M Sc CHEMISTRY

LOCF SYLLABUS 2023

Department of Chemistry

School of Physical Sciences

St. Joseph's College (Autonomous)

Tiruchirappalli - 620002, Tamil Nadu, India

SCHOOLS OF EXCELLENCE WITH CHOICE BASED CREDIT SYSTEM (CBCS) POSTGRADUATE COURSES

St. Joseph's College (Autonomous), an esteemed institution in the realm of higher education in India, has embarked on a journey to uphold and perpetuate academic excellence. One of the pivotal initiatives in this pursuit is the establishment of five Schools of Excellence commencing from the academic year 2014-15. These schools are strategically designed to confront and surpass the challenges of the 21st century.

Each School amalgamates correlated disciplines under a unified umbrella, fostering synergy and coherence. This integrated approach fosters the optimal utilization of both human expertise and infrastructure. Moreover, it facilitates academic fluidity and augments employability by nurturing a dynamic environment conducive to learning and innovation. Importantly, while promoting collaboration and interdisciplinary study, the Schools of Excellence also uphold the individual identity, autonomy, and distinctiveness of every department within.

The overarching objectives of these five schools are as follows:

1. Optimal Resource Utilization: Ensuring the efficient use of both human and material resources to foster academic flexibility and attain excellence across disciplines.

2. Horizontal Mobility for Students: Providing students with the freedom to choose courses aligning with their interests and facilitating credit transfers, thereby enhancing their academic mobility and enriching their learning experience.

3. Credit-Transfer Across Disciplines (CTAD): The existing curricular structure, compliant with regulations from entities such as TANSCHE and other higher educational institutions, facilitates seamless credit transfers across diverse disciplines. This underscores the adaptability and uniqueness of the choice-based credit system.

4. Promotion of Human Excellence: Nurturing excellence in specialized areas through focused attention and resources, thus empowering individuals to excel in their respective fields.

5. Emphasis on Internships and Projects: Encouraging students to engage in internships and projects, serving as stepping stones toward research endeavors, thereby fostering a culture of inquiry and innovation.

6. Addressing Stakeholder Needs: The multi-disciplinary nature of the School System is tailored to meet the requirements of various stakeholders, particularly employers, by equipping students with versatile skills and competencies essential for success in the contemporary professional landscape.

In essence, the Schools of Excellence at St. Joseph's College (Autonomous) epitomize a holistic approach towards education, aiming not only to impart knowledge but also to cultivate critical thinking, creativity, and adaptability – qualities indispensable for thriving in the dynamic global arena of the 21st century.

Credit system

The credit system at St. Joseph's College (Autonomous) assigns weightage to courses based on the hours allocated to each course. Typically, one credit is equivalent to one hour of instruction per week. However, credits are awarded regardless of actual teaching hours to ensure consistency and adherence to guidelines.

The credits and hours allotted to each course within a programme are detailed in the Programme Pattern table. While the table provides a framework, there may be some flexibility due to practical sessions, field visits, tutorials, and the nature of project work.

For postgraduate (PG) courses, students are required to accumulate a minimum of 110 credits, as stipulated in the programme pattern table. The total minimum number of courses offered by the department is outlined in the Programme Structure.

OUTCOME-BASED EDUCATION (OBE)

OBE is an educational approach that revolves around clearly defined goals or outcomes for every aspect of the educational system. The primary aim is for each student to successfully achieve these predetermined outcomes by the culmination of their educational journey. Unlike traditional methods, OBE does not prescribe a singular teaching style or assessment format. Instead, classes, activities, and evaluations are structured to support students in attaining the specified outcomes effectively.

In OBE, the emphasis lies on measurable outcomes, allowing educational institutions to establish their own set of objectives tailored to their unique context and priorities. The overarching objective of OBE is to establish a direct link between education and employability, ensuring that students acquire the necessary skills and competencies sought after by employers.

OBE fosters a student-centric approach to teaching and learning, where the delivery of courses and assessments are meticulously planned to align with the predetermined objectives and outcomes. It places significant emphasis on evaluating student performance at various levels to gauge their progress and proficiency in meeting the desired outcomes.

Here are some key aspects of Outcome-Based Education:

Course: A course refers to a theory, practical, or a combination of both that is done within a semester.

Course Outcomes (COs): These are statements that delineate the significant and essential learning outcomes that learners should have achieved and can reliably demonstrate by the conclusion of a course. Typically, three or more course outcomes are specified for each course, depending on its importance.

Programme: This term pertains to the specialization or discipline of a degree programme.

Programme Outcomes (POs): POs are statements that articulate what students are expected to be capable of by the time they graduate. These outcomes are closely aligned with Graduate Attributes.

Programme Specific Outcomes (PSOs): PSOs outline the specific skills and abilities that students should possess upon graduation within a particular discipline or specialization.

Programme Educational Objectives (PEOs): PEOs encapsulate the expected accomplishments of graduates in their careers, particularly highlighting what they are expected to achieve and perform during the initial years postgraduation.

LEARNING OUTCOME-BASED CURRICULUM FRAMEWORK (LOCF)

The Learning Outcomes-Centric Framework (LOCF) places the learning outcomes at the forefront of curriculum design and execution. It underscores the importance of ensuring that these outcomes are clear, measurable, and relevant. LOCF orchestrates teaching methodologies, evaluations, and activities in direct correlation with these outcomes. Furthermore, LOCF adopts a backward design approach, focusing on defining precise and attainable learning objectives. The goal is to create a cohesive framework where every educational element is in harmony with these outcomes.

Assessment practices within LOCF are intricately linked to the established learning objectives. Evaluations are crafted to gauge students' achievement of these outcomes accurately. Emphasis is often placed on employing authentic assessment methods, allowing students to showcase their learning in real-life scenarios. Additionally, LOCF frameworks emphasize flexibility and adaptability, enabling educators to tailor curriculum and instructional approaches to suit the diverse needs of students while ensuring alignment with the defined learning outcomes.

Some important terminologies

Core Courses (CC): *These are compulsory courses that students must undertake as essential components of their curriculum, providing fundamental knowledge within their primary discipline. Including core courses is essential to maintain a standardized academic programme, ensuring recognition and consistency across institutions.*

Common Core (CC): *A common core course is a shared educational element encompassing fundamental topics across disciplines within a school. It promotes interdisciplinary comprehension and collaboration among students by providing a foundational understanding of key subjects essential for academic and professional success across diverse fields of study.*

Elective Courses (ES): *Elective courses are offered within the main discipline or subject of study. They allow students to select specialized or advanced options from a range of courses, offering in-depth exposure to their chosen area of study. Typically, ES are more applied in nature and provide a deeper understanding of specific topics.*

Generic Elective Courses (EG): *These elective courses are chosen from disciplines unrelated to the student's main area of study, aiming to broaden their exposure and knowledge base. As per the Choice Based Credit System (CBCS) policy, students may opt for generic elective courses offered by other disciplines within the college, enhancing the diversity of their learning experience.*

Ability Enhancement Course (AE): *AE is designed to enhance skills and proficiencies related to the student's main discipline. It aims to provide practical training and hands-on experience, contributing to the overall development of students pursuing academic programmes.*

Skill Enhancement Course (SE): *SE focus on developing specific skills or proficiencies relevant to students' academic pursuits. While it is open to students from any discipline, SE is particularly beneficial for those within the related academic programme.*

Self-paced Learning (SP): *This course promotes independent learning habits among students and they have to undergo the course outside the regular class hours within a specified timeframe.*

Comprehensive Examinations (CE): *These examinations cover detailed syllabi comprising select units from courses offered throughout the programme. They are designed to assess crucial knowledge and content that may not have been covered extensively in regular coursework.*

Extra Credit Courses: *To support students in acquiring knowledge and skills through online platforms such as Massive Open Online Courses (MOOCs), additional credits are granted upon verification of course completion. These extra credits can be availed across five semesters (2 - 6). In line with UGC guidelines, students are encouraged to enhance their learning by enrolling in MOOCs offered by portals like SWAYAM, NPTEL, and others. Additionally, certificate courses provided by the college are also considered for these extra credits.*

Outreach Programme (OR): *It is a compulsory course to create a sense of social concern among all the students and to inspire them to dedicated service to the needy.*

Course Coding

The following code system (10 alphanumeric characters) is adopted for Postgraduate courses:

23	**UXX**	**0**	**XX**	**00/X**
Year of Revision	PG Department Code	Semester Number	Course Specific Initials*	Running Number/with Choice

***Course Specific Initials**

CC - Core Course

CP - Core Practical

ES - Elective

AE - Ability Enhancement Course

SP - Self-paced Learning

EG - Generic Elective

PW - Project and Viva Voce

CE - Comprehensive Examination

OR - Outreach Programme

IS - Internship

EVALUATION PATTERN

Continuous Internal Assessment

Sl No	Component	Marks Alloted
1	Mid Semester Test	30
2	End Semester Test	30
3	*Three Components (15 + 10 + 10)	35
4	Library Referencing (30 hours)	5
	Total	**100**

Passing minimum: 50 marks

* *The first component is a compulsory online test (JosTEL platform) comprising 15 multiple choice questions (10 questions at K1 level and 5 questions at K2 level); The second and the third components are decided by the course in-charge.*

Question Paper Blueprint for Mid and End Semester Tests

<table>
<tr><td colspan="3">Duration: 2 Hours</td><td colspan="6">Maximum Marks: 60</td></tr>
<tr><td colspan="2" rowspan="2">Section</td><td colspan="6">K levels</td><td rowspan="2">Marks</td></tr>
<tr><td>K1</td><td>K2</td><td>K3</td><td>K4</td><td>K5</td><td>K6</td></tr>
<tr><td colspan="2">A (compulsory)</td><td>7</td><td></td><td></td><td></td><td></td><td></td><td>7 × 1 = 7</td></tr>
<tr><td colspan="2">B (compulsory)</td><td></td><td>5</td><td></td><td></td><td></td><td></td><td>5 × 3 = 15</td></tr>
<tr><td colspan="2">C (either…or type)</td><td></td><td></td><td>3</td><td></td><td></td><td></td><td>3 × 6 = 18</td></tr>
<tr><td rowspan="4">D (2 out of 3)</td><td>For courses with K5 as the highest cognitive level, one K4 and one K5 question is compulsory. (Note: two questions on K4 and one question on K5)</td><td></td><td></td><td></td><td>1</td><td>1*</td><td></td><td rowspan="4">2 × 10 = 20</td></tr>
<tr><td rowspan="3">For courses with K6 as the highest cognitive level: Mid Sem: two questions on K4 and one question on K5; End Sem: two questions on K5 and one question on K6)</td><td></td><td></td><td></td><td colspan="2">Mid Sem</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="2">End Sem</td></tr>
<tr><td></td><td></td><td></td><td>1</td><td>1</td><td>1*</td></tr>
<tr><td colspan="7">Total</td><td>60</td></tr>
</table>

***** *Compulsory*

Question Paper Blueprint for Semester Examination

Duration: 3 Hours						**Maximum Marks: 100**
UNIT	**Section A** *(Compulsory)*	**Section B** *(Compulsory)*	**Section C** *(Either…or type)*	**Section D** *(3 out of 5)*		
	K1	**K2**	**K3**	**K4**	**K5**	**K6**
UNIT I	2	2	2	2*	2*	1*
UNIT II	2	2	2			
UNIT III	2	2	2			
UNIT IV	2	2	2			
UNIT V	2	2	2			
Marks	**10 × 1 = 10**	**10 × 3 = 30**	**5 × 6 = 30**	**3 × 10 = 30**		

** For courses with K6 as the highest cognitive level wherein one question each on K4, K5 and K6 is compulsory. (Note: two questions each on K4 and K5 and one question on K6)*

Evaluation Pattern for One/Two-credit Courses

Title of the Course	CIA	Semester Examination	Total Marks
• Ability Enhancement Course	20 + 10 + 20 = 50	50 *(A member from the Department other than the course instructors)*	100
• Self-paced Learning • Comprehensive Examination	25 + 25 = 50	50 *(CoE)*	100
• Internship	100	-	100
• Skill Enhancement Course: Soft Skills	100	-	100
• Project Work and Viva Voce	100	100	100

Grading System

The marks obtained in the CIA and semester for each course will be graded as per the scheme provided in Table - 1.

From the second semester onwards, the total performance within a semester and the continuous performance starting from the first semester are indicated by Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA), respectively. These two are calculated by the following formulae:

$$SGPA \ and \ CGPA = \frac{\sum_{i=1}^{n} C_i Gp_i}{\sum_{i=1}^{n} C_i}$$

$$WAM = \frac{\sum_{i=1}^{n} C_i M_i}{\sum_{i=1}^{n} C_i}$$

Where,

Ci - credit earned for the Course i

Gpi - Grade Point obtained for the Course i

Mi - Marks obtained for the Course i

*n - Number of Courses **passed** in that semester*

WAM - Weighted Average Marks

Table - 1: Grading of the Courses

Mark Range	Grade Point	Corresponding Grade
90 and above	10	O
80 and above and below 90	9	A+
70 and above and below 80	8	A
60 and above and below 70	7	B+
50 and above and below 60	6	B
Below 50	0	RA

Table - 2: Grading of the Final Performance

CGPA	Grade	Performance
9.00 and above	O	Outstanding*
8.00 to 8.99	A+	Excellent*
7.00 to 7.99	A	Very Good
6.00 to 6.99	B+	Good
5.00 to 5.99	B	Above Average
Below 5.00	RA	Re-appear

**The Candidates who have passed in the first appearance and within the prescribed duration of the PG programme are eligible. If the Candidates Grade is O/A+ with more than one attempt, the performance is considered "Very Good".*

Vision

Forming globally competent, committed, compassionate and holistic persons, to be men and women for others, promoting a just society.

Mission

- Fostering learning environment to students of diverse background, developing their inherent skills and competencies through reflection, creation of knowledge and service.
- Nurturing comprehensive learning and best practices through innovative and value- driven pedagogy.
- Contributing significantly to Higher Education through Teaching, Learning, Research and Extension.

Programme Educational Objectives (PEOs)

1. Graduates will be able to accomplish professional standards in the global environment.
2. Graduates will be able to uphold integrity and human values.
3. Graduates will be able to appreciate and promote pluralism and multiculturalism in working environment.

Programme Outcomes (POs)

1. Graduates will be able to apply assimilated knowledge to evolve tangible solution to emerging problems.
2. Graduates will be able to analyze and interpret data to create and design new knowledge.
3. Graduates will be able to engage in innovative and socially relevant research and effectively communicate the findings.
4. Graduates will become ethically committed professional and entrepreneurs upholding human values.
5. Graduates imbibed with ethical values and social concern will be able to understand and appreciate cultural diversity, social harmony and ensure sustainable environment.

Programme Specific Objectives (PSOs)

1. Graduates will be able to apply assimilated knowledge to evolve chemical alternatives to emerging environmental requisites.
2. Graduates will be able to analyze, interpret and create data for emerging scientific needs.
3. Graduates will be able to engage in innovative and socially relevant research with ethical concern.
4. Graduates will be able to lead, appreciate and exhibit compatibility with humane values for social harmony.
5. Graduates will be able to effectively communicate and apply modern tool knowledge to evolve financial rewarding projects.

PROGRAMME STRUCTURE				
Semester	**Course Specification**	**Number of Courses**	**Hours**	**Credits**
1 - 4	Core Course	10	53	51
1 - 4	Core Practical	5	22	18
1, 2, 4	Elective	4	20	14
1	Ability Enhancement Course	1	2	1
2	Self-paced Learning	1	-	2
2	Skill Enhancement Course	1	4	3
2, 3	Generic Elective	2	8	6
3	Common Core	1	5	4
2 - 4	Extra Credit Course	3	-	(9)
4	Project Work and Viva Voce	1	6	5
4	Comprehensive Examination	1	-	2
2 - 4	Outreach Programme (SHEPHERD)	-	-	4
	Total	**30**	**120**	**110(9)**

M Sc CHEMISTRY							
Course Details					Scheme of Exams		
Sem	**Course Code**	**Title of the Course**	**Hours**	**Credits**	**CIA**	**SE**	**Final**
1	23PCH1CC01	**Core Course - 1:** Organic Reaction Mechanism - 1	6	6	100	100	100
	23PCH1CC02	**Core Course - 2:** Structure and Bonding in Inorganic Compounds	6	6	100	100	100
	23PCH1CP01	**Core Practical - 1:** Organic Chemistry	6	4	100	100	100
	23PCH1ES01	**Elective - 1:** Nano Materials and Nano Technology	5	3	100	100	100
	23PCH1ES02	**Elective - 2:** Electrochemistry	5	3	100	100	100
	23PCH1AE01	**Ability Enhancement Course:** Analytical Techniques	2	1	100	-	100
		Total	**30**	**23**			
2	23PCH2CC03	**Core Course - 3:** Transition Elements, Covalent Bonding and Periodicity	4	4	100	100	100
	23PCH2CC04	**Core Course - 4:** Quantum Chemistry and Statistical Thermodynamics	5	5	100	100	100
	23PCH2CP02	**Core Practical - 2:** Inorganic Chemistry - 1	4	3	100	100	100
	23PCH2CP03	**Core Practical - 3:** Physical Chemistry - 1	4	3	100	100	100
	23PCH2SP01	**Self-paced Learning:** Selected Topics in Inorganic Chemistry and Physical Chemistry*	-	2	50	50	50
	23PCH2ES03A	**Elective - 3**: Addition, Elimination and Redox Reactions in Organic Chemistry	5	4	100	100	100
	23PCH2ES03B	**Elective - 3**: Stereochemistry					
	23PSS2SE01	**Skill Enhancement Course:** Soft Skills	4	3	100	-	100
	-	**Generic Elective - 1: Refer ANNEXURE 1**	4	3	100	100	100
	-	Extra Credit Courses (MOOC/Certificate Courses)-1	-	(3)			
		Total	**30**	**27(3)**			
3	23PCH3CC05	**Core Course - 5:** Organic Synthesis and Spectroscopy	6	6	100	100	100
	23PCH3CC06	**Core Course - 6:** Advanced Coordination Chemistry	5	5	100	100	100
	23PCH3CC07	**Core Course - 7:** Research Methodology	2	2	100	100	100
	23PCH3CP04	**Core Practical - 4:** Inorganic Chemistry - 2	4	4	100	100	100
	23PCH3CP05	**Core Practical - 5:** Physical Chemistry - 2	4	4	100	100	100
	23SPS3CC01	**Common Core:** Materials Science	5	4	100	100	100
	-	**Generic Elective - 1: Refer ANNEXURE 2**	4	3	100	100	100
	-	Extra Credit Courses (MOOC/Certificate Courses)-2	-	(3)			
		Total	**30**	**28(3)**			
4	23PCH4CC08	**Core Course - 8:** Advanced Organic Chemistry	5	5	100	100	100
	23PCH4CC09	**Core Course - 9:** Nuclear and Bioinorganic Chemistry	7	6	100	100	100
	23PCH4CC10	**Core Course - 10:** Chemical Kinetics, Group Theory and Applications of Quantum Chemistry	7	6	100	100	100
	23PCH4ES04A	**Elective - 4:** Bioorganic Chemistry	5	4	100	100	100
	23PCH4ES04B	**Elective - 4:** Drug Design and Synthesis					
	23PCH4PW01	Project Work and Viva Voce	6	5	100	100	100
	23PCH4CE01	Comprehensive Examination*	-	2	50	50	50
	-	Extra Credit Courses (MOOC/Certificate Courses)-3	-	(3)			
		Total	**30**	**28(3)**			
2 - 4	23PCW4OR01	Outreach Programme (SHEPHERD)	-	4			
1 - 4		**Total (2 years)**	**120**	**110(9)**			

*- for grade calculation 50 marks are converted into 100 in the mark statements

Passed by	***Board of Studies held on 18.12.2023***
Approved by	***48th Academic Council Meeting held on 27.03.2024***

ANNEXURE 1
Generic Elective - 1 (WS)*

Course Details		
School	**Course Code**	**Title of the Course**
SPS	23PEL2EG01	Electronics Media
	23PPH2EG01A	Solar Energy and Utilization
	23PPH2EG01B	Renewable Energy Resources

**Offered to students from other Departments within School*

ANNEXURE 2
Generic Elective - 1 (BS)*

Course Details		
School	**Course Code**	**Title of the Course**
SBS	23PBI3EG02	First Aid Management
	23PBT3EG02	Food Technology
	23PBO3EG02	Horticulture and Landscaping
SCS	23PCA3EG02	Web Design
	23PCS3EG02	Advances in Computer Science
	23PDS3EG02	Information Security and Ethics
	23PMA3EG02	Operations Research
SLAC	23PEN3EG02	English for Effective Communication
SMS	23PCO3EG02	Basics of TallyPrime
	23PCC3EG02	Dynamics of Human Behaviour in Business
	23PCP3EG02	Social Psychology
	23PEC3EG02	Managerial Economics
	23PHR3EG02	Counselling and Guidance

**Offered to students from other Schools*

Semester	Course code	Title of the Course	Hours/Week	Credits
1	23PCH1CC01	**Core Course - 1:** Organic Reaction Mechanism-1	6	6

Course Objectives
To understand the feasibility and the mechanism of various organic reactions.
To comprehend the techniques in the determination of reaction mechanisms.
To understand the concept of stereochemistry involved in organic compounds.
To correlate and appreciate the differences involved in the various types of organic reaction mechanisms.
To design feasible synthetic routes for the preparation of organic compounds.

