M.Sc. CHEMISTRY

LOCF SYLLABUS 2023

Department of Chemistry
School of Physical Sciences
St. Joseph's College (Autonomous)
Tiruchirappalli - 620 002, Tamil Nadu, India

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)

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

Programme Outcomes (POs)

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

Programme Specific Objectives (PSOs)

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

CONTINUOUS INTERNAL ASSESSMENT
Categorizing Outcome Assessment Levels Using Bloom's Taxonomy

Level	Cognitive Domain	Description
K1	Remember	It is the ability to remember the previously learned concepts or ideas.
K2	Understand	The learner explains concepts or ideas.
K3	Apply	The learner uses existing knowledge in new contexts.
K4	Analyse	The learner is expected to draw relations among ideas and to compare and contrast.
K5	Evaluate	The learner makes judgements based on sound analysis.
K6	Create	The learner creates something unique or original.

Question Paper Blueprint for Mid and End Semester Tests

<table>
<tr><td colspan="3">Duration: 2 Hours</td><td colspan="6">Maximum Marks: 60</td></tr>
<tr><td colspan="2" rowspan="2">Section</td><td colspan="6">K level*</td><td rowspan="2">Marks</td></tr>
<tr><td>K1</td><td>K2</td><td>K3</td><td>K4</td><td>K5</td><td>K6</td></tr>
<tr><td colspan="2">A (no choice)</td><td>7</td><td></td><td></td><td></td><td></td><td></td><td>7 × 1 = 7</td></tr>
<tr><td colspan="2">B (no choice)</td><td></td><td>5</td><td></td><td></td><td></td><td></td><td>5 × 3 = 15</td></tr>
<tr><td colspan="2">C (either… or type)</td><td></td><td></td><td>3</td><td></td><td></td><td></td><td>3 × 6 = 18</td></tr>
<tr><td rowspan="4">D (2 out of 3)</td><td>Courses with K4 as the highest cognitive level</td><td></td><td></td><td></td><td>2</td><td></td><td></td><td rowspan="4">2 × 10 = 20</td></tr>
<tr><td>Courses with K5 as the highest cognitive level wherein one question each on K4 and K5 is compulsory.
(Note:K4 has two questions whereas, K5 has no choice.)</td><td></td><td></td><td></td><td>1</td><td>1</td><td></td></tr>
<tr><td rowspan="2">Courses with K6 as the highest cognitive level wherein one question each on K5 and K6 is compulsory.
(Note: Mid Sem: K4 has two questions whereas, K5 has no choice; End sem: K5 has two questions whereas, K6 has no choice)</td><td></td><td></td><td></td><td colspan="2">Mid Sem</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="2">End Sem</td></tr>
<tr><td colspan="6">Total</td><td>60</td></tr>
</table>

** K4 and K5 levels will be assessed in the Mid semester test whereas K5 and K6 levels will be assessed in the End semester test.*

Question Paper Blueprint for Mid and End Semester Tests *(For quantitative courses only)*

Duration: 2 Hours							**Maximum Marks: 60**
Section	**K level**						**Marks**
	K1	**K2**	**K3**	**K4**	**K5**	**K6**	
A *(no choice)*	5	4					9 × 1 = 9
B *(either… or type)*			2	1			3 × 5 = 15
C *(2 out of 3)*					1	1*	2 × 18 = 36
						Total	**60**

NOTE: *K4 and K5 will be assessed in the Mid semester test whereas K5 and K6 will be assessed in the End semester test.*
** K6 compulsory*

SEMESTER EXAMINATION
Question Paper Blueprint for Semester Examination

Duration: 3 Hours								**Maximum Marks: 100**
Section		**K level**						**Marks**
		K1	**K2**	**K3**	**K4**	**K5**	**K6**	
A *(no choice, two questions from each unit)*		10						10 × 1 = 10
B *(no choice, two questions from each unit)*			10					10 × 3 = 30
C *(either… or type, one question from each unit)*				5				5 × 6 = 30
D *(3 out of 5, one question from each unit)*	*Courses with K4 as the highest cognitive level*				3			3 × 10 = 30
	Courses with K5 as the highest cognitive level wherein two K4 questions and one K5 question are compulsory. (Note: Three questions on K4 and two questions on K5)				2	1		
	Courses with K6 as the highest cognitive level wherein one question each on K4, K5, and K6 is compulsory. (Note: Two questions each on K4 and K5 and one question on K6)				1	1	1	
							Total	**100**

