Holy Cross College (Autonomous), Nagercoil

Kanyakumari District, Tamil Nadu.
Accredited with A^{+} by NAAC - IV cycle – CGPA 3.35

Affiliated to

Manonmaniam Sundaranar University, Tirunelveli

DEPARTMENT OF CHEMISTRY

SYLLABUS FOR POSTGRADUATE PROGRAMME

TEACHING PLAN

ODD SEMESTER 2024-2025

Vision

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

Mission

- To develop intellectual and professional skills of the students
- To provide a firm foundation in chemical concepts, laws and theories
- To sharpen the scientific knowledge
- To enhance critical thinking, problem solving ability, scientific temper and innovation
- 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

CO	Upon completion of this course, the students will be able to:	PSO addressed	Cognitive level
CO-1	recall the basic principles of organic chemistry	PSO - 1	K2(U)
CO-2	understand the formation and detection of reaction intermediates of organic reactions.	PSO - 2	K2(U)
CO-3	predict the reaction mechanism of organic reactions and stereochemistry of organic compounds.	PSO - 3	K4(An)
CO-4	apply the principles of kinetic and non-kinetic methods to determine the mechanism of reactions.	PSO - 1	K3(Ap)
CO-5	design and synthesize new organic compounds by correlating the stereochemistry of organic compounds.	PSO - 2	K5(E)

Teaching plan

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

Unit	Module	Topic	Teaching Hours	Cognitive level	Pedagogy	Assessment/ Evaluation
I	**Methods of Determination of Reaction Mechanism**					
	1	Reaction intermediates, The transition state, Reaction coordinate diagrams, Thermodynamic and kinetic requirements of reactions:	5	K2(U)	Lecture with ppt	Oral test
	2	Hammond postulate. Methods of determining mechanism: non-kinetic methods - product analysis, determination of intermediates-isolation, detection, and trapping	7	K3(Ap)	Lecture with ppt	Short test
	3	Cross-over experiments, isotopic labelling, isotope effects and stereo chemical evidences. Kinetic methods - relation of rate and mechanism.	3	K4(An)	Lecture using chalk and talk	Slip test and MCQ
	4	Effect of structure on reactivity: Hammett and Taft equations. Linear free energy relationship, partial rate factor, substituent and reaction constants.	6	K3(Ap)	Lecture using chalk	Slip test and MCQ
II	**Aromatic and Aliphatic Electrophilic Substitution**					
	1	Aromaticity: Aromaticity in benzenoid, non-benzenoid, heterocyclic compounds and annulenes.	5	K2(U)	Lecture with ppt	Short summary
	2	Aromatic electrophilic substitution: Orientation and reactivity of di- and polysubstituted phenol, nitrobenzene and halobenzene.	4	K3(Ap)	Lecture using chalk and talk	Class test
	3	Reactions involving nitrogen electrophiles: nitration, nitrosation and diazonium coupling; Sulphur electrophiles: sulphonation;	5	K3(Ap)	Group discussion	Oral test

	4	Halogen electrophiles: chlorination and bromination; Carbon electrophiles: Friedel-Crafts alkylation, acylation and arylation reactions	4	K4(An)	Lecture using chalk and talk	Short test and quiz
	5	Aliphatic electrophilic substitution Mechanisms: SE2 and SEi, SE1-Mechanism and evidences.	3	K2(U)	Lecture with ppt	Oral test
III	**Aromatic and Aliphatic Nucleophilic Substitution**					
	1	Aromatic nucleophilic substitution: Mechanisms - S_NAr, S_N1 and Benzyne mechanisms - Evidences - Reactivity, Effect of structure, leaving group and attacking nucleophile.	5	K2(U)	Lecture using ppt	Concept explanations
	2	Reactions: Oxygen and Sulphur-nucleophiles, Bucherer and Rosenmund reactions, von Richter, Sommelet- Hauser and Smiles rearrangements.	5	K3(Ap)	Lecture using chalk and talk	Slip test
	3	S_N1, ion pair, S_N2 mechanisms and evidences. Aliphatic nucleophilic substitutions at an allylic carbon, aliphatic trigonal carbon and vinyl carbon.	5	K3(Ap)	Lecture using chalk and talk	Class test
	4	S_N1, S_N2, S_Ni, and S_E1 mechanism and evidences, Swain- Scott, Grunwald-Winstein relationship - Ambident nucleophiles	6	K4(An)	Lecture using chalk and talk	Slip test and quiz
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 with C, N, S based chiral	4	K2(U)	Lecture using videos and ppt	Concept explanations and short summary

		centers				
	2	Optical purity, prochirality, enantiotopic and diastereotopic atoms, groups, faces, axial and planar chirality, chirality due to helical shape, methods of determining theconfiguration.	4	K3(Ap)	Lecture using chalk and talk	Class test
	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	K3(Ap)	Lecture using chalk and talk	Short test
	4	Configurations of allenes, spiranes, biphenyls, cyclooctene, helicene, binaphthyls, ansa and cyclophanic compounds, exo-cyclic alkylidene-cycloalkanes. Topicity and prostereoisomerism, chiral shift reagents and chiral solvating reagents	5	K4(An)	Lecture using chalk and talk	Class test
	5	Criteria for optical purity: Resolution of racemic modifications, asymmetric transformations, asymmetric synthesis, destruction. Stereoselective and stereospecific synthesis.	4	K4(An)	Lecture using chalk and talk	Group discussion and class test
V	**Stereochemistry-II**					
	1	Conformation and reactivity of acyclic systems, intramolecular rearrangements, neighbouring group participation, chemical consequence of conformational equilibrium - Curtin-Hammett Principle	5	K3(Ap)	Lecture using chalk and talk	slip test
	2	Stability of five and six-membered rings: mono-, di- and polysubstituted cyclohexanes, conformation	5	K6(E)	Lecture using chalk and talk and Group	Short test

		and reactivity in cyclohexane systems.			discussion	
	3	Fused and bridged rings: bicyclic, poly cyclic systems, decalins and Brett's rule	5	K3(Ap)	Lecture using chalk and talk	Class test
	4	Optical rotation and optical rotatory dispersion, conformational asymmetry, ORD curves, octant rule, configuration and conformation, Cotton effect, axial haloketone rule and determination of configuration.	6	K4(An)	Lecture using ppt	Slip test and MCQ

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^o> 2^o> 1^o (b) Benzyl > 1^o> 2^o> 3^o

   (c) 3^o> 2^o> 1^o> Benzyl(d) 1^o> 2^o> 3^o > Benzyl

2. Benzyl radical is more stable than allyl radical. (True/ False)

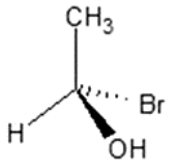
3. In SN1 reaction, the first step involves the formation of_____.

