Holy Cross College (Autonomous), Nagercoil
Kanyakumari District, Tamil Nadu.
Accredited with A^{++} by NAAC - V cycle – CGPA 3.53

Affiliated to

Manonmaniam Sundaranar University, Tirunelveli

DEPARTMENT OF CHEMISTRY

TEACHING PLAN (PG)
ODD SEMESTER
2025-2026

DEPARTMENT OF CHEMISTRY

Vision

Impart quality education, scientific skills, academic excellence, research attitude and skills to face global challenges.

Mission

1. To develop intellectual and professional skills of the students
2. To provide a firm foundation in chemical concepts, laws and theories
3. To sharpen the scientific knowledge
4. To enhance critical thinking, problem solving ability, scientific temper and innovation
5. To apply chemistry in medicine, biology, industry and environment

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEOs	Upon completion of M. Sc. Chemistry Programme, the graduates will be able to:	Mapping with Mission
PEO1	apply scientific and computational technology to solve social and ecological issues and pursue research.	M1, M2
PEO2	continue to learn and advance their career in industry both in private and public sectors.	M4 & M5
PEO3	develop leadership, teamwork, and professional abilities to become a more cultured and civilized person and to tackle the challenges in serving the country.	M2, M5 & M6

PROGRAMME OUTCOMES (POs)

POs	Upon completion of M.Sc. Chemistry Programme, the graduates will be able to:	Mapping with PEOs
PO1	apply their knowledge, analyze complex problems, think independently, formulate and perform quality research.	PEO1 & PEO2
PO2	carry out internship programmes and research projects to develop scientific and innovative ideas through effective communication.	PEO1, PEO2 & PEO3
PO3	develop a multidisciplinary perspective and contribute to the knowledge capital of the globe.	PEO2
PO4	develop innovative initiatives to sustain eco-friendly environment	PEO1, PEO2
PO5	through active career, team work and using managerial skills guide people to the right destination in a smooth and efficient way.	PEO2
PO6	employ appropriate analysis tools and ICT in a range of learning scenarios, demonstrating the capacity to find, assess, and apply relevant information sources.	PEO1, PEO2 & PEO3
PO7	learn independently for lifelong executing professional, social and ethical responsibilities leading to sustainable development.	PEO3

Programme Specific Outcomes (PSOs)

PSO	Upon completion of M.Sc Chemistry programme, the graduates will be able to:	Mapping with POs
PSO-1	impart in-depth knowledge about various aspects of chemistry within an environment committed to excellence	PO1
PSO-2	develop critical thinking, technical skills and innovative ideas in analysing and solving problems in the field of chemistry	PO2, PO3
PSO-3	explore and expedite the recent avenues in chemistry research across the globe with professional competency	PO4
PSO-4	inculcate positive approach towards environment and ecology from the chemistry perspective	PO4, PO7
PSO-5	promote entrepreneurial skills and become self-reliant	PO5, PO6

Department : **Chemistry**
Class : **I M. Sc Chemistry**
Title of the Course : **Core Course I: Organic Reaction Mechanism – I**
Semester : **I**
Course Code : **CP231CC1**

Course Code	L	T	P	Credits	Inst. Hours	Total Hours	Marks		
							CIA	External	Total
CP231CC1	**7**	**-**	**-**	**5**	**7**	**105**	**25**	**75**	**100**

Objectives

1. To understand the mechanism of various organic reactions.
2. To correlate and appreciate the differences involved in the various types of organic reaction mechanisms.
3. To design feasible synthetic routes for the preparation of organic compounds.

Course Outcomes

On the successful completion of the course, student will be able to:		
1.	remember & understand the basic concepts of reaction mechanisms, stereochemistry and conformation in organic compounds	**K1 & K2**
2.	apply the reaction mechanism, stereochemistry and conformation for the synthesis of organic compounds	**K3**
3.	analyze the types of reaction mechanisms involved in synthetic organic transformation.	**K4**
4.	evaluate the suitable reaction mechanisms for the synthesis of organic compounds	**K5**
5.	design and synthesize new organic compounds by correlating the stereochemistry of organic compounds.	**K6**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create

Teaching plan

Total Contact hours: 105 (Including lectures, assignments and tests)

Unit	Module	Topic	Teaching Hours	Assessment Hours	Cognitive level	Pedagogy	Student Centric Method	E-Resources	Assessment/ Evaluation
I	**Methods of Determination of Reaction Mechanism**								
	1	Reaction intermediates, The transition state, Reaction coordinate diagrams, Thermodynamic and kinetic requirements of reactions:	4	1	K2(U)	Lecture with visualization	Brainstorming	Slide share	Oral test CIA I
	2	Hammond postulate. Methods of determining mechanism: non-kinetic methods - product analysis, determination of intermediates-isolation, detection, and trapping	4		K3(Ap)	Conceptual demonstration	Think-pair-share	PPT	Short test CIA I
	3	Cross-over experiments, isotopic labelling, isotope effects and stereo chemical evidences.	3		K4(An)	Collaborative approach	Group discussion	You tube videos	Slip test and MCQ CIA I

	4	Kinetic methods - relation of rate and mechanism. Effect of structure on reactivity: Hammett and Taft equations.	3	1	K3(Ap)	Lecture with demonstration	Concept mapping	Slide share	Assignment CIA I
	5	Linear free energy relationship, partial rate factor, substituent and reaction constants.	4	1	K5(E)	Socratic Questioning	Inquiry-Based Learning	Notes	Problem solving CIA I
II	**Aromatic and Aliphatic Electrophilic Substitution**								
	1	Aromaticity: Aromaticity in benzenoid, non-benzenoid, heterocyclic compounds and annulenes.	4	1	K2(U)	Active learning, Conceptual Demonstration	Think-pair-share	Video Lectures	Workout examples CIA II
	2	Aromatic electrophilic substitution: Orientation and reactivity of di- and polysubstituted phenol, nitrobenzene and halobenzene.	3	1	K3(Ap)	Simulation-Based Learning,	Jigsaw activity	Simulations	Class test CIA II
	3	Reactions involving nitrogen electrophiles: nitration, nitrosation and diazonium	4		K3(Ap)	Conceptual Demonstration	Inquiry-Based Learning	Interactive practice via	Work out Illustrations CIA II

		coupling; Sulphur electrophiles: sulphonation				, Group discussion		Pearson resources	
	4	Halogen electrophiles: chlorination and bromination; Carbon electrophiles: Friedel-Crafts alkylation, acylation and arylation reactions	4	1	K4(An)	Flipped Classroom	Problem-Solving	Interactive PPT	Short test and quiz CIA II
	5	Aliphatic electrophilic substitution Mechanisms: SE2 and SEi, SE1- Mechanism and evidences.	3		K2(U)	Lecture with visualization	Case-based analysis	Slide share	Oral test CIA II
III	**Aromatic and Aliphatic Nucleophilic Substitution**								
	1	Aromatic nucleophilic substitution: Mechanisms - SNAr, SN1 and Benzyne mechanisms - Evidences - Reactivity, Effect of structure, leaving group and attacking nucleophile.	4	1	K2(U)	Concept-based discussion	Collaborative Learning, Think–pair–share	NPTEL Lectures	Concept explanations CIA II
	2	Reactions: Oxygen and Sulphur-nucleophiles, Bucherer and Rosenmund reactions, von Richter,	4		K3(Ap)	Socratic Questioning	Concept mapping	Slide share	Slip test CIA II

		Sommelet- Hauser and Smiles rearrangements.							
	3	SN1, ion pair, SN2 mechanisms and evidences. Aliphatic nucleophilic substitutions at an allylic carbon, aliphatic trigonal carbon and vinyl carbon.	4	1	K3(Ap)	Visual Lecture with mechanisms	Collaborative Learning	Video lectures	Class test CIA II
	4	SN1, SN2, SNi, and SE1 mechanism and evidences	3	1	K4(An)	Concept-based discussion	Group discussion	Slide share	Slip test and quiz CIA II
	5	Swain- Scott, Grunwald-Winstein relationship - Ambident nucleophiles	3		K3(Ap)	Constructivist Learning	Problem-Based Learning	PPT	Quiz CIA II
IV	**Stereochemistry-I**								
	1	Introduction to molecular symmetry and chirality – axis, plane, center, alternating axis of symmetry. Optical isomerism due to asymmetric and dissymmetric molecules	3	1	K2(U)	Socratic Questioning	Inquiry-Based Learning	Slide Share	Concept explanations and short summary CIA I

		with C, N, S based chiral centers							
	2	Optical purity, prochirality, enantiotopic and diastereotopic atoms, groups, faces, axial and planar chirality, chirality due to helical shape, methods of determining theconfiguration.	3		K3(Ap)	Conceptual Demonstration	Peer learning	PPT	Oral presentation CIA I
	3	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.	4	1	K3(Ap)	Simulation-Based Learning	Think-Pair-Share	Simulations	Short test CIA I
	4	Configurations of allenes, spiranes, biphenyls, cyclooctene, helicene, binaphthyls, ansa and cyclophanic compounds, exo-cyclic alkylidene-cycloalkanes. Topicity and	4	1	K4(An)	Flipped Classroom	Concept mapping	Video lectures	Class test CIA I

		prostereoisomerism, chiral shift reagents and chiral solvating reagents							
	5	Criteria for optical purity: Resolution of racemic modifications, asymmetric transformations, asymmetric synthesis, destruction. Stereoselective and stereospecific synthesis.	4		K4(An)	Concept-based discussion	Jigsaw Method	Interactive PPT	Quiz CIA I
V	**Stereochemistry-II**								
	1	Conformation and reactivity of acyclic systems, intramolecular rearrangements, neighbouring group participation, chemical consequence of conformational equilibrium - Curtin-Hammett Principle	4	1	K3(Ap)	Socratic Questioning	Collaborative Learning	Video lectures	slip test CIA I
	2	Stability of five and six-membered rings: mono-, di- and polysubstituted cyclohexanes, conformation and reactivity in cyclohexane systems.	3		K5(E)	Peer teaching	Brain storming, Group discussion	PPT	Short test CIA I

	3	Fused and bridged rings: bicyclic, poly cyclic systems, decalins and Brett's rule	3	1	K3(Ap)	Lecture with visualization	Inquiry-Based Learning	3D simulations	Class test
	4	Optical rotation and optical rotatory dispersion conformational asymmetry, ORD curves, octant rule	4		K4(An)	Blended learning	Concept Mapping	Video Lectures	MCQ CIA I
	5	Configuration and conformation, Cotton effect, axial haloketone rule and determination of configuration.	4	1	K3(Ap)	Conceptual Demonstration	Think-Pair-Share	YouTube videos	Slip test CIA I

Course Focusing on Employability/ Entrepreneurship/ Skill Development: Employability and Skill Development

Activities (Em/SD): Stereospecific and stereoselective synthesis

Demonstration of symmetry elements

Assignment:

Effect of structure, leaving group and attacking nucleophile, Assign R & S configuration of organic compounds- Reflective writing

Seminar Topic

Unit I

Determination of intermediates

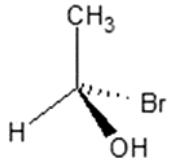
Unit II

Reactions involving nitrogen electrophiles

Sample questions

PART A

1. Arrange the following carbocations in the order of increasing stability:
   (a) Benzyl > 3° > 2° > 1° (b) Benzyl > 1° > 2° > 3° (c) 3° > 2° > 1° > Benzyl (d) 1° > 2° > 3° > Benzyl
   (K2, CO1, U)
2. **(True/False):** Benzyl radical is more stable than allyl radical.
   (K1, CO1, R)
3. In SN1 reaction, the first step involves the formation of:
   (a) free radical (b) carbanion (c) carbocation (d) final product
   (K1, CO2, R)
4. Which of the following acts as a catalyst in the nitration of benzene?
   (a) Conc. H_2SO_4 (b) Dil. HCl (c) Conc. HNO_3 (d) HNO_2
   (K1, CO2, R)
5. Assign the (R, S) nomenclature of the following compound:



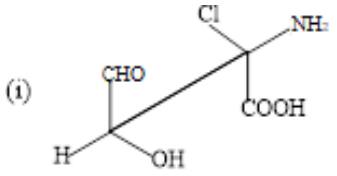
   (K3, CO3, Ap)

6. Predict the most stable conformation of cyclohexane:
   (a) Chair (b) Boat (c) Half-chair (d) Twist-boat
   (K2, CO2, U)

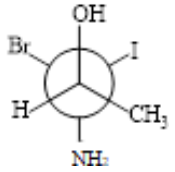
PART B

1. Interpret **any two applications** of the **Hammett equation**.
   (K3, CO4, Ap)
2. Explain the **Hammett and Taft equations**.
   (K2, CO4, U)
3. Demonstrate **aromatic nucleophilic substitution** in **aryl halides**.
   (K3, CO2, Ap)
4. Convert the following **Sawhorse and Newman projections** into equivalent **Fischer projections**: **(K3, CO3, Ap)**

(i)



(ii)



5. Evaluate the effect of conformation on the reactivity of S_N1 and S_N2 reactions of cyclic systems. **(K5, CO5, E)**
6. Validate the effect of conformation on the reactivity of base catalysed dehydrobromination of 1-bromo-1,2-diphenyl propane. **(K5, CO5, E)**

Part: C

1. Sketch and explain the energy profile diagrams of simple organic reactions. **(K3, CO4, Ap)**
2. Interpret the generation and stability of benzynes and carbocations. **(K4, CO4, An)**
3. Explain Sommelet- Hauser and Smiles rearrangements. **(K2, CO2, U)**
4. Illustrate aliphatic nucleophilic substitutions in an allylic carbon. **(K3, CO3, Ap)**
5. Illustrate the mechanism of SN^{Ar} substitution with an example. **(K3, CO3, Ap)**