UNIT I: Methods of Determination of Reaction Mechanism (18 Hours)

Reaction intermediates, The transition state, Reaction coordinate diagrams, Thermodynamic and kinetic requirements of reactions: Hammond postulate. Methods of determining mechanism: non-kinetic methods - product analysis, determination of intermediates-isolation, detection, and trapping. Cross-over experiments, isotopic labelling, isotope effects and stereo chemical evidences. Kinetic methods - relation of rate and mechanism. Effect of structure on reactivity: Hammett and Taft equations. Linear free energy relationship, partial rate factor, substituent and reaction constants.

UNIT II: Aromatic and Aliphatic Electrophilic Substitution (18 Hours)

Aromaticity: Aromaticity in benzenoid, non-benzenoid, heterocyclic compounds and annulenes. Aromatic electrophilic substitution: Orientation and reactivity of di- and polysubstituted phenol, nitrobenzene and halobenzene. Reactions involving nitrogen electrophiles: nitration, nitrosation and diazonium coupling; Sulphur electrophiles: sulphonation; Halogen electrophiles: chlorination and bromination; Carbon electrophiles: Friedel-Crafts alkylation, acylation and arylation reactions. Aliphatic electrophilic substitution Mechanisms: SE2 and SEi, SE1- Mechanism and evidences.

UNIT III: Aromatic and Aliphatic Nucleophilic Substitution (18 Hours)

Aromatic nucleophilic substitution: Mechanisms - S_NAr, S_N1 and Benzyne mechanisms - Evidences - Reactivity, Effect of structure, leaving group and attacking nucleophile. Reactions: Oxygen and Sulphur-nucleophiles, Bucherer and Rosenmund reactions, von Richter, Sommelet- Hauser and Smiles rearrangements. S_N1, ion pair, S_N2 mechanisms and evidences. Aliphatic nucleophilic substitutions at an allylic carbon, aliphatic trigonal carbon and vinyl carbon.S_N1, S_N2, S_Ni, and S_E1 mechanism and evidences, Swain- Scott, Grunwald-Winstein relationship - Ambident nucleophiles.

UNIT IV: Stereochemistry - I (18 Hours)

Introduction to molecular symmetry and chirality-axis, plane, center, alternating axis of symmetry. Optical isomerism due to asymmetric and dissymmetric molecules with C, N, S based chiral centers. Optical purity, prochirality, enantiotopic and diastereotopic atoms, groups, faces, axial and planar chirality, chirality due to helical shape, methods of determining the configuration. Racemic modifications: Racemization by thermal, anion, cation, reversible formation, epimerization, mutarotation. D, L system, Cram's and Prelog's rules: R, S-notations, proR, proS, side phase and re phase Cahn-Ingold-Prelog rules, absolute and relative configurations. Configurations of allenes, spiranes, biphenyls, cyclooctene, helicene, binaphthyls, ansa and cyclophanic compounds, exo-cyclic alkylidene-cycloalkanes. Topicity and prostereoisomerism, chiral shift reagents and chiral solvating reagents. Criteria for optical purity: Resolution of racemic modifications, asymmetric transformations, asymmetric synthesis, destruction. Stereoselective and stereospecific synthesis.

UNIT V: Stereochemistry - II (18 Hours)

Conformation and reactivity of acyclic systems, intramolecular rearrangements, neighbouring group participation, chemical consequence of conformational equilibrium - Curtin-Hammett Principle. Stability of five and six-membered rings: mono-, di- and polysubstituted cyclohexanes, conformation and reactivity in cyclohexane systems. Fused and bridged rings: bicyclic, poly cyclic systems, decalins and Brett's rule. Optical rotation and optical rotatory dispersion, conformational asymmetry, ORD

curves, octant rule, configuration and conformation, Cotton effect, axial haloketone rule and determination of configuration.

Teaching Methodology	Chalk & Talk, PPT, videos and demonstration

Books for study

1. March, J., & Smith, M. (2001). *Advanced Organic Chemistry*, (5th Ed.). John-Wiley & Sons.
2. Gould, E. S. (1959). *Mechanism and Structure in Organic Chemistry*. Holt, Rinehart & Winston Inc.
3. Kalsi, P. S. (2015). *Stereochemistry of Carbon Compounds*, (8th Ed.). New Age International Publishers.
4. Bruice, P. Y. (2013). *Organic Chemistry*, (7th Ed.). Prentice Hall.
5. Clayden, J. G.N., & Warren, S. (2014). *Organic Compounds*, (2nd Ed.). Oxford University Press.

Books for Reference

1. Carey, F. A., & Sundberg, R. J. (2007). *Advanced Organic Chemistry Part-A and B*, (5th Ed.). Kluwer Academic / Plenum Publishers.
2. Morris, D. G. (2001). *Stereochemistry*. RSC Tutorial Chemistry Text 1.
3. Isaacs, N. S. (1987). *Physical Organic Chemistry*. ELBS, Longman.
4. Eliel, E. L. (2000). *Stereochemistry of Carbon Compounds*. Tata-McGraw Hill.
5. Finar, I. L. (2004). O*rganic Chemistry*. *Vol-1 & 2*, (6th Ed.). Pearson Education Asia.

Websites and eLearning Sources

1. 1.https://sites.google.com/site/chemistryebookscollection02/home/organic- chemistry/organic
2. https://www.organic-chemistry.org/

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	understand the concepts of stereochemistry and write the configurational nomenclature	**K1**
CO2	examine the mechanisms of nucleophilic substitution reactions and describe nucleophilic substitution on aromatic rings.	**K2**
CO3	compose multiple ways for addition-elimination reactions and predict the stereochemistry of elimination mechanisms.	**K3**
CO4	assess the concept of aromaticity and classify the reactions on aromatic rings.	**K4**
CO5	identify the types of intermediates and justify their role in identifying organic mechanisms.	**K5**
CO6	evaluate the orientation of aliphatic and aromatic substitution reactions	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**						**Hours**	**Credits**
1	**23PCH1CC01**			**Core Course - 1:** Organic Reaction Mechanism -1						**6**	**6**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	3	2	2	3	1	2	2	2	**2.2**
CO2	3	3	2	2	2	2	3	2	2	3	**2.4**
CO3	2	2	3	3	2	2	3	2	2	2	**2.3**
CO4	3	2	2	3	2	2	1	3	2	2	**2.2**
CO5	3	1	2	3	2	1	2	2	3	3	**2.2**
CO6	3	1	2	3	2	1	2	2	3	3	**2.2**
										Mean Overall Score	**2.26 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
1	23PCH1CC02	**Core Course - 2:** Structure and Bonding in Inorganic Compounds	6	6

Course Objectives
To determine the structural properties of main group compounds and clusters
To gain fundamental knowledge on the structural aspects of ionic crystals.
To familiarize various diffraction and microscopic techniques.
To study the effect of point defects and line defects in ionic crystals.
To evaluate the structural aspects of solids.

UNIT I: Structure of Main Group Compounds and Clusters (18 Hours)

VB theory-Effect of lone pair and electronegativity of atoms (Bent's rule) on the geometry of the molecules; Structure of silicates - applications of Paulings rule of electrovalence - isomorphous replacements in silicates-ortho, meta and pyro silicates-one dimensional, two dimensional and three-dimensional silicates. Structure of silicones, Structural and bonding features of B-N, S-N and P-N compounds; Poly acids-types, examples and structures; Borane cluster: Structural features of closo, nido, arachano and klado; carboranes, hetero and metalloboranes; Wade's rule to predict the structure of borane cluster; main groupclusters -zintl ions and mno rule

UNIT II: Solid State Chemistry-I (18 Hours)

Ionic crystals: Packing of ions in simple, hexagonal and cubic close packing, voids in crystal lattice, Radius ratio, Crystal systems and Bravis lattices, Symmetry operations in crystals, glide planes and screw axis; point group and space group; Solid state energetics: Lattice energy-Born-Lande equation - Kapustinski equation, Madelung constant.

UNIT III: Solid State Chemistry-II (18 Hours)

Structural features of the crystal systems: Rock salt, zinc blende & wurtzite, fluorite and anti-fluorite, rutile and anatase, cadmium iodide and nickel arsenide; Spinels -normal and inverse types and perovskite structures. Crystal Growth methods: From melt and solution (hydrothermal, sol-gel methods)-principles and examples.

UNIT IV: Techniques in Solid State Chemistry (18 Hours)

X-ray diffraction technique: Bragg's law, Powder diffraction method-Principle and Instrumentation; Interpretation of XRD data-JCPDS files, Phase purity, Scherrer formula, lattice constants calculation; Systematic absence of reflections; Electron diffraction technique-principle, instrumentation and application. Electron microscopy-difference between optical and electron microscopy, theory, principle, instrumentation, sampling methods and applications of SEM and TEM.

UNIT V: Band Theory and Defects in Solids (18 Hours)

Band theory-features and its application of conductors, insulators and semiconductors, Intrinsic and extrinsic semiconductors; Defects in crystals-point defects (Schottky, Frenkel, metal excess and metal deficient) and their effect on the electrical and optical property, laser and phosphors; Linear defects and its effects due to dislocations.

Teaching Methodology	Interactive videos, PPT, demonstration and creation of models

Books for Study

1. West, A. R. (2014). *Solid state Chemistry and its Applications,* (2nd Ed.) (Students Edition). John Wiley & Sons Ltd.
2. Bhagi, A. K., & Chatwal, G. R. (2001). *A textbook of Inorganic Polymers*. Himalaya Publishing House.
3. Smart, L. & Moore, E. (2012). *Solid State Chemistry-An Introduction,* (4th Ed.). CRC Press.
4. Purcell, K. F., & Kotz, J. C. (1977). *Inorganic Chemistry.* W.B. Saunders Company.
5. Huheey, J. E., Keiter, E. A., & Keiter, R. L. (1983). *Inorganic Chemistry*, (4th Ed.). Harper & Row.

Books for Reference

1. Douglas, D. E., Mc Daniel, D. H., & Alexander, J. J. (1994). *Concepts and models in Inorganic chemistry*, (3rd Ed.).
2. Tilley, R. J. D. (2013). *Understanding solids - The Science of Materials*, (2nd Ed.). Wiley Publication.
3. Rao, C. N. R., & Gopalakrishnan, J. (1995). *New Directions in solid-state Chemistry*, (2nd Ed.). Cambridge University Press.
4. Moeller, T. (1982). *Inorganic Chemistry, A Modern Introduction.* John Wiley.
5. Shriver, D. F., Atkins, P. W. & Langford, C.H. (2001). *Inorganic Chemistry,* (3rd Ed.). Oxford University Press.

Website and eLearning Source

1. https://ocw.mit.edu/courses/3-091-introduction-to-solid-state-chemistry-fall2018/video_galleries/lecture-videos/

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	predict the geometry of main group compounds and clusters.	**K1**
CO2	explain about the packing of ions in crystals and apply the radius ratio rule to predict the coordination number of cations.	**K2**
CO3	understand the various types of ionic crystal systems and analyze their structural features.	**K3**
CO4	explain the crystal growth methods.	**K4**
CO5	understand the principles of diffraction techniques and microscopic techniques	**K5**
CO6	design and improve the new crystals in main group compounds and clusters	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**								**Hours**	**Credits**
1	**23PCH1CC02**	**Core Course - 2:** Structure and Bonding in Inorganic Compounds								**6**	**6**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	2	2	2	2	3	2	2	2	**2.1**
CO2	2	3	2	2	2	3	3	2	2	2	**2.3**
CO3	3	3	3	2	2	3	2	3	2	2	**2.5**
CO4	2	2	2	2	2	2	3	3	2	2	**2.2**
CO5	2	2	2	2	3	2	3	2	2	2	**2.7**
CO6	3	3	3	2	2	3	3	3	2	3	**2.2**
										Mean Overall Score	**2.3 (High)**

Semester	Course code	Title of the Course	Hours/Week	Credits
1	23PCH1CP01	**Core Practical - 1:** Organic Chemistry	6	4

Course Objectives
To understand the concept of separation, qualitative analysis and preparation of organic compounds
To develop analytical skill in the handling of chemical reagents for separation of binary and ternary organic mixtures
To analyze the separated organic components systematically and derivatize them suitably
To construct suitable experimental setup for the organic preparations involving two stages
To experiment different purification and drying techniques for the compound processing

UNIT I: Separation and Analysis

Two component mixtures.

UNIT II: Estimations

a) Estimation of Phenol (bromination)
b) Estimation of Aniline (bromination)
c) Estimation of Ethyl methyl ketone (iodimetry)
d) Estimation of Glucose (redox)
e) Estimation of Ascorbic acid (iodimetry)

UNIT III: Two Stage Preparations

a) *p*-Bromoacetanilide from aniline
b) *p*-Nitroaniline from acetanilide
c) 1,3,5-Tribromobenzene from aniline
d) Acetyl salicyclic acid from methyl salicylate

Books for Study

1. Ganapragasm, N. S., & Ramamurthy, C. (2015). *Organic Chemistry Lab Manual*, (2nd Ed.). Vishwanathan S Printers and Publishers (P) Ltd.
2. Furniss, B. S., Hannaford, A. J., Smith, P. W. G., & Tatchell, A. R. *Vogel's Textbook of Practical Organic Chemistry,* (5th Ed.). Pearson publication.

Books for Reference

1. Venkateswaran, V., Veeraswamy, R., & Kulandaivelu, A. R. (1997). *Basic principles of practical chemistry,* (2nd ed.). Sultan Chand & Sons.
2. *Organic Chemistry Lab Manual for Micro Qualitative Analysis*. Department of Chemistry, St. Joseph's College, Tiruchirappalli-620 002. (Private circulation).

Website and eLearning Sources

1. https://youtu.be/EyWGc-vizic
2. https://youtu.be/mQ035ZrdD4Y
3. https://youtu.be/N96JaRnE7n0

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	recall the basic principles of organic separation, qualitative analysis and preparation.	**K1**
CO2	explain the method of separation and analysis of separated organic mixtures and convert them as derivatives by suitable preparation method.	**K2**
CO3	determine the characteristics of separation of organic compounds by various chemical reactions.	**K3**
CO4	develop strategies to separate, analyze and prepare organic compounds.	**K4**
CO5	formulate a method of separation, analysis of organic mixtures and design suitable procedure for organic preparations.	**K5**
CO6	evaluate the basic principles of organic separation, qualitative analysis and preparation.	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**						**Hours**	**Credits**
1	**23PCH1CP01**			**Core Practical - 1:** Organic Chemistry						**6**	**4**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	3	2	2	3	1	2	2	2	**2.2**
CO2	3	3	2	2	2	2	3	2	2	3	**2.4**
CO3	2	2	3	3	2	2	3	2	2	2	**2.3**
CO4	3	2	2	3	2	2	1	3	2	2	**2.2**
CO5	3	1	2	3	2	1	2	2	3	3	**2.2**
CO6	3	1	2	3	2	1	2	2	3	3	**2.2**
									Mean Overall Score		**2.26 (High)**

Semester	Course code	Title of the Course	Hours/Week	Credits
1	23PCH1ES01	**Elective - 1:** Nano Materials and Nano Technology	5	3

Course Objectives
To understand the different types of nanomaterials and their characteristics.
To comprehend the different synthetic strategies available for the synthesis of nanomaterials.
To evaluate the unique properties of the nanomaterials.
To determine the suitable characterization tools for the nanomaterials.
To propose various applications for the nanomaterials.

UNIT I: Introduction to Nanochemistry **(15 Hours)**

Introduction of nanomaterials and nanotechnologies, Introduction-role of size, classification0D, 1D, 2D, 3D. Consolidation of Nano powders. Features of nanostructures, Background of nanostructures. Fullerenes- Discovery -endohedral chemistry of Fullerenes- - Introduction of Carbon nanotubes and its types, Core-shell nanoparticles-types of core-shell nanoparticles.

UNIT II: Synthesis Methodologies Of Nanomaterials **(15 Hours)**

Synthesis- Top-down and bottom up approach. Physical methods- arc discharge, laser ablation, inert gas condensation, and chemical methods - sol-gel, solvothermal, sonochemical and hydrothermal-CVD-types, metallo organic, plasma enhanced, and low-pressure CVD. Microwave assisted and electrochemical synthesis.

UNIT III: Properties of Nanomaterials **(15 Hours)**

Properties of Nanoparticles, Metal Nano Clusters-Magic numbers, theoretical modeling of nanoparticles, geometric structures, electronic structure, reactivity, fluctuations, magnetic clusters, bulk to nanotransition. Semiconducting nanoparticles-optical properties, photofragmentation, coloumbic explosion. Molecular clusters-inert gas clusters, molecular clusters.

UNIT IV: Characterization Techniques 1 **(15 Hours)**

Characterization- principle and instrumentation. Tools to Characterize Nanomaterials-X- Ray Diffraction (XRD) -Small Angle X-Ray Scattering (SAXS)-Scanning Electron Microscopy (SEM)-Transmission Electron Microscopy (TEM)-Atomic Force Microscopy (AFM). Interpretation of results from microscopic analysis.

UNIT V: Characterization Techniques 2 and Advanced Applications **(15 Hours)**

Scanning Tunnelling Microscope (STM)-Field Ion Microscope (FIM)-3-Dimensional Atom Probe (3DAP)-Energy Dispersive X-Ray Analysis (EDX) - Nanoidentation

Advanced Applications of Nanomaterials

Nano-electronics- Fundamentals of semiconductor devices-MOSFET-Solid State quantum effect devices-Hybrid micro-nano-electronic resonant tunneling transistors-Molecular electronic devices-Novel opto-electronic devices

Teaching Methodology	Interactive videos, PPT, demonstration and creation of models

Books for Study

1. Pradeep, T. (2009). *Nano: The Essentials-understanding Nanoscience and Nanotechnology*, McGraw-Hill Education.
2. Poole, C. P. Jr., & Owens, F. J. (2009). *Introduction to Nanotechnology*. Wiley.
3. Shah, M. A. & Ahmad, T. (2010). *Principles of Nanoscience and Nanotechnology*. Narosa Publishing House.
4. Murty, B. S., Shankar, P. R., B. B. Rath, B., & Murday, J. *Textbook of Nanoscience and Nanotechnology*. University Press-IIM- Series in Metallurgy and Materials Science.
5. Rao, C. N. R., Muller, A., & Cheetham, A. K. (2004). *The chemistry of nanomaterials*. WILEY-VCH Verlag GmbH & Co. KgaA, Weinheim.

