for qualitative org analysis
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO2. understand and apply spectroscopic techniques	SO1,SO2	Unit2. 2.1. Verification of Beer's Law and concentration of $KMnO_4$ by digital double beam Spectrophotometer. 2.2 Spectrophotometric determination of fluoride, iron, 2.3. Spectrophotometric determination of carbohydrate, ascorbic acid		Purification of organic compounds(with bi functional group) by crystallization Prepartaion of Required reagent for qualitative org analysis
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO.3: apply and understand conductivitymeter,ph meter, and potentiometery	SO1,SO2	Unit3. 3.1 To determine the solubility of the given sparingly soluble salt by conductance measurements. 3.2 Determine the composition of mixture of Acetic acid and HCl by conductometric titration. 3.3 Determination of Hammett equation of o, m, p amoino / nitro benzoic acid by ph measurement method 3.4 Determination of pk values of maleic acid/ malonic acid by potentiometric titration with sodium hydroxide		Purification of synthesized compounds via methods other than crystalization
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO.4: analyze inorganic & organic qualitative analysis techniques	SO1,SO2	**Unit4**. Inorganic qualitative analysis Insoluble residue, Rare metal analysis white residue, yellow residue and green residue analysis of mixture containing rare elements like molybdenum,tellurium,zirconium organic qualitative analysis Separation and identification of ternary mixture of organic compounds		Purification by distillation under reduced pressure
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO.5: Apply and understand microwave and ultra sound organic synthesis techniques	SO1,SO2	**Unit5**. Two step Micro wave/ ultrasound assisted synthesis of organic compounds/inorganic compounds Microwave / ultrasound assisted extraction of natural products		Physical parameters of oil and fat analysis

CODE: **Audit Course

Course Name: Human Value, Professional Ethics & Scientific Writing

CREDIT 0

L	T	P
1	**0**	**0**

Pre-requesites- Students should have good coummications skill

Rationale- Stduents will prepare for holistic development, impeccable governance, effective management and Justify climate where 'rights' are encouraged and 'wrongs' are discouraged

Course Outcome: After completion of this course students will

CO1: Create environment in industry/institutions with the highest level of values and ethics

CO2: Apply learning process for holistic development

CO3: Create an environment of impeccable governance

CO4: Create an environment well-laid system of rewards and reprimand

CO5: Will act enable justice and equity for all And Expert in writing scientifically

HUMAN VALUES AND PROFESSIONAL ETHICS

UNIT I Ethics -Definitional aspects; relevance of ethics in society; scope of ethics

UNIT II The philosophical basis of ethics, considerations on moral philosophy personal and family ethics.

UNIT III Ethics in publics affairs - Ethical standards for elected representatives of the people; ethics for the bureaucracy, police and other institutions of coercive authority; basic values in the civil services such as dispassion ,non –partisanship,moral integrity,objectivity,dedication to public service and empathy for weaker sections and groups in society,and non-corruptibility.

UNIT IV Ethics and professions: - ethical values, standard and practices concerning the legal profession, medicine, engineering, etc. Ethics at the workplace: - cybercrime, plagiarism, sexual misconduct, fraudulent use of institutional resources, etc.

UNIT V: Review paper writing, Report writing, Research paper writing, Thesis Writing.

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, 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.

CO1: Create environment in industry/institutions with the highest level of values and ethics

UNIT I Ethics -Definitional aspects; relevance of ethics in society; scope of ethics

Activity	AppX Hrs

CI	1
SW	0
SL	0
Total	1

Session Outcomes (SOs)	**Laboratory Instruction(LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
Create environment in industry/institutions with the highest level of values and ethics		Definitional aspects; relevance of ethics in society; scope of ethics	.

SW-1SuggestedSessionalWork(SW):
a. Assignments:
b. Mini Project
c. Other Activities (Specify):

CO2: Apply learning process for holistic development
The philosophical basis of ethics, considerations on moral philosophy personal and family ethics

Activity	**AppX Hrs**
CI	1
SW	0
SL	0
Total	1

Session Outcomes (SOs)	**Laboratory Instruction(LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
Apply learning process for holistic development		The philosophical basis of ethics, considerations on moral philosophy personal and family ethics	.

CO3: Create an environment of impeccable governance

Ethics in publics affairs - Ethical standards for elected representatives of the people; ethics for the bureaucracy, police and other institutions of coercive authority; basic values in the civil services such as dispassion ,non –partisanship,moral integrity,objectivity,dedication to public service and empathy for weaker sections and groups in society,and non-corruptibility

Activity	AppX Hrs
CI	1
SW	0
SL	0
Total	1

Session Outcomes (SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self Learning (SL)
Create an environment of impeccable governance		Ethical standards for elected representatives of the people; ethics for the bureaucracy, police and other institutions of coercive authority; basic values in the civil services	.

CO4: Create an environment well-laid system of rewards and reprimand
ethical values, standard and practices concerning the legal profession, medicine, engineering, etc. Ethics at the workplace: - cybercrime, plagiarism, sexual misconduct, fraudulent use of institutional resources

Activity	AppX Hrs
CI	2
SW	0
SL	0
Total	2

Session Outcomes (SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self Learning (SL)
Create an environment well-laid system of rewards and reprimand		ethical values, standard and practices concerning the legal profession, medicine, engineering, etc. . Ethics at the	.

		workplace: - cybercrime, plagiarism, sexual misconduct, fraudulent use of institutional resources	

CO5: Will act enable justice and equity for all And Expert in writing scientifically
Review paper writing, Report writing, Research paper writing, Thesis Writing.

Activity	AppX Hrs
CI	2
SW	0
SL	0
Total	2

Session Outcomes (SOs)	**Laboratory Instruction(LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
Will act enable justice and equity for all And Expert in writing scientifically		Review paper writing, Report writing, Research paper writing, Thesis Writing.	.

S. No.	Title	Author	Publisher	Edition& Year
1	*A Textbook on Professional Ethics and Human Values*	*R.S. Naagarazan*	.	2nd *Edition* 2016
2	A Foundation Course in Human Values and Professional Ethics	*Gp Bagaria Rr Gaur,R Sangal*	Perfect Paperback	2016 edition)
		=		

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

MODEOFTRANSACTION:Lecture,demonstration,E-tutoring,discussion,assignments,quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite,MSPower-Point, Online Resources.

CODE: 76CH-352

Course Name: Project Work

-2 0 credit (10credit 3rd+ 10 credit 4th semester)

Pre-requisite: Students should have fundamental of ahemical analysis

Rational: Students will do research in selected area and interpretate data

Course outcome: After completion of thiscourse studends will

CO1: Create new knowledge in chemical science

CO2; Explain data obataned during research

CO3: Prsent and evaluate research findings

CO4; Write research findings in form of research paper

CO5: Solve environmental issues which are based on chemical science

<u>Guidelines for Project work</u>

To provide expertise in research, project work will be alloted to students in 3rd semester and it will be ended in last of 4th semeater. Projrct topic will be selected by students in 3rd semester after review of some research papers according to chosen field in chemical science .The project workcanbe selected and carriedoutinanythrustareas of subject (Experimental or Theoretical) under the guidance of allotted supervisor of thedepartment. The students must submit their thesis/ report in the department as per the date announcedforthe submission. In 3rd semeater students will submit current report and final submission will be in 4th semester.

Internal assessment of the project work will be carried out by respective supervisor throughpower point presentation given by candidatesin last of semester 3rd and 4th. External assessment of thedissertation work will be carried out by an external examiner (nominated by the Chairperson of theDepartment) through power-pointpresentationgiven by candidates

1. Dissertation will contain a cover page, certificate signed by student and supervisor, table ofcontents,introduction,Objective,Literaturereview,methodology,resultsanddiscussionsconclusion,and references.

- The paper sizeto be used should beA-4 size.
- The font size should be12 withTimes New Roman.
- The text of the dissertation may be typed in 1.5 (oneand ahalf) space.

- The print out of the dissertation shall be done on boths ides of the paper (instead of single side printing)
- Thetotal no.of written pages should be between 40 to 60 for dissertation.

2. The candidate shall be required to submit two soft bound copies of dissertation along with a CDinthedepartment as per thedate announced.
3. Dissertation will be evaluated internally by the supervisor allotted to the student during thesemester.
4. The candidate will defend her/his dissertation/project workthrough presentation before the External examiner at theend of semester and willbeawardedmarks.
5. In case, a student is not able to score passing marks in the dissertation exam, he/she will have to resubmit her/his dissertation after making all corrections/improvements & this dissertation shall be evaluated as above.The candidate is required to submit the correctedcopy of the dissertation in hard bound within two weeks after the viva-voce .

Course Title: Project Work **Course Code : 76CH352**

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
	Knowledge	**Research Aptitude**	**Communication**	**Problem Solving**	**Individual and Team Work**	Investigation of Problems	**Modern Tool usage**	**Science and Society**	**Life-Long Learning**	**Ethics**	**Project Management**	**Environment and sustainability**	**The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry**	**To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.**	**understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon -based problems in chemical sciences.**	**Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science**
CO1: Create new knowledge in chemical science	**3**	**1**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**3**	**2**	**2**	**3**	**3**	**1**
CO2; Explain data obataned during research	**2**	**1**	**2**	**2**	**1**	**2**	**3**	**2**	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**1**
CO3: Prsent and evaluate research findings chemical science	**2**	**2**	**1**	**1**	**1**	**2**	**2**	**2**	**1**	**2**	**1**	**2**	**1**	**1**	**2**	**2**
CO4; Write research findings in form of research paper	**2**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**2**	**3**	**3**	**3**	**3**	**2**
CO5: Solve environmental issues which are based on	**2**	-	-	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**3**	**1**	**3**

Legend:1–Low,2–Medium, 3– High

M Sc. Chemistry Semester Iv
Code: 76ch-401
Course Name: Industrial Chemistry
Credits:4

L	T	P
4	0	0

Pre-requisite: Students should have basic knowledge of chemical industry, theoretical aspect of glass, ceramics, fertilizer and cement manufacturing soap, match,metal powders'.

Rationale: The students studying organic chemistry should possess foundational understanding about chemical bonding, structure, reactions and stereochemistry of organic compounds. This will provide applicalbe knoweledge about Nature of bonding in organic compounds, stereochemistry of organic compounds, reaction mechanisms, structure and reactivity, aliphatic and aromatic nucleophilic substitution

CourseOutcomes:

Afterthe completionofthiscourse, thelearner willbeableto:

76CH401.1: Apply quality of raw materials and energy for specific chemical industry
76CH401.2: Expert in theoretical aspect of glass, ceramics, fertilizer and cement manufacturing.
76CH401.3: Explain preparation of materials in small scale industries like soap, match,metal powders etc
76CH401.4:Perform work according to need of sugar industry
76CH401.5: Capable to provide solution of environmental issues related to chemical industry

Unit I

Raw Materials and Energy for Chemical Industry: Raw materials – Characteristics of raw materials and their resources – methods of raw material concentrations – integral utilization of raw materials. Energy for chemical industry – Fuels – classification of fuels – coal – fuel gases and liquid fuels – petroleum – cracking – Octane number – cetane number – composition and uses of coal gas, water gas, producer gas, oil gas and gobar gas.

Unit II

Cement, Ceramics, Glass and Fertilizers Cement: Manufacture – Wet Process and Dry process. Types, Analysis of major constituents, setting of cement, reinforced concrete. Cement industries in India. Ceramics: Important clays and feldspar, glazing and verification.
Glass: Types, Composition, manufacture of Optical glass, colored glasses, lead glass and neutron absorbing glass. Fertilizers: Fertilizer industries in India, Manufacture of ammonia, ammonium salts, urea, superphosphate, triple superphosphate and nitrate salts.

Unit III

Small Scale Chemical Industries Electrothermal and electrochemical industries: electroplating surface coating industries – oils, fats and waxes – soaps and detergents – cosmetics. Match industries and fire works: manufacture of some industrially important chemicals like potassium chlorate, and red phosphorus – metal powders.

Unit IV

Sugar and Agro Chemical Sugar: Cane sugar manufacture, recovery of sugar from molasses, sugar estimation, sugar industries in India. Agrochemical industries: Important categories of insecticides, fungicides, herbicides. Mode of action and synthesis of common pesticides like Gammexane, DDT, alathrin, Parathion, Malathion, Baygon, DDVP, Warfarin.

Unit V

Industrial Pollution & Chemical Toxicology Introduction – causes of industrial pollution – thermal power plants – nuclear power reactors– fertilizers andchemical industry – pulp and paper industries – agro based industries – cement industry. Toxic Chemicals in the environment – biochemical effects of arsenic, cadmium, lead, mercury and cyanide.

SchemeofStudies:

Board ofStudy	CourseCode	CourseTitle	Scheme ofstudies(Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
ProgramCore(PCC)	76CH401	INDUSTRIAL Chemistry	4	0	1	1	5	4

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

Note:

SW&SLhastobeplannedandperformedunderthecontinuousguidanceandfeedbackofteacherto ensure outcome ofLearning.

Scheme of Assessment: Theory

Board ofStudy	CouseCode	CourseTitle	SchemeofAssessment(Marks)						
			ProgressiveAssessment(PRA)					EndSemesterAssessment	Total Marks
			Class/HomeAssignment5number 3 markseach (CA)	Class Test2 (2bestout of3) 10 marks each(CT)	Seminarone (SA)	ClassAttendance (AT)	TotalMarks (CA+CT+SA +AT)	(ESA)	(PRA+ESA)
PCC	76CH401	IndustralL Chemistry	15	20	10	5	50	50	100

Course-Curriculum Detailing:

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

76CH401.1: Apply quality of raw materials and energy for specific chemical industry

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self Learning (SL)
SO1.1 Expain Raw materials Characteristics of raw materials and their resources.		Unit-1. Raw Materials and Energy for Chemical Industry	Characteristics of raw

SO1.2 Apply methods of raw material concentrations ,integral utilization of raw materials SO1.3 Explain Fuels , classification of fuels coal fuel gases and liquid fuels SO1.4 Describe petroleum , cracking, Octane number , cetane number SO1.5 explain following topic-water gas, producer gas, oil gas and gobar gas.		1.1 methods of raw material concentrations integral utilization of raw materials 1.2 Energy for chemical industry 1.3 Fuels , classification of fuels 1.4 coal solid fuel gases and liquid fuels 1.5 petroleum – cracking 1.6 Octane number – cetane number 1.7 composition and uses of coal gas, 1.8 water gas, producer gas, 1.9 oil gas and gobar gas. T1- Fuels and characterization T2- raw material method T3 classification of coal analysis	materials and their resources compositio n and uses fuels

SW-1SuggestedSessionalWork(SW):

a.Assignments: discuss Raw materials – Characteristics of raw materials and their resources – methods of raw material concentrations – integral utilization of raw materials
b.Mini Project: Fuels – classification of fuels
c.Other Activities (Specify):

- Note on applications of coal gas, water gas, producer gas, oil gas and gobar gas.

76CH401.2: Explain in theoretical aspect of glass, ceramics, fertilizer and cement manufacturing**.**

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 Describe & apply Cement: Manufacture – Wet Process and Dry process **SO2.2** Explain Analysis of major constituents, setting of cement, reinforced concrete. Cement industries in India **SO2.3** Explain Glass: Types, Composition, manufacture of Optical glass, colored glasses, lead glass and neutron absorbing glass. **SO2.4** Understand and apply Glass: Types, Composition,		Unit-2 Cement, Ceramics, Glass and Fertilizers Cement: Manufacture 2.1Wet Process and Dry process. Types of cement . 2.2 Analysis of major constituents, 2.3 setting of cement, reinforced concrete. Cement industries in India. 2.4 Ceramics Important clays and feldspar, glazing and verification. 2.4 Glass Types, Composition, 2.5 manufacture of Optical glass, colored glasses, lead glass and neutron absorbing glass. 2.6 Fertilizers Fertilizer industries in India, 2.7 Manufacture of ammonia, ammonium salts,	Types of cement . Glass: Types, Composition, manufacture of Optical glass, colored glasses, lead glass and neutron absorbing glass Fertilizers use

manufacture of Optical glass, colored glasses, lead glass and neutron absorbing glass. **SO2.5** Explain Fertilizers: Fertilizer industries in India, Manufacture of ammonia, ammonium salts, urea, superphosphate, triple superphosphate and nitrate salts.		2.8 urea, superphosphate, 2.9 triple superphosphate and nitrate salts. T1- manufacture of Fertilizers T2- Manufacture of ammonia, ammonium salts, T3- setting and hardning of cement	

SW-2 Suggested Sessional Work (SW):

a.Assignments:

Apply Glass Types, Composition, manufacture of Optical glass, colored glasses, lead glass and neutron absorbing glass.

b.Mini Project: Fertilizers: Fertilizer industries in India,

c.Other Activities (Specify): Write uses of Fertilizers.