6. Elucidate planar chirality and helicity with suitable examples. **(K4, CO4, An)**

7. Illustrate Cram's rule with examples**. (K3, CO3, Ap)**

8. Verify Curtin-Hammet principle with an example. **(K4, CO4, E)**

Course Instructor: Dr. M. Antilin Princela

Head of the Department: Dr. R. Gladis Latha

Department : **Chemistry**
Class : **I M. Sc Chemistry**
Title of the Course : **Core Course II: Structure and Bonding in Inorganic compounds**
Semester : **I**
Course Code : **CP231CC2**

Course Code	L	T	P	Credits	Inst. Hours	Total Hours	Marks		
							CIA	External	Total
CP231CC2	7	-	-	5	7	105	25	75	100

Objectives

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

Course Outcomes

On the successful completion of the course, student will be able to:		
1.	recall & understand the structure and bonding in inorganic compounds	**K1 & K2**
2.	apply the concepts of chemical bonding to predict the structure of inorganic compounds	**K3**
3.	analyze the types of bonding, crystal defects and interpret the crystal lattices using diffraction techniques.	**K4**
4.	evaluate bond energy, lattice energy, properties of inorganic compounds	**K5**
5.	create new crystal structures by adopting various crystal growth methods	**K6**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create

Teaching plan

Total Contact hours: 105 (Including lectures, assignments and tests)

Unit	Module	Topic	Teaching Hours	Assessment Hours	Cognitive level	Pedagogy	Student Centric Method	E-Resources	Assessment/ Evaluation
I		**Structure of main group compounds and clusters**							
	1.	VB theory – Effect of lone pair and electronegativity of atoms (Bent's rule) on the geometry of the molecules	3	1	K3(Ap)	Lecturing	Think-pair-share	Interactive PPT	Concept explanations, short summary CIA II
	2.	Applications of Paulings rule of electrovalence	2		K3(Ap)	Concept Mapping	Collaborative Group Activities	LibreTexts Chemistry, NCERT/UGC ePathshala modules	Short summary CIA II

	3.	Structure of silicates - isomorphous replacements in silicates – ortho, meta and pyro silicates – one dimensional, two dimensional and three-dimensional silicates.	4		K4(An)	Lecture with Visual Aids	Hands-on Clay Model Activity	pHET Interactive Simulations	Simple definitions, MCQ CIA II
	4.	Structure of silicones Structural and bonding features of B-N, S-N and P-N compounds	3	1	K4(An)	Lecture with Molecular Diagrams	Case-Based Learning	MolView	Diagram-Based Questions CIA II
	6.	Poly acids – types, examples and structures	2		K2(U)	Lecture with Slides	Group Chart Creation	MolView	Simple definitions, short essay CIA II
	7.	Borane cluster: Structural features of closo, nido, arachano and klado; carboranes, hetero and metalloboranes	2	1	K4(An)	Lecture with PPT	Think-Pair-Share	Video	Evaluation through short test CIA II

	8.	Wade's rule to predict the structure	2		K3(Ap)	Lecture with Worked Examples	Group Puzzle Challenge	ChemLibreTexts	Evaluation through quiz CIA II
II		**Solid state chemistry – I**							
	1.	Ionic crystals: Packing of ions in simple, hexagonal and cubic close packing	3	1	K2(U)	Lecture using animation and videos	Model making	LibreTexts Chemistry Chemguide	MCQ CIA I
	2.	Voids in crystal lattice, Radius ratio	2		K3(Ap)	Lecture with models	Hands-on model activity: Students build voids using balls.	PhET Simulations – Solids	Quiz CIA I
	3.	Crystal systems and Bravis lattices	3	1	K2(U)	Lecture using PPT	Think-Pair-Share	Videos	Short test CIA I

	4.	Symmetry operations in crystals	2		K3(Ap)	Visual demonstrations using 3D models	Group-based crystal symmetry identification	Videos	MCQ CIA I
	5.	Glide planes and screw axis; point group and space group	3	1	K2(U)	Concept Mapping	Group activity	YouTube: Glide Planes & Screw Axis animation	One-minute paper summarizing glide vs screw CIA I
	6.	Solid state energetics: Lattice energy – Born-Lande equation - Kapustinski equation, Madelung constant.	5		K5(E)	Inquiry-based Teaching	Solving examples	Videos	Problem-solving questions CIA I
III	**Solid state chemistry – II**								
	1.	Structural features of the crystal systems: Rock salt, zinc blende & wurtzite.	4	1	K2(U)	Visual Lecture with 3D Models	Think-pair-share	VESTA	Short summary CIA II

	2.	Fluorite and anti-fluorite, rutile and anatase	4	1	K2(U)	Visual Lecture with 3D Models	Group Discussion	3D Animation (YouTube)	Short essays CIA II
	3.	Cadmium iodide and nickel arsenide.	3		K2(U)	Visual Lecture with 3D Models	Model making	VESTA	Evaluation through short test CIA II
	4.	Spinels -normal and inverse types and perovskite structures	3	1	K4(An)	Visual Lecture with 3D Models	Model making	3D Animation (YouTube)	MCQ, simple definitions CIA II
	5.	Crystal Growth methods: From melt and solution (hydrothermal, sol-gel methods) – principles and examples.	4		K4(An)	Visual Lecture with 3D Models	Group Discussion	3D Animation (YouTube)	Short essays CIA II
IV		**Techniques in solid state chemistry**							

	1.	X-ray diffraction technique: Bragg's law, Powder diffraction method – Principle and Instrumentation	3	1	K2(U)	Interactive lecture with PPT	Think-Pair - Share	Interactive PPT	Derivation exercise CIA I
	2.	Interpretation of XRD data – JCPDS files	3		K3(Ap)	Video demonstration with schematic diagrams	Hands-on data interpretation	JCPDS sample printouts, simulated data	Worksheet: Identify phase from XRD CIA I
	3.	Phase purity, Scherrer formula, lattice constants calculation	3	1	K5(E)	Problem-solving session	Inquiry based learning	Videos	Calculation-based test CIA I
	4.	Systematic absence of reflections; Electron diffraction technique – principle, instrumentation and application.	3		K3(Ap)	Lecture using PPT	Group Discussion	Interactive PPT	True/False, MCQ CIA I
	5.	Electron microscopy – difference between optical and electron	3		K4(An)	Lecture using videos	Think-pair-share	You tube Videos	Evaluation through short test

		microscopy, theory, principle, instrumentation		1					CIA I
	6.	Sampling methods and applications of SEM and TEM.	3		K3(Ap)	Lecture using videos	Group Discussion	Videos	Short essays CIA I
V		**Band theory and defects in solids**							
	1.	Band theory – features and its application of conductors, insulators and semiconductors	4	1	K3(Ap)	Lecture using Videos	Think-Pair-Share	Videos	Simple definitions CIA I
	2.	Intrinsic and extrinsic semiconductors	3		K4(An)	Lecture using PPT	Group Discussion	Interactive PPT	Short test CIA I
	3.	Defects in crystals – point defects (Schottky, Frenkel, metal excess and metal deficient) and their effect on the	4	1	K2(U)	Interactive Lecture with diagrams	Concept Mapping	YouTube videos	MCQ CIA I

		electrical and optical property							
	4.	laser and phosphors	3		K2(U)	Video-based explanation with real-world applications	Group Discussion	Videos	Quiz CIA I
	5.	Linear defects and its effects due to dislocations.	4	1	K2(U)	Lecture using videos	Think-Pair-Share	Videos	Review CIA I

Course Focussing on Employability/ Entrepreneurship/ Skill Development: Employability

Activities (Em/ En/SD): Interpretation of XRD data of various samples– JCPDS files

Assignment: Classification of semiconductors.

1. Crystal defect and their effect on properties of semiconductors
2. Application of SEM and TEM

Seminar Topic:

Structure of silicates - isomorphous replacements in silicates – ortho, meta and pyro silicates – one dimensional, two dimensional and three-dimensional silicates.

Sample questions

Part A

1. The transition elements present in polyacids are _____. **(K1, CO1, R)**
2. An octahedral void is surrounded by _____spheres. **(K2 – CO1 – U)**

a) 4 b) 3 c) 6 d) 8

3. The general formula of perovskite structure is ABX 3. (True/False) **(K1 – CO1 – R)**

4. Define lattice energy. **(K2 – CO1 – U)**

5. The conduction band overlaps with the valence band in _____.**(K2 – CO1 – U)**

a) conductors b) insulators c) semiconductors d) non metals

Part B

1. Classify the types of silicates. **(K3 – CO2 – Ap)**
2. Write a note on different types of voids. **(K2 – CO1 – U)**
3. Sketch the structure of rock salt. **(K3 – CO2 – Ap)**
4. List out the difference between optical and electron microscopy. **(K4 – CO3 – An)**
5. Mention the applications of band theory**. (K2 – CO2 – U)**

Part C

1. Predict the geometry of the molecules using Bent's rule. **(K4 – CO3 – An)**
2. Calculate lattice energy of a crystal from the Born-Lande equation? **(K3 – CO2 – Ap)**
3. Compare the structure of zinc blende and wurtzite. **(K4 – CO3 – An)**

4. Explain the morphology of a sample using SEM and TEM. **(K5 – CO4 – E)**
5. Discuss the different types of defects in solids. **(K4 – CO3 – An)**

Course Instructor: Dr. B. T. Delma

Head of the Department: Dr. R. Gladis Latha

Department : Chemistry
Class : I M.Sc. Chemistry
Title of the Course : CORE LAB COURSE I: ORGANIC CHEMISTRY PRACTICAL
Semester : I
Course Code : CP231CP1

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP231CP1	-	-	6	-	4	6	90	25	75	100

Pre-requisites:

Students should have a practical knowledge of Organic Chemistry.

Learning Objectives:

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

Course Outcomes

On the successful completion of the course, student will be able to:		
1	understand the methods for the separation and estimation of organic compounds	**K2**
2.	apply the theoretical concepts to identify and synthesize organic compounds	**K3**
3	analyze the elements and functional groups using microscale analysis	**K4**
4	evaluate the quality and quantity of organic compounds	**K5**
5	create organic compounds using various rearrangement reactions	**K6**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create

Teaching Plan
Total Contact hours: 90 (Including Practical Classes and Assessments)

Unit	Topic	Teaching Hours	Assessment Hours	Cognitive level	Pedagogy	Student Centric Method	E-Resources	Assessment/ Evaluation Methods
I	**SEPARATION AND ANALYSIS**							
	Two component mixtures.	13	2	K4 (An)	**Demonstration method Experiential Learning**	Predict-Observe-Explain	Virtual Lab	Reporting results, Model Exam
	Three component mixtures.	12	3	K4 (An)	Inquiry based learning	Hands- on experience	O Lab	Functional group detection, Model Exam
II	**ESTIMATIONS**							
	Estimation of Ethyl methyl ketone (iodimetry) Estimation of Glucose – Bertrand's method	7	2	K5 (E)	**Experimental method**	Flipped method	Virtual Lab	Rubric based practical skill evaluation
	Estimation of Ascorbic acid (iodimetry) Estimation of Glycine (acidimetry)	6		K5 (E)	**Experimental method**	Active learning	Virtual Lab	Calculation and report the results

	Estimation of Formalin (iodimetry) Estimation of Acetyl group in ester (alkalimetry)	6	3	K5 (E)	**Experimental method**	Inquiry based learning	Virtual Lab	Formative Mini Tests
	Estimation of Hydroxyl group (acetylation) Estimation of Amino group (acetylation) Estimation of Aromatic nitro groups (reduction).	6		K5 (E)	**Heuristic method**	Experiential Learning	O Lab	Calculation, Model exam
III	**TWO STAGE PREPARATIONS**							
	a) *p*-bromoacetanilide from aniline b) *p*-Nitroaniline from acetanilide	7	1	K3 (Ap)	**Demonstration**	Active learning	Virtual Lab	Calculate the yield
	c) 1,3,5- Tribromobenzene from aniline d) Acetyl salicyclic acid from methyl salicylate	7	1	K4(An)	**Experiential** **Learning**	Peer - Led and Cooperative learning	Virtual Lab	Calculate the yield
	e) Benzilic acid from benzoin	7	2	K3 (Ap)	**Demonstration**	Peer - Led and	Virtual Lab	Calculate the yield

	f) *m*-Nitroaniline from nitrobenzene					Cooperative learning		
	g) *m*-Nitrobenzoic acid from methyl benzoate	4	1	K4(An)	**Heuristic method**	Inquiry based learning	O Lab	Peer and self-assessment, Model Exam.

Course Focussing on Employability/ Entrepreneurship/ Skill Development: Employability, Skill Development

Activities (Em / En /SD): Hands on Training, Project

Course Focusing on Cross Cutting Issues (Professional Ethics/ Human Values/Environment Sustainability/ Gender Equity): NIL

Environment Sustainability activities related to Cross Cutting Issues: NIL

Sample questions

1. Separate the given two component mixture and report the preferred method of separation.

   Analyze systematically the two components separated, record your observations and report the following:

   (i) Aromatic/aliphatic

   (ii) Saturated/unsaturated

   (iii) Element present/absent

   (iv) Functional groups

(v) Prepare solid derivatives for the functional groups detected

Exhibit the separated components and the derivatives for inspection.

2. Estimate the amount of ethyl methyl ketone present in the whole of the given solution. You are provided with analar potassium dichromate crystals.
3. Estimate the amount of glucose present in the whole of the given solution. You are provided with analar potassium permanganate crystals.
4. Estimate the amount of ascorbic acid present in the whole of the given solution. You are provided with analar Sodium thiosulphate crystals.
5. Estimate the amount of glycine present in the whole of the given solution. You are provided with analar potassium hydroxide crystals.
6. Estimate the amount of formalin present in the whole of the given solution. You are provided with analar Sodium thiosulphate crystals.
7. Exhibit the prepared samples for inspection.

Course Instructor: Dr. M. Antilin Princela

Head of the Department: Dr. R. Gladis Latha

Department : Chemistry
Class : I M.Sc. Chemistry
Title of the Course : Elective Course-I Pharmaceutical Chemistry

Semester : I

Course Code : CP231EC2

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP233EC2	**4**	1	–	–	**3**	**5**	**75**	**25**	**75**	**100**

Learning Objectives:

1. To understand the advanced concepts of pharmaceutical chemistry.
2. To recall the principle and biological functions of various drugs.