Books for Reference

1. Mohan, S., & Arjunan, V. (2016). *Principles of Materials Science*. MJP Publishers.
2. Arumugam. (2007). *Materials Science*. Anuradha Publications.
3. Giacavazzo. *et al.* (2010). *Fundamentals of Crystallography*. International Union of Crystallography. Oxford Science Publications.
4. Woolfson. (2012). A*n Introduction to crystallography*. Cambridge University Press.
5. Shackelford, J. F., & Muralidhara, M. K. *Introduction to materials science for engineers*, (6th Ed.). Pearson Press.

Websites and eLearning Sources

1. Baig, N, et al. Mater. Adv., 2021, 2, 1821.
2. Manzano, M. et al. Nanomaterials 2023, 13(12), 1828.
3. http://xrayweb.chem.ou.edu/notes/symmetry.html.
4. http://www.uptti.ac.in/classroom-content/data/unit%20cell.pdf
5. https://nanohub.org/

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	describe and consolidate the various types of nanomaterials.	**K1**
CO2	explain methods of fabricating nanostructures.	**K2**
CO3	relate the unique properties of nanomaterials to reduce dimensionality of the material.	**K3**
CO4	discuss the tools to characterize the nanoparticles.	**K4**
CO5	discuss the advanced applications of nanomaterials.	**K5**
CO6	synthesize and characterize the various nanomaterials.	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**						**Hours**	**Credits**
1	**23PCH1ES01**			**Elective - 1:** Nano Materials and Nano Technology						**5**	**3**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	3	2	3	2	2	3	2	2	2	**2.3**
CO2	2	3	2	2	3	3	3	2	2	2	**2.4**
CO3	3	3	3	2	2	3	2	3	2	2	**2.5**
CO4	2	3	2	2	3	2	3	3	2	2	**2.4**
CO5	3	3	3	2	2	3	3	3	2	3	**2.7**
CO6	2	2	2	3	3	2	3	2	2	2	**2.3**
										Mean Overall Score	**2.3 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
1	23PCH1ES02	**Elective - 2:** Electrochemistry	5	3

Course Objectives
To understand the behavior of electrolytes in terms of conductance, ionic atmosphere, interactions and structure of electrical double layer.
To compare electrodes between current density and over potential.
To discuss the mechanism of electrochemical reactions.
To highlight the different types of over voltages and its applications in electroanalytical techniques.
To familiarize about electro active species and energy production systems

UNIT I: Ionics **(15 Hours)**

Arrhenius theory -limitations- Debye Huckel theory of strong electrolytes-ion- solvent and ion-ion interactions- radius of ionic atmosphere-calculations of thickness of ionic atmosphere-evidences of ionic atmosphere-asymmetry effect -electrophoretic effect-Debye Falkenhagen effect-Wien effect- Born equation- Debye-Huckel Bjerrum model- Derivation of Debye-Huckel limiting law at appreciable concentration of electrolytes- modifications and applications - Electrolytic conduction-Debye-Huckel Onsager treatment of strong electrolytequalitative and quantitative verification and limitations-finite ion size model-Huckel- Bronsted equation-calculation of activity coefficient-determination of ion size parameter - Evidence for ionic atmosphere, Ion association and triple ion formations.

UNIT II: Electrode-electrolyte interface **(15 Hours)**

Interfacial phenomena -Evidences for electrical double layer- polarizable and non-polarizable interfaces- Electrocapillary phenomena-Lippmann equation- electro capillary curves- Electro-kinetic phenomena- electro-osmosis- electrophoresis- streaming and sedimentation potentials - colloidal and poly electrolytes - Structure of double layer: Helmholtz -Perrin, Guoy- Chapman and Stern models of electrical double layer- Zeta potential and potential at zero charge- Applications and limitations.

UNIT III: Electrodics of Elementary Electrode Reactions **(15 Hours)**

Behavior of electrodes: Standard electrodes and electrodes at equilibrium- Anodic and Cathodic currents- condition for the discharge of ions- Nernst equation- polarizable and nonpolarizable electrodes- Model of three electrode system- over potential- Rate of electro chemical reactions: Rates of simple elementary reactions- Butler-Volmer equation-significance of exchange current density- net current density and symmetry factor- Low and high field approximations- Symmetry factor and transfer coefficient- Tafel equations and Tafel plots.

UNIT IV: Electrodics of Multistep Multi Electron System **(15 Hours)**

Rates of multi-step electrode reactions- Butler-Volmer equation for a multi-step reaction Rate determining step- electrode polarization and depolarization- Transfer coefficients- its significance and determination- Stoichiometric number- Electro-chemical reaction mechanisms-rate expressions- order- and surface coverage- Reduction of I^{3-}, Fe^{2+}, and dissolution of Fe to Fe^{2+}- Overvoltage-Chemical and electro chemical- phase- activation and concentration over potentials- Evolution of oxygen and hydrogen at different pH- Pourbiax and Evan's diagrams.

UNIT V: Concentration Polarization, Batteries and Fuel cells **(15 Hours)**

Modes of Transport of electro active species-Diffusion- migration and hydrodynamic modes - Role of supporting electrolytes- Polarography-principle and applications- Principle of square wave polarography- Cyclic voltammetry- anodic and cathodic stripping voltammetry and differential pulse voltammetry- Sodium and lithium-ion batteries and redox flow batteries- Mechanism of charge storage: conversion and alloying- Capacitors- mechanism of energy storage- charging at constant current and constant voltage- Energy production systems -Fuel Cells: classification- alkaline fuel cells- phosphoric acid fuel cells- high temperature fuel cells.

Teaching Methodology	Videos, PPT, demonstration, group discussion and creation of models

Books for Study

1. Glasstone, S. (2008). *An introduction to Electro Chemistry*. Affiliated EastWest Press Pvt., Ltd.
2. Bockris, J. O. M., & Reddy, A. K. N. (2008). *Modern Electro Chemistry*. Vol.1, 2A and 2B. Springer, Plenum Press.
3. Antropov, L. I. (1977). *Theoretical electrochemistry*, (2nd Ed.). Mir Publishers.

Books for Reference

1. Rajaram, J., & Kuriakose, J. C. (2011). *Kinetics and Mechanism of Chemical Transformations*. Macmillan India Ltd.
2. Viswanathan, B., Sundaram, B., Venkataraman, R., Rengarajan, K., & Raghavan, P. S. (2007). *Electrochemistry-principles and Applications*. S. Viswanathan Printers.
3. Crow, D. R. (2014*). Principles and Applications of Electrochemistry*, (4th Ed.). Chapman & Hall.
4. Wang, J. *Analytical electrochemistry*, (2nd Ed.). Wiley.
5. Philip, H. R. (2010). *Electrochemistry*, (2nd Ed.). Springer.
6. Kapoor, K. L. (2001). *A Text book of Physical Chemistry*. Vol.3. Macmillan.

Website and eLearning Source

1. https://www.pdfdrive.com/modern-electrochemistry-e34333229.

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	identify the behaviour of electrolytes in solution and the structures of electrical double layers	**K1**
CO2	predict the kinetics of electrode reactions	**K2**
CO3	apply the different concepts of electrolytes and electrode-electrolyte interface	**K3**
CO4	explain the theories of electrolytes, electrical double layer and electrodics	**K4**
CO5	evaluate and interpret the outcomes of Debye Huckel theory and electrode kinetics	**K5**
CO6	design and improve information regarding electroytes, electrode kinetics and devise new storage devices	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**					**Hours**	**Credits**	
1	**23PCH1ES02**			**Elective - 2:** Electrochemistry					**5**	**3**	
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	3	2	3	2	2	3	2	2	2	**2.3**
CO2	2	3	2	2	3	3	3	2	2	2	**2.4**
CO3	3	3	3	2	2	3	2	3	2	2	**2.5**
CO4	2	3	2	2	3	2	3	3	2	2	**2.4**
CO5	3	3	3	2	2	3	3	3	2	3	**2.7**
CO6	2	2	2	3	3	2	3	2	2	2	**2.3**
										Mean Overall Score	**2.3 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
1	23PCH1AE01	**Ability Enhancement Course:** Analytical Techniques	2	1

Course Objectives
To understand the principles of analytical methods.
To evaluate the different analytical methods for better results.
To discuss the instrumentation technique of spectrophotometry, thermo-analytical, chromatographic and spectral techniques.
To emphasize the importance of the analytical methods in research.
To familiarize the handling of spectral instruments.

UNIT I: Spectrophotometric methods **(6 Hours)**

Spectrophotometric Methods-Principle and Instrumentation - Colorimetry, Flame Photometry, Fluorimertry, Phosphorimetry, Atomic Absorption Spectroscopy (AAS). Colorimetry-Fundamental laws-deviation from Beer's law.

UNIT II: Thermal methods **(6 Hours)**

General characteristic of thermo-analytical methods-Thermogravimetric analysis (TGA)-Principle, instrumentation and applications-Factors affecting thermogram-Differential Thermal Analysis (DTA) - instrumentation.

UNIT III: Chromatography **(6 Hours)**

Principles of Chromatography - Classification of chromatographic techniques-Principle, instrumentation and application of gas chromatography (GC), Thin-layer chromatography (TLC) and High-performance liquid Chromatography (HPLC).

UNIT IV: Spectroscopy **(6 Hours)**

Principle and instrumentation of UV-Visible and IR spectroscopy. Principle and instrumentation of Cyclic voltammetry (CV).

UNIT V: Spectroscopy Demonstration **(6 Hours)**

Spectral interpretation and Demonstration of Chromatographic techniques, UV-Visible, Fluorescence, Infra-red, Cyclic Voltammetry and High-performance liquid Chromatography.

Teaching Methodology	Chalk & Talk, PPT, videos and demonstration.

Book for study

1. Jeffery, G. H., Bassett, J., Mendham, J. & Denney, R. C. (1989). V*ogel's textbook of Quantitative Chemical Analysis*, (5th Ed.). Longman Scientific & Technical.
2. Pavia, D. L., Lampman, G. M., Kriz, G. S. & Vyvyan, J. R. (2015). *Introduction to Spectroscopy*, (5th Ed.). Cengage Learning.
3. Gopalan, R., Subramanian, P. S. & Rengarajan, K. (2005). *Elements of Analytical Chemistry*, (3rd Ed.). Sultan Chand & Sons.

Books for Reference

1. Skoog, D. A., West, D. M., Holler, F. J. & Crouch, S. R. (2014). *Fundamental of Analytical Chemistry*, (9th Ed.). Brooks/Cole Cengage Learning.
2. Silverstein, R. M. & Bassler, G. C. (1993). *Spectrometric Identification of Organic Compounds*, (4th Ed.). John-Wiley & Sons.
3. Kemp, W. (1987). *Organic Spectroscopy*, (3rd Ed.). ELBS.

Websites and eLearning Sources

1. https://www.classcentral.com/course/analyticalchem-838
2. https://ocw.mit.edu/courses/chemistry/

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, the students will be able to	**Cognitive Levels (K -Level)**
CO1	apply the thermal methods to characterize materials	**K4**
CO2	interpret and predict the presence of functional groups and structural information of molecules using IR and UV-Vis spectra	**K5**
CO3	demonstrate spectral instruments like IR, UV-Visible and CV	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**						**Hours**	**Credits**
1	**23PCH1AE01**			**Ability Enhancement Course:** Analytical Techniques						**2**	**1**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	3	3	2	2	3	2	2	2	**2.3**
CO2	3	2	2	3	2	2	1	3	2	2	**2.2**
CO3	3	1	2	3	2	1	2	2	3	3	**2.2**
										Mean Overall Score	**2.3 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PCH2CC03	**Core Course - 3:** Transition Elements, Covalent Bonding and Periodicity	4	4

Course objectives
To identify and examine the catalytic and magnetic properties of transition elements
To understand the structures of selected complexes
To summarize the concepts of acids and bases
To understand the chemistry of halogens and noble gases
To apply the VSEPR theory to predict the structures

UNIT I: Periodicity and the Chemistry of Halogens and Noble Gases (12 Hours)

Periodicity: The use of *p*-orbitals in *pi*-bonding - Carbon-silicon similarities and contrasts - Nitrogen-phosphorous analogies and contrasts - the use or not use of *d* orbitals by non-metals - theoretical arguments and experimental evidences - experimental evidences for *d*-orbital contraction and participation. Chemistry of halogens and noble gases: Interhalogen compounds - polyhalide ions - oxyacids of heavier halogens -structure and reactivity of noble gas fluorides.

UNIT II: Covalent Bonding (12 Hours)

Octet rule - valence bond theory - resonance - conditions of resonance - formal charge - hybridization - molecular orbital theory - symmetry and overlap - molecular orbital in homonuclear diatomic molecules: O_2, B_2 , N_2 and C_2 - MO treatment of hetero nuclear diatomic molecules: CO and HCl - VSEPR theory: methane, ammonia, water, PCl_3F_2 (Bent's rule), SF_4, BrF_3, TeF_5^-, ICl_2^-, ICl_4^-, XeF_2, XeF_4, XeF_6, XeO_3, XeO_4, XeO_2F_2, $XeOF_4$, phosphorus trihalides, ammonia and NX_3 dipole moments, OF_2 and COF_2 - bond angle - s, p character relationship.

UNIT III: Acids and Bases (12 Hours)

Acid-base concepts: Bronsted-Lowry, Lux-Flood, Usanovich, Lewis, solvent system and generalized acid base concepts - measures of acid-base strength - steric effect and solvation effects F-strain and B-strain - hard and soft acids and bases - acid base strength - hardness and softness - symbiosis - theoretical basis of hardness and softness, electronegativity and hardness and softness - types of solvents, types of reactions - autoionisation, neutralisation, precipitation, solvation, solvolysis and complex formation. Liq. NH_3, liq. SO_2, HF and H_2SO_4 as solvents - alkali metals in liq. NH_3.

UNIT IV: Transition Elements (12 Hours)

Transition elements - general characteristics - atomic, ionic radii - variation along the period and group - variable valency, colour, magnetic properties, non-stoichiometry, catalytic property, formation of alloys, complexing tendency - stabilization of unusual oxidation states.

UNIT V: Inner Transition Elements (12 Hours)

Inner transition elements - position in the periodic table - electronic configuration, oxidation states, solubility, colour and spectra, magnetic properties - separation of lanthanides - lanthanide contraction: causes and consequences - gadolinium break, shift reagents - extraction of thorium and uranium-comparison of actinides and lanthanides.

Teaching Methodology	Chalk and Talk, PPT, Videos

Books for Study

1. Huheey, J. E., Keiter, E. A., & Keiter, R. L., (2008). *Inorganic Chemistry Principles of Structure and Reactivity*, (4th Ed.). Pearson Education.

Unit I *Chapter 17 & 18*
Unit III *Chapter 9 & 10*
Unit II *Chapter 5*
Unit IV and V *Chapter 14*

2. Lee, J. D., (1998). *Concise Inorganic Chemistry*, (5th Ed.). ELBS.
Unit I *Chapter 18*
Unit II *Chapter 29 and 30*

Books for Reference

1. Cotton, F. A., & Wilkinson, G. (1972). *Inorganic Chemistry A Comprehensive Text*, (3rd Ed.). Inter Science Publishers.
2. Miessler, G. L., Fischer, P. J., &Tarr, D. A., (2014). *Inorganic Chemistry*, (5th Ed.). Pearson Education.
3. Housecroft, C. E., & Sharpe, A. G., (2012). *Inorganic Chemistry*, (4th Ed.). Pearson Education.

Websites and eLearning Source

1. https://www.thoughtco.com/ionic-and-covalent-chemical-bond-differences-606097
2. https://chemEditionchem.purdue.edu/genchem/topicreview/bp/ch11/acidbase.php
3. https://cbpbu.ac.in/userfiles/file/2020/STUDY_MAT/CHEM/Metal%20cluster_1.pdf

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K- Level)**
	On successful completion of this course, students will be able to	
CO1	identify and examine the catalytic and magnetic properties of transition elements	**K1**
CO2	understand the structures of selected complexes	**K2**
CO3	summarize the concepts of acids and bases	**K3**
CO4	discuss the chemistry of halogens and noble gases	**K4**
CO5	apply the VSEPR theory to predict the structures	**K5**
CO6	evaluate the properties of solvents and their applications	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**				**Hours**		**Credits**	
2	**23PCH2CC03**			**Core Course - 3:** Transition Elements, Covalent Bonding and Periodicity				**4**		**4**	
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Scores of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	2	2	1	3	2	2	2	1	**2.1**
CO2	2	2	2	2	1	2	2	2	2	2	**2.0**
CO3	2	2	2	2	1	2	2	2	2	2	**2.0**
CO4	3	2	2	2	1	3	2	2	2	1	**2.0**
CO5	2	3	2	2	2	2	3	2	2	2	**2.2**
CO6	3	3	2	2	1	3	2	2	2	1	**2.1**
									Mean Overall Score		**2.0 (Medium)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PCH2CC04	**Core Course - 4:** Quantum Chemistry and Statistical Thermodynamics	5	5

Course Objectives
To recognize the principles of classical mechanics and statistical thermodynamics
To understand the mathematical concepts of quantum mechanics and statistical thermodynamics
To apply the knowledge of quantum mechanics and statistical thermodynamics to simple systems
To classify the importance of quantum mechanics and statistical thermodynamics
To justify the application of quantum mechanics and statistical thermodynamics to systems of importance

UNIT I: Classical Mechanics **(15 Hours)**

Conservation principles: conservation of linear momentum, angular momentum and energy. Equations of motion: Newtonian, Lagrangian and Hamiltonian. Failure of classical mechanics: black body radiation- photoelectric effect - heat capacity of substances- hydrogen atomic spectrum- wave particle dualism- de-Broglie equation- Compton effect - uncertainty principle. Conversion of classical wave equation into Schrodinger wave equation.

UNIT II: Mathematics for Quantum Chemistry **(15 Hours)**

Functions - definition- classification- linearly dependent and independent functions- odd and even functions- inner product- normalization- orthogonality- orthonormal functions-Kronecker delta - need for normalization - Eigen functions - operators - linear and non-linear operators- commutation relationship-Construction of operators-linear momentum- angular momentum and energy operators-commutation relation among angular momentum operators- Hermitian operators and their properties-anti Hermitian - postulates of quantum mechanics - the Schrodinger equation.

UNIT III: Basic Quantum Chemistry **(15 Hours)**

Solution of the Schrodinger equation for exactly solvable problems - particle in 1D and 3D boxes - The harmonic oscillator- energy, energy and wave function, Hermite polynomial, power series method and relations among Hermite polynomial. The Rigid rotor- energy, wave function (Spherical Harmonics) and angular momentum operators - Schrodinger equation for hydrogen atom - solution for radial and angular wave equations and probability distributions of atomic orbitals and electron spin - Pauli's exclusion principle.

UNIT IV: Fundamentals of Statistical Thermodynamics **(15 Hours)**

Statistical method - microstates- macro states - permutations and combinations - combinatory rule - probability theorems - ensembles and grand canonical ensemble - phase space - thermodynamic probability- relationship between entropy and probability - statistical equilibrium - Stirling's approximation-Binomial and Multinomial Distribution- Method of most probable distribution and evaluation of undetermined multipliers. Statistical meaning of third law of thermodynamics. Electronic heat capacity of gases - equipartition of energy - classical and quantum statistical theory of heat capacities - heat capacities for diatomic molecule - rotational heat capacity of hydrogen molecule - Heat capacity of solids - Einstein and Debye models.

