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

POSTGRADUATE PROGAMME

TEACHING PLAN

EVEN SEMESTER 2024-2025

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

Teaching plan

Department : Chemistry
Class : II M. Sc Chemistry
Title of the Course : Core Course VII: Coordination Chemistry – II
Semester : IV
Course Code : CP234CC1

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP234CC1	**6**	**-**	**-**	**-**	**5**	**6**	**90**	**25**	**75**	**100**

Pre-requisite:

Basic knowledge of inorganic chemistry

Learning Objectives:

1. To remember the fundamental concepts and understand the structural aspects of coordination compounds.
2. To study the reactions and catalytic behaviour of organometallic compounds.

Course Outcomes

CO	Upon completion of this course, the students will be able to:	PSO addressed	Cognitive level
CO-1	recall the fundamental concepts and understand the structural aspects of coordination compounds.	PSO - 1	**K1 & K2**
CO-1	apply the concepts and mechanisms to study the structure and bonding in inorganic compounds.	PSO - 2	**K3**
CO-2	analyze and predict the structure of coordination complexes using spectroscopic tools.	PSO - 3	**K4**
CO-3	evaluate the spectral characteristics of complexes	PSO - 1	**K5**
CO-4	design new catalysts from organometallic compounds	PSO - 2	**K6**

Teaching plan

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

Unit	Module	Topic	Teaching Hours	Cognitive level	Pedagogy	Assessment/ Evaluation
I	**Chemistry of organometallic compounds**					
		Classification of organometallic compounds based on M-C bond - 18 and 16 electron rule; Bonding in metal - olefin complexes (example: Ziese's salt)- metal-acetylene and metal-allyl complexes; Metal-cyclopentadienyl complexes -	5	K2(U)	Lecture with ppt	Oral test
		Examples and MO approach to bonding in metallocenes; fluxional isomerism.	4	K3(Ap)	Lecture with ppt	Short test
		Metal- carbonyl complexes: MO diagram of CO; Structure and bonding - bonding modes- MO approach of M-CO bonding- π-acceptor nature of carbonyl group- synergistic effect (stabilization of lower oxidation states of metals);	5	K4(An)	Lecture using chalk and talk	Slip test and MCQ
		Carbonyl clusters: Low nuclearity and high nuclearity carbonyl clusters - Structures based on polyhedral skeleton electron pair theory or Wade's rule.	4	K3(Ap)	Lecture using chalk	Slip test and MCQ
II	**Reactions and catalysis of organometallic compounds**					
		Reactions of organometallic compounds: Oxidative addition - reductive elimination (α and β eliminations) - migratory insertion reaction and metathesis reaction.	6	K2(U)	Lecture with ppt	Short summary

		Organo-metallic catalysis: Hydrogenation of olefins (Wilkinson's catalyst) - hydroformylation of olefins using cobalt or rhodium catalysts (oxo process)	6	K3(Ap)	Lecture using chalk and talk	Class test
		oxidation of olefin (Wacker process) - olefin isomerisation - water gas shift reaction - cyclo-oligomerisation of acetylenes using Reppe's catalysts - Monsanto process.	6	K3(Ap)	Group discussion	Oral test
III	**Inorganic spectroscopy -I**					
		IR spectroscopy: Effect of coordination on the stretching frequency- sulphato - carbonato - sulphito - aqua- nitro- thiocyanato - cyano - thiourea - DMSO complexes	6	K2(U)	Lecture using ppt	Concept explanations
		IR spectroscopy of carbonyl compounds. NMR spectroscopy- Introduction	6	K3(Ap)	Lecture using chalk and talk	Slip test
		applications of ^{1}H- ^{15}N- ^{19}F- ^{31}P-NMR spectroscopy in structural identification of inorganic complexes - fluxional molecules - quadrupolar nuclei- effect in NMR spectroscopy	6	K3(Ap)	Lecture using chalk and talk	Class test
IV	**Inorganic spectroscopy-II**					
		Introductory terminologies: g and A parameters-definition - explanation and factors affecting g and A.	5	K2(U)	Lecture using videos and ppt	Concept explanations and short summary
		Applications of ESR to coordination compounds with one and more than one unpaired electron - hyperfine	4	K3(Ap)	Lecture using chalk and talk	Class test

		and secondary hyperfine splitting and Kramer's doublets.				
		ESR spectra of V(II)- Mn (II)- Fe (II)- Co (II)- Ni (II)- Cu (II) complexes- bis(salicylaldimine)copper (II) and $[(NH_3)_5Co\text{-}O_2\text{-}Co(NH_3)_5]^{5+}$	4	K3(Ap)	Lecture using chalk and talk	Short test
		Mossbauer spectroscopy - Mossbauer effect - Recoil energy - Mossbauer active nuclei - Doppler shift - Isomer shift - quadrupole splitting and magnetic interactions. Applications of Mössbauer spectra to Fe and Sn compounds.	5	K4(An)	Lecture using chalk and talk	Class test
V	**Photo Electron Spectroscopy**					
		Theory – Types - origin of fine structures - shapes of vibrational fine structures - adiabatic and vertical transitions.	6	K3(Ap)	Lecture using chalk and talk	slip test
		PES of homonuclear diatomic molecules (N_2- O_2) and heteronuclear diatomic molecules (CO- HCl) and polyatomic molecules (H_2O- CO_2- CH_4- NH_3) - evaluation of vibrational constants of the above molecules.	6	K6(E)	Lecture using chalk and talk and Group discussion	Short test
		Koopman's theorem applications and limitations. Optical Rotatory Dispersion - Principle of CD and ORD - Δ and λ isomers in complexes - Assignment of absolute configuration using CD and ORD techniques	6	K3(Ap)	Lecture using chalk and talk	Class test

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

Activities (Em/SD): Demonstration on IR Spectroscopy.