76CH401.3: Explain preparation of materials in small scale industries like soap, match,metal powders etc

Activity	AppX Hrs

CI	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Understand and applySmall Scale Chemical Industries **SO3.2** ExplainElectrothermal and electrochemical industries **SO3.3** Explain electroplating – surface coating industries **SO3.4** Apply effect oils, fats and waxes – soaps and detergents – cosmetics **SO3.5** Explain and apply Match industries and fire works: manufacture of some industrially important chemicals like potassium chlorate, and red phosphorus – metal powders.		**Unit-3.** 3.1Small Scale Chemical Industries 3.2 Electrothermal and electrochemical industries 3.3 electroplating 3.4 surface coating industries oils, fats and waxes 3.5 soaps and detergents 3.6 cosmetics. 3.7 Match industries and fire works 3.8 manufacture of some industrially 3.9 important chemicals potassium chlorate, and red phosphorus – metal powders. T1- manufacture of some industrially chemical T2- manufacture of soap and detergents. T3- important chemicals potassium chlorate, and red phosphorus – metal powders.	oils, fats and waxes chemicals like potassium chlorate, and red phosphorus – metal powders.

SW-3 Suggested Sessional Work (SW):

a.Assignments: soaps and detergents – cosmetics.
b.Mini Project: Match industries and fire works
c.Other Activities (Specify): manufacture of some industrially important chemicals potassium chlorate, and red phosphorus – metal powders.

76CH401.4: **Explain Perform work according to need of sugar industry.**

Activity	AppX Hrs
CI	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Explain and apply Sugar and Agro Chemical Sugar: **SO4.2** ExplainCane sugar manufacture, recovery of sugar from molasses, **SO4.3** Explain Agrochemical industries **SO4.4**Explain and apply Important categories of insecticides, fungicides, herbicides **SO4.5** Explain and apply synthesis of common pesticides like Gammexane, DDT, alathrin, Parathion, Malathion, Baygon, DDVP, Warfarin.		**Unit-4** 4.1Sugar and Agro Chemical Sugar 4.2 Cane sugar manufacture, 4.3 recovery of sugar from molasses, 4.4 sugar estimation, sugar industries in India. 4.5 Agrochemical industries 4.6 Important categories of insecticides, fungicides, herbicides. 4.7 Mode of action and synthesis of common pesticides 4.8 Gammexane, DDT, alathrin, 4.9 Parathion, Malathion, Baygon, DDVP, Warfarin. T1- manufacture of suger . T2- synthesis of common pesticides T3- synthesis of fungicides	sugar estimation, sugar industries in India. Agrochemical industries

SW-4 Suggested Sessional Work (SW):

a.Assignments: Cane sugar manufacture, recovery of sugar from molasses,
b.Mini Project: synthesis of common pesticides like Gammexane, DDT, alathrin, Parathion, Malathion, Baygon, DDVP, Warfarin.
c.Other Activities (Specify):
Impotance and applications of insecticides, fungicides, herbicides.
76CH401.5: Apply the knowledge of the Capable to provide solution of environmental issues related to chemical industry

Activity	AppX Hrs
Cl	07
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 Explain and apply Industrial Pollution & Chemical Toxicology Introduction **SO5.2** Explain causes of industrial pollution thermal power plants power reactors– fertilizers andchemical industry **SO5.3** Explain and apply effect of pulp and paper industries – agro based industries – cement industry **SO5.4** Explain Toxic Chemicals in the environment – **SO5.5** Explain and apply biochemical effects of arsenic, cadmium, lead, mercury and cyanide.	.	**Unit-5-** 5.1 Industrial Pollution 5.2 Chemical Toxicology 5.3causes of industrial pollution 5.4 thermal power plants 5.5 power reactors– fertilizers andchemical industry 5.6 pulp and paper industries 5.7 agro based industries – 5.8 cement industry. Toxic Chemicals in the environment 5.9 biochemical effects of arsenic, cadmium, lead, mercury and cyanide. T1- Toxic Chemicals in the environment T2- biochemical effects of many chemicals. T3- causes of industrial pollution	Toxic Chemicals in the environment – biochemical effects of arsenic, cadmium, lead, mercury and cyanide.

SW-5 Suggested Sessional Work (SW):
a.Assignments: power reactors– fertilizers andchemical industry, causes of industrial pollution – thermal power plants

b.Mini Project: Toxic Chemicals in the environment
c.Other Activities (Specify): biochemical effects of arsenic, cadmium, lead, mercury and cyanide

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
76CH401.1: Apply quality of raw materials and energy for specific chemical industry	12	02	01	15

76CH401.2: Expert in theoretical aspect of glass, ceramics, fertilizer and cement manufacturing.	12	02	01	15
76CH401.3: Explain preparation of materials in small scale industries like soap, match, metal powders etc	12	02	01	15
76CH401.4:Perform work according to need of sugar industry	12	02	01	15
76CH401.5:. Capable to provide solution of environmental issues related to chemical industry	12	02	01	15
Total Hours	60	10	05	75

Suggestion for End Semester Assessment

SuggestedSpecificationTable(ForESA)

CO	**UnitTitles**	**MarksDistribution**			**Total Marks**
		R	**U**	**A**	
CO-1	Unit1	03	01	01	05
CO-2	Unit 2	02	06	02	10
CO-3	Unit 3	03	07	05	15
CO-4	Unit4	-	10	05	15
CO5	Unit 5	3	2	0	05
Total		11	26	13	50

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

The end of semester rassessment for industrial chemistry will be held with written examination of 50 marks

Note.Detailed Assessment rubric need to be prepared by the cours ewiseteachersforabovetasks.Teacherscanalsodesigndifferenttasksasperrequirement,for end semester assessment.

Suggested Instructional/Implementation Strategies:

37. ImprovedLecture
38. Tutorial
39. CaseMethod
40. GroupDiscussion
41. RolePlay
42. Visitto NCL, CSIR laboratories
43. Demonstration
44. ICTBasedTeachingLearning(VideoDemonstration/TutorialsCBT,Blog,Facebook,Twitter,Whatsapp,Mobile,Onlinesources)
45. Brainstorming

Suggested Learning Resources:

(l) **Books:**

(m)

S. No.	Title	Author	Publisher	Edition& Year
1	Chemical Technology,Vol.1	I.Mukhlyonov(ed.), ,	Mir publication, Moscow	III edn., 1979
2	Environmental Chemistry,	A.K.De.,	Wiley Eastern Ltd.,11	edn., Meerut 1989.Chs 5-7
3	Industrial chemistry	B.K Sharma	Goel publishing house	
4	, Industrial Chemistry	B.N.Chakrabarty,	, Oxford&IBH Publishing Co.,New Delhi, 1981.	.,New Delhi, 1981.
5	Industrial Chemistry,	P.P.Singh, T.M.Joseph, R.G.Dhavale,	, Himalaya Publishing House, Bombay,	, 4^{th} edn., 1983
6	, Environmental Pollution and Health Hazards – Causes and Control	A.K. Mukherjee,	Galgotia Press, New Delhi 1986.	Press, New Delhi 1986.

Suggested Web Sources:

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

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

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

Delhi 1986…….

Cours title ; Industrial Chemistry

Course code:76CH 401

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Knowledge	Research Aptitude	Communication	Problem Solving	Individual and Team Work	Investigation of Problems	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and sustainability	The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry	To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.	understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon-based problems in chemical sciences.	Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science
CO1 : Apply quality of raw materials and energy for specific chemical industry	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO 2 : : Expert in theoretical aspect of glass, ceramics, fertilizer and cement manufacturing	2	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3 : Explain preparation of materials in small scale industries like soap, match,metal powders etc	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO 4: Perform work according to need of sugar industry	2	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
CO 5:. Capable to provide solution of envirmental issues related to chemical industry	2	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

Course Curriculum Mapping

POs &PSOsNo.	COsNo.&Titles	SOsNo.	LaboratoryInstruction(LI)	Classroom Instruction(CI)	Self Learning(SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1:Apply quality of raw materials and energy for specific chemical industry	SO1.1SO1.2S O1.3SO1.4 SO1.5		Unit-1.Raw Materials and Energy for Chemical Industry 1.1,1.2,1.3,1.4,1.5,1.6,1.7	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 2 : Expert in theoretical aspect of glass, ceramics, fertilizer and cement manufacturing.	SO2.1SO2.2S O2.3 SO2.4 SO2.5		Unit-2. Cement, Ceramics, Glass and Fertilizers Cement: Manufacture 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9	.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3 : : Explain preparation of materials in small scale industries like soap, match,metal powders etc	SO3.1SO3.2 SO3.3 SO3.4 SO3.5		Unit-3 : Small Scale Chemical IndustriesElectrothermal and electrochemical industries 3.1, 3.2,3.3,3.4,3.5,3.6,3.7	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4: Perform work according to need of sugar industry	SO4.1SO4.2S O4.3SO4.4 SO4.5		Unit-4 : Sugar and Agro Chemical Sugar 4.1, 4.2,4.3,4.4,4.5,4.6,4.7	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 5: :. Capable to provide solution of envirmental issues related to chemical industry	SO5.1SO5. 2SO5.3SO5 .4 SO5.5		Unit 5: Industrial Pollution & Chemical Toxicology 5.1,5.2,5.3,5.4,5.5,5.6,5.7	Toxic Chemicals in the environment .

Course Name: Research Methodology & Research Ethics
Course Code: 76 CH402
No. Of Credits: 2

L	T	P
2	0	0

Pre-requisite: Students must have fundamental knowledge of precision and accuracy, types of error, data collections, mean, median and mod etc to understand the concept of research program and its methodology.

Rationale: The rationale for choosing a specific research methodology is crucial as it provides a solid foundation for the entire research process. The choice of methodology should align with the research objectives and questions, guiding the researcher in collecting, analyzing, and interpreting data.

Course Outcomes:
After the completion of this course, the learner will able to
76CH401.1: Discuss the purpose of research, research process and research design by acquiring the knowledge of types and method of research.

76CH-401.2: Conceptualize and design research projects, including selecting appropriate data collection methods and planning for subsequent analysis.

76CH-401.3: Explain the processing and analysis of data with the skills and knowledge necessary to manage and analyze data effectively.

76CH-401.4:Understand a foundational understanding of the ethical considerations, philosophical principles, and standards of scientific conduct that are crucial in various fields of study.
76CH-401.5: Explain of the ethical considerations and standards related to publishing academic and research work.

UNIT-I (76CH401.1): Introduction & Research design
Nature and objectives of research, Methods of Research: historical, descriptive and experimental. Types of Research, Research process, research approaches, criteria for good research meaning of research design .

UNIT II (76CH-401.2): Data Collection & Analysis

Types of data, methods and techniques of data collection, Hypothesis Testing, primary and secondary data, meta analysis, historical methods, content analysis, devices used in data collection.

UNIT III (76CH-401.3): Processing and analysis of data

Measures of central Tendency. Measures of dispersion. Measures of variation. Measures of central tendency vs. measures of dispersion. Normal distribution. Measures of skewness and Interpretation. Correlation and regression: types & application. Chi-square test its purpose and use.

UNIT IV (76CH-401.4): Philosophy, Ethics & Scientific conduct

Introduction to philosophy: definition, nature and scope, concept, branches, Ethics: definition, moral philosophy, nature of moral judgements and reactions, Ethics with respect to science and research Intellectual honesty and research integrity,

UNIT V (76CH-401.5): Publication Ethics

Publication ethics: definition, introduction and importance , Best practices / standards setting initiatives and guidelines: COPE, WAME, etc. Conflicts of interest Pblication misconduct: definition, concept, problems that lead to unethical behavior and vice versa.

Reference Book

Research in Education, 10th Edition, Best & Kahn

Research Methodology C.R.KOTHAR

Methodology of Educational Research, Lokesh Koul

SUGGESTED WEB SOURCES

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

Mode OF Transaction:Lecture,demonstration,E-tutoring,discussion,assignments,quizzes, case study, power point; LMS/ICT Tools**:** Digital Classrooms, DLMS, ZOOM, G-Suite,MSPower-Point, Online Resources.

Mappingof COandPO for 76CH-401

Scheme of Studies:

Board ofStudy	CourseCode	CourseTitle	Scheme ofstudies (Hours/Week)					Total Credits(C)
			CI	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
ProgramCore(PCC)	76CH-401	Research Methodology & Research Ethics	2	0	1	1	4	2

Legend : CI: ClassroomInstruction(Includesdifferentinstructionalstrategiesi.e.Lecture(L)andTutorial (T)andothers),

LI: LaboratoryInstruction(IncludesPracticalperformancesinlaboratoryworkshop,fieldorotherlocationsusingdifferentinstructionalstrategies)

SW: SessionalWork(includesassignment,seminar,miniprojectetc.),

SL: SelfLearning,

C: Credits.

Note:

SW&SLhastobeplannedandperformedunderthecontinuousguidanceandfeedbackofteacherto ensure outcome ofLearning.

SchemeofAssessment: Theory

Board ofStudy	Course Code	CourseTitle	SchemeofAssessment(Marks)						
			ProgressiveAssessment(RA)					**EndSemesterAssessment (ESA)**	**Total Marks** (PRA+ ESA)
			Class/HomeAssignment5number 3 markseach (CA)	Class Test2 (2bestoutof3) 10 markseach(CT)	Seminarone + Class activity	ClassAttendance (AT)	Total Marks (CA+CT +SA +AT)		
PCC	76CH-401	Research Methodology & Research Ethics	15	20	10	5	50	50	100

Course-Curriculum Detailing:

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

UNIT-I (76CH401.1): Introduction & Research design

Nature and objectives of research, Methods of Research: historical, descriptive and experimental. Types of Research, Research process, research approaches, criteria for good research meaning of research design.

Activity	**AppX Hrs**
CI	06
LI	0
SW	1
SL	1
Total	08

Session Outcomes (SOs)	LI	CI	SL
After the completion of topics students will be able to SO1.1 understand the nature and objectives of research SO1.2 describe the methods of research like historical, descriptive and experimental SO1.3 explain the criteria for good research like meaning of research design		**UNIT-I (76CH401.1): Introduction & Research design** 1.1 Introduction to nature and objectives of research 1.2 Methods of Research: historical, descriptive and experimental. 1.3 Types of Research 1.4 Research process 1.5 Research approaches Criteria for good research meaning of research design.	• Error types of error

SW-1 Suggested Sessional Work(SW):
Assignments: Precision and accuracy
Mini Project:
Other Activities (Specify):

UNIT II (76CH-401**.2): Data Collection & Analysis**

Types of data, methods and techniques of data collection, Hypothesis Testing, primary and secondary data, meta analysis, historical methods, content analysis, devices used in data collection.

Activity	AppX Hrs
CI	06
LI	0
SW	1
SL	1
Total	08

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
After the completion of topics students will be able to **SO2.1** understand the types of data, methods and techniques of data collection **SO2.2** Explain primary and secondary data **SO2.3 Explain** devices used in data collection		**UNIT II (**76CH-401**.2): Data Collection & Analysis** 2.13Types of data, methods and techniques of data collection 2.14Hypothesis Testing, 2.15Primary and secondary data 2.16Deta analysis 2.17Historical methods T1. Content analysis, devices used in data collection.	• Sampling of materials

SW-2 Suggested Sessional Work (SW):
Assignments: Mean, median and mod
Mini Project:
Other Activities (Specify):

UNIT III (76CH-401**.3): Processing and analysis of data**

Measures of variation. Measures of central tendency vs. measures of dispersion. Normal distribution. Measures of skewers and Interpretation. Correlation and regression: types & application. Chi-square test its purpose and use.

Activity	**AppX Hrs**
CI	06
LI	0
SW	1
SL	1
Total	08

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
After the completion of topics students will be able to **SO3.1** understand the measures of central tendency vs. measures of dispersion **SO3.2** understand measures of skewers and Interpretation **SO3.3** explain correlation and regression: types & application		**UNIT III (**76CH-401**.3): Processing and analysis of data** 3.13 Measures of central Tendency 3.14 Measures of dispersion 3.15 Measures of variation 3.16 Normal distribution 3.17 Measures of skewers and Interpretation 3.18 Correlation and regression: types & application	• Chi-square test, its purpose and use.

