M Sc CHEMISTRY

LOCF SYLLABUS 2025

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 92 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.*

Discipline Specific 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.*

Research Methodology/IPR(RM)*: It is a two-credit course offered in the third semester as a common program across disciplines within the school. It is designed to acquaint postgraduate learners with the research foundations and legal frameworks vital for innovation and entrepreneurship in technology and business.*

Open Elective Courses (OE): *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 open elective courses offered by other disciplines within the college, enhancing the diversity of their learning experience.*

Ability Enhancement Course (AEC): *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 (SEC): *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-Learning (SL): *A two-credit course designed to foster students' ability for independent and self-directed learning. There are* Three Self-Learning Courses:

- 'Global Citizenship Education' *a common online course offered to all PG students in Semester I on JosTEL.*
- *Compulsory MOOC on NPTEL-SWAYAM in Semester I or II*
- *A Department-Specific Self-Learning Course in Semester III on JosTEL*

Comprehensive Examination (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 three semesters (2 - 4). 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:

25	**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 - Discipline Specific Elective

AE - Ability Enhancement Course

SL - Self-Learning

OE – Open Elective

PW - Project and Viva Voce

CE - Comprehensive Examination

OR - Outreach Programme

IS – Internship

RM – Research Methodology

EVALUATION PATTERN (PG)

Continuous Internal Assessment

Sl No	Component	Marks Allotted
1	Mid Semester Test	30
2	End Semester Test	30
3	*Two Components (15 + 20)	35
4	Library Referencing	5
	Total	**100**

Passing minimum: 50 marks

* *The first component is a compulsory online test (JosTEL platform) for 15 marks comprising 7 questions (1 mark) at K1 level and 4 questions (2 marks) at K2 level;* The second component is decided by the course in-charge in accordance with the prescribed K levels.

Question Paper Blueprint for Mid and End Semester Tests

Duration: 2 Hours								**Maximum Marks: 60**
Section		**K levels**						**Marks**
		K1	**K2**	**K3**	**K4**	**K5**	**K6**	
A *(compulsory)*		7						7 × 1 = 7
B *(compulsory)*			5					5 × 3 = 15
C *(either…or type)*				3				3 × 6 = 18
D *(2 out of 3)*	Mid Sem				1(2)	1*		2 × 10 = 20
	End Sem					1(2)	1*	
							Total	**60**

***** *Compulsory*

Question Paper Blueprint for Semester Examination

Duration: 3 Hours							**Maximum Marks: 100**
Section	**K levels**						**Marks**
	K1	**K2**	**K3**	**K4**	**K5**	**K6**	
A *(compulsory)*	10						10 × 1 = 10
B *(compulsory)*		10					10 × 3 = 30
C *(either…or type)*			5				5 × 6 = 30
D *(3 out of 5)*				1(2)	1(2)	1*	3 × 10 = 30
						Total	**100**

***** *Compulsory*

Evaluation Pattern for One/Two-credit Courses

Title of the Course	CIA	Semester Examination	Final
• Ability Enhancement Course	20 + 10 + 20 = 50	50 *(Department)*	100
• Self - Learning Course (Dept. Specific) • Comprehensive Examination	25 + 25 = 50	50 *(CoE)*	100
• Internship • Self - Learning Course (Common) • Self - Learning Online Course (NPTEL / SWAYAM)	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 for PG

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 for PG

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 Outcomes (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.

M. SC. Chemistry				
Programme Structure				
Semester	**Specification**	**No. of Courses**	**Hours**	**Credits**
1 – 4	Core Course	11	60	49
1 - 4	Core Practical	6	24	12
1, 3 & 4	Discipline Specific Elective	3	12	9
1 – 2	Open Elective	2	8	4
1	Ability Enhancement Course	1	2	1
1 – 3	Self-Learning	3	-	4
2	Skill Enhancement Course	1	4	2
3	Research Methodology	1	4	2
4	Project	1	6	3
4	Comprehensive Examination	1	-	2
2 – 4	Outreach Programme (SHEPHERD)	-	-	4
1 – 4	Extra Credit Course	4	-	12
	Total	**34**	**120**	**92 (12)**

M. Sc. CHEMISTRY PROGRAMME PATTERN								
			Course Details			Scheme of Exams		
Sem.	**Course Code**	**Course Type**	**Title of the Course**	**Hours**	**Credits**	**CIA**	**SE**	**Final**
1	25PCH1CC01	**CC Major**	**Core Course - 1:** Inorganic Chemistry - 1	6	5	100	100	100
	25PCH1CC02		**Core Course - 2:** Physical Chemistry - 1	6	6	100	100	100
	25PCH1CP01		**Core Practical - 1:** Inorganic Chemistry Practical - 1	4	2	100	100	100
	25PCH1CP02		**Core Practical - 2:** Physical Chemistry Practical - 1	4	2	100	100	100
	25PCH1ES01A	**DSE**	**Discipline Specific Elective – 1:** Organic Chemistry - 1	4	3	100	100	100
	25PCH1ES01B		**Discipline Specific Elective – 1:** Stereochemistry					
	25PCH1AE01	**AEC**	**Ability Enhancement Course:** Analytical Chemistry	2	1	100	-	100
	25PCH1OE01	**OE**	**Open Elective - 1 (WS):** Advanced Materials and Nano Technology	4	2	100	100	100
	25PGC1SL01	**SL**	Global Citizenship Education (Online)	0	1	100	-	100
			Extra Credit Course	0	(3)			
			Total	**30**	**22 (3)**			
2	25PCH2CC03	**CC Major**	**Core Course - 3:** Inorganic Chemistry – 2 (Internship Embedded Course)	4	4	100	100	100
	25PCH2CC04		**Core Course - 4:** Organic Chemistry - 2	4	4	100	100	100
	25PCH2CC05		**Core Course - 5:** Physical Chemistry - 2	6	4	100	100	100
	25PCH2CP03		**Core Practical - 3:** Inorganic Chemistry Practical - 2	4	2	100	100	100
	25PCH2CP04		**Core Practical - 4:** Organic Chemistry Practical - 1	4	2	100	100	100
	25PCH2OE02	**OE**	**Open Elective - 2 (BS):** Chemistry of Health and Nutrition	4	2	100	100	100
	25PSS2SE01	**SEC**	**Skill Enhancement Course:** Soft Skills	4	2	100	-	100
	25PCH2SL02	**SL**	Online Courses: NPTEL / SWAYAM	0	2	-	100	100
			Extra Credit Course	0	(3)			
			Total	**30**	**22 (3)**			
3	25PCH3CC06	**CC Major**	**Core Course - 6:** Inorganic Chemistry - 3	6	5	100	100	100
	25PCH3CC07		**Core Course - 7:** Organic Chemistry - 3	6	5	100	100	100
	25PCH3CC08		**Core Course - 8:** Physical Chemistry - 3	6	4	100	100	100
	25PCH3CP05		**Core Practical - 5:** Physical Chemistry Practical - 2	4	2	100	100	100
	25PCH3ES02A	**DSE**	**Discipline Specific Elective – 2:** Organic Chemistry - 4	4	3	100	100	100
	25PCH3ES02B		**Discipline Specific Elective – 2:** Organic Pharmaceutical Chemistry					
	25SPS3RM01	**RM**	Research Methodology and IPR	4	2	100	100	100
	25PCH3SL03	**SL**	**Self-Learning:** Selected Topics in Chemistry*	0	1	50	50	50
			Extra Credit Course	0	(3)			
			Total	**30**	**22 (3)**			
4	25PCH4CC09	**CC Major**	**Core Course - 9:** Inorganic Chemistry – 4	4	3	100	100	100
	25PCH4CC10		**Core Course - 10:** Organic Chemistry – 5	6	5	100	100	100
	25PCH4CC11		**Core Course - 11:** Physical Chemistry - 4	6	4	100	100	100
	25PCH4CP06		**Core Practical - 6:** Organic Chemistry Practical - 2	4	2	100	100	100
	25PCH4ES03A	**DSE**	**Discipline Specific Elective – 3:** Organometallic Chemistry	4	3	100	100	100
	25PCH4ES03B		**Discipline Specific Elective – 3**: Materials Chemistry					
	25PCH4PW01	**PW**	Project	6	3	100	100	100
	25PCH4CE01	**CE**	Comprehensive Examination*	0	2	50	50	50
			Extra Credit Course	0	(3)			
			Total	**30**	**22 (3)**			
	25PCW4OR01	OR	Outreach Programme	0	4			
1-4			**TOTAL**	**120**	**92 (12)**			

***For Grade Calculation:** Marks obtained out of 50 will be converted into 100 in the mark statements.

Open Elective - 1 (WS): 1st Semester

School	Course Code	Title of the Course
SPS		
Chemistry	25PCH1OE01	Advanced Materials and Nano Technology
Electronics	25PEL1OE01	Electronics Media
Physics	25PPH1OE01A	Solar Energy and Utilization
	25PPH1OE01B	Renewable Energy Resources

Open Elective – 2 (BS): 2nd Semester
Offered to students from other Schools

School	Course Code	Title of the Course
SBS		
Botany	25PBO2OE02	Sustainable Horticulture and Urban Landscaping
Biochemistry	25PBI2OE02	First Aid Management
Biotechnology	25PBT2OE02	Food Technology
SCS		
Artificial Intelligence and Machine Learning	25PAI2OE02	Cyber Security
Computer Science	25PCA2OE02A	Web Design
	25PCA2OE02B	Cyber Security
Information Technology	25PCS2OE02	Recent Trends in Computing
Data Science	25PDS2OE02	Discrete Mathematics
Mathematics	25PMA2OE02	Operations Research
Visual Communication	25PVC2OE02	Women and Media
SLAC		
English	25PEN2OE02	English for Digital Media
History	25PHS2OE02	Public Administration
Tamil	25PTA2OE02	விளம்பரக்கலை (Art of advertising)
SMS		
Commerce	25PCO2OE02	Basics of Tally Prime
Commerce Computer Application	25PCC2OE02	Behavioural Dynamics and Psychology
Counselling Psychology	25PCP2OE02	Artificial Intelligence in Psychology
Economics	25PEC2OE02	Managerial Economics
Human Resource Management	25PHR2OE02	Counselling and Guidance
SPS		
Chemistry	25PCH2OE02	Chemistry of Health and Nutrition
Electronics	25PEL2OE02	Computer Hardware and Networks
Physics	25PPH2OE02A	Physics for Competitive Exams
	25PPH2OE02B	Nanoscience

Semester	Course Code	Title of the Course	Hours / Weeks	Credits
1	25PCH1CC01	**Core Course - 1:** Inorganic Chemistry - 1	6	5

Course Objectives
To know the packing of ions in crystalline solids.
To understand the effect of defects on the properties of solids.
To be able to predict the stability of nuclei based on their nucleons composition.
To understand the applications of radioactivity in chemical sciences.
To understand the basics of coordination chemistry

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

Structural features of the crystal systems: Rock salt, zinc blende, fluorite and anti-fluorite, rutile and, cadmium iodide and nickel arsenide; Spinels -normal and inverse types and perovskite structures. 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)

UNIT III: Nuclear Chemistry-I (18 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 IV: Nuclear Chemistry-II and Chemistry of Transition Elements (18 Hours)

Nuclear Chemistry-II: 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.

Chemistry of Transition Elements: size – variation across the period and down the group – variable oxidation states – complexing tendency – colour–d-d transition, LMCT and MLCT– magnetic properties - spin & orbital contribution– comparison of first, second and third transition series – Stabilisation of unusual oxidation states

UNIT V: Coordination Complexes: Structures and Isomers (18 Hours)

Introduction to coordination complexes – Nomenclature – rules. Isomerism – Stereoisomers – 4 coordinate complexes – chirality – 6 coordinate complexes – combinations of chelate rings. Constitutional isomers - Hydrate Isomerism - Ionization Isomerism - Coordination Isomerism - Linkage (Ambidentate) Isomerism. Separation and identification of isomers – ORD-CD – Cotton effect – Coordination numbers and structures – Chelate effect – Coordination frameworks.

Teaching Methodology	Chalk and talk, PPT, Molecular models, simulation
Assessment Methods	MCQ, snap test, seminar, assignments

Books for Study:

1. Huheey, J. E., Keiter, E. A., & Keiter, R. L. (1993). *Inorganic Chemistry, Principles of Structure and Reactivity* (4th Ed.). Harper Collins College Publishers, New York.
   Units I, II, IV and V
2. Glasstone, S. (1967). *Source Book on Atomic Energy*. Affiliated East West Press Pvt. Ltd.
   Units III and IV

Books for Reference:

1. Housecroft, C. E., & Sharpe, A.G. (2018). *Inorganic Chemistry*, (5th Ed.), Pearson Education, New York.
2. Weller, M., Overton, T., Rourke, J., & Armstrong, F., *(2018). Inorganic Chemistry* (7th Ed.), Oxford University Press, Oxford, UK.
3. Miessler, G.L., Fischer, P. J., & Tarr, D. A. (2014). *Inorganic Chemistry* (5th Ed.), Pearson Education, New York.
4. Purcell, K. F., & Kotz, J. C. (2010). *Inorganic Chemistry*. W. B. Saunders Company, Philadelphia, PA.
5. Douglas, D. E., Mc Daniel, D. H., & Alexander, J. J. (1994). *Concepts and models in Inorganic chemistry*, (3rd Ed.).
6. Friedlander, G., Macias, E. S., Kennedy, J. W., & Miller, J. M. (1981). *Nuclear and Radiochemistry*, (3rd Ed.). John Wiley and Sons Inc.
7. Arniker, H. J. (2005). *Essentials of Nuclear Chemistry*, (1st Ed.). New Age International Publishers

Websites and eLearning Sources:

1. https://archive.nptel.ac.in/courses/104/104/104104101/
2. https://onlinecourses.nptel.ac.in/noc23_cy21/preview
3. https://archive.nptel.ac.in/courses/115/102/115102017/
4. https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/chemistry/inorganic_chemistry-iii/23.structure_and_bonding_of_carboranes/et/4838_et_et.pdf
5. https://onlinecourses.nptel.ac.in/noc22_cy60/preview

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-Level)**
	On successful completion of this course, students will be able to	
CO1	Define the type of close packing in ionic solids.	**K1**
CO2	Predict the whether a given spinel will have the normal or inverse structure.	**K2**
CO3	Summarize the various types of nuclear reactions.	**K3**
CO4	Examine the nature of electronic transition that is responsible for the color of metal complexes.	**K4**
CO5	Determine the type of isomerism in coordination complexes.	**K5**
CO6	Justify the application of radioactivity for peaceful uses.	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
1	**25PCH1CC01**		**Core Course - 1:** Inorganic Chemistry - 1							**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	2	1	2	3	2	2	3	2	3	2	**2.2**
CO2	1	2	3	2	2	3	2	2	2	2	**2.1**
CO3	2	2	3	2	2	2	3	2	2	3	**2.3**
CO4	2	2	1	2	3	2	3	2	3	2	**2.2**
CO5	3	2	2	3	2	2	2	1	2	2	**2.1**
CO6	2	3	2	1	2	3	2	2	3	2	**2.2**
Mean Overall Score											**2.18 (Medium)**

Semester	Course Code	Title of the Course	Hours / Weeks	Credits
1	25PCH1CC02	**Core Course - 2:** Physical Chemistry - 1	6	6

Course Objectives
To recognize the principles of classical mechanics, statistical thermodynamics and nano materials
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 statistical thermodynamics and Nanomaterials
To justify the application of quantum mechanics, statistical thermodynamics and nanomaterials to systems of importance

UNIT I: Quantum Mechanics I (18 Hours)

Introduction and conservation laws - Generalised coordinates and Lagrange's equations - Hamilton's equations - vibration of a mechanical system - rotation of a rigid mechanical system - Inadequacy of classical mechanics - Blackbody radiation - photoelectric effect and heat capacity of solids - de Broglie postulate and Heisenberg uncertainty principle - Mathematics for quantum chemistry -Functions, odd and even functions – normalization – orthogonality - orthonormal functions - Operators- linear and nonlinear operators - construction of momentum and Hamiltonian and angular momentum operators - commutation relation - Hermitian operators and their properties - postulates of quantum mechanics.

UNIT-II: Quantum Mechanics II (18 Hours)

Schrodinger equation and its applications - Particle in 1D and 3D boxes - energy and wave functions - Harmonic oscillator- energy and wave functions - Hermit polynomial and power series method - Rigid rotator- conversion of Cartesian coordinates into polar coordinates – energy - spherical harmonics and angular momentum - The hydrogen atom- Energy , radial and angular functions -Laguerre functions - probability distribution of atomic orbitals – s. p and d orbitals - Pauli's exclusion principle.

UNIT III: Fundamentals of Statistical Thermodynamics (18 Hours)

Statistical method – microstates – macrostates - permutations and combinations - combinatory rule - probability theorems – ensembles and grand canonical ensemble – phases pace - 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 IV: Applications of Statistical Thermodynamics (18 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.