Course Outcomes

On the successful completion of the course, student will be able to:		
1.	understand the concepts of pharmaceutical chemistry.	**K2**
2.	apply the principles of drug action and computers in drug formulation.	**K3**
3.	analyze the drug dosage forms in drug delivery system.	**K4**
4.	evaluate the structure activity relationship in drug formulation.	**K5**
5.	synthesize new drugs after understanding the concepts of SAR.	**K6**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create

Teaching plan

Total Contact hours: 75(Including lectures, assignments and tests)

Unit	Module	Topic	Teaching Hours	Assessment Hours	Cognitive level	Pedagogy	Student Centric Method	E-Resources	Assessment/ Evaluation Methods
I	**PHYSICAL PROPERTIES IN PHARMACEUTICALS**								
	1	Physical properties of drug molecule: physical properties. Refractive index-Definition, explanation, formula, importance, determination, specific & molar refraction.	2	1	K1(R) & K3 (Ap)	Lecture with Visual Aids such as PPT, Demonstration ,	Hands-On Lab Activity	YouTube: Tutorials on "How to Use a Refractometer.	Quick quizzes (MCQs and True/False) on definitions, formulas, and concepts CIA I
	2	Optical activity\rotation-monochromatic & polychromatic light, optical activity, angle of rotation, specific rotation examples, measurement of optical activity.	2		K4(An)	Lecture Method with Demonstration	Think-Pair-Share:	YouTube: Videos explaining chirality, optical activity, and polarimetry (e.g., MIT OpenCourse	Quizzes Conceptual MCQs and Diagrams CIA I

								Ware, Chemguide).	
	3	Dielectric constant & Induced Polarization- Dielectric constant explanation & determination. Rheology of pharmaceutical systems:	3	1	K3(Ap)	Case Study Method.	Inquiry-Based Learning	PowerPoint with graphical representations of coordinate systems and potential surfaces, - 3D simulations for visualizing boundary surfaces, - Use of Mathematica/ Matlab/Python for plotting potential fields.	*Quizzes*: Define dielectric constant, identify dielectric materials, numerical on capacitance. Conceptual MCQs and Diagrams. CIA I
	4	Introduction, Definition, Applications, concept of viscosity, Newton's law of flow, Kinematic, Relative, Specific,	2		K3(Ap)	Application-Based Teaching	Inquiry-Based Learning / Lab-Based Discovery	MIT Open Courseware – videos on viscosity and fluid flow PubMed/ Science Direct – for	MCQs / Quizzes: Identify viscosity types and correct units.

		Reduced & Intrinsic viscosity.						real applications of viscosity in pharmaceutical research.	Application-based questions.
	5	Newtonian system, non-Newtonian system- Plastic flow, Pseudoplastic flow, Dilatent flow. Viscosity measurements-selection of viscometer for Newtonian and non-Newtonian system.	3	1	K4(An)	Hands-on Demonstration	Peer Group Projects**:** Groups study a specific product (e.g., toothpaste) and analyze its flow behavior, measurement techniques, and suitable viscometer	ScienceDirect / PubMed for pharmaceutical rheology research articles.	MCQs / Quizzes: Identify flow types based on behavior. Match viscometer types to appropriate system CIA I
II	**ISOTOPIC DILUTION ANALYSIS**								
	1	Principle and applications, Neutron activation analysis	2	1	K3(Ap)	Application-Focused Teaching	Think-Pair-Share:	SWAYAM / NPTEL: Courses on Nuclear Chemistry, Analytical Chemistry Techniques.	Poster Presentation, , CIA I

	2	Principle, advantages and limitations, Scintillation counters: Body scanning	2		K4(An)	Demonstration / Video Explanation	Group Projects / Micro-Teaching	YouTube / "How Scintillation Counters Work" "Scintillators in Nuclear Medicine"	Quick quizzes, Peer discussions and concept maps, CIA I
	3	Introduction to radiopharmaceuticals. Properties of various types of radiopharmaceuticals,	2	1	K3(Ap)	Case-Based Teaching	Group Discussions	NPTEL / SWAYAM: Courses on Radiopharmaceutical Chemistry, Nuclear Pharmacy.	MCQs / Quizzes: Identify types and uses of different radiopharmaceuticals. CIA I
	4	Radiopharmaceuticals as diagnostics, as therapeutics, for research and sterilization	3		K3(Ap)	Comparative and Application-Oriented Teaching:	Problem-Based Learning (PBL)	NPTEL videos on radiopharmaceuticals, radiation physics, radiopharmacy	MCQs / Concept Checks CIA I
	5	Physico Chemical Properties and drug action. Physico chemical properties of drugs (a) Partition	3		K5(E)	Demonstration / Experimental Teaching	Concept Mapping: Students create visual maps linking:	SWAYAM / NPTEL: Physical pharmaceutics modules	Lab Tasks / Reports: Conduct and report solubility or partition

		coefficient, (b) solubility (c) surface activity, (d) degree of ionization.					Physicochemical properties → Drug absorption → Bioavailability → Therapeutic action .		coefficient experiments. CIA I
III	**DRUG DOSAGE AND PRODUCT DEVELOPMENT**								
	1	Introduction to drug dosage Forms & Drug Delivery system – pharmacopoeias formularies,	2	1	K1(R) & K3 (Ap)	Conceptual Teaching with Charts & Tables	Hands-on Demonstration Case-Based Learning	Video Lectures "Introduction to Dosage Forms" "Basics of Drug Delivery Systems" "What is a Pharmacopoeia?	**MCQs and Quizzes**: Classification of dosage forms Identify correct pharmacopoeial standards for a given drug CIA I
	2	Definition of Common terms. Drug Regulation and control,	2		K2(U)	Lecture Method with Real-Life Context	Poster / Chart Preparation	YouTube: Channels like Pharma Factz, Pharma Guide, and Pharmacology Animated	Quizzes / MCQs: CIA I

	3	Drug nomenclature, routes of administration of drugs products,	2	1	K3(Ap)	Case-Based Teaching	Group Project / Poster Presentation Topics:"Routes of drug administration: a comparative review" or "The significance of drug nomenclature in patient safety".	YouTube Clinical Pharmacology Channels For animated videos and tutorials on routes of drug administration.	MCQs, True/False, Assertion-Reason on: Types of drug names. Route selection based on drug properties and clinical need. CIA I
	4	Sources of drug, need for a dosage form, classification of dosage forms	3		K3(Ap)	Demonstration Method	Group Activity / Chart Preparation	**YouTube Channels**: Osmosis, PharmaFactz, Khan Academy (Pharmacology), – for animated explanations of dosage forms and drug origin.	MCQs and Quizzes: For quick assessment on drug sources and classification. Flashcards / Pictionary: Identify dosage form from images or

									characteristics.CIA I
	5	Drug dosage and product development.	3	1	K4(An)	Sequential Step-by-Step Teaching	Concept Mapping Group Presentation	SWAYAM/NPTEL: Modules on drug formulation and development	MCQs / Quizzes Case Study Analysis CIA II
IV	**DEVELOPMENT OF NEW DRUGS**								
	1	Introduction, procedure followed in drug design, the research for lead compounds, molecular modification of lead compounds. Structure-Activity Relationship (SAR):	3	1	K1(R) & K3 (Ap)	Application-Focused Teaching	Problem-Based Learning (PBL)	NPTEL / SWAYAM: Courses on Medicinal Chemistry and Drug Design	Group Project Evaluation CIA II
	2	Factors effecting bioactivity, resonance, inductive effect, isoterism, bioisosterism, spatial considerations, biological	2		K4(An)	Concept-Based Teaching	SAR Mapping / Function-Activity Prediction	YouTube Channels: Osmosis, PharmaFactz, – for animated explanations on receptor	Quizzes and MCQs Case-Based Evaluation CIA II

		properties of simple functional groups, theories of drug activity, occupancy theory, rate theory, induced-fit theory						theory and drug activity. NPTEL/SWAYAM: Medicinal Chemistry and Pharmacodynamics modules	
	3	Quantitative structure activity relationship (QSAR): Development of QSAR, drug receptor interactions, the additivity of group contributions,	3		K3(Ap)	Conceptual Teaching with Case Examples	Case-Based Learning	NPTEL/SWAYAM: Medicinal Chemistry and QSAR lectures.	Group Project Evaluation Oral Presentations CIA II
	4	Physico-chemical parameters, lipophilicity parameters, electronic parameter,	2	1	K3(Ap)	Demonstration Method	Chart Making	NPTEL/SWAYAM: Courses in Medicinal Chemistry and Drug Design	Structural Analysis Assignments MCQs and Fill-in-the-Blanks CIA II
	5	Ionization constants, steric parameters, chelation parameters, redox	2	1	K4(An)	Lecture with Visual Aids	Mini Projects or Case-Based Learning	NPTEL/SWAYAM: Modules on drug design, physicochemi	Quizzes and MCQs Project / Poster Evaluation

		potential, indicator-variables					"Chelation in Drug Design: Benefits and Risks"	cal descriptors.	CIA II
V	**COMPUTERS IN PHARMACEUTICAL CHEMISTRY**								
	1	Need of computers for chemistry. Computers for Analytical Chemists	2	1	K2(U)	Demonstration Method Demonstrate software used by analytical chemists (e.g., ChemDraw, Origin, SpectraSuite, MS Excel for calibration curves).	Problem-Based Learning (PBL)	Software Tools for Chemistry ChemDraw/ ChemSketch: Molecular drawing and property prediction.	Online Quizzes and MCQs CIA II
	2	Introduction to computers: Organization of computers, CPU, Computer memory, I/O devices, information storage, software components	2		K3(Ap)	Analogy-Based Teaching	Flowchart/ Diagram Drawing Think-Pair-Share	NPTEL / SWAYAM: Basic computer science modules (with Indian context).	Worksheets and Concept Mapping CIA II
	3	Application of computers in chemistry:	2		K3(Ap)	Activity-Based Learning 3D visualization of molecules	Hands-on Practice Sessions Drawing chemical structures	**NPTEL/SWAYAM** – Modules on Computational Chemistry and	MCQs and Quizzes CIA II

							(ChemSketch)	Analytical Chemistry	
	4	Programming in high level language (C^+) to handle various numerical methods in chemistry	3	1	K3(Ap)	Conceptual and Practical Lectures	Project-Based Learning	YouTube: ChemCompute, Neso Academy, MySirG (C++ for science students).	Mini Projects Assignments like: Write a C++ program to simulate first-order kinetics." CIA II
	5	Least square fit, solution to simultaneous equations, interpolation, extrapolation, data smoothing, numerical differentiation and integrations.	3		K4(An)	Chalk and Talk + Graphical Explanation	Real Data Interpretation	NPTEL / SWAYAM – Numerical Methods for Science students.	Group Project or Case Study CIA II

Course Focussing on Employability/ Entrepreneurship/ Skill Development: **Employability, Skill Development**

Activities (Em / En /SD): **Hands on Practice Sessions Drawing chemical structures using ChemDraw,**

Course Focusing on Cross Cutting Issues (Professional Ethics/ Human Values/Environment Sustainability/ Gender Equity): **Professional Ethics**

Assignment: **Structural Analysis**

Seminar Topics: **"Scintillators in Nuclear Medicine"**

Part A (1 mark)

1. Assertion (A): Molar refraction is an additive and constitutive property.
   Reason (R): It depends on the number and types of atoms in the molecule. **(K2-U, CO-1)**
   a) Both A and R are true and R is the correct explanation.
   b) Both A and R are true but R is not the correct explanation.
   c) A is true but R is false.
   d) A is false but R is true.
2. The specific rotation of a compound varies with concentration and path length. (True/False) **(K2-U, CO-1)**
3. Match the following:
   a) Scintillation counter - i) Body scanning
   b) Isotopic dilution - ii) Trace analysis
   c) Radiopharmaceuticals - iii) Diagnostic and therapeutic uses
   d) Neutron activation - iv) Radioactivity-based detection **(K2-U, CO-1)**
4. Neutron activation analysis involves:
   a) UV radiation
   b) Bombardment with neutrons
   c) Acid-base titration
   d) Redox reaction **(K2-U, CO-1)**
5. The term “Drug Delivery System” refers to:
   a) Manufacturing procedure
   b) Routes of administration
   c) Technology to deliver drugs at a targeted site
   d) Drug testing method **(K3-Ap, CO-2)**
6. Parenteral dosage forms are administered orally. (True/False) **(K2-U, CO-1)**

7. SAR is useful because:
   a) Saves cost
   b) Avoids animal testing
   c) Predicts drug properties
   d) Eliminates side effects **(K4-An, CO-3)**
8. In drug design, “lead modification” refers to:
   a) Discarding initial drugs
   b) Repeating bioassays
   c) Systematic structural changes
   d) Changing administration route **(K3-Ap, CO-2)**
9. Information storage device includes:
   a) CPU
   b) RAM
   c) Hard Disk
   d) Arithmetic unit **(K3-Ap, CO-2)**
10. CPU is considered the brain of the computer. **(K2-U, CO-1)**

Part B (6 marks)

11. Differentiate between Newtonian and non-Newtonian systems with examples. **(K4-An, CO-3)**
12. Describe the principle of rheology and its significance in pharmaceutical formulations. **(K3-Ap, CO-2)**
13. Discuss the use of radiopharmaceuticals in diagnostics and therapy. **(K3-Ap, CO-2)**
14. How does the partition coefficient affect the distribution of drugs in the body? **(K3-Ap, CO-2)**
15. List the various routes of drug administration with advantages. **(K3-Ap, CO-2)**
16. Differentiate between solid, liquid, and semisolid dosage forms. **(K4-An, CO-3)**
17. Evaluate the advantages of novel drug delivery systems over conventional systems. **(K5-E, CO-4)**
18. Illustrate the relationship between dosage form and bioavailability. **(K5-E, CO-4)**
19. List and explain any four input/output devices used in chemistry labs. **(K2-U, CO-1)**

20. How are numerical differentiation and integration performed in C++? **(K4-An, CO-3)**

Part C (12 marks)

21. Discuss the refractive index and its pharmaceutical importance. Include derivation of specific and molar refraction. **(K5-E, CO-4)**
22. Describe in detail the various viscosity types and the viscometers used for their measurement. **(K4-An, CO-3)**
23. Compare and contrast different types of radiopharmaceuticals with their biological behavior. **(K4-An, CO-3)**
24. Evaluate the role of radiopharmaceuticals in diagnosis and therapy, citing two examples. **(K5-E, CO-4)**
25. Differentiate between solid, liquid, and semisolid dosage forms. **(K4-An, CO-3)**
26. Discuss factors influencing choice of dosage form. **(K3-Ap, CO-2)**
27. How do electron-donating and withdrawing groups influence pharmacological activity? **(K4-An, CO-3)**
28. Propose a hypothetical modification of a known drug using SAR principles to improve efficacy. **(K6-C, CO-5)**
29. Evaluate the impact of computer technology on modern pharmacy education and practice. **(K5-E, CO-4)**
30. Propose an ideal computer-aided drug formulation system with workflow and tools used. **(K6-C, CO-5)**

Course Instructor: Dr. S. Lizy Roselet

Head of the Department: Dr. R. Gladis Latha

Department : Chemistry
Class : I M.Sc. Chemistry
Title of the Course : Elective Course II b: Molecular Spectroscopy
Semester : I
Course Code : CP231EC5

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP231EC5	**4**	1	–	–	**3**	**5**	**75**	**25**	**75**	**100**

Pre-requisites:

Students should know the basic knowledge of spectroscopy.