Question Paper Blueprint for Semester Examination *(For quantitative courses only)*

Section	Marks	K level
A	10 × 1 = 10	K1
B	5 × 6 = 30 *(either…or)*	K2 *(Q. No. 11 & 12)* K3 *(Q. No. 13, 14 & 15)*
C	4 × 15 = 60 *(4 out of 5)*	K4 *(Q. No. 16 & 17)* K5 *(Q. No. 18 & 19)* K6 *(Q. No. 20 compulsory)*
Total Marks: 100		

Evaluation Pattern for Part IV One/Two Credit Courses

Title of the Course	CIA	Semester Examination	Total Marks
Internship	100		**100**
UG Skill Enhancement Course (Non Major Elective) Foundation Course **PG** Ability Enhancement Course	20 + 10 + 20 = 50	50 *(External member from the Department)*	**100**
Value Education	50	50 *(CoE)*	**100**

M.Sc. CHEMISTRY							
PROGRAMME PATTERN							
Course Details					**Scheme of Exams**		
Sem	**Course Code**	**Title of the Course**	**Hours**	**Credits**	**CIA**	**SE**	**Final**
1	23PCH1CC01	**Core Course - 1:** Organic Reaction Mechanism - 1	6	6	100	100	100
	23PCH1CC02	**Core Course - 2:** Structure and Bonding in Inorganic Compounds	6	6	100	100	100
	23PCH1CP01	**Core Practical - 1:** Organic Chemistry	6	4	100	100	100
	23PCH1ES01	**Elective - 1:** Nano Materials and Nano Technology	5	3	100	100	100
	23PCH1ES02	**Elective - 2:** Electrochemistry	5	3	100	100	100
	23PCH1AE01	**Ability Enhancement Course:** Analytical Techniques	2	1	100	-	100
		Total	**30**	**23**			
2	23PCH2CC03	**Core Course - 3:** Transition Elements, Covalent Bonding and Periodicity	4	4	100	100	100
	23PCH2CC04	**Core Course - 4:** Quantum Chemistry and Statistical Thermodynamics	5	5	100	100	100
	23PCH2CP02	**Core Practical - 2:** Inorganic Chemistry - 1	4	3	100	100	100
	23PCH2CP03	**Core Practical - 3:** Physical Chemistry - 1	4	3	100	100	100
	23PCH2SP01	**Self-paced Learning:** Selected Topics in Inorganic Chemistry and Physical Chemistry*	-	2	50	50	50
	23PCH2ES03A	**Elective - 3**: Addition, Elimination and Redox Reactions in Organic Chemistry	5	4	100	100	100
	23PCH2ES03B	**Elective - 3**: Stereochemistry					
	23PSS2SE01	**Skill Enhancement Course:** Soft Skills	4	3	100	-	100
	23PCH2EG01A	**Generic Elective - 1 (WS):** Chemistry for Physical Sciences - 1	4	3	100	100	100
	23PCH2EG01B	**Generic Elective - 1 (WS):** Chemistry for Physical Sciences - 2					
	-	Extra Credit Courses (MOOC/Certificate Courses) - 1	-	(3)			
		Total	**30**	**27(3)**			
3	23PCH3CC05	**Core Course - 5:** Organic Synthesis and Spectroscopy	6	6	100	100	100
	23PCH3CC06	**Core Course - 6:** Advanced Coordination Chemistry	5	5	100	100	100
	23PCH3CC07	**Core Course - 7:** Research Methodology	2	2	100	100	100
	23PCH3CP04	**Core Practical - 4:** Inorganic Chemistry - 2	5	4	100	100	100
	23PCH3CP05	**Core Practical - 5:** Physical Chemistry - 2	4	4	100	100	100
	23SPS3CC01	**Common Core:** Materials Science	4	4	100	100	100
	23PCH3EG02	**Generic Elective - 2 (BS):** Health Science	4	3	100	100	100
	-	Extra Credit Courses (MOOC/Certificate Courses) - 2	-	(3)			
		Total	**30**	**28(3)**			
4	23PCH4CC08	**Core Course - 8:** Advanced Organic Chemistry	5	5	100	100	100
	23PCH4CC09	**Core Course - 9:** Nuclear and Bioinorganic Chemistry	7	6	100	100	100
	23PCH4CC10	**Core Course - 10:** Chemical Kinetics, Group Theory and Applications of Quantum Chemistry	7	6	100	100	100
	23PCH4ES04A	**Elective - 4:** Bioorganic Chemistry	5	4	100	100	100
	23PCH4ES04B	**Elective - 4:** Drug Design and Synthesis					
	23PCH4PW01	Project Work and Viva Voce	6	5	100	100	100
	23PCH4CE01	Comprehensive Examination*	-	2	50	50	50
	-	Extra Credit Courses (MOOC/Certificate Courses) - 3	-	(3)			
		Total	**30**	**28(3)**			
2 - 4	23PCW4OR01	Outreach Programme (SHEPHERD)	**-**	4			
1 - 4		**Total (2 years)**	**120**	**110**			