UNIT V: Nano Chemistry (18 Hours)

Introduction of nanomaterials and nanotechnologies - role of size, classification – 0D, 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 – Synthesis – Top - down and bottom up approach – Physical methods - arc discharge, laser ablation, inertgas 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.

Teaching Methodology	Chalk and talk, PPT, videos, group discussion, peer learning
Assessment Methods	MCQ, snap test, open book test, seminar, assignments, group discussion

Books for Study:

1. Donald McQuarrie. (2011) *Quantum Chemistry*, Viva Student Edition. Unit-I, Unit- II
2. Kuriakose, J. C., & Rajaram, J. C. (1996). *Thermodynamics*, ShobanLal Co. Unit-III, Unit- IV
3. Pradeep, T. (2009). *Nano*: *The Essentials-understanding Nanoscience and Nanotechnology*, McGraw-Hill Education. Unit V

Books for Reference:

1. Prasad R. K. (2022). *Quantum Chemistry*, (5th Ed.), New Age International publishers. Unit-I, Unit-II.
2. Levine, I.N. (2009). *Quantum Chemistry*, (6th Ed). Prentice Hall of India Pvt. Ltd. Unit-I, Unit-II.
3. Anderson, J. M. (2005). *Mathematics of Quantum Chemistry*, (1st Ed.). W.A. Benjamine Inc.
4. Unit-I, Unit-II.
5. Gupta, M. C. (1998). *Statistical Thermodynamics* (2nd Ed.). New Age International Publishers. Unit-III, Unit- IV
6. Donald, A., McQuarrie. (2003). *Statistical Mechanics*, Viva Books Private Ltd. Unit-III, Unit- IV
7. Poole, C. P. Jr., & Owens, F. J. (2009). *Introduction to Nanotechnology*. Wiley.

Websites and eLearning Sources:

1. Bing Videos
2. Bing Videos
3. Bing Videos
4. https://nanohub.org/

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-Level)**
	On successful completion of this course, students will be able to	
CO1	Recall the concepts of classical mechanics, quantum chemistry, statistical thermodynamics and nanomaterials	**K1**
CO2	Understand the fundamentals of quantum chemistry, statistical thermodynamics and nanomaterials	**K2**
CO3	Apply mathematical relations in quantum chemistry and statistical thermodynamics	**K3**
CO4	Correlate the concepts of classical mechanics, Schrodinger equation, statistical thermodynamics and nano chemistry in real situations	**K4**
CO5	Validate the concepts of quantum chemistry and statistical thermodynamics in various systems and types of nanomaterials	**K5**
CO6	Solve problems in quantum chemistry and statistical thermodynamics Applied to simple systems and creating new methods in synthesising nano materials.	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**						**Hours**	**Credits**	
1	**25PCH1CC02**		**Core Course - 2:** Physical Chemistry - 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	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/ Weeks	Credits
1	25PCH1CP01	**Core Practical - 1:** Inorganic Chemistry Practical - 1	4	2

Course Objectives
To understand the basics of semimicro inorganic analysis.
To know the classification of metal cations into different groups
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	Chalk and talk and Laboratory Demonstration.
Assessment Methods	Viva Voce and Test

Books for Study:

1. *Inorganic Laboratory Manual*, Department of Chemistry, St. Joseph's College (Autonomous), Tiruchirappalli–2
   Unit III and **Unit–V**
2. Ramanujam, V. V. (1990) *Inorganic Semi Micro Qualitative Analysis* (3rd Ed.), National Publishing Company, Chennai.
   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, England.
   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, New York.

3. 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.

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 successful completion of this course, 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	Develop skills in analysing the metal ions colorimetrically	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
1	**25PCH1CP01**		**Core Practical - 1:** Inorganic Chemistry Practical - 1							**4**	**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	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	**2.4**
CO4	2	1	2	2	2	2	1	2	2	2	**2.0**
CO5	2	2	2	2	1	2	2	2	2	1	**1.8**
CO6	2	1	1	2	2	2	2	1	2	2	**1.7**
Mean Overall Score											**2.06 (Medium)**

SCHEME OF VALUATION

INTERNAL

CIA	**100 Marks**
Cumulative mark of regular practical classes	40 Marks
Record	10 Marks
Two CIA tests	50 Marks

For Each CIA Test **100 marks**

Test	10 Marks
Results	90 Marks (60 Marks for Analysis & 30 Marks for colorimetry)

Scheme of valuation

Inorganic Analysis

15 marks for each radical
Only 10 marks for group identification

Colorimetry

<5% Error	30 Marks
10%	20 Marks
>10%	10 Marks

EXTERNAL

Total	**100 Marks**
Viva voce	10 Marks
Results	90 Marks (60 Marks for Analysis & 30 Marks for colorimetry)

Scheme of valuation

Inorganic Analysis

15 marks for each radical
Only 10 marks for group identification

Colorimetry

<5% Error	30 Marks
10%	20 Marks
>10%	10 Marks

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
1	25PCH1CP02	**Core Practical - 2:** Physical Chemistry Practical - 1	4	2

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 and optical rotation
To experiment the concepts of phase rule

UNIT I: Theory Behind Experiments **(12 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 **(12 Hours)**

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

UNIT III: Cycle I **(12 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 **(12 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 **(12 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.

Teaching Methodology	Demonstration, videos, hands on training
Assessment Methods	MCQ, Viva Voce, each experiment evaluation, test

Books for Study:

1. *Lab Manual,* Department of Chemistry, St. Joseph's College, Tiruchirappalli.
2. Venkateswaran, V., Veeraswamy, R., & Kulandaivelu, A. R. (1997). *Basic Principles of Practical Chemistry,* (2nd Ed.). Sultan Chand & Sons.

Books for Reference:

1. Daniels, Mathews, F., Howard, J. &John Warren, W. (1970). *Experimental Physical Chemistry,* (7th Ed.). McGraw Hill.
2. Findlay, A., (1959). *Practical Physical Chemistry,* (7th Ed.). Longmans Green.

Websites and eLearning Source:

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

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**
1	**25PCH1CP02**		**Core Practical - 2:** Physical Chemistry Practical - 1							**4**	**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	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)**

SCHEME OF VALUATION

INTERNAL

CIA 100 Marks

Cumulative mark of Regular Practical Classes 50 Marks
Two CIA tests 50 Marks
For Each CIA Test 100 marks
Procedure 10 Marks
Record 10 Marks
Viva 10 Marks
Results 70 Marks
Table10marks
Calculation10 marks
Graph 10 marks
Results40 marks

Scheme of valuation

<2% 40 Marks
< 3 %30 Marks
< 4 %20 Marks
>4% 10 Marks

EXTERNAL Total 100 Marks

Procedure 10 Marks
Viva 10 Marks
Results/Analysis 80 Marks
Table10marks
Calculation10 marks
Graph 10 marks
Results 50 marks

Scheme of valuation

< 2% 40 Marks
< 3 % 30 Marks
< 4 % 20 Marks
> 4% 10 Marks

Semester	Course Code	Title of the Course	Hours / Weeks	Credits
1	25PCH1ES01A	**Discipline Specific Elective – 1:** Organic Chemistry - 1	4	3

Course Objectives
To understand the concepts of hybridization, field effects and elements of stereochemistry
To explain the structure, stability and reactions of reactive intermediates
To illustrate the stereoselective and stereospecific synthesis.
To interpret the configurations of allenes, spiranes, biphenyls, cyclooctene, helicene, binaphthyls and cyclophanes.
To discuss the structure and reactions of monosaccharides and polysaccharides.

UNIT I: Electronic Effects and Structure of Molecules (12 Hours)

Description of Molecular Structure using VBT Concepts – Hybridization - Origin of electron-electron repulsion – Electronegativity and Polarity – Polarizability, Hardness and Softness – Resonance and Conjugation – Hyperconjugation – Origin of the Torsional Barrier in Ethane and other small molecules – Anomeric effect in acylic molecules – Bonding in cyclopropane and other small ring compounds.

UNIT II: Organic Stereochemistry-1 (12 Hours)

Introduction to molecular symmetry and chirality-axis, plane, center, alternating axis of symmetry. Optical isomerism due to asymmetric and dissymmetric molecules - Prochirality, enantiotopic and diastereotopic atoms, groups, faces, axial and planar chirality, chirality due to helical shape, methods of determining the configuration. - D, L system, Cram's and Prelog's rules: R, S-notations, proR, proS, si 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. Stereoselective and stereospecific synthesis.

UNIT III: Organic Stereochemistry-2 (12 Hours)

Conformation and reactivity of acyclic systems - 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, decalins and Brett's rule. Optical rotation and optical rotatory dispersion, ORD curves, octant rule, configuration and conformation, Cotton effect, axial haloketone rule and determination of configuration.

UNIT IV: Reactive Intermediates (12 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

UNIT V: Carbohydrates (12 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 – disacharrides – structures – sucrose – maltose – lactose -cellobiose – polysaccharides – starch and cellulose - structure and function – chitin - cyclodextrins – types.

Teaching Methodology	Chalk and talk, PPT, Molecular models, simulation
Assessment Methods	MCQ, snap test, seminar, assignments

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 1*
2 Nasipuri D, (1996), *Stereochemistry of Carbon Compounds*, (2nd Ed.). New–Age International Publishers. **Unit II**
3. Eliel, E. L., (1998), *Stereochemistry of Carbon Compounds*, Tata–McGraw Hill Publishing Company. **Unit III**
4. Carey F A, Sundberg R J, (2007), *Advanced Organic Chemistry, Part B: Structure and mechanisms*, (5th Ed.). Springer (India) Pvt Ltd. **Unit 1V** *Chapter 10*
5. Bruice, P.Y., (2011), *Organic Chemistry*, (8th Ed.). University of California, Santa Barbara, Pearson Ltd. **Unit V** *Chapter 20*

Books for Reference:

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

Websites and eLearning Source:

1. https://www.youtube.com/watch?v=x21FhoKh7bE
2. https://www.dalalinstitute.com/wp-content/uploads/sites/2/Books/A-Textbook-of-Organic-Chemistry-Volume-1/ATOOCV1-2-8-Enantiotopic-and-Diastereotopic-Atoms-Groups-and-Faces.pdf
3. https://www.pbsiddhartha.ac.in/LMS/eContent/ORD%20and%20CD%2022CH3T1.pdf

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-Level)**
	On successful completion of this course, students will be able to	
CO1	Describe the origin of the torsional Barrier in ethane and other small molecules, symmetry elements required for chirality and reactions of carbohydrates	**K1**
CO2	Distinguish between absolute and relative configurations	**K2**
CO3	Demonstrate the structure, stability and reactions of reactive intermediates	**K3**
CO4	Outline the Curtin-Hammett Principle and Brett's rule.	**K4**
CO5	Access the ORD curves, octant rule, Cotton effect and axial haloketone rule.	**K5**
CO6	Design a comparative study for the reactions of mono-, di-, and polysaccharides	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**						**Hours**	**Credits**	
1	**25PCH1ES01A**		**Discipline Specific Elective – 1:** Organic Chemistry - 1						**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	1	2	2	3	2	1	3	2	2.2
CO2	2	3	1	1	2	3	2	2	1	2	2.1
CO3	3	3	1	3	1	3	3	1	2	2	2.2
CO4	2	2	1	3	2	3	2	2	3	3	2.3
CO5	3	3	2	3	2	2	2	1	2	2	2.2
CO6	2	2	2	3	2	2	3	2	2	2	2.2
										Mean Overall Score	**2.20(High)**

Semester	Course Code	Title of the Course	Hours / Weeks	Credits
1	25PCH1ES01B	**Discipline Specific Elective – 1:** Stereochemistry	4	3

Course Objectives
To describe the chirality of biphenyls, allenes, spiranes
To understand the concept of resolution and methods of resolution
To interpret the favourable conditions for asymmetric synthesis using chiral reagents, chiral catalyst and chiral auxiliaries
To demonstrate the Fischer, Newmann and Sawhorse projections and conformational isomerism in cycloalkanes
To evaluate the chemoselectivity and regioselectivity in organic reactions

Unit I: Configuration (12 Hours)

Configuration: 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 prostereoisomerism – topocity of ligands and faces – enantiotopic ligands and faces – diastereotopic ligands and faces – configuration at prochiral centers.

Unit II: Resolution (12 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 (12 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 (12 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 (12 Hours)

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

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

Teaching Methodology	Chalk and talk, PPT, Molecular models, simulation
Assessment Methods	MCQ, snap test, seminar, assignments

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 2, Unit II Chapter 2
2. Clayden J, Greeves N, and Warren S, (2012), *Organic Chemistry*, (2nd Ed.). Oxford University Press.
   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.
Unit IV Chapter 3

Books for Reference:

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

Websites and eLearning Source:

1.https://www.youtube.com/watch?v=9kSCbVIdkDQ
2.https://www.youtube.com/watch?v=B23i9_jC5T8
3.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	Describe the symmetry concept of atropisomerism, helicity and chirality, topocity and prostereo isomerism.	**K1**
CO2	Distinguish between chemoselectivity and regioselectivity in organic reactions	**K2**
CO3	Demonstrate the different methods of resolution	**K3**
CO4	Outline the various methods of asymmetric synthesis	**K4**
CO5	Evaluate causes and consequences of angle strain in cycloalkanes	**K5**
CO6	Justify the diastereo selectivity in aldol reaction and epoxidation reactions	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
1	**25PCH1ES01B**		**Discipline Specific Elective – 1:** Stereochemistry							**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	2	3	1	2	2	3	2	1	3	2	2.1
CO2	2	3	1	2	2	3	1	2	1	2	2.0
CO3	3	3	1	3	1	3	3	1	2	2	2.2
CO4	2	2	1	3	2	3	2	2	1	2	2.0
CO5	1	3	2	3	2	2	3	1	2	1	2.1
CO6	2	2	2	3	2	2	3	2	2	2	2.2
										Mean Overall Score	**2.1 (Medium)**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
1	25PCH1AE01	**Ability Enhancement Course:** Analytical Chemistry	2	1

Course Objectives
To understand the fundamental principles of various analytical techniques.
To explain the instrumentation techniques of spectrophotometry, thermal, chromatographic, and spectral methods.
To analyze the significance of analytical methods in scientific research.
To evaluate different analytical methods to achieve better accuracy in results.
To demonstrate the handling and operation of spectral instruments.

Unit I: Spectrophotometric Methods (6 Hours)

Spectrophotometric Methods – Principle, instrumentation and applications -Colorimetry, Fluorimertry, Phosphorimetry & Atomic Absorption Spectroscopy (AAS). Colorimetry – Fundamental laws – deviations from Beer-Lambert's law.

Unit II: Thermal Methods (6 Hours)

General characteristics 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 applications of Column Chromatography, Thin-Layer Chromatography (TLC), High-Performance Liquid Chromatography (HPLC) and Gas Chromatography (GC).

Unit IV: Spectroscopy and Voltammetry (6 Hours)

Principle, instrumentation and spectral interpretations of UV-Visible and IR spectroscopy. Principle and instrumentation of Cyclic Voltammetry (CV).

Unit V: Hands on Demonstration of Analytical Techniques (6 Hours)

Demonstration of Chromatographic techniques, UV-Visible, Fluorescence, Infra-red, Cyclic Voltammetry and Scanning Electron Microscope (SEM).

Teaching Methodology	PPT, Videos, Demonstration and Chalk & Talk.
Assessment Methods	Seminar, GD, Group project & Practical evaluation.

Books for Study:

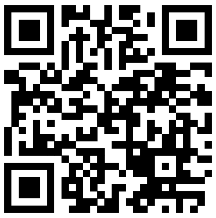
1. Jeffery, G. H., Bassett, J., Mendham, J., & Denney, R. C. (1989). *Vogel's Textbook of Quantitative Chemical Analysis* (5th Ed.). Longman Scientific & Technical.
2. Pavia, D. L., Lampman, G. M., Kriz, G. S., & Vyvyan, J. R. (2015). *Introduction to Spectroscopy* (5th Ed.). Cengage Learning.
3. Skoog, D. A., West, D. M., Holler, F. J., & Crouch, S. R. (2014). *Fundamentals of Analytical Chemistry* (9th Ed.). Brooks/Cole Cengage Learning.

Books for Reference:

1. Silverstein, R. M., & Bassler, G. C. (1993). *Spectrometric Identification of Organic Compounds* (4th Ed.). John Wiley & Sons.
2. Christian, G. A. (2003). *Analytical Chemistry* (6th Ed.). John Wiley & Sons.
3. Kemp, W. (1987). *Organic spectroscopy* (3rd Ed.). ELBS.
4. Gopalan, R., Subramanian, P. S., & Rengarajan, K. (2005). *Elements of Analytical Chemistry* (3rd Ed.). Sultan Chand & Sons.
5. Rao, C. N. R., & Gopalakrishnan, J. (1995). *New Directions in Solid-State Chemistry* (2nd Ed.). Cambridge University Press.