   (a) free radical (b) carbanion (c) carbocation (d) final product

4. Which of the following act as catalyst in the nitration of benzene

(a) Conc. H_2SO_4 (b) Dil. HCl (c) Conc. HNO_3 (d) HNO_2

5. Assign the R, S nomenclature of the following compound:

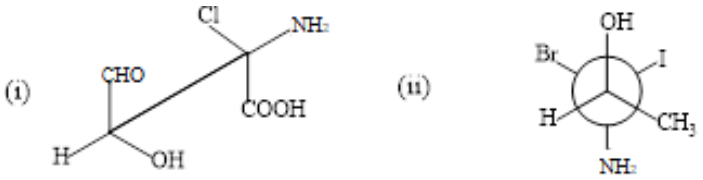


6. Predict the most stable conformation of cyclohexane.

(a) Chair (b) Boat (c) Half chair (d) Twist boat

PART B

1. Interpret any two applications of Hammett equation.
2. Explain Hammett and Taft equations.
3. Demonstrate aromatic nucleophilic substitution in aryl halides.
4. Convert the following sawhorse and Newman projections into equivalent Fischer projections:



(OR)

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

Part: C

1. Sketch and explain the energy profile diagrams of simple organic reactions.
2. Interpret the generation and stability of benzynes and carbocations.
3. Explain Sommelet- Hauser and Smiles rearrangements
4. Illustrate aliphatic nucleophilic substitutions in an allylic carbon
5. Illustrate the mechanism of S_N^{Ar} substitution with an example.
6. Elucidate planar chirality and helicity with suitable examples.
7. Illustrate Cram's rule with examples.
8. Verify Curtin-Hammet principle with an example.

Head of the Department **Course Instructor**

Dr. M. Anitha Malbi Dr. M. Antilin Princela

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

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

Course outcomes

CO	Upon completion of this course, the students will be able to:	PSO addressed	Cognitive level
CO-1	recall & predict the geometry of main group compounds and clusters.	PSO - 2	K3(Ap)
CO-2	explain about the packing of ions in crystals and apply the radius ratio rule to predict the coordination number of cations.	PSO - 2	K3(Ap)
CO-3	understand the various types of ionic crystal systems and analyze their structural features.	PSO - 3	K4(An)
CO-4	explain the crystal growth methods	PSO - 1	K2 (U)
CO-5	understand the principles of diffraction techniques and microscopic techniques and evaluate the structure of solids.	PSO - 2	K5(E)

Teaching plan

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

Unit	Module	Topic	Teaching Hours	Cognitive level	Pedagogy	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	K3(Ap)	Introductory session, Lecture using Chalk and talk	Concept explanations, short summary
	2.	Applications of Paulings rule of electrovalence	2	K3(Ap)	Group Discussion and Lecture using Chalk and talk	Short summary
	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 using videos and PPT	Simple definitions, MCQ
	4.	Structure of silicones	2	K2(U)	Review	True/False
	5.	Structural and bonding features of B-N, S-N and P-N compounds	3	K4(An)	Lecture using Chalk and talk, Group Discussion	Differentiate between bonding in B-N, S-N and P-N compounds
	6.	Poly acids – types, examples and structures	2	K2(U)	PPT	Simple definitions, short essay
	7.	Borane cluster: Structural features of closo, nido, arachano and klado; carboranes, hetero and metalloboranes	3	K4(An)	Group Discussion and Lecture using Chalk and talk	Evaluation through short test
	8.	Wade's rule to predict the structure	2	K3(Ap)	Group Discussion	Evaluation through quiz
II	**Solid state chemistry – I**					
	1.	Ionic crystals: Packing of ions in simple, hexagonal and cubic close packing	4	K2(U)	Lecture using Chalk and talk	MCQ
	2.	Voids in crystal lattice,	2	K3(Ap)	Group	Evaluation

		Radius ratio			Discussion	through quiz
	3.	Crystal systems and Bravis lattices	3	K2(U)	PPT	Evaluation through short test
	4.	Symmetry operations in crystals	3	K3(Ap)	Demonstration, Review	Evaluation through short test
	5.	Glide planes and screw axis; point group and space group	4	K2(U)	Lecture using videos	Simple definitions
	6.	Solid state energetics: Lattice energy – Born-Lande equation - Kapustinski equation, Madelung constant.	5	K5(E)	Lecture using Chalk and talk	Problem-solving questions
III	**Solid state chemistry – II**					
	1.	Structural features of the crystal systems: Rock salt, zinc blende & wurtzite.	4	K2(U)	Lecture using PPT	Short summary
	2.	Fluorite and anti-fluorite, rutile and anatase	4	K2(U)	Lecture using Chalk and talk	Short essays
	3.	Cadmium iodide and nickel arsenide.	4	K2(U)	Lecture using PPT	Evaluation through short test
	4.	Spinels -normal and inverse types and perovskite structures	4	K4(An)	Group Discussion and Lecture using Chalk and talk	MCQ, simple definitions
	5.	Crystal Growth methods: From melt and solution (hydrothermal, sol-gel methods) – principles and examples.	5	K4(An)	Introductory session, Group Discussion and Lecture using Chalk and talk	Short essays
IV	**Techniques in solid state chemistry**					
	1.	X-ray diffraction technique: Bragg's law, Powder diffraction method – Principle and Instrumentation	4	K2(U)	Introductory session, and Lecture using Chalk and talk	Short essays
	2.	Interpretation of XRD data – JCPDS files	4	K3(Ap)	Demonstration	Review
	3.	Phase purity, Scherrer formula, lattice	3	K5(E)	Lecture using Chalk and talk	Problem solving

		constants calculation			and Problem solving	
	4.	Systematic absence of reflections; Electron diffraction technique – principle, instrumentation and application.	3	K3(Ap)	Lecture using PPT	True/False, MCQ
	5.	Electron microscopy – difference between optical and electron microscopy, theory, principle, instrumentation	4	K4(An)	Group Discussion and PPT	Evaluation through short test
	6.	Sampling methods and applications of SEM and TEM.	3	K3(Ap)	Demonstration	Short essays
V	**Band theory and defects in solids**					
	1.	Band theory – features and its application of conductors, insulators and semiconductors	4	K3(Ap)	Introductory session, Group Discussion	Simple definitions
	2.	Intrinsic and extrinsic semiconductors	3	K4(An)	Lecture using Chalk and Talk, Group Discussion	Evaluation through short test
	3.	Defects in crystals – point defects (Schottky, Frenkel, metal excess and metal deficient) and their effect on the electrical and optical property	6	K2(U)	Lecture using PPT	Sort essays, MCQ
	4.	laser and phosphors	4	K2(U)	Lecture using Chalk and Talk	True/False
	5.	Linear defects and its effects due to dislocations.	4	K2(U)	Lecture using videos	Review

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 _____.

2. An octahedral void is surrounded by _____ spheres.

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

3. The general formula of perovskite structure is ABX 3. (True/False)

4. Define lattice energy.

5. The conduction band overlaps with the valence band in _____.

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

Part B

1. Classify the types of silicates.
2. Write a note on different types of voids.
3. Sketch the structure of rock salt
4. List out the difference between optical and electron microscopy
5. Mention the applications of band theory.

Part C

1. Predict the geometry of the molecules using Bent's rule.
2. Calculate lattice energy of a crystal from the Born-Lande equation?
3. Compare the structure of zinc blende and wurtzite.
4. Explain the morphology of a sample using SEM and TEM.
5. Discuss the different types of defects in solids.