Group discussion on Circular Dichroism and Optical Rotatory Dispersion

Case Study Analysis on Spectroscopy

Assignment:

^{31}P-NMR spectroscopy in structural identification of inorganic complexes - fluxional molecules - quadrupolar nuclei- effect in NMR spectroscopy

Seminar Topic

- 18 and 16 electron rules
- olefin complexes (example: Ziese's salt)
- metal- acetylene and metal-allyl complexes
- Metal-cyclopentadienyl complexes

Sample questions

PART A

1. Which of the following organometallic compounds follows the 18-electron rule?

   a) Ferrocene
   b) Manganocene
   c) Chromium hexacarbonyl
   d) Nickel tetracarbonyl

2. The Monsanto process is used to produce acetic acid. (True / False)
3. Which of the following techniques is best for identifying structural information about metal carbonyl complexes?

   a) UV-Vis Spectroscopy b) Mass Spectrometry

   c) IR Spectroscopy d) ESR Spectroscopy

4. In Mössbauer spectroscopy, which of the following is NOT observed?

   a) Isomer shift b) Quadrupole splitting

   c) Doppler shift d) Electronic transition spectra

5. **Assertion (A):** Koopman's theorem is used to approximate ionization energies in PES.

Reason (R): Koopman's theorem assumes that the molecular orbitals remain unchanged after electron removal.

a) Both (A) and (R) are true, and (R) is the correct explanation of (A).

b) Both (A) and (R) are true, but (R) is not the correct explanation of (A).

c) (A) is true, but (R) is false.

d) (A) is false, but (R) is true.

PART B

1. Analyze the bonding in a metal-allyl complex and compare it with that in a metal-cyclopentadienyl complex.
2. Describe the catalytic hydroformylation of olefins using rhodium catalyst. Explain how the mechanism leads to the formation of aldehydes.
3. Analyze the mechanism of migratory insertion reactions in organometallic compounds and discuss their significance in catalysis.
4. Explain hyperfine splitting in ESR spectroscopy and its significance for identifying unpaired electrons.
5. Analyze the PES spectrum of a diatomic molecule like O_2. Identify the vibrational fine structure and what it reveals about the molecule.

Part: C

1. Evaluate the bonding modes in metal-carbonyl complexes. How does the synergistic effect between metal and CO ligands stabilize metal centers in low oxidation states?
2. Describe the application of ^{1}H, ^{15}N, ^{19}F, and ^{31}P NMR spectroscopy in determining the structure of inorganic complexes. Explain the effect of quadrupolar nuclei on NMR spectra.
3. Apply NMR spectroscopy to interpret the structure of a given inorganic complex. Discuss the significance of fluxional behavior observed in the NMR spectra.
4. Describe the catalytic hydroformylation of olefins using rhodium catalysts (oxo process). Explain how the mechanism leads to the formation of aldehydes.
5. Compare CD and ORD techniques. Discuss how they complement each other in determining the stereochemistry of chiral complexes.

Course Instructor
Dr. B.T. Delma

Head of the Department
Dr. M. Anitha Malbi

Teaching Plan

Department : Chemistry
Class : II M. Sc Chemistry
Title of the Course: Core Course VIII: Physical Chemistry II
Semester : IV
Course Code : CP234CC2

Course Code	L	T	P	Credits	Inst. Hours	Total Hours	Marks		
							CIA	External	Total
CP234CC2	6	-	-	5	6	90	25	75	100

Objectives

1. To understand the essential characteristics of wave functions and need for the quantum mechanics.
2. To know the importance of quantum mechanical models of particle in a box, rigid rotor and harmonic oscillator.

Course outcomes

CO	Upon completion of this course, the students will be able to:	PSO addressed	Cognitive level
CO-1	remember the basic laws, equations and understand the characteristics of wave functions and symmetry functions.	PSO - 1	K1(R) & K2(U)
CO-2	apply the concept of quantum mechanics and group theory to predict the electronic structure.	PSO - 2	K3(Ap)
CO-3	classify the symmetry operation and wave equations.	PSO - 2	K5(An)
CO-4	evaluate eigen values and eigen functions	PSO - 2	K5(E)
CO-5	construct the character table for different point groups	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	**Quantum Mechanics**					
	1	Wave particle duality- Uncertainty principle	2	K2 (U)	Inquiry based approach	MCQ
	2	Particle wave - wave function. Properties of wave function.	2	K2(U)	Collaborative approach	Group discussion
	3	Normalized. Orthogonal. orthonormal.	2	K4(An)	Integrative method	Short test
	4	Eigen values. Eigen functions. Hermitian properties of operators.	2	K5(E)	Collaborative approach	Assignment
	5	Introduction to quantum mechanics black body radiation.	2	K2(U)	Blended learning	Slip test- Nearpod
	6	Photoelectric effect. hydrogen spectrum.	2	K3(Ap)	Lecture with interactive PPT	Short summary
	7	Need for quantum mechanics.Postulates of Quantum Mechanics.	2	K2(U)	Inquiry based approach	Class test
	8	Schrodinger wave equation Time independent and time dependent	4	K3(Ap)	Integrative method	Assignment
II	**Quantum models**					
	1	Particle in a box 1D- Two dimensional and three dimensional degeneracy	5