Website and E-learning Sources:

1. https://www.classcentral.com/course/analyticalchem-838
2. https://ocw.mit.edu/courses/chemistry/
3. Introduction to Spectroscopy - Khan Academy
4. Chromatography and Spectroscopy Methods - Coursera
5. Thermal Analysis Techniques - edX



UV Visible Spectroscopy

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-Level)**
	On successful completion of this course, students will be able to	
CO1	Compare different analytical techniques to determine their efficiency.	**K1**
CO2	Apply chromatographic and spectrophotometric techniques for material analysis.	**K2**
CO3	Analyze thermal methods and their effectiveness in material characterization.	**K3**
CO4	Interpret spectroscopic data to determine molecular structures.	**K4**
CO5	Demonstrate spectral instruments like IR, UV-Visible and CV	**K5**
CO6	Recall the principles of various spectrophotometric and chromatographic techniques.	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
1	**25PCH1AE01**		**Ability Enhancement Course:** Analytical Chemistry							**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	3	2	2	1	2	3	2	1	2	3	**2.1**
CO2	2	3	3	2	2	2	3	1	2	2	**2.2**
CO3	3	3	3	3	3	2	2	3	2	3	**2.7**
CO4	2	2	3	3	3	2	2	3	2	3	**2.5**
CO5	2	2	2	3	3	3	2	3	3	2	**2.5**
CO6	3	2	2	3	3	3	3	3	3	3	**2.7**
										Mean Overall Score	**2.52 (High)**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
1	25PCH1OE01	**Open Elective – 1 (WS):** Advanced Materials and Nanotechnology	4	2

Course Objectives
To understand the fundamental concepts of crystalline solids, including crystal structures, lattice systems, and X-ray diffraction techniques for structure determination.
To explore different synthetic methodologies in the manufacture of nanomaterials**.**
To introduce the principles of polymer science, covering polymerization mechanisms, classification, properties, and applications of polymers.
To familiarize students with material characterization techniques, including spectroscopy and microscopy (SEM, TEM, AFM)
To provide insights into smart materials, their unique properties, and applications in sensors, actuators, and transducers for advanced technological applications.

UNIT I: Crystalline Solids (12 Hours)

Crystal structures, lattice, unit cell, metallic crystal structures, the face-centered cubic crystal structure, coordination number and the atomic packing factor, the body-centered cubic crystal structure, the hexagonal close-packed crystal structure, problems in unit cell volume and packing factors, density computations, polymorphism and allotropy, crystal systems, point coordinates, determination of planar (miller) indices, crystalline and monocrystalline materials. x-ray diffraction: determination of crystal structures

UNIT II: Advanced Polymers Science (12 Hours)

Introduction to polymers- monomers- polymerization- Polymer structure, Molar mass and molar mass distribution-glass transition temperature- crystalline melting point, Relationship between glass transition temperature and melting point of polymers- Relationship between Tg, Tm and other transition temperatures- Light scattering- Absorption- Optical appearance properties- Magnetic susceptibility (magnetic inductive capacity).

UNIT III: Synthetic Methodologies of Nanomaterials (12 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 IV: Material Characterization (12 Hours)

Characterization- principle and instrumentation. UV/Vis Spectroscopy-X- Ray Diffraction (XRD) and Energy Dispersive X-ray analysis-Scanning Electron Microscopy (SEM)- Transmission Electron Microscopy (TEM)-Atomic Force Microscopy (AFM). Interpretation and Problem solving using SEM-EDX data.

UNIT V: Applications of Nanomaterials and Smart Materials (12 Hours)

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

Smart Materials - Structures and Products Technologies - Electrical properties- Piezoelectric Materials - Electro strictive Materials - Magneto strictive materials - Magneto electric materials - Shape Memory Materials – Fiber Optic Sensors

Teaching Methodology	Chalk and talk, PPT, simulation
Assessment Methods	MCQ test, Poster making, Class tests, Seminars

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*, (4th Ed.). CRC Press.

3. Van Krevelen, D. W., &Nijenhuis, K. T. (2009). *Properties of Polymers: Their Correlation with Chemical Structure; Their Numerical Estimation and Prediction from Additive Group Contributions* (4th ed.). Elsevier,
4. Gandhi, M. V., & Thompson, B. S. (1992). *Smart Materials and Structures*. (2nd Ed.) Chapman & Hall.
5. Rao, C. N. R., Muller, A., & Cheetham, A. K. (2004). *The Chemistry of Nanomaterials*. WILEYVCH Verlag GmbH & Co. KgaA.

Books for Reference:

1. Lee, J. D. (2006). *Concise Inorganic Chemistry* (5th Ed.). Blackwell Science.
2. Shah, M. A. & Ahmad, T. (2010). *Principles of Nanoscience and Nanotechnology*. Narosa Publishing House.
3. 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.
4. Shackelford, J. F. (2005). *Introduction to Materials Science for Engineers* (6th Ed.). Pearson.

Websites and eLearning Sources:

1. https://pubs.rsc.org/en/content/articlelanding/2021/ma/d0ma00807a
2. https://onlinecourses.nptel.ac.in/noc21_mm18/preview
3. https://onlinecourses.nptel.ac.in/noc19_cy35/preview

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	Identify and classify different types of crystal structures and compute unit cell parameters using mathematical models.	**K1**
CO2	Analyze ceramic and metallic phase diagrams and evaluate their mechanical properties for industrial applications.	**K2**
CO3	Differentiate various polymerization methods and apply polymer property relationships to material selection in real-world applications.	**K3**
CO4	Interpret and compare results obtained from advanced material characterization techniques to assess structural, optical, and mechanical properties.	**K4**
CO5	Integrate and design smart materials and sensor-based technologies for innovative applications in engineering and industry.	**K5**
CO6	Identify and classify different types of crystal structures and compute unit cell parameters using mathematical models.	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**								**Hours**	**Credits**
1	**25PCH1OE01**	**Open Elective - 1 (WS):** Advanced Materials and Nanotechnology								**4**	**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	3	3	2	3	1	3	2.0
CO2	2	2	2	2	3	3	1	2	1	3	2.1
CO3	2	1	2	3	1	3	2	3	1	3	2.1
CO4	2	2	2	2	3	3	2	3	1	3	2.1
CO5	2	3	2	3	3	2	1	3	1	3	2.3
CO6	2	2	2	2	3	3	2	3	1	3	2.3
										Mean Overall Score	**2.15 (Medium)**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
1	25PGC1SL01	Global Citizenship Education	Online	1

Course Objectives
To develop an understanding of global governance structures, rights and responsibilities.
To recognize and respect differences, multiple identities and diversity.
To examine beliefs and perceptions about social justice, equality and civic engagement.
To develop attitudes of care and empathy for others and the environment.
To develop global competence and ethical considerations by enhancing communication and collaboration skills across cultures

UNIT I: Introduction to Global Citizenship

01. Historical and Philosophical Foundations of Global Citizenship
02 Rights and Responsibilities of Global Citizenship
03. Key Organizations and Movements Promoting Global Citizenship

UNIT II: Globalization and Its Impact on Society

04. Globalization and Its Key Drivers
05. Positive and Negative Impacts of Globalization
06. Role of Education in Fostering a Global Perspective

UNIT III: Human Rights, Social Justice, Equality and Diversity

07. Key Human Rights Treaties, Frameworks and Declarations
08. Advocacy, Activism, and Movements for Social Justice and Equality
09. Global Challenges to Human Rights, Equality and Diversity

UNIT IV: Sustainable Development and Environmental Responsibility

10. The Sustainable Development Goals and Their Relevance to Global Citizenship
11. Climate Change, Environmental Degradation and Sustainable Development
12. Strategies for Promoting Environmental Responsibility

UNIT V: Building Global Competence and Engagement

13. Effective Communication and Collaboration Across Cultures
14. Volunteering and Community Engagement in Global Initiatives
15. Ethical Considerations in Global Citizenship

Teaching Methodology	Recorded Lectures/Videos, Reading Materials, PPTs, Case Studies, Collaborative Projects, Quizzes and Polls
Assessment Methods	Seminars, Assignments, MCQs, Reflection Essays, Group Project Presentations, Problem-Solving Scenarios

Books for Study:

1. Clapham, A. (2007). *Human rights: A very short introduction.* Oxford University Press.
2. Desai, A. (2018). *Global citizenship and cultural diplomacy: India's role in a changing world*. Routledge India.
3. Gould, J. A. (2012). *The ethics of global citizenship*. Routledge.
4. Held, D., et al. (2022). *Globalization and its impact on the developing world*. Cambridge University Press.
5. Sen, A. (2009). *The idea of justice*. Penguin Books India.

Books for Reference:

1. Ghosh, A. (2007). *The global impact of Indian civilization*. HarperCollins India.
2. Krecker, E. (2008). *The global citizen: A guide to creating an international life and career*. Career Press.
3. Kumar, R. (2017). *Sustainable development and environmental justice in India*. Oxford University Press.
4. Nair, K. G. (2014). *Human rights: A socio-political perspective*. Orient Blackswan.

5. Patel, V. (2015). *Social justice and equality in India: Theories and practices*. Oxford University Press.
6. Pillai, V. (2016). *Globalization and its impact on Indian society*. SAGE Publications India.

Websites and eLearning Sources:

1. https://www.unesco.org/en/global-citizenship-peace-education/need-know
2. TEDxCincinnati: Global Citizenship in the Classroom: Jenny Buccos at TEDxCincinnati https://www.youtube.com/watch?v=6jjLHmyBs7o
3. Social justice -- is it still relevant in the 21st century? | Charles L. Robbins | TEDxSBU https://www.youtube.com/watch?v=Wtroop739uU
4. Are We the Last Generation — or the First Sustainable One? | Hannah Ritchie | TED https://www.youtube.com/watch?v=Kl3VVrggKz4
5. Diversity, Equity & Inclusion. Learning how to get it right | Asif Sadiq | TEDxCroydon https://www.youtube.com/watch?v=HR4wz1b54hw

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	Recall the historical, philosophical and practical foundations of global citizenship.	**K1**
CO2	Explain the key drivers of globalization and the role of education in fostering a global perspective.	**K2**
CO3	Apply human rights frameworks, social justice principles, and advocacy strategies to real-world challenges.	**K3**
CO4	Analyze the relevance of the Sustainable Development Goals in addressing climate change and environmental degradation.	**K4**
CO5	Develop strategies for fostering global competence by enhancing communication and collaboration skills across cultures.	**K5**
CO6	Critically evaluate the effectiveness of current global strategies and policies in addressing social justice and environmental sustainability.	**K6**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
2	25PCH2CC03	**Core Course - 3:** Inorganic Chemistry – 2 (Internship Embedded Course)	4	4

Course Objectives
To understand the basics of covalent bonding in inorganic molecules.
To be able to predict the types of acids and bases
To know the different types of reactions in non-aqueous media.
To understand the sources of errors in chemical analysis.
Predict the chemical properties of halogens and noble gases.

UNIT I: 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^-, ICI_2^-, ICI_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 – energetics of hybridization.

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

Periodicity: First and second row anomalies - The use of *p*–orbitals in □–bonding – *p*□–*p*□ bonding in phosphine complexes and□-bonding – comparison of *p*□–d□□□non–metals – the use of (or not) *d*–orbitals by non–metals – experimental evidences for *d*□-*p*□ bonding; the P-O bond in phosphoryl compounds – 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 III: Electrode Potentials and Acid-Base Chemistry (12 Hours)

Electrode potentials and electromotive forces – applications. Acid–base concepts: Bronsted–Lowry, Lux–Flood, Usanovich, Lewis, solvent system and generalised 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.

UNIT IV: Non-aqueous Solvents (12 Hours)

Types of solvents, types of reactions – autoionization, neutralisation, precipitation, solvation, solvolysis and complex formation. Alkali metals in liquid ammonia. Liquid ammonia, liquid sulphur dioxide, liquid hydrogen fluoride, liquid sulphuric acid and liquid boron trifluoride, dinitrogen tetraoxide as solvents – ionic liquids.

UNIT V: Error Analysis (12 Hours)

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 (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.

Teaching Methodology	Chalk and talk, PPT, molecular models.
Assessment Methods	MCQ, snap test, open book test, seminar, assignments, group discussion

Books for Study:

1. Huheey, J. E., Keiter, E. A., & Keiter, R. L. (1993). *Inorganic Chemistry, Principles of Structure and Reactivity* (4th Ed.). Harper Collins College Publishers, New York.
   Units, I, II, III and IV
2. Skoog D. A., West, D. M., Holler, F. J., & Crouch S. R. (2014). *Fundamentals of Analytical Chemistry* (9th Ed.). BROOKES/COLE CENAGE Learning, Belmont, CA, USA.

Unit V

Books for Reference:

1. Housecroft, C. E., & Sharpe, A.G. (2018). *Inorganic Chemistry*, (5th Ed.), Pearson Education, New York.
2. Weller, M., Overton, T., Rourke, J., & Armstrong, F., (2018). *Inorganic Chemistry* (7th Ed.), Oxford University Press, Oxford, UK.
3. Miessler, G.L., Fischer, P. J., & Tarr, D. A. (2014). *Inorganic Chemistry* (5th Ed.), Pearson Education, New York.
4. Purcell, K. F., & Kotz, J. C. (2010). *Inorganic Chemistry*. W. B. Saunders Company, Philadelphia, PA.
5. Douglas, D. E., Mc Daniel, D. H., & Alexander, J. J. (1994). *Concepts and models in Inorganic chemistry*, (3rd Ed.).
6. Christian., G. D., Dasgupta, P. K., & Schug, K. A. (2014) *Analytical Chemistry* (7th Ed.), Wiley, New York.

Websites and eLearning Sources:

1. https://archive.nptel.ac.in/courses/104/103/104103069/
2. https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Supplemental_Modules_(Physical_and_Theoretical_Chemistry)/Acids_and_Bases/Acid/Overview_of_Acids_and_Bases
3. https://chem.libretexts.org/Bookshelves/Inorganic_Chemistry/Map%3A_Inorganic_Chemistry_(Housecroft)/09%3A_Non-aqueous_Media
4. https://nptel.ac.in/courses/122103010
5. https://onlinecourses.nptel.ac.in/noc24_cy07/preview

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-Level)**
	On successful completion of this course, students will be able to	
CO1	Define the various concepts of acids and bases and terms in statistical treatment of analytical data.	**K1**
CO2	Summarize the chemistry of noble gases and types of reactions in non-aqueous media.	**K2**
CO3	Solve problems related to structure and bonding in inorganic compounds.	**K3**
CO4	Relate the errors in a set of experimental data to their source.	**K4**
CO5	Criticize the reactivity of inorganic species with reference to their acid or basic character.	**K5**
CO6	Write the reaction of an inorganic species in a given non-aqueous solvent.	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**						**Hours**	**Credits**	
2	**25PCH2CC03**		**Core Course - 3:** Inorganic Chemistry – 2 (Internship Embedded Course)						**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	2	2	1	2	3	2	2	2	3	2	**2.10**
CO2	2	3	2	2	2	2	3	2	2	2	**2.20**
CO3	2	2	2	2	1	2	2	2	2	3	**2.00**
CO4	2	2	3	2	2	2	3	2	2	2	**2.20**
CO5	1	2	3	2	3	2	2	3	2	3	**2.30**
CO6	2	2	3	2	2	3	2	2	2	2	**2.20**
										Mean Overall Score	**2.17 (Medium)**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
2	25PCH2CC04	**Core Course - 4:** Organic Chemistry - 2	4	4

Course Objectives
To understand the Non-kinetic, kinetic methods of determining the reaction mechanism
To explain the characteristics, structures and importance of aromatic, homo aromatic and hetero aromatic systems
To illustrate the stereochemistry, mechanism of aliphatic and aromatic nucleophilic substitution reactions
To understand the feasibility and the mechanism of electrophilic addition reactions.
To comprehend the techniques in the determination of reaction mechanisms of elimination reactions.

UNIT I: Methods of Determining Reaction Mechanism (12 Hours)

Non–kinetic methods: Product analysis and its importance– intermediates and transition states – trapping, testing and detection of intermediates – cross–over experiments – isotopic labeling –stereochemical studies. **Kinetic methods**: isotope effects–primary, secondary and solvent isotope effect–correlation analysis–linear free energy relationships – Hammett equation–significances of σ and ρ–applications of Hammett equation – Taft equation and its applications.

UNIT II: Aromaticity (12 Hours)

Huckel's theory of aromaticity: Huckel Molecular Orbital (HMO) energies for conjugated planar ring systems of 3–9 carbon atoms – annulenes – cyclobutadiene – benzene – cyclooctatetraene – [10–18] and larger annulenes – aromaticity in charged rings – cations and anions – homoaromaticity – fused ring systems – polycyclic aromatic compounds – hydrocarbons incorporating exocyclic bonds – heteroaromatic systems.

UNIT III: Nucleophilic Substitution Reactions (12 Hours)

Mechanisms of nucleophilic substitution: Ionization mechanism: S_N1 and direct displacement mechanism: S_N2 – borderline mechanism – stereochemistry and mechanism – structural and solvation effects on reactivity – nucleophilicity – leaving group ability – steric and strain effects – effect of conjugation on reactivity – ambient nucleophiles and substrates – hydrolysis of esters – mechanisms – phase transfer catalysis (PTC) – crown ethers.