Head of the Department **Course Instructor**

Dr. M. Anitha Malbi Dr. M. Shirly Treasa

Department : Chemistry
Class : I M. Sc Chemistry
Title of the Course : Elective Course I: a) Nano Materials and Nano Technology
Semester : I
Course Code : CP231EC1

Course Code	L	T	P	Credits	Inst. Hours	Total Hours	Marks		
							CIA	External	Total
CP231EC1	4	1	-	3	5	75	25	75	100

Objectives

- To understand the various types of nano materials and their properties.
- To understand the applications of synthetically important nano materials.
- To correlate the characteristics of various nano materials synthesized by new technologies.

Course outcomes

CO	Upon completion of this course, the students will be able to:	PSO addressed	Cognitive level
CO - 1	Understand the methods of fabricating nanostructures.	PSO - 1	K2 (U)
CO - 2	relate the unique properties of nanomaterials to reduce dimensionality of the material.	PSO – 2,3	K4 (An)
CO - 3	describe the tools for properties of nanostructures.	PSO – 3, 4	K2 (U)
CO - 4	discuss the applications of nanomaterials.	PSO – 3, 5	K3 (Ap)
CO - 5	synthesize nano composites.	PSO - 3	K6 (C)

Teaching plan

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

Unit	Module	Topic	Teaching Hours	Cognitive level	Pedagogy	Assessment/ Evaluation
I	**Introduction of nanomaterials and nanotechnologies**					
	1	Introduction-role of size, classification-0D, 1D, 2D, 3D.	3	K2(U)	Lecture using chalk and talk, Group discussion	Recall definitions and concept explanations
	2	Synthesis-Bottom –Up, Top–Down, consolidation of nano powders.	4	K3(Ap)	Lecture using videos and ppt	MCQ and class test
	3	Features of nanostructures, Background of nanostructures.	2	K4(An)	Flipped classroom and lecture using chalk and talk	Group discussion and short test
	4	Techniques of synthesis of nanomaterials, Tools of the nanoscience.	3	K2(U)	Lecture using chalk and talk	Slip test and MCQ
	5	Applications of nanomaterials and technologies.	3	K3(Ap)	Lecture using chalk and talk and Group discussion	Short summary or overview
II	**Bonding and structure of the nanomaterials**					
	1	Predicting the Type of Bonding in a Substance crystal structure.	2	K4(An)	Lecture using chalk and talk	Short summary or overview
	2	Metallic nanoparticles, Surfaces of Materials, Nanoparticle Size and Properties.	4	K2(U)	Group discussion	Slip test and Quiz
	3	Synthesis- Physical and chemical methods - inert gas condensation, arc discharge, laser ablation, sol-gel, solvothermal and hydrothermal methods	5	K3(Ap)	Lecture using videos and ppt	Slip test and MCQ
	4	CVD-types, metallo organic, plasma enhanced, and low-pressure CVD.	2	K4(An)	Lecture using chalk and talk	Short test and quiz
	5	Microwave assisted and electrochemical synthesis.	2	K3(Ap)	Lecture using chalk and talk, videos	Short summary or overview

III	**Mechanical properties of nanomaterials**					
	1	Mechanical properties of materials, theories relevant to mechanical properties.	4	K2(U)	Lecture using chalk and talk	Concept explanations
	2	Techniques to study mechanical properties of nanomaterials, adhesion and friction, thermal properties of nanomaterials	5	K4(An)	Lecture using chalk and talk	Slip test and quiz
	3	Nanoparticles: gold and silver	3	K3(Ap)	Lecture using ppt	Short summary or overview
	4	Metal oxides: silica, iron oxide and alumina–synthesis and properties.	3	K3 (Ap)	Lecture using chalk and talk	Short test and MCQ
IV	**Electrical properties**					
	1	Electrical properties, Conductivity and Resistivity, Classification of Materials based on Conductivity, magnetic properties, electronic properties of materials.	4	K4(An)	Lecture using videos and ppt	Concept explanations and short summary
	2	Classification of magnetic phenomena. Semiconductor materials – classification-Ge, Si, GaAs, SiC, GaN, GaP, CdS, PbS.	4	K2(U)	Lecture using chalk and talk	Slip test and quiz
	3	Identification of materials as p and n –type semiconductor-Hall effect - quantum and anomalous, Hall voltage - interpretation of charge carrier density.	4	K4(An)	Lecture using chalk and talk	Short test and MCQ
	4	Applications of semiconductors: p-n junction as transistors and rectifiers, photovoltaic and photogalvanic cell.	3	K3(Ap)	Lecture using chalk and talk, mind mapping and group discussion	Class test
V	**Nanocomposites.**					

	1	Nano thin films, nanocomposites. Application of nanoparticles in different fields.	3	K2(U)	Group discussion and problem solving	Slip test
	2	Core-shell nanoparticles-types, synthesis, and properties.	4	K3(Ap)	Lecture using chalk and talk	Group discussion and slip test
	3	Nanocomposites-metal, ceramic and polymer matrix composites-applications.	4	K3(Ap)	Lecture using ppt	MCQ and short test
	4	Characterization– SEM, TEM and AFM - principle, instrumentation and applications.	4	K4(An)	Lecture using chalk and talk,Videos	Short summary

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

Activities (Em/ En/SD):

Preparation of nanoparticles, Checking the conductivity of nanomaterials, Characterizing the nanoparticle using SEM

Assignment:

Topic: Synthesis of nanomaterials by chemical methods, Applications of semiconductors -Reflective writing

Seminar Topic:

Unit- I

Synthesis-Bottom –Up, Top–Down, consolidation of nano powders.

Unit- II

Synthesis- Physical and chemical methods - inert gas condensation, arc discharge, laser ablation, sol-gel, solvothermal and CVD

Unit-III

Preparation of Gold and Silver nanoparticles, metal nanocomposites

Sample questions

Part A

1. Which one of the following is a two-dimensional nanoparticle?
   (a) Nanotubes (b) Nanorods
   (c) Nanosheets (d) Nano wires
2. One nanometer is equivalent to
   (a) 10^{-9}m (b) 10^{-9}cm (c) 10^{-9}dm (d) 10^{-9}pm
3. An example of Top-down approach is
   (a) Thermolysis (b) Sol-gel method
   (c) Sonochemical approach (d) Laser ablation method
4. Which one of the following is a polymer nanocomposite?
   (a) Epoxy nanocomposite (b) Bimetallic nanocomposite
   (c) Metal oxide nanomaterial (d) Trimetallic nanocomposite
5. In polymer nanocomposites, matrix phase is polymer and dispersed phase is_____.
   (a) Monomer (b) Compound
   (c) nanomaterial (d) Micromaterial
6. Quantum wire is a
   (a) 1-D structure (b) 3-D structure
   (c) 2-D structure (d) 0-D structure
7. Which of the following is an example of top-down approach of synthesis of the nano-material?
   (a) Physical vapour deposition (PVD) (b) Sputtering
   (c) Chemical vapour deposition (CVD) (d) Mechanical attrition

Part B

1. Classify the nanoparticles based on their structure.
2. Explain laser ablation process for producing nanomaterials with a neat diagram.
3. Discuss about the size dependent properties of nanomaterials.
4. With a neat sketch, explain Sol-gel synthesis for producing nanomaterials.
5. Discuss the properties and applications of metal matrix composites.
6. Analyse the p and n-type semiconductor in nanomaterials using Hall effect.