Learning Objectives:

1. To understand the influence of rotation and vibrations on the spectra of the polyatomic molecules.
2. To study the principle of Raman spectroscopy, ESR spectroscopy, EPR spectroscopy and fragmentation patterns in Mass spectroscopy.
3. To highlight the significance of Franck-Condon principle to interpret the selection rule, intensity and types of electronic transitions.
4. To interpret the first and second order NMR spectra in terms of splitting and coupling patterns using correlation techniques such as COSY, HETCOR, NOESY.
5. To carry out the structural elucidation of molecules usingdifferent spectral techniques.

Course Outcomes

On the successful completion of the course, student will be able to:		
1.	Understand the advanced concepts of spectroscopy.	**K2**
2.	apply the different spectral techniques to elucidate the structure of compounds.	**K3**
3.	Analyze the structure of compounds using spectroscopic techniques.	**K4**
4.	Evaluate different electronic spectra of simple molecules using electronic spectroscopy.	**K5**
5.	develop the knowledge on principle, instrumentation and structural elucidation of simple molecules using Mass Spectrometry, EPR and Mossbauer Spectroscopy techniques.	**K6**

K1-Remember; **K2** -Understand; **K3**-Apply; **K4**-Analyze; **K5**-Evaluate; **K6**– Create

Teaching plan

Total Contact hours:75(Including lectures, assignments and tests)

Unit	Module	Topic	Teaching Hours	Assessment Hours	Cognitive level	Pedagogy`	Student Centric Method	E-Resources	Assessment/ Evaluation Methods
I	**ROTATIONAL AND RAMAN SPECTROSCOPY**								
	1	Rotational spectra of diatomic and polyatomic molecules.	2	1	K1(R) & K2 (U)	**Lecture with integrative approach.**	Inquiry-Based Learning and PeerTeaching	*Video Lectures, Slides*.	Formative Quiz using Google Forms, Assignment-Conceptual Questions, CIA I
	2	Intensities of rotational spectral lines, effect of isotopic substitution. Non-rigid rotators.	2		K2(U) & K4(An)	Visual Lecture with Graphical explanation, Integrative Teaching	Group Discussion, Collaborative learning	PowerPoint with graphical representations	Assignment on Non rigid rotators, Group Presentation, CIA I
	3	Classical theory of the Raman effect, polarizability as a tensor, polarizability	3	1	K2(U)	Discussion method, Socratic / Questioning method	Cooperative Learning, Mind Mapping	Youtube Videos of Raman effect, slideshare.	Oral presentation, Quizzes, slip test CIA I.

		ellipsoids, quantum theory of the Raman effect							
	4	Pure rotational Raman spectra of linear and asymmetric top molecules, Stokes and anti-Stokes lines. Vibrational Raman spectra, Raman activity of vibrations, rule of mutual exclusion,	3	1	K2 (U) & K3(Ap)	Inquiry based teaching, flipped classroom, Lecture with visual aids.	Collaborative learning, conceptual mapping	You tube videos and Lectures	Open book exam, short test, CIA I.
	5	Rotational fine structure- O and S branches, Polarization of Raman scattered photons.	2		K3 (Ap) & K4(An)	Lecture with interactive PPT	Peer Learning, Inquiry based learning	PPT, Slideshare	Short summary, conceptual quiz, CIA I
II	**VIBRATIONAL SPECTROSCOPY**								
	1	Vibrations of molecules, harmonic and anharmonic oscillators- vibrational energy expression, energy level diagram, vibrational wave functions and their symmetry	3	1	K1®, K2 (U)& K3(Ap)	Lecture with interactive elements, visualization tools, mind mapping	Inquiry based learning, Collaborative group work	You tube Lectures, Videos of harmonic and anharmonic oscillations	MCQ, Symmetry analysis assignment, CIA I

	2	selection rules, expression for the energies of spectral lines, computation of intensities, hot bands, effect of isotopic substitution.	2		K2(U)& K4(An)	Integrative method, discussion on selection rule and symmetry.	Cooperative learning, group discussion	You Tube Lectures	Slip test, Oral presentation, CIA I
	3	Diatomic vibrating rotor,vibrational-rotational Spectra of diatomic molecules	2	1	K3(Ap)	Inquiry based teaching, Flipped classroom	Group work for calculating frequencies, peer teaching	Animations on vibrating rotar	Quizzes, Open Book Exam Questions, CIA I
	4	P,Rbranches,breakdownoftheBorn-Oppenheimer approximation.	1		K2(U)&K 4(An)	Inquiry based approach	Participative learning	Slideshare	Short summary, CIA I
	5	Vibrations of polyatomic molecules – symmetry properties, overtone and combination frequencies. Influence of rotation on vibrational spectra of polyatomic molecule	2		K2(U) &K4(An)	Collaborative teaching approach, Integrative method	Group discussion, Peer teaching	Interactive PPT	Solving problems, analyzing rotational and vibrational spectra of polyatomic molecule. CIA II

	6	P, Q, R branches, parallel and perpendicular vibrations of linear and symmetric top molecules.	2	1	K2 (U)	Inquiry based method	Concetual learning	You tube lecture	MCQ, oral presentation, CIA II
III	**ELECTRONIC SPECTROSCOPY**								
	1	Electronic spectroscopy of diatomic molecules, Frank-Condon principle, dissociation and predissociation spectra.	3	1	K1(R), K2(U) & K3 (Ap)	Conceptional visualization, Integrative method, problem-based learning	Flipped Classroom, collaborative activities, comparative spectral analysis	Video Lectures	MCQs, numerical problems, and spectra interpretation exercises. CIA II
	2	$\pi \rightarrow \pi^*$, $n \rightarrow \pi^*$ transitions and their selection rules.	1		K2(U)	Lecture, experimental correlation	Think-pair-share	slideshare	Quick Quizzes, CIA II
	3	Photoelectron Spectroscopy: Basic principles, photoelectron spectra of simple molecules	3	1	K1(R), K2(U) & K3 (Ap	Conceptual teaching, blended classroom,Integrative method	Inquiry based learning, case study discussion, group tasks	Physical Chemistry by LibreTexts	Diagram task, online quizzes, group presentation, CIA II
	4	Xray photoelectron spectroscopy (XPS).	2		K2(U) & K3(Ap)	Visual based teaching, Comparative and problem-solving approach	Problem Solving, participative learning	You tube videos	MCQs, short answers, CIA II

	5	Lasers: Laser action, population inversion, properties of laser radiation, Examples of simple laser systems.	3	1	K1(R), K2(U) & K3 (Ap)	Integrated theoretical and experimental approach, application driven teaching	Concept Mapping, Flipped classroom	Educational video - LearnChemE, Interactive PPT	Oral presentation, Assignment CIA II
IV	**NMR AND ESR SPECTROSCOPY**								
	1	Chemical shift, Factors influencing chemical shifts: electro negativity and electrostatic effects; Mechanism of shielding and deshielding. Spin systems: First order and second order coupling of AB systems, Simplification of complex spectra.	2	1	K1(R), K2(U) & K4(An)	Lecture with discussion, Inquiry-Based teaching approach	Think-Pair-Share, Cooperative learning	LibreTexts, YouTube videos	MCQs, Interpretation task, CIA I
	2	Spin-spin interactions: Homo nuclear coupling interactions-AX, AX2, AB types. Vicinal, germinal and long- range coupling-spin decoupling. Nuclear Overhauser	2		K2(U), & K3(Ap)	Conceptual and visual teaching method, problem-based learning	Collaborative group work, peer teaching	PhET – Wave on a String NPTEL Lectures: Electromagnetic Theory by Prof. S.C. Dutta Roy	Quizzes using Nearpod, Assignment, CIA I

		effect (NOE), Factors influencing coupling constants and Relative intensities.						MIT OCW – Electromagnetics and Applications	
	3	13CNMR and structural correlations,Satellites. Brief introduction to 2DNMR–COSY, NOESY.Introductiont o31P,19FNMR.	1		K2(U), K3 (Ap) & K4(An)	Lecture using molecular models, Interactive spectral annotation	Spectral puzzle, Flipped classroom	Videos, MIT Open Course Ware (NMR modules)	Slip test, oral presentation, CIA I
	4	ESR spectroscopy Characteristic features of ESR spectra, line shapes and line widths; ESR spectrometer. The g value and the hyperfine coupling parameter (A), origin of hyperfine interaction.	3	1	K2(U)	Conceptual teaching, Inquiry based leaning, blended learning	Group discussion, peer teaching	Slide share G-pathsala notes	Quizzes, spectra drawing, oral presentation, CIA I
	5	Interpretation of ESR spectra and structure elucidation of organic radicals using ESR spectroscopy; Spin orbit coupling and significance of g-tensors, zero/non-	2	1	K2(U), K3 (Ap) & K4(An)	Application-Oriented Learning, Analytical Learning	Collaborative learning, problem-based learning	NPTEL: Wave Reflection & Transmission – Prof. A. Nandi, YouTube: Optics	Short summary, spectrum labelling task, CIA I

		zero field splitting, Kramer's degeneracy						Academy – Fresnel Equations Explained	
	6	application to transition metal complexes (having one to five unpaired electrons) including biological molecules and inorganic free radicals. ESR spectra of magnetically dilute samples.	2		K2(U), K3 (Ap)	Lecture with structural spectroscopic integration, case studies of biological molecules and inorganic free radicals	Flipped learning, collaborative spectral assignment	Video lectures, tutorials	Quizzes, group presentation, CIA II
V	**MASS SPECTROMETRY, EPR AND MOSSBAUER SPECTROSCOPY**								
	1	Ionization techniques- Electron ionization (EI), chemical ionization (CI), desorption ionization (FAB/MALDI), electrospray ionization (ESI)	2	1	K2(U)	Lecture with animation, Flipped classroom	Group discussion, peer teaching	You tube animations	Quiz, Diagram labelling, CIA II
	2	Isotope abundance, molecular ion, fragmentation processes of organic molecules, deduction of structure through	2		K2(U)	Lecture using bar diagrams and spectra	Inquiry based learning, Peer teaching	Slide share, videos	Spectrum puzzle, oral presentation, CIA II

		mass spectral fragmentation, high resolution. Effect of isotopes on the appearance of mass spectrum							
	3	EPR spectra of anisotropic systems - anisotropy in g-value, causes of anisotropy, anisotropy in hyperfine coupling, hyperfine splitting caused by quadrupole nuclei.	2	1	K2(U), K4(An)	Inquiry based learning, Problem solving analysis	Active learning, Inquiry based group analysis of spectra	Gpathsala notes	Short test, MCQs, CIA II
	4	Zero-field splitting (ZFS) and Kramer's degeneracy. Applications of EPR to organic and inorganic systems. Structural elucidation of organic compounds	2		K2(U), K3(Ap)	Lecture using animation, Problem solving method	Problem based learning, Flipped classroom	Animation videos	Group presentation, assignment, CIA II

		by combined spectral techniques.							
	5	Principle of Mossbauer spectroscopy: Doppler shift, recoil energy. Isomer shift, quadrupole splitting, magnetic interactions	2	1	K2(U)	Conceptual teaching method, Collaborative approach	Concept mapping, Spectral analysis	Slide share, Gpathsala notes	Slip test, Analyzing given spectra, CIA II
	6	Applications: Mossbauer spectra of high and low-spin Fe and Sn compounds.	2		K3(Ap)	Case based teaching	Inquiry based learning, Group discussion	Slideshare	Quizzes, short test, CIA II

Course Focussing on Employability/ Entrepreneurship/ Skill Development: **Employability, Skill Development**

Activities (Em / En /SD): **Hands on Training on Problem solving, Interpretation of spectra, Poster presentation**

Course Focusing on Cross Cutting Issues (Professional Ethics/ Human Values/Environment Sustainability/ Gender Equity): - Environment Sustainability activities related to Cross Cutting Issues: -

Assignment: Harmonic and anharmonic oscillators- vibrational energy expression, energy level diagram, Applications: Mossbauer spectra of high and low-spin Fe and Sn compounds. (Last date to submit – example: 18-08-2025)

Seminar Topics: Photoelectron Spectroscopy: Basic principles, photoelectron spectra of simple molecule, X ray photoelectron spectroscopy (XPS), Kramer's degeneracy, application to transition metal complexes (having one to five unpaired electrons) including biological molecules and inorganic free radicals.