SW-3 Suggested Sessional Work (SW):
Assignments: Chi-square test its purpose and use
Mini Project:
Other Activities (Specify):

UNIT IV (76CH-401**.4): Philosophy, Ethics & Scientific conduct**
Introduction to philosophy: definition, nature and scope, concept, branches, Ethics: definition, moral philosophy, nature of moral judgments and reactions, Ethics with respect to science and research Intellectual honesty and research integrity,

Activity	**AppX Hrs**
CI	06
LI	0
SW	1
SL	1

Total	08

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
After the completion of topics students will be able to **SO4.1 understand** the term philosophy **SO4.2 explain the term e**thics with respect to science and research **SO4.3 explain i**ntellectual honesty and research integrity		UNIT IV (76CH-401**.4): Philosophy, Ethics & Scientific conduct** 4.13 Introduction to philosophy 4.14 Introduction to ethics: definition, moral philosophy 4.15 Nature of moral judgments and reactions 4.16 Ethics with respect to science and research 4.17 Intellectual honesty T1 Research integrity	• Ethics with respect to science

SW-4 Suggested Sessional Work (SW)
Assignment: Nature of moral judgments and reactions
Mini Project:
Other Activities (Specify):

UNIT V (76CH-401**.5): Publication Ethics**

Publication ethics: definition, introduction and importance , Best practices / standards setting initiatives and guidelines: COPE, WAME, etc. Conflicts of interest Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa.

Activity	**AppX Hrs**
CI	06
LI	0
SW	1
SL	1
Total	08

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
After the completion of topics students will be able to **SO5.**1 understand publication ethics **SO5.2** explains best practices and standards setting initiatives **SO5.3 Explain the c**onflicts of interest and publication misconduct	.	UNIT V (76CH-401.5): Publication Ethics 5.13 Publication ethics: definition, introduction and importance 5.14 Best practices / standards setting initiatives and guidelines 5.15 COPE 5.16 WAME 5.17 Conflicts of interest 5.18 Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa.	• Best practices

SW-5 Suggested Sessional Work (SW):
Assignments: Standards setting initiatives and guidelines: COPE, WAME, etc
Mini Project:
Other Activities (Specify):

Brief of Hours suggested for the Course Outcome

Course Outcomes	**Class Lecture (Cl)**	**Sessional Work (SW)**	**Self Learning (Sl)**	**Total hour (Cl+SW+Sl)**
76CH401.1: Discuss the purpose of research, research process and research design by acquiring the knowledge of types and method of research	12	02	01	15
76CH-401.**2**: conceptualize and design research projects, including selecting appropriate data collection methods and planning for subsequent analysis.	12	02	01	15
76CH-401.**3**: explain the processing and analysis of data with the skills and knowledge necessary to manage and analyze data effectively.	12	02	01	15

76CH-401.**4**:understand a foundational understanding of the ethical considerations, philosophical principles, and standards of scientific conduct that are crucial in various fields of study.	12	02	01	15
76CH-401.**5: Explain** of the ethical considerations and standards related to publishing academic and research work.	12	02	01	15
Total Hours	60	10	05	75

Suggestion for End Semester Assessment

SuggestedSpecificationTable(ForESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	76CH401.1: Discuss the purpose of research, research process and research design by acquiring the knowledge of types and method of research	03	01	01	05
CO-2	76CH-401.2: Conceptualize and design research projects, including selecting appropriate data collection methods and planning for subsequent analysis.	02	06	02	10
CO-3	76CH-401.3: Explain the processing and analysis of data with the skills and knowledge necessary to manage and analyze data effectively.	03	07	05	15
CO-4	76CH-401.4:Understand a foundational understanding of the ethical considerations, philosophical principles, and standards of scientific conduct that are crucial in various fields of study.	-	10	05	15
CO-5	76CH-401.5: Explain of the ethical considerations and standards related to publishing academic and research work.	03	02	-	05
Total		11	26	13	50

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

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

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

SuggestedInstructional/ImplementationStrategies:

46. Improved Lecture
47. Tutorial
48. Case Method
49. Group Discussion
50. Role Play
51. Visitto NCL, CSIR laboratories
52. Demonstration
53. ICT Based Teaching Learning (VideoDemonstration/TutorialsCBT,Blog,Facebook,Twitter,Whatsapp ,Mobile,Onlinesources)
54. Brainstorming

Suggested Learning Resources:

(n) **Books:**

S. No.	Title	Author	Publisher	Edition& Year
1	Research Methodology	C.R. Kothari	New Age International Publisher	2nd Revision edition
2	Handbook ofResearch Methodology	Dr. Shanti Bhushan Mishra and Dr. Shashi Alok	Educreation Publishing	2nd edition

SuggestedWebSources:

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

ModeofDelivery:Lecture,demonstration,E-tutoring,discussion,assignments,quizzes, case study, power point;

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

AKSUniversity

FacultyofBasic Science, DepartmentofChemistry

CurriculumofM. Sc. In Chemistry Program (Revisedason01August2023)

Title:Research Methodology & Research Ethics **Course Code : 76CH-401**

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Knowledge	Research Aptitude	Communication	Problem Solving	Individual and Team Work	Investigation of Problems	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and sustainability	The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry	To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.	understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon-based problems in chemical sciences.	Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science
76CH401.1: Discuss the purpose of research, research process and research design by acquiring the knowledge of types and method of research	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
76CH-401.**2**: conceptualize and design research projects, including selecting appropriate data collection methods and planning for subsequent analysis.	2	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
76CH-401.**3**: explain the processing and analysis of data with the skills and knowledge necessary to manage and analyze data effectively.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
76CH-401.**4**:understand a foundational understanding of the ethical considerations, philosophical principles, and standards of scientific conduct that are crucial in various fields of study.	2	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
76CH-401.**5:** Explain of the ethical considerations and standards related to publishing academic and research work.	2	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

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

Course Curriculum Map:

POs &PSOsNo.	Cos No. & Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	76CH401.1: Discuss the purpose of research, research process and research design by acquiring the knowledge of types and method of research	SO1.1SO 1.2SO1.3 SO1.4 SO1.5		UNIT-I (76CH401.1): Introduction & Research design 1.1,1.2,1.3,1.4,1.5,1.6,1.7	• Error types of error
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	76CH-401.2: conceptualize and design research projects, including selecting appropriate data collection methods and planning for subsequent analysis.	SO2.1SO 2.2SO2.3 SO2.4 SO2.5		UNIT II (76CH-401.2): Data Collection & Analysis 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9	• Sampling of materials
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	76CH-401.3: explain the processing and analysis of data with the skills and knowledge necessary to manage and analyze data effectively.	SO3.1SO3 .2 SO3.3 SO3.4 SO3.5		UNIT III (76CH-401.3): Processing and analysis of data 3.1, 3.2,3.3,3.4,3.5,3.6,3.7	• Chi-square test, its purpose and use.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	76CH-401.4:understand a foundational understanding of the ethical considerations, philosophical principles, and standards of scientific conduct that are crucial in various fields of study.	SO4.1SO 4.2SO4.3 SO4.4 SO4.5		UNIT IV (76CH-401.4): Philosophy, Ethics & Scientific conduct 4.1, 4.2,4.3,4.4,4.5,4.6,4.7	• Ethics with respect to science
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	76CH-401.5: Explain of the ethical considerations and standards related to publishing academic and research work.	SO5.1SO 5.2SO5.3 SO5.4 SO5.5		UNIT V (76CH-401.5): Publication Ethics 5.1,5.2,5.3,5.4,5.5,5.6,5.7	• Best practices

SEMESTER IV

Elective Courses:

6 Polymer Chemistry (76CH403)
7 Heterocyclic Chemistry (76CH404)

8 Medicinal Chemistry & Natural product (76CH405)

9 Chemistry of materials (76CH406)

10 Advanced synthetic organic chemistry (76 CH407)

Elective Courses
CODE: 76CH-403
COURSE NAME: Polymer Chemistry, No. Of credits:4

L	T	P
4	0	0

Pre-requisite: Students should have basic knowledge of Basic concepts : Monomers, repeat units, degree of polymerization Linear, branched and network polymers.

Rationale: The students studying polymer chemistry should possess foundational understanding about polymer chemistry, structure, reactions and application of organic and inorganic polymers . This will provide applicalbe knoweledge about classification of polymers. polymerization : condensation, addition/radical chain-ionic and co-ordination and copolymerization. polymerization conditions and polymer reactions. polymerization in homogeneous and heterogeneous systems.

Course Outcomes:
Afterthe completionofthiscourse, thelearner will
76CH403.1: Explain the Basic concepts of Monomers, repeat units, degree of polymerization Linear, branched and network polymers and Classification of polymers.
76CH403.2: Explain average molecular weight concept. Number, weight and viscosity averagemolecular weights. Polydispersity an molecular weight distribution
76CH403.3: Describe the analysis and testing of polymers Chemical and physical analysis of polymers
76CH403.4:Explain the structure, Properties and Applications of borazines, boranes and carboranes.

silicone's, polymetalloxanes and polymetallosiloxanes,

76CH403.5: Apply the knowledge of Polymers based on Phosphorous-Phosphazenes, Polyphosphates

Polymers based on Sulphure-Tetrasulphur tetranitride and related compounds

Polymer Chemistry

Unit - 1

Basics: Importance of polymers. Basic concepts : Monomers, repeat units, degree of polymerization Linear, branched and network polymers. Classification of polymers. Polymerization : condensation, addition/radical chain-ionic and co-ordination and copolymerization. Polymerization conditions and polymer reactions. Polymerization in homogeneous and heterogeneous systems.

Unit - 2

Polymer Characterization: Polydispersion-average molecular weight concept. Number, weight and viscosity averagemolecular weights. Polydispersity an molecular weight distribution. The practical significance of molecular weight. Measurement of molecular-weights. End-group, viscosity, light scattering, osmotic and ultracentrifugation methods.

Unit - 3

Analysis and testing of polymers Chemical analysis of polymers, spectroscopic methods, X-ray diffraction study.Microscopy. Thermal analysis and physical testing-tensile strength. Fatigue, impact. Tearresistance, Hardness and abrasion resistance.

Unit - 4

Inorganic Polymers: A general survey and scope of Inorganic Polymers special characteristics, classification, homo and hetero atomic polymers. Structure, Properties and Applications of

a. Polymers based on boron-borazines, boranes and carboranes.
b. Polymers based on Silicon, silicone's polymetalloxanes and polymetallosiloxanes, silazanes.

Unit - 5

Structure, Properties and Application of

a. Polymers based on Phosphorous-Phosphazenes, Polyphosphates
b. Polymers based on Sulphure-Tetrasulphur tetranitride and related compounds.

Co-ordination and metal chelate polymers.

Scheme of Studies:

Board ofStudy	CourseCode	CourseTitle	Scheme ofstudies(Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
ProgramCore(PCC)	76CH403	Polymer Chemistry	4	0	1	1	5	4

Legend: **CI:**Class room Instruction (Includesdifferentinstructionalstrategiesi.e.Lecture(L)andTutorial (T)andothers),
LI: Laboratory Instruction (Includes Practicalperformancesinlaboratoryworkshop,fieldorotherlocationsusingdifferentinstructionalstrategies)
SW: Sessional Work(includesassignment,seminar,miniprojectetc.),

SL: Self Learning,
C:Credits.

Note: SW&SL has to be planned andperformedunderthecontinuousguidanceandfeedbackofteacherto ensure outcome ofLearning.

Scheme of Assessment: Theory

Board ofStudy	CouseCode	CourseTitle	SchemeofAssessment(Marks)						
			ProgressiveAssessment(PRA)					EndSemesterAssessment (ESA)	Total Marks (PRA+ESA)
			Class/HomeAssignment 5number 3 markseach (CA)	Class Test2 (2bestout of3) 10 marks each(CT)	Seminarone (SA)	ClassAttendance (AT)	TotalMarks (CA+CT+SA+AT)		
PCC	76CH407	Polymer Chemistry	15	20	10	5	50	50	100

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

76CH403.1: Apply the concept of classification of polymers. Polymerization process of compound.
Approximate Hours

Activity	AppX Hrs
CI	12
LI	0

SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO1.1 understand importance of polymers. basic concepts : monomers, repeat units, degree of polymerization SO1.2 Apply linear, branched and network polymers. classification of polymers. SO1.3 Explain polymerization : condensation, addition/radical chain-ionic and co-ordination and copolymerization. SO1.4 Explain polymerization conditions and polymer reactions. SO1.5 Understand and apply Polymerization in homogeneous and heterogeneous systems.	. bonding in fullerenes	**Unit-1.0 Basic Polymerisation** 1.1Importance of polymers. basic concepts 1.2 Monomers, repeat units, degree of polymerization 1.3 Linear, branched and network polymers. 1.4 Classification of polymers. 1.5 Polymerization : condensation, addition/radical chain-ionic. 1.6 Co-ordination polymerization. 1.7 Copolymerisation. 1.8 Polymerization conditions 1.9 Polymer reactions. T1-Polymerization in homogeneous. T2-Heterogeneous system T3- Mechanism of polymerization.	linear, branched and network polymers. classification of polymers.

SW-1Suggested Sessional Work(SW):

a.Assignments:

Discuss polymerization : condensation, addition/radical chain-ionic and co-ordination and copolymerization.

b.Mini Project:

polymerization conditions and polymer reactions.

c.Other Activities (Specify):

Note on applications of Polymerization in homogeneous and heterogeneous systems.

76CH403.2: Explain Polydispersion-average molecular weight concept. Number, weight and viscosity averagemolecular weights.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 Understand and apply polydispersion-average molecular weight concept. **SO2.2** Explain number, weight and viscosity averagemolecular weights. **SO2.3** Explain polydispersity an molecular weight distribution. the practical **SO2.4** understand and apply significance of molecular weight. measurement of molecular-weights. **SO2.5** Explain End-group, viscosity,light scattering, osmotic and ultra centrifugation methods.		**Unit-2.0** Polymer Characterization 2.1Introduction of Polymer Characterization 2.2 Property of Polymer Characterization 2.3 Introduction of Polydispersion 2,4Mechanism of Polydispersion 2.5 The practical significance of molecular weight. 2.6 Properties of molecular weight. 2.7 Measurement of molecular-weights. 2.8 Concept of PDI. 2.9 Average molecular weight concept. T1- Number, weight and viscosity. T2- Average molecular weights. T3-Polydispersity an molecular weight distribution.	The practical significance of molecular weight.

SW-2 Suggested Sessional Work (SW):

a.Assignments:

apply polydispersion-average molecular weight concept. number, weight and viscosity averagemolecular weights.

b.Mini Project:

polydispersity an molecular weight distribution

c.Other Activities (Specify):

Write an eassy on Measurement of molecular-weights. End-group, viscosity, light scattering, osmotic and ultra centrifugation methods.

76CH403.3: describe analysis and testing of polymers chemical analysis of polymers, spectroscopic methods, x-ray diffraction study.microscopy.

Activity	**AppX Hrs**
Cl	12
LI	0
SW	2
SL	1
Total	15

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

SO3.1 Understand and apply Analysis and testing of polymers Chemical analysis of polymers **SO3.2** Explainspectroscopic methods, X-ray diffraction study.Microscopy. **SO3.3** explain thermal analysis and physical testing-tensile. so3.4 apply strength. fatigue, impact. tearresistance **SO3.5** explain and apply hardness and abrasion resistance		**Unit-3.0 Analysis and testing of polymers** 3.1Introduction of Analysis an Testing of polymers 3.2 Mechanism of analysis an Testing of polymers. 3.3 Propertiess of analysis and testing of polymers. 3.4 Chemical analysis of polymers. 3.5 Spectroscopic methods, 3.6 X-ray diffraction study. 3.7Microscopy method . 3.8 Thermal analysis of polymer 3.9 physical testing-tensile. T1-Strength and fatigue T2-Impact. tearresistance T3-Hardness and abrasion resistance.	spectroscopic methods, X-ray diffraction study.Microscopy.

SW-3 Suggested Sessional Work (SW):

a.Assignments:

analysis and testing of polymers chemical analysis of polymers

b.Mini Project:

spectroscopic methods, X-ray diffraction study.Microscopy.

c.Other Activities (Specify):

Tearresistance, Hardness and abrasion resistance.

76CH403.4: Explain a general survey and scope of inorganic polymers special characteristics, classification, homo and hetero atomic polymers.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Explain and apply a general survey and scope of Inorganic Polymers special characteristics, **SO4.2** Explainclassification, homo and hetero atomic polymers **SO4.3** Explain Structure, Properties and Applications of Polymers based on boron-borazines, boranes and carboranes. **SO4.4**Explain and apply Structure, Properties and Applications of Polymers based on Silicon. **SO4.5** Explain and apply thesilicone's polymetalloxanes and polymetallosiloxanes, silazanes.		**Unit-4.0 Inorganic Polymers** 4.1 A general survey and scope of Inorganic Polymers special characteristics. 4.2 classification of polymers. 4.3 Introduction of homo polymers. 4.4 Properties of homo Polymers. 4.5 Introduction of hetero atomic polymers 4.6 Properties of hetero atomic polymers. 4.7Structure, Properties and Applications of Polymers. 4.8Introduction of boron-borazines,. 4.9Properties of boron-borazines,. T1-boranes and carboranes T2-.Structure, Properties and Applications of Polymers based on Silicon. T3-Explain and apply thesilicone's polymetalloxanes and polymetallosiloxanes, silazanes.	Structure, Properties and Applications of Polymers based on boron-borazines, boranes and carboranes.