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

Semester	Course code	Title of the Course	Hours/Week	Credits
1	23PCH1CC01	**Core Course -1:** Organic Reaction Mechanism-1	6	5

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

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

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

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

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

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

Aromatic nucleophilic substitution: Mechanisms - S_NAr, S_N1 and Benzyne mechanisms - Evidences - Reactivity, Effect of structure, leaving group and attacking nucleophile. Reactions: Oxygen and Sulphur-nucleophiles, Bucherer and Rosenmund reactions, von Richter, Sommelet- Hauser and Smiles rearrangements. S_N1, ion pair, S_N2 mechanisms and evidences. Aliphatic nucleophilic

substitutions at an allylic carbon, aliphatic trigonal carbon and vinyl carbon.S_N1, S_N2, S_Ni, and S_E1 mechanism and evidences, Swain- Scott, Grunwald-Winstein relationship - Ambident nucleophiles.

UNIT IV: Stereochemistry-I **(18 hours)**

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

UNIT V: Stereochemistry-II **(18 hours)**

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

Teaching Methodology	Chalk & Talk, PPT, videos and demonstration

Books for study

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

Books for Reference

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

Web Sources

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

2. https://www.organic-chemistry.org/

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

Relationship Matrix											
Semester	**Course code**	**Title of the Course**								**Hours**	**Credits**
1	23PCH1CC01	**Core Course -1:** Organic Reaction Mechanism-1								6	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**	**3**	**1**	**2**	**2**	**2**	**2.2**
CO2	**3**	**3**	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**3**	**2.4**
CO3	**2**	**2**	**3**	**3**	**2**	**2**	**3**	**2**	**2**	**2**	**2.3**
CO4	**3**	**2**	**2**	**3**	**2**	**2**	**1**	**3**	**2**	**2**	**2.2**
CO5	**3**	**1**	**2**	**3**	**2**	**1**	**2**	**2**	**3**	**3**	**2.2**
CO6	**3**	**1**	**2**	**3**	**2**	**1**	**2**	**2**	**3**	**3**	**2.2**
Mean overall Score											**2.26 (High)**

Semester	Course code	Title of the Course	Hours/Week	Credits
1	23PCH 1CC02	**Core Course -2:** Structure and Bonding in Inorganic Compounds	6	5

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

UNIT I: Structure of Main Group Compounds and Clusters (15 Hours)

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

UNIT II: Solid State Chemistry – I (15 Hours)

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

UNIT III: Solid State Chemistry – II (15 Hours)

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

UNIT IV: Techniques in Solid State Chemistry (15 Hours)

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

UNIT V: Band Theory and Defects in Solids **(15 Hours)**

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

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

Books for Study

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

Books for Reference

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

Website and e-learning source

1. https://ocw.mit.edu/courses/3-091-introduction-to-solid-state-chemistry- fall-2018/video_galleries/lecture-videos/

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

Relationship Matrix											
Semester	**Course code**	**Title of the Course**								**Hours**	**Credits**
1	**23PCH 1CC02**	**Core Course -2:** Structure and Bonding in Inorganic Compounds								**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**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**2.1**
CO2	**2**	**3**	**2**	**2**	**2**	**3**	**3**	**2**	**2**	**2**	**2.3**
CO3	**3**	**3**	**3**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**2.5**
CO4	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**3**	**2**	**2**	**2.2**
CO5	**2**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**2.7**
CO6	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**3**	**2**	**3**	**2.2**
Mean overall Score											**2.3 (High)**

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

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

UNIT I: Separation and Analysis

Two component mixtures.