UNIT V: Applications of Statistical Thermodynamics **(15 Hours)**

Nuclear spin statistics - nuclear spin entropy- quantum statistics - Maxwell Boltzmann statistics - Bose - Einstein statistics - Fermi - Dirac statistics. Partition functions - molar- translational- rotational, electronic, nuclear and vibrational partition functions of diatomic and polyatomic molecules - separation of partition function according to forms of energy-partition function and vibrational energy - total partition function - derivation of thermodynamic quantities E, S, A, H, G, K and Cp, Cv using partition function-Sackur-Tetrode equation.

Teaching Methodology	Videos, PPT, demonstration, group discussion and creation of models

Books for Study

1. Prasad, R. K., (2022). *Quantum Chemistry,* (5th Ed.). New Age International Publishers. UNIT- I, UNIT- II, UNIT- III
2. Anderson, J. M., (2005). *Mathematics of Quantum Chemistry,* (1st Ed.). W.A. Benjamine Inc. NIT- I, UNIT- II.
3. McQuarrie, D. A., (2007). *Quantum Chemistry,* (1st Ed.). Viva Books Private Ltd. UNIT- I, UNIT- II , UNIT- III
4. Kuriakose, J. C., & Rajaram, J. C. (1996). *Thermodynamics,* Shoban Lal Co. UNIT- IV, UNIT- V

Books for Reference

1. Levine, I. N. (2009). *Quantum Chemistry* (6th Ed.). Prentice Hall of India, Pvt. Ltd.
2. Atkins, P., Friedman, R. (2011). *Molecular Quantum Mechanics* (5th Ed.). Oxford University Press.
3. Gupta, M. C. (1998). *Statistical Thermodynamics* (2nd Ed.). New Age International Publishers.
4. Donald, A., McQuarrie. (2003). *Statistical Mechanics*. Viva Books Private Ltd.

Website and eLearning Source

1. Bing Videos

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K- Level)**
CO1	recall the concepts of classical mechanics, quantum chemistry and statistical thermodynamics	**K1**
CO2	understand the fundamentals of quantum chemistry and statistical thermodynamics	**K2**
CO3	apply mathematical relations in quantum chemistry and statistical thermodynamics	**K3**
CO4	Correlating the concepts of classical mechanics, statistical thermodynamics and Schrodinger equation in simple systems	**K4**
CO5	validate the concepts of quantum chemistry and statistical thermodynamics in various systems	**K5**
CO6	Solving problems in quantum chemistry and statistical thermodynamics applied to simple systems	**K6**

Relationship Matrix											
Semester	**Course code**			**Title of the Course**						**Hours**	**Credits**
2	**23PCH2CC04**			**Core Course - 4:** Quantum Chemistry and Statistical Thermodynamics						**5**	**5**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Scores of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	3	2	2	1	3	3	2	2	1	**2.1**
CO2	2	2	2	2	1	2	2	2	2	1	**1.8**
CO3	3	2	2	2	2	3	2	2	2	2	**2.2**
CO4	2	3	2	2	2	2	3	2	2	2	**2.2**
CO5	3	2	3	2	2	3	3	3	2	2	**2.5**
CO6	2	2	2	2	1	3	3	3	2	1	**2.1**
										Mean Overall Score	**2.15(Medium)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PCH2CP02	**Core Practical - 2:** Inorganic Chemistry - 1	4	3

Course Objectives
To understand the basics of semimicro inorganic analysis.
To know the classification of metal cations into different groups
Able to examine a given inorganic mixture and find out the different groups of cations in it.
To apply the principles of colorimetry to analyze pollutants in environment samples
To investigate the presence of trace metal ions using colorimetry

UNIT I: Introduction to Inorganic Semimicro Analysis **(12 Hours)**

Introduction to the semimicro method - apparatus and procedures - reaction vessels - reagent bottles - the dropper pipette - stirrers - spatula - generators for hydrogen sulphide - heating devices- centrifuge - evaporation - testing for gaseous products

UNIT II: Classification of Cations into Groups **(12 Hours)**

Classification of cations into groups - analysis of group I - separation of copper and tin groups - analysis of groups IIA and IIB - analysis of group III - analysis of group IV - analysis of group V - analysis of group VI

Unit III: Systematic Semimicro Analysis of Inorganic Mixtures Containing Two Common and Two Less Common (rare) Cations **(12 Hours)**

Systematic semimicro analysis of any five inorganic mixtures.

UNIT IV: Introduction to Colorimetric Analysis **(12 Hours)**

Basic principles of colorimetry - Lambert's law - Beer's law -Beer-Lambert law - applications of Beer's law - deviations from Beer's law - classification of methods of colour measurement - the standard series method - photoelectric photometric method - spectrophotometric method.

UNIT V: Experimental Colorimetric Determinations **(12 Hours)**

Some general remarks on colorimetric determinations - general procedure for colorimetric determinations - colorimetric estimation of iron as its thiocyanate complex - colorimetric estimation of copper by its reaction with ferrocyanide - colorimetric estimation of nickel as its dimethyl glyoxime complex.

Teaching Methodology	Videos, PPT, demonstration, group discussion and creation of models

Books for Study

1. *Inorganic Laboratory Manual*, Department of Chemistry
   Unit III and **Unit-V**
2. Ramanujam, V. V. (1990). *Inorganic Semi Micro Qualitative Analysis*, (3rd Ed.). National Publishing Company.
   Unit-I *Chapter 1 and 2*
   Unit-II *Chapter 3 and 4*
3. Jeffery, G. H., Bassett, J., Mendham, J., & Denney R. C. (1989). *Vogel's Textbook of Quantitative Chemical Analysis*, (5th Ed.). Longman Scientific and Technical, Essex.
   Unit-IV *Chapter 17*
   Unit-V *Chapter 17*

Books for Reference

1. Svehla, G., (1996). *Vogel's Qualtitative Inorganic Analysis*, (7th Ed.). Longmann, London.
2. Metz, C., & Castellion, M. E. (1980). *Chemistry: Inorganic Qualitative Analysis in the Laboratory*, Academic Press.
3. Skoog, D. A., West, D. M., Holler, F. J. & Crouch, S. R. (2014). *Fundamentals of Analytical*

Chemistry, (9th Ed.). Brooks/Cole Cengage Learning.

Websites and eLearning Sources

1. https://www.canterbury.ac.nz/media/documents/science-outreach/iron_colorimeter.pdf
2. https://vlab.amrita.edu/index.php?sub=2&brch=193&sim=348&cnt=1

Course Outcomes		
CO No.	**CO-Statements** On completion of this course, the students will be able to	**Cognitive Levels (K- Level)**
CO1	understand the basics of semimicro inorganic analysis.	**K1**
CO2	explain the classification of metal cations into different groups	**K2**
CO3	examine a given inorganic mixture and find out the different groups of cations in it.	**K3**
CO4	recommend colorimetry for the analysis of environmental pollutants	**K4**
CO5	investigate the presence of trace metal ions using colorimetry	**K5**
CO6	inspect the presence of trace metal ions using colorimetry	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**					**Hours**		**Credits**
2	**23PCH2CP02**			**Core Practical - 2:** Inorganic Chemistry - 1					**4**		**3**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Scores of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	3	2	2	2	2	3	2	2	**2.2**
CO2	1	3	2	2	3	2	3	2	2	3	**2.3**
CO3	3	2	3	2	1	3	2	3	2	1	**2.2**
CO4	2	1	2	2	2	2	1	2	2	2	**1.8**
CO5	2	2	2	2	1	2	2	2	2	1	**1.8**
CO6	3	2	3	2	1	3	2	3	2	1	**2.2**
Mean Overall Score											**2.08 (Medium)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PCH2CP03	**Core Practical - 3:** Physical Chemistry - 1	4	3

Course Objectives
To prepare solutions of different concentrations
To recognize the principles of physical chemistry
To understand the practical concepts behind chemical kinetics, phase rule and optical rotation
To apply the knowledge of chemical kinetics and phase rule in different chemical systems
To experiment the concepts of chemical kinetics, phase rule and optical rotation

UNIT I: Theory Behind Experiments **(8 Hours)**

Kinetics of reaction between iodide and persulphate- Iodination of acetone- hydrolysis of ester- phase diagram (simple and compound forming systems)- adsorption isotherm- heat of solution- polarimetry.

UNIT II: Preparation of Solutions **(4 Hours)**

Preparation and standardization of HCl, NaOH, iodine, potassium persulphate, oxalic acid, sucrose.

UNIT III: Cycle I **(16 Hours)**

1.Neutral salt effect - kinetics of reaction between iodide and persulphate - effect of ionic strength on rate constant.
2.Kinetics of iodination of acetone.
3.Kinetics of hydrolysis of ester - comparison of acid strengths.

UNIT IV: Cycle II **(16 Hours)**

1.Phase diagram of naphthalene - *m*-dinitrobenzene system. (Simple eutectic system).
2.Freundlich's adsorption isotherm - adsorption of acetic acid by charcoal.
3. Phase diagram of two-component system forming a compound.

UNIT V: Cycle III **(16 Hours)**

1.Determination of Arrhenius parameters - Hydrolysis of methyl acetate by acid
2. Heat of solution of oxalic acid by solubility.
3.Polarimetry - Inversion of Cane sugar.

Books for Study

1. *Lab Manual*, Department of Chemistry.
2. Venkateswaran, V., Veeraswamy, R., &Kulandaivelu, A. R. (1997). *Basic Principles of Practical Chemistry,* (2nd Ed.). Sultan Chand & Sons.
3. Daniels, Mathews, F., Howard, J. & John Warren, W. (1970). *Experimental Physical Chemistry*, (7th Ed.). Mc Graw Hill.
4. Findlay, A., (1959). *Practical Physical Chemistry,* (7th Ed.).

Websites and eLearning Source

Phase diagram of naphthalene - *m*-dinitrobenzene system.

Freundlich's adsorption isotherm

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K- Level)**
CO1	learn concepts of kinetics of chemical reaction and adsorption isotherm.	**K1**
CO2	understand the effect of ionic strength on the rate constant.	**K2**
CO3	analyze the phase transformations.	**K3**
CO4	experiment the concepts of surface catalysis and adsorption.	**K4**
CO5	justify the concepts of phase rule in different component systems.	**K5**
CO6	Experiment the concepts of kinetics, phase rule and optical rotation	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**						**Hours**	**Credits**
2	**23PCH2CP03**			**Core Practical - 3:** Physical Chemistry - 1						**4**	**3**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Scores of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	2	2	2	3	2	2	2	2	**2.2**
CO2	3	3	2	2	1	3	3	2	2	1	**2.2**
CO3	3	3	3	3	2	3	3	3	3	2	**2.8**
CO4	3	2	3	2	1	3	3	2	2	2	**2.3**
CO5	2	3	3	2	2	2	3	3	2	2	**2.4**
CO6	3	3	3	2	2	3	3	3	2	2	**2.6**
										Mean Overall Score	**2.4 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	**23PCH2SP01**	**Self-paced Learning:** Selected Topics in Inorganic Chemistry and Physical Chemistry	**-**	**2**

Course Objectives
make the students analyze the types of errors in analyses
learn the concepts of hybridization and acid-base concepts
To understand the properties of colloids
To analyze the structure of solid surfaces in terms of adsorption isotherm
appraise the principles of polymerization kinetics and determination of its molecular weight
summarize the concepts of NQR and Radiation chemistry

UNIT I: Error Analysis

Error Analysis - Significant figures - rounding off the values - accuracy and precision- errors - classification of errors - constant errors and proportional errors - determinate errors (systematic errors) and indeterminate errors (random and accidental) - minimization of errors: calibration of apparatus, analysis of standard samples, running a blank determination, and independent analysis. Average, range, median, average deviation, relative average deviation and standard deviation, variance, coefficient of variation - the normal error curve - testing of significance: *F*-test, *t*- test and *Q*-test - confidence limit - method of least squares.

UNIT II: Structure and Properties

Hybridization - Electronegativity - dipole moments - polarity of solvents - hydrogen bonding - Bonds weaker than Hydrogen Bonding - Addition Compounds - Acids and Bases - HSAB Theory. Electronic Effects - inductive, resonance and hyperconjucative effects and their influence - rules of resonance - tautomerism - steric effects.

UNIT III: Surface Chemistry

Colloids, Properties of sols-stability of sols- coagulation-protective colloids-structure of solid surface-Adsorption-theories of isotherm-catalysis of reaction by solid acids-catalysis of green chemistry with solid surface.

UNIT IV: Polymer Chemistry

Kinetics of polymerization-number average molecular weight of polymers-molecular weight determination-Thermal behavior of polymers-sedimentation velocity. Models of viscoelastic behavior-Hooke model, Newton model, Voigt model, Burger Maxwell model, Measurement of glass transition temperature and its molecular weight interpretation.

UNIT V: NQR spectroscopy and Radiation Chemistry

Nuclear Quadrupole Spectroscopy-Theory and principle -Instrumentation-Applications related to location of point group, chemical bonding, hydriogen bonding and phase transition. Radiation Chemistry-Sources of high energy radiation- Interaction of high energy radiation with matter. Detection of radiation -Dosimeters- Prinary and secondary process-Radialysis of water -Hydrated electron and G-value.

Teaching Methodology	PPT and Videos

Books for Study

1. Skoog, D. A., West, D. M., Holler, F. J. & Crouch, S. R. (2014). *Fundamentals of Analytical Chemistry*, (9th Ed.). Brooks/Cole Cengage Learning, Belmont, CA 94002-3098, USA. Unit I: Part I
2. Bruice P.Y. (2012). *Organic Chemistry*, (4th Ed.). Pearson Education, New Delhi.

Unit II:Chapter 1

3. Atkin's P, Paula, D.J., Keller, J. (2018). *Physical Chemistry*, International Publication, Oxford University Press
   Unit III:Chapter 17 E, 19A-C
   Unit IV:Chapter 17
4. Drago, R. S. (1965). *Physical Methods in Inorganic Chemistry* (1st Ed.). Affiliated East-West Press Private Limited, New Delhi. Unit V:

Book for References

1. Puri, B.P., & Sharma, L.R. (2018). *Principles of Physical Chemistry*, (47th Ed.). Vishal Publication.
2. Castellan, G W. (2004). *Physical Chemistry*, (4th Ed.). Narosa.

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K- Level)**
CO1	understand the types of errors, minimization of errors and analytical calculations.	**K1**
CO2	interpret the geometry and bonding based on hybridization concepts	**K2**
CO3	understand the nature of colloids and solid surfaces	**K3**
CO4	examine the thermal properties of solids	**K4**
CO5	understand the applications of NQR spectroscopy	**K5**
CO6	develop the knowledge in the field of radiation chemistry and its importance.	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**								**Hours**	**Credits**
2	**23PCH2SP01**	**Self-paced Learning:** Selected Topics in Inorganic Chemistry and Physical Chemistry								**-**	**2**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Scores of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	2	2	1	3	2	3	2	1	2.2
CO2	3	3	2	2	1	3	2	3	2	2	2.3
CO3	2	2	2	2	2	2	2	2	2	2	2.0
CO4	3	2	3	2	1	3	2	2	2	1	2.1
CO5	3	3	3	2	2	3	3	2	2	2	2.5
CO6	3	2	3	2	1	3	2	2	3	2	2.3
Mean Overall Score											**2.23 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PCH2ES03A	**Elective - 3:** Addition, Elimination and Redox Reactions in Organic Chemistry	5	4

Course Objectives
To understand feasibility and the mechanism of electrophilic addition reactions.
To comprehend elements of elimination mechanisms.
To master various ways of oxidation of different functional groups.
To understand stereochemistry and selectivity in reductions organic functional groups.
To design reactions involving stable intermediates and plausible transition states.

UNIT I: Electrophilic Addition reactions **(15 hours)**

Introduction - addition of HX to alkenes - Markovnikov's regioselectivity - acid catalyzed hydration and related reactions - addition of HBr/Peroxide - addition of halogens - halonium ion intermediate - reaction mechanism and *anti*-addition stereochemistry - hydroboration-oxidation - regioselectivity and *syn*-addition - oxymercuration-demercuration - regioselectivity and *anti*-addition - mechanism of addition to allenes and alkynes - regioselectivity and syn/anti addition mechanism - kinetic vs thermodynamic control in 1,2- and 1,4- addition to conjugated dienes.

UNIT II: Elimination reactions **(15 hours)**

E1, E2, and E1CB mechanisms -kinetic and stereochemical evidences - regioselectivity - Zaitsev's rule - thermodynamic stability of the ene formed - dehydrohalogenations - *anti*-elimination - strength of bases - leaving group ability - relative ease of reactivity of halides - dehydration of alcohols - dehalogenations of vicinal halides - Chugaevreaction - Hofmann exhaustive methylation-elimination and its regioselectivity - Cope elimination - Shapiro reaction - extrusion reactions -examples.

UNIT III: Oxidation reactions **(15 Hours)**

Oxidation of alcohols to aldehydes, ketones, and carboxylic acids - transition metal oxidants - addition of oxygen to C=C - transition metal oxidants - epoxides from alkenes and peroxide reagents - subsequent transformations of epoxides - allylic oxidations - transition metal oxidants - reactions of alkenes with singlet oxygen - oxidative cleavage of C=C - transition metal oxidants - oxidation of ketones and aldehydes by oxygen and peroxidic compounds - oxidation with other reagents - selective oxidative cleavages at functional groups - cleavage of glycols - oxidative decarboxylations - oxidations at unfunctionalized carbon.

UNIT IV: Reduction reactions **(15 Hours)**

C-C multiple bonds: Hydrogenation using heterogeneous and homogeneous catalysts - enantioselective hydrogenation - partial reduction of alkynes - hydrogen transfer from diimidecarbonyl groups: Group III hydride donor reagents - comparative reactivity of common hydride donors - stereoselectivity of hydride reduction - enantioselective reduction of carbonyl compounds - reduction of other functional groups - dissolving metal reductions - addition of hydrogen - reductive removal of functional groups - reductive coupling of carbonyl compounds - reductive deoxygenation of carbonyl groups to methylene - reduction of carbonyl compounds to alkenes.

UNIT V: Reactive Intermediates **(15 Hours)**

Carbocations: Structure and stability - direct observation of carbocations - competing reactions - rearrangement of carbocations - non-classical carbocations.

Carbenes: Reactivity - generation - addition and insertion reactions - generation and reactions of ylides by carbenoid decomposition - rearrangement reactions: ring expansion of cycloalkanones - Wolff - aldehyde to alkyne elongation *via* carbine and carbenoid.

Nitrenes: Generation - rearrangements to electron deficient nitrogen.

Free radicals: Sources of radicals - addition reactions of radicals with substituted alkenes -cyclization - addition to C=N bonds - Tandem radical cyclizations and alkylations - fragmentation and rearrangements - intramolecular functionalization by radical reactions.

Teaching Methodology	Chalk and Talk, PPT, Videos

Books for Study

1. Carey, F.A., & Sundberg, R.J. (2007). Advanced Organic Chemistry, **Part A**: Structure and mechanisms, (5th Ed.). Springer (India) Pvt. Ltd.
   Unit I: Chapter 5
   Unit II: Chapter 5
2. Carey, F.A., Sundberg, R.J. (2007). Advanced Organic Chemistry, **Part B**: Structure and Mechanisms, (5th Ed.). Springer (India) Pvt. Ltd.
   Unit I: Chapter 4
   Unit III: Chapter 12
   Unit IV: Chapter 5
   Unit V: Chapter 10

Books for Reference

1. Clayden, J., Greeves, N., & Warren, S. (2012). *Organic Chemistry*, (2nd Ed.). Oxford University Press, New York.
2. Smith, M.B., & March, J. (2007). *March's Advanced Organic Chemistry*, (6th Ed.). John-Wiley and Sons, New York.
3. Bruckner, R. (2010). *Organic Mechanisms - Reactions, Stereochemistry and Synthesis*, Springer-Verlag, Berlin, Heidelberg.
4. Stanley, H.P. (2006). *Organic Chemistry*, (5th Ed). Tata-McGraw Hill.
5. Anastas, P.T. (2006). *Text Book on Green Chemistry*, Oxford University Press.