Nucleophilic substitutions on aromatic rings: S_NAr mechanism – S_N1 (Aromatic) mechanism with evidences – Benzyne mechanism – effect of substrate structure, leaving group, attacking nucleophile and solvent.

UNIT IV: Electrophilic Addition Reactions (12 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 V: Elimination Reactions (12 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 – Chugaev reaction - Hofmann exhaustive methylation-elimination and its regioselectivity - Cope elimination - Shapiro reaction - extrusion reactions-examples

Teaching Methodology	Chalk and talk, PPT, Molecular models, simulation
Assessment Methods	Multiple choice questions, seminar, assignment, snap test, open book test

Books for Study:

1. March, J., & Smith, M. (2001). *Advanced Organic Chemistry*, (5th Ed.). John-Wiley & Sons.
   Unit I: *Chapter 6*
2. Bruice, P. Y. (2021). *Organic Chemistry*, (8th Ed.). Pearson Education, New Delhi.
   Unit II: *Chapter 8*

Unit III: *Chapter 9*

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

Books for Reference:

1. Clayden, J., Greeves, N., & Warren, S. (2012). *Organic Chemistry*, (2nd Ed.). Oxford University Press, New York.
2. Finar, I. L. (2004). *Organic Chemistry.* (6th Ed.). Pearson Education Asia.
3. Bruckner, R. (2010). *Organic Mechanisms – Reactions, Stereochemistry and Synthesis,* Springer–Verlag, Berlin, Heidelberg.
4. Stanley, H., & Pine. (2006). *Organic Chemistry*, (5th Ed.). Tata-McGraw Hill.

Websites and eLearning Sources:

1. https://www.youtube.com/watch?v=MBkHyBW1NNw
2. https://www.youtube.com/watch?v=ixlkEoYC-jQ
3. https://www.youtube.com/watch?v=gqTQX4rQyfs

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-Level)**
	On successful completion of this course, students will be able to	
CO1	Understand the types of aromaticity, substitution, addition and elimination reactions	**K1**
CO2	Examine the mechanisms of various reactions based on stereochemistry of reactants and products	**K2**
CO3	Compose multiple ways for conversion in substitution, addition and elimination reactions of organic molecules	**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 reaction mechanism	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
2	**25PCH2CC04**		**Core Course - 4:** Organic 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	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	3	2	2	2	3	2	1	3	2	2	2.2
									Mean Overall Score		**2.2 (High)**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
2	25PCH2CC05	**Core Course - 5:** Physical Chemistry - 2	6	4

Course Objectives
To understand the principles of rotational and vibrational spectroscopy, molecular energy quantization, and spectral analysis techniques.
To explore the principles, theories, and applications of Raman and electronic spectroscopy, including molecular interactions and spectroscopic techniques.
To understand the principles and applications of NMR, NQR, and ESR spectroscopy in structural and molecular analysis
To analyse the symmetry of the molecules using group theory
To interpret the reducible and irreducible representations

UNIT I: Rotational and Vibrational Spectroscopy (18 Hours)

Basic aspects of spectroscopy - Atomic and molecular spectra - Characterization of electromagnetic radiation - Quantization of energy -Absorption and emission spectra – Microwave spectroscopy-Rotation of molecules and selection rules -Diatomic molecules - Rigid and non-rigid rotator - Intensities of spectral lines - Effect of isotopic substitution-Rotational constant (B) and centrifugal distortion constant (D) - Techniques and Instrumentation - Vibration spectroscopy - Harmonic and anharmonic oscillators - Zero point energy, dissociation energy and force constant (k). Fundamental absorption and overtones (Hot Bands; Fermi resonance) - Breakdown of Born -Oppenheimer approximation-Vibrations of polyatomic molecules - Fundamental vibrations and their symmetry - Influence of nuclear spin - Techniques and Instrumentation.

UNIT-II: Raman and Electronic Spectroscopy (18 Hours)

Raman spectroscopy - Raman and Rayleigh scattering - Quantum and classical theories of Raman effect - Molecular polarizabiltiy - Pure rotational Raman spectra - Stokes and antistokes lines - Vibrational Raman spectra-Mutual exclusion rule - Polarised and depolarized Raman lines - Techniques and instrumentation. Electronic spectra - Electronic spectra of diatomic molecules - Franck - Condon Principle, Dissociation energy determination and dissociation products - Pre dissociation - BirgeSponer extrapolation - Fortrate Diagram. Photo electron spectroscopy – Principle – UV and X-ray photo electron spectrometers-Molecular photoelectron spectroscopy – ESCA - Auger electron spectroscopy - Applications.

UNIT III: NMR, NQR and ESR spectroscopy (18 Hours)

NMR - Hydrogen nuclei - Chemical shift and spin - spin splitting - Coupling constant (J). Splitting with and without chemical exchange - Interaction between spin and magnetic field - Gyromagnetic ratio - FT NMR. Applications of C13 NMR spectroscopy. NQR principle and applications - ESR-Principle - Position of ESR absorptions - g value - Hyperfine splitting - Zero field splitting - ESR spectrum of free radicals.

Unit IV: Fundamentals of Group Theory (18 Hours)

Introduction to group theory - symmetry elements - symmetry operations –Group postulates-types of groups - multiplication table - subgroups – classes- similarity transformation - molecular point groups –Flow chart for point groups - Schoenflies symbols - optical activity and dipole moments on the basis of point group symmetry- matrix representations of symmetry operations - reducible and irreducible representations - statement of Great orthogonality theorem –properties of irreducible representations - construction of character tables for point groups (C_{2v} and C_{3v}) - explanation for the complete character table for a point group.

Unit V: Applications of Group Theory (18 Hours)

Applications of group theory - standard reduction formula relating reducible and irreducible representations – hybridization of atomic orbitals 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 – screw axis and glide plane - comparison of molecular symmetry with crystallographic symmetry.

Teaching Methodology	Charts and Diagrams, PPT, chalk and talk, Group Discussion, Problem-Solving Sessions, Flipped Classroom, Models, Online Learning Tools
Assessment Methods	MCQ, snap test, open book test, seminar, assignments, group discussion

Books for Study:

1. Banwell, C. N., (1997), *Molecular Spectroscopy*, New Delhi, TATA McGraw Hill Co.
   Unit- I
   Unit- II
   Unit - III
2. Raman, K.V., (1990), *Group Theory and its Applications to Chemistry*, Tata McGraw-Hill Publishing Company, New Delhi,
   Unit- IV
3. Cotton, F.A., (1990), *Chemical Applications of Group theory*, (3rd Ed.), John Wiley and Sons, New York.
   Unit- V

Books for Reference:

1. Drago, R.S., (1971), *Physical methods in Inorganic Chemistry*, New Delhi, East West Press Ltd.,
2. Chang, R., (1978), *Basic Principles of Spectroscopy,* New Jersy, Englewood Cliffs.
3. Straughan, B.P., and Walker, S. *Spectroscopy Vol. 2, 3*, New York, London Chapman and Hall.
4. Halstet, A., (1975), Press Book, John Wely & Sons Ins.
5. Barrow G. M., (1993), *Introduction to Molecular spectroscopy*, Tata McGraw- Hill Edition.
6. Gurdeep, R., Chatwal and Sham K Anand, (2009), *Spectroscopy*, Himalaya Publishing House.

Websites and eLearning Sources:

1. https://personal.colby.edu/personal/t/twshattu/PhysicalChemistryText/Part2/Ch27.pdf
1. https://www.physics.dcu.ie/~be/Ps415/Vibrational-Rotational.pdf
2. https://www.youtube.com/watch?v=iHYPzZcLv_Q
3. https://www.maths.gla.ac.uk/~mwemyss/teaching/3alg1-7.pdf
4. https://www3.uji.es/~planelle/APUNTS/TGS/taules_TG_oxford.pdf

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	Gain knowledge of atomic and molecular spectra, selection rules, isotopic effects, vibrational modes, and spectroscopic instrumentation.	**K1**
CO2	Develop an understanding of Raman and electronic spectra, selection rules, molecular transitions, and advanced spectroscopic instrumentation.	**K2**
CO3	Gain knowledge of chemical shifts, spin interactions, spectral splitting, hyperfine structures, and advanced spectroscopic techniques for molecular characterization.	**K3**
CO4	Develop the knowledge of the symmetry elements and operations of the molecules.	**K4**
CO5	Deduce character tables for the point groups.	**K5**
CO6	Gain knowledge of applications of group theory	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
2	**25PCH2CC05**		**Core Course - 5:** Physical Chemistry - 2							**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	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	3	2	2	2	3	2	1	3	2	2	2.2
Mean Overall Score											**2.2 (High)**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
2	25PCH2CP03	**Core Practical - 3:** Inorganic Chemistry Practical - 2	4	2

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 (12 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 (12 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 (12 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 (12 Hours)

Quantitative analysis of a mixture of iron (volumetry) and copper (gravimetry)

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

Unit V: Preparation and Characterization of Selected Complexes (12 Hours)

Preparation and characterization of hexamminecobalt (III) chloride

a) Preparation of tetrammine copper (II) sulphate
b) Preparation of *tris*–(thiourea)copper(I) chloride
c) Preparation of potassium *tris*–(oxalato) chromate (III) trihydrate

Teaching Methodology	Chalk and talk and Laboratory Demonstration.
Assessment Methods	Viva Voce and Test

Books for Study:

1. *Inorganic Laboratory Manual*, Department of Chemistry, St. Joseph's College (Autonomous), Tiruchirappalli–2
   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, England.
   Unit I *Chapter 10*
   Unit II *Chapter 11*
3. Pass, G. & Sutcliffe, H. (1974), *Practical Inorganic Chemistry* (2nd Ed.). Chapman and Hall, London.
   Unit III *Chapter 18, 20, 21 and 22*
   Unit V *Chapters 6 and 9*

Books 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, Belmont, CA 94002–3098, USA.

Websites and eLearning Sources:

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

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-Level)**
	On successful completion of this course, students will be able to	
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	**K4**
CO5	Recommend a suitable thermal method for the quantification of metal cations	**K5**
CO6	Pivot the identified components and quantify them	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**						**Hours**	**Credits**	
2	**25PCH2CP03**		**Core Practical - 3:** Inorganic Chemistry Practical - 2						**4**	**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	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	3	3	1	2	2	2	1	2	2	2	**2.2**
Mean Overall Score											**2.18 (Medium)**

SCHEME OF VALUATION

INTERNAL

CIA **100 Marks**

Cumulative mark of Regular Practical Classes	40 Marks
Record	10 Marks
Two CIA tests	50 Marks

For Each CIA Test ***100 marks***

Test	10 Marks
Results	90 Marks (60 Marks for Estimations & 30 Marks for Preparation)

Scheme of valuation

Inorganic Estimations

Thirty Marks each for the volumetric and gravimetric estimations

Gravimetry		***Volumetry***	
<2% Error	30 Marks	<1% Error	30 Marks
3%	25 Marks	2%	25 Marks
4%	20 Marks	3%	20 Marks
>4%	15 Marks	4% and above	15 Marks

Preparation

Fifteen marks each for the crude and re–crystallized samples

EXTERNAL

Total **100 Marks**

Test	10 Marks
Results	90 Marks (60 Marks for Estimations & 30 Marks for Preparation)

Scheme of valuation

Inorganic Estimations

Thirty Marks each for the volumetric and gravimetric estimations

Gravimetry		***Volumetry***	
<2% Error	30 Marks	<1% Error	30 Marks
3%	25 Marks	2%	25 Marks
4%	20 Marks	3%	20 Marks
>4%	15 Marks	4% and above	15 Marks

Preparation

Fifteen marks each for the crude and re–crystallized samples

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
2	25PCH2CP04	**Core Practical - 4:** Organic Chemistry Practical - 1	4	2

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 organic mixtures
To analyze the separated organic components systematically and derivatize them suitably
To construct suitable experimental setup for the organic preparations involving single stage
To experiment different purification and drying techniques for the compound processing

UNIT I: Micro Qualitative Analysis of an Organic Binary Mixture (12 Hours)

Pilot separation –Ether separation, Bicarbonate separation, Alkali separation and Acid separation, Bulk separation, Preliminary tests–Colour and appearance – solubility tests – acidic/basic/neutral nature – tests for aliphatic and aromatic compounds – tests for saturation/unsaturation.

UNIT-II: Tests for Characteristic Elements in Organic Compounds (12 Hours)

Preparation of sodium fusion extract –chemistry of converting organic N/S/halogens into inorganic ion in sodium fusion extract – tests for Nitrogen – tests for sulphur – tests for halogens such as chlorine, bromine and iodine – need for blank test.

UNIT III: Analysis of Functional Groups–1 (12 Hours)

Tests for carbonyl functional groups – mono– & di-carboxylic acids, esters, aldehydes and ketones, phenol, sulphanilic acid, alcohol and hydrocarbon.

UNIT IV: Analysis of Functional Groups–1 (12 Hours)

Primary and secondary amines, amide, diamide, anilide, and nitro compounds.

UNIT V: Single Stage Preparations (12 Hours)

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

Teaching Methodology	Chalk and talk and Laboratory Demonstration.
Assessment Methods	Viva Voce and Test

Books for Study:

1. Gnanapragasam, N. S., & Ramamurthy, G. (2015). *Organic Chemistry Lab Manual*, (2nd Ed.). Vishwanathan Printers and Publishers Pvt. 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 and Sons, New Delhi.
2. *Organic Chemistry Lab Manual for Micro Qualitative Analysis*, Department of Chemistry, St. Joseph's College, Tiruchirappalli.

Websites and eLearning Sources:

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

Organic Analysis-I

Organic Analysis-II

Separation of mixtures

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-Level)**
	On successful completion of this course, students will be able to	
CO1	Determine the solvent for separation for organic binary mixture	**K1**
CO2	Identify the functional group of the compounds from characteristic reactions.	**K2**
CO3	Apply the skills of micro level analysis to identify the nature of organic compounds	**K3**
CO4	Apply the skills of micro level analysis to identify the functional groups of organic compounds	**K4**
CO5	Confirm the functional group by preparing a solid derivative	**K5**
CO6	Determine the nature of techniques adopted for the preparation of organic compounds	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
2	**25PCH2CP04**		**Core Practical - 4:** Organic Chemistry Practical - 1							**4**	**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	1	2	3	1	2	3	2	3	3	2.2
CO2	3	2	1	3	2	3	1	3	3	3	2.4
CO3	2	3	2	3	2	2	3	2	2	2	2.3
CO4	3	2	3	3	2	2	3	1	2	3	2.4
CO5	1	3	2	2	3	2	2	3	3	1	2.2
CO6	2	1	2	3	1	2	3	2	3	3	2.2
Mean Overall Score											**2.3(High)**

Scheme of valuation

Organic Chemistry Practical – 1

INTERNAL

CIA	**100 Marks**
Cumulative mark of Regular Practical Classes	40 Marks
Record	10 Marks
Two CIA tests	50 Marks

For Each CIA Test	***100 marks***
Solvent for separation	10 Marks
Viva/Test	10 Marks
Results	60 Marks (30 marks for each compound)
Preparation	20 Marks

Organic Analysis

Solubility	5 Marks
Saturation/unsaturation	5 Marks
Aromatic/Aliphatic	5 Marks
Elements	5 marks
Functional Group	5 Marks
Derivative	5 marks

EXTERNAL

Total	**100 Marks**
Solvent for separation	10 Marks
Test	10 Marks
Results	60 Marks (30 marks for each compound)
Preparation	20 Marks

Organic Analysis

Solubility	5 Marks
Saturation/unsaturation	5 Marks
Aromatic/Aliphatic	5 Marks
Elements	5 marks
Functional Group	5 Marks
Derivative	5 marks

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
2	25PCH2OE02	**Open Elective – 2 (BS):** Chemistry of Health and Nutrition	4	2

Course Objectives
To recall fundamentals of health, blood and its related diseases.
To demonstrate an understanding of the functions of carbohydrates, proteins, lipids, and enzymes in metabolic processes.
To apply the principles of environmental chemistry to identify and assess the health impacts of chemical pollutants.
To analyze and act for emergency medical needs.
To evaluate the effects of lifestyle-related chemicals on health.
To design strategies to address health concerns, food safety, and sustainable green chemistry approaches to improve health outcomes.

UNIT I: Fundamentals of Health Chemistry (12 Hours)

Introduction to Health- mental health – physical health- food habits-food pyramid-diet chart for good health-composition of blood- blood groups-functions of blood - disease related to blood-diabetes-blood pressure-heart attack-stroke-causes, symptoms, food diet and treatment.

UNIT-II: Biochemical Basis of Health and Nutrition (12 Hours)

Nutrients-micro and macro nutrients-Carbohydrates, Proteins, and Lipids: definition, classification and biological functions- Vitamins-types, classification and disease caused by its deficiency. Digestion process-Chemistry of Respiration-Chemical Composition of Processed Foods and Its Impact on Health-Food Additives, Preservatives, and Their Health Implications.