Sample questions (minimum one question from each unit)

Part A (1 mark)

1. Raman effect is due to (**K2-U, CO-1)**

a) Elastic scattering of photons b) Inelastic collision of photon with molecule c) Absorption of photons d) Emission of photons

2. In a pure harmonic oscillator, overtone transitions are strictly forbidden. (True/False). **(K2-U, CO-1)**

3. The spectroscopy that measures the binding energy of electrons is _____. **(K2-U, CO-1)**

4 In a methyl radical ESR, the hyperfine splitting yields: **(K5-U, CO-4)**

a) 1 line b) 3 lines (1:2:1) c) 4 lines (1:3:3:1) d) 4 lines (1:2:2:1)

5. In Mössbauer spectroscopy, the selection rule $\Delta MI = 0, \pm 1$ applies to: **(K2-U, CO-1)**

a) Magnetic dipole transitions b) Quadrupole interactions c) Isomer shift d) Recoil energy

Part B (6 marks)

21. Explain how isotopic substitution affects the rotational spectra of diatomic molecules. **(K2-U, CO-1)**
22. Derive the energy level expression for an anharmonic oscillator up to first order wavefunction. **(K2-U, CO-1)**
23. Describe the selection rules for electronic transitions in diatomic molecules. (**K3-Ap, CO-2)**
24. Discuss the Nuclear Overhauser Effect (NOE). How is it used in structural elucidation? **(K3-Ap, CO-2)**
25. Define zero-field splitting (ZFS) and Kramers' degeneracy in EPR. **(K2-U, CO-1)**

Part C (12 marks)

1. Explain the quantum mechanical interpretation of the Raman effect and differentiate between Stokes and anti-Stokes lines. (**K4-An, CO-3)**
2. Analyze vibrational-rotational spectra of linear versus symmetric top molecules, describing the P, Q, R branches. **(K4-An, CO-3)**
3. What is a laser? Explain in detail the principles of laser action, properties of laser radiation, and give examples of simple laser system. **(K2-U, CO-1)**
4. Explain spin-spin interactions in NMR, detailing AX, AX_2, AB, vicinal, germinal, and long-range couplings. How does spin decoupling help simplify complex spectra? **(K4-Ap, CO-2)**
5. Analyze Mössbauer spectra for high-spin vs. low-spin Fe and Sn compounds, describing key distinguishing features. **(K4-An, CO-3)**

Course Instructor: Dr. M. Shirly Treasa

Head of the Department: Dr. R. Gladis Latha

Semester III
Teaching Plan

Department : Chemistry
Class : II M. Sc Chemistry

Title of the Course : Core Course V: Organic Synthesis and Photochemistry
Semester III
Course Code : CP233CC1

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP233CC1	5	1	-	-	5	6	90	25	75	100

Objectives:

1. To understand the molecular complexity of carbon skeletons and the presence of functional groups and their relative positions.
2. To study various synthetically important reagents for any successful organic synthesis.

CO	On the successful completion of the course- students will be able to:	
CO-1	recall the basic principles of organic chemistry and understand the various reactions of organic compounds with reaction mechanisms.	K1 &K2
CO-2	apply the versatility of various special reagents and to correlate their reactivity with various reaction conditions.	K3
CO-3	analyze the synthetic strategies in the preparation of various organic compounds.	K4

CO-4	evaluate the suitability of reaction conditions in the preparation of tailor- made organic compounds.	K5
CO-5	design and synthesize novel organic compounds with the methodologies learnt during the course.	K6

Teaching plan

Total Contact hours: 90 (Including lectures, assignments and tests)

Unit	Module	Topic	Teaching Hours	Assessment Hours	Cognitive level	Pedagogy	Student Centric Method	E-Resources	Assessment/ Evaluation
I	**Planning an Organic Synthesis**								
	1	Preliminary Planning- steps in planning the synthesis- Retrosynthetic Analysis and its terminologies - linear and convergent approach - advantages of convergent synthesis	4	1	K2(U)	Lecture using ppt	Think- pair-share, Conceptual Demonstration	Slide share	Concept explanations I CIA
	2	Target molecule - synthons and synthetic equivalents- types of synthons: donor and acceptor synthons. Transformations in Retrosynthesis - Functional group addition and interconversions.	3		K4(An)	Lecture with Visual Aids- PPT	Inquiry-Based Learning, Concept Mapping.	Video Lectures	Slip test I CIA

	3	Monofunctional disconnection: alcohol disconnection - ketone disconnection	3	1	K3(A)	Group discussion, Peer Teaching	Collaborative Learning	Notes	Problem solving I CIA
	4	Acid and their derivatives disconnection - amide disconnection.	2		K4(An)	Conceptual Demonstration	Inquiry-Based Learning	Interactive PPT	Formative worksheet I CIA
	5	Bifunctional 1-2, 1-3, 1-4 and 1-5 disconnections.	3	1	K4(An)	Lecture with visualization, Group discussion	Guided Inquiry Worksheets, Problem Solving	You tube lectures	Short test I CIA
II	**Organic Synthetic Methodology**								
	1	Control elements- Regiospecific control elements. Use of protective groups - protection of hydroxyl- carboxyl- carbonyl and amino groups	3	1	K2(U)	Socratic Questioning, Conceptual Demonstration	Concept Mapping	YouTube Lectures	Concept explanations I CIA
	2	Activating groups. Latent polarity. Synthesis based on umpolung concepts of Seebach - typical examples.	3		K3(A)	Concept Building	Flipped Classroom	Slide share	Short summary I CIA

	3	Designing synthesis: Disconnection approach in Cis-jasmone- Epothilone	4	1	K5(E)	Lecture using chalk and talk	Inquiry-Based Learning	Interactive PPT	Slip test and quiz I CIA
	4	Disconnection approach in bisabolene, Juvabione and longifolene.	4		K3(A)	Conceptual Demonstration	Think-Pair-Share	Notes	Assignment I CIA
	5	Synthetic uses of nitrocompounds and alkenes.	1	1	K4(An)	Peer teaching	Collaborative Learning	You tube videos	Quiz I CIA
III	**Pericyclic Reactions**								
	1	Characteristics and classifications of pericyclic reactions -Cycloaddition - Electrocyclic - Chelotropic and Sigmatropic reactions.	2	1	K2(U)	Lecture using ppt, Conceptual Demonstration	Concept Mapping.	Video lectures	Short summary or overview I CIA
	2	Woodward Hofmann rule- The Mobius and Huckel concept- FMO- PMO method and correlation diagrams.	3		K4(An)	Lecture cum Group Discussion	Problem-Solving	Notes	Short test and quiz I CIA
	3	Cycloaddition and retrocycloaddition reactions- [2+2]- [2+4]- [4+4]- Cationic- anionic- and 1-3-dipolar cycloadditions.	3	1	K2(U)	Lecture using chalk and talk, Discussion	Think-Pair-Share	Interactive Notes	Slip test and class test I CIA

	4	Chelotropic reactions - Electrocyclization and ring opening reactions of conjugated dienes and trienes.	2		K4(An)	Concept-based discussion	Collaborative Learning	You tube lectures	Formative quiz I CIA
	5	Sigmatropic rearrangements: (1-3)- (1-5)- (3-3) and (5-5)-carbon migrations. Ionic sigmatropic rearrangements.	3	1	K3(A)	Group discussion, problem solving	Jig saw method	Interactive PPT	Problem solving I CIA
	6	Group transfer reactions- Regioselectivity- stereoselectivity and periselectivity in pericyclic reactions.	2		K2(U)	Lecture using videos and ppt	Problem solving	Slide share	Short summary or overview I CIA
IV	**Organic Photochemistry-I**								
4 U	1	Introduction - Thermal versus photochemical reactions - Photochemical excitation: Experimental techniques-	3	1	K2(U)	Concept mapping	Flipped classroom	Interactive PPT	Slip test II CIA
	2	Electronic transitions- Jablonski diagram- intersystem crossings- energy transfer processes.	3		K3(Ap)	Lecture cum Group discussion	Think-Pair-Share	You tube lectures	Quiz II CIA
	3	Photochemical reactions of ketones - photosensitization -	3	1	K3(Ap)	Conceptual Demonstration	Collaborative Learning	Video lectures	class test II CIA

	4	Norrish type - I and Norrish type - II cleavage reactions	3		K4(An)	Flipped classroom, lecture using chalk and talk	Inquiry-Based Learning	Notes	Short test II CIA
	5	Photooxidation and photoreduction of ketones-Paterno-Buchi reaction	3	1	K3(Ap)	Lecture with PPT	Peer learning	Interactive PPT	Oral presentation II CIA
V	**Organic Photochemistry-II**								
	1	Photochemistry of □-□-unsaturated ketones - cis-trans isomerization and Photodimerization	4	1	K2(U)	Conceptual Demonstration	Conceptual Demonstration	Video lectures	Slip test and MCQ II CIA
	2	Photon energy transfer reactions- Photo Cycloaddition	3		K4(An)	Lecture using illustrations	Blended learning	You tube videos	Slip test and quiz II CIA
	3	Photochemistry of aromatic compounds-Photochemical rearrangements	3	1	K2(U)	Group discussion	Peer tutoring	Slide share	Overview II CIA
	4	Photo-stationery state- di-π-methane rearrangement-	2	1	K4(An)	Flipped classroom	Inquiry-based learning	Interactive notes	Workout Examples II CIA

	5	Reaction of conjugated cyclohexadienone to 3-4-diphenyl phenols-Barton reaction.	3		K3(A)	Lecture using ppt	Problem solving	Interactive PPT	Group discussion and slip test II CIA

Course Focusing on Employability/ Entrepreneurship/ Skill Development: Employability and Skill Development

Activities (Em/SD):

FMO diagram- Group Discussion

Monofunctional disconnection- Peer Teaching

Assignment:

Disconnection approach in bisabolene, Juvabione and longifolene- Reflective writing

Correlation diagram- Reflective writing

Part A (1 mark)

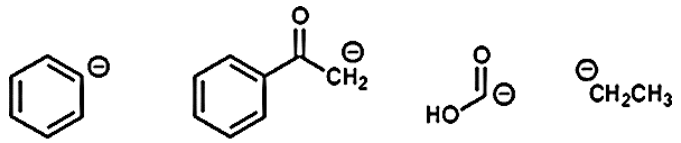
1. Assertion (A): Carbonyl groups are protected by converting it into ketals **(K3-Ap, CO-2)**
   Reason (R): Ketals does not react with hydrides
   (a) A and R are true and R is the not the correct explanation of A
   (b) A and R are true and R is the correct explanation of A
   (c) Both A and R are false
   (d) A is true but R is false

2. Which retrosynthetic terminology is associated with the disconnection of a specific functional group in the target molecule? **(K2-U, CO-1)**

(a) Linear approach (b) Convergent approach

(c) Functional group disconnection (d) Protecting group strategy

3. Which of the following synthon is an example of Umpulong? **(K3-Ap, CO-2)**



(a) Structure A (b) Structure B (c) Structure C (d) Structure D

4. Which of the following precursors can be used in the disconnection approach to synthesize Cis-jasmone? **(K1-R, CO-1)**

(a) Acetic acid b) Ethanol c) Butanol d) Propylene

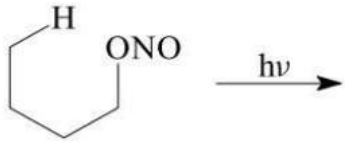
5. HOMO for hexa-1,3,5-triene under thermal condition is **(K2-U, CO-1)**

(a) Ψ1 (b) Ψ2 (c) Ψ3 (d) Ψ4

6. Pericyclic reaction takes place in the presence heat and light. (True/ False) **(K3-Ap, CO-2)**

7. The photochemical intermolecular abstraction of a γ-hydrogen is named as _____. **(K2-U, CO-1)**

8. Predict the product. **(K4-An, CO-3)**



9. Which of the following act as Photosensitizer? **(K3-Ap, CO-2)**

(a) H_2O (b) CO_2 (c) Chlorophyll (d) Light

10. Photodimerization is a process in which **(K2-U, CO-1)**

(a) Two molecules combine under the influence of light to form a dimer.

(b) A molecule absorbs light and undergoes isomerization.

(c) A molecule releases energy in the form of light upon dimerization.

(d) Two molecules split apart upon exposure to light.

Part- B (6 marks)

1. Differentiate linear and convergent approach in reterosynthesis. **(K3-Ap, CO-2)**
2. Discuss the concept of synthons and synthetic equivalents. **(K2-U, CO-1)**
3. Analyze the synthetic uses of nitrocompounds. **(K4-An, CO-3)**
4. Highlight the importance of protecting functional groups in organic synthesis. **(K3-Ap, CO-2)**
5. Draw the FMO diagram of electrocyclic reaction. **(K3-Ap, CO-2)**
6. Explain the characteristic features of pericyclic reaction. **(K2-U, CO-1)**
7. Illustrate photosensitization reaction with an example. **(K2-U, CO-1)**
8. Differentiate thermal and photochemical reactions. **(K3-Ap, CO-2)**
9. Explain mechanism of Hunsdicker and photoisomerisation reaction. **(K2-U, CO-1)**
10. Illustrate photodimerization with an example. **(K3-Ap, CO-2)**

Part C

1. Explain how functional group addition and interconversions contribute to the strategic planning of organic synthesis. **(K3-Ap, CO-2)**
2. Analyse two group disconnections of carbonyl compounds with examples. **(K4-An, CO-3)**

3. Discuss the retrosynthetic analysis of cis-jasmone. **(K2-U, CO-1)**

4. Discuss the synthetic strategies based on umpolung concepts proposed by Seebach, emphasizing their application in the design and execution of organic synthesis. **(K2-U, CO-1)**

5. Illustrate the mechanism of Cope and Claisen rearrangements. **(K3-Ap, CO-2)**

6. Draw FMO and PMO diagram of cycloaddition reaction. **(K3-Ap, CO-2)**

7. Explain Norrish type - I and Norrish type - II reactions of ketones. **(K2-U, CO-1)**

8. Discuss photooxidation and photoreduction of ketones. **(K2-U, CO-1)**

9. Discuss the principles and mechanisms underlying the photochemistry of α-β-unsaturated ketones, exploring both cis-trans isomerization and photodimerization reactions in detail. **(K4-An, CO-3)**

10. Describe the photochemistry of aromatic compounds, including photochemical rearrangements and the di-π-methane rearrangement. **(K2-U, CO-1)**

Course Instructor: Dr. M. Antilin Princela

Head of the Department: Dr. R. Gladis Latha

Teaching Plan

Department : Chemistry
Class : II M.Sc. Chemistry
Title of the Course : Core Course VI: Coordination Chemistry – I

Semester : III

Course Code : CP233CC2

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP233CC2	6	–	–	–	5	6	90	25	75	100

Learning Objectives

1. To gain insights into the modern theories of bonding in coordination compounds.
2. To learn various methods to determine the stability constants of complexes.