SW-4 Suggested Sessional Work (SW):

a.Assignments:

Explain and apply A general survey and scope of Inorganic Polymers special characteristics,

b.Mini Project:
thesilicone's polymetalloxanes and polymetallosiloxanes, silazanes.

c.Other Activities (Specify):
Explain and apply thesilicone's polymetalloxanes and polymetallosiloxanes, silazanes.

a. **76CH403.5**: Apply the knowledge of the Structure, Properties and Application of Polymers based on Phosphorous-Phosphazenes, Polyphosphates.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 Explain and apply the Polymers based on Phosphorous **SO5.2** Explain and apply the Polymers based on Phosphazenes, Phosphazenes, **SO5.3** Explain and apply Polymers based on Polyphosphates **SO5.4** Explain and apply Polymers based on Sulphure-Tetrasulphur tetranitride and related compounds. **SO5.5** Explain and apply The Co-ordination and metal chelate polymers.	.	**Unit-5.0:Structure, Properties and Application of polymer** 5.1Polymers based on Phosphorous. 5.2Polymers based on Phosphazenes. 5.3 Introducton of Phosphazenes. 5.4 Properties of Phosphazenes. 5.5 Structure of Phosphazenes. 5.6 Polymers based on Polyphosphates 5.7 Introducton of Polyphosphates 5.8 Properties of Polyphosphates. 5.9Polymers based on Sulphure. T1-Tetrasulphur tetranitride and related compounds. T2-The Co-ordination and metal chelate polymers. T3- Properties of The Co-ordination and metal chelate polymers.	Polymers based on Phosphazenes, Phosphazenes, Polymers based on Polyphosphates

SW-5 Suggested Sessional Work (SW):

a.Assignments:

Structure, Properties and Application of Polymers based on Phosphorous

b.Mini Project:

Structure, Properties and Application of Polymers based on Phosphazenes, Polyphosphates.

c.Other Activities (Specify):

Polymers based on Sulphure-Tetrasulphur tetranitride and related compounds

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
76CH102.1: Apply the concept of Basics: Importance of polymers. Basic concepts : Monomers, repeat units, degree of polymerization Linear, branched and network polymers. Classification of polymers.	12	02	01	15
76CH102.2: Explain Polydispersion-average molecular weight concept. Number, weight and viscosity averagemolecular weights. Polydispersity an molecular weight distribution.	12	02	01	15
76CH102.3: Describe Analysis and testing of polymers Chemical analysis of polymers, spectroscopic methods, X-ray diffraction study.Microscopy. Thermal analysis and physical testing-tensile strength. Fatigue, impact. Tearresistance, Hardness and abrasion resistance.	12	02	01	15
76CH102.4:Explain A general survey and scope of Inorganic Polymers special characteristics, classification, homo and hetero atomic polymers. Structure, Properties and Applications of Polymers based on boron-borazines, boranes and carboranes.	12	02	01	15
76CH102.5: Apply the knowledge of the **Structure, Properties and Application of** a. Polymers based on Phosphorous-Phosphazenes, Polyphosphates b. Polymers based on Sulphure-Tetrasulphur tetranitride and related compounds. Co-ordination and metal chelate polymers.	12	02	01	15
Total Hours	60	10	05	75

Suggestion for End Semester Assessment

SuggestedSpecificationTable(ForESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Basics: Importance of polymers. Basic concepts	03	01	01	05
CO-2	Polymer Characterization	02	06	02	10
CO-3	Analysis and testing of polymers	03	07	05	15
CO-4	Inorganic Polymers	-	10	05	15
CO-5	Structure, Properties and Application of Polymers	03	02	-	05
Total		11	26	13	50

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

The end of semester assessment for Organic Chemistry I will be held with written examination of 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/ImplementationStrategies:

55. ImprovedLecture
56. Tutorial
57. CaseMethod
58. GroupDiscussion
59. RolePlay
60. Visitto NCL, CSIR laboratories
61. Demonstration
62. ICTBasedTeachingLearning(VideoDemonstration/TutorialsCBT,Blog,Facebook,Twitter,Whatsapp,Mobile,Onlinesources)
63. Brainstorming

Suggested Learning Resources:

(o) **Books:**

S. No.	Title	Author	Publisher	Edition& Year
1	The Chemistry of Polymers	John W Nicholson	Royal Society of Chemistry	Fourth edition 2015
2	Developments in Inorganic polymer Chemistry,	M.F. Lappert and G.J. Leigh.	Elsevier Pub. Co.	2007
3	Principles of Polymer Systems	Ferdinand Rodriguez, Claude Cohen, Christopher K. Ober, Lynden Archer	Taylor & Francis	Sixth edition 2014
4	Handbook of Polymer Synthesis	Graham Swift, Hans R. Kricheldorf, Oskar Nuyken	CRC Press	Revised edition 2004
5	Inorganic Chemistry	Gary Wulfsberg	University Science Books	Third edition 2000
6	Textbook of Polymer Science	Billmeyer	Wiley India Pvt. Limited	Third edition 2007

SuggestedWebSources:

38. https://nptel.ac.in/course.html
39. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
40. https://swayam.gov.in/explorer?category=Chemistry

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

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

AKSUniversity

FacultyofBasic Science, **DepartmentofChemistry**

CurriculumofM. Sc. In Chemistry Program (Revisedason01August2023)

Title: Polymer Chemistry **Course Code : 76CH403**

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Knowledge	Research Aptitude	Communication	Problem Solving	Individual and Team Work	Investigation of Problems	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and sustainability	The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry	To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.	understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon-based problems in chemical sciences.	Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science
CO1: Apply the concept of Importance of polymers. Basic concepts : Monomers, repeat units, degree of polymerization Linear, branched and network polymers. Classification of polymers. Polymerization condensation, addition/radical chain-ionic and co-ordination and copolymerization.	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO2: Explain Polydispersion-average molecular weight concept. Number, weight and viscosity averagemolecular weights. Polydispersity an molecular weight. distribution.	2	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3 : Describe Analysis and testing of polymers Chemical analysis of polymers, spectroscopic methods, X-ray diffraction study.Microscopy	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO 4: ExplainA general survey and scope of Inorganic Polymers special characteristics, classification, homo and hetero atomic polymers. Structure, Properties and Applications of Polymers based on boron-borazines, boranes and carboranes.	2	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
CO 5: Apply the knowledge of the Structure, Properties and Application of Polymers.	2	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

Course Curriculum Mapping

POs &PSOsNo.	Cos No. & Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1 Apply the concept of Importance of polymers. Basic concepts : Monomers, repeat units, degree of polymerization Linear, branched and network polymers. Classification of polymers. Polymerization condensation, addition/radical chain-ionic and co-ordination and copolymerization.	SO1.1SO1.2S O1.3SO1.4 SO1.5		Unit-1.0 Basic importance of polymer 1.1,1.2,1.3,1.4,1.5,1.6,1.7	linear, branched and network polymers. classification of polymers.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 2 : Explain Polydispersion-average molecular weight concept. Number, weight and viscosity averagemolecular weights. Polydispersity an molecular weight. distribution.	SO2.1SO2.2S O2.3 SO2.4 SO2.5		Unit-2 Polymer Characterization 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9	The practical significance of molecular weight.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3 Describe Analysis and testing of polymers Chemical analysis of polymers, spectroscopic methods, X-ray diffraction study.Microscopy	SO3.1SO3.2 SO3.3 SO3.4 SO3.5		Unit-3 :Analysis and testing of polymers 3.1, 3.2,3.3,3.4,3.5,3.6,3.7	spectroscopic methods, X-ray diffraction study.Microscopy. .
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4: ExplainA general survey and scope of Inorganic Polymers special characteristics, classification, homo and hetero atomic polymers. Structure, Properties and Applications of Polymers based on boron-borazines, boranes andcarboranes.	SO4.1SO4.2S O4.3SO4.4 SO4.5		Unit-4 : Inorganic Polymers 4.1, 4.2,4.3,4.4,4.5,4.6,4.7	boron-borazines, boranes andcarboranes.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 5: Apply the knowledge of the Structure, Properties and Application of Polymers**.**	SO5.1SO5.2S O5.3SO5.4 SO5.5		Unit 5: Structure, Properties and Application of Polymers 5.1,5.2,5.3,5.4,5.5,5.6,5.7	Polymers based on Polyphosphates

M.Sc. Chemistry Semester IV

Course Code: 76CH404

Course Name: Heterocyclic Chemistry (Elective Paper)

L	T	P
3	1	0

Pre-requisite: Students should have basic knowledge of nomenclature of heterocycliccompound,aromatic and non aromatic compound.

Rationale: This course will provide applicable knowledge about heterocyclic synthesis & small ring heterocycles, Fused heterocyclic systems & meso-ionic heterocycles, synthesis and characteristics of 5- and 6-membered ring systems-phosphorinanes, and phosphorines.

Course outcomes:

Afterthe completionofthiscourse, thelearner willbeableto:

CO1: Explain & apply heterocyclic chemistry
CO2: Explain nomenclatureof heterocyclic chemistry.
CO3: Explain synthesis of heterocyclic compounds.
CO4: Apply heterocyclic synthetic route.
CO5: Explain to predict theoretically synthesis of newer heterocyclic

Unit-I

Nomenclature of Heterocycles & Aromatic Heterocycles

Replacement and systematic nomenclature (Hantzsch-wWidman system) for monocyclic fused and bridged heterocycles. General chemical behavior of aromatic heterocycles, classification (structural type), criteria of aromaticity (bond lengths, ring current and chemical shifts in H NMR-spectra, empirical resonance energy, delocaization energy and Dewar resonance energy, diamagnetic susceptibility exaltations).

Unit-II

Non-aromatic Heterocycles

Strain- Bond angle and torsional and their consequences in small ring heterocycles. Conformation of six-membered heterocycles with reference to molecular geometry, barrier to ring inversion, pyramidal inversion and 1,3-diaxial interaction. Stereo-electronic effects-anomeric and related effects. Attractive interactions- hydrogen bonding and intermolecular nucleophilic interactions.

Unit-III

Heterocyclic Synthesis & Small Ring Heterocycles

Principles of heterocyclic synthesis involing cyclization reactions and cycloaddition reactions.

Three-membered and four-membered heterocycles-synthesis and reactions of aziridines, oxiranes thiiranes and Azitidines.

Unit-IV

Fused Heterocyclic systems & Meso-ionic heterocycles.

Synthesis and reactions including medicinal applications of benzopyrroles, benzofurans and benzothiophenes. General classification, chemistry of some impotant meos-ionic heterocycles of type-A and B and their applications. Synthesis and reactions of pyrylium salts and pyrones Synthesis and reactions of quinolizinum, benzopyrylim salts and coumarins. Synthesis and reactions of diazines, triazines and thiazines. Synthesis and reactions of azepines and oxepines,

Unit-V

Heterocyclic systems Containing P, As, Sb and B

Heterocyclic ring containing P (synthesis and characteristics of 5- and 6-membered ring systems-phosphorinanes, and phosphorines), Heterocyclic rings containing As and Sb (synthesis and characteristics of 5- and 6-membered ring systems). Heterocyclic rings containing B (synthesis and reactivity).

Scheme of Studies:

Board ofStudy	CourseCode	CourseTitle	Scheme ofstudies(Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
ProgramCore(PCC)	76CH404	Heterocyclic Chemistry	4	0	1	1	5	4

Legend: **CI:** Class room Instruction (Includes different in structional strategies i.e. Lecture(L) and Tutorial (T) andothers),
LI: Laboratory In struction (Includes Practical performances in laboratory workshop, field or other location susing different in structional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

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

Scheme of Assessment: Theory

Board ofStudy	CouseCode	CourseTitle	SchemeofAssessment(Marks)						
			ProgressiveAssessment(PRA)					EndSemesterAssessment	Total Marks
			Class/HomeAssignment5number 3 marks each (CA)	Class Test2 (2bestout of3) 10 marks each(CT)	Seminarone (SA)	ClassAttendance (AT)	TotalMarks (CA+CT+SA +AT)	(ESA)	(PRA+ESA)
PCC	76CH404	Heterocyclic Chemistry	15	20	10	5	50	50	100

Course-Curriculum Detailing:

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

76CH404.1: CO1: Explain & apply heterocyclic chemistry

Activity	**AppX Hrs**
CI	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO1.1 Explain Systematic nomenclature allows individuals to uniquely identify and communicate the structures of heterocyclic and aromatic heterocyclic compounds. SO1.2 Explain The outcome of applying the nomenclature rules to heterocycles and aromatic heterocycles is a standardized way of naming these compounds. SO1.3 Explain The classification (structural type), criteria of aromaticity . SO1.4 Explain NMR-spectra, empirical resonance energy. SO1.5 Explain delocaization energy and Dewar resonance energy, diamagnetic susceptibility exaltations).		Unit-1.0 Nomenclature of Heterocycles & Aromatic Heterocycles 1.1Introduction of Heterocyclic compound. 1.2Replacement and systematic nomenclature (Hantzsch-wWidman system) for monocyclic fused 1.3Replacement and systematic nomenclature (Hantzsch-Widman system) for bridged heterocycles. 1.4 Introduction of aromatic heterocycles. 1.5 Properties of aromatic heterocycles. 1.6 Explain General chemical behavior of aromatic heterocycles. 1.7 classification (structural type), criteria of aromaticity 1.8 Introduction of the NMR spectra. 1.9 Properties of the NMR-	Types of heterocyclic compound

		spectra. T1-Empirical resonance energy. T2- Delocaization energy and Dewar resonance energy. T3-diamagnetic susceptibility exaltations).	

SW-1SuggestedSessionalWork(SW):

a.Assignments:

Discuss Replacement and systematic nomenclature (Hantzsch-wWidman system) for monocyclic fused and bridged heterocycles.

b.Mini Project:

Delocaization energy and Dewar resonance energy

c.Other Activities (Specify):

Note on applications of NMR-spectra, empirical resonance energy.

76CH404.2: Explain nomenclatureof heterocyclic chemistry.

Activity	**AppX Hrs**
CI	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO2.1 Understand Strain-Bond angle and torsional and their consequences in small ring heterocycles **SO2.2** Explain Conformation of six-membered heterocycles with reference to molecular geometry **SO2.3** Explain barrier to ring inversion,pyramidal inversion		**Unit-2.0 Non-aromatic Heterocycles** 2.1Introduction of the non aromatic hetercycles. 2.2 Properties of the non aromatic hetercycles. 2.3 Introduction of the of the Strain-Bond angle. 2.4 Introduction of the of the torsional.	Conformation of six-membered heterocycles with reference to molecular geometry.

and 1,3-diaxial interaction. **SO2.4** Explain Stereo-electronic effects-anomeric and related effects. **SO2.5** Understand Attractive interactions- hydrogen bonding and intermolecular nucleophilic interactions.		2.5 Strain- Bond angle and torsional and their consequences in small ring heterocycles. 2.6 Introduction of the Conformation of six-membered heterocycles compound. 2.7 Properties of the Conformation of six-membered heterocycles compound. 2.8 The Conformation of six-membered heterocycles with reference to molecular geometry. 2.9 barrier to ring inversion, pyramidal inversion and 1,3-diaxial interaction. T1- Stereo-electronic effects-anomeric and related effects . T2- Attractive interactions- hydrogen bonding. T3- Intermolecular nucleophilic interactions.	

SW-2 Suggested Sessional Work (SW):

a.Assignments:

Apply Strain- Bond angle and torsional and their consequences in small ring heterocycles.

b. Mini Project:

Explain Conformation of six-membered heterocycles with reference to molecular geometry

c. Other Activities (Specify):

Write an eassy on Stereo-electronic effects-anomeric and related effects.

76CH404.3: Explain synthesis of heterocyclic compounds.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Understand and apply Principles of heterocyclic synthesis involing cyclization reactions . **SO3.2** Explain Principles of heterocyclic synthesis involing cycloaddition reactions. **SO3.3** Explain Three-membered and four-membered heterocycles-synthesis and reactions of aziridines, **SO3.4** Explain Three-membered and four-membered heterocycles-synthesis and reactions of oxiranes **SO3.5** Explain Three-membered and four-membered heterocycles-synthesis and reactions of thiiranes and Azitidines.		Unit-3. **Heterocyclic Synthesis & Small Ring Heterocycles** 3.1Principles of heterocyclic synthesis 3.2 Properties of the heterocyclic synthesis 3.3 Heterocyclic synthesis Involing cyclization reactions . 3.4 Introduction of the Three-membered compound.. 3.5 Introduction of the four-membered compound.. 3.6 Properties of the Three-membered compound.. 3.7 Properties of the four-membered compound.. 3.8 Three-membered and four-membered heterocycles-synthesis and reactions of aziridines. 3.9. Three-membered and four-membered heterocycles-synthesis and reactions of oxiranes **T1-** Three-membered and four-membered heterocycles-synthesis and reactions of	. Three-membered and four-membered heterocycles-synthesis and reactions of aziridines.

		thiiranes T2- Properties of three-membered and four-membered heterocycles-synthesis reactions of thiiranes **T3-** Properties of three-membered and four-membered heterocycles-synthesis reactions of oxiranes.	