Part C

1. Validate the electrical properties of nanoparticles.
2. Write an informative note on the applications of nanomaterials.
3. Discuss the CVD and laser ablation techniques for the synthesis of nanoparticles.
4. Construct the diagram, working principle and procedure of Scanning Electron Microscopy.
5. Explain the preparation and properties of gold and silver nanoparticles.
6. Elaborate briefly the applications of semiconductor based on nanomaterials.

Head of the Department **Course Instructor**

Dr. M. Anitha Malbi Dr. B. T. Delma

Department : Chemistry
Class : I M. Sc Chemistry
Title of the Course : Elective Course II: a) Electrochemistry
Semester : I
Course Code : CP231EC4

Course Code	L	T	P	Credits	Inst. Hours	Total Hours	Marks		
							CIA	External	Total
CP231EC4	4	1	-	3	5	75	25	75	100

Objectives

- To understand the behavior of electrolytes in terms of conductance, ionic atmosphere, interactions.
- To get knowledge regarding the different types of over voltages and its applications in electro analytical techniques.

Course Outcomes (COs)

CO	Upon completion of this course, the students will be able to:	PSO Addressed	Cognitive level
CO - 1	understand the behaviour of electrolytes in solution and compare the structures of electrical double layer of different models	PSO - 1	K2(U)
CO - 2	predict the kinetics of electrode reactions applying Butler-Volmer and Tafel equations	PSO - 2,3	K3(Ap)
CO - 3	analyse different thermodynamic mechanism of corrosion	PSO - 2,4	K4(An)
CO - 4	evaluate the theories of electrolytes, electrical double layer, electrodics and activity coefficient of electrolytes	PSO - 2,3	K5(E)
CO - 5	construct fuel cells and storage devices	PSO – 4,5	K6(C)

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

Unit	Module	Topic	Teaching Hours	Cognitive level	Pedagogy	Assessment/ Evaluation
I	**Ionics**					
	1	Arrhenius theory -limitations, van't Hoff factor and its relation to colligative properties. Deviation from ideal behavior	3	K2(U)	Lecture using Chalk and talk,PPT	Evaluation through short test,
	2	Ionic activity, mean ionic activity and mean ionic activity coefficient-concept of ionic strength, Debye Huckel theory of strong electrolytes, activity coefficient of strong electrolytes	3	K3(Ap)	Flipped classroom and lecture using chalk and talk	Problem solving and class test
	3	Effect of solvent polarity on λ_{max}. Determination of activity coefficient ion solvent and ion-ion interactions.	3	K4(An)	Lecture using Chalk and talk,PPT, Group Discussion	Slip test and MCQ
	4	Derivation of Debye-Huckel limiting law at appreciable concentration of electrolytes modifications and applications.	3	K2(U)	Lecture using videos and ppt	Recall steps, Concept definitions
	5	Electrolytic conduction-Debye-Huckel Onsager treatment of strong electrolyte-qualitative and quantitative verification and limitations	3	K3(Ap)	Lecture using chalk and talk and Group discussion	Group discussion and short test
II	**Electrode-electrolyte interface**					
	1	Interfacial phenomena - Evidences for electrical double layer, polarizable and non-polarizable interfaces,	3	K2(U)	Lecture using videos and ppt	Short summary or overview
	2	Electrocapillary phenomena - Lippmann equation electro capillary curves.	2	K2(U)	Lecture using chalk and talk	Slip test and class test
	3	Electro-kinetic phenomena electro-osmosis, electrophoresis, streaming and sedimentation potentials	3	K3(Ap)	Group discussion and problem solving	Problem solving
	4	Colloidal and poly electrolytes.	2	K4(An)	Lecture using chalk and talk	Short test and quiz

	5	Structure of double layer: Helmholtz -Perrin, Guoy-Chapman and Stern models of electrical double layer	3	K3(Ap)	Lecture using chalk and talk	Short summary or overview
	6	Zeta potential and potential at zero charge. Applications and limitations.	2	K3(Ap)	Lecture using chalk and talk,PPT	Short test and quiz
III	**Electrodics of Elementary Electrode Reactions**					
	1	Behavior of electrodes: Standard electrodes and electrodes at equilibrium. Anodic and Cathodic currents, condition for the discharge of ions.	3	K2(U)	Lecture using chalk and talk,Videos	Evaluation through short test,
	2	Nernst equation, polarizable and non-polarizable electrodes. Model of three electrode system, over potential.	3	K4(An)	Lecture using chalk and talk	Slip test
	3	Rate of electro chemical reactions: Rates of simple elementary reactions.	2	K3(Ap)	Lecture using chalk and talk	Short summary or overview
	4	Butler-Volmer equation-significance of exchange current density, net current density and symmetry factor.	3	K5(E)	Lecture using chalk and talk	Slip test and quiz
	5	Low and high field approximations. symmetry factor and transfer coefficient Tafel equations and Tafel plots.	4	K3(Ap)	Lecture using ppt	Group discussion
IV	**Electrodics of Multistep Multi Electron System**					
	1	Rates of multi-step electrode reactions. Rate determining step, electrode polarization and depolarization	3	K2(U)	Lecture using videos and ppt	Concept explanations and short summary
	2	Transfer coefficients, its significance and determination, Stoichiometric number	2	K4(An)	Lecture using chalk and talk	Slip test and quiz
	3	Reduction of I^{3-}, Fe^{2+}, and dissolution of Fe to Fe^{2+}..	2	K2(U)	Lecture using chalk and talk	Short test

	4	Overvoltage - Chemical and electro chemical, Phase, activation and concentration over potentials	4	K4(An)	Lecture using chalk and talk,	Group discussion and class test
	5	Evolution of oxygen and hydrogen at different pH, Pourbaix and Evan's diagrams	4	K4(An)	Mind mapping and group discussion	Concept explanation and short test
V	**Concentration Polarization, Batteries and Fuel cells:**					
	1	Modes of Transport of electro active species - Diffusion, migration and hydrodynamic modes.	3	K3(Ap)	Group discussion and Lecture using chalk and talk	Slip test
	2	Role of supporting electrolytes. Polarography-principle and applications.	3	K3(Ap)	Lecture with chalk and talk, PPT	Discussion and slip test
	3	Cyclic voltammetry- anodic and cathodic stripping voltammetry and differential pulse voltammetry.	3	K3(Ap)	Lecture with chalk and talk,PPT	Concept explanation and short test
	4	Sodium and lithium-ion batteries and redox flow batteries	3	K5(E)	Group discussion and Lecture using chalk and talk	Concept explanations and short summary
	5	Energy production systems: FuelCells: classification, alkaline fuel cells, phosphoric acid fuel cells, high temperature fuel cells.	3	K6(C)	Lecture with chalk and talk,videos	Discussion and slip test

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

Activities (Em/SD): Demonstration of Pourbaix and Evan's diagrams, Construction of Fuel Cells

Assignment:

Topic: Structure of double layer: Helmholtz -Perrin, Guoy- Chapman and Stern models of electrical double layer

Type: Poster presentation on different models of electrical double layer**.**

Seminar Topic

Unit I

Arrhenius theory -limitations, van't Hoff factor and its relation to colligative properties.Ionic activity, mean ionic activity and mean ionic activity coefficient-concept of ionic strength, Debye Huckel theory of strong electrolytes, activity coefficient of strong electrolytes

Unit II

Electro-kinetic phenomena electro-osmosis,electrophoresis, streaming and sedimentation potentials Zeta potential and potential at zero charge. Applications and limitations

Unit V

Sodium and lithium-ion batteries and redox flow batteries. Energy production systems:
Fuel Cells: classification, alkaline fuel cells, phosphoric acid fuel cells, high temperature fuel cells.