UNIT II: Estimations

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

UNIT III: Two Stage Preparations

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

Book for study

1. Ganapragasm, N. S. & Ramamurthy, C. (2015). *Organic Chemistry Lab Manual* (2nd ed.). Vishwanathan S Printers and Publishers (P) Ltd..

2. Furniss, B. S., Hannaford, A. J., Smith, P. W. G. & Tatchell, A. R. (n.d). *Vogel's Textbook of Practical Organic Chemistry* (5th ed.). Pearson publication.

Books for Reference

1. Venkateswaran, V., Veeraswamy, R. & Kulandaivelu, A. R. (1997). *Basic principles of practical chemistry* (2nd ed.). Sultan Chand & Sons.

2. *Organic Chemistry Lab Manual for Micro Qualitative Analysis*, Department of Chemistry, St. Joseph's College, Tiruchirappalli–620 002. (Private circulation).

Website and E-learning Sources

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

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

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

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

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

UNIT I: Introduction to Nanochemistry (15 Hours)

Introduction of nanomaterials and nanotechnologies, Introduction-role of size, 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.

UNIT II: Synthesis Methodologies Of Nanomaterials (15 Hours)

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

UNIT III: Properties of Nanomaterials (15 Hours)

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

UNIT IV: Characterization Techniques 1 (15 Hours)

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

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

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

Advanced Applications of Nanomaterials

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

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

Books for Study

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

Books for Reference

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

Web Sources

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

Course Outcomes		
CO No.	**CO – Statements**	**Cognitive Levels (K - level)**
	On successful completion of this course, students will be able to	
CO1	describe and consolidate the various types of nanomaterials.	**K 1**
CO2	explain methods of fabricating nanostructures.	**K 2**
CO3	relate the unique properties of nanomaterials to reduce dimensionality of the material.	**K 3**
CO4	discuss the tools to characterize the nanoparticles.	**K4**
CO5	discuss the advanced applications of nanomaterials.	**K5**
CO6	synthesize and characterize the various nanomaterials.	**K6**

Semester	**Course Code**	**Title of the Course**					**Hours**	**Credits**		
1	**23PCH1ES01**	**Elective 1: NANO MATERIALS AND NANO TECHNOLOGY**					5	4		
Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	**2**	**3**	**2**	**3**	**2**	**2**	**3**	**2**	**2**	**2**	**2.3**
CO.2	**2**	**3**	**2**	**2**	**3**	**3**	**3**	**2**	**2**	**2**	**2.4**
CO3	**3**	**3**	**3**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**2.5**
CO4	**2**	**3**	**2**	**2**	**3**	**2**	**3**	**3**	**2**	**2**	**2.4**
CO5	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**3**	**2**	**3**	**2.7**
CO6	**2**	**2**	**2**	**3**	**3**	**2**	**3**	**2**	**2**	**2**	**2.3**
									Mean overall Score		**2.3 (High)**

Semester	Course Code	Title of the Course	Hours	Credits
1	23PCH1ES02	**ELECTIVE 2:** Electrochemistry	5	4

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

UNIT I: Ionics (15 Hours)

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

UNIT II: Electrode-electrolyte interface (15 Hours)

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

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

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

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

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

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

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

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

Books for Study

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

Books for Reference

1. Rajaram, J. & Kuriakose, J. C. (2011). Kinetics and mechanism of chemical transformations. Macmillan India Ltd.
2. Viswanathan, B., Sundaram, B., Venkataraman, R., Rengarajan, K. & Raghavan, P. S. (2007). Electrochemistry-principles and applications. S. Viswanathan Printers.
3. Crow, D. R. (2014). Principles and applications of electrochemistry. (4^{th}ed.).

Chapman & Hall.
4. Joseph Wang. (n.d). Analytical electrochemistry. (2nd ed.). Wiley.
5. Philip H. Rieger. (2010). Electrochemistry. (2nd ed.). Springer.
6. Kapoor, K. L. (2001). A Text book of Physical Chemistry. Vol.3, Macmillan.