SW-3 Suggested Sessional Work (SW):

a.Assignments:

Explain Principles of heterocyclic synthesis involing cyclization reactions .

b.Mini Project:

Explain Three-membered and four-membered heterocycles-synthesis and reactions of aziridines,**c.Other Activities (Specify):**

Explain Principles of heterocyclic synthesis involing cycloaddition reactions.

76CH404.4: Apply heterocyclic synthetic route.

Activity	**AppX Hrs**
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
		Unit-4.0 Fused Heterocyclic	Synthesis and reactions of diazines,

SO4.1 Explain and apply The Synthesis and reactions including medicinal applications of benzopyrroles. **SO4.2** Explainanalysis of benzofurans and benzothiophenes. **SO4.3** Explain the General classification, chemistry of some impotant meos-ionic heterocycles of type-A and B and their applications . **SO4.**4Explain and apply Synthesis and reactions of pyrylium salts and pyrones Synthesis and reactions of quinolizinum, benzopyrylim salts and coumarins. SO4.5 Explain and apply Synthesis and reactions of diazines, triazines and thiazines. Synthesis and reactions of azepines and oxepines,		systems & Meso-ionic heterocycles. 4.1 Introduction of fused heterocyclic systems. 4.2Introduction of meso-ionic heterocycles. 4.3 The Synthesis and reactions including medicinal applications of benzopyrroles. 4.4 The Synthesis and reactions including medicinal applications of benzofurans 4.5 The Synthesis and reactions including medicinal applications of benzothiophenes. 4.6 General classification, chemistry of some impotant meos-ionic heterocycles of type-A and B and their applications 4.7 Synthesis and reactions of pyrylium salts 4.8 Synthesis and reactions of pyrones 4.9 Synthesis and reactions of quinolizinum. T1 - Synthesis and reactions of benzopyrylim salts and coumarins. T2-Synthesis and reactions of diazines, triazines and thiazines. T3-Synthesis and reactions of azepines and oxepines.	

SW-4 Suggested Sessional Work (SW):

a.Assignments:

Explain and apply The Analysis of Synthesis and reactions including medicinal applications of benzopyrroles

b.Mini Project:

Explainanalysis of Synthesis and reactions of pyrylium salts and pyrones Synthesis and reactions of coumarins.

c.Other Activities (Specify):

Explain and apply Synthesis and reactions of azepines and oxepines,

76CH404.5: Explain to predict theoretically synthesis of newer heterocyclic

Activity	**AppX Hrs**
CI	12
LI	0
SW	2
SL	1
Total	10

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 Explain and apply the Heterocyclic ring containing P (synthesis and characteristics of 5- and 6-membered ring systems- phosphorinanes. **SO5.2** Explain Heterocyclic ring containing P (synthesis and characteristics of 5- and 6- membered ring systems- phosphorines . **SO5.3** Explain and apply Heterocyclic rings containing As. **SO5.4**Explain and apply The Heterocyclic rings containing Sb (synthesis and characteristics of 5- and 6-membered ring systems). **SO5.5** Explain and apply The Heterocyclic rings containing B (synthesis and reactivity).	.	**5.1 Clinical chemistry:** 5.1Introduction of heterocyclic ring compound. 5.2 Heterocyclic ring containing P (synthesis and characteristics of 5- membered ring systems- phosphorinanes 5.3Heterocyclic ring containing P (synthesis and characteristics of 6- membered ring systems- phosphorinanes. 5.4Heterocyclic ring containing P (synthesis and characteristics of 5- and 6-membered ring systems- phosphorines . 5.5 Introduction of Heterocyclic rings containing As. 5.6 Properties of Heterocyclic rings containing As. 5.7Explain and apply Heterocyclic rings containing As. 5.8 The Heterocyclic rings containing Sb (synthesis and characteristics of 5- membered ring systems 5.9 The Heterocyclic rings containing Sb (synthesis and characteristics of 6-membered ring systems). **T1-**Introduction of Heterocyclic rings containing B (synthesis and reactivity). T2- Properties of Heterocyclic rings containing B (synthesis and reactivity). T3-4Heterocyclic ring containing P (synthesis and characteristics of 6-membered ring systems- phosphorines .	Explain and apply Heterocyclic rings containing As.

SW-5 Suggested Sessional Work (SW):

a.Assignments:

Explain and apply Heterocyclic ring containing P (synthesis and characteristics of 5- and 6-membered ring systems-phosphorinanes.

b.Mini Project:

Explain and apply Heterocyclic rings containing As.

c.Other Activities (Specify):

Explain The Heterocyclic rings containing Sb (synthesis and characteristics of 5- and 6-membered ring systems).

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
76CH404.1: Explain & apply heterocyclic chemistry	12	02	01	15
76CH404.2: Explain nomenclatureof heterocyclic chemistry.	12	02	01	15
76CH404.3: Explain synthesis of heterocyclic compounds.	12	02	01	15
76CH404.4:Apply heterocyclic synthetic route.	12	02	01	15
76CH404.5: Explain to predict theoretically synthesis of newer heterocyclic.	12	02	01	15
Total Hours	60	10	05	75

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	UnitTitles	MarksDistribution			Total Marks
		R	U	A	
CO-1	**Nomenclature of Heterocycles & Aromatic Heterocycles**	03	01	01	05
CO-2	**Non-aromatic Heterocycles**	02	06	02	10
CO-3	**Heterocyclic Synthesis & Small Ring Heterocycles**	03	07	05	15
CO-4	**Fused Heterocyclic systems & Meso-ionic heterocycles.**	-	10	05	15
CO-5	**Heterocyclic systems Containing P, As, Sb and B**	03	02	-	05
Total		11	26	13	50

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

Theendofsemesterassessmentfor Medicinal Chemistry and Natural Product I willbeheldwithwrittenexaminationof50 marks

Note.DetailedAssessmentrubricneedtobepreparedbythecoursewiseteachersforabovetasks.Teacherscanalsodesigndifferenttasksasperrequirement,forendsemesterassessment.

SuggestedInstructional/ImplementationStrategies:

64. ImprovedLecture
65. Tutorial
66. CaseMethod
67. GroupDiscussion
68. RolePlay
69. Visitto NCL, CSIR laboratories
70. Demonstration
71. ICTBasedTeachingLearning(VideoDemonstration/TutorialsCBT,Blog,Facebook,Twitter,Whatsapp,Mobile,Onlinesources)
72. Brainstorming

Suggested Learning Resources:

(p) **Books:**

S.No	Title	Author	Publisher	Edition& Year
1	Heterocyclic Chemistry Vol. 1-3	R. R. Gupta, M. Kumar and V. Gupta	Springer Verlag	Edition,2023
2	The Chemistry of Heterocycles	T. Eicher and S. Hauptmann, Thieme	Weinheim : Wiley-VCH	Edition, 2012
3	Heterocyclic Chemistry	J.A. Joule, K. Mills and G.F. Smith, Chapman and Hall.	Taylor & Francis Group	3rd Edition,2020
4	Heterocyclic Chemistry	T.L Gilchrist,	Longman Scientific & Technical, Wiley	Edition,1992
5	An Introduction to the Heterocyclic Compounds	L R. M. Acheson	JohnWiley.	Edition,1976

SuggestedWebSources:

41. https://nptel.ac.in/course.html
42. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
43. https://swayam.gov.in/explorer?category=Chemistry

ModeofDelivery:Lecture,demonstration,E-tutoring,discussion,assignments,quizzes, case study, power point;

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

Title: Hetercycles Chemistry I **Course Code : 76CH404**

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Knowledge	Research Aptitude	Communication	Problem Solving	Individual and Team Work	Investigation of Problems	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and sustainability	The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry	To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.	understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon-based problems in chemical sciences.	Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science
CO1: Explain & apply heterocyclic chemistry	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO2: Explain nomenclatureof heterocyclic chemistry.	2	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3:Explain synthesis of heterocyclic compounds.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO4: Apply heterocyclic synthetic route.	2	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
CO5: Explain to predict theoretically synthesis of newer heterocyclic.	2	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

Legend:1–Low,2–Medium, 3–High

Course Curriculum Map:

POs &PSOsNo.	Cos No.&Titles	SOsNo.	LaboratoryInstruction(LI)	Classroom Instruction(CI)	Self Learning(SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO1: Explain & apply heterocyclic chemistry	SO1.1SO 1.2SO1.3 SO1.4 SO1.5		Unit-1.0 Nature of bonbing in organic molecules 1.1,1.2,1.3,1.4,1.5,1.6,1.7	Types of heterocyclic compound.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO2: Explain nomenclatureof heterocyclic chemistry.	SO2.1SO 2.2SO2.3 SO2.4 SO2.5		Unit-2 Stereochemistry 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9	Conformation of six-membered heterocycles with reference to molecular geometry
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3: Explain synthesis of heterocyclic compounds.	SO3.1SO3 .2 SO3.3 SO3.4 SO3.5		Unit-3 : Reaction mechanism structure and reactivity 3.1, 3.2,3.3,3.4,3.5,3.6,3.7	Three-membered and four-membered heterocycles-synthesis and reactions of aziridines.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO4: Apply heterocyclic synthetic route.	SO4.1SO 4.2SO4.3 SO4.4 SO4.5		Unit-4 : Aliphatic nucleophilic substitution 4.1, 4.2,4.3,4.4,4.5,4.6,4.7	Synthesis and reactions of diazines.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO5: Explain to predict theoretically synthesis of newer heterocyclic	SO5.1SO 5.2SO5.3 SO5.4 SO5.5		Unit 5: Aromatic nucleophilic substitution 5.1,5.2,5.3,5.4,5.5,5.6,5.7	.Explain and apply Heterocyclic rings containing As.

CODE: 76CH405

SUBJECT NAME: Medicinal Chemistry and Natural Product (Elective Paper), Credit 04

L	T	P
3	1	0

Pre-requisite: Students should have basic knowledge of Structure determination, sterochemistry, biosynthesis terpenoids, caretenoids, Plant Pigments.

Rationale: This course will provide applicable knowledge about Development of new drugs, uses of pharmacokinetics in drug development process, Cardiovascular Drug.

COURSE OUTCOMES:

CO1 Explain occurrence, structure properties terpenoids& caretenoids and apply biosynthesis of terpenoids and caretenoids

CO2 Create use of alkaloids and steroids natural products as starting materials for medicines.

CO3 Explain and apply of the field of Plant Pigments, Porphyrins & Prostaglandins natural product chemistry.

CO4. Apply the SAR, Mechanism of action and Pharmacokinetics & Pharmacodynamics of Natural products based medicine.

CO5 Explain and apply the metabolic process of biomolecules in health and illness (metabolic disorders)

UNIT 1: Terpenoids and caretenoids:

Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule. Structure determination, sterochemistry, biosynthesis and synthesis of the following representative molecules: Citral, Geraniol, a-Terpeneol, Menthol, Farnesol, Zingiberene, Santonin, Phytol, Abietic acid and Beta-Carotene.

UNIT II: Alkaloids & Steroids

Definition, nomenclature and physiological action, occurrence, isolation, general methods of structure elucidation, degradation, classification based on nitrogen heterocyclic ring, role of alkaloids in plants.

Structure, stereochemistry, synthesis, Nicotine, Atropine, Quinine and Morphine.

Steroids :Isolation, structure determination and synthesis of cholestereol, Bile acids, Andosterone, Testosterone, progestrone, Aldosterone.

UNIT III - Plant Pigments, Porphyrins & Prostaglandins

Plant Pigments- Isolation and synthesis of Apigenin, Luteolin, Quercetin, Myrcetin, Quercetin-3-glucoside, Vitexin, Diadzein, Butein, Aureusin, Cyanidine-7- arabinoside, Cyanidin, Hirsutidin.

Porphyrins - Structure and synthesis of Haemoglobin and Chlorophyll Prostaglandins

Occurrence , nomenclature classification, biogenesis and physiological effects. Synthesis of PGE_2 and PGF_2

UNITIV: Drug design, Pharmacokinetics & Pharmacodynamics

Development of new drugs, procedures followed in drug design, concepts of lead compound and lead modification, concepts of prodrug and soft drug , structure- activity relationship(SAR), factors affecting bioactvity, resonance, inductive effect, isosterism, bio-isosterism, spatial considerations. Theories of drug activity: occupancy theory, rate theory, induced fit theory. Quantitative structure activity relationship . History and development of QSAR. Concepts of drug receptors. Free-Wilson analysis, Hansch analysis, relationship between free-Wilson and Hansch analysis. LD-50,ED-50(Mathematical deivations of equations excluded).

Pharmacokinetics

uses of pharmacokinetics in drug development process.

Pharmacodynamics

drug metabolism, xenobiotics, biotransformations, significance of drug metabolism in medicinal chemistry.

UNIT V: Different types medicine, structure function and uses

Antineoplastic agents, Cardiovascular Drug, Local Antiinfective Drugs, Psychoactive Drug- the Chemotherapy of mind, Antibiotics

Scheme of Studies:

Board ofStudy	**CourseCode**	**CourseTitle**	**Scheme ofstudies(Hours/Week)**					**Total Credits (C)**
			Cl	**LI**	**SW**	**SL**	**Total Study Hours(CI+LI+SW+SL)**	
ProgramCore(PCC)	76CH102	Medicinal Chemistry & Natural product	4	0	1	1	5	4

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

Note: SW& SL has to be planned and performed under the continuous guidance and feed back of teacher to ensure outcome ofLearning.

Scheme of Assessment: Theory

			SchemeofAssessment(Marks)

Board ofStudy	CouseCode	CourseTitle	**ProgressiveAssessment(PRA)**					**EndSemesterAssessment (ESA)**	**Total Marks** (PRA+ESA)
			Class/HomeAssignment5number 3 markseach (CA)	Class Test2 (2bestout of3) 10 marks each(CT)	Seminarone (SA)	ClassAttendance (AT)	TotalMarks (CA+CT+SA +AT)		
PCC	76CH405	Medicinal Chemistry & Natural product	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.

76CH405.1: **Explain occurrence, structure properties terpenoids& caretenoids and apply biosynthesis of terpenoids and caretenoids**

Activity	**AppX Hrs**
CI	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO1.1 Explain Classification, nomenclature, occurrence of terpenoids. SO1.2 Explain Isolation of terpenoids, general methods of structure determination of terpenoids. SO1.3 Explain isoprene rule in terpenoids. SO1.4 Explain Structure determination, sterochemistry, biosynthesis and synthesis of the following representative molecules: Citral, Geraniol, Menthol, Farnesol SO1.5 Explain Structure determination, sterochemistry, biosynthesis and synthesis of the following representative molecules: Zingiberene, Santonin, Phytol, Abietic acid and Beta-Carotene.		Unit-1.0 Terpenoids 1.1 ntroduction of terpenoids, occurrence of terpenoids. 1.2Isolation of terpenoids, general methods of structure determination of terpenoids. 1.3isoprene rule. 1.4 Structure determination, sterochemistry, 1.6 Biosynthesis and synthesis of the following representative molecules: Citral, 1.7 Structure determination, sterochemistry, biosynthesis and synthesis of the Geraniol, 1.8 Structure determination, sterochemistry, biosynthesis and synthesis of the Zingiberene, 1.9 Structure determination, sterochemistry, biosynthesis and synthesis of the Santonin,	Application of terpenoids

		T1 - Structure determination, sterochemistry, biosynthesis and synthesis of the Phytol, T2 - Structure determination, sterochemistry, biosynthesis and synthesis of the Abietic acid and T3 - Structure determination, sterochemistry, biosynthesis and synthesis of the Beta-Carotene.	

SW-1SuggestedSessionalWork(SW):

a.Assignments:

Discuss Structure determination, sterochemistry, biosynthesis and synthesis of the following representative molecules: Citral, Geraniol,

b.Mini Project:

Isolation of terpenoids from plants.

c.Other Activities (Specify):

Note on applications of Abietic acid and Beta-Carotene.