Websites and eLearning Source

1. https://www.youtube.com/watch?v=9kSCbVIdkDQ

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K- Level)**
CO1	understand the types of addition, elimination, oxidation and reduction reactions	**K1**
CO2	examine the mechanisms of various reactions based on stable intermediates and transition states	**K2**
CO3	compose multiple ways for conversion in organic synthesis	**K3**
CO4	assess the possible synthetic pathways for organic molecules	**K4**
CO5	evaluate the various concerns related to environment in organic synthetic methodologies	**K5**
CO6	propose new synthetic routes and pathways in organic synthesis	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**								**Hours**	**Credits**
2	**23PCH2ES03A**	**Elective - 3:** Addition, Elimination and Redox Reactions in Organic Chemistry								**5**	**4**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	2	1	3	3	2	3	2	1	**2.1**
CO2	2	2	2	2	3	2	2	2	3	2	**2.2**
CO3	3	2	3	2	3	3	1	2	2	2	**2.3**
CO4	3	2	2	3	2	2	3	1	1	2	**2.1**
CO5	2	3	1	2	3	3	2	2	2	3	**2.3**
CO6	2	1	2	2	3	3	2	3	1	2	**2.1**
										Mean Overall Score	**2.2(Medium)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PCH2ES03B	**Elective - 3:** Stereochemistry	5	4

Course Objectives
To assign R or S configuration for the chiral centres of organic compounds
To comprehend the techniques in the determination of reaction mechanisms of elimination reactions.
To understand the methods of resolution to form chiral compounds
To correlate and appreciate the Fischer, Newmann and Sawhorse formulae of organic compounds
To design asymmetric synthesis using chiralauxillaries, chiral reagents and chiral catalysts.

UNIT I: Configuration **(15 Hours)**

Double bonds - cyclic systems - tetrahedral atoms - with multiple stereogenic centres - other types of stereogenic centres - axial chirality - biphenyls, allenes, spiranes - assigning *R/S* - chirality and symmetry concept of atropisomerism - helicity and chirality - topocity and prostereo isomerism - topocity of ligands and faces - enantiotopic ligands and faces - diastereotopic ligands and faces - configuration at prochiral centers.

UNIT II: Resolution **(15 Hours)**

Absolute configuration - enantiomers - diastereomers - polarimeter - resolution - methods - chiral shift reagents and chiral solvating agents - separation of enantiomers - enzymatic resolution and disymmetrization - the anomeric effect in cyclic compounds.

UNIT III: Conformational Analysis **(15 Hours)**

Conformational isomerism in ethane and n-butane - projection formula - Fischer, Newmann and Sawhorse - conformational isomerism in cycloalkanes - Baeyer's strain theory- mono and disubstituted three-, four-, five- and six- membered ring systems and their optical activity - conformations of decalin - chirality in molecules with non-carbons stereocenters (N, S and P).

UNIT IV Stereoselectivity **(15 Hours)**

Chemoselectivity: Chemo-, regio-, and stereoselectivity - reactivity of carbonyl groups towards nucleophiles - selectivity of hydrides in reduction - selectivity in oxidations - Protecting groups - hydroxyl, amino, carbonyl and carboxylic acid protecting groups.

Regioselectivity: Regioselectivity in electrophilic and nucleophilic aromatic substitution, regioselectivity in elimination reactions, electrophilic attack on alkenes, regioselectivity in radical reactions, nucleophilic attack on allylic compounds, electrophilic attack on conjugated dienes and conjugate addition.

UNIT V Asymmetric Synthesis **(15 Hours)**

Chiral auxiliaries: Alkylation of chiral enolates - enantiomeric excess - optical purity - chiral reagents and chiral catalysis - asymmteric hydrogenation - asymmetric epoxidation - asymmetric dihydroxylation.

Diastereoselectivity: Prochirality, Cram's rule and chelation effect, diastereoselectivity in aldol reaction, diastereoselective epoxidation.

Teaching Methodology	Chalk and Talk, PPT, Videos

Books for Study

1. Carey, F.A., Sundberg, R. J. (2007). Advanced Organic Chemistry, Part A: Structure and mechanisms, (5th Ed.). Springer (India) Pvt Ltd, New Delhi.
   Unit I Chapter 2
   Unit II Chapter 2
2. Clayden, J., Greeves, N., & Warren, S. (2012). Organic Chemistry, (2nd Ed.). Oxford University Press, New York,.

Unit III Chapter 16
Unit IV Chapter 23
Unit V Chapter 41

3. Carey, F.A., & Sundberg, R.J. (2007). Advanced Organic Chemistry, Part B: Structure and Mechanisms, (5th Ed.). Springer (India) Pvt Ltd, New Delhi.
   Unit IV Chapter 3

Books for Reference

1. Bruckner, R. (2010). *Organic Mechanisms - Reactions, Stereochemistry and Synthesis,* Springer-Verlag, Berlin, Heidelberg.
2. Gould, E.S. (1959). *Mechanism and Structure in Organic Chemistry*, Holt-Reinhart and Winston, New York.
3. Eliel, E.L. (1998). *Stereochemistry of Carbon Compounds*, Tata-McGraw Hill Publishing Company, New Delhi.
4. Nasipuri, D. (1996). *Stereochemistry of Carbon Compounds*, (2nd Ed.). New-Age International Publishers, New Delhi.

Websites and eLearning Source

1. https://www.youtube.com/watch?v=B23i9_jC5T8
2. https://www.youtube.com/watch?v=fLXyKLVd6Hc

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K- Level)**
	On successful completion of this course, students will be able to	
CO1	find the configuration and understand the importance of stereochemical aspects of organic molecules	**K1**
CO2	find conformational isomers and justify conformational analysis of cyclic and acyclic systems.	**K2**
CO3	outline chiral auxiliaries in asymmetric synthesis and design diastereoselectivity in selective organic reactions.	**K3**
CO4	use the absolute configuration and design techniques of resolution.	**K4**
CO5	assess the importance of protecting groups and categorize Chemo-, regio-, and stereoselectivity in selective organic synthesis.	**K5**
CO6	apply the absolute configuration to design stereochemical techniques.	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**					**Hours**		**Credits**
2	**23PCH2ES03B**			**Elective - 3:** Stereochemistry					**5**		**4**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	2	1	3	3	2	3	2	1	**2.1**
CO2	2	2	2	2	3	2	2	2	3	2	**2.2**
CO3	3	2	3	2	3	3	1	2	2	2	**2.3**
CO4	3	2	2	3	2	2	3	1	1	2	**2.1**
CO5	2	3	1	2	3	3	2	2	2	3	**2.3**
CO6	1	2	2	3	2	3	3	2	1	2	**2.1**
Mean Overall Score											**2.18 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PSS2SE01	**Skill Enhancement Course:** Soft Skills	4	3

Course Objectives
To provide a focused training on soft skills for students in colleges for better job prospects
To communicate effectively and professionally
To help the students take active part in group dynamics
To familiarize students with numeracy skills for quick problem solving
To make the students appraise themselves and assess others

UNIT I: Effective Communication & Professional Communication (12 Hours)

Definition of communication, Barriers of Communication, Non-verbal Communication; Effective Communication - Conversation Techniques, Good manners and Etiquettes; Speech Preparations & Presentations; Professional Communication.

UNIT II: Resume Writing & Interview Skills (12 Hours)

Resume Writing: What is a résumé? Types of résumés, - Chronological, Functional and Mixed Resume, Purpose and Structure of a Resume, Model Resume.

Interview Skills: Types of Interviews, Preparation for an interview, Attire, Body Language, Common interview questions, Mock interviews & Practicum

UNIT III: Group Discussion & Personal effectiveness (12 Hours)

Basics of Group Discussion, Parameters of GD, Topics for Practice, Mock GD & Practicum & Team Building.

Personal Effectiveness: Self Discovery; Goal Setting with questionnaires & Exercises

UNIT IV: Numerical Ability (12 Hours)

Introducing concepts Average, Percentage; Profit and Loss, Simple Interest, Compound Interest; Time and Work, Pipes and Cisterns.

UNIT V: Test of Reasoning (12 Hours)

Introducing Verbal Reasoning: Series Completion, Analogy; Data Sufficiency, Assertion and Reasoning; and Logical Deduction. Non-Verbal Reasoning: Series; and Classification

Teaching Methodology	Chalk and talk, Lectures, Demonstrations, PPT.

Book for Study

1. Melchias G., Balaiah, J. & Joy, J. L. (Eds). (2018). *Winner in the Making: A Primer on soft Skills.* Trichy, India: St. Joseph's College.

Books for Reference

1. Aggarwal, R. S. (2010). *A Modern Approach to Verbal and Non-Verbal Reasoning.* S. Chand.
2. Covey, S. (2004). *7 Habits of Highly effective people.* Free Press.
3. Gerard, E. (1994). *The Skilled Helper* (5th Ed.). Brooks/Cole.
4. Khera, S. (2003). *You Can Win.* Macmillan Books.
5. Murphy, R. (1998). *Essential English Grammar,* (2nd Ed.). Cambridge University Press.
6. Sankaran, K., & Kumar, M. (2010). *Group Discussion and Public Speaking* (5th Ed.). M.I. Publications.
7. Trishna, K. S. (2012). *How to do well in GDs & Interview*s? (3rd Ed.). Pearson Education.
8. Yate, M. (2005). *Hiring the Best: A Manager's Guide to Effective Interviewing and Recruiting*

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K - Level)**
CO1	recall various soft skill sets	**K1**
CO2	understand personal effectiveness in any managerial positions	**K2**
CO3	apply verbal and non-verbal reasoning skills to solve problems	**K3**
CO4	differentiate problems at work and home; and design solutions to maintain work-life balance	**K4**
CO5	assess growth and sustainability and infuse creativity in employment that increases professional productivity	**K5**
CO6	construct plans and strategies to work for better human society	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**					**Hours**		**Credits**
2	**23PSS2SE01**			**Skill Enhancement Course:** Soft Skills					**4**		**3**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	3	3	2	3	2	3	2	3	**2.7**
CO2	3	3	3	2	3	3	3	3	3	3	**2.9**
CO3	3	2	2	3	3	3	3	3	3	3	**2.8**
CO4	3	3	2	2	3	3	3	3	3	3	**2.8**
CO5	3	3	3	2	2	3	3	3	3	3	**2.8**
CO6	3	3	3	2	2	3	3	3	3	3	**2.8**
										Mean Overall Score	**2.8 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
3	23PCH3CC05	**Core Course - 5:** Organic Synthesis and Spectroscopy	6	6

Course Objectives
To understand the principle, theory and applications of ^{1}H NMR and ^{13}C NMR spectra.
To comprehend the mass spectrometric analysis in the determination of molecular mass of the organic compounds.
To analyze the synthetic pathways for biologically important target molecules.
To correlate and differentiate various organometallic reagents in organic synthesis.
To design reactions from their respective synthons and synthetic equivalents.

UNIT I: Retro-synthetic analysis **(18 Hours)**

Synthons and synthetic equivalents - types of synthons: donor and acceptor synthons - umpolung reactions - typical examples. Functional Group Interconversion (FGI), Functional Group Addition (FGA) - monofunctional disconnection: alcohol disconnection - alkene disconnection - ketone disconnection - acid and their derivatives disconnection - alkane disconnection - amine disconnection - Bifunctional 1,2-, 1,3-, 1,4-, 1,5-, and 1,6- disconnections.

UNIT II: Asymmetric Synthesis **(18 Hours)**

Chiral auxiliaries - alkylation of chiral enolates - enantiomeric excess-optical purity - chiral reagents and chiral catalysis - asymmetric hydrogenation - Sharpless asymmetric epoxidation -asymmetric dihydroxylation - Chemo selectivity - Protecting groups - hydroxyl, amino, carbonyl and carboxylic acid protecting groups - Deprotecting methods.

Diastereo selectivity: prochirality, Cram's rule and chelation effect, Diastereo selectivity in aldol reaction, diastereoselectiveep oxidation.

UNIT III: Organometallic reagents in organic synthesis **(18 Hours)**

Preparation of organometallics: oxidative insertion of Mg and Li into alkyl halides, deprotonation of alkyne, ortho lithiation of functionalized benzene rings, halogen metal exchange, transmetallation - preparation and properties and synthetic applications of organolithium, organomagnesium, organocopper reagents and intermediates - synthesis, features and reactions of organosilicon compounds - reactions involving organopalladium intermediates - Heck reaction - cross coupling reactions - Suzuki, Stille, Fukuyama - Negishi, Kumada - Chan-Lam - Hiyama couplings - Corey-Fuchs couplings - Sonogashira reaction - Baylis-Hillman reaction - Biginelli reaction - Prins reaction, Mitsunobu reaction - Weinreb ketone synthesis - Henry reaction - Hosomi-Sakurai reaction

UNIT IV: NMR Spectroscopy **(18 Hours)**

^{1}H NMR: Principle - Chemical shift - Factors influencing shielding - deshielding - local diamagnetic shielding - magnetic anisotropy - spin-spin splitting (n+1) rule - coupling constants - symbols - spectra of diastereotopic systems - measuring coupling constants - spin system notation: A_2, AB, AX, AB_2, AX_2, A_2B_2, A_2X_2 spin systems - PMR absorptions by hydrocarbons and functional groups

^{13}C NMR: ^{13}C nucleus-chemical shifts - correlation charts - proton coupled and decoupled ^{13}C spectra - nuclear overhauser effect - off resonance decoupling - DEPT experiments Two dimensional spectroscopic methods: COSY, HETCOR (HMQC) and NOESY experiments - Magnetic resonance imaging - problem solving.

UNIT V: Mass spectrometry **(18 Hours)**

Basic principles - instrumentation - sampling techniques - ionization methods: EI, CI, desorption ionization techniques (SIMS, FAB, and MALDI), ESI - Mass analysis: magnetic, double focusing, quadrupole and ToF mass analyzers - determination of molecular weight - molecular ion peak - parent ion peak, base and meta stable peaks - calculation of molecular formula - fragmentation and structural analysis - fundamental fragmentation processes - Stevenson's rule - α-cleavage - inductive cleavage - two bond cleavage - retro Diels-Alder cleavage - McLafferty rearrangements - fragmentation of

hydrocarbons - alcohols, phenols, thiols - ethers and sulfides - carbonyl compounds - amines and nitrogen compounds - halides - Solving Combined problems.

Teaching Methodology	Chalk and Talk, PPT, Videos.

Books for Study

1. Clayden, J., Greeves, N. & Warren, S. (2012). *Organic Chemistry*, (2nd Ed.). Oxford University Press.
   a. **Unit I** **Chapter 28**
   b. **Unit II** **Chapters 41 & 33**
   c. **Unit III** **Chapter 40**
2. Pavia, D. L, Lampman, G. M., Kriz, G. S. & Vyvyan, J. R. (2015). *Introduction to Spectroscopy*, (5th Ed.). Cengage Learning.
   a. **Unit IV** **Chapters 5 & 6**
   b. **Unit V** **Chapters 8 & 9**

Books for Reference

1. Silverstein, R. M. & Bassler, G. C. (1993). *Spectrometric Identification of Organic Compounds*, (4th Ed.). John- Wiley and Sons.
2. Kemp, W. (1987). *Organic Spectroscopy*, (3rd Ed.). ELBS.
3. Fleming, I. (1988). *Spectroscopic Methods in Organic Chemistry*, (4th Ed.). Tata-McGraw Hill Publishing Company.
4. Smith, M. B. & March, J. (2007). *March's Advanced Organic Chemistry,* (6th Ed.). John-Wiley and Sons.
5. Carey, F. A. & Sundberg, R. J. (2007). Advanced *Organic Chemistry*, ***Part A****: Structure and mechanisms*, (5th Ed.). Springer (India) Pvt. Ltd.
6. Carey, F. A. & Sundberg, R. J. (2007). *Advanced Organic Chemistry*, ***Part B****: Structure and Mechanisms*, (5th Ed.). Springer (India) Pvt. Ltd.

Websites and eLearning Source

1. https://www.chemEditionchem.purdue.edu/retrosynthesis
2. https://www.youtube.com/sp=mAEA&search_query

Course Outcomes		
CO No.	**CO-Statements** On successful completion of course, students will be able to	**Cognitive Levels (K - Level)**
CO1	describe the concepts and applications of ^{1}H NMR, ^{13}C NMR and mass spectrometry	**K1**
CO2	identify and characterize the structure of unknown organic compounds using spectral data	**K2**
CO3	illustrate the catalytic applications of organometallics in organic synthesis	**K3**
CO4	compare and contrast between different methods of asymmetric synthesis	**K4**
CO5	predict the mechanistic pathway of cross coupling reactions	**K5**
CO6	design synthetic routes for complex organic molecules using retrosynthesis and determination of the structure of unknown compounds using spectral data	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the course**							**Hours**	**Credits**
3	**23PCH3CC05**		**Core Course - 5:** Organic Synthesis and Spectroscopy							**6**	**6**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	2	2	1	3	2	2	2	1	**2.1**
CO2	2	2	2	2	1	2	2	2	2	2	**2.0**
CO3	2	2	2	2	1	2	2	2	2	2	**2.0**
CO4	3	2	2	2	1	3	2	2	2	1	**2.0**
CO5	2	3	2	2	2	2	3	2	2	2	**2.2**
CO6	3	3	2	2	1	3	2	2	2	1	**2.1**
Mean Overall Score											**2(Medium)**

Semester	Course code	Title of the course	Hours/Week	Credits
3	23PCH3CC06	**Core Course - 6:** Advanced Coordination Chemistry	5	5

Course Objectives
To understand the stability of the complexes
To know the organometallic complexes and draw their structures
To analyze the electronic spectra of the complexes
To predict mechanisms of reactions of complexes
To predict the structure of the complexes utilizing spectral techniques

UNIT I: Theories of Coordination Chemistry **(15 Hours)**

Crystal field theory - splitting pattern of octahedral, tetrahedral, square planar, trigonalbipyramidal and square pyramidal complexes - magnetic properties, CFSE, high spin - low spin cross over - limitations - structural and thermodynamic effects of inner orbital splitting, Jahn-Teller effect (static, dynamic, elongation and flattening) - ligand field theory - evidences for M-L overlap, spin-orbit coupling constant and Racha parameters - MO theory of octahedral complexes (sigma and pi bonding).

UNIT II: Basics of Organometallics **(15 Hours)**

Hapticity- 16 and 18 electron rules - applications and limitations - carbonyls- bonding - terminal, doubly, triply bridged carbonyls - structure of carbonyls - CO stretching frequencies of carbonyls and mixed carbonyls - carbonyl hydrides - nitrosyls - terminal, bridging and bent - *pi* complexes with olefins - ferrocene and benzenoid metal complexes - non-benzenoid aromatics as ligands and carbene complexes - fluxional molecules.

UNIT III: Reaction Kinetics in Coordination Chemistry **(15 Hours)**

Inert and labile complexes - Stepwise, overall stability constants - Chelate effect-mechanisms of substitutions in octahedral complexes - dissociative (*D*), associative (*A*), and interchange (*I*) mechanisms - Aquation (acid hydrolysis) and anation - conjugate base mechanism of base hydrolysis - Substitution reactions in square planar complexes - Trans effect-theories and applications - electron transfer reactions - inner and outer sphere mechanisms.