Web Sources

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

Course Outcomes		
CO No.	**CO - Statements**	**Cognitive Levels (K - level)**
	On successful completion of this course, students will be able to	
CO1	identify the behaviour of electrolytes in solution and the structures of electrical double layers	**K 1**
CO2	predict the kinetics of electrode reactions	**K 2**
CO3	apply the different concepts of electrolytes and electrode – electrolyte interface	**K 3**
CO4	explain the theories of electrolytes, electrical double layer and electrodics	**K4**
CO5	evaluate and interpret the outcomes of Debye Huckel theory and electrode kinetics	**K5**
CO6	design and improve information regarding electroytes, electrode kinetics and devise new storage devices	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**				**Hours**		**Credits**	
1	**23PCH1ES02**			**DSE–2: Electrochemistry**				**5**		**4**	
Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	3	2	3	2	2	3	2	2	2	2.3
CO2	2	3	2	2	3	3	3	2	2	2	2.4
CO3	3	3	3	2	2	3	2	3	2	2	2.5
CO4	2	3	2	2	3	2	3	3	2	2	2.4
CO5	3	3	3	2	2	3	3	3	2	3	2.7
CO6	2	2	2	3	3	2	3	2	2	2	2.3
										Mean overall Score	**2.3(High)**

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

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

Unit – I Spectrophotometric methods (6 Hours)

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

Unit – II Thermal methods (6 Hours)

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

Unit – III Chromatography (6 Hours)

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

Unit – IV Spectroscopy (6 Hours)

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

Unit – V Spectroscopy Demonstration (6 Hours)

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

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

Book for study

1. Jeffery, G. H., Bassett, J., Mendham, J. & Denney, R. C. (1989). V*ogel's textbook of quantitative chemical analysis* (5th ed.). Longman Scientific & Technical.
2. Pavia, D. L., Lampman, G. M., Kriz, G. S. & Vyvyan, J. R. (2015). *Introduction to spectroscopy,* (5th ed.). Cengage Learning.
3. Gopalan, R., Subramanian, P. S. & Rengarajan, K. (2005). *Elements of analytical chemistry* (3rd ed.). Sultan Chand & Sons.

Books for Reference

1. Skoog, D. A., West, D. M., Holler, F. J. & Crouch, S. R.(2014) *Fundamental of analytical chemistry* (9th ed.). Brooks/Cole Cengage Learning.
2. Silverstein, R. M. & Bassler, G. C. (1993). *Spectrometric identification of organic compounds* (4th ed.). John-Wiley & Sons.
3. Kemp, W. (1987). *Organic spectroscopy*, (3rd ed.). ELBS.

Website and E-learning Sources

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

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

Relationship Matrix											
Semester	**Course code**	**Title of the Course**					**Hours**				**Credits**
1	23PCH 1AE01	**Ability Enhancement Course:** Analytical Techniques					**2**				**1**
Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of Cos**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	**2**	**2**	**3**	**3**	**2**	**2**	**3**	**2**	**2**	**2**	**2.3**
CO2	**3**	**2**	**2**	**3**	**2**	**2**	**1**	**3**	**2**	**2**	**2.2**
CO3	**3**	**1**	**2**	**3**	**2**	**1**	**2**	**2**	**3**	**3**	**2.2**
Mean overall Score											**2.3 (High)**

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

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

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

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

UNIT II: Covalent Bonding (12 Hours)

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

UNIT III: Acids and Bases (12 Hours)

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

UNIT IV: Transition Elements (12 Hours)

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

UNIT V: Inner Transition Elements (12 Hours)

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

Teaching Methodology	Chalk and Talk, PPT, Videos

Books for Study

1. Huheey, J. E., Keiter, E. A. & Keiter, R. L., (2008). *Inorganic Chemistry Principles of Structure and Reactivity*, (4th Ed.). Pearson Education.
   Unit I *Chapter 17 & 18*
   Unit III *Chapter 9 & 10*
   Unit II *Chapter 5*
   Unit IV and V *Chapter 14*
2. Lee, J. D., (1998). *Concise Inorganic Chemistry*, (5th Ed.). ELBS.
   Unit I *Chapter 18*
   Unit II *Chapter 29 and 30*

Books for Reference

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

Websites and eLearning Source

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

Course Outcomes		
CO No.	**CO-Statements** 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 transition elements	**K1**
CO2	understand the structures of selected complexes	**K2**
CO3	summarize the concepts of acids and bases	**K3**
CO4	discuss the chemistry of halogens and noble gases	**K4**
CO5	apply the VSEPR theory to predict the structures	**K5**
CO6	evaluate the properties of solvents and their applications	**K6**

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

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

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

UNIT I: Classical Mechanics (15 Hours)

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

UNIT II: Mathematics for Quantum Chemistry (15 Hours)

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

UNIT III: Basic Quantum Chemistry (15 Hours)

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

UNIT IV: Fundamentals of Statistical Thermodynamics (15 Hours)

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

UNIT V: Applications of Statistical Thermodynamics (15 Hours)

Nuclear spin statistics - nuclear spin entropy- quantum statistics - Maxwell Boltzmann statistics - Bose -

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

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

Books for Study

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

Books for Reference

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

Website and eLearning Source

1. Bing Videos

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

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

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

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

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

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

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

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

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

Systematic semimicro analysis of any five inorganic mixtures.