76CH405.2: **Create use of alkaloids and steroids natural products as starting materials for medicines.**

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 Understand Definition, nomenclature and physiological action of alkaloid. **SO2.2** Explain occurrence, isolation, general methods of		**Unit-2.0** Alkaloid 2.1.Definition, nomenclature and physiological action of alkaloid.	Steroids :Isolation, structure determination and synthesis of cholestereol, Bile acids.

structure elucidation, degradation of alkaloid. **SO2.3**Explain classification based on nitrogen heterocyclic ring, role of alkaloids in plants. **SO2.4** Understand and apply Structure, stereochemistry, synthesis of Nicotine, Atropine, Quinine and Morphine. **SO2.5** Explain Steroids :Isolation, structure determination and synthesis of cholestereol, Bile acids, Andosterone, Testosterone, progestrone, Aldosterone.		2.2 Occurrence, isolation, general methods of structure elucidation, degradation of alkaloid. 2.3 Classification based on nitrogen heterocyclic ring, 2.4 Role of alkaloids in plants. 2.5 Structure, stereochemistry, synthesis of Nicotine. 2.6 Structure, stereochemistry, synthesis of Atropine. 2.7 Structure, stereochemistry, synthesis of Quinine. 2.8 Structure, stereochemistry, synthesis of Morphine. 2.9 Steroids :Isolation, structure determination and synthesis of cholestereol. T1 - Structure, stereochemistry, synthesis of Bile acids. T2 - Structure, stereochemistry, synthesis of Andosterone, Testosterone. T3 - Structure, stereochemistry, synthesis of Progestrone, Aldosterone.	

SW-2 Suggested Sessional Work (SW):

a.Assignments:

Apply Structure, stereochemistry, synthesis of Nicotine, Atropine.

b.Mini Project:

Occurrence, isolation, general methods of structure elucidation, degradation of alkaloid.

c.Other Activities (Specify):

Write an eassy on medicinal values of specific structure determination and synthesis of Quinine

76CH405.3: **Explain and apply of the field of Plant Pigments, Porphyrins & Prostaglandins natural product chemistry.**

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Explain and apply typesofPlant Pigments- Isolation and synthesis of Apigenin, Luteolin, Quercetin. **SO3.2** Explain Isolation and synthesis3-glucoside, Vitexin, Diadzein, Butein. **SO3.3** Explain Isolation and synthesisAureusin, Cyanidine-7-arabinoside, Cyanidin, Hirsutidin. **SO3.4** Explain Porphyrins - Structure and synthesis of Haemoglobin and Chlorophyll. SO3.5 Explain Prostaglandins Occurrence , nomenclature classification, biogenesis and physiological effects. Synthesis of PGE_2 and PGF_2.		3.1TypesofPlant Pigments. 3.2 Isolation and synthesis of Apigenin, Luteolin. 3.3 Isolation and synthesis of Quercetin. 3.4 Isolation and synthesis of 3-glucoside, Vitexin, 3.5 Isolation and synthesis of Diadzein, Butein. 3.6 Isolation and synthesisAureusin, 3.7 Isolation and synthesisCyanidine-7-arabinoside,. 3.8 Isolation and synthesisCyanidin. 3.9 Isolation and synthesisHirsutidin. T1-Introduction of Porphyrins T2- Structure and synthesis of Haemoglobin and Chlorophyll. T3 - Prostaglandins Occurrence , nomenclature classification, biogenesis and physiological effects. Synthesis of PGE_2 and PGF_2.	Porphyrins - Structure and synthesis of Haemoglobin and Chlorophyll.

SW-3 Suggested Sessional Work (SW):

a.Assignments:

Porphyrins - Structure and synthesis of Haemoglobin and Chlorophyll.

b.Mini Project:

Isolation and synthesis of Cyanidin.

c.Other Activities (Specify):

Explanatory note on impotance of Prostaglandins - Occurrence , nomenclature classification, Synthesis of PGE2 and PGF2

76CH405.4: Apply the SAR, Mechanism of action and Pharmacokinetics & Pharmacodynamics of Natural products based medicine.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Explain and apply The Development of new drugs, procedures followed in drug design, concepts of lead compound and lead modification, concepts of prodrug and soft drug , structure- activity relationship(SAR). **SO4.2** Explainfactors		4.1Development of new drugs, procedures followed in drug design. 4.2 Concepts of lead compound and lead modification, 4.3 Concepts of prodrug and soft drug , structure- activity relationship(SAR). 4.4 Factors affecting bioactvity, resonance, 4.5 inductive effect. 4.6 Isosterism, bio-isosterism, spatial considerations. 4.7 Theories of drug activity:	The Free-Wilson analysis, Hansch analysis, relationship between free-Wilson and Hansch analysis.

affecting bioactvity, resonance, inductive effect, isosterism, bio-isosterism, spatial considerations. Theories of drug activity: occupancy theory, rate theory, induced fit theory. Quantitative structure activity relationship. History and development of QSAR. Concepts of drug receptors. **SO4.3** Explain the Free-Wilson analysis, Hansch analysis, relationship between free-Wilson and Hansch analysis. LD-50,ED-50(Mathematical deivations of equations excluded). SO4.4Explain and apply Pharmacokinetics uses of pharmacokinetics in drug development process. SO4.5 Explain and apply the Pharmacodynamics Drug metabolism, xenobiotics, biotrans formations, significance of drug metabolism in medicinal chemistry.		occupancy theory, rate theory, induced fit theory. 4.8 Introduction of quantitative structure activity relationship . 4.9 History and development of QSAR. Concepts of drug receptors. T1- The Free-Wilson analysis, Hansch analysis, relationship between free-Wilson and Hansch analysis. T2 - Introduction of LD-50,ED-50(Mathematical deivations of equations excluded).Pharmacokinetics uses of pharmacokinetics in drug development process **T3 -** Pharmacodynamics drug metabolism, xenobiotics, biotransformations, significance of drug metabolism in medicinal chemistry.	

SW-4 Suggested Sessional Work (SW):

a.Assignments:

Pharmacokinetics uses of pharmacokinetics in drug development process.

b.Mini Project:

Development of new drugs, procedures followed in drug design,

c.Other Activities (Specify):

Impotance and applications of Pharmacodynamics drug metabolism, xenobiotics, biotransformations, significance of drug metabolism in medicinal chemistry.

76CH405.5: **Explain and apply the metabolic process of biomolecules in health and illness (metabolic disorders)**

Activity	AppX Hrs
CI	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO5.1 Explain and apply the aromatic nucleophilic SNAr, SN1 reactions. **SO5.2** Explain benzyne and SRN1 mechanisms **SO5.3** Explain and apply effect of substrate structure, leaving group andattacking nucleophile in aromatic nucleophilic reactions. **SO5.4**Explain and apply Bucherer reaction, alkylation, and amination **SO5.5** Explain and apply The Bamberger rearrangement. The von Richter rearrangement	.	**Unit-5.0: Aromatic Nucleophilic Substitution.** 5.1 Introduction of the aromatic compound. 5.2Aromatic Nucleophilic Substitution. 5.3 Properties of Aromatic Nucleophilic Substitution. 5.4 Introduction of the SNAr mechanism. 5.5 Properties of the SNAr mechanism. 5.6 Introduction and properties of SN1 mechanism 5.7 Introduction and properties of Benzyne mechanism 5.8 Reactivity, effect of substrate structure. 5.9 Effect of leaving group. T1-Effect of attacking nucleophile. T2- Bucherer reaction, the Bamberger rearrangement. T3 - The von Richter rearrangement	Alkylation, amination ,SRN1 mechanism

SW-5 Suggested Sessional Work (SW):

a.Assignments:

Importance of Bucherer reaction, Bamberger rearrangement, Von Richter rearrangement

b.Mini Project:

Pictorial diagram of benzyne intermediate structure and stability

c.Other Activities (Specify):

Stabiltiy of entermediates occur in aromatic nucleophilic reactions.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
76CH103.1: Explain occurrence, structure properties terpenoids& caretenoids and apply biosynthesis of terpenoids and caretenoids	12	02	01	15
76CH103.2: Create use of alkaloids and steroids natural products as starting materials for medicines.	12	02	01	15
76CH103.3: Explain and apply of the field of Plant Pigments, Porphyrins & Prostaglandins natural product chemistry.	12	02	01	15
76CH103.4: Apply the SAR, Mechanism of action and Pharmacokinetics & Pharmacodynamics of Natural products based medicine.	12	02	01	15
76CH103.5: Explain and apply the metabolic process of biomolecules in health and illness (metabolic disorders)	12	02	01	15
Total Hours	60	10	05	75

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	UnitTitles	MarksDistribution			Total Marks
		R	U	A	
CO-1	Terpenoids and caretenoids	03	01	01	05
CO-2	Alkaloids & Steroids	02	06	02	10

CO-3	Plant Pigments, Porphyrins & Prostaglandins.	03	07	05	15
CO-4	drug design, pharmacokinetics & pharmacodynamics	-	10	05	15
CO-5	Different types medicine, structure function and uses.	03	02	-	05
Total		11	26	13	50

R:Remember, U:Understand, A:Apply

The end of semester assessment for Medicinal Chemistry and Natural Product I will be held with written examination of 50 marks

Note.Detailed Assessment rubricneed to be prepared by the coursewise teachers for above tasks.Teacher scan also design different tasks as per requirement, for end semester rassessment.

Suggested Instructional/Implementation Strategies:

73. Improved Lecture
74. Tutorial
75. CaseMethod
76. GroupDiscussion
77. RolePlay
78. Visitto NCL, CSIR laboratories
79. Demonstration
80. ICTBasedTeachingLearning(VideoDemonstration/TutorialsCBT,Blog,Facebook,Twitter,Whatsapp,Mobile,Onlinesources)
81. Brainstorming

Suggested Learning Resources:

(q) **Books:**

S. No.	Title	Author	Publisher	Edition& Year
1	Chemistry, Biological and Pharmacological Properties of Medicinal Plants from the Americas	Ed.Kurt Hostettmann, M.P. Gupta and A. Marston	Harwood Academic	Revised editioneditio n2018

			Publishers. .	
2	Organic Chemistry, Vol 2, Stereochemistry and the chemistry of natural products	I.L. Finar, ELBS.	Longman Scientific & Technical	edition, 1988
3	Rodd's Chemistry of Carbon Compounds.	Martin Frederick Ansell	Elsevier Scientific Publishing Company	2009
4	An Introduction to Medicinal Chemistry	Graham L. Patrick ·	OUP Oxford	Revised edition 2013
5	An Introduction to Drug Design	S. S. Pandeya and J. R. Dimmock	new age international	edition 1997
6	Goodman and Gilman's Pharmacological Basis of Therapeutics	Louis Sanford Goodman, Laurence Brunton, Alfred Gilman, John Lazo, Keith Parker	McGraw-Hill	edition 2005

SuggestedWebSources:

44. https://nptel.ac.in/course.html
45. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
46. https://swayam.gov.in/explorer?category=Chemistry

ModeofDelivery:Lecture,demonstration,E-tutoring,discussion,assignments,quizzes, case study, power point;

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

AKSUniversity

FacultyofBasic Science, **DepartmentofChemistry**

CurriculumofM. Sc. In Chemistry Program (Revisedason01August2023)

Course Title: Natural product and Medicinal Chemistry

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
Course Outcomes	**Knowledge**	**Research Aptitude**	**Communication**	**Problem Solving**	**Individual and Team Work**	Investigation of Problems	**Modern Tool usage**	**Science and Society**	**Life-Long Learning**	**Ethics**	**Project Management**	**Environment and sustainability**	**The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry**	**To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.**	**understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon-based problems in chemical sciences.**	**Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science**
CO1 : Explain occurrence, structure properties terpenoids& caretenoids and apply biosynthesis of terpenoids and caretenoids	3	**1**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**3**	**2**	**2**	**3**	**3**	**1**
CO 2 : Create use of alkaloids and steroids natural products as starting materials for medicines.	2	**1**	**2**	**2**	**1**	**2**	**3**	**2**	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**1**
CO3 : Explain and apply of the field of Plant Pigments, Porphyrins & Prostaglandins natural product chemistry.	2	**2**	**1**	**1**	**1**	**2**	**2**	**2**	**1**	**2**	**1**	**2**	**1**	**1**	**2**	**2**
CO 4: Apply the SAR, Mechanism of action and Pharmacokinetics & Pharmacodynamics of Natural products based medicine.	2	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**2**	**3**	**3**	**3**	**3**	**2**
CO 5: Explain and apply the metabolic process of biomolecules in health and illness (metabolic disorders)	2	**-**	**-**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**3**	**1**	**3**

Course Curriculum Map:

POs &PSOsNo.	Cos No.&Titles	SOsNo.	LaboratoryInstruction(LI)	Classroom Instruction(CI)	Self Learning(SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1:Explain occurrence, structure properties terpenoids& caretenoids and apply biosynthesis of terpenoids and caretenoids	SO1.1SO 1.2SO1.3 SO1.4 SO1.5		Unit-1.0 Nature of bonbing in organic molecules 1.1,1.2,1.3,1.4,1.5,1.6,1.7	Application of terpenoids
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 2 : Create use of alkaloids and steroids natural products as starting materials for medicines.	SO2.1SO 2.2SO2.3 SO2.4 SO2.5		Unit-2 Stereochemistry 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9	Steroids :Isolation, structure determination and synthesis of cholestereol, Bile acids.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3 : Explain and apply of the field of Plant Pigments, Porphyrins & Prostaglandins natural product chemistry.	SO3.1SO3 .2 SO3.3 SO3.4 SO3.5		Unit-3 : Reaction mechanism structure and reactivity 3.1, 3.2,3.3,3.4,3.5,3.6,3.7	Porphyrins - Structure and synthesis of Haemoglobin and Chlorophyll.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4: Apply the SAR, Mechanism of action and Pharmacokinetics & Pharmacodynamics of Natural products based medicine.	SO4.1SO 4.2SO4.3 SO4.4 SO4.5		Unit-4 : Aliphatic nucleophilic substitution 4.1, 4.2,4.3,4.4,4.5,4.6,4.7	The Free-Wilson analysis, Hansch analysis, relationship between free-Wilson and Hansch analysis.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 5: Explain and apply the metabolic process of biomolecules in health and illness (metabolic disorders)	SO5.1SO 5.2SO5.3 SO5.4 SO5.5		Unit 5: Aromatic nucleophilic substitution 5.1,5.2,5.3,5.4,5.5,5.6,5.7	Alkylation, amination ,SRN1 mechanism.

M.Sc. Semester IV

Course Name: Chemistry of Materials, Corse Code 76CH406

L	T	P
3	1	0

Pre-requisite: Students should have basic knowledge of the chemistry of the design, synthesis, and characterization of assemblies of molecules whose properties arise from interactions between them of Chemistry of Material.

Rationale: The students studying chemistry of Materials should possess foundational understanding about Nanmaterials , Thermotropic liquid crystal, Ionic conductors, and application , High Tc superconductivity and Molecular hyperpolarisability. This will provide applicable knoweledge about Ceramic structures , mechanical properties Dielectric susceptibility and dielectric constants chemistry of Material.

CourseOutcomes:

Afterthe completionofthiscourse, the learner will

76CH-406.1 Apply the concept of *Ceramics*, Composites and Nanomaterials explain the characterization, properties and applications.

76CH-406.2 Explain the Liquid crystals the positional order and bond orientation and Optical properties of liquid crystals by Liquid crystals.

76CH-406.3 Explain the mechanism of ionic conduction, interstitial jumps (Frenkel); vacancy mechanism, diffusion superionic conductors, phase transtions and mechanism of conduction in superionic conductors. Examples and applications of ionic conductors.

76CH-406.4 Explain the High Tc superconductivity Preparation and characterization of 1-2-3 and 2-1-4 materials. Normal state properties, anisotropy, Tempature dependence of electrical resistance.

76CH-406.5 Apply the knowledge of the Molecular rectifiers and transistors, artificial photosynthetic devices, optical storage memory and switches, sensors. Conducting organics, organic superconductors, magnetism in organic materials. Fullerenes, doped and superconductors.

UNIT I: *Ceramics*, Composites and Nanomaterials.Ceramic structures, mechanical properties, clay products. Refractories, characterization, properties and
applications. Microscopic composites, dispersion-strengthened and particle-reinforced composites, macroscopic composites. Nanocrystalline phase,
preparation procedures, properties and applications.

UNIT II: Liquid Crystals.Thermotropic liquid crystals, positional order, bond orientational order, nematic and smectic mesophases. Molecular arrangement in
smectic A and smectic C phases, optical properties of liquid crystals. Dielectric susceptibility and dielectric constants. Lyotropic phases and their description of
ordering in liquid crystals.

UNIT III: Ionic Conductors.Types of ionic conductors, mechanism of ionic conduction, interstitial jumps (Frenkel); vacancy mechanism, diffusion superionic
conductors, phase transtions and mechanism of conduction in superionic conductors. Examples and applications of ionic conductors.