Course Outcomes

On the successful completion of the course- students will be able to:		
1.	remember elementary aspects of crystal field theory and molecular orbital theory	**K1**
2.	understand various theories of coordination compounds.	**K2**
3.	apply various experimental methods to determine the stability of complexes.	**K3**
4.	analyze the spectroscopic and magnetic properties of coordination complexes.	**K4**
5.	evaluate the mechanism of substitution reactions in octahedral and square planar complexes.	**K5**

Teaching plan

Total Contact hours: 90 (Including lectures, assignments and tests)

Unit	Module	Topic	Teaching Hours	Assessment Hours	Cognitive level	Pedagogy	Student Centric Method	E-Resources	Assessment/ Evaluation Methods
I	**MODERN THEORIES OF COORDINATION COMPOUNDS**								
	1	Crystal field theory - splitting of d orbitals in octahedral-tetrahedral and square planar symmetries	3	1	K1(R) & K3 (Ap)	Flipped Classroom Inquiry Based Learning	Concept Mapping. Role play Peer teaching	*Video Lectures* https://chem.libretexts.org	Formative Quiz using Google Forms, Conceptual Assignments "Compare and contrast tetrahedral and octahedral crystal field splitting." "Justify the magnetic moment of $[Ni(CN)_4]^{2-}$, CIA I
	2	Measurement of 10Dq - factors affecting 10Dq - spectrochemical	3		K4(An)	Problem-Based Learning (PBL)	Case discussion, solving	https://chem.libretexts.org	Formative Worksheet, Conceptual Quiz, Group

		series - crystal field stabilisation energy for high spin and low spin complexes					complex problems Numerical problems on CFSE calculation		Presentation, CIA calculation Quick quizzes
	3	Evidences for crystal field splitting – site selections in spinels and antispinels - Jahn Teller distortions and its consequences	3	1	K3(Ap)	Lecture with visualization, Concept-based discussion using real-world applications.	Collaborative Learning, Concept Mapping	Interactive PowerPoint	Quiz Seminar Formative Assessment CIA I.
	4	Molecular Orbital Theory and energy level diagrams concept of Weak and strong fields	3		K3(Ap)	Blended Learning	Open discussion and Collaborative Learning	Youtube Videos of Molecular Orbital Theory	Project based Presentation, CIA I.
	5	Sigma and pi bonding in octahedral- square planar and tetrahedral complexes.	3	1	K4(An)	Case study Method	Peer Learning, Real-World Application Projects	Online Tutorials and Notes:	Problem-Solving Assignments, Open Book Exam Questions, CIA I
II	**SPECTRAL CHARACTERISTICS OF COMPLEXES**								
	1	Term states for d ions -characteristics of d-d transitions	3	1	K3(Ap)	Collaborative Learning	Peer Instruction, Blended Learning,	NPTEL Lectures, YouTube Lectures	Quick quiz, CIA I

	2	Charge transfer spectra - selection rules for electronic spectra	3		K4(An)	Demonstration Problem Based Learning	Peer Teaching	**YouTube/ Visuals**: Videos demonstrating CT spectra and electron movement.	Quick quizzes, Think, pair and share exercises. CIA I
	3	Orgel correlation diagrams	3	1	K3(Ap)	Conceptual introduction via lecture and discussion	Guided derivation and problem solving.	NPTEL Video Lectures	Label the diagram exercises Match the complex to orgel diagram Formative Assessment CIA I
	4	Sugano-Tanabe energy level diagrams	3		K3(Ap)	Guided Diagram Reading	Hands on practice	NPTEL Lecture Series: Inorganic Chemistry (Prof. S. J. Raj, IIT Madras, etc.) YouTube: "Tanabe-Sugano Diagrams Explained"	Label the diagram exercises Short quizzes on Match the complex to orgel diagram CIA I

	5	Nephelauxetic series -Racah parameter and calculation of inter-electronic repulsion parameter.	3		K5(E)	Inquiry-Based Learning Case-Based Learning	Hands-On Experiments Data Interpretation Activity	Interactive Worksheets and Online Calculators	Quizlet .CIA I
III	**STABILITY AND MAGNETIC PROPERTY OF THE COMPLEXES**								
	1	Stability of complexes: Factors affecting stability of complexes- Thermodynamic aspects of complex formation	3	1	K1(R) & K3 (Ap)	Flipped Classroom Case Study Analysis	Role Play	Video Lectures Virtual flashcards and quizzes on factors affecting stability	Quick quizzes, Interactive Polls CIA I
	2	Stepwise and overall formation constants	3		K2(U)	concept-based teaching	Think-Pair-Share	NPTEL (IIT-K/IIT-M): Coordination chemistry and stability YouTube: Explainer videos on thermodynamic stability, stepwise/overall constants	**Assignment:** Research β values of a metal with different ligands, compare stability and explain in terms of ligand properties and chelation, CIA I
	3	Stability correlations-	3	1	K3(Ap)	Group-Based Discovery Learning	Guided Inquiry Activity	NPTEL Lectures	Quick MCQs on chelate effect,

		statistical factors and chelate effect						YouTube: "Chelate Effect Explained", "Formation Constants and Stability"	statistical binding steps Formative Assessment CIA I
	4	Formation curves and Bjerrum's half method- Potentiometric method- Spectrophotometric method- Ion exchange method- Polorographic method and Continuous variation method (Job's method)	3		K3(Ap)	Flipped Classroom	Case-Based Learning (CBL):	YouTube: "Determining Stability Constants – Spectrophotometric Method" Job's Method for Complex Stoichiometry"NPTEL: Analytical Chemistry or Coordination Chemistry (IIT-Madras)	Quick quizzes - Concept check MCQs - Exit slips: CIA I
	5	Magnetic property of complexes: Spin- orbit coupling-effect of spin-orbit coupling on magnetic moments- quenching of	3	1	K4(An)	Core Conceptual Approach Demonstration and Data Interpretation	Concept Mapping Activity	**Video Lectures:** NPTEL: Coordination Chemistry (IIT-Kanpur, IIT-Madras) YouTube:	Group Worksheet CIA I

		orbital magnetic moments.						"Magnetic Properties of Complexes" "Spin-Orbit Coupling in Transition Metal Complexes"	
IV	**KINETICS AND MECHANISMS OF SUBSTITUTION REACTIONS OF OCTAHEDRAL AND SQUARE PLANAR COMPLEXES**								
	1	Inert and Labile complexes; Associative-Dissociative and SNCB mechanistic pathways for substitution reactions	3	1	K1(R) & K3 (Ap)	Constructivist Learning, Inquiry-Based Learning	Think-Pair-Share, Analogy-Based Demonstration:	NPTEL (IIT-Madras, IIT-Kanpur): Substitution mechanisms in coordination chemistry	Conceptual Quiz Assignment, CIA II
	2	Acid and base hydrolysis of octahedral complexes	3		K4(An)	Inquiry-Based Learning,	Comparative Case Studies Think-Pair-Share	NPTEL (IIT-Madras/IIT-Kanpur): Coordination Chemistry: Hydrolysis Reactions Substitution Mechanisms in Octahedral Complexes	Concept Check Quiz**:** Identify acid/base hydrolysis type from reaction equations CIA II

	3	Classification of metal ions based on the rate of water replacement reaction and their correlation to Crystal Field Activation Energy	3		K3(Ap)	Flipped Classroom	Concept Mapping Mechanism-Rate Correlation Case Study	NPTEL: Coordination Chemistry — Kinetics of substitution reactions	Numerical problems Quick Quiz CIA II
	4	Substitution reactions in square planar complexes	3	1	K3(Ap)	Blended Learning	Group Case Study Analysis	YouTube: "Substitution in Square Planar Complexes **Quizlet:** Trans effect series flashcards Google Slides: Collaborative mapping of ligand effects	Concept Quizzes, CIA II
	5	Trans effect-theories of trans effect and applications of trans effect in synthesis of square planar compounds; Kurnakov test.	3	1	K4(An)	Application-Oriented Learning, Analytical Learning	Derivation, Interactive graphing	**NPTEL (IIT-Kanpur/IIT-Madras):** Trans effect in coordination chemistry **YouTube:** "Trans Effect Explained	Quick Quiz: CIA II

								with Examples" "Cisplatin Synthesis and Trans Effect"	
V	**ELECTRON TRANSFER REACTIONS IN OCTAHEDRAL COMPLEXES**								
	1	Outer sphere electron transfer reactions	3	1	K2(U)	Constructivist Learning	Concept Mapping	LibreTexts – Redox chemistry sections with integrated theory and models	**Online quizzes** (Google Forms, Kahoot) on terminology, classification, and mechanisms **Assignments /Essays**: Compare outer and inner sphere reactions using examples CIA II
	2	Marcus-Hush theory	3		K3(Ap)	Real-World Contextualization applications in biochemistry, photosynthesis	Case Study Analysis	YouTube Lectures: "Marcus Theory of Electron Transfer" by	Concept Quizzes CIA II

						, and battery technology.		"Marcus Theory of Electron Transfer" by MIT OpenCourse Ware Marcus Theory Explained" – LearnChemE or ChemLibreTexts videos	
	3	Inner sphere electron transfer reactions	3		K3(Ap)	Case-based approach	Peer Teaching or Role Play	YouTube Lectures *Chem LibreTexts* – Transition metal chemistry and redox reactions	Quiz on key concepts: suitable bridging ligands, oxidation state changes, coordination changes-CIA II
	4	Nature of the bridging ligand in inner sphere electron transfer reactions	3	1	K3(Ap)	Socratic Method	Think-Pair-Share	YouTube: "Electron Transfer Mechanisms – Inner Sphere" (LearnChem E,	MCQs and Matching CIA II

	5	Photo-redox-photo-substitution and photo-isomerisation reactions in complexes and their applications.	3		K4(An)	Inquiry-Based Learning:	Group-Based Case Studies	YouTube channels: MIT Open Courseware (Inorganic Chemistry lectures)	Projects / Posters Role of Coordination Complexes in Solar Energy Harvesting" "Photoactivated Metal Complexes in Cancer Treatment" CIA II

Course Focussing on Employability/ Entrepreneurship/ Skill Development: Employability and Skill Development

Activities (Em/ En/SD): Group Case Study Analysis

Assignment: Associative- Dissociative and SNCB mechanistic pathways for substitution reactions

Seminar Topic: Evidences for crystal field splitting

Sample questions

Part A

1. Assertion (A): Octahedral d^8 complexes often adopt square planar geometry. **(K3-Ap, CO-3)**

   Reason (R): Square planar field causes maximum CFSE for d^8 configuration.
   a) A and R are true, and R is the correct explanation of A.
   b) A and R are true, but R is not the correct explanation.

c) A is true, R is false.
d) A is false, R is true.

2. Which of the following complexes shows Jahn-Teller distortion? **(K4-An, CO-4)**
a) $[Ti(H_2O)6]^{3+}$ b) $[Ni(H_2O)6]^{2+}$ c) $[Cu(H_2O)6]^{2+}$ d) $[Zn(H_2O)6]^{2+}$

3. Match the following **(K3-Ap, CO-3)**

a) Orgel diagram	i) Qualitative splitting for high-spin
b) Tanabe-Sugano	ii) Quantitative term-energy vs Dq
c) Racah parameter	iii) Inter-electronic repulsion
d) Nephelauxetic effect	iv) Covalency effect on B

4. Orgel diagrams apply to both high-spin and low-spin complexes. True/False **(K2-U, CO-2)**

5. Which of the following ligands shows highest chelate effect? **(K4-An, CO-4)**

a) Cl- b) H_2O c) ethylenediamine d) NH_3

6. Match the following **(K2-U, CO-2)**

a) SN1 mechanism	- i) Dissociative
b) SN2 mechanism	- ii) Associative
c) Trans effect	- iii) Labilizing effect of ligands
d) Kurnakov test	- iv) Identity of reaction product

7. Which is the correct order of trans effect? **(K5-E, CO-5)**

a) $H_2O < Cl^- < NH_3 < CN^-$
b) $Cl^- < H_2O < CN^- < NH_3$
c) $NH_3 < H_2O < Cl^- < CN^-$
d) $CN^- < Cl^- < H_2O < NH_3$

8. Which factor favors high magnetic moment? **(K4-An, CO-4)**
   a) Low oxidation state
   b) High number of unpaired electrons
   c) Low-spin configuration
   d) Strong-field ligands

9. Which ligand is least likely to act as a bridge? **(K3-Ap, CO-3)**
   a) Cl^- b) CN^- c) CO d) CH_3COO^-

10. Example of photoredox complex: **(K1-R, CO-1)**
   a) $[Ru(bpy)_3]^{2+}$ b) $[Ni(CN)_4]^{2-}$ c) $[Co(NH_3)_6]^{3+}$ d) $[Fe(H_2O)_6]^{2+}$

Part B (6 Marks)