UNIT III: Environmental Chemistry (12 Hours)

Environment- Introduction-Pollution-types of pollution-Air pollution-air pollutants and their sources-acid rain-Greenhouse effect – depletion of ozone layer- air borne diseases – types-causes-symptoms – treatment -Water Pollution-water pollutants-toxic elements present- water borne diseases-types-causes-symptoms – treatment - Soil pollution- causes of soil pollution.

UNIT IV: Medicinal Chemistry (12 Hours)

Poisons and antidotes - detection of hallucinogens and poisons-poisons and their antidotes-acid poisoning-alkali poisoning-disinfectants-atropine-alcohol-mercury and salicylate poisoning.

UNIT V: Action of Drugs (12 Hours)

Drugs–classification of drugs–mechanism of drug action–general anaesthetics, hypnotics & sedatives, narcotics, antipyretics, antirheumatics, analgesics, anticonvulsants and antitussives–chemotherapeutic drugs–antibiotics, antiseptics and disinfectants – cardiovascular agents – anti cancer drugs.

Teaching Methodology	Chalk and talk, PPT, Videos, group discussion
Assessment Methods	MCQ, slip test, poster presentation

Books for Study:

1. Ghosh, J. A. (1999). *Textbook of pharmaceutical chemistry*. S. Chand & Co. Ltd.
2. Deb, A. C. (1994). *Fundamentals of biochemistry* (4th ed.). New Central Book Agency.
3. Puri, B. R., & Sharma, L. R. (2010). *Principles of inorganic chemistry* (31st ed.). Vishal Publishing.

Books for Reference:

1. Nelson, D. L., & Cox, M. M. (2017). *Lehninger principles of biochemistry* (7th ed.). W.H. Freeman and Company.
2. Baird, C., & Cann, M. (2012). *Environmental Chemistry* (5th ed.). W.H. Freeman and Company.
3. De, A. K. (2015). *Environmental chemistry* (5th ed.). New Age International Publishers.

4. Ravikrishnan, A. (2015). *Environmental science & engineering* (11th ed.). Sri Krishna High Tech Publishing Company Pvt. Ltd.
5. Kar, A. (1993). *Medicinal chemistry*. Wiley Eastern Limited.
6. Satake, M., &Mido, Y. (2003). *Chemistry for Health Science*. Discovery Publishing House.

Websites and eLearning Sources:

1. https://archive.org/details/david-l.-nelson-michael-m.-cox-lehninger-principles-of-biochemistry-w.-h.-freeman-2017-kopyasi/page/n7/mode/2up
2. https://archive.org/details/environmentalche0000bair_j7l2/page/n9/mode/2up

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	Recall and define basic chemical concepts, the role of water and essential nutrients in maintaining human health.	**K1**
CO2	Demonstrate an understand the functions of carbohydrates, proteins, lipids, and enzymes in metabolic processes.	**K2**
CO3	Apply the principles of environmental chemistry to identify and assess the health impacts of chemical pollutants.	**K3**
CO4	Analyze the emergency medical need.	**K4**
CO5	Evaluate the effects of lifestyle-related chemicals and the importance of sustainable chemistry practices for public health.	**K5**
CO6	Design strategies that incorporate knowledge of chemistry over health concerns.	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**						**Hours**		**Credits**
2	**25PCH2OE02**		**Open Elective - 2 (BS):** Chemistry of Health and Nutrition						**4**		**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	3	2	3	2	2	3	2	3	2	2	2.4
CO2	2	2	2	2	2	2	2	1	2	2	1.9
CO3	3	2	3	2	2	3	2	3	2	2	2.4
CO4	2	2	3	2	2	2	2	2	2	2	2.1
CO5	3	2	1	2	2	1	2	3	2	2	2.0
CO6	2	2	3	2	2	2	2	1	2	2	2.0
Mean Overall Score											**2.13 (Medium)**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
2	25PSS2SE01	**Skill Enhancement Course:** Soft Skills	4	2

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, PPT, Mathematical models, Video presentation

Books 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 & Interviews? (3rd Ed.). Pearson Education.
8. Yate, M. (2005). Hiring the Best: A Manager 's Guide to Effective Interviewing and Recruiting

Websites and eLearning Sources:

6. https://www.indeed.com/career-advice/resumes-cover-letters/communication-skills
7. https://www.seek.com.au/career-advice/article/50-communication-skills-for-the-workplace-your-resume
8. https://southeast.iu.edu/career/files/power-phrases.pdf
9. https://dese.ade.arkansas.gov/Files/20201209124449_Professional-Communication.docx

10. https://www.dol.gov/sites/dolgov/files/ETA/publications/00-wes.pdf
11. https://www.tmu.ac.in/other_websites/cdoe.tmu.ac.in.old/study-material/28-08-2024/COMMON/SEMESTER_2/MAIN_SOFT_SKILLS.pdf
12. https://byjus.com/maths/profit-and-loss-questions/
13. https://www.indiabix.com/

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-Level)**
	On successful completion of this course, students will be able to	
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	**25PSS2SE01**		**Skill Enhancement Course:** Soft Skills							**4**	**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	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/ Weeks	Credits
3	25PCH3CC06	**Core Course - 6:** Inorganic Chemistry - 3	6	5

Course Objectives
To learn the properties and structure of silicones and silicates.
To understand the bonding and properties of coordination compounds.
To interpret different types of mechanism of coordination complexes.
To study different types of magnetic behaviour and their methods of measurement.
To study different types of spectra and its applications.

UNIT I: Inorganic rings, cages and clusters (18 Hours)

Structure of silicates - 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 clusters – structural features of *closo*, *nido*, *arachano* and *klado*; carboranes, hetero and metalloboranes; Wade's rule to predict the structure of borane cluster; main group clusters -zintl ions and *mno* rule

UNIT II: Theories of coordinate bond (18 Hours)

Crystal field theory - splitting pattern of octahedral, tetrahedral, square planar, trigonal bipyramidal 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 III: Kinetics and reaction mechanism (18 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. Excited state outer sphere electron transfer reactions. Mixed valence complexes. Photochemistry of chromium complexes – Adamson's rules.

UNIT IV: Physical methods in Coordination Chemistry-I (18 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 (18 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.

Nuclear quadrupole resonance spectroscopy – the fundamental requirements – general principles – energy levels in half-integral and integral spin systems - chemical applications - 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, Molecular models, simulation
Assessment Methods	MCQ, snap test, seminar, assignments

Books for Study:

1. Miessler, G.L., Fischer, P. J., & Tarr, D. A. (2014). *Inorganic Chemistry* (5th Ed.), Pearson Education, New York.

2. Huheey, J. E., Keiter, E. A., & Keiter, R. L. (1993). *Inorganic Chemistry Principles of Structure and Reactivity,* (4th Ed.). Harper Collins College Publishers.
3. Drago, R. S. (1965). *Physical Methods in Inorganic Chemistry* (1st Ed.). Affiliated East-West Press Private Limited, New Delhi.

Books for Reference:

1. Purcell, K. F., & Kotz, J. C. (2010). *Inorganic Chemistry*. Cengage Learning.
1. Weller, M., Overton, T., Rourke, J., and Armstrong, F., (2018). *Inorganic Chemistry* (7th Ed.). Oxford University Press, Oxford, UK.
2. Housecroft, C. E., & Sharpe, A.G. (2018). *Inorganic Chemistry,* (5th Ed.). Pearson Education, New York.
3. Lewis, J., & Wilkins, R. G. (1960). *Modern Coordination Chemistry,* (1st Ed.). Interscience Publishers. Inc.
4. Roundhill, D. M. (1994) *Photochemistry and Photophysics of Metal Complexes*. Springer Science+Business Media, LLC.
5. Nakamoto, K. (2009). *Infrared and Raman Spectra of Inorganic and Coordination Compounds* Part A and B, (6th Ed.). John-Wiley and Sons, Inc.
6. Cotton, F. A. & Wilkinson, G. (1972). *Inorganic Chemistry A Comprehensive Text*, (3rd Ed.). Interscience Publishers.
7. Parish, R. V., (1990). *NMR, NQR, EPR, and Mossbauer Spectroscopy in Inorganic Chemistry*, Ellis Harwood.

Websites and eLearning Sources:

1. https://onlinecourses.nptel.ac.in/noc19_cy19/preview
2. https://onlinecourses.nptel.ac.in/noc25_cy11/preview
3. https://archive.nptel.ac.in/courses/104/105/104105033/
4. https://onlinecourses.nptel.ac.in/noc24_cy14/preview#:~:text=These%20spectroscopic%20techniques%20allow%20us,strength%20of%20a%20chemical%20bond.
5. https://onlinecourses.nptel.ac.in/noc22_cy51/preview

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-Level)**
	On successful completion of this course, students will be able to	
CO1	Identify the structure of borane clusters using Wade's rule	**K1**
CO2	Discuss the various theories of coordinate bond.	**K2**
CO3	Interpret the magnetic behaviour of coordination complexes.	**K3**
CO4	Predict the NMR, ESR and Mossbauer spectral pattern of complexes.	**K4**
CO5	Construct the Orgel diagrams for complexes.	**K5**
CO6	Judge the correct structure of a complex based on its spectral data.	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
3	**25PCH3CC06**		**Core Course - 6:** Inorganic Chemistry - 3							**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	2	3	2	2	3	2	2	2	3	2	**2.3**
CO2	2	2	2	3	2	1	2	2	3	2	**2.1**
CO3	1	2	3	2	2	3	2	2	2	2	**2.1**
CO4	3	2	1	2	3	2	2	3	2	2	**2.2**
CO5	2	2	2	2	2	2	2	2	2	2	**2.0**
CO6	2	3	2	2	2	2	2	2	3	2	**2.2**
										Mean Overall Score	**2.15 (Medium)**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
3	25PCH3CC07	**Core Course - 7:** Organic Chemistry - 3	6	5

Course Objectives
To understand the chemical reactions of heterocycles and interpretation of IR, NMR and Mass spectra
To learn the types, characteristics of five membered and six-membered heterocycles
To summarize the structure of proteins and characterization of organic compounds by spectral techniques
To be aware of the principles involved in UV, IR, NMR and Mass spectra
To overview the fundamental aspects of ionization techniques in Mass analysis

UNIT I: UV and IR Spectroscopy (18 Hours)

UV Spectroscopy: Nature of Electronic Excitations - Presentation of UV Spectra - Solvents - Effect of Conjugation on Alkenes - Woodward–Fieser Rules for Dienes - Woodward's Rules for Enones - alpha, beta-Unsaturated Aldehydes, Acids, and Esters -Aromatic Compounds - Substituents with Unshared Electrons - Electron-Releasing and Electron-Withdrawing Effects - Visible Spectra: Color in Compounds

IR Spectroscopy: Uses of the Infrared Spectrum -The Modes of Stretching and Bending - Bond Properties and Absorption Trends - Hydrocarbons - Aromatic Rings - Alcohols and Phenols - Ethers - Carbonyl Compounds - Factors that Influence the C=O Stretching Vibration in Aldehydes - Ketones - Carboxylic Acids - Esters - Amides - Acid Chlorides - Amines – Nitriles - Nitro Compounds

UNIT II: 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 III: Mass Spectrometry and Spectroscopy Problems (18 Hours)

Basic principles - instrumentation - sampling techniques - ionization methods: EI, CI, desorption ionization techniques (FAB, and MALDI) - determination of molecular weight - molecular ion peak - parent ion peak, base and meta stable peaks - 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 - carbonyl compounds - amines - nitrogen compounds - halides - Solving Combined problems

UNIT IV: Heterocycles (18 Hours)

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

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 V: Amino acids, Peptides, and Proteins (18 Hours)

Classification of amino acids - 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 – self-assembled structures of proteins.

Teaching Methodology	Chalk and talk, PPT, Molecular models, simulation
Assessment Methods	MCQ, snap test, seminar, assignments

Books for Study:

1. Clayden, J., Greeves, N., & Warren, S. (2012). *Organic Chemistry*, (2nd Ed.). Oxford University Press, New York.
   Unit IV: Chapters 28 and 29
2. Pavia, D. L, Lampman, G. M, Kriz, G. S, Vyvyan, J. R, (2015), *Introduction to Spectroscopy*, (5th Ed.). Cengage Learning.
   Unit I: Chapters 2 and 7
   Unit II: Chapter 6
   Unit III: Chapter 8
3. Bruice P Y, (2012), *Organic Chemistry*, (4th Ed.). Pearson Education, New Delhi.
   Unit V: Chapter 21

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

Websites and eLearning Sources:

1. https://www.youtube.com/watch?v=6b2gZA70xxg
2. https://www.youtube.com/watch?v=1FQPXtN7MeI (Khan Academy)
3. https://www.youtube.com/watch?v=WTmj_9VT5oE

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-Level)**
	On successful completion of this course, students will be able to	
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 synthesis of various five and six membered heterocycles	**K3**
CO4	Compare and contrast between different structural aspects of proteins	**K4**
CO5	Predict the mechanistic pathway of reactions of heterocycles	**K5**
CO6	Interpret the structure of complex organic molecules using spectral data	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
3	**25PCH3CC07**		**Core Course - 7:** Organic Chemistry - 3							**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	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	2	3	2	2	2	3	2	2	2	2.2
Mean Overall Score											**2.15 (Medium)**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
3	25PCH3CC08	**Core Course - 8:** Physical Chemistry - 3	6	4

Course Objectives
To understand fundamental theories of reaction rates, including Arrhenius equation, collision theory, and activated complex theory and electrode kinetics
To analyze reaction mechanisms and factors affecting reaction kinetics in gas-phase and solution-phase reactions and electrode kinetics
To apply theories of unimolecular reactions and principles of microscopic reversibility to complex reaction mechanism and of electrode kinetics
To explore the role of catalysts in chemical reactions, including acid-base catalysis, biological catalysis, heterogeneous catalysis, and electrode kinetics
To investigate surface chemistry principles, adsorption isotherms, and their applications in catalysis and electrode kinetics

UNIT I: Theories of Reaction Rate and Reaction Mechanisms **(18 Hours)**

Fundamental Theories of Reaction Rates Arrhenius equation - Potential energy surfaces and reaction coordinates - Collision theory - Activated complex theory (ARRT) - thermodynamic treatment only - Application of ARRT to unimolecular, bimolecular, and termolecular reactions **Reaction Mechanisms and Kinetics** - Kinetic isotope effect - Isokinetic relation and temperature - Theories of unimolecular reactions: Lindemann and Rice-Ramsperger-Kassel(RRK) theory - Principle of microscopic reversibility and detailed balancing

UNIT II: Solution Kinetics and Catalysis (18 Hours)

Application of ARRT to solution kinetics - Factors affecting reaction rate in solution: internal pressure, solvent dielectric constant, ionic strength - Van't Hoff equation and volume of activation - Catalysis: characteristics, types (homogeneous and heterogeneous) - Acid-base catalysis: Van't Hoff and Arrhenius intermediates, protolytic and prototropic catalysis laws - Acidity functions - Hammett-Zucker hypothesis - Catalysis in biological systems: Michaelis-Menten equation, Lineweaver-Burk and Eadie-Hofstee plots - Influence of substrate concentration, pH, and temperature on rate - Influence of substituents on reaction rates: Hammett and Taft equations, linear free energy relations. **Surface Chemistry and Heterogeneous Catalysis** - Physical and chemical adsorption, adsorption and free energy relations at interface - Adsorption isotherms: Langmuir, Gibbs, BET - Measurement of surface area - Mechanism of heterogeneous catalysis: Langmuir-Hinshelwood and Langmuir-Rideal bimolecular mechanisms - Role of surface in catalysis

UNIT III: Huckel Theory and Its Applications (18 Hours)

Debye Huckel theory - Radius of ionic atmosphere - Calculations of thickness of ionic atmosphere - Evidences of ionic atmosphere - Asymmetry effect - Electrophoretic effect - Debye - Huckel Onsager equation - Modification and verification of the equation - Debye - Huckel limiting law - Modification and verification - Debye Falkenhagen effect - Wien effect - Finite ion size model - Huckel -Bronsted equation - Calculation of activity coefficient - Determination of ion size parameter - solubility - solubility product of sparingly soluble salt - common ion effect - neutral salt effect and solubility - determination of solubility and solubility product.

UNIT IV: Electrode Kinetics (18 Hours)

Theories of electrical double layer - Electric double layer at the electrode - electrolyte interface - Helmholtz model of double layer - Law of electro neutrality -Gouy-Chapman diffused charged model - Adsorption theory of double layer - Stern's model, triple-layer theory-. Electro capillary phenomenon - Electro capillary curves for solutions containing anions, cations and molecular substances - Electro capillary maximum - Lipmann equations and Lipmann potential - Experimental measurement and calculation of Lipmann potential - Capillary electrometer and contact angle method - Electro kinetic phenomena - Classification - Electro osmosis and electrophoresis - Streaming potential and sedimentation potential -Kinetics of electrode process - Equilibrium and non-equilibrium process - Concentration and activation polarization - Theory of electrochemical over potential - Derivation and verification of the equations - Butler - Volmer equation - Tafel equation - Hydrogen over potential - Mechanism of hydrogen evolution reactions - pH and metal deposition - Application of hydrogen over potential.