UNIT IV: Introduction to Colorimetric Analysis (12 Hours)

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

UNIT V: Experimental Colorimetric Determinations (12 Hours)

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

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

Books for Study

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

Books for Reference

1. Svehla, G., (1996). *Vogel's Qualtitative Inorganic Analysis*, (7th Ed.). Longmann, London.

2. Metz, C., & Castellion, M. E. (1980). *Chemistry: Inorganic Qualitative Analysis in the Laboratory*, Academic Press.
3. Skoog, D. A., West, D. M., Holler, F. J. & Crouch, S. R. (2014). *Fundamentals of Analytical Chemistry*, (9th Ed.). Brooks/Cole Cengage Learning.

Websites and eLearning Sources

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Books for Study

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

Websites and eLearning Source

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

Freundlich's adsorption isotherm

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

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

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

Course Objectives
To make the students analyze the types of errors in analyses
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 appraise the principles of polymerization kinetics and determination of its molecular weight
To summarize the concepts of NQR and Radiation chemistry

UNIT I: Error Analysis

Error Analysis - Significant figures - rounding off the values - accuracy and precision- errors - classification of errors - constant errors and proportional errors - determinate errors (systematic errors) and indeterminate errors (random and accidental) - minimization of errors: calibration of apparatus, analysis of standard samples, running a blank determination, and independent analysis.

Average, range, median, average deviation, relative average deviation and standard deviation, variance, coefficient of variation - the normal error curve - testing of significance: *F*-test, *t*- test and *Q*-test - confidence limit - method of least squares.

UNIT II: Structure and Properties

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

UNIT III: Surface Chemistry

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

UNIT IV: Polymer Chemistry

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

UNIT V: NQR spectroscopy and Radiation Chemistry

Nuclear Quadrupole Spectroscopy-Theory and principle -Instrumentation-Applications related to location of point group, chemical bonding, hydriogen bonding and phase transistion.

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

Teaching Methodology	PPT and Videos

Books for Study

1. Skoog, D. A., West, D. M., Holler, F. J. & Crouch, S. R. (2014). *Fundamentals of Analytical Chemistry*, (9th Ed.). Brooks/Cole Cengage Learning, Belmont, CA 94002-3098, USA.
   Unit I: Part I
2. Bruice P.Y. (2012). *Organic Chemistry*, (4th Ed.). Pearson Education, New Delhi.
   Unit II: Chapter 1
3. Atkin's P, Paula, D.J., Keller, J. (2018). *Physical Chemistry*, International Publication, Oxford University Press
   Unit III: Chapter 17 E, 19A-C
   Unit IV: Chapter 17
4. Drago, R. S. (1965). *Physical Methods in Inorganic Chemistry* (1st Ed.). Affiliated East-West Press Private Limited, New Delhi.
   Unit V:

Book for References

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Nitrenes: Generation - rearrangements to electron deficient nitrogen.

Free radicals: Sources of radicals - addition reactions of radicals with substituted alkenes -cyclization -

addition to C=N bonds - Tandem radical cyclizations and alkylations - fragmentation and rearrangements - intramolecular functionalization by radical reactions.

Teaching Methodology	Chalk and Talk, PPT, Videos

Books for Study

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

Books for Reference

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

Websites and eLearning Source

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

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

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

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

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

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

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

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

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

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

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

UNIT IV Stereoselectivity **(15 Hours)**

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

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

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

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

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

Teaching Methodology	Chalk and Talk, PPT, Videos

Books for Study

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

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

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

Books for Reference

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

Websites and eLearning Source

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

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

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

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

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

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

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

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

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

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

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

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

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

Unit IV: Numerical Ability (12 Hours)

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

Unit V: Test of Reasoning (12 Hours)

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

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

Book for study

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

Books for References

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

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

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

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PCH2EG01A	**Generic Elective - 1 (WS):** Chemistry for Physical Sciences - 1	4	3

Course Objectives
To know the prelims of synthesis
To compare different spectrophotometric methods
To apply thermal methods to characterize minerals and polymers.
To differentiate the principles and instrumentation of chromatography.
To utilise chromatography for the separation of the chemical species
To apply sonochemistry for the synthesis of chemical species in eco-friendly manner

UNIT I: Synthesis and characterization **(12 Hours)**

Mole calculation-solvent selection -reaction condition optimisation- calculation of yield and atom economy- catalyst- purification methods-checking purity with TLC -distillation-fractional distillation - crystallisation - determination of melting /boiling point.