1. Outline the factors influencing the 10Dq parameter in crystal field theory. **(K3-Ap, CO-3)**
2. Discuss the difference between high spin and low spin complexes, emphasizing their magnetic properties. **(K4-An, CO-4)**
3. Describe the principles behind Orgel correlation diagrams and their relevance in understanding d-d transitions. **(K2-U, CO-2)**
4. Apply the selection rules for electronic spectra, to charge transfer transitions? **(K3-Ap, CO-3)**
5. Describe the chelate effect and give a thermodynamic explanation. **(K2-U, CO-2)**
6. Outline the potentiometric method for determining stability constants. **(K3-Ap, CO-3)**
7. Compare acid hydrolysis and base hydrolysis mechanisms in octahedral complexes. **(K4-An, CO-4)**
8. Classify metal ions based on water exchange rate constants. **(K3-Ap CO-3)**
9. The presence of a bridging ligand affects the rate of inner-sphere electron transfer.Comment. **(K3-Ap, CO-3)**
10. Discuss the importance of photochemical reactions in designing molecular electronic devices. **(K3-Ap, CO-3)**

Part C (12 Marks)

1. Discuss the principles of crystal field theory, including the splitting of d orbitals in octahedral, tetrahedral, and square planar geometries. **(K2-U, CO-2)**
2. Explain the concept of crystal field stabilization energy (CFSE) and its significance in determining the stability of transition metal complexes. **(K2-U, CO-2)**
3. Discuss Tanabe–Sugano diagrams for d^2 and d^6 ions and extract 10 Dq and B from spectral data. **(K3-Ap, CO-4)**
4. Elaborate on the selection rules for electronic transitions and their relaxation mechanisms. **(K2-U, CO-2)**
5. Derive expressions for overall and stepwise stability constants. Give examples. **(K3-Ap, CO-3)**
6. Compare paramagnetism and diamagnetism in transition metal complexes. **(K4-An, CO-4)**
7. Compare associative and dissociative mechanisms with examples and reaction profiles. **(K4-An, CO-4)**
8. Analyze acid hydrolysis and base hydrolysis pathways in octahedral complexes. **(K3-Ap, CO-3)**
9. Describe the role of bridging ligands in inner-sphere reactions and give examples. **(K2-U, CO-2)**
10. Explain the mechanistic aspects of photo-substitution and its kinetic consequences. **(K2-U, CO-2)**

Course Instructor: Dr. S. Lizy Roselet

Head of the Department: Dr. R. Gladis Latha

Department : Chemistry
Class : II M. Sc Chemistry
Title of the Course : **Elective Course V: a) Research Tools and Techniques**
Semester : **III**
Course Code : CP233EC1

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP233EC1	4	-	-	-	3	4	60	25	75	100

Learning Objectives

1. To motivate the students for research-based studies.
2. To explore relationships between variables and interpret research findings accurately.

Course Outcomes

On the successful completion of the course- students will be able to:		
1.	remember the information gathered from diverse sources in research.	**K1**
2.	understand the advanced search strategies and analytical techniques relevant to research topics.	**K2**
3.	apply the research tools and techniques for advance research and development.	**K3**
4.	analyze the scientific data from diverse sources in research.	**K4**
5.	evaluate the scientific output to interpret the research findings.	**K5**

K1 - Remember; K2 - Understand; K3– Apply; K4 - Analyze; K5 - Evaluate

Teaching plan

Total Contact hours: 60 (Including lectures, assignments and tests)

Unit	Module	Topic	Teaching Hours	Assessment Hours	Cognitive level	Pedagogy	Student Centric Method	E-Resources	Assessment/ Evaluation
I	**Source of chemical information**								
	1.	Primary - secondary and tertiary sources. Literature survey - indexes and abstracts in science and technology. Applied science and technology index	2	1	K2(U)	Lecture with ppt	Group Discussion	Journals, Books	Oral test I CIA
	2.	chemical abstracts - chemical titles - current chemical reactions - current contents and science citation index	2	1	K3(Ap)	Lecture with ppt	Think pair share	Online Databases: Chemical Abstracts, Science Citation Index	Short test I CIA
	3.	Classical and comprehensive reference works in chemistry- synthetic methods and techniques – treatises	2		K4(An)	Lecture with ppt	Hands-on literature review sessions using online Databases	E-journals, e-books	Literature Review Assignment I CIA
	4.	reviews - monographs. Access points for searching CA indexes- index guide - general subject - terms - chemical substance names -	2	1	K4(An)	Lecture with PPT	Group Discussion	Indexes: Applied Science & Technolo g y Index	Slip test and MCQ I CIA

		molecular formulas - ring systems - author names							
	5.	patent numbers. Locating the reference - finding the abstract - finding the original document chemical abstract and service source index.	1		K3(Ap)	Blended Learning	Online discussions	Patent databases	Slip test and MCQ I CIA
II	**Research Problem and Scientific Writing**								
	1.	Identification of research problem - assessing the status of the problem - guidance from the supervisor - actual investigation and analysis of experimental results - conclusions.	2	1	K2(U)	Lecture with ppt	brainstorming sessions	Videos on formulating research questions YouTube channels - Elsevier Researcher Academy.	Short summary I CIA
	2.	Scientific writing - research reports - thesis - journal articles and books. Steps to publishing a scientific article in a journal.	2	1	K3(Ap)	Lecture with PPT	Group discussions on current research Trends	Videos	Class test I CIA
	3.	Types of publications - communications - articles and reviews.	2		K3(Ap)	Lecture with Videos	Group Discussion	NCBI, Google Scholar	Seminar I CIA

	4.	Documenting - Abstracts indicative - descriptive abstracts - informative abstract - footnotes - end notes	2	1	K2(U)	Lecture using chalk and talk	Peer teaching	Journals	Short test and quiz Oral test I CIA
	5.	Referencing styles – bibliography journal - abbreviations - abbreviation used in scientific writing	1		K3(Ap)	Lecture with PPT	Group activity to match journal names with abbreviations	ACS Style Guide, Journal abbreviation search tool: https://cassi.cas.org/search.jsp	Quiz I CIA
III	**Instrumental Analysis**								
	1.	Principle - instrumentation and applications - AFM - SEM - STM	2	1	K2(U)	Lecture with visualization and demonstration	Visual learning	Virtual labs, Interactive ppt	Quiz, Image labelling activity, short test I CIA
	2.	Principle - instrumentation and applications -TEM and XRD.	2	1	K4 (An)	Lecture with visual aids	Visual learning, Concept mapping	Virtual labs, Interactive ppt, JCPDS Files	Slip test, Image labelling activity I CIA
	3.	Determination of surface morphology and particle size.	1		K3(Ap)	Visual concept lecture,	Think-Pair-Share,	Interactive videos,	Task on particle size and

						Structure based learning	Concep t mappin g	Image J software	morphology determination I CIA
	4.	Sample preparations and applications of UV - IR -	2	1	K3(Ap)	Lecture with visual aids and models, Demonstration	Inquiry based learning, Live demonstrati o n of Concepts	Interactiv e videos, tutorials and ppt	Concept explanations, slip test I CIA
	5.	NMR and mass spectroscopy.	2		K4(An)	Interactive lecture	Group discussion, Concept Mapping	Interactiv e PPT	Short test I CIA
IV	**Cheminformatics**								
	1.	Cheminformatics - history and applications.	1	1	K2(U)	Lecture with interactive ppt	Think pair Share	Videos and ppt	Slip test II CIA
	2.	Representing molecules - connection tables and line notation - InChi - SMILES and WLN canonicalization. Line notation versus connection tables. Query languages	2		K4 (An)	Lecture with visualization, Flipped classroom	Inquiry based learning, Blended learning	Molecular Representa tion tools	Concept explanations, short test II CIA
	3.	SMARTS. Molecular similarity. 2D topology and 3D configuration.	2	1	K3(Ap)	Lecture with visual representation	Group discussion	Videos and ppt	Class test II CIA
	4.	Chemistry softwares - Chemdraw .writing chemical equations and schemes - editing -	2		K3(Ap)	Demonstration	Live demonstrati on of Concepts	Software Tools: Chemdraw	Assignment on chemical structure of molecules

		transporting picture to word and image document.							II CIA
	5.	Origin -importing and exporting data - scientific graphing and data analysis - curve fitting and peak analysis - transporting graph to tag image file format	2	1	K4(An)	Demonstration	Live demonstration of concepts	Software Tools: Origin	Task on Graph creation II CIA
V	**Intellectual Property Rights**								
	1.	Introduction to Intellectual Property Rights	1	1	K2(U)	Lecture using ppt	Group Discussion	Interactive PPT	Quiz, slip test II CIA
	2.	Components of Intellectual Property-Patents-Trademarks-Copyrights-Trade Secrets-Industrial designs and Geographical Indications (GI)	2		K3(Ap)	Lecture with PPT and Videos	Logo identification game, Case discussion: Coca-Cola formula or KFC spice blend.	Patent database	Group discussion and Quiz II CIA
	3.	The Patent's act 1970-Protectable Subject Matter patentable invention.	2	1	K5(E)	Interactive lecture	Think-Pair-Share	India's IP Portal: https://ipindia.gov.in/	Short test II CIA

	4.	Patent Infringement and enforcement of patents	2	1	K3(Ap)	Interactive lecture	Group discussion	Indian Patent Search: https://iprsearch.ipindia.gov.in/	Class test II CIA
	5.	Action for Infringement- - Brief Discussion on Case Law on Patents.	2		K4(An)	Interactive lecture	Debate: The copyrightability of memes – fair use or infringement?	Indian Patent Search: https://iprsearch.ipindia.gov.in/	Slip test and MCQ II CIA

Course Focusing on Employability/ Entrepreneurship/ Skill Development:

Employability and Skill Development

Activities (Em/SD):

- Chemdraw -writing chemical equations and schemes - editing - transporting picture to word and image document.
- Origin -importing and exporting data - scientific graphing and data analysis - curve fitting and peak analysis - transporting graph to tag image file format

  Demonstration on Chemdraw and Origin

Assignment:

Primary - secondary and tertiary sources.

Seminar Topic

Unit I

Classical and comprehensive reference works in chemistry-synthetic methods and

techniques – treatises

Unit II

Types of publications - communications - articles and reviews.

Sample questions

PART- A (1 mark)

1. Which of the following is a primary source of chemical information? **(K2-U, CO-2)**
    a) Review articles
    b) Monographs
    c) Research articles
    d) Indexes and abstracts
2. Which of the following databases is specifically used for chemical abstracts? **(K3-Ap, CO-3)**
    a) PubMed
    b) Chemical Titles

c) Science Citation Index

d) Current Contents

3. In scientific writing, which type of abstract provides a summary including the purpose, methodology, results, and conclusion of the research? **(K4-An, CO-4)**

    a) Descriptive abstract

    b) Indicative abstract

    c) Informative abstract

    d) Footnote

4. Which spectroscopy technique is used for determining molecular structure? **(K2-U, CO-2)**

    a) SEM

    b) NMR

    c) AFM

    d) TEM

5. SMILES notation is used in which field? **(K3-Ap, CO-3)**

    a) Bibliographic indexing

    b) Molecular representation

    c) Spectroscopy

    d) Patent law

6. The Applied Science and Technology Index is a primary source of chemical information. (True/False) **(K2-U, CO-2)**

7. **Assertion**: Chemical Abstracts is an example of a secondary source of chemical information. **(K4-An, CO-4)**

   Reason: Secondary sources compile and summarize information from primary sources.

   a) Both the assertion and reason are true, and the reason is the correct explanation for the assertion.

   b) Both the assertion and reason are true, but the reason is not the correct explanation for the assertion.

   c) The assertion is true, but the reason is false.

   d) The assertion is false, but the reason is true.

PART B (6 marks)

1. Describe the process and importance of a literature survey, including primary, secondary, and tertiary sources, and the role of indexes and abstracts in chemistry. **(K2-U, CO-2)**
2. Explain the steps in identifying and investigating a research problem, and outline the components of scientific writing and publication. **(K2-U, CO-2)**
3. Compare the principles, instrumentation, and applications of AFM and SEM for determining surface morphology and particle size. **(K3-Ap, CO-3)**
4. Discuss the role of cheminformatics, molecule representation (InChI, SMILES, WLN), and query languages like SMARTS. **(K4-An, CO-4)**
5. Define Intellectual Property Rights (IPR), overview the Patent Act of 1970, and discuss a case law example related to patents. **(K2-U, CO-2)**

PART C (12 marks)

1. Critically analyze the role of chemical abstracts and indexes in the advancement of chemical research. How have they evolved with the advent of digital databases? **(K4-An, CO-4)**

2. Detail the process of identifying a research problem in chemistry. How can a supervisor guide the investigation and analysis of experimental results? **(K2-U, CO-2)**

3. Compare and contrast different types of publications in scientific writing: communications, articles, and reviews. Provide examples of each and discuss their significance in the dissemination of scientific knowledge. **(K3-Ap, CO-3)**

4. Evaluate the principle, instrumentation, and applications of Atomic Force Microscopy (AFM) and Transmission Electron Microscopy (TEM). How do they differ in terms of their capabilities and use cases? **(K5-E, CO-5)**

5. Discuss the historical development of cheminformatics and its impact on drug discovery and development. Include examples of how molecular similarity and 3D configuration are utilized. **(K2-U, CO-2)**

6. Explain the concept of patentable subject matter under the Patent Act of 1970. How does it ensure innovation while protecting the rights of inventors? **(K2-U, CO-2)**

7. Discuss the significance of molecular representation techniques such as connection tables and line notation in cheminformatics. How do they aid in the analysis and visualization of chemical compounds? **(K2-U, CO-2)**

8. Analyze the various steps involved in documenting scientific research, from data collection to publishing. How do abstract types and referencing styles contribute to the clarity and credibility of scientific communication? **(K4-An, CO-4)**

9. Describe the role of instrumental analysis techniques like UV, IR, NMR, and mass spectroscopy in modern chemical research. How do they complement each other in providing comprehensive data on chemical substances? **(K2-U, CO-2)**

10. Examine the importance of intellectual property rights in the chemical industry. How do patents, trademarks, copyrights, and trade secrets contribute to the protection and commercialization of chemical inventions? **(K4-An, CO-4)**

Course Instructor: Dr. B. T. Delma **Head of the Department:** Dr. R. Gladis Latha

Teaching Plan

Department : Chemistry
Class : II M.Sc. Chemistry
Title of the Course : CORE LAB COURSE III: PHYSICAL CHEMISTRY PRACTICAL
Semester : III
Course Code : CP233CP1

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP233CP1	-	-	6	-	5	6	90	25	75	100

Pre-requisite:

Students should have the basic knowledge of physical chemistry.