UNIT V: Advanced Applications of Material Science in Chemistry (18 Hours)

Advanced applications of material science in chemistry, functional materials, nanotechnology, and sustainable materials. smart materials (shape-memory alloys, self-healing polymers, piezoelectric materials), nanomaterials (carbon nanotubes, quantum dots, graphene, and their applications in catalysis, drug delivery, and energy storage), and biomaterials (biodegradable polymers, hydrogels, bio-based polymers, recyclable composites, and environmentally friendly coatings and bioactive ceramics in medical applications)- The role of materials in energy conversion and storage (fuel cells, super capacitors, and next-generation batteries).

Teaching Methodology	Chalk and talk, PPT, Molecular models, simulation
Assessment Methods	MCQ, snap test, seminar, assignments

Books for Study:

1. Laidler, K. J., (1984) *Chemical Kinetics,* (3rd Ed.). New Delhi TATA McGraw Hill Co. Unit I and II
2. Kuriacose, J. C., and Rajaram, J., (1993) *Kinetics and Mechanism of Chemical Transformation*, Macmillan & Co, Delhi. Unit I -III
3. Glasstone, S., (1956) *An Introduction to Electrochemistry*, New Delhi, East West Press Pvt. Ltd, Unit IV and V
4. Antorpov, L., (1977) *Theoretical Electrochemistry*, (2nd Ed.). Mir Publishers, Moscow,
5. Bockris, J., O'M and Reddy A K N., (1998) *Modern Electrochemistry, Vol. 1 & 2*, (2nd Ed.). Plenum Press, New York,

Books for Reference:

1. Castellan, G. W., (2004) *Physical Chemistry*, (4th Ed.). Narosa, New Delhi.
2. Kapoor, K. L., (2013) *A Textbook of Physical Chemistry*, Vol. 3 Macmillan, India Ltd.
3. Huges, G., (1973) *Radation Chemistry,* Oxford series.

Websites and eLearning Sources:

1. MIT Open Course Ware: Chemical Kinetics - https://ocw.mit.edu
2. Khan Academy: Reaction Rates and Mechanisms - https://www.khanacademy.org
3. NPTEL Courses: Chemical Kinetics and Catalysis - https://nptel.ac.in/courses
4. Dr. Vishal D. Sharma - Electroanalytical Techniques

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-Level)**
	On successful completion of this course, students will be able to	
CO1	Memorize and retain the basics of various concepts of kinetics, solution kinetics catalysis and electrodics	**K1**
CO2	Understand the underlying principles of solution kinetics catalysis and electrodics.	**K2**
CO3	Apply the underlying concepts of solution kinetics and electrodics in day to day	**K3**
CO4	Analyze the intricacies of solution kinetics, catalysis and electrodics	**K4**
CO5	Evaluate the concepts of kinetics, catalysis and electrodics	**K5**
CO6	Create new electrochemical cells and newer electrodes for application.	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
3	**25PCH3CC08**		**Core Course - 8:** Physical Chemistry - 3							**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	3	2	2	2	3	2	2	2	1	**2.2**
CO2	2	2	2	2	2	2	2	2	2	1	**1.9**
CO3	3	2	2	2	2	3	2	2	2	1	**2.1**
CO4	2	3	2	2	2	2	3	2	2	2	**2.2**
CO5	2	2	2	2	2	2	2	2	2	1	**1.9**
CO6	2	2	2	2	2	2	2	2	2	1	**1.9**
Mean Overall Score											**2.03 (Medium)**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
3	25PCH3CP05	**Core Practical - 5:** Physical Chemistry Practical - 2	4	2

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
To experiment the concepts of conductometric and potentiometric titrations

UNIT I: Principle Behind Experiments **(12 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 **(12 Hours)**

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

UNIT III: Cycle I **(12 Hours)**

1. Conductometric acid-base titration-mixture of acids.
2. Conductometric precipitation titration-iodide and chloride mixture.
3. Determinationofsecond-orderrateconstantforsaponificationofethylacetatebyconductivity

UNIT IV: Cycle II **(12 Hours)**

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

UNIT V: Cycle III **(12 Hours)**

1. Potentiometric redox titration
2. Solubility of sparingly soluble salt by (i) Conductivity and (ii) Potentiometry
3. Determinationofequivalentconductanceofastrongelectrolyteatinfinitedilution.
4. Dissociation constant of weak acid by conductivity method.

Teaching Methodology	Demonstration, videos, hands on training
Assessment Methods	MCQ, Viva Voce, each experiment evaluation, test

Books for Study:

1. *Lab Manual*. Department of Chemistry. St. Joseph's College (Autonomous).
2. Findlay, A. (1959). *Practical Physical Chemistry,* (7th Ed.). Longman.

Books for Reference:

1. Venkateswaran, V., Veeraswamy., & Kulandaivelu, A. R. (1997). *Basic Principles of Practical Chemistry* (4th Ed.). Sultan Chand &sons.
2. Daniels, Mathews, F., Howard, J., &John Warren, W. (1970). *Experimental Physical Chemistry,* (7th Ed.). McGraw Hill.

Website and eLearning Sources:

Conductometric precipitation titration

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 of electrode potential.	**K1**
CO2	Understand the concept of salting out constant.	**K2**
CO3	Learn the concepts and measurement of equivalent conductance.	**K3**
CO4	Apply the concepts of potentiometric titrations.	**K4**
CO5	Experiment the concepts of conductometric titrations.	**K5**
CO6	Interpret the results of physical chemistry experiments.	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
3	**25PCH3CP05**		**Core Practical - 5:** Physical Chemistry Practical - 2							**4**	**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	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)**

SCHEME OF VALUATION

INTERNAL

CIA 100 Marks

Cumulative mark of Regular Practical Classes 50 Marks
Two CIA tests 50 Marks
For Each CIA Test 100 marks
Procedure 10 Marks
Record 10 Marks
Viva 10 Marks
Results 70 Marks
Table10marks
Calculation10 marks
Graph 10 marks
Results40 marks

Scheme of valuation
<2% 40 Marks
< 3 %30 Marks
< 4 %20 Marks
>4% 10 Marks

EXTERNAL Total 100 Marks

Procedure 10 Marks
Viva 10 Marks
Results/Analysis 80 Marks
Table10marks
Calculation10 marks
Graph 10 marks
Results 50 marks

Scheme of valuation
< 2% 40 Marks
< 3 % 30 Marks
< 4 % 20 Marks
> 4% 10 Marks

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
3	25PCH3ES02A	**Discipline Specific Elective - 2:** Organic Chemistry - 4	4	3

Course Objectives
To understand the concept of oxidation reactions of some functional groups.
To correlate and appreciate the differences involved in the various types of reduction reactions and their mechanisms.
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: Oxidations (12 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 II: Reductions (12 Hours)

C-C multiple bonds: Hydrogenation using heterogeneous and homogeneous catalysts - enantioselective hydrogenation - partial reduction of alkynes - hydrogen transfer from diimide carbonyl 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 III: Stereoselectivity (12 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 IV: Reactions of Organometallics (12 Hours)

Preparation of organometallics: oxidative insertion of Mg and Li into alkyl halides, deprotonation of alkyne, ortholithiation 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 V: Retrosynthetic Analysis (12 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.

Teaching Methodology	Chalk and talk, PPT, Molecular models, simulation
Assessment Methods	MCQ, snap test, seminar, assignments

Books for Study:

1. Carey, F. A., Sundberg R. J., (2007), *Advanced Organic Chemistry, Part B: Structure and Mechanisms*, (5th Ed.). Springer (India) Pvt. Ltd.
   Unit I Chapter 12
   Unit II Chapter 5
2. Clayden, J., Greeves, N., and Warren, S., (2012), *Organic Chemistry*, (2nd Ed.). Oxford University Press.
   Unit III Chapter 28
   Unit IV Chapters 23
   Unit V Chapter 40

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. Smith, M. B., and March, J., (2007), *March's Advanced Organic Chemistry*, (6th Ed.). John–Wiley and Sons, New York.
4. Stanley, H. Pine., (2006), *Organic Chemistry*, (5th Ed.). Tata-McGraw Hill.

Websites and eLearning Sources:

1. https://www.youtube.com/watch?v=9kSCbVIdkDQ
2. https://www.youtube.com/watch?v=B23i9_jC5T8
3. https://www.youtube.com/watch?v=fLXyKLVd6Hc

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	Understand the concept of oxidation reactions of some functional groups.	**K1**
CO2	Correlate and appreciate the differences involved in the various types of reduction reactions and their mechanisms.	**K2**
CO3	Analyze the synthetic pathways for biologically important target molecules.	**K3**
CO4	Correlate and differentiate various organometallic reagents in organic synthesis	**K4**
CO5	Design reactions from their respective synthons and synthetic equivalents.	**K5**
CO6	Understand the concept of oxidation reactions of some functional groups.	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**								**Hours**	**Credits**
3	**25PCH3ES02A**	**Discipline Specific Elective - 2:** Organic Chemistry - 4								**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	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	2	3	2	2	2	3	2	2	2	2.2
Mean Overall Score											**2.15 (Medium)**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
3	25PCH3ES02B	**Discipline Specific Elective - 2:** Organic Pharmaceutical Chemistry	4	3

Course Objectives
To understand the impurities in pharmaceutical substances
To understand the physiological acid-base balance.
To outline the biological functions of gastrointestinal agents
To examine the pharmaceutical application of radioactive substances.
To evaluate the haematological diseases and their treatment

UNIT I: Impurities in Pharmaceutical Substances (12 Hours)

History of Pharmacopoeia, Sources and types of impurities, principle involved in the limit test for Chloride, Sulphate, Iron, Arsenic, Lead and Heavy metals, modified limit test for Chloride and Sulphate.

UNIT-II: Intracellular electrolytes (12 Hours)

Functions of major isotonicity, physiological ions, Electrolytes used in the replacement therapy: Sodium chloride, Potassium chloride, Calcium gluconate and Oral Rehydration Salt. Physiological acid-base balance.

UNIT III: Gastrointestinal Agents (12 Hours)

Acidifiers- Ammonium chloride and Dil. HCl, Antacid- Ideal properties of antacids, combinations of antacids, Aluminum hydroxide gel, Magnesium hydroxide mixture Cathartics- Magnesium sulphate, Sodium orthophosphate, Kaolin and Bentonite, Antimicrobials- Mechanism, classification, Potassium permanganate, Boric acid, Hydrogen peroxide, Chlorinated lime, Iodine and its preparations.

UNIT IV: Radio Pharmaceuticals (12 Hours)

Radio activity, Measurement of radioactivity, Properties of α, β, γ radiations, Half life, radio isotopes and study of radio isotopes - Sodium iodide I^{131}, Storage conditions, precautions & pharmaceutical application of radioactive substances.

UNIT V: Haematological Diseases (12 Hours)

Nervous system- Epilepsy, Parkinson's disease, stroke, psychiatric disorders, Endocrine system- Diabetes, thyroid diseases, disorders of sex hormones, Iron deficiency- megaloblastic anemia (Vitamin B_{12} and folic acid), sickle cell anemia, thalasemia, hereditary acquired anemia, hemophilia depression, schizophrenia and Alzheimer's disease.

Teaching Methodology	Chalk and talk, PPT, Molecular models, simulation
Assessment Methods	MCQ, snap test, seminar, assignments

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* 8
2. Ghosh, J., *Textbook of Pharmaceutical Chemistry* (3rd Ed.). S. Chand & Company.
   - **Unit I** *Chapter 2*
   - **Unit III** *Chapter 6*
   - **Unit V** *Chapter 10*
3. George, M., & Joseph, L. (2009). *Textbook of Pharmaceutical Chemistry*. Viva Books.
   - **Unit II** *Chapter 3*

Books for Reference:

1. Srivastava, S. K. (2012). *A Complete Textbook of Medical Pharmacology: Volume I* (2nd Ed.). Avichal Publishing Company.
2. Srivastava, S. K. (2012). *A Complete Textbook of Medical Pharmacology: Volume II* (2nd Ed.). Avichal Publishing Company.

3. Deb, A. C. (1994). *Fundamentals of Biochemistry*. New Central Book Agency.
4. Satake, M., & Mido, Y. (2003). *Chemistry for Health Science*. Discovery Publishing House.
5. Kar, A. (1993). *Medicinal Chemistry*. Wiley Eastern Limited.

Websites and eLearning Sources:

1.https://www.youtube.com/watch?v=lUxkcEoGkVg
2. https://www.youtube.com/watch?v=PJZABdqB05M
3. https://nptel.ac.in/content/storage2/courses/104103022/download/module1.pdf

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	Understand the mode of action of pharmaceutical substances	**K1**
CO2	Understand the major extra and intracellular electrolytes	**K2**
CO3	Outline the ideal properties of antacids	**K3**
CO4	Examine the properties and uses of radioactive pharmaceuticals	**K4**
CO5	Evaluate the functions of endocrine system	**K5**
CO6	Design new pharmaceuticals for various diseases	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
3	**25PCH3ES02B**		**Discipline Specific Elective - 2:** Organic Pharmaceutical Chemistry							**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	2	2	2	3	3	2	3	2	2.5
CO2	3	3	3	2	2	3	3	2	3	2	2.6
CO3	3	3	2	2	2	3	3	2	2	2	2.4
CO4	3	3	3	3	2	3	2	2	3	2	2.6
CO5	2	2	2	2	2	2	2	2	3	2	2.1
CO6	3	3	2	2	2	3	3	2	3	2	2.5
Mean Overall Score											**2.44 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
3	**25SPS3RM01**	Research Methodology and IPR	**4**	**2**

Course Objectives
To spell the research methodology and IPR
To compare different methods of doing research
To experiment with various methodology
To evaluate applied method and IPR
To do the research by following appropriate method

UNIT I: Introduction to Research Methodology (12 Hours)

Definition and importance of research in Science - Types of research - fundamental - applied research - Scientific method: Observation – hypothesis – experimentation – conclusion - Identifying research gaps in science - Framing hypotheses and objectives - Importance of literature review in research - Tools for finding relevant research papers - evaluation and critical analysis of existing work.

UNIT II: Research Design, Planningand Methodology (12 Hours)

Choosing a research problem in science - Formulating research objectives and specific goals - Creating a timeline for research work - Types of sampling methods - Tools and techniques for data collection in science experiments - Ethical considerations in scientific research - Plagiarism, falsification, and fabrication - Ensuring transparency and reproducibility in research - Quantitative Research Methods in Science - Qualitative Methods in Science - Data Visualization and Interpretation - Experimental Research - Computational Research.

UNIT III: Writing a Research Paper (12 Hours)

Structure of a Scientific Paper: Sections of a research paper (Abstract, Introduction, Methods, Results, Discussion, Conclusion) - Writing tips for clarity and precision.

Citing Sources and Referencing: Proper citation formats - Using reference management tools. Peer Review Process: Importance of peer review in scientific research - How to write and respond to peer reviews.

Data Interpretation and Presentation: Analyzing Results - Presenting Research Findings.

UNIT IV: Intellectual Property Rights (IPR) (12 Hours)

Intellectual Property - Types of IPR - Importance of IPR in science and innovation - The role of IPR in academic and industrial collaborations – Patents - Patent Search and Filing - Copyrights in Scientific Research - Trade Secrets and Confidentiality.

UNIT V: Licensing and Commercialization of Research (12 Hours)

Licensing Agreements - Commercialization of Research - Legal and Ethical Considerations in IPR - IPR in Academia vs Industry - IPR Enforcement and Litigation - Case Studies and Recent Developments in IPR and Research - Emerging Trends in IPR.

Teaching Methodology	Chalk and talk, PPT, Molecular models, simulation
Assessment Methods	MCQ, snap test, seminar, assignments

Books for Study:

1. Text Prepared by the Department.

Unit	Book	Chapters	Sections
I	1	1	All
II	1	2	All
III	1	3	All
IV	1	4	All
V	1	5	All

Books for Reference:

1. Michael Alley (2018), *The Craft of Scientific Writing* (3rd Ed.). Springer.
2. Ranjit Kumar, *Research Methodology: A Step-by-Step Guide for Beginners*,

3. Lee and Wills, *Intellectual Property and Innovation Management in Small Firms*
4. Howard G. Birnberg, *Patent Law for Researchers and Engineers*
5. Frederick J. R. P, *Introduction to Scientific Research*.
6. Geoffrey Marczyk, David DeMatteo and David Festinger (2005), *Essentials of Research Design and Methodology*, John Wiley & Sons, Inc.