UNIT II: Chromatography **(12 Hours)**

Principles of chromatography - retardation factor - plate theory - column efficiency - Classification of chromatographic techniques - Principle, instrumentation and applications of Column Chromatography, Thin-layer chromatography (TLC), Gas chromatography (GC) and high-performance liquid chromatography (HPLC).

UNIT III: Thermal methods **(12 Hours)**

General Characteristics of thermo-analytical methods - Thermogravimetric analysis - Principle, instrumentation and applications - Factors affecting thermogram - Differential Thermal Analysis- DTA instrumentation and applications - Differential scanning calorimetry - Principle, instrumentation and applications.

UNIT IV: Spectrophotometric methods **(12 Hours)**

Spectral analysis- -instrumentation and applications of spectrophotometry – FTIR and UV - Visible spectroscopy -fundamental laws - deviations from Beer-Lambert's law- Luminescence- types-Jablonski diagram, quantum yield, spectrofluorimetry and sensing applications.

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UNIT V: Sonochemistry **(12 Hours)**

Principles of green chemistry - Ultrasound- Acoustic cavitation - homogeneous liquid-phase reactions-cavitation near a surface-heterogeneous powder-liquid reactions.

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

Books for Study

1. Furniss, B.S., Hanoford, A.J., Smith, W.G., & Tatchell, A.R. *Vogel's Textbook of Practical Organic Chemistry,* (5th Ed.). Pearson Education Ltd.
   Unit I: *Chapter 2*
2. Skoog, D. A., West, D. M., Holler, F. J. & Crouch, S. R. (2014) *Fundamentals of Analytical Chemistry*, (9th Ed.). Brooks/Cole Cengage Learning, Belmont, CA 94002-3098, USA.
   Unit I: *Chapter 6*
3. Jeffery, G.H., Bassett., J.,Mendham, J., & Denney, R. C. (1989). *Vogel's Textbook of Quantitative Chemical Analysis*, (5th Ed). Longman Scientific & Technical, Essex, England

Unit IV: *Chapters 17, 18, 20 and 21*
Unit III: *Chapters 11*
Unit II: *Chapters 8 and 9*

4. Lakowicz, J. R. (2010). *Principles of fluorescence spectroscopy*. Springer Publications,
Unit IV: *Chapter 1*
5. Pollet, G.B., Ashokkumar, M. (2019). *Introduction to Ultrasound and Sonochemistry and Sonoelectrochemistry*, Springer.
Unit V: *Chapter 1*

Books for Reference

1. Mason, T.J. & Lorimer, J.P. (1990). *Sonochemistry: Theory, Application and Uses of Ultrasound in Chemistry*. Elis Horwood Ltd., John Wiley.
2. Srivasta, A.K., & Jain, P.C. (2012). *Instrumental Approach to Chemical Analysis*. S. Chand.
3. Gopalan, R. (2017). *Elements of Analytical Chemistry*, Sultan Chand and Sons.

Website and eLearning Source

1. https://www.youtube.com/watch?v=W38aZ6XWJps
2. https://www.youtube.com/watch?v=gaBXQW9rCDA
3. https://www.youtube.com/watch?v=OFh_Id8Ja4Y