UNIT IV: High Tc Materials. High Tc superconductivity. Preparation and characterization of 1-2-3 and 2-1-4 materials. Normal state properties, anisotropy,
temperature dependence of electrical resistance, and optical phonon modes. Superconducting state; heat capacity; coherence length, elastic constants,

microwave absorption-pairing and multigap structure in high Tc materials. Applications of high Tc materials.

UNIT V: Organic Solids, Fullerenes, Molecular Devices.Conducting organics, organic superconductors, magnetism in organic materials. Fullerenes, doped,
fullerenes as superconductors. Molecular rectifiers and transistors, artificial photosynthetic devices, optical storage memory and switches, sensors.Non-linear optical materials, non-linear optical effects. Molecular hyperpolarisability.

Scheme of Studies:

Board ofStudy	CourseCode	CourseTitle	Scheme ofstudies(Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
ProgramCore(PCC)	76CH406	Chemistry of material	4	0	1	1	6	4

Legend: **CI:**Class room Instruction (Includesdifferentinstructionalstrategiesi.e.Lecture(L)andTutorial (T)and others),
LI: Laboratory Instruction (Include sPractica lperformancesi nlaboratory workshop,fieldorotherlocationsusingdifferentinstructionalstrategies)
SW: Sessiona lWork (include sassignment,seminar,miniprojectetc.),
SL: Self Learning,
C:Credits.

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

Scheme of Assessment: Theory

Board ofStudy	Couse Code	CourseTitle	SchemeofAssessment(Marks)						
			ProgressiveAssessment(PRA)					EndSemesterAssessment	Total Marks
			Class/HomeAssignment5number 3 markseach (CA)	Class Test2 (2bestout of3) 10 marks each(CT)	Seminarone (SA)	ClassAttendance (AT)	TotalMarks (CA+CT+SA+AT)	(ESA)	(PRA+ESA)
PCC	**76CH406**	**Chemistry of material**	15	20	10	5	50	50	100

Course-Curriculum Detailing:

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

76CH406.1: Apply the concept of *Ceramics*, Composites and Nanomaterials explain the characterization, properties and applications.

Approximate Approximate Hours

Activity	AppX Hrs
CI	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction(LI)	Class room Instruction (CI)	Self Learning (SL)
SO1.1 Explain and Apply the mechanical properties Refractories, characterization, properties and applicatons. SO1.2 Apply the clay products characterization, properties and applicatons. SO1.3 Explain Microscopic composites, dispersion-strengthened. SO1.4 Explain the particle-reinforced composites, macroscopic composites. SO1.5 , Apply the concept of macroscopic composites.		Unit-1.0 *Ceramics*, Composites and Nanomaterials. 1.1 properties and applicatons. 1.2 characterization, properties and applications. 1.3, dispersion- strengthened. 1.4 preparation procedures, properties and applications. 1.5 Draw the Ceramic structures. 1.6 Define the mechanical properties. 1.7 Clay products. 1.8 particle-reinforced composites. 1.9 Microscopic composites. T-1Refractories, characterization, properties and Applications. T-2 Apply the concept of dispersion-strengthened. T-3 Nano crystalline phase, preparation procedures.	Nanocrystalline phase, preparation procedures, properties and applications.

SW-1SuggestedSessionalWork(SW):

a.Assignments: Discuss Microscopic composites, dispersion-strengthened and particle-reinforced composites, macroscopic composites.

b.Mini Project: Apply the project of clay products. Refractories, characterization, properties and applications.

c.Other Activities (Specify):
Note on applications of Nanocrystalline phase and macroscopic composites.

76CH406.2: Explain the Liquid crystals the positional order and bond orientation and Optical properties of liquid crystals by Liquid crystals.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 Describe & apply Cement: Manufacture – Wet Process and Dry process **SO2.2** Explain Analysis of major constituents, setting of cement, reinforced concrete. Cement industries in India **SO2.3** Explain Glass: Types, Composition, manufacture of Optical glass, colored glasses, lead glass and neutron absorbing glass. **SO2.4** Understand and apply Glass: Types, Composition, manufacture of Optical glass, colored glasses, lead glass and neutron absorbing glass. **SO2.5** Explain Fertilizers: Fertilizer industries in India, Manufacture of ammonia, ammonium salts, urea, superphosphate, triple superphosphate and nitrate salts.		Unit-2 Cement, Ceramics, Glass and Fertilizers Cement: Manufacture 2.1Wet Process and Dry process. Types of cement . 2.2 Analysis of major constituents, 2.3 setting of cement, reinforced concrete. Cement industries in India. 2.4 Ceramics Important clays and feldspar, glazing and verification. 2.4 Glass Types, Composition, 2.5 manufacture of Optical glass, colored glasses, lead glass and neutron absorbing glass. 2.6 Fertilizers Fertilizer industries in India, 2.7 Manufacture of ammonia, ammonium salts, 2.8 urea, superphosphate, 2.9 triple superphosphate and nitrate salts. T1- manufacture of Fertilizers T2- Manufacture of ammonia, ammonium salts, T3- setting and hardning of cement	Types of cement . Glass: Types, Composition, manufacture of Optical glass, colored glasses, lead glass and neutron absorbing glass Fertilizers use

SW-2 Suggested Sessional Work (SW):

a.Assignments: .Thermotropic liquid crystals, positional order, bond orientational order.

b.Mini Project: Explain and apply the optical properties of liquid crystals.
c.Other Activities (Specify):
description of ordering in liquid crystals.

76CH406.3: Explain the mechanism of ionic conduction, interstitial jumps (Frenkel); vacancy mechanism, diffusion superionic
conductors, phase transtions and mechanism of conduction in superionic conductors. Examples and applications of ionic conductors.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Explain the Types of ionic conductors. **SO3.2 Discuss the** interstitial jumps (Frenkel); vacancy mechanism. **SO3.3 Explain the** Diffusion superionic conductors, **SO3.4** phase transtions and mechanism of conduction. superionic conductors. **SO3.5** Application of ionic conductors and examples.		**Unit-3.0** Ionic Conductors. **3.1** mechanism of ionic conduction. 3.2Mechanism of Frenkel. 3.3Diffusion and mechanism of superionic conductors. 3.4Example and applications. 3.5 vacancy mechanism. 3.6 superionic Conductors 3.7 phase transitions 3.8 Types of ionic conductors 3.9 interstitial jumps (Frenkel) T-1 Types of ionic conductors, mechanism of ionic conduction. T-2 mechanism of conduction in superionic conductors. T-3 applications of ionic conductors.	mechanism of conduction in superionic conductors. Examples and applications of ionic conductors.

SW-3 Suggested Sessional Work (SW):

a.Assignments: Types of ionic conductors, mechanism of ionic conduction.
b.Mini Project: Examples and applications of ionic conductors.

c.Other Activities (Specify): Apply the concept ofdiffusion superionic conductors, phase transtions and mechanism.

76CH406 .4: Explain Preparation and characterization of 1-2-3 and 2-1-4 materials. Normal state properties, anisotropy, temperature dependence of electrical resistance, and optical phonon modes. Superconducting state; heat capacity; coherence length, elastic constants, microwave absorption-pairing and multigap structure in high Tc materials. Applications of high Tc materials.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Explain High Tc superconductivity. **SO4.2** ExplainPreparation and characterization of 1-2-3 and 2-1-4 materials. **SO4.3**Explain the anisotropy, temperature dependence of electrical resistance, and optical phonon modes. **SO4.4** Explain Superconducting state; heat capacity; coherence length, elastic constants. **SO4.5** Apply the concept of microwave absorption-pairing and multigap structure in high Tc materials. Applications of high Tc materials.		**Unit-4.0** High Tc Materials 4.1The Preparation of Tc superconductivity. 4.2characterization of 1-2-3 and 2-1-4 materials. 4.3Normal state properties. 4.4anisotropy and optical phonon modes. 4.5Discuss the microwave absorption-pairing. 4.6 Draw the multigap structure. 4.7 Applications of high Tc materials. 4.8 optical phonon modes. 4.9 Superconducting state; heat capacity. T-1 Explain the heat capacity; coherence length, elastic constants. T-2 microwave absorption-pairing T-3 Draw the structure in high Tc materials.	Superconducting sta Discuss the microwave absorption-pairing and multigap structure in high Tc materials.

SW-4 Suggested Sessional Work (SW):

a.Assignments: Preparation and characterization of 1-2-3 and 2-1-4 materials.

b.Mini Project: Discuss theSuperconducting state; heat capacity
c.Other Activities (Specify): Importance andApplications of high Tc materials.

76CH102.5: Apply the knowledge of the Conducting organics, organic superconductors, magnetism in organic materials. Fullerenes, doped, fullerenes as superconductors. Molecular rectifiers and transistors, artificial photosynthetic devices, optical storage memory and switches, sensors. Non-linear optical materials, non-linear optical effects. Molecular hyperpolarisability.

Activity	**AppX Hrs**
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 Explain organic superconductors, magnetism in organic materials. **SO5.2** Explain Fullerenes, doped, fullerenes as superconductors. **SO5.3** Explain and apply Molecular rectifiers and transistors, artificial photosynthetic devices, optical storage memory and switches, sensors. **SO5.4**Explain and apply the Non-linear optical materials, non-linear optical effects. **SO5.5** Explain and apply Molecular hyperpolarisability.	.	**Unit-5.0:** **5.1**Organic Solids, Fullerenes, Molecular Devices. 5.2Apply the knowledge of magnetism in organic materials. 5.3Fullerences as supercondors. 5.4Artificial photosynthetic devices. 5.5optical storage memory and switches, sensors. 5.6 Effects of non-linear optical materials. 5.7Hyperpolarisability molecular compounds. 5.8 Non-linear optical materials, 5.9 non-linear optical effects. T-1 Explain the Molecular hyperpolarisability. T-2 Discuss the Molecular rectifiers and transistors. T-3 Explain the artificial photosynthetic devices.	Explain the Fullerenes, doped, fullerenes as superconductors.

SW-5 Suggested Sessional Work (SW):
a.Assignments: Organic materials in magnetism of superconductors**.**

b.Mini Project: Artificial photosynthetic devices, optical storage memory and switches, sensors.

c.Other Activities (Specify):
Effects of Non-linear optical materials.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
76CH406.1: Understand the concept ofheterocyclic chemistry composites and Nonmaterial's compound properties and application and Microscopic composites in chemistry of material.	12	02	01	15
76CH406.2: Explain Liquid crystals the positional order and bond orientation and Optical properties of liquid crystals by Liquid crystals.	12	02	01	15
76CH406.3:Describe the mechanism of ionic conduction diffusion superionic, and application by ionic conductors.	12	02	01	15
76CH406.4 Explain the High Tc superconductivity Preparation and characterization of 1-2-3 and 2-1-4 materials. Normal state properties, anisotropy, Tempature dependence of electrical resistance.	12	02	01	15
76CH406.5:. Apply the knowledge of the Molecular rectifiers and transistors, artificial photosynthetic devices, optical storage memory and switches, sensors. Conducting organics, organic superconductors, magnetism in organic materials. Fullerenes, doped and superconductors.	12	02	01	15
Total Hours	60	10	05	75

Suggestion for End Semester Assessment

Suggested Specification Table (ForESA)

CO	UnitTitles	MarksDistribution			Total Marks
		R	U	A	
CO-1	*Ceramics*, Composites and Nanomaterials.	03	01	01	05
CO-2	Liquid Crystals.	02	06	02	10

CO-3	Ionic Conductors.	03	07	05	15
CO-4	High Tc Materials	-	10	05	15
CO-5	Organic Solids, Fullerenes, Molecular Devices.	03	02	-	05
Total		11	26	13	50

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

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

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

Suggested Instructional/Implementation Strategies:

Improved Lecture/Tutorial/Case Method/Group Discussion /Role Play
Visitto NCL, CSIR laboratories
Demonstration
ICTBased Teaching Learning (Video Demonstration /Tutorials CBT, Blog, Facebook, Twitter, Whatsapp, Mobile, Online sources)Brainstorming

Suggested Learning Resources:

(r) Books:

S. No.	Title	Author	Publisher	Edition& Year
1	Material Science and Engineering-An Introduction	W.D. Callister	Wiley	1990
2	Solid State Physics	N.W. Ashcroft	N.D. Mermin, Saunders College	1998
3	Principles of the Solid State	H.V. Keer	Wiley Eastern.	2006
4	Materials Science	J.C. Anderson, K.D. Leaver, J.M. Alexander and R.D. Rawlings,	ELBS.	1994
5	Thermotropic Liquid Crystals.	G.W. Gray, editor, John Wiley.	Wiley	1993
6	Handbook of Liquid Crystals	Kelker and Hatz, Chemie Verlag.	Ke lker	1996

Suggested Web Sources:

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

ModeofDelivery: Lecture,demonstration,E-tutoring,discussion, assignments,quizzes, case study, power point;

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

.

Course Title: Chemistry of Material **Course Code : 76CH406**

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Knowledge	Research Aptitude	Communication	Problem Solving	Individual and Team Work	Investigation of Problems	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and sustainability	The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry	To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.	understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon-based problems in chemical sciences.	Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science
CO1 : Apply the concept of Ceramics, Composites and Nanomaterials explain the characterization, properties and applications.	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO 2 : Explain the Liquid crystals the positional order and bond orientation and Optical properties of liquid crystals by Liquid crystals.	2	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3 :Explain the mechanism of ionic conduction, interstitial jumps (Frenkel); vacancy mechanism, diffusion superionic conductors, phase transtions and mechanism of conduction in superionic conductors. Examples and applications of ionic conductors.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO 4: Explain the High Tc superconductivity Preparation and characterization of 1-2-3 and 2-1-4 materials. Normal state properties, anisotropy, Tempature dependence of electrical resistance.	2	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
CO 5: Applythe knowledge of the Molecular rectifiers and transistors, artificial photosynthetic devices, optical storage memory and switches, sensors. Conducting organics, organic superconductors, magnetism in organic materials. Fullerenes, doped and superconductors.	2	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

Legend:1–Low,2–Medium, 3–High

POs &PSOsNo.	COsNo.&Titles	SOsNo.	LaboratoryInstruction(LI)	Classroom Instruction(CI)	Self Learning (SL)	Self Learning(SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1:. Apply the concept of *Ceramics*, Composites and Nanomaterials explain the characterization, properties and applications. .	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5		Unit-1.0 *Ceramics*, Composites and Nanomaterials. 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9	Nanocrystalline phase, preparation procedures, properties and applications.	Aromaticity in annulenes,Inclusion Compounds
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 2 : Explain Liquid crystals the positional order and bond orientation and Optical properties of liquid crystals by Liquid crystals.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5		Unit-2 Liquid Crystals. 2.1,2.2,2.3,2.4,2.5,2.6,2.7,2.8,2.9	positional order, bond orientational order.	Interconversion of Fischer, Newman, Sawhorse and flying wedge formulae. (practice) Conformational analysis, simple, acyclic systems.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3 : Explain the mechanism of ionic conduction, interstitial jumps (Frenkel); vacancy mechanism, diffusion superionic conductors, phase transtions and mechanism of conduction in superionic conductors. Examples and applications of ionic conductors.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5		Unit-3 :Ionic Conductors. 3.1, 3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9	mechanism of conduction in superionic conductors. Examples and applications of ionic conductors	neration, structure, stability andreactivity of carbocations, carbanions Taftequation
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4: Explain the High Tc superconductivity Preparation and characterization of 1-2-3 and 2-1-4 materials. Normal state properties, anisotropy, Tempature dependence of electrical resistance.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5		Unit-4 :High Tc Materials. 4.1,4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9	Discuss the microwave absorption-pairing and multigap structure in high Tc materials.	Nucleophilic substitution at an aliphatic trigonal carbon. Phase transfer catalysis
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 5: : Apply the knowledge of the Molecular rectifiers and transistors, artificial photosynthetic devices, optical storage memory and switches, sensors. Conducting organics, organic superconductors, magnetism in organic materials. Fullerenes, doped and superconductors.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5		Unit 5: Organic Solids, Fullerenes, Molecular Devices 5.1,5.2,5.3,5.4,5.5 ,5.6,5.7,5.8,,5.9	Explain the Fullerenes, doped, fullerenes as superconductors.	Alkylation,amination SRN1 mechanism

M.Sc. Chemistry Semester IV

Code: 76CH-407

Course Name: Advanced Synthetic Organic Chemistry , Credit :4

L	T	P
3	1	0

Pre- requisite; Students should have basic knowledge of organic synthesis

Rational: After completion of this course students will design to synthesize organic molecules

COURSE OUTCOMES:

Afterthe completionofthiscourse, thelearner willbeableto:

CO1: Explain and apply theoretical aspect of Organometallic reagent.
CO2: Explain oxidative process of hydrocarbon,carbonyl compound.
CO3:Analyse the reduction process of hydrocarbon,carbonyl compound.