Sample questions

Part A

1. What is the value of the Van't Hoff factor (i) for solutes that dissociate in water?
   a) > 1
   b) < 1
   c) = 0
   d) Not defined
2. The Van't Hoff Factor for a solution of glucose in water is equal to 1.
   a) True
   b) False
3. A polarizable electrode is an electrode in an electrochemical cell that is characterized by _____at the electrode-electrolyte boundary.
4. Selective discharge of ions depends on:
   A. the nature of the electrode
   B. the relative concentration of ions
   C. the relative position of ions in the electrochemical (activity) series
   D. all of the above
5. Exchange current density is the current per unit area of either oxidation or reduction process at_____.
6. Voltammetry is based on the measurement of _____ as function of applied potential conductance pH current concentration.
7. Supporting electrolyte is used in Polarography to suppress_____ Diffusion current Migration current convention current limiting current.

Part B

1. Enlist the limitations of Arrhenius theory.

2. Correlate the terms Ionic activity, mean ionic activity and mean ionic activity coefficient.
3. Differentiate polarizable and non-polarizable interfaces.
4. Comment on the significance of exchange current density, net current density and symmetry factor.
5. Discuss the types of overvoltage.
6. Write a note on the role of supporting electrolytes.
7. What are the types of fuel cells?

Part C

1. Derive Debye-Huckel limiting law at appreciable concentration of electrolytes.
2. Discuss Debye-Huckel Onsager treatment of strong electrolyte-qualitative and quantitative verification and limitations.
3. Analyse the various models proposed for the structure of electrical double layer.
4. Derive the Butler-Volmer equation.
5. Sketch and explain the Pourbaix diagram and its significance.
6. Discuss the principle and application of polarography.
7. Explain the principle of cyclic voltammetry and its types.

Head of the Department **Course Instructor**

Dr. M. Anitha Malbi Dr. S. Lizy Roselet

Department : Chemistry
Class : II M. Sc Chemistry
Title of the Course : **Core Course V: Organic Synthesis and Photochemistry**
Semester : **III**
Course Code : CP233CC1

Learning Objectives:

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

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.

Course outcomes

CO	Upon completion of this course, the students will be able to:	PSO addressed	Cognitive level
CO-1	recall the basic principles of organic chemistry and to understand the various reactions of organic compounds with reaction mechanisms.	PSO - 1	K1 (R) & K2(U)
CO-2	apply the versatility of various special reagents and to correlate their reactivity with various reaction conditions.	PSO - 2	K3(Ap)
CO-3	analyze the synthetic strategies in the preparation of various organic compounds.	PSO - 3	K4(An)
CO-4	evaluate the suitability of reaction conditions in the preparation of tailor-made organic compounds.	PSO -2	K5(E)
CO-5	design and synthesize novel organic compounds with the methodologies learnt during the course.	PSO - 3	K6(C)

Teaching plan

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

Unit	Module	Topic	Teaching Hours	Cognitive level	Pedagogy	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	K2(U)	Lecture using ppt	Concept explanations
	2	Target molecule - synthons and synthetic equivalents- types of synthons: donor and acceptor synthons. Transformations in Retrosynthesis - Functional group addition and interconversions.	6	K4(An)	Lecture using chalk and talk	Slip test
	3	Monofunctional disconnection: alcohol disconnection - ketone disconnection - acid and their derivatives disconnection - amide disconnection.	4	K3(A)	Group discussion and Peer Teaching	Problem solving
	4	Bifunctional 1-2, 1-3, 1-4 and 1-5 disconnections.	4	K4(An)	Lecture using chalk and talk and Group discussion	Group discussion and short test
II	**Organic Synthetic Methodology**					
	1	Control elements- Regiospecific control elements. Use of protective groups - protection of hydroxyl- carboxyl- carbonyl and amino groups- activating groups.	5	K2(U)	Lecture using ppt	Concept explanations
	2	Latent polarity. Synthesis based on umpolung concepts of Seebach - typical examples.	4	K3(A)	Lecture using chalk and talk	Short summary or overview
	3	Designing synthesis: Disconnection approach in Cis-jasmone- Epothilone-	5	K5(E)	Lecture using chalk and talk	Slip test and quiz

		Juvabione.				
	4	Disconnection approach in bisabolene and longifolene. Synthetic uses of nitrocompounds and alkenes.	4	K3(A)	Lecture using ppt	Group discussion
III	**Pericyclic Reactions**					
	1	Characteristics and classifications of pericyclic reactions -Cycloaddition - Electrocyclic - Chelotropic and Sigmatropic reactions.	2	K2(U)	Lecture using videos and ppt	Short summary or overview
	2	Woodward Hofmann rule- The Mobius and Huckel concept- FMO- PMO method and correlation diagrams.	3	K4(An)	Lecture cum Group Discussion	Short test and quiz
	3	Cycloaddition and retrocycloaddition reactions- [2+2]- [2+4]- [4+4]- Cationic- anionic- and 1-3-dipolar cycloadditions.	5	K2(U)	Lecture using chalk and talk	Slip test and class test
	4	Chelotropic reactions - Electrocyclization and ring opening reactions of conjugated dienes and trienes.	2	K4(An)	Lecture using chalk and talk	Short test and quiz
	5	Sigmatropic rearrangements: (1-3)- (1-5)- (3-3) and (5-5)-carbon migrations. Ionic sigmatropic rearrangements.	4	K3(A)	Group discussion and problem solving	Problem solving
	6	Group transfer reactions- Regioselectivity- stereoselectivity and periselectivity in pericyclic reactions.	2	K2(U)	Lecture using videos and ppt	Short summary or overview
IV	**Organic Photochemistry-I**					
	1	Introduction - Thermal versus photochemical reactions - Photochemical excitation: Experimental techniques-	3	K2(U)	Flipped classroom and lecture using chalk and talk	Slip test and concept explanations
	2	Electronic transitions- Jablonski diagram- intersystem crossings- energy transfer processes.	5	K3(Ap)	Lecture cum Group discussion	Quiz

	3	Photochemical reactions of ketones - photosensitization - Norrish type - I and Norrish type - II cleavage reactions	5	K3(Ap)	problem solving	Problem solving and class test
	4	photooxidation and photoreduction of ketones- Paterno-Buchi reaction	5	K4(An)	Flipped classroom and lecture using chalk and talk	Short test
V	**Organic Photochemistry-II**					
	1	Photochemistry of α-β-unsaturated ketones - cis-trans isomerization and Photodimerisation	5	K2(U)	Lecture using videos and ppt	Slip test and MCQ
	2	Photon energy transfer reactions- Photo Cycloaddition- Photochemistry of aromatic compounds.	5	K4(An)	Lecture using illustrations	Slip test and quiz
	3	Photochemical rearrangements-photo-stationery state- di-π-methane rearrangement-	4	K2(U)	Group discussion and Peer tutoring	Overview
	4	Reaction of conjugated cyclohexadienone to 3-4-diphenyl phenols-Barton reaction.	4	K3(A)	Lecture using ppt	Group discussion and slip test

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

Activities (Em/SD):

FMO diagram- Group Discussion

Monofunctional disconnection- Peer Teaching

Assignment:

Bifunctional 1-2, 1-3, 1-4 and 1-5 disconnections- Reflective writing

Correlation diagram- Reflective writing

Part A

1. Assertion (A): Carbonyl groups are protected by converting it into ketals

   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

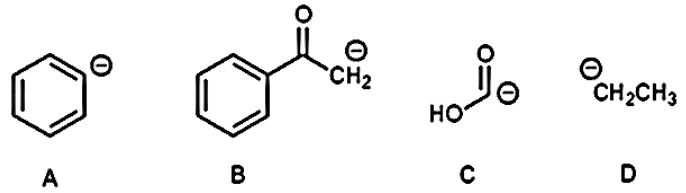
   (d) A is true but R is false

2. Which retrosynthetic terminology is associated with the disconnection of a specific functional group in the target molecule?