Websites and eLearning Sources:

1. https://paperpal.com/blog/academic-writing-guides/what-is-research-methodology
2. https://www.indeed.com/career-advice/career-development/research-methodology
3. https://research.com/research/how-to-write-research-methodology
4. https://ipindia.gov.in/
5. https://www.youtube.com/watch?v=nJza2kfI8GU
6. https://www.wto.org/english/tratop_e/trips_e/intel1_e.htm

(* subject to availability - not to be used for exam purpose)

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-Level)**
	On successful completion of this course, students will be able to	
CO1	Define research and different methods to be followed and IPR	**K1**
CO2	Understand different methodology adapted for scientific research and IPR	**K2**
CO3	Apply various methodology to do research	**K3**
CO4	Examine suitable methods for scientific research	**K4**
CO5	Evaluate and interpret the results of research	**K5**
CO6	Formulate scientific methods and do the research	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**						**Hours**		**Credits**
3	**25SPS3RM01**		Research Methodology and IPR						**4**		**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	2	3	2	3	2	3	2	1	**2.3**
CO2	3	3	2	2	3	3	2	2	2	1	**2.3**
CO3	3	2	2	3	3	2	2	3	**3**	**2**	**2.5**
CO4	3	2	2	3	3	2	3	3	2	1	**2.4**
CO5	3	3	2	3	3	2	2	3	**3**	**2**	**2.5**
CO6	3	2	3	3	3	2	2	3	2	2	**2.3**
										Mean Overall Score	**2.38 (High)**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
3	25PCH3SL03	**Self - Learning:** Selected Topics in Chemistry	-	1

Course Objectives
To understand the basic concepts in supramolecular chemistry
To understand the applications in supramolecular chemistry
To 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
To summarize the concepts of Radiation chemistry

UNIT I: Supramolecular Chemistry I

Definition, nature of supramolecular interactions, host-guest interaction, molecular recognition, types of recognition, self-assembly.

Cation-binding Hosts - concepts, cation receptors, crown ethers, cryptands, spherands, calixarens, selectivity of cation complexation, macrocyclic and template effects.

Unit II: Supramolecular Chemistry II

Binding of anions and neutral molecules - concepts, anion host design, anion receptors, shape and selectivity, neutral receptors, clathrates, cavitands, cyclodextrins, cyclophanes.

Applications of supramolecular chemistry - rational design, molecular paneling, supramolecular reactivity and catalysis, supramolecular devices, nanoscience applications.

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 hyper conjugative 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 V: Radiation Chemistry

Radiation Chemistry-Sources of high energy radiation- Interaction of high energy radiation with matter. Detection of radiation - Dosimeters- Primary and secondary process-Radialysis of water -Hydrated electron and G value.

Teaching Methodology	Self-Study
Assessment Methods	Multiple choice questions, snap test

Books for Study:

1. Steed, J. W.; Atwood, J. L. (2000). *Supramolecular Chemistry, A Concise Introduction*, (1st Ed.). John Wiley.
   Unit – I, II: *Chapter 1, 2*
2. Bruice, P.Y., (2012). *Organic Chemistry*, (4th Ed.). Pearson Education.
   Unit - III: *Chapter 1*
3. Atkin's, P., Paula, D.J., Keller, J. (2018). *Physical Chemistry*, International Publication.
   Unit - IV: *Chapter 17 E, 19A-C*
4. Drago, R. S., (1965). *Physical Methods in Inorganic Chemistry* (1st Ed.). Affiliated East-West Press Private Limited.
   Unit - V: *Chapter 3*

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.

Websites and eLearning Sources:

1. https://www.youtube.com/watch?v=fROf2j2SoYQ
2. https://www.youtube.com/watch?v=Dj0jGX7ytB8
3. https://www.youtube.com/watch?v=EP0zfm_FVqc
4. https://www.youtube.com/watch?v=GdtE7b04Aso
5. https://www.youtube.com/watch?v=j00zNcRwll0

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-Level)**
	On successful completion of this course, students will be able to	
CO1	Understand the students basic concepts in supramolecular chemistry	**K1**
CO2	Learn the concepts of hybridization and acid-base concepts	**K2**
CO3	Understand the properties of colloids	**K3**
CO4	Analyze the structure of solid surfaces in terms of adsorption isotherm	**K4**
CO5	Appraise the principles of polymerization kinetics and determination of its molecular weight	**K5**
CO6	Summarize the concepts of Radiation chemistry	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
3	**25PCH3SL03**		**Self – Learning:** Selected Topics in Chemistry							-	**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	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		**2.2 (High)**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
4	25PCH4CC09	**Core Course - 9:** Inorganic Chemistry - 4	4	3

Course Objectives
To compare and contrast the properties of lanthanides and actinides
To design the synthesis and formation of bulk materials
To determine the suitable characterization tools for the nanomaterials.
To examine various metal ion binding to biomolecules and their functions
To design metal complexes for anticancer activity

UNIT I: Lanthanides and Actinides (12 Hours)

General characteristics of lanthanides –Electronic configuration–Term symbols for lanthanide ions – Oxidation states – cause and consequences of lanthanide contraction — colour and spectra – magnetic properties– shapes of *f*-orbitals–coordination complexes of lanthanides–lanthanide complexes as shift reagents – factors influencing the formation of lanthanide complexes.

General characteristics of actinides – Electronic configuration– Oxidation states – colour and spectra – magnetic properties–Difference between 4*f* and 5*f* orbitals–comparative account of coordination chemistry of lanthanides and actinides.

UNIT-II: Materials Chemistry (12 Hours)

Synthesis of materials – the formation of bulk materials - Direct synthesis at high temperature - Solution methods. Defects and ion transport – extended defects – atom and ion diffusion – solid cationic and anionic electrolytes. Metal oxides, nitrides and fluorides – monoxides of the 3d metals - Defects and non-stoichiometry - Electronic properties - Magnetic properties – higher oxides and complex oxides – high temperature superconductors.

UNIT III: Nanomaterials (12 Hours)

Nanomaterials-Nanomaterial terminology and history – solution-based synthesis of nanoparticles - Vapour-phase synthesis of nanoparticles via solutions or solids. Templated synthesis of nanomaterials using frameworks, supports, and substrates – nanosized reaction vessels. One-dimensional control: carbonnanotubes and inorganic nanowires - Two-dimensional control: graphene, quantum wells, and solid-state superlattices -Three-dimensional control: mesoporous materials and composites.

UNIT IV: Bioinorganic Chemistry-I (12 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 functions of myoglobin, Non-heme oxygen carriers: hemerythrin and hemocyanin-structure and function of cytochromes a, b, c and P-450.

UNIT V: Bioinorganic Chemistry-II (12 Hours)

Zinc enzymes: carboxy peptidase and carbonic anhydrase, *Copper enzymes*: superoxide dismutase and plastocyanin-structure and function of vitamin B_{12} - *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, Molecular models, simulation
Assessment Methods	MCQ, snap test, seminar, assignments

Books for Study:

1. Housecroft, C. E., & Sharpe, A. G., (2012). *Inorganic Chemistry*, (4th Ed.). Pearson Education.
2. Weller, M., Overton, T., Rourke, J., & Armstrong, F. (2018). *Inorganic Chemistry,* (7th Ed.). Oxford University Press.
3. Rao, C. N. R., Muller, A., & Cheetham, A. K. (2004). *The chemistry of nanomaterials*. WILEY-VCH Verlag GmbH & Co. KgaA, Weinheim.

4. Huheey, J. E., Keiter, E. A., & Keiter, R. L. (2008). *Inorganic Chemistry Principles of Structure and Reactivity*, (4th Ed.). Pearson Education.
5. Shriver, D. F., Atkins, P. W. & Langford, C.H. (2001). *Inorganic Chemistry*, (3rd Ed.). Oxford University Press.
6. Tilley, R. J. D. (2013). *Understanding solids - The Science of Materials*, (2nd Ed.). Wiley Publication.

Books for Reference:

1. Shackelford, J. F., & Muralidhara, M. K. *Introduction to materials science for engineers*, (6th Ed.). Pearson Press.
2. Rosette M. Roat-Malone (2020). *Bioinorganic Chemistry: A Short Course*, (3rd Ed.). Wiley Publications.
3. Miessler, G. L., Fischer, P. J., & Tarr, D. A. (2014). *Inorganic Chemistry*, (5th Ed.). Pearson Education.
4. Cotton, F. A., & Wilkinson, G. (1972). *Inorganic Chemistry a Comprehensive Text*, (3rd Ed.). Inter Science Publishers.

Websites and eLearning Sources:

1. Baig, N, et al. Mater. Adv., 2021, 2, 1821.https://pubs.rsc.org/en/content/articlehtml/2001/mo/d0ma00807a
2. Manzano, M. et al. Nanomaterials 2023, 13(12), 1828. https://www.mdpi.com/2079-4991/13/12/1828
3. https://chem.libretexts.org/Bookshelves/Inorganic_Chemistry/Inorganic_Chemistry_(Saito)/08%3A_Reaction_and_Physical_Properties/8.02%3A_Bioinorganic_chemistry
4. https://onlinelibrary.wiley.com/journal/4036

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	Identify and examine the catalytic and magnetic properties of inner-transition elements	**K1**
CO2	Understand the function of high temperature superconductors	**K2**
CO3	Comprehend the different synthetic strategies available for the synthesis of nanomaterials.	**K3**
CO4	Examine various metal ion binding to biomolecules and their functions	**K4**
CO5	Evaluate the different kinds of chemical reactions in biological system	**K5**
CO6	Design metal complexes for anti-cancer activity	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
4	**25PCH4CC09**		**Core Course - 9:** Inorganic Chemistry - 4							**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	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	2	3	2	2	2	3	2	2	2	**2.2**
										Mean Overall Score	**2.15 (Medium)**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
4	25PCH4CC10	**Core Course - 10:** Organic Chemistry - 5	6	5

Course Objectives
To understand the feasibility and the mechanism of electrophilic addition reactions.
To comprehend the techniques in the determination of reaction mechanisms of elimination reactions.
To understand the concept of oxidation and reduction reactions of some functional groups.
To propose new synthetic green and sustainable methodologies in organic synthesis
To design reactions involving stable intermediates and plausible transition states

UNIT I: Asymmetric Synthesis (18 Hours)

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

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

UNIT II: Photochemical Reactions (18 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 III: Pericyclic Reactions (18 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 enolate Claisen, and Claisen rearrangement of *N*,*N*-dialkylketene-[2,3]-sigmatropic rearrangements-Sigmatropic rearrangements of N, S, and Se oxides

UNIT IV: Rearrangements (18 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 V: Green Chemistry (18 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-polymer supported solid phase synthesis.

Teaching Methodology	Chalk and talk, PPT, Molecular models, simulation
Assessment Methods	MCQ, snap test, seminar, assignments

Books for Study:

1. Clayden, J., Greeves, N., and Warren, S., (2012), *Organic Chemistry*, (2nd Ed.). Oxford University Press.
   Unit I & IV Chapter 41 & 33

2. 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
3. Smith, M. B., and March J, (2007), *March's Advanced Organic Chemistry*, (6th Ed.). John-Wiley and Sons.
   Unit III Chapters 13,17 &18
4. Bruice, P. Y., (2012), *Organic Chemistry*, (4th Ed.). Pearson Education, New Delhi.
   Unit V Chapter 30
5. Paul, T., Anastas and John, C., Warner, (1998), *Green Chemistry: Theory and Practice*, Oxford University Press.
   Unit IV Chapter 2 & 4

Books for Reference:

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

1. https://www.chem.iitb.ac.in/~rfernand/links/pdfs/as.pdf
2. https://egyankosh.ac.in/bitstream/123456789/15757/1/Unit-13.pdf
3. https://www2.chemistry.msu.edu/faculty/reusch/virttxtjml/pericycl.htm
4. https://www.masterorganicchemistry.com/2011/10/17/introduction-to-rearrangement-reactions/
5. https://pmc.ncbi.nlm.nih.gov/articles/PMC9598646/

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	Compare and contrast between different methods of asymmetric synthesis	**K1**
CO2	Understand the fundamentals of photochemical, pericyclic and rearrangement reactions and methods of finding reaction mechanisms	**K2**
CO3	Predict the mechanistic pathway of pericyclic reactions	**K3**
CO4	Evaluate the various methods and evidences for rearrangement reactions.	**K4**
CO5	Design the synthetic methodologies for terpenoid and steroid molecules	**K5**
CO6	Predict the products, reagents, reactants and methods for the synthesis of organic alkaloid, terpenoid and steroid lead molecules	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
4	**25PCH4CC10**		**Core Course - 10:** Organic Chemistry - 5							**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	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/ Weeks	Credits
4	25PCH4CC11	**Core Course - 11:** Physical Chemistry - 4	6	4

Course Objectives
To understand the principles of approximation methods perturbation and variation
To apply the variation principle to VB and MO theories, HMO method and various hybridizations.
To enhance the knowledge in kinetics of polymerization and to understand the properties of polymer
To familiarize the importance of polarography and cyclic voltammetry
To study the principle, instrumentation and applications of amperometry and coulometry

UNIT I: Applications of Quantum Chemistry I (18 Hours)

Need for approximation, Perturbation method- First and second order perturbations, applications of perturbation with reference to particle in a box, anharmonic oscillator and helium atom.Variation principle-proof of variation principle, trial function and secular determinant, applications of variation principle with reference to hydrogen and helium atoms.

UNIT II: Applications of Quantum Chemistry II (18 Hours)

VB theory of hydrogen molecule-The Born-Oppenheimer approximation, wave function and secular determuinant, overlap,coulomb and exchange integrals, energy and wave functions . Molecular orbital theory of hydrogen molecular ion, Comparison of VB and MO theories. Applications of Huckel molecular orbital theory to ethylene, butadiene, benzene, cyclobutadiene, trimethylenemethane, bicyclobutadiene. and allyl systems. sp sp^2 and sp^3 hybrdizations, Hartee Fock approximation, self consistent field method.

UNIT III: Kinetics of Polymer Chemistry (18 Hours)

Kinetics of polymerization - Free radical polymerization - Cationic polymerization -Anionic polymerization - Emulsion polymerization-Number average molecular weight of polymers - Molecular weight by Cryoscopy, Ebullioscopy, Osmotic pressure methods - average molecular weight determination - Light scattering method – Using ultracentrifugation by sedimentation equipment - Sedimentation velocity – Differential scanning colorimetry - Differential thermal analysis - Thermo gravimetric analysis -Models of viscoelastic behaviour - Hooke model -Newton model - Voigt model -Burger Maxwell model - Kelvin - Voigt model -Glass transition temperature -Measurement of T_g - molecular interpretation of T_g.

Unit IV: Electroanalytical Techniques-I (18 Hours)

Polarography - experimental setup - advantages of dropping mercury electrode -supporting electrolyte - polarographic peak maxima - types of peak maxima -polarographic peak maxima suppressor - residual current - migration current -diffusion current - polarogram - half wave potential - Ilkovic equation (derivation is not required) - outline of applications (Polarogram of Zn^{2+} and Cd^{2+}) – cyclic voltametry, principle, experimental set up - cyclic voltammogram of Fe^{2+} in H_2SO_4 -anodic peak current - cathodic peak current - electrochemically reversible couple -cathodic peak potential - anodic peak potential - electrochemically irreversible couple- outline of applications.

Unit V: Electroanalytical Techniques-II (18 Hours)

Amperometry - principle of amperometric titration - different types of current voltage curves - amperometric titration between Pb^{2+} vs $K_2Cr_2O_7$, Pb^{2+} vs SO_4^{2-} , SO_4^{2-} vs Pb $^{2+}$, Ni^{2+} vs DMG - Electrogravimetry - principle - experimental set up – physical characteristics of metal deposits - separation of Cu -amd Ni . Coulometry - principle, experimental set up - controlled potential coulometric analysis and applications - experimental set up for constant current coulometry - coulometric titration of Fe (II) with Cerium (III).

Teaching Methodology	Chalk and talk, PPT, Molecular models, simulation
Assessment Methods	MCQ, snap test, seminar, assignments

Books for Study:

1. McQuarrie, D. A., (2011). *Quantum Chemistry* (Viva Student Edition). Viva Books.
2. Billmeyer, F. W. Jr. (n.d.). *Textbook of Polymer Science*. Wiley.'

3. Gowariker, V. R., Viswanathan, N. V., & Sreedhar, J. (n.d.). *Polymer Science*. New Age International Publishers.
4. Skoog, D. A., West, D. M., Holler, F. J., & Crouch, S. R. (n.d.). *Fundamentals of Analytical Chemistry*. Cengage Learning.
5. Bard, A. J., & Faulkner, L. R. (n.d.). *Electrochemical Methods: Fundamentals and Applications*. Wiley.

Books for Reference:

1. Prasad, R. K., (2022). *Quantum Chemistry* (5th Ed.). New Age International Publishers.
2. Levine, I. N., (2009). *Quantum Chemistry* (6th Ed.). Prentice Hall of India Pvt. Ltd.