CO4: Explain Disconnection approach, functional group inter-conversions
CO5: Analyse two Group C-C Disconnections

UNIT I

Organometallic ReagentsPrinciple , preparations, properties and applications of the following in organic synthesis with mechanistic details.Group I and II metal organic compounds-Li, Mg, Hg, Cd, Zn and Ce compounds.Transition metals- Cu, Pd, Ni, Fe , Co, Rh, Cr and Ti compounds
Other elements- S, Si, B and I compound.

UNIT II

Oxidation Introduction ,different oxidative processes. Hydrocarbons- alkenes, aromatic rings, saturated C-H groups(activated and unactivated).alcohols, diol, aldehydes, ketones, ketals and carboxylix acids. Amines, hydrazines, and sulphides.
Oxidations with ruthenium tetraoxide, iodobenzene diacetate and thallium(III) nitrate.

UNIT III

Reduction Introduction .diffrent reductive processes.
Hydrocarbon – alkanes , alkenes, alkynes and aromatic ring .
Carbonyl compounds- aldehydes, ketones, acids and their derivatives. Epoxides. Nitro, nitroso, azo and oxime groups. Hydrogenolysis.Metallocenes, Nonbenzenoid Aromatics and polycyclic aromatic compound
General considerations, synthesis and reactions ofsome representative compounds.

UNIT IV

Disconnection Approach, Protecting Groups & One group C-C Disconnections
An introduction to synthons and synthetic equivalents. Disconnection approach, functional group inter-conversions, the importance of the order of events in organic synthesis, one group C-X disconnections, chemoselectivity, rebersal of polarity, cyclisation reactions, amine synthesis
Principle of protection of alcohol, amine, carbonyl and carboxyl groups.
Alcohols and carbonyl compounds, regioselectivity, alkene synthesis, use of acetylenes and aliphatic nitro compounds in organic synthesis

UNIT V

Two Group C-C Disconnections, Ring synthesis & Synthesis of some complex molecules
Diels –Aalder reaction, 1,3-difunctionalised compounds, alpha,beta-unsaturated carbonyl compounds,control in carbonyl condensations, 1,5-difunctionalised compounds. Micheal addition and Robinson annelation. Saturated heterocycles, synthesis of 3,4,5 and 6- membered rings, aromatic heterocycles in organic synthesis. Application of the above in the synthesis of following compounds: Camphor, longifoline, Cortisone, Reserpine, Vitamin D, Juvabione, Aphidicolin and Fredericamcin A.

Scheme of Studies:

Board ofStudy	CourseCode	CourseTitle	Scheme ofstudies(Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
ProgramCore(PCC)	76CH-407	**Advanced Organic Chemistry**	4	0	1	1	5	4

Legend: **CI:**Class room Instruction (Includes different in structional strategies i.e.Lecture (L) andTutorial (T)and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: SessionalWork(includesassignment,seminar,miniprojectetc.),
SL: SelfLearning,
C:Credits.

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

Scheme of Assessment: Theory

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.

76CH407.1: Explain theoretical aspect of Organometallic reagent.

Activity	**AppX Hrs**
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO1.1 Explain role of Principle , preparations, properties and applications of the following in organic synthesis with mechanistic details. **SO1.2** Explain types of Group I and II metal organic compounds-Li, Mg, Hg compounds. **SO1.3** Explain Types of Group I and II metal organic compounds- Cd, Zn and Ce compounds. **SO1.4** Explain Transition metals- Cu, Pd, Ni, Fe , Co, Rh, Cr and Ti compounds **SO1.5** Explain Other elements- S, Si, B and I compound.		Unit-1.0 Organometallic Reagents 1.1 Principle of organometallic reagents. 1.2 Preparations of organometallic reagents. 1.3 Properties of organometallic reagents. 1.4 Application of organometallic reagents. 1.5 Introduction of Group I and II metal organic compounds- Li, Mg, Hg. 1.6 Application of Group I and II metal organic compounds Li, Mg, Hg. 1.7Synthesis of Group I and II metal organic compounds Li, Mg, Hg. 1.8 Explain types of Group I and II metal organic compounds- Cd, Zn and Ce compounds. 1.9 Transition metals- Cu, Ni, Fe , Rh and Ti compounds 1.10 T1- Explain transition metals Pd 1.11 T2- Explain transition metals Co. 1.12 T3- Explain transition metals Cr	Properties of Group I and II metal organic compounds Li.

SW-1Suggested Sessional Work(SW):

a.Assignments:

Discuss 2 Explain types of Group I and II metal organic compounds- Mg, Hg compounds.

.

b.Mini Project:

Explain Transition metals- Rh and Ti compounds

c.Other Activities (Specify):

Note on applications of understand and explain Other elements- Si, B and I compound.

76CH407.2: Explain oxidative process of hydrocarbon, carbonyl compound.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 Understand Introduction ,different oxidative processes. **SO2.2** Explain Hydrocarbons- alkenes, aromatic rings, saturated C-H groups(activated and unactivated) **SO2.3**Explain alcohols, diol, aldehydes, ketones, ketals and carboxylix acids. **SO2.4** Explain types of Amines, hydrazines, and sulphides. **SO2.5** Understand and apply Oxidations with ruthenium tetraoxide, iodobenzene diacetate and thallium(III) nitrate.		Unit-2.0 Oxidation 2.1 Introduction of Oxidation reaction.different oxidative processes. 2.2 Introduction of Hydrocarbons. 2.3 Introduction and Properties of alkenes. 2.4Properties of aromatic rings. 2.5saturated C-H groups(activated and unactivated) 2.6 Properties of alcohols, aldehydes, ketones. 2.7Properties of Amines. 2.8Properties hydrazines, and sulphides. 2.9 Oxidations with ruthenium tetraoxide. 2.10 T1- Properties of diol. 2.11 T2 Properties of aldehydes, ketones. 2.12 T3- Thallium(III) nitrate.	Explain ketals and carboxylix acids.

SW-2 Suggested Sessional Work (SW):

a.Assignments:

Explain iodobenzene diacetate and thallium(III) nitrate.

b.Mini Project:

Explain types of Amines, hydrazines, and sulphides.

c.Other Activities (Specify):

Write an eassy on Oxidations with ruthenium tetraoxide

76CH407.3: Analyse the reduction process of hydrocarbon, carbonyl compound.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO3.1 Understand and apply Introduction .diffrent reductive processes. **SO3.2** Explain Hydrocarbon – alkanes , alkenes, alkynes and aromatic ring . **SO3.3** Explain Carbonyl compounds-aldehydes, ketones, acids and their derivatives. SO3.4 Explain Epoxides. Nitro, nitroso, azo and oxime groups.Hydrogenolysis. SO3.5 Explain Metallocenes, Nonbenzenoid Aromatics and		Unit-3. Reduction 3.1 Introduction of reduction. 3.2 diffrent reductive processes. 3.3 Physical and chemical Properties of alkanes. 3.4 Physical and chemical Properties of alkenes. 3.5 Physical and chemical Properties of alkynes. 3.55 Physical and chemical Properties of aromatic rings. 3.6 Introduction of carbonyl compound. 3.7 Properties of aldehyde, ketone. acid. 3.8 Properties of Aromatics compound General considerations, synthesis and reactions ofsome representative compounds.	. Explain Epoxides. Nitro, nitroso, azo and oxime groups.

polycyclic aromatic compound General considerations, synthesis and reactions ofsome representative compounds.		3.9 Properties of Properties of nitroso, azo and oxime groups, Hydrogenolysis. 3.10 T1-Properties of Epoxides, Nitro compound. 3.11 T2-Metallocenes, Nonbenzenoid 3.12 T3 polycyclic aromatic compound.	

SW-3 Suggested Sessional Work (SW):

a.Assignments:

Explain hydrocarbon – alkanes , alkenes, alkynes and aromatic ring .

b.Mini Project:

Explain Carbonyl compounds- aldehydes, ketones, acids and their derivatives.

c.Other Activities (Specify):

Explain epoxides. nitro, nitroso, azo and oxime groups.

76CH407.4: Explain Disconnection approach, functional group inter-conversions

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

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

SO4.1 Explain and apply An introduction to synthons and synthetic equivalents. **SO4.2** Explainanalysis Disconnection approach, functional group inter-conversions, the importance of the order of events in organic synthesis, one group C-X disconnections **SO4.3** Explain chemoselectivity, rebersal of polarity, cyclisation reactions, amine synthesis SO4.4Explain and apply Principle of protection of alcohol, amine, carbonyl and carboxyl groups. SO4.5 Explain and apply Alcohols and carbonyl compounds, regioselectivity, alkene synthesis, use of acetylenes and aliphatic nitro compounds in organic synthesis .		Unit-4.0 Disconnection Approach, Protecting Groups & One group C-C Disconnections 4.1 The Analysis An introduction to synthons and synthetic equivalents. 4.2 Disconnection approach, 4.3 The importance of the order of events in organic synthesis 4.4 one group C-X disconnections. 4.5chemoselectivity, rebersal of polarity. 4.6 cyclisation reactions, amine synthesis. 4.6 Principle of protection of alcohol,anine. 4.7 Principle of protection of carbonyl. 4.8 Alcohols and carbonyl compounds. 4.9 use of acetylenes and aliphatic nitro compounds in organic synthesis 4.10 Tutorial Class – functional group inter-conversions. 4.11 Tutorial Class – alkene synthesis, 4.12 Tutorial Class – Principle of protection of carboxyl groups.	Chemoselectivity, rebersal of polarity.

SW-4 Suggested Sessional Work (SW):

a.Assignments:

Explain and apply the regioselectivity of compound.

b.Mini Project:

Explain analysis the importance of the order of events in organic synthesis.

c.Other Activities (Specify):

Explain and apply Principle of protection of alcohol and carboxyl groups.

76CH407.5: Analyset to group C-C disconnections approach.

Activity	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 Explain and apply the Diels –Aalder reaction, 1,3-difunctionalised compounds, **SO5.2** Explain alpha,beta-unsaturated carbonyl compounds,control in carbonyl condensations, 1,5-difunctionalised compounds. **SO5.3** Explain and apply Micheal addition and Robinson annelation. Saturated heterocycles, synthesis of 3,4,5 and 6- membered rings **SO5.4**Explain and apply The aromatic heterocycles in organic synthesis. **SO5.5** Explain and apply The Application of the above in the synthesis of following compounds: Camphor, longifoline, Cortisone, Reserpine, Vitamin D, Juvabione,	.	**5.0 Ring synthesis & Synthesis of some complex molecules** Composition of blood collection and preservation of samples 5.1 the Diels –Aalder reaction, 1,3-difunctionalised compounds, 5.2alpha,beta-unsaturated carbonyl compounds 5.3 control in carbonyl condensations, 1,5-difunctionalised compounds. 5.4 Micheal addition and Robinson annelation. **5.**5 Saturated heterocycles 5.6 synthesis of 3,4,5 and 6-membered rings 5.7 The Application of the above	Application of the above in the synthesis of following compounds: Camphor, longifoline.

Aphidicolin and Fredericamcin A.		in the synthesis of following compounds, longifoline. 5.8 The Application of the above in the synthesis of following compounds: Reserpine, Vitamin D. 5.9 The Application of the above in the synthesis of following compounds: Juvabione, and Fredericamcin A. 5.10 Tutorial Class – The Application of Camphor compound. 5.11 Tutorial Class – Cortosone. 5.12 Tutorial Class – Aphidicolin	

SW-5 Suggested Sessional Work (SW):

a.Assignments:

Explain and apply alpha,beta-unsaturated carbonyl compounds,control in carbonyl condensations,

b. Mini Project:

Saturated heterocycles, synthesis of 3, 4,5 and 6- membered rings,

c. Other Activities (Specify):

Application of the above in the synthesis of following compounds: Camphor, longifoline,

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
76ch303.1: Explain theoretical aspect of organometallic reagent.	12	02	01	15
76ch403.2: Explain oxidative process of hydrocarbon,carbonyl compound.	12	02	01	15
76ch403.3: Analyse the reduction process of hydrocarbon,carbonyl compound.	12	02	01	15
76ch403.4: Explain disconnection approach, functional group inter-conversions	12	02	01	15

76ch403.5: Analyse two group c-c disconnections approach..	12	02	01	15
Total Hours	60	15	05	75

Suggestion for End Semester Assessment

Suggested Specification Table(For ESA)

CO	UnitTitles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Organometallic Reagents	03	01	01	05
CO-2	Oxidation	02	06	02	10
CO-3	Reduction	03	07	05	15
CO-4	Disconnection Approach, Protecting Groups & One group C-C Disconnections	-	10	05	15
CO-5	Ring synthesis & Synthesis of some complex molecules	03	02	-	05
Total		11	26	13	50

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

The end of semester assessment Advanced Synthetic organic chemistry will be held with written examination of 50 marks

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

Suggested Instructional/Implementation Strategies:

82. Improved Lecture
83. Tutorial
84. CaseMethod
85. GroupDiscussion
86. RolePlay
87. Visitto NCL, CSIR laboratories

88. Demonstration
89. ICTBasedTeachingLearning(VideoDemonstration/TutorialsCBT,Blog,Facebook,Twitter,Whatsapp,Mobile,Online sources)
90. Brainstorming

Suggested Learning Resources:

(s) **Books:**

S No.	Title	Author	Publisher	Edition& Year
1	Advanced organic chemistry: part a structure and mechanicsms	Francis A. Carey , Richard J. Sundberg	Springer	Edition,2008
2	Organic Synthesis (Reaction Mechanisms and Reagents)	Medtech Science Press	Medtech Science Press	Edition, 2022 1 January 2022
3	Organic Synthesis through Disconnection Approach	by P. S. Kalsi	Medtech Science Press	Edition,2022
4	Intermediates for Organic Synthesis	by V.K. Ahluwalia , Pooja Bhagat	I.k. International	Edition,2020
5	Organic Synthesis (Reaction Mechanisms and Reagents)	by G. Joshi	Medtech Science Press	Edition,2022

SuggestedWebSources:

47. https://nptel.ac.in/course.html
48. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
49. https://swayam.gov.in/explorer?category=Chemistry

ModeofDelivery: Lecture, demonstration,E-tutoring,discussion,assignments,quizzes, case study, power point;

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

AKSUniversity

FacultyofBasic Science, DepartmentofChemistry

CurriculumofM. Sc. In Chemistry Program (Revisedason01August2023)

Title: Advanced Synthetic organic chemistry **Course Code : 76CH403**

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Knowledge	Research Aptitude	Communication	Problem Solving	Individual and Team Work	Investigation of Problems	Modern Tool usage	Science and Society	Life-Long Learning	Ethics	Project Management	Environment and sustainability	The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry	To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.	understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon-based problems in chemical sciences.	Provide opportunities to excel in academics, research or Industry by research based innovative knowledge for sustainable development in chemical science
CO1: Explain and apply theoretical aspects of Organometallic reagent.	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO2: Explain oxidative process of hydrocarbon,carbonyl compound.	2	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3: Analyse the reduction process of hydrocarbon,carbonyl compound.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO4 Explain Disconnection approach, functional group inter-conversions	2	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
CO5: Analyse two group C-C disconnections approach.	2	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

Legend:1–Low,2–Medium, 3–High

Course Curriculum Map:

POs &PSOsNo.	Cos No.&Titles	SOsNo.	LaboratoryInstruction(LI)	Classroom Instruction(CI)	Self Learning(SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO1: Explain theoretical aspect of Organometallic reagent.	SO1.1SO 1.2SO1.3 SO1.4 SO1.5		Unit-1.0 Nature of bonbing in organic molecules 1.1,1.2,1.3,1.4,1.5,1.6,1.7	Properties of Group I and II metal organic compounds Li.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO2: Explain oxidative process of hydrocarbon, carbonyl compound.	SO2.1SO 2.2SO2.3 SO2.4 SO2.5		Unit-2 Stereochemistry 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9	Explain ketals and carboxylix acids.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3: Analyse the reduction process of hydrocarbon, carbonyl compound.	SO3.1SO3 .2 SO3.3 SO3.4 SO3.5		Unit-3 : Reaction mechanism structure and reactivity 3.1, 3.2,3.3,3.4,3.5,3.6,3.7	Explain Epoxides. Nitro, nitroso, azo and oxime groups.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO4 Explain Disconnection approach, functional group inter-conversions	SO4.1SO 4.2SO4.3 SO4.4 SO4.5		Unit-4 : Aliphatic nucleophilic substitution 4.1, 4.2,4.3,4.4,4.5,4.6,4.7	Chemoselectivity, rebersal of polarity.
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO5: Analyse two groups C-C disconnections approach. .	SO5.1SO 5.2SO5.3 SO5.4 SO5.5		Unit 5: Aromatic nucleophilic substitution 5.1,5.2,5.3,5.4,5.5,5.6,5.7	Application of the above in the synthesis of following compounds: Camphor, longifoline.

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