   (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?



   (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?

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

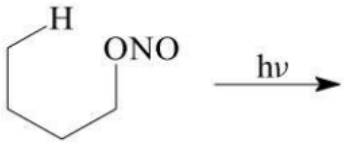
5. HOMO for hexa-1,3,5-triene under thermal condition is

   (a) Ψ1 (b) Ψ2 (c) Ψ3 (d) Ψ4

6. Pericyclic reaction takes place in the presence heat and light. (True/ True)

7. The photochemical intermolecular abstraction of a γ-hydrogen is named as _____.

8. Predict the product.



9. Which of the following act as Photosensitizer?

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

10. Photodimerization is a process in which

(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

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

Part C

1. Explain how functional group addition and interconversions contribute to the strategic planning of organic synthesis.
2. Analyse two group disconnections of carbonyl compounds with examples.
3. Discuss the retrosynthetic analysis of cis-jasmone.
4. Discuss the synthetic strategies based on umpolung concepts proposed by Seebach, emphasizing their application in the design and execution of organic synthesis.
5. Illustrate the mechanism of Cope and Claisen rearrangements
6. Draw FMO and PMO diagram of cycloaddition reaction.
7. Explain Norrish type - I and Norrish type - II reactions of ketones
8. Discuss photooxidation and photoreduction of ketones.
9. Discuss the principles and mechanisms underlying the photochemistry of α-β-unsaturated ketones, exploring both cis-trans isomerization and photodimerization reactions in detail.
10. Describe the photochemistry of aromatic compounds, including photochemical rearrangements and the di-π-methane rearrangement.

Head of the Department **Course Instructor**

Dr. M. Anitha Malbi Dr. M. Antilin Princela

Department : Chemistry
Class : I 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

CO	Upon completion of this course, the students will be able to:	PSO addressed	Cognitive level
CO-1	remember elementary aspects of crystal field theory and molecular orbital theory	PSO - 2	**K1(R)**
CO-2	understand various theories of coordination compounds.	PSO - 2	**K2(U)**
CO-3	apply various experimental methods to determine the stability of complexes.	PSO - 3	**K3(Ap)**
CO-4	analyze the spectroscopic and magnetic properties of coordination complexes.	PSO - 1	**K4(An)**
CO-5	evaluate the mechanism of substitution reactions in octahedral and square planar complexes.	PSO - 2	**K5(E)**

Teaching plan

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

Unit	Module	Topic	Teaching Hours	Cognitive level	Pedagogy	Assessment/ Evaluation
I	**Modern theories of coordination compounds**					
	1	Crystal field theory - splitting of d orbitals in octahedral- tetrahedral and square planar symmetries	4	K3(Ap)	Lecture and interactive Discussion using models	Concept explanations, Draw and interpret diagrams of splitting of d-orbitals
	2	Measurement of 10Dq - factors affecting 10Dq - spectrochemical series	3	K5(E)	Problem Solving Method	Assignments, Solve problems
	3	Crystal field stabilisation energy for high spin and low spin complexes- evidences for crystal field splitting	4	K5(E)	Group Discussion	Simple definitions, MCQs on CFSE calculation
	4	Site selections in spinels and antispinels - Jahn Teller distortions and its consequences	2	K4(An)	Group Discussion method	Assignment on spinels
	5	Molecular Orbital Theory and energy level diagrams concept of Weak and strong fields	3	K4(An)	Interactive Method, Case study Method	Quizzes Seminar Presentation
	6	Sigma and pi bonding in octahedral-square planar and tetrahedral complexes.	2	K3(Ap)	Lecture and PPT	Simple definitions, short essay
II	**Spectral characteristics of complexes**					
	1	Term states for d ions - characteristics of d-d transitions	5	K4(An)	Flipped Classroom	MCQ
	2	Charge transfer spectra - selection rules for electronic spectra	4	K3(Ap)	Group Discussion	Quiz, Polls
	3	Orgel correlation diagrams - Sugano-Tanabe energy level diagrams	5	K4(An)	Lecture using visual representations	short quizzes to assess understanding of Orgel and Sugano-Tanabe diagrams.
		Nephelauxetic Series -	4	K5(E)	Demonstration,	Evaluation

	4	Racah parameter and calculation of inter-electronic repulsion parameter			Review	through short test
III	**Stability and Magnetic property of the complexes**					
	1	Stability of complexes: Factors affecting stability of complexes- Thermodynamic aspects of complex formation	3	K2(U)	Lecture using PPT	Short summary
	2	Stepwise and overall formation constants- Stability correlations- statistical factors and chelate effect	3	K3(Ap)	Lecture using Chalk and talk	Assignment on stability constants
	3	Determination of stability constant and composition of the complexes: Formation curves and Bjerrum's half method- Potentiometric method	4	K5(E)	Discussion on stability constant and composition of the complexes	Evaluation through short test
	4	Spectrophotometric method- Ion exchange method- Polarographic method and Continuous variation method (Job's method)	4	K4(An)	Lecture using Chalk and talk	MCQ, simple definitions
	5	Magnetic property of complexes: Spin- orbit coupling- effect of spin-orbit coupling on magnetic moments- quenching of orbital magnetic moments	4	K5(E)	Group Discussion and Calculation of magnetic moments	Problems on magnetic moments
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;	4	K2(U)	Introductory session, and Lecture using Chalk and talk	Short essays
	2	Acid and base hydrolysis of octahedral complexes	4	K3(Ap)	Demonstration	Review
	3	Classification of metal ions based on the rate of water replacement reaction and their	4	K5(E)	Lecture using Chalk and talk and Problem solving	True/False, MCQ

		correlation to Crystal Field Activation Energy				
	4	Substitution reactions in square planar complexes	3	K3(Ap)	Lecture using PPT	Slip Test
	5	Trans effect- theories of trans effect and applications of trans effect in synthesis of square planar compounds; Kurnakov test	3	K4(An)	Group Discussion and PPT	Evaluation through short test
V	**Electron Transfer reactions in octahedral complexes**					
	1	Outer sphere electron transfer reactions and Marcus-Hush theory;	4	K3(Ap)	Group Discussion	Simple definitions
	2	Inner sphere electron transfer reactions	2	K4(An)	Lecture using Chalk and Talk,	Evaluation through short test
	3	Nature of the bridging ligand in inner sphere electron transfer reactions.	6	K2(U)	Lecture using PPT	Sort essays, MCQ
	4	Photo-redox- photo-substitution and photo-isomerisation reactions in complexes and their applications.	6	K2(U)	Blended Learning	True/False