UNIT IV: Physical Methods in Coordination Chemistry - I **(15 Hours)**

Types of magnetic behaviour - magnetic susceptibility measurements - Gouy's method-orbital contribution-spin-orbit coupling and its effects on magnetic properties - Temperature independent paramagnetism (TIP) - Electronic spectra of complexes-band width and intensity-Sugano-Tanabe and Orgel Diagrams - charge transfer spectra - infrared spectra of Coordination complexes-characteristic frequencies - mode of coordination and interpretation of IR spectra of complexes containing CO, CN^-, NO_2^-, nitrosyls, amide, DMSO ligands.

UNIT V: Physical Methods in Coordination Chemistry - II **(15 Hours)**

NMR - Applications of NMR to inorganic compounds - NMR of metal hydrides (^{1}H NMR), metal carbonyls (^{13}C NMR), ^{19}F and ^{31}P NMR -ESR- zero- field splitting - Krammer's degeneracy - pattern for number of lines of complexes having d^1-d^9 systems -bis(salicylaldimine) Cu (II), Mn (II) complexes - Mossbauer spectroscopy - quadrupole interactions - magnetic interactions -$FeSO_4$, $FeCl_3$, ferro - and ferricyanides, nitroprusside, FeC_2O_4,$Fe_3(CO)_{12}$.

Teaching Methodology	Chalk and Talk, PPT, Videos.

Books for Study

1. Huheey, J. E., Keiter, E. A. & Keiter, R. L. (2008). *Inorganic Chemistry Principles of Structure and Reactivity,* (4th Ed.). Pearson Education.
   Unit I *Chapter 14*
   Unit II *Chapter 18,6*
   Unit III *Chapter 16,17*

Unit IV *Chapter 15 Appendix - G*

2. Drago, R. S. (1965). *Physical Methods in Inorganic Chemistry*, (1st Ed.). Affiliated East-West Press Private Limited.
   Unit I *Chapter 3*
   Unit IV *Chapter 6, 7 & Appendix - A*
   Unit V *Chapter 8, 9, 10, 11*

Books for Reference

1. Cotton, F. A. & Wilkinson, G. (1972). *Inorganic Chemistry A Comprehensive Text*, (3rd Ed.). Interscience Publishers.
2. Purcell, K. F., & Kotz, J. C. (1977). *Inorganic Chemistry*. WB Saunders Company. Philadelphia.
3. Weller, M., Overton, T., Rourke, J. & Armstrong, F. (2018). *Inorganic Chemistry*, (7th Ed.). Oxford University Press.
4. Miessler, G. L., Fischer, P. J., & Tarr, D. A. (2014). *Inorganic Chemistry*, (5th Ed.). Pearson Education.
5. Housecroft, C. E. & Sharpe, A. G. (2012). *Inorganic Chemistry*, (4th Ed.). Pearson Education.
6. Lewis, J., & Wilkins, R. G. (1960). *Modern Coordination Chemistry*, (1st Ed.). Interscience Publishers. Inc.
7. Crabtree, R. H. (2014). *The Organometallic Chemistry of the Transition Metals*, (6th Ed.). John-Wiley and Sons Inc.
8. Nakamoto, K. (2009). *Infrared and Raman Spectra of Inorganic and Coordination Compounds* Part A and B, (6th Ed.). John-Wiley and Sons, Inc.

Website and eLearning Sources

1. https://www.youtube.com/watch?v=4ew9LqftVXg
2. https://slideplayer.com/slide/3264925/
3. https://www.youtube.com/watch?v=8lT21wKoXyQ

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K - Level)**
CO1	understand the stability of the complexes	**K2**
CO2	know the organometallic complexes and draw their structures	**K2**
CO3	analyze the electronic spectra of the complexes	**K4**
CO4	predict mechanisms of reactions of complexes	**K5**
CO5	predict the structure of the complexes utilizing spectral techniques	**K5**

Relationship Matrix											
Semester	**Course Code**			**Title of the course**					**Hours**	**Credits**	
3	**23PCH3CC06**			**Core Course - 6:** Advanced Coordination Chemistry					**5**	**5**	
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	3	2	1	2	2	3	2	1	**2.0**
CO2	3	2	2	2	3	3	2	2	2	3	**2.3**
CO3	2	2	3	3	2	2	2	3	3	2	**2.4**
CO4	2	3	2	2	2	3	2	2	2	2	**2.2**
CO5	3	2	2	1	2	2	3	2	1	2	**2.0**
										Mean Overall Score	**2.18(Medium)**

Semester	Course Code	Title of the Course	Hours/week	Credits
3	23PCH3CC07	**Core Course - 7:** Research Methodology	2	2

Course Objectives
To introduce the purpose and importance of research.
To learn the scientific method of literature survey and the research assisting tools.
To master scientific writing in manuscript preparation.
To be aware of the ethical guidelines for the authors
To be ready for carrying out researchproject.

UNIT I: Scientific Research **(6 Hours)**

The search for knowledge, purpose of research, scientific method, role of theory, characteristics of research - Types of research: fundamental or pure research, applied research, action research, historical research, experimental research.

UNIT II: Chemical Literature and Drawing and Presentation Software **(6 Hours)**

Computer search of literature: SciFinder, Chemspider, Pubmed, ChemPort - ScienceDirect, STN International, Journal home pages - A report on literature survey - An overview of selected list of compilation of data: Dictionary of Organic Compounds, Merck Index, CRC Handbook of Chemistry and Physics, Lange's Handbook of Chemistry - An overview of selected list of synthetic methods and techniques and general treatises: Organic Synthesis, Reagents for Organic Synthesis, Comprehensive Organic Chemistry, Encyclopaedia of Reagents for Organic Synthesis. Drawing software: Chemdraw, Chemsketch and Origin Presentation software: Libreoffice, MS-word, excel, and PPT

UNIT III: The Scientific Writing **(6 Hours)**

Types of research articles- journal articles, monographs, communications, reviews, research reports, theses, Format and writing style of journal articles: - Requirement of technical communications: eliminating wordiness and jargon tautology - redundancy, imprecise words, superfluous phrases - Steps to publishing a scientific article in a journal: types of publications, communications, articles, reviews; when to publish, where to publish, specific format required for submission, organization of the material - abstracts - keywords - highlights - referencing styles, bibliography-journal abbreviations - abbreviations used in scientific writing- drafting manuscript using AI tools.

UNIT IV: Structure of an Article **(6 Hours)**

Choosing the right article - article preparation - article templates - figures, graphs, images , art covers - table of contents entry - photographs - chemical structures - crystal structure images - article content - Section details & bibliography - Title - Authorship - Abstract - Introduction - Experimental - Results & discussion - Conclusions - Author Contributions (optional) - Conflicts of interest - Acknowledgements- Footnotes - Bibliographic references & notes - experimental reporting requirements - Experimental reporting requirements for submission - Experimental data - Characterisation of new compounds - General guidance - Presentation of experimental data - Guide to the presentation of experimental data - X-Ray crystallography - Small molecule single crystal data - CheckCIF - Information for inclusion in the CIF - data sharing - preparing electronic supplementary information - language editing service.

UNIT V: Ethical Guidelines to Publication of Chemical Research **(6 Hours)**

Ethical Obligations of Authors - Ethical Obligations of Scientists Publishing outside the Scientific Literature - Top 10 Tips for Ethical Authorship - Author List and Co-author Notification - **Permissions - Funding Disclosures - Conflict of Interest Disclosure -**Plagiarism - Safety and hazards- human and animal welfare - authenticity and professionalism - publication of related work.

Books for References

1. Dominoswki, R. L. (1981). *Research Methods*. Prentice Hall.
2. Ebel, H. F., Bliefert, C., & Russey, W. E. (1988). *The Art of Scientific Writing*. VCH, Weinheim.
3. Cain, B. E. (1988). *The Basis of Technical Communicating*, ACS. Washington, D.C.
4. Kanare, H. M. (1985). *Writing the Laboratory Notebook*. American Chemical Society: Washington. DC.

5. J. S. Dodd, Ed. (1985). *The ACS Style Guide: A Manual for Authors and Editors*. American Chemical Society: Washington. DC.
6. Gibaldi, J., & Achtert, W. S. (1987). *Handbook for Writers of Research Papers* (2nd Ed.). Wiley Eastern.
7. Ethical Guidelines to Publication of Chemical Research. ACS publications. (2023).
8. Full guidelines for authors. RSC Journals. (2023).

Website and eLearning Sources

1. https://pubs.acs.org/pb-assets/documents/policy/EthicalGuidelines-1676503020770.pdf
2. https://www.rsc.org/journals-books-databases/author-and-reviewer-hub/authors-information/

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K - Level)**
	On successful completion of course, students will be able to	
CO1	understand the characteristics of research and research ethics.	**K1**
CO2	comprehend the method of literature survey and the stages in manuscript preparation	**K2**
CO3	prepare a report on literature survey	**K3**
CO4	identify a research problem	**K4**
CO5	present a research proposal	**K5**
CO6		**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the course**					**Hours**		**Credits**
3	**23PCH3CC07**			Research Methodology					**2**		**2**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	2	2	1	1	2	3	3	2	**2.0**
CO2	2	3	3	1	2	1	2	3	2	1	**2.0**
CO3	3	3	2	3	2	2	2	2	2	1	**2.2**
CO4	2	2	2	2	2	2	2	2	2	2	**2.0**
CO5	1	2	1	3	1	2	1	2	3	3	**1.9**
										Mean Overall Score	**2.02 (Medium)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
3	23PCH3CP04	**Core practical - 4:** Inorganic Chemistry - 2	5	4

Course objectives
To discuss the basics of titrimetric analysis
To discuss the methods of preparation of complexes
To understand various methods of characterization of complexes
To identify the components of a binary inorganic mixture and quantify them
To recommend a suitable thermal method for the quantification of metal cations

UNIT I: Basic Principles of Titrimetric Analysis (5 Hours)

Titrimetric analysis - classifications of reactions in titrimetric analysis - Standard solutions - Equivalents, normality and oxidation numbers - Preparation of standard solutions - Primary and secondary standards - redox titrations - complexation titrations.

UNIT II: Basic Principles of Gravimetric and Thermo Gravimetric Analyses (5 Hours)

Introduction to gravimetric analysis - precipitation methods - the colloidal state - supersaturation and precipitate formation - the purity of the precipitate: co-precipitation - of the precipitate: thermogravimetric method of analysis.

UNIT III: Methods of preparation and characterization of complexes (5 Hours)

Preparatory methods of coordination complexes - characterization methods - conductance measurements - magnetic measurements - potentiometric measurements - polarimetry - UV-Visible spectra

UNIT IV: Estimations of Metal Ions in a Binary Mixture (30 Hours)

a) Quantitative analysis of a mixture of iron (volumetry) and copper (gravimetry)
b) Quantitative analysis of a mixture of copper (volumetry) and nickel (gravimetry)
c) Quantitative analysis of a mixture of calcium (volumetry) and magnesium (gravimetry)
d) Quantitative analysis of a mixture of calcium and magnesium (both by volumetry)
e) Quantitative analysis of a mixture of iron (volumetry) and zinc (gravimetry)
f) Quantitative analysis of a mixture of copper (volumetric) and zinc (gravimetry)

UNIT V: Preparation and Characterization of Selected Complexes (15 Hours)

a) Preparation and characterization of hexamminecobalt (III) chloride
b) Preparation of tetramminecopper (II) sulphate
c) Preparation of *tris*-(thiourea)copper(I) chloride
d) Preparation of potassium *tris*-(oxalato) chromate (III) trihydrate

Books for Study

1. *Inorganic Laboratory Manual*. Department of Chemistry. St. Joseph's College (Autonomous).
   Unit IV and Unit V
2. Jeffery, G. H., Bassett, J., Mendham, J., & Denney, R. C. (1989). *Vogel's Textbook of Quantitative Chemical Analysis*, (5th Ed.). Longman Scientific and Technical. Essex.
   Unit I *Chapter 10*
   Unit II *Chapter 11*
3. Pass, G., & Sutcliffe, H. (1974). *Practical Inorganic Chemistry*, (2nd Ed.). Chapman and Hall.
   Unit III *Chapter 18, 20, 21 and 22*
   Unit V *Chapters 6 and 9*

Book for Reference

1. Skoog, D. A., West, D. M., Holler, F. J. & Crouch, S. R. (2014). *Fundamentals of Analytical Chemistry*, (9th Ed.). Brooks/Cole Cengage Learning.

Website and eLearning Sources

1. https://onlinecourses.nptel.ac.in/noc19_cy19/preview

Course Outcomes		
CO No.	**CO-Statements** On successful completion of course, students will be able to	**Cognitive Levels (K - Level)**
CO1	discuss the basics of titrimetric analysis	**K1**
CO2	discuss the methods of preparation of complexes	**K2**
CO3	illustrate various methods of characterization of complexes	**K3**
CO4	identify the components of a binary inorganic mixture and quantify them	**K4**
CO5	recommend a suitable thermal method for the quantification of metal cations	**K5**
CO6	demonstrate the experiments of thermogravimetric analysis	**K6**

Relationship matrix											
Semester	**Course Code**		**Title of the Course**						**Hours**		**Credits**
3	**23PCH3CP04**		**Core practical - 4:** Inorganic Chemistry - 2						**5**		**4**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	3	2	1	2	2	3	2	1	**2.0**
CO2	3	2	2	2	3	3	2	2	2	3	**2.3**
CO3	2	2	3	3	2	2	2	3	3	2	**2.4**
CO4	3	2	2	1	2	3	2	2	1	2	**2.0**
CO5	2	3	2	2	2	2	3	2	2	2	**2.2**
CO6	2	2	3	2	1	2	2	3	2	2	**2.1**
										Mean Overall Score	**2.16 (Medium)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
3	23PCH3CP05	**Core Practical - 5:** Physical Chemistry - 2	4	4

Course Objectives
To understand the theory behind the physical chemistry experiments
To measure the emf and conductance of potentiometric and conductometric titrations respectively.
To learn the methods of analysis of redox reactions
To prepare the standard solutions for different physical chemistry experiments
To describe the concept electrode potential

UNIT I: Principle Behind Experiments **(8 Hours)**

Standard electrode potential - dissociation constant -conductometric acid-base and precipitation titrations- saponification of ethyl acetate by conductivity- potentiometric acid- base, precipitation and redox titrations - effect of NaCl on solubility of benzoic acid- solubility of sparingly soluble salt- equivalent conductance of a strong electrolyte at infinite dilution.

UNIT II: Preparation of Solutions **(4 Hours)**

Preparation and standardization of HCl, CH_3COOH, NaOH, KCl, KI, $AgNO_3$ and NaCl.UNIT III:

Cycle I (16 Hours)

1. Conductometric acid-base titration -mixture of acids.
2. Conductometric precipitation titration-iodide and chloride mixture.
3. Determination of second-order rate constant for saponification of ethylacetate by conductivity

UNIT IV: Cycle II **(16 Hours)**

1. Potentiometric acid-base titration -mixture of acids.
2. Potentiometric precipitation titration -iodide and chloride mixture.
3. Salting out constant-effect of NaCl on solubility of benzoic acid.
4. Determination of standard electrode potential of zinc and copper.

UNIT V: Cycle III **(16 Hours)**

1. Potentiometric redoxtitration
2. Solubilityof sparingly soluble salt by(I)Conductivty and(ii) Potentiometry
3. Determinationofequivalentconductanceofastrongelectrolyteatinfinitedilution.
4. Dissociation constant of weak acid by conductivity method.

Books for Study

1. *Lab Manual*. Department of Chemistry. St. Joseph's College (Autonomous).
2. Venkateswaran, V., Veeraswamy., & Kulandaivelu, A. R. (1997). *Basic Principles of Practical Chemistry* (4th Ed.). Sultan Chand & sons.
3. Daniels, Mathews, F., Howard, J., & John Warren, W. (1970). *Experimental Physical Chemistry*, (7th Ed.). Mc Graw Hill.
4. Findlay, A. (1959). *Practical Physical Chemistry*, (7th Ed.). Longman.

Website and eLearning Sources

Conductometric precipitation titration

Saponification of ethylacetate by conductivity

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K - Level)**
CO1	describe the concept electrode potential.	**K1**
CO2	understand the concept of salting out constant.	**K2**
CO3	Learn the concepts and measurement of equivalent conductance.	**K2**
CO4	apply the concepts of potentiometric titrations.	**K3**
CO5	experiment the concepts of conductometric titrations.	**K4**
CO6	interpret the results of physical chemistry experiments.	**K5**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**					**Hours**		**Credits**
3	**23PCH3CP05**			**Core Practical - 5:** Physical Chemistry - 2					**4**		**4**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	2	2	1	3	3	2	2	1	**2.2**
CO2	3	2	2	2	2	3	2	2	2	2	**2.2**
CO3	3	3	3	3	2	3	3	3	3	2	**2.8**
CO4	3	3	2	2	2	3	2	2	2	2	**2.3**
CO5	3	2	3	2	1	3	3	2	2	3	**2.4**
CO6	3	3	2	2	2	3	2	2	2	2	**2.3**
Mean Overall Score											**2.34 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
3	23SPS3CC01	**Common Core:** Materials Science	5	4

Course Objectives
To know the basic concepts in materials science and characterization of materials.
To understand the structure and properties of various materials and the working of characterization techniques.
To choose materials based on characterization of properties for appropriate applications.
To analyze and evaluate various properties of materials.
To develop and suggest materials design for practical problems and applications.

UNIT I: Metal Alloys **(15 Hours)**

Elastic deformation– Stress-Strain Behavior- Anelasticity- Elastic properties- tensile properties- Hardness- Mechanism of strengthening in metals- Binary Phase diagrams- Phase transformation- microstructural and property changes in Iron-carbon alloy- types of metal alloys- fabrication - thermal processing of metals- Applications.

UNIT II: Ceramics **(15 Hours)**

Ceramic structure- crystal structure-silicate ceramics- Carbon-Ceramic Phase diagrams-mechanical properties- Stress-Strain Behavior -mechanics of Plastic deformation- types of ceramic-fabrication and processing of ceramics- glasses and glass-ceramics- clay- powder pressing-tape casting- 3D printing- Applications of ceramics.

UNIT III: Polymers Science **(15 Hours)**

Introduction to polymers- monomers- polymerization- types of polymerizations methods- Addition polymerization and condensation polymerization - Thermoplastics and thermos settings- classification of polymers - properties of polymers - molecular weight– viscosity-mechanical property - molecular weight relationships - number average and weight average molecular weight - optical property-Glass transition temperature - Applications of polymers.

UNIT IV: Material Characterization **(15 Hours)**

Principle and Instrumentation: X-Ray Photoelectron spectroscopy and Auger Electron spectroscopy- Scanning Tunneling Microscopy and Atomic Force Spectroscopy– X-Ray Diffraction- Transmission Electron Microscopy- Scanning Electron Microscopy - Infrared Spectroscopy and UV/Vis Spectroscopy -Macro and Micro Thermal Analyses.

UNIT V: Smart Materials **(15 Hours)**

Overview of Smart Materials - Structures and Products Technologies - Electrical properties - Piezoelectric Materials - Electro strictive Materials - Magneto strictive Materials - Magneto electric Materials - Magnetorheological Fluids - Electrorheological Fluids - Shape Memory Materials - Fiber-Optic Sensors - Smart Sensors: Accelerometers - Force Sensors - Load Cells - Torque Sensors - Pressure Sensors – Microphones - Impact Hammers - MEMS Sensors - Sensor Arrays Smart Actuators - Displacement Actuators - Force Actuators - Power Actuators - Vibration Dampers - Ultrasonic Transducers.