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K- Level)**
CO1	Know the prelims of synthesis	**K1**
CO2	compare different spectrophotometric methods	**K2**
CO3	apply thermal methods to characterize minerals and polymers.	**K3**
CO4	differentiate the principles and instrumentation of chromatography.	**K4**
CO5	Utilise chromatography for the separation of the chemical species	**K5**
CO6	Apply sonochemistry for the synthesis of chemical species in eco-friendly manner	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**					**Hours**		**Credits**
2	**23PCH2EG01A**			**Generic Elective - 1 (WS):** Chemistry for Physicist					**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	1	2	3	2	2	2	**2.0**
CO2	1	2	3	3	2	2	3	1	2	3	**2.2**
CO3	2	3	2	2	1	3	2	2	2	2	**2.1**
CO4	2	3	2	3	2	2	3	2	2	2	**2.3**
CO5	2	3	2	2	3	2	2	3	3	2	**2.4**
CO6	2	3	2	3	2	3	3	2	3	2	**2.5**
										Mean Overall Score	**2.25 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PCH2EG01B	**Generic Elective - 1 (WS):** Chemistry for Physical Sciences - 2	4	3

Course Objectives
To describe manufacturing processes of cement and glass
To understand the importance of plastic and fibres
To explain the composition and applications of fertilizers
To illustrate the preparation and uses of cosmetics
To identify the uses of cosmetics
To classify the dyes, pigments and paints

UNIT I: Cement and Glass **(12 Hours)**

Cement - Composition, different methods of manufacturing and uses - Portland cement - Composition, different methods of manufacturing (Wet and Dry process), uses - Setting of cement, Glass- - Composition, Types, different methods of manufacturing - Melting, Blowing, Pressing, Annealing and finishing- chemical and physical properties of glass.

UNIT II: Pigments, Dyes and Paints **(12 Hours)**

Pigments - Classification, Manufacture and uses; Dyes - Classification, preparation, dyeing processes; Paints - Composition, Types, Manufacture and testing of Paints.

UNIT III: Fibers, Plastics and Rubber **(12 Hours)**

Fibres - definition-difference between Natural and synthetic fibres-properties of synthetic fibres - Artificial silk, rayon, nylon and Terylene Plastics - composition, Classification, manufacture, properties and uses recycling of plastics Rubber: types of rubber-synthetic rubber- natural rubber - Vulcanizations of Rubber- properties and uses of rubber.

UNIT IV: Fertilizers and Fuels **(12 hours)**

Fertilizers - Types of Fertilizers: Organic and Inorganic fertilizers, Preparation and uses, Fuels - Energy resources - Industrial gases, Water gas, Producer gas, Oil gas, natural gas, coal gas, Gobar gas, Indane gas, Petroleum products and coal products.

UNIT V: Cosmetics **(12 hours)**

Shampoo - composition and its preparation, lipstick - preparation, Face cream and face powder - composition and their preparation. Hair dyes - chemical and herbal dyes. Perfumes and Deodorants.

Teaching Methodology	Chalk and Talk, PPT, Videos

Books for Study

1. Charkarabarthy, B.N. (2002). *Industrial Chemistry*, (1st Ed.). Oxford and IBH Publishing. Co. New Delhi,
   Unit I -III: *Chapter:2,3,4,5,& 6*
2. Sharma, B.K. (2011). *Industrial Chemistry*, (1st Ed.). Goel Publishing House, New Delhi,.
   Unit IV -IV *Chapter:2,3,4,5 & 6*

Books for Reference

1. Othmer, K. (1999). *Encyclopedia of Chemical Technology*, John Wiley and Sons, USA.

Websites and eLearning Sources

1. https://www.slideshare.net/prashantlpingale/introduction-to-cosmetics-138603089

2. https://coatings.specialchem.com/selection-guide/pigments#:~:text=Pigments%20are%20finely%20ground%20natural,Organic%20pigments

Cosmetics

Cosmetics and Additives

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K- Level)**
CO1	describe manufacturing processes of cement and glass	**K1**
CO2	understand the importance of plastic and fibres	**K2**
CO3	explain the composition and applications of fertilizers	**K3**
CO4	illustrate the preparation and uses of cosmetics	**K4**
CO5	Identify the uses of cosmetics	**K5**
CO6	classify the dyes, pigments and paints	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**					**Hours**		**Credits**
2	**23PCH2EG01B**			**Generic Elective - 1 (WS):** Chemistry for Physical Sciences - 2					**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	1	2	3	2	2	2	**2.0**
CO2	1	2	3	3	2	2	3	1	2	3	**2.2**
CO3	2	3	2	2	1	3	2	2	2	2	**2.1**
CO4	2	3	2	3	2	2	3	2	2	2	**2.3**
CO5	2	3	2	2	3	2	2	3	3	2	**2.4**
CO6	1	2	3	3	2	2	3	1	2	3	**2.2**
										Mean Overall Score	**2.25 (High)**