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

Activities (Em/ En/SD): Interactive Discussion using models

Assignment: Site selections in spinels and antispinels - Jahn Teller distortions and its consequences

Seminar Topic: Molecular Orbital Theory and energy level diagrams concept of Weak and strong fields

Sample questions

Part A

1. Which of the following geometries results in the highest Δo splitting for d-orbitals?

   (a) Tetrahedral
   (b) Octahedral

(c) Square planar
(d) Trigonal bipyramidal

2. The spectrochemical series arranges ligands based on their

(a) Electronegativity
(b) Charge density
(c) Donor strength
(d) Crystal field stabilization energy (CFSE)

3. In crystal field theory, the 10Dq parameter measures

(a) Ligand field strength
(b) Electron pairing energy
(c)Spin-orbit coupling
(d) Crystal field stabilization energy (CFSE)

4. Factors affecting 10Dq10Dq10Dq include

(a) Metal oxidation state
(b) Nature of ligands
(c) Geometry of the complex
(d) All of the above

5. High spin and low spin complexes differ primarily in their:

(a) Coordination number
(b) Geometry
(c) Magnetic properties
(d) Ligand field splitting energy

Part B

1. Explain the factors influencing the 10Dq parameter in crystal field theory.
2. Discuss the difference between high spin and low spin complexes, emphasizing their magnetic properties.
3. Describe the principles behind Orgel correlation diagrams and their relevance in understanding d-d transitions.
4. What are the selection rules for electronic spectra, and how do they apply to charge transfer transitions?
5. Define the nephelauxetic effect and its significance in coordination chemistry.
6. Compare and contrast the molecular orbital theory and crystal field theory in the context of bonding in coordination complexes.
7. Explain how the Racha parameter is calculated and its role in predicting ligand field strength.
8. Discuss the spectrochemical series and its implications for transition metal coordination chemistry.
9. Describe the factors affecting the stability of metal complexes, including the chelate effect.

10. What is the Kurnakov test, and how is it used in the synthesis of square planar complexes?

Part C

1. Discuss the principles of crystal field theory, including the splitting of d orbitals in octahedral, tetrahedral, and square planar geometries.
2. Explain the concept of crystal field stabilization energy (CFSE) and its significance in determining the stability of transition metal complexes.
3. Compare and contrast molecular orbital theory and crystal field theory in their approaches to bonding in coordination complexes.
4. Analyze the spectrochemical series and its role in predicting the behavior of transition metal complexes.
5. How do selection rules for electronic spectra govern the observed transitions in transition metal complexes?
6. Evaluate the Jahn-Teller effect and its consequences in coordination chemistry.
7. Explain the mechanisms of substitution reactions in octahedral and square planar complexes, including associative, dissociative, and SNCB pathways.
8. Describe the methods used to determine stability constants of metal complexes, such as Bjerrum's method and spectrophotometric methods.
9. Discuss the magnetic properties of transition metal complexes, including spin-orbit coupling and the factors influencing magnetic moments.
10. Explore the applications of Orgel correlation diagrams and Sugano-Tanabe energy level diagrams in understanding the electronic spectra of transition metal complexes.

Head of the Department **Course Instructor**

Dr. M. Anitha Malbi Dr. S. Lizy Roselet

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

CO	Upon completion of this course, the students will be able to:	PSO addressed	Cognitive level
CO-1	recall the information gathered from diverse sources for use in research projects.	PSO - 1	**K1(R)**
CO-1	understand the advanced search strategies to efficiently locate and evaluate primary- secondary- and tertiary sources relevant to research topics.	PSO - 2	**K2(U)**
CO-2	apply advanced analytical techniques like electron spin resonance (ESR) and the study of morphology using XRD- SEM- STM- and AFM for detailed material analysis.	PSO - 3	**K3(Ap)**
CO-3	analyze the information gathered from diverse sources for use in research projects.	PSO - 1	**K4(An)**
CO-4	evaluate the data using regression analysis and correlation analysis and interpret research findings accurately.	PSO - 2	**K5(E)**

Teaching plan

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

Unit	Module	Topic	Teaching Hours	Cognitive level	Pedagogy	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	3	K2(U)	Lecture with ppt	Oral test
	2.	chemical abstracts - chemical titles - current chemical reactions - current contents and science citation index. Classical and comprehensive reference works in chemistry- synthetic methods and techniques – treatises	3	K3(Ap)	Lecture with ppt	Short test
	3.	reviews - monographs. Access points for searching CA indexes- index guide - general subject - terms - chemical substance names - molecular formulas - ring systems - author names	3	K4(An)	Lecture using chalk and talk	Slip test and MCQ
	4.	patent numbers. Locating the reference - finding the abstract - finding the original document chemical abstract and service source index.	3	K3(Ap)	Lecture using chalk	Slip test and MCQ
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.	3	K2(U)	Lecture with ppt	Short summary

	2.	Scientific writing - research reports - thesis - journal articles and books. Steps to publishing a scientific article in a journal.	3	K3(Ap)	Lecture using chalk and talk	Class test
	3.	Types of publications - communications - articles and reviews.	3	K3(Ap)	Group discussion	Seminar
	4.	Documenting - Abstracts indicative - descriptive abstracts - informative abstract - footnotes - end notes - referencing styles – bibliography journal - abbreviations - abbreviation used in scientific writing	3	K2(U)	Lecture using chalk and talk	Short test and quiz Oral test
III	**Instrumental Analysis**					
	1.	Principle - instrumentation and applications - AFM - SEM - STM - TEM and XRD.	4	K2(U)	Lecture using ppt	Concept explanations
	2.	Determination of surface morphology and particle size.	4	K3(Ap)	Lecture using chalk and talk	Slip test
	3.	Sample preparations and applications of UV - IR - NMR and mass spectroscopy.	4	K3(Ap)	Lecture using chalk and talk	Class test
IV	**Cheminformatics**					
	1.	Cheminformatics - history and applications. Representing molecules - connection tables and line notation - Inchi - SMILES and WLN canonicalization. Line notation versus connection tables. Query languages	3	K2(U)	Lecture using videos and ppt	Concept explanations and short summary
	2.	SMARTS. Molecular similarity. 2D topology and 3D configuration.	3	K3(Ap)	Lecture using chalk and talk	Class test

	3.	Chemistry softwares - Chemdraw .writing chemical equations and schemes - editing - transporting picture to word and image document.	3	K3(Ap)	Demonstration	Assignment on chemical structure of molecules
	4.	Origin -importing and exporting data - scientific graphing and data analysis - curve fitting and peak analysis - transporting graph to tag image file format	3	K4(An)	Demonstration	Task on Graph creation
V	**Intellectual Property Rights**					
	1.	Introduction to Intellectual Property Rights- Components of Intellectual Property- Patents-Trademarks- Copyrights-Trade Secrets- Industrial designs and Geographical Indications (GI)	3	K3(Ap)	Lecture using ppt and Videos	slip test and MCQ
	2.	The Patent's act 1970- Protectable Subject Matter patentable invention.	3	K6(E)	Lecture using chalk and talk and Group discussion	Short test
	3.	Patent Infringement and enforcement of patents	3	K3(Ap)	Lecture using ppt	Class test
	4.	Action for Infringement- - Brief Discussion on Case Law on Patents.	3	K4(An)	Lecture using ppt	Slip test and MCQ

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. **Which of the following is a primary source of chemical information?**
    a) Review articles
    b) Monographs
    c) Research articles
    d) Indexes and abstracts
2. **Which of the following databases is specifically used for chemical abstracts?**
    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?**
    a) Descriptive abstract
    b) Indicative abstract
    c) Informative abstract
    d) Footnote
4. **Which spectroscopy technique is used for determining molecular structure based on**
    a) SEM

b) NMR

c) AFM

d) TEM

5. **SMILES notation is used in which field?**

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)

7. **Assertion**: Chemical Abstracts is an example of a secondary source of chemical information.