Teaching Methodology	Lectures, Demonstrations, Presentations and Videos.

Books for Study

1. Callister, Jr. W. D., & Rethwisch, D. G. (2018). *Materials Science and Engineering an Introduction*, (10th Ed.). Wiley.
2. Zhang, S., Li, L., & Kumar, A. (2008). *Materials Characterization Techniques*. CRC Press.
3. Gowariker, V. R., Viswanathan, N. V., & Sreedhar, J. (2005). *Polymer Science*. New Age International (P) Ltd.

4. Gandhi, M. V.,& Thompson, B. S. (1992). *Smart Materials and Structures*. Chapman & Hall.

Unit	Book	Chapters	Sections
I	1	6, 7, 9, 10, 11	6.3-6.10, 7.8-7.10, 9.7, 10.2-10.9, 11.1-11.10
II	1	12, 13	12.2-12.10, 13.2-13.10,13.11-13.15
III	2	1,2,3 &6	1.1-1.4, 2.1 – 2.5, 3.1 – 3.7, 6.1 – 6.10
IV	3	3,4,5,7,9 & 10	3.3,3.4,4.2,4.3,5.1 -5.6 ,7.1,7.2,7.2,9.1.4,9.2,10.1,10.3
V	4	1,2,13	1.1-1.10,2.1-2.12,13.8 – 13.15

Books for Reference

1. Billmeyer, F. W. (1994). *Textbook of Polymer Science,* (3rd Ed.). John Wiley.
2. Lee, J. D. (2008). *Concise Inorganic Chemistry,* (5th Ed.). Wiley Blackwell Publications.
3. Sze, S. M. (2007). *Physics of Semiconductor Devices*. Wiley-Inter Science.

Websites and eLearning Sources*

1. https://www.britannica.com/technology/materialsscience#:~:text=materials%20science%2C%20the%20study%20of,a%20material's%20composition%20and%20structure.
2. https://www.annualreviews.org/doi/pdf/10.1146/annurev.ms.24.080194.000245#:~:text=This%20is%20the%20same%20set,composition%2C%20properties%2C%20and%20performance.
3. https://www.coursera.org/learn/materials-science

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	know the various types of materials, their applications and characterization techniques.	**K1**
CO2	understand the structure and properties of various materials and the working of various characterization methods.	**K2**
CO3	identify and choose materials based on properties characterized by various methods.	**K3**
CO4	analyze and investigate the properties and characteristics of materials using various techniques.	**K4**
CO5	evaluate and interpret the features of the materials for appropriate applications.	**K5**
CO6	develop and modify materials design to address various problems	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**					**Hours**	**Credits**	
3	**23SPS3CC01**			**Common Core:** Materials Science					**5**	**4**	
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	2	3	2	3	2	3	2	1	**2.3**
CO2	2	3	2	2	3	3	2	2	2	1	**2.2**
CO3	3	3	2	3	3	2	3	2	2	1	**2.4**
CO4	3	2	2	3	3	2	2	3	2	1	**2.3**
CO5	3	3	2	2	2	2	2	2	2	1	**2.1**
CO6	2	2	2	2	3	3	2	3	2	1	**2.2**
										Mean Overall Score	**2.25 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
4	23PCH4CC08	**Core Course - 8:** Advanced Organic Chemistry	5	5

Course Objectives
To understand the photochemical and photophysical processes in organic reactions
To learn the types, characteristics, and stereochemistry of pericyclic reactions.
To summarize the various naming rearrangement reactions involving intermediates.
To be aware of the green chemistry principles in their applications in organic synthesis.
To overview the fundamental aspects of drug designing and its implications in pharmaceuticals.

UNIT I: Photochemical reactions **(15 Hours)**

Photochemistry - Fundamental concepts - Jablonskii diagram - photosensitization - photo chemistry of carbonyl compounds: - reaction - Norrish Type I and II reactions - Paterno-Buchi and its regioselectivity - photochemistry of alkenes - photocycloaddition - photochemical rearrangements: Barton reaction - photolysis of diazo compounds - photo substitution reactions: - photochemistry of dienes - Hofmann - Loeffler-Freytag reaction and photochemistry of aromatic compounds.

UNIT II: Pericyclic Reactions **(15 Hours)**

Cycloaddition reactions: stereochemistry of Diels-Alder reactions - substituent effects on reactivity, regioselectivity and stereochemistry - catalysis by Lewis acid - enantioselectivity-synthetic applications - 1,3-dipolar additions - relative reactivity - regioselectivity - stereoselectivity - thermal [2+2] cycloaddition reactions of ketenes and alkenes Electrocyclic reactions: overview - orbital basis for stereospecificity - FMO and MO correlation diagram methods - thermal and photochemical reactions - Woodward - Hoffman rules Sigmatropic rearrangements: Types shifts of hydrogen and alkyl groups - [3,3] sigmatropic - Cope, oxy-cope, anionic Cope rearrangements - Claisen rearrangements-*ortho* ester Claisen, Ireland-Claisen, Ester enolateClaisen, and Claisen rearrangement of *N*,*N*-dialkylketene - [2,3]-sigmatropic rearrangements-Sigmatropic rearrangements of N, S, and Se oxides.

UNIT III: Rearrangements involving intermediates **(15 Hours)**

Classifications - mechanisms and applications of the following rearrangements: Wagner-Meerwein in tandem and cascade rearrangements - Tiffenev-Demsanov ring expansion - Pinacol-Pinacolone - semi pinacolone - Baeyer-Villiger, Beckmann, Curtius, Favorskii, Fries, Lossen, Neber, Schmidt, Stevens, Bamford - Stevens reaction - Von Richter, Sommelet-Hauser and Smiles rearrangements - Di-pi methane and its related rearrangements.

UNIT IV: Green Chemistry **(15 Hours)**

Green Chemistry - The 12 principles - atom economy for addition, elimination, substitution reactions and its calculation - green starting materials - green reagents - green catalysts - green solvents - green reactions.

UNIT V: Drug design **(15 Hours)**

Naming drugs -lead compounds - molecular modification - random screening - serendipity in drug discovery - receptors - drugs as enzyme inhibitors - designing a suicide substrate - therapeutic index - quantitative structure-activity relationships (QSAR) - molecular modeling - combinatorial organic synthesis - antiviral drugs - economics of drugs - governmental regulations - orphan drugs

Teaching Methodology	Chalk and Talk, PPT, Videos

Books for study

1. Carey, F. A., & Sundberg, R. J. (2007). *Advanced Organic Chemistry, Part A: Structure and mechanisms*, (5th Ed.). Springer (India) Pvt.
   Unit I ***Chapter 12***
   Unit II ***Chapter 10***

Unit III ***Chapter 4***

2. Smith, M. B. & March, J. (2007). *March's Advanced Organic Chemistry*, (6th Ed.). John-Wiley and Sons.

Unit III ***Chapters 13,17&18***

3. Paul, T. A. & John, C. W. (1998). *Green Chemistry: Theory and Practice*. Oxford University Press.

Unit IV ***Chapter 2 & 4***

4. Bruice, P. Y. (2012). *Organic Chemistry*, (4th Ed.). Pearson Education.

Unit V ***Chapter 30***

Books for reference

1. Clayden, J., Greeves, N. & Warren, S. (2012). *Organic Chemistry*, (2nd Ed.). Oxford University Press.
2. Bruchner, R. (2010). *Organic Mechanisms - Reactions, Stereochemistry and Synthesis.* Springer-Verlag.
3. Norman, R. O. C. & Coxon, J. M. (1993). *Principles of Organic Synthesis*, (3rd Ed.). CRC Press.

Course Outcomes		
CO No.	**CO-Statements** On successful completion of the course, students will be able to	**Cognitive Levels (K-Level)**
CO1	understand the fundamentals of photochemical, pericyclic and rearrangement reactions and methods of finding reaction mechanisms	**K1**
CO2	overview the reactions, mechanisms and drug designing	**K2**
CO3	comprehend the organic synthetic methods, reaction mechanisms, and drug activity	**K3**
CO4	predict the products, reagents, reactants and methods for the synthesis of organic drug lead molecules	**K4**
CO5	evaluate the various methods and evidences for selected rearrangement reactions.	**K5**
CO6	propose new synthetic green and sustainable methodologies in organic synthesis	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**						**Hours**		**Credits**
4	**23PCH4CC08**		**Core Course - 8:** Advanced Organic Chemistry						**5**		**5**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO 4**	**PSO 5**	
CO1	3	2	2	1	2	2	3	2	3	1	**2.1**
CO2	1	2	3	3	2	2	3	1	2	3	**2.2**
CO3	2	3	2	2	1	3	2	2	1	2	**2.0**
CO4	2	3	2	3	2	2	3	2	1	1	**2.1**
CO5	2	3	1	2	3	2	2	3	3	2	**2.3**
CO6	2	3	2	3	2	2	3	2	3	2	**2.4**
										Mean Overall Score	**2.18 (Medium)**

Semester	Course Code	Title of the Course	Hours/week	Credits
4	23PCH4CC09	**Core Course - 9:** Nuclear and Bioinorganic Chemistry	7	6

Course Objectives
To summarize the applications of nuclear chemistry
To comprehend the fundamental aspects of nuclear chemistry
To apply concepts of photochemistry in the reactions of organometallic complexes
To examine various metal ion binding to biomolecules and their functions
To design metal complexes for anticancer activity

UNIT I: Fundamentals of Nuclear Chemistry **(21 Hours)**

Subatomic particles and their properties - nuclear binding energy - nuclear structure - liquid drop model and nuclear shell model - n/p ratio - nuclear forces - orbital electron capture - nuclear isomerism - internal conversion. Q-value of nuclear reactions, coloumbic barrier, nuclear cross section, threshold energy and excitation function - different types of nuclear reactions: fragmentation, nuclear fission, nuclear fusion and spallation.

UNIT II: Applications of Fission, Fusion and Tracers **(21 Hours)**

Characteristics of fission reactions - product distribution, theories of fission - fissile and fertile isotopes - nuclear fusion and stellar energy- applications of isotopes - neutron activation analysis - isotopic dilution analysis - uses of tracers in structural and mechanistic studies, agriculture, medicine and industry - radio carbon dating - hot atom chemistry.

UNIT III: Inorganic Photochemistry **(21 Hours)**

Laws of photochemistry - photophysical processes - Jablonski diagram - fluorescence - phosphorescence - Kasha's rule - Stoke's shift - types of electronic transitions in transition metal complexes - photochemistry of Cr(III) complexes - photosubstitution - photoaquation - Adamson's rules - photorearrangement - photoredox reactions - photochemistry of organometallic compounds.

UNIT IV: Bioinorganic Chemistry-I **(21 Hours)**

Structure and function of chlorophyll - photo system-I and photo system-II - light reactions and dark reactions - Mn Catalyzed oxidation of H_2O to O_2 in chlorophyll - role of Mg^{2+} ion- structure and function of haemoglobin - cooperative effect in haemoglobin - role of globin - structure and function of myoglobin - structure and function of cytochrome C.

UNIT V: Bioinorganic Chemistry-II **(21 Hours)**

Structure and function of blue copper proteins - structure and function of vitamin B_{12} - *in vitro* and *in vivo* nitrogen fixation - Fe-S proteins - ionophores - ion transport mechanism in cell membrane - Na-K pump - role of metal ions in DNA replication, transcription, translation - *cis*-platin and its mode of action in the treatment of cancer

Teaching Methodology	Chalk and Talk, PPT, Videos

Books for Study

1. Glasstone, S. (1967). *Source Book on Atomic Energy*. Affiliated East West Press Pvt. Ltd.
   Unit I ***Chapter 1, 5 and 6***
   Unit II ***Chapter 13-18***
2. Rohatgi-Mukherjee, K. K. (2006). *Fundamentals of Photochemistry*. New Age International Publishers.
   Unit III ***Chapter 4***
3. Huheey, J. E., Keiter, E. A., & Keiter, R. L. (2008). *Inorganic Chemistry Principles of Structure and Reactivity*, (4th Ed.). Pearson Education.
   Unit II ***Chapter 4***
   Unit IV & V ***Chapter 20***

Books for Reference

1. Cotton, F. A., & Wilkinson, G. (1972). *Inorganic Chemistry a Comprehensive Text*, (3rd Ed.). Inter Science Publishers.
2. Miessler, G. L., Fischer, P. J., & Tarr, D. A. (2014). *Inorganic Chemistry*, (5th Ed.). Pearson Education.
3. Housecroft, C. E., & Sharpe, A. G. (2012). *Inorganic Chemistry*, (4th Ed.). Pearson Education.
4. Weller, M., Overton, T., Rourke, J., & Armstrong, F. (2018). *Inorganic Chemistry*, (7th Ed.). Oxford University Press.
5. Friedlander, G., Macias, E. S., Kennedy, J. W., & Miller, J. M. (1981). *Nuclear and Radiochemistry*, (3rd Ed.). John Wiley and Sons Inc.
6. Arniker, H. J. (2005). *Essentials of Nuclear Chemistry*, (1st Ed.). New Age International Publishers.

Websites and eLearning Sources

1. https://www.youtube.com/watch?v=iMhDYarsfII
2. https://www.youtube.com/watch?v=nDZxVR_y8BY
3. https://www.youtube.com/watch?v=vPJidbP_oLM
4. https://nptel.ac.in/content/storage2/courses/103106101/Module%20-%201/Lecture%20-%201.pdf
5. https://nptel.ac.in/content/storage2/courses/104103019/module1/lec1/7.html

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	Summarize the applications of nuclear chemistry	**K1**
CO2	Comprehend the fundamental aspects of nuclear chemistry	**K2**
CO3	Apply concepts of photochemistry in the reactions of organometallic complexes	**K3**
CO4	Examine various metal ion binding to biomolecules and their functions	**K4**
CO5	Design metal complexes for anti-cancer activity	**K5**
CO6	To evaluate the different kinds of photochemical reactions	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**					**Hours**	**Credits**	
4	**23PCH4CC09**			**Core Course - 9:** Nuclear and Bioinorganic Chemistry					**7**	**6**	
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	2	2	2	3	2	2	2	2	**2.2**
CO2	3	2	2	2	2	3	2	2	2	2	**2.2**
CO3	3	3	2	2	2	2	3	2	2	2	**2.3**
CO4	3	2	2	2	2	2	3	2	2	2	**2.2**
CO5	3	2	2	2	2	3	3	2	2	2	**2.3**
CO6	3	2	2	2	2	2	3	2	2	2	**2.2**
										Mean Overall Score	**2.23 (Medium)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
4	23PCH4CC10	**Core Course - 10:** Chemical Kinetics, Group Theory and Applications of Quantum Chemistry	7	6

Course Objectives
To recognize the principles of kinetics and enzyme catalysis
To understand the theories of reaction rate in gaseous state.
To apply the knowledge of kinetics in solution phase.
To explain the theories and applications of perturbation and variation theories.
To describe the principle and applications of group theory

UNIT I: Theories of Reaction Rate **(21 Hours)**

Theories of reaction rates and reaction mechanism - - potential energy surfaces and reaction coordinates - collision theory - ARRT - application of ARRT to unimolecular, bimolecular and termolecular reactions - kinetic isotope effect- isokinetic relation and temperature - theories of unimolecular reactions - Lindemann and Rice-Ramsperger-Kassel -Slater's Treatment-principle of microscopic reversibility and detailed balancing. Kinetics of chain reaction-H 2 -O 2 explosive reaction.

UNIT II: Application of ARRT to Solution Kinetics and Catalysis **(21 Hours)**

Application of ARRT to solution kinetics - factors affecting reaction rate in solution- Double and Single shere models - ionic strength - reactions - Van't Hoff equation and volume of activation - catalysis- characteristics of a catalyst -factors affecting catalytic reactions - types of catalysis - homogeneous catalysis -acid - base catalysis - Van't Hoff and Arrhenius intermediates -mechanism - protolytic and prototropic catalysis laws - acidity functions -Hammett-Zucker hypothesis - catalysis in biological systems- Michaelis-Menten equation - Lineweaver-Burk and Eadie-Hofstee plots - - andtemperature on rate - influence of substituent's on reaction rates - Hammett and Taft equations - linear free energy relations.

UNIT III: Applications of Quantum Chemistry -I **(21 Hours)**

Approximation methods - need for approximation - perturbation theory - time independent perturbation - first order and second order perturbation theory - application of perturbation theory to particle in one dimensional box - anharmonic oscillator and helium atom - principle of variation and its proof - trial function and secular determinant- variation methods and its applications to hydrogen and helium atoms - particle in one dimensional box. 67

UNIT IV: Applications of Quantum Chemistry-II **(21 Hours)**

The Born - Oppenheimer approximation- VB theory of hydrogen molecule and MO theory of hydrogen molecular ion (H_2^+) - coulomb integral- exchange integral and overlap integral, detailed calculation of energy and overlaps- construction of sp, sp2 and sp3 hybrid orbitals. Huckel molecular orbital theory - principles and applications to ethylene, butadiene, benzene, cyclobutadiene, trimethylamine, bicyclobutadiene and allyl systems- Hartee - Fockmethodself-consistent field method and Roothan equations.

UNIT IV: Rudiments of Group Theory **(21 Hours)**

Principles of group theory - symmetry elements - symmetry operations - multiplication tables - classes - subgroups - 37 molecular point groups - Schoenflies symbols - optical activity and dipole moment on the basic of point groups matrices for symmetry operations - reducible and irreducible representations - statement of great orthogonality theorem - construction of character table -C_2V, C_3V- explanation of a character table.

UNIT V: Applications of Group Theory **(21 Hours)**

Applications of group theory - standard reduction formula relating reducible and irreducible representations - hybridization schemes for atoms in molecules of different geometry - AB_4 tetrahedral, AB_3 triangular planar and AB (linear)- symmetries of vibrational modes in nonlinear molecules (H_2O, NH_3 and BF_3) - integration method - selection rules in spectroscopy - IR & Raman active - vibration

modes -mutual exclusion rule - symmetry in crystals - Hermann - Mauguin symbols - space groups of crystals -translational elements of symmetry - comparison of crystal symmetry with molecular symmetry.

Teaching Methodology	Chalk and Talk, PPT, Videos

Books for Study

1. Laidler, K. J. (1984). *Chemical Kinetics*, (3rd Ed.). TATA McGraw Hill Co. **Unit I and II** Chapters 2 and 3
2. Kuriacose, J. C., & Rajaram, J. (1993). *Kinetics and Mechanism of Chemical Transformation*. Macmillan &Co. **Unit I and II** Chapters 5 -10
3. Anatharaman, R. (2001). *Fundamentals of Quantum Chemistry*. McMillan. **Unit II and IV** Chapter 5 - 7
4. Prasad, R. K. (2008). *Quantum Chemistry*, (4th Ed.). New age international (P) Ltd. **Unit III and IV** Chapter 5&6
5. McQuarrie, D.A. (2007). *Quantum Chemistry,* (1st Ed.). Viva Books Private Ltd. **Unit III and IV**
6. Raman, K. V. (1990). *Group Theory and its Applications to Chemistry*. Tata McGraw-Hill Publishing Company. **Unit V** Chapter 1- 8

Books for Reference

1. Levine, I. N. (2009). *Quantum Chemistry,* (6th Ed.). Prentice Hall of India. Pvt. Ltd.
2. Atkins, P., & Ronald Friedman. (2011). *Molecular Quantum Mechanics,* (5th Ed.). Oxford University Press.