Learning Objectives:

1. To understand the principle of conductivity experiments through conductometric titrations.
2. To evaluate the order of the reaction.temperature coefficient.and activation energy of the reaction by following pseudo first order kinetics.

Course Outcomes

On the successful completion of the course students will be ablet o:		
1.	recall the basic theory of titrations and understand the principle of conductometrictitrations	**K1 &K2**
2.	apply theprinciplesofconductometrytodeterminethestrength ofunknown solutions.	**K3**
3.	analyze the strength of acids by adsorption method	**K4**
4.	evaluate conductance-dissociation constant and heat of solution	**K5**
5.	Construct the phase diagram of two component system forming congruent melting solid.	**K6**

K1-Remember; **K2**-Understand; **K3**–Apply; **K4**-Analyze; **K5**-Evaluate; **K6**-Create

Total Contact hours: 90 (Including Practical Classes and Assessments)

Unit	Topic	Teaching Hours	Assessment Hours	Cognitive level	Pedagogy	Student Centric Method	E-Resources	Assessment/ Evaluation Methods
I	**CONDUCTIVITY EXPERIMENTS**							
	Determination of equivalent conductance of a strong electrolyte & the verification of DHO equation.	4	1	K5	Heuristic method	Predict-Observe-Explain	O Lab	Formative Mini Tests, Model Exam
	Verification of Ostwald's Dilution Law & Determination of pKa of a weak acid.	4	1	K5	Demonstration method	Hands- on using conductometer kit	Virtual Lab	Rubic based practical skill evaluation, Model Exam
	Verification of Kohlrausch's Law for weak electrolytes.	4		K1, K2& K3	Experimental learning	Wrap-up discussion		Group presentation, Model Exam
	Determination of solubility of a sparingly soluble salt.	4	1	K5	Activity-Based Learning	Peer Teaching	PhET Virtual Lab	Peer and self assessment, Model Exam.

	Acid base titration (strong acid and weak acid vs sNaOH).	4		K1, K2& K3	Experiential Learning	Pre - lab video(flipped model)	CHEM Collective virtual Lab	Oral presentation, Model Exam
	Precipitation titrations (mixture of halides only).	5	1	K1, K2& K3	Inquiry-Based Pedagogy	Hands- on using conductometer kit	O Lab	Observation calculation , Model Exam
II	KINETICS							
	Study the kinetics of acid hydrolysis of an ester.determine the temperature coefficient and also the activation energy of the reaction.	12	2	K5	Experimental method	Flipped method	Virtual Lab	Rubic based practical skill evaluation, Model Exam
	Study the kinetics of the reaction between acetone and iodine in acidic medium by half-life method and determine the order with respect to iodine and acetone.	13	3	K5	Experimental method	Inquiry based learning	Virtual Lab	Formative Mini Tests, Model Exam
III	PHASEDIAGRAM							
	Construction of phase diagram for a simple binary system 1. Naphthalene phenanthrene	8	1	K1, K2& K3	Demonstration	Active learning	PhET Virtual Lab	Observation calculation , Model Exam

	2.Benzophenonediphenylamine	9	2	K1, K2& K3	Demonstration	Peer - Led and Cooperative learning		
	ADSORPTION							
	Adsorption of oxalic acid on charcoal & determination of surface area (Freundlich isotherm only).	8	2	K5	Heuristic method	Guided inquiry-based learning	O Lab	Peer and self-assessment, Model Exam.

Course Focussing on Employability/ Entrepreneurship/ Skill Development: Employability, Skill Development

Activities (Em / En /SD): Hands on Training , Project

Course Focusing on Cross Cutting Issues (Professional Ethics/ Human Values/Environment Sustainability/ Gender Equity): NIL

Environment Sustainability activities related to Cross Cutting Issues: NIL

Sample questions

1. Determine the equivalent conductance of a strong electrolyte and verify the DHO equation.

2. Verify Ostwald's Dilution Law and determine the pKa of a weak acid.

3. Determine the strength of given CH_3COOH and HCl in the mixture by conductometric titration. You are provided with 0.05N HCl and sodium hydroxide solution as a link.

4. Determine the strength of Cl^- and I^- ion in the given mixture by conductometric titration. You are provided with AR KCl crystals and silver nitrate solution as a link.

5. Determine the value of the adsorption constants k and n. Prepare a Std. Oxalic acid (0.2N) and NaOH (0.05N) and estimate the unknown strengths of the given acid solutions.

6. Compare the strength of given acids by acid hydrolysis of methyl acetate and determine the temperature coefficient and activation energy.

7. Construct the phase diagram for a simple binary system of Naphthalene- phenanthrene and determine the eutectic temperature, eutectic composition and unknown concentration.

8. Construct the phase diagram for a simple binary system of Benzophenone - diphenyl amine and determine the eutectic temperature, eutectic composition and unknown concentration.

Course Instructor: Dr. M. Shirly Treasa **Head of the Department:** Dr. R. Gladis Latha

Teaching Plan

Department : **Chemistry**
Class : **II M.Sc. Chemistry**
Title of the Course : **Skill Enhancement Course II: Chemical Analysis- Tools and Techniques**
Semester : **III**
Course Code : **CP233SE1**

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP233SE1	2	1	-	-	2	3	45	25	75	100

Pre-requisites:

Students should know the basic skills of Analytical Chemistry

Learning Objectives:

1. To understand the principles and importance of food preservation.
2. To execute analytical techniques accurately, interpret results and prepare comprehensive reports based on findings.

Course Outcomes

On the successful completion of the course, student will be able to:		
1	understand the chemical analysis procedures effectively, including sample collection, preparation, analysis, interpretation of results and report writing.	**K1&K2**
2	Apply separation and purification techniques to isolate and purify substances based on their physical and chemical properties.	**K3**
3	Analyze and interpret experimental data obtained from analysis, physical properties Determination and separation techniques	**K4**
4	Evaluate the importance of food preservation techniques and apply appropriate methods for preserving food products	**K5**
5	Collaborate effectively with peers in laboratory settings, demonstrating team work and Communication skills.	**K6**

K1-Remember; **K2**-Understand; **K3**-Apply; **K4**-Analyze; **K5**-Evaluate; **K6**–Create

Teaching plan

Total Contact hours:75 (Including lectures, assignments and tests)

Unit	Module	Topic	Teaching Hours	Assessment Hours	Cognitive level	Pedagogy`	Student Centric Method	E-Resources	Assessment/ Evaluation Methods
I	**CHEMICAL ANALYSIS**								
	1	Definition- collection of samples technique	1	1	K2 (U)	Problem based experiential learning	Hand on activities like fieldwork	Data collection software	Oral presentation, CIA I
	2	Selection of appropriate analytical method.	1		K4(An)	Lecture through comparative analysis	Group Discussion	Databaes tools	Written group reports, CIA I
	3	Preparation of the sample	2		K3(Ap)	Demonstratio n	Experimental learning	Instructional videos.	Quizzes, CIA I.
	4	Analysing the sample using the selected method	1	1	K4(An)	Guided practice session	Collaborative learning	Virtual instruments	Self assessment, CIA I.
	5	Interpreting the results - report preparation.	2		K5 (E) & K6(C)	Lecture with discussion	Peer teaching	Data visualization tools	Data interpretation report, CIA I
II	**FOOD PRESERVATION TECHNIQUES**								
	1	Food preservation- techniques of food preservation-	3	1	K1(R), K2 (U)& K3(Ap)	Inquiry based lecture, demonstratio	Hands on leaening, project based learning	SWAYAM online course lecture	Quizzes, poster presentation, CIA I

		chemical and physical methods-				n, case studies			
	2	Importanceof food preservation.	2	1	K2(U)& K4(An)	Collaborative approach, lecture with group discussion	Cooperative learning, group discussion	ICAR E learning portal	SGroup presentation, peer review, CIA I
	3	Food preservatives and food packing.	2		K3(Ap)	Lecture using multimedia resources like videos, animations	Experiential and community connected learning,design thinking	Animations and videos	Food exhibit, product assessment, CIA I
III	**QUANTITATIVEANALYSIS**								
	1	Titration- Definition and difference between qualitative and quantitative analysis-	1	1	K1(R), K2(U) & K4 (An)	Inquiry based lecture	Think-pair-share	Video Lectures	MCQs, CIA I
	2	Types of titrations	1		K2(U)	Virtual simulations	Group discussion	Virtual lab	Quick Quizzes, CIA II
	3	End point-equivalence point.Indicators-types	2		K2(U) & K5(E)	Experimental correlation	Experiential learning	O lab	Observation report, CIA II
	4	Oxidizing and reducing agents	1	1	K2(U) & K3(Ap)	Inquiry based lecture	participative learning	Slideshare	MCQs, short test, CIA II
	5	gravimetric analysis-Detaileddescription ofthestepsofgravime	2		K1(R), K2(U) & K5 (E)	Integrated theoretical and experimental approach	Performing titrations	Online video	Observation reportt CIA II

		tric analysis-applications.							
IV	**PHYSICALPROPERTIESOF LIQUIDS**								
	1	Physical states of matter- melting point, determination of melting point-	3	1	K1(R), K2(U) & K5(E)	Lecture with discussion, Inquiry-Based teaching approach	Experiential learning,cooperative learning	Virtual lab	Observation,lab performance, CIA II
	2	Decomposition-evaporation-sublimation.	2	1	K2(U), & K3(Ap)	Conceptual and visual teaching method	Active learning, experimental learning	Study.com video lessons	Quizzes using Nearpod, , CIA II
	3	Boiling point-determination of boiling point.	2		K2(U), & K4(An)	Hands on exploration	Performing experiments	PhET / Labster simulations	Record report, CIA II
V	**SEPARATION AND PURIFICATION TECHNIQUES**								
	1	Characterization-uses and selection ofseparationprocess--distillation- types of distillation-simple	2	1	K2(U)	Inquiry based lecture, Flipped classroom	Group discussion, peer teaching	ClassCentral YouTube tutorial	Quiz,peer explanation, CIA II
	2	Filtrationtechniques -filter paper- simple filtration- filtration through vacuum pump	3		K3(Ap)	Demonstration	Inquiry based learning, Perforing experiments	abster Virtual Lab	Summative project, CIA II
	3	Distillation fractional distillation-difference between	2	1	K3(Ap), K4(An)	Heuristic method, collaborative approach	Experiential learning,activity based learnig	PhET / Gizmos Simulations	Practical lab task , CIA II

		simple and fractional distillation.							

Course Focussing on Employability/ Entrepreneurship/ Skill Development: **Employability, Skill Development, Entrepreneurship**

Activities (Em / En /SD): **Hands on Training on food preservation, separation and purification of mixture, Exhibition on food preservation Techniques**

Course Focusing on Cross Cutting Issues (Professional Ethics/ Human Values/Environment Sustainability/ Gender Equity): - Environment Sustainability activities related to Cross Cutting Issues:-NIL

Assignment: Food preservation-techniques of food preservation-chemical and physical methods- importance of food preservation-food preservatives and food packing. (Last date to submit – example: 25-07-2025)

Seminar Topics: Characterization-uses and selection of separation process-filtration techniques-filter paper-simple filtration-filtration through vacuum pump-distillation- types of distillation-simple distillation-fractional distillation-difference between simple and fractional distillation.

Sample questions

Part A (2 mark)

1. Describe the basic steps involved in preparing a sample. **(K2-U, CO-1)**
2. Evaluate the effectiveness of vacuum packing as a method of food preservation. **(K5-E, CO-4)**
3. What is the difference between qualitative and quantitative analysis? **(K4-An, CO-3)**
4. How will you determine the melting point of a given solid substance? **(K5-E, CO-4)**
5. What is simple distillation? **(K2-U, CO-1)**

Part B (6 marks)

6. List the main techniques used for sample analysis in environmental testing. **(K2-U, CO-1)**

7. Explain the significance of using chemical preservatives in food preservation. **(K3-Ap, CO-2)**
8. List the main techniques used for sample analysis in environmental testing. **(K3-Ap, CO-2)**
9. How would you differentiate between a primary and secondary standard in titration? (**K4-An, CO-3)**
10. List and describe the three primary physical states of matter. **(K2-U, CO-1)**
11. Evaluate the impact of the choice of filter paper on the effectiveness of the filtration process. **(K5-E, CO-4)**

Part C (12 marks)

12. List and define five different analytical techniques commonly used in chemical analysis. **(K2-U, CO-1)**
13. List and define five common chemical preservatives used in the food industry. **(K2-U, CO-1)**
14. Evaluate the benefits and limitations of using natural food preservatives compared to synthetic ones. **(K5-E, CO-4)**
15. List and define the different types of indicators used in titrations. **(K3-Ap, CO-2)**
16. Analyze the role of oxidizing and reducing agents in the determination of the equivalence point in redox titrations. (**K4-An, CO-3)**
17. Describe in detail the process of determining the boiling point of a liquid using a distillation apparatus. **(K5-E, CO-4)**
18. Analyze the role of intermolecular forces in determining the melting and boiling points of substances. **(K3-Ap, CO-2)**
19. Describe in detail the process of setting up and performing fractional distillation. **(K2-U, CO-1)**

Course Instructor: Dr. M. Shirly Treasa

Head of the Department: Dr. R. Gladis Latha