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

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.
2. Explain the steps in identifying and investigating a research problem, and outline the components of scientific writing and publication.
3. Compare the principles, instrumentation, and applications of AFM and SEM for determining surface morphology and particle size.
4. Discuss the role of cheminformatics, molecule representation (InChI, SMILES, WLN), and query languages like SMARTS.
5. Define Intellectual Property Rights (IPR), overview the Patent Act of 1970, and discuss a case law example related to patents.

PART C

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?
2. Detail the process of identifying a research problem in chemistry. How can a supervisor guide the investigation and analysis of experimental results?
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.
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?
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.
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?
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?
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?
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?
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?

Head of the Department **Course Instructor**

Dr. M. Anitha Malbi Dr. B. T. Delma

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	3	1	-	-	2	4	60	25	75	100

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

CO	Upon completion of this course, the students will be able to:	PSO addressed	Cognitive level
CO-1	understand the chemical analysis procedures effectively, including sample collection, preparation, analysis, interpretation of results, and report writing.	PSO - 1	**K1 (R) &K2(U)**
CO-1	apply separation and purification techniques to isolate and purify substances based on their physical and chemical properties.	PSO - 2	**K3 (Ap)**
CO-2	analyze and interpret experimental data obtained from analysis, physical properties determination, and separation techniques	PSO - 3	**K4 (An)**
CO-3	evaluate the importance of food preservation techniques and apply appropriate methods for preserving food products	PSO - 1	**K5 (E)**
CO-4	collaborate effectively with peers in laboratory settings, demonstrating teamwork and communication skills.	PSO - 2	**K6 (C)**

Teaching plan

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

Unit	Module	Topic	Teaching Hours	Cognitive level	Pedagogy	Assessment /Evaluation
I	**Chemical Analysis**					
	1.	Definition- collection of samples- selection of appropriate analytical method	4	K2(U)	Lecture with ppt and Demonstration	Oral test
	2.	Preparation of the sample-analysing the sample using the selected method	4	K3(Ap)	Demonstration	Short test
	3.	Technique- interpreting the results- report preparation.	4	K4(An)	Interactive Session	Presentation of the report
II	**Food Preservation Techniques**					
	1.	Food preservation-techniques of food preservation	4	K2(U)	Lecture with ppt	Short summary
	2.	Chemical and physical methods-importance of food preservation	4	K3(Ap)	Lecture using chalk and talk	Class test
	3.	Food preservatives and food packing.	4	K3(Ap)	Group discussion	Oral test
III	**Quantitative Analysis**					
	1.	Titration- Definition and difference between qualitative and quantitative analysis	4	K2(U)	Lecture using ppt	Concept explanations
	2.	Types of titrations-end point-equivalence point. Indicators-types-oxidizing and reducing agents-gravimetric analysis-	4	K3(Ap)	Demonstration	MCQ

	3.	Detailed description of the steps of gravimetric analysis-applications.	4	K3(Ap)	Hands on training	Class test
IV	**Physical Properties of Liquids**					
	1.	Physical states of matter	4	K2(U)	Lecture using videos and ppt	Concept explanations and short summary
	2.	Melting point, determination of melting point-decomposition-evaporation-sublimation.	4	K3(Ap)	Hands on training	Class test
	3.	Boiling point- determination of boiling point	4	K3(Ap)	Demonstration	MCQ
V	**Separation and Purification Techniques**					
	1.	Characterization-uses and selection of separation process-filtration techniques-filter paper-simple filtration-filtration through vacuum pump-distillation-	6	K3(Ap)	Lecture using ppt and Videos	slip test and MCQ
	2.	Types of distillation-simple distillation-fractional distillation-difference between simple and fractional distillation.	6	K6(E)	Lecture using chalk and talk and Group discussion	Short test

Course Focusing on Employability/ Entrepreneurship/ Skill Development:

Skill Development

Activities (Em/SD):

Industrial Visit on Food Preservation Techniques

Assignment:

Interpreting the results and report preparation.

Seminar Topic

Unit V

Characterization-uses and selection of separation process-filtration techniques-filter paper- simple filtration-filtration through vacuum pump-distillation.

Sample questions

PART A

1. **Which of the following is the first step in chemical analysis?**
    a) Interpreting the results
    b) Collection of samples
    c) Report preparation
    d) Analyzing the sample
2. **Which method is not a food preservation technique?**
    a) Canning
    b) Freezing
    c) Titration
    d) Dehydration
3. **In titration, the point at which the reaction is complete is called the:**
    a) Endpoint
    b) Start point
    c) Midpoint
    d) Completion point
4. **Which technique is used to determine the boiling point of a liquid?**
    a) Filtration
    b) Titration
    c) Distillation
    d) Evaporation
5. Fractional distillation does not use a column. (**True /False)**
6. Vacuum filtration is a slower process compared to simple filtration. (**True /False)**
7. **Assertion**: Simple distillation is typically used to separate liquids with very close boiling points.

    Reason: Simple distillation relies on the difference in boiling points to separate components.

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

1. Describe the process of chemical analysis, starting from the collection of samples to the preparation of the final report.
2. Explain the importance of food preservation and compare chemical and physical methods of food preservation.
3. Differentiate between qualitative and quantitative analysis, and explain the role of titrations in quantitative analysis.
4. Describe the process of determining the boiling point of a liquid and its significance in physical property analysis.
5. Compare and contrast simple distillation and fractional distillation, highlighting their uses and selection criteria.

PART C

1. Discuss the steps involved in the preparation and analysis of a sample using an appropriate analytical method. Include an example to illustrate the process.
2. Describe various techniques of food preservation, both chemical and physical, and discuss the role of food preservatives and packaging in extending the shelf life of food products.
3. Explain the detailed steps involved in gravimetric analysis and its applications. Provide an example of how gravimetric analysis is used in real-world scenarios.
4. Describe the physical states of matter and the processes of melting point determination, decomposition, evaporation, and sublimation. Explain their importance in chemical analysis.
5. Discuss the various filtration techniques, including simple filtration and filtration through a vacuum pump. Explain their principles, advantages, and applications in laboratory settings.
6. Explain the different types of titrations, including acid-base, redox, and complexometric titrations. Describe how indicators are used in these titrations and the significance of the equivalence point.

Head of the Department **Course Instructor**

Dr. M. Anitha Malbi Dr. M. Shirly Treasa