Websites and eLearning Sources:

1. ScienceDirect - Polymer Chemistry & Electroanalysis www.sciencedirect.com
2. SpringerLink - Advances in Electroanalytical Chemistry www.springer.com , www.rsc.org
3. NPTEL - Polymer Science & Technology (IIT Kharagpur, Prof. N. Ramesh)
4. MIT OpenCourseWare - Polymer Chemistry- MIT Polymers Course
5. YouTube Channels: nptelhrd - Polymer Science Lectures,The Organic Chemistry Tutor - Polymer Basics
6. University of California, Berkeley - Electrochemical Methods- Online Course,Covers cyclic voltammetry, polarography, and amperometric titrations.
7. YouTube Channels:LearnChemE - Analytical Chemistry, Dr. Vishal D. Sharma - Electroanalytical Chemistry, Electrochemistry Explained - Cyclic Voltammetry & Polarography

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-Level)**
	On successful completion of this course, students will be able to	
CO1	Understand the principle and determinations of energy and wave function associated with perturbation and variation methods	**K1**
CO2	Determine the principle of variation to huckel molecular orbital theory and hybridization	**K2**
CO3	Apply the principle of kinetics to polymers and determine the molecular weight of polymers by different techniques	**K3**
CO4	Explain the important techniques of electroanalytical methods in research	**K4**
CO5	Analyze the importance of polymers in the industry	**K5**
CO6	Evaluate energy and wave functions of different molecules on the basis of variation methods	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
4	**25PCH4CC11**		**Core Course - 11:** Physical Chemistry - 4							**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	2	2	1	1	2	2	2	2	**1.9**
CO2	3	2	2	2	1	1	2	2	2	2	**1.9**
CO3	3	2	2	2	2	1	2	2	2	2	**2.0**
CO4	3	2	2	2	2	1	2	2	2	2	**2.0**
CO5	3	2	2	2	2	1	2	2	2	2	**2.0**
CO6	3	2	2	2	2	1	2	2	2	2	**2.0**
										Mean Overall Score	**2.0 (Medium)**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
4	25PCH4CP06	**Core Practical - 6:** Organic Chemistry Practical - 2	4	2

Course Objectives
To describe the principles of quantitative analysis in organic chemistry
To understand the procedure for estimation of organic compounds
To analyze the amount of oils, proteins and dyes
To estimate the phenol, Aniline and Glucose
To prepare organic compounds *via* single and double stage method

UNIT I: Theory of Iodimetric Titrations **(12 Hours)**

Chemical reactions involved in the estimation of phenol, aniline and ketone. Importance of determining the saponification value and iodine value of edible oils

UNIT II: Quantitative Analysis of Organic Compounds **(12 Hours)**

1. Determination of saponification value of edible oil
2. Estimation of iodine value of oil
3. Estimation of phenol
4. Estimation of aniline

UNIT III: Quantitative Analysis Organic Compounds **(12 Hours)**

1. Estimation of ketone.
2. Estimation of glucose.
3. Estimation of ascorbic acid.

UNIT IV: Preparation of Organic Compounds (Two–stage) **(12 Hours)**

1. Preparation of orange–II dye
2. Preparation of *p*–nitroaniline
3. Preparation of methyl orange dye
4. Preparation of *p*–bromoaniline

UNIT V: Preparation of Organic Compounds (Two–stage) **(12 Hours)**

1. Preparation of 1,3,5–tribromobenzene
2. Preparation of acetyl salicyclic acid (aspirin)
3. Preparation of methyl red

Teaching Methodology	Chalk and talk and Laboratory Demonstration.
Assessment Methods	Viva Voce and Test

Books for Study:

1. Ganapragasm, N. S., & Ramamurthy, C. (2015). *Organic chemistry lab manual* (2nd Ed.). Vishwanathan S Printers and Publishers (P) Ltd.
2. Venkateswaran, V., Veeraswamy, R., & Kulandaivelu, A. R. (1997). *Basic principles of practical chemistry* (2nd Ed.). Sultan Chand and Sons.

Books for Reference:

1. Furniss, B. S., Hannaford, A. J., Smith, P. W. G., & Tatchell, A. R. (1989). *Vogel's textbook of practical organic chemistry* (5th Ed.). Pearson.

Websites and eLearning Sources:

1. https://www.youtube.com/watch?v=iqZWvs8vpF8
2. https://www.youtube.com/watch?v=Q3M_RJJno20

Estimation of Phenol

Preparation of Orange II Dye

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-Level)**
	On successful completion of this course, students will be able to	
CO1	Identify the suitable titration method for the estimation of various organic compounds	**K1**
CO2	Summarize the reactions involved in the preparation of organic compounds	**K2**
CO3	Relate the methods followed to estimate the organic compounds	**K3**
CO4	Illustrate the mechanism of reactions involved in organic synthesis	**K4**
CO5	Criticize the iodine value and saponification value of different edible oils	**K5**
CO6	Collaborate the theoretical method followed in the estimation with real samples which are expected to have the phenolic and carbonyl compounds	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
4	**25PCH4CP06**		**Core Practical - 6:** Organic Chemistry Practical - 2							**4**	**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	1	2	3	3	2	3	2	3	3	**2.4**
CO2	1	2	3	3	2	3	3	3	3	3	**2.6**
CO3	2	3	2	3	2	2	3	2	2	2	**2.3**
CO4	3	2	3	3	2	2	3	1	2	3	**2.4**
CO5	2	3	2	2	3	2	2	3	3	1	**2.3**
CO6	2	3	3	3	3	3	3	3	3	3	**2.9**
										Mean Overall Score	**2.5 (High)**

Scheme of Valuation

Organic Chemistry Practical–2 Estimation and preparation

INTERNAL

CIA	**100 Marks**
Cumulative mark of Regular Practical Classes	40 Marks
Record	10 Marks
Two CIA tests	50 Marks

For Each CIA Test 100 marks

Procedure	10 Marks
Test/Viva	10 Marks
Results	80 Marks (60 marks for estimation and 20 marks for preparation)

Organic Estimations

<1% Error	60 Marks
2%	50 Marks
3%	40 Marks
4%	30 Marks
>4%	20 marks

Preparation

10 marks each for the crude and recrystallized samples

EXTERNAL

Total	**100 Marks**
Procedure	10 Marks
Test	10 Marks
Results	80 Marks (60 marks for estimation and 20 marks for preparation)

Organic Estimations

<1% Error	60 Marks
2%	50 Marks
3%	40 Marks
4%	30 Marks
>4%	20 marks

Preparation

10 marks each for the crude and recrystallized samples

Semester	Course Code	Title of the Course	Hours/Weeks	Credits
4	25PCH4ES03A	**Discipline Specific Elective - 3:** Organometallic Chemistry	4	3

Course Objectives
To study the basics of organometallic compounds.
To know the different types of organometallic reactions.
To understand the mechanisms of organometallic catalysis.
To understand the parallels between main group and organometallic compounds
To know the fluxional behaviour of organometallic compounds.

UNIT I: Basics of Organometallics (12 Hours)

Organic ligands and nomenclature - Hapticity- 16 and 18 electron rules - applications and limitations. Ligands in organometallic chemistry – Carbonyl complexes – bonding – bridging modes of CO – binary carbonyl complexes and their synthesis – NO complexes – hydride and dihydrogen complexes. Ligands having extended pi system – linear and cyclic pi systems – bonding in pi-ethylene complexes – bonding in ferrocene – other metallocenes and related complexes. Carbene complexes – Fisher and Schrok carbenes.

UNIT II: Unique Reactions in Organometallic Chemistry (12 Hours)

Oxidative addition and oxidative coupling – oxidative addition involving C-X bonds – agnostic and anagostic interactions – oxidative addition involving C-H bond and cyclometallation – orthometallation – oxidative addition involving C-C bond – oxidative addition of ligands with pi system. Reductive elimination – mononuclear system – binuclear system. Migratory insertion reactions – Lewis-acid acceleration – redox acceleration – migration versus insertion – insertion of alkenes – beta-hydrogen elimination versus reductive elimination.

Unit III: Ligand Substitution Reactions and Fluxionality in Organometallics (12 Hours)

Types of ligand substitution reactions – activation entropy and activation volume – factors affecting substitution reactions. Associative substitutions – hapticity change in multidentate ligands. Dissociative substitution – interchange mechanism – associative interchange – dissociative interchange. Stereochemical non-rigidity in organometallic compounds – ring whizzing in □^{1}- and □-^{5} Cp rings – allyl complexes – allene complexes – scrambling of CO group in metal carbonyls.

UNIT IV: Organometallic Catalysis (12 Hours)

Catalysis – terminology in catalysis – turnover - turnover number – turnover frequency – sequences involved in a catalysed reaction – other important terminology used in catalysis – asymmetric synthesis using a catalyst – heterogneous catalysis. Catalytic deuteration - Hydroformylation - Monsanto Acetic Acid Process - Wacker (Smidt) Process - Hydrogenation by Wilkinson's Catalyst – olefine metathesis. Heterogeneous catalysis – Ziegler-Natta polymerization – Water gas reaction.

UNIT V: Parallels between Main Group and Organometallic Chemistry (12 Hours)

Main Group Parallels with Binary Carbonyl complexes – The isolobal analogy - Extensions of the Analogy - Examples of Applications of the Analogy Metal–Metal Bonds - Multiple Metal–Metal Bonds – quadruple bonds – quintiple bonds. Boranes - A Method for Classifying Boranes – Heteroboranes - Metallaboranes and Metallacarboranes - Carbonyl Clusters - Carbon-Centered Clusters - Additional Comments on Clusters.

Teaching Methodology	Chalk and talk, PPT, Molecular models, simulation
Assessment Methods	Seminar, assignment, oral test, written test.

Books for Study:

1. Miessler, G. L., Fischer, P. J., & Tarr, D. A. (2014). *Inorganic Chemistry*, (5th Ed.). Pearson Education.
   Unit I, Unit IV, Unit V
2. Gupta, B.D., & Elias, A.J., (2017) *Basic Organometallic Chemistry concepts, synthesis and applications* (2nd Ed.). Universities Press (India) Private Limited.
   Unit II, Unit III, Unit IV

Books for Reference:

1. Huheey, J. E., Keiter, E. A. & Keiter, R. L. (2008). *Inorganic Chemistry Principles of Structure and Reactivity*, (4th Ed.). Pearson Education.
2. Cotton, F. A., & Wilkinson, G. (1972). *Inorganic Chemistry A Comprehensive Text*, (3rd Ed.). Interscience Publishers

Websites and eLearning Sources:

1. https://www.google.com/search?q=1.+Mod-01+Lec-01+Introduction+to+Organometallic+chemistry&oq=1.%09Mod-01+Lec-01+Introduction+to+Organometallic+chemistry&gs_lcrp=EgZjaHJvbWUqBggAEEUYOzIGCAAQRRg7MgcIARAhGJ8FMgcIAhA
2. http://www.digimat.in/nptel/courses/video/104101123/L60.html

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-Level)**
	On successful completion of this course, students will be able to	
CO1	Know the structures of organometallic complexes and their catalytic properties.	**K1**
CO2	Interpret the type of organometallic reactions.	**K2**
CO3	Solve problems dealing with the nature of bonding in metal clusters.	**K3**
CO4	Correlate the structures of organometallics to their reactivity and catalytic activity.	**K4**
CO5	Value the industrial importance of organometallic catalysts like Wilkinson's catalyst.	**K5**
CO6	Rewrite the equations of organometallic reactions.	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**								**Hours**	**Credits**
4	**25PCH4ES03A**	**Discipline Specific Elective - 3:** Organometallic Chemistry								**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	2	1	2	1	2	3	2	2	3	1	**1.9**
CO2	2	3	2	2	2	2	2	1	2	2	**2.0**
CO3	2	1	2	2	3	1	2	3	2	2	**2.0**
CO4	2	3	2	3	2	2	2	1	2	2	**2.1**
CO5	2	2	2	2	3	2	1	3	2	2	**2.1**
CO6	2	2	3	1	2	2	3	2	2	2	**2.1**
										Mean Overall Score	**2.03 (medium)**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
4	25PCH4ES03B	**Discipline Specific Elective - 3:** Materials Chemistry	4	3

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 pigments.
To analysis characterization of materials

UNIT I: Metals and Alloys (12 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 (12 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: Chalcogenides, Intercalation Chemistry, and Metal-rich phase (12 Hours)

Layered MS_2 compounds and intercalation - synthesis and crystal growth - structure - intercalation and insertion. Chevrel phases - Framework structures – structures based on tetrahedral oxoanions– contemporary zeolite chemistry – Aluminophosphates – phosphates and silicates. Structures based on octahedral and tetrahedral – clays, pillared clays, and layered double hydroxides – advances in inorganic framework chemistry.

UNIT IV: Inorganic Pigments (12 Hours)

Coloured pigments – white and black inorganic materials – white pigments – black, absorbing, and specialist pigments – semiconductor chemistry – Group 14 semiconductors – semiconductors systems isoelectronic with silicon. Molecular materials and fullerides – Fullerides – Molecular materials chemistry – one dimensional metals– molecular magnets – Inorganic liquid crystals

UNIT V: Material Characterization (12 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.

Teaching Methodology	Chalk and talk, PPT, Molecular models, simulation
Assessment Methods	Seminar, assignment, oral test, written test.

Books for Study:

1. Callister, Jr. W. D., & Rethwisch, D.G. (2018). *Materials Science and Engineering an Introduction*, (10th Ed.). Wiley.
   Unit I, Unit II, Unit IV
2. Atkins. P., Overton. T., Rourke. J., Weller. M., Armstrong. F., (2010) *Inorganic Chemistry* (4th Ed.). International student edition
   Unit III, Unit IV

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-InterScience.

Websites and e-Learning 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**	**Cognitive Levels (K-Level)**
	On successful completion of this course, students will be able to	
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**
4	**25PCH4ES03B**		**Discipline Specific Elective - 3:** Materials Chemistry							**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	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/ Weeks	Credits
4	25PCH4CE01	Comprehensive Examination	-	2

Course Objectives
To gain a deep understanding of the periodic trends, principles of coordination compounds.
To learn about the roles of metal ions in biological systems, including metalloenzymes and metal-based drugs.
To grasp the concept of stereochemistry, including enantiomers and diastereomers
To learn to interpret NMR, IR and MS spectra to identify the organic compounds
To 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. Stereochemical principles: Asymmetric induction, diastereoselectivity, 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 Includes topics such as Ionic equilibria, Conductometric and potentiometric titrations, DebyeHuckel theory

Unit-IV CSIR Questions

Solving the CSIR Questions of the years: 2020, 2021 and 2022

Unit V CSIR Questions

Solving the CSIR Questions of the years: 2023, 2024 and 2025

Teaching Methodology	Self-study
Assessment Methods	MCQ, Test

Books for Study:

1. Cotton F A and Wilkinson G, (1972.), *Inorganic Chemistry A Comprehensive Text*, (3rd Ed.). Interscience Publishers, New York.

2. Shriver D, Weller M, Overton T, Rourke J and Armstrong F, (2014.) *Inorganic Chemistry* (6th Ed.). W H Freeman and Company, New York.
3. Housecroft C E and Sharpe A G, (2012.), *Inorganic Chemistry* (4th Ed.). Pearson Education Limited, Essex.
4. Ebsworth EAV, (1987.) *Structural Methods in Inorganic Chemistry*, (3rd Ed.). Great Britain, ELBS.
5. March J, (1992.), *Advanced Organic Chemistry*, (4th Ed.). John-Wiley and Sons, New York.
6. Kemp W, (1987), *Organic Spectroscopy*, (3rd Ed.). ELBS, London.
7. Jonathan Clayden, Nick Greeves, and Stuart Warren, (2012), *Organic Chemistry*, (2nd Ed.). Oxford University Press, New York.

Books for Reference:

1. Final I L, (1997.), *Organic Chemistry* Volume I and II, (4th Ed). ELBS with Longmann, Singapore.
2. Laidler K J, (1984.), *Chemical Kinetics*, (3rd Ed.). New Delhi TATA McGraw Hill Co.
3. Drago R S, (1971.). *Physical Methods in Inorganic Chemistry*, New Delhi, East West Press Ltd.

Websites and eLearning Sources:

1. https://www.adda247.com/teaching-jobs-exam/csir-net-previous-year-question-papers/?srsltid=AfmBOooLL0PtINAMeCzrnLogo8Uk8rAAfzNwS3k6BQzlpL9rntc35Wg8
2. https://ifasonline.com/csir-net/life-science-previous-year-question-paper/6433b5b36f88433b504b4258/6433ae116f88433b504b4151?srsltid=AfmBOooiDGV6QqEU7x6Jv8oEmLD-3B2k_80nQ1Yn-f04GyXKAArI-cVi
3. https://www.pw.live/exams/csir-net/csir-net-previous-year-question-papers/
4. https://www.shiksha.com/exams/csir-net-exam-pattern
5. https://ifasonline.com/csir-net/chemical-science-previous-year-question-paper/6433b5b36f88433b504b4258/6433acdf6f88433b504b4144?srsltid=AfmBOood094cBUh1WjsM1rd-AMTAewqtrXQUkm02zegzrj6F6iDCVDST

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	Understand and recall the fundamental principles 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	**25PCH4CE01**		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)**