Websites and eLearning Sources

1. https://www.youtube.com/watch?v=Ejz8YFqDMy8
2. https://www.slideshare.net/GDRCSTChemistry/gibbs-adsorption-isotherm-56115564
3. https://www.youtube.com/watch?v=xCnYzAgYou0 Butler

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K - Level)**
CO1	recall, relate and list the basic definitions of reaction theories and catalysis.	**K1**
CO2	compare and contrast between the collision and ARRT theories	**K2**
CO3	apply the concepts of variation and perturbation to hydrogen atoms and helium atoms.	**K3**
CO4	analyze hmotheory and investigate energies and wave functions of different organic molecules.	**K4**
CO5	evaluate and interpret the linkage of group theory and spectroscopy	**K5**
CO6	design the point group and character tables for different molecules	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**								**Hours**	**Credits**
4	**23PCH4CC10**	**Core Course - 10:** Chemical Kinetics, Group Theory and Applications of Quantum Chemistry								**7**	**6**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	1	2	3	1	2	3	2	3	**3**
CO2	3	3	2	1	3	2	3	1	3	3	**3**
CO3	2	2	3	2	3	2	2	3	2	2	**2**
CO4	3	3	2	3	3	2	2	3	1	2	**3**
CO5	1	1	3	2	2	3	2	2	3	3	**1**
CO6	3	3	2	3	2	3	2	3	3	3	**3**
										Mean Overall Score	**2.36(High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
4	23PCH4ES04A	**Elective - 4:** Bioorganic Chemistry	5	4

Course Objectives
To understand the mechanism of electrophilic and nucleophilic substitution reactions of five and six membered heterocycles.
To describe the important name reactions of heterocyclic compounds.
To demonstrate the nitrogenous bases, nucleosides and nucleotides, thereby the helical structures of nucleic acids.
To distinguish the structures of mono, di & polysaccharides and their conformations.
To criticize various methods in the determination of primary, secondary and tertiary structures of proteins.

UNIT I: Heterocycles-I **(15 Hours)**

Hantzsch pyridine synthesis - electrophilic aromatic substitution in pyridine and activated pyridine - nucleophilic substitution in pyridine - pyridone in nucleophilic substitutions - pyridine as catalyst and reagent - pyrones - structures of triazoles, and tetrazole and their tautomers - quinoline and isoquinoline - electrophilic and nucleophilic substitution reactions.

UNIT II: Heterocycles-II **(15 Hours)**

Preparation of imidazole - structures, numbering and naming of diazins (pyrazine, pyrimidine and pyrazine), azines (oxazine and azepine)-electrophilic aromatic substitution reactions in five membered heterocycles - pyrrole, furan, thiophene and indole - electrophilic addition in furan - lithiation in furan and thiophene - five membered heterocycles in Diels-Alder reactions.

UNIT III: Nucleic Acids **(15 Hours)**

Structures and names of nucleosides and nucleotides - ATP - carrier of chemical energy - phosphoryl transfer reaction-mechanisms for phosphoryl transfer reactions - structures of dinucleotides - NAD+, NADP+, NADH, NADPH and GTP - Nucleic acids - DNA and RNA - primary and double helical structures - base pair - replication - transcription - ribosomal RNA - transfer RNA - translation.

UNIT IV: Carbohydrates **(15 Hours)**

The reactions of monosaccharides in basic solutions - oxidation and reduction reactions of monosaccharides - glucose and fructose - anomerization - epimerization - mutarotation - Kiliani-Fischer synthesis - Ruff's degradation - the Wohl degradation - measuring the blood glucose level in diabetes - anomeric effect in glucose - disaccharides - structures - sucrose - maltose - lactose -cellobiose - polysaccharides - starch and cellulose - structure and function - cyclodextrins - types.

UNIT V: Amino acids, peptides and proteins **(15 Hours)**

Classification of aminoacids - separation of amino acids - electrophoresis - TLC - ion exchange chromatography - synthesis of amino acids - HVZ reaction - phthalimido-malonic ester synthesis - peptide and disulfide bonds - peptide synthesis - solid phase peptide synthesis - terminal analysis - Edman - Sanger - enzymatic methods - sequencing proteins - structural and globular proteins - functions of proteins - protein structure.

Teaching Methodology	Chalk and Talk, PPT, Videos

Books for Study

1. Clayden, J., Greeves, N., & Warren, S. (2012). *Organic Chemistry*, (2nd Ed.). Oxford University Press.
   Unit I *Chapter* 29
   Unit II *Chapter* 30
2. Bruice, P Y. (2012). *Organic Chemistry*, (4th Ed.). Pearson Education.
   Unit III *Chapter* 27
   Unit IV *Chapter* 22 **Unit V** *Chapter* 24

Books for Reference

1. Rodwell, D., Bender, D., & Botham, K. (2018). *Harper's Illustrated Biochemistry.* (31st Ed.). McGraw Hill Professional.
2. Stryer, L, Berg, J. M., Tymoczko, J. L., & Gatto, G. (2019). *Biochemistry*, (9th Ed.). W. H. Freeman and Company.

Course Outcomes		
CO No.	**CO-Statements** On successful completion of course, students will be able to	**Cognitive Levels (K-Level)**
CO1	understand the structural and functional chemistry of heterocycles and biomolecules	**K1**
CO2	outline the synthesis and reactions of heterocycles and biomolecules	**K2**
CO3	classify the bimolecular transformations in biological systems	**K3**
CO4	explain the mechanism of reactions of heterocycles and biomolecules	**K4**
CO5	evaluate transport and biomolecular recognition in biological systems,	**K5**
CO6	design the synthetic methodologies for biomolecules	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**						**Hours**		**Credits**
4	**23PCH4ES04A**		**Elective - 4:** Bioorganic Chemistry						**5**		**4**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	3	2	2	2	3	3	3	2	**2.5**
CO2	2	2	2	2	2	3	2	2	2	2	**2.1**
CO3	3	3	3	2	2	3	3	3	2	2	**2.6**
CO4	3	2	3	3	2	2	3	2	3	2	**2.5**
CO5	2	2	2	3	2	2	3	2	2	2	**2.2**
CO6	2	2	3	2	2	2	3	2	3	2	**2.3**
Mean Overall Score											**2.28 (High)**

Semester	Course Code	Title of the Course	Hours/week	Credits
4	23PCH4ES04B	**Elective - 4:** Drug Design and Synthesis	5	4

Course Objectives
To understand the classification and nomenclature of drugs.
To interpret the action of drugs based on their structures.
To demonstrate the different types of diseases and their treatment.
To summarize the uses of chemotherapeutic drugs for the treatment of diseases.
To mark the pharmacodynamic functions of cardiovascular drugs.

UNIT I: Introduction to Chemistry of Drugs **(15 Hours)**

Drugs - definition- sources- study of drugs -classification (Biological chemical, commercial and utility) -Nomenclature of drugs- Mechanism of drug action and metabolism of drugs-Biotransformation- Drug design - factors affecting the stability of drugs- Encapsulation - drug delivery systems and sustained release of drugs.

UNIT II: Pharmaceutical Aids **(15 Hours)**

Preservatives- Antioxidants- Sequestering agents- Emulsifiers- Colorants - Flavoring agents - Sweeteners - Stabilizers - suspending agents- Ointment bases- Solvents.

UNIT III: Common Diseases and Treatment **(15 Hours)**

Insect borne diseases - Treatment using drugs - Air borne diseases-Treatment using drugs - water borne diseases- Treatment using drugs-Digestive disorders - treatment- diseases of respiratory system-treatment diseases of nervous system - treatment - other common diseases- treatment.

UNIT IV: Pathogenicidal Drugs **(15 Hours)**

Antibiotics - Classification- Chloramphenicol- penicillin-streptomycin-Tetracycline -Macrolides-Erythromycin - Rifamycin- Antiseptics and disinfectants - Phenols Halogen compounds - Analgesics - Antipyretics - Anti -inflammatory agents - Sulpha drugs.

UNIT V: Bio-Regulatory Drugs **(15 Hours)**

Cardiovascular drugs - Cardiac glycosides - anti arrhythmic drugs - antihypertensive agents -antianginal agents. Diabetes and Hypoglycaemic drugs - two types of diabetes - Diabetes insipidus and diabetes mellitus - Control of diabetes - Insulin -Hypoglycaemic agents. Anticonvulsants - Cancer and antineoplastic drugs - Common causes - antimetabolites.

Teaching Methodology	Chalk and Talk, PPT, Videos

Book for Study

1. Gosh, J. (1997). *Text Book of Pharmaceutical Chemistry*. S. Chand & Chand Publications.
   Unit I Chapter 1, 2 and 3
   Unit II Chapter 19
   Unit III Chapter 6
   Unit IV Chapter 16, 18 and 23
   Unit V Chapter 10, 13, 14 and 15 and Appendix II

Books for Reference

1. Srivastava, S K. (2012). *A Complete Text Book of Medical Pharmacology.* Volumes I and II, (2nd Ed.). Avichal Publishing Company.
2. Deb, A. C. (1994). *Fundamentals of Biochemistry*. New Central Book Agency.
3. Satake, M., & Mido, Y. (2003). *Chemistry for Health Science*. Discovery Publishing House.
4. Kaur, A. (1993). *Medicinal Chemistry*. Wiley Easterns Limited.

Course Outcomes		
CO No.	**CO-Statements** On successful completion of course, students will be able to	**Cognitive Levels (K-Level)**
CO1	understand the fundamental concepts of drugs and drug design	**K1**
CO2	explain the nature of diseases and their drugs	**K2**
CO3	describe pharmaceutical aids and treatments	**K3**
CO4	classify the types of drugs based on their activity	**K4**
CO5	apply assimilated knowledge to explain the various mechanisms of action of drugs	**K5**
CO6	create new synthetic pathways in drug designing	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**					**Hours**		**Credits**
4	**23PCH4ES04B**			**Elective - 4:** Drug Design and Synthesis					**5**		**4**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	2	2	2	2	2	2	2	2	**2.0**
CO2	2	1	2	2	2	2	2	2	2	2	**1.9**
CO3	3	2	2	2	1	3	2	2	2	2	**2.1**
CO4	2	2	2	2	1	1	2	2	2	2	**1.8**
CO5	3	2	2	2	2	3	2	2	2	2	**2.2**
CO6	2	2	2	2	2	2	2	2	2	2	**2.0**
										Mean Overall Score	**2.0 (Medium)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
4	23PCH4PW01	Project Work and Viva Voce	6	5

UNIT I: Introduction and Fundamentals of Research **(5 Hours)**

Research: Definition - search for knowledge - role of theory-research hypothesis and null hypothesis - populations and sampling - purposes of research - types of educational research: fundamental research - applied research - action research - descriptive research, assessment, and evaluation.

UNIT II: Problem identification and Research Design **(5 Hours)**

Scientific research problem: Definition, objectives, purposes and components of research problem-ethics in research.

UNIT III: Chemical Literature Survey **(5 Hours)**

Introduction to the chemical literature-non-patent primary literature: communications, articles, reviews, conference papers, reports, abstracts and preprints-chemical patents.

Searching using text: beyond web search engines-searching by structure and substructure.

UNIT IV: Project Work-Lab **(70 Hours)**

Identification of research problem - collection of materials -preliminary analysis - finalizing the methodology - execution of the research work - collection of data and evidences - finalizing the results.

UNIT V: Compilation of Report **(5 Hours)**

Scientific Writing and Effective Presentation: Requirement of scientific communications: eliminating wordiness and jargon-tautology, redundancy, imprecise words, superfluous phrases - style of writing-footnotes and end notes- referencing styles-bibliography-journal abbreviations (CAS source index) - abbreviations used in scientific writing-Effective presentation: slide presentation and poster presentation- Report preparation:

Format of the Research Report

I. Title Page
- Title
- Author's name and institutional affiliation
- Running head

II. Introduction (no heading)
- Statement of the problem
- Background/review of literature
- Purpose and rationale/hypothesis

III. Method
- 1.Apparatus or instrumentation
- 2. Procedure

IV. Results
- Tables and figures, as appropriate (these follow the author note)
- Statistical/ analytical presentation

V. Discussion
- 1.Support or nonsupport of hypotheses
- 2. Practical and theoretical implications
- 3. Summary and Conclusions

VII. References

VIII. Appendix (if appropriate)

Books for Study

1. Best, J. W., & Kahn, J. V. (2006). *Research in Education*, (10th Ed.). Pearson Education Inc.
   Unit I *Chapters 1*
   Unit II *Chapters 2*, **Unit V** *Chapter 3*
2. Currano, J., & Roth, D. (2013). *Chemical Information for Chemists: A Primer*. Royal Society of

Chemistry.
Unit III *Chapters 1-5*

3. Coghill, A. M., & Garson, L. R. (editors). (2006). *The ACS Style Guide: Effective Communication of Scientific Information,* (3rd Ed.). American Chemical Society: Washington, DC, Oxford University Press.
Unit V Style guide

Books for Reference

1. Dominoswki, R. L. (1981). *Research Methods*. Prentice Hall.
2. Ebel, H. F., Bliefert, C., & Russey, W. E. (1988). *The Art of Scientific Writing*. VCH. Weinheim.
3. Dawson, C. (2019). *Introduction to Research Methods: A practical guide for anyone undertaking a research project,* (5th Ed.). Robinson.

Website and eLearning Source

1. Chemistry: A Guide to Web Resourceshttp://libguides.library.albany.edu/chem_web_guide

Guide to Web Resources

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	understand the basic aspects of research.	**K1**
CO2	identify current chemical literature and other search engines judiciously.	**K2**
CO3	apply synthetic skills in carrying out research problem	**K3**
CO4	apply scientific writing and presentation skill for preparing project reports.	**K4**
CO5	evaluate the potential areas of research in chemistry	**K5**
CO6	design new research problems and carry out systematically.	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**					**Hours**		**Credits**
4	**23PCH4PW01**			Project Work and Viva Voce					**6**		**5**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	2	2	3	3	3	2	2	2	**2.5**
CO2	2	2	2	2	3	2	3	2	2	3	**2.3**
CO3	3	2	2	2	3	3	3	2	2	3	**2.5**
CO4	2	3	2	2	3	2	3	2	2	3	**2.3**
CO5	3	3	2	3	3	3	3	2	3	3	**2.8**
CO6	2	2	2	2	3	2	3	2	2	3	**2.3**
										Mean Overall Score	**2.45 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
4	23PCH4CE01	Comprehensive Examination	-	2

Course Objectives
Gain a deep understanding of the periodic trends, principles of coordination compounds.
Learn about the roles of metal ions in biological systems, including metalloenzymes and metal-based drugs.
Grasp the concept of stereochemistry, including enantiomers and diastereomers
Learn to interpret NMR, IR and MS spectra to identify the organic compounds
Explore the relationship between chemical reactions and electric current, including redox potentials.
To pass GATE, CSIR-NET exams

UNIT I: Inorganic Chemistry

Chemical periodicity, Shapes of molecule (VSEPR Theory), structure and bonding in homo- and heteronuclear molecules. Concepts of acids and bases: Theories of acid-bases, Non-aqueous solvents, hard-soft acid-base. The compounds of main group elements: industrial importance, bonding, allotropy, structure, and synthesis. Bonding theories, reaction mechanisms, spectral and magnetic properties, and structure are the topics that come under transition elements and coordination compounds. Inner transition elements: analytical applications, magnetic and spectral properties, and redox chemistry. Organometallic compounds: Bonding and structure, reactivity, and synthesis, Organometallics in homogeneous catalysis. Bioinorganic chemistry. Nuclear chemistry: Radio-analytical techniques, Activation analysis, Nuclear reactions, fission, and fusion.

UNIT II: Organic Chemistry

The IUPAC nomenclature of organic molecules, including stereoisomers and region. Stereo chemical principles: Asymmetric induction, diastereo selectivity, enantioselectivity, stereogenicity, stereoselectivity, and Configurational and conformational isomerism in acyclic and cyclic compounds. Aromaticity: benzenoid and non-benzenoid compounds. Free radicals, benzynes, nitrenes, generation, carbenes, carbanions, stability and reactivity of carbocations are included in Organic reactive intermediates. Reactivity and synthesis of common heterocyclic compounds with one or two heteroatoms (O, N, S). Pericyclic reactions: Mass spectroscopic techniques, UV-Vis, IR, and 1H& 13C NMR, structure determination of organic compounds

UNIT III: Physical Chemistry

Chemical applications: Group theory, Symmetry elements, Character tables. Solid-state, Bragg's law and applications, Band structure of solids, Crystal structures. Colloids and surfaces, isothers and surface area, heterogeneous catalysis, Properties of colloids. Principles of quantum mechanics Operator algebra, Orbital and spin angular momenta, Postulate. Chemical kinetics Complex reactions, Determination of reaction mechanisms, Steady-state approximation Empirical rate laws and temperature dependence, Enzyme kinetics. Molecular spectroscopy Basic principles of magnetic resonance, Electronic spectra, Rotational and vibrational spectra of diatomic molecules. Approximate methods of quantum mechanics. Elementary concepts of MO and VB theories, Electrochemistry including topics such as Ionic equilibria, DebyeHuckeltheory, Conductometric and potentiometric titrations.

UNIT IV: CSIR Questions

Solving the CSIR Questions of the years: 2017, 2018 and 2019

UNIT V: CSIR Questions

Solving the CSIR Questions of the years: 2020, 2021 and 2023

Books for Reference

1. Cotton, F. A., & Wilkinson, G. (1972). *Inorganic Chemistry a Comprehensive Text,* (3rd Ed.). Inter science Publishers.
2. Shriver, D., Weller, M., Overton, T., Rourke, J., & Armstrong, F. (2014). *Inorganic Chemistry,* (6th Ed.). W H Freeman and Company.

3. Housecroft, C. E. & Sharpe, A. G. (2012). *Inorganic Chemistry,* (4th Ed.). Pearson Education Limited. Essex.
4. Ebsworth, EAV. (1987). *Structural Methods in Inorganic Chemistry,* (3rd Ed.). ELBS.
5. March, J. (1992). *Advanced Organic Chemistry,* (4th Ed.). John-Wiley and Sons.
6. Kemp, W. (1987). *Organic Spectroscopy,* (3rd Ed.). ELBS.
7. Clayden, J., Greeves, N., & Warren, S. (2012). *Organic Chemistry,* (2nd Ed.). Oxford University Press.
8. Final, I. L. (1997). *Organic Chemistry.* Volume I and II, (6th Ed.). ELBS with Longmann.
9. Laidler, K. J. (1984). *Chemical Kinetics,* (3rd Ed.). TATA McGraw Hill Co.
10. Drago, R. S. (1971). *Physical Methods in Inorganic Chemistry*. East West Press Ltd.

Course Outcomes		
CO No.	**CO-Statements** On successful completion of the course, students will be able to	**Cognitive Levels (K-Level)**
CO1	understand and recall the fundamentalprinciples of inorganic, organic and physical chemistry including spectroscopy	**K1**
CO2	apply various concepts and theories of inorganic and organic and physical chemistry	**K2**
CO3	revise the various aspects of inorganic rings, cages and redox chemistry	**K3**
CO4	predict the reactions and mechanisms in the organic synthesis	**K4**
CO5	solve the different spectroscopic problems	**K5**
CO6	develop problem-solving skills by applying knowledge of periodicity, thermodynamics, stereochemistry and spectroscopy to complex chemical problems.	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**					**Hours**		**Credits**
4	**23PCH4CE01**			Comprehensive Examination					**-**		**2**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	3	3	2	2	2	3	3	3	2	**2.5**
CO2	2	2	2	2	2	3	2	2	2	2	**2.1**
CO3	3	3	3	2	2	3	3	2	3	2	**2.6**
CO4	3	2	3	3	2	2	3	2	3	2	**2.5**
CO5	2	2	2	3	2	2	3	2	2	2	**2.2**
CO6	2	3	2	2	2	2	3	2	3	2	**2.3**
Mean Overall Score											**2.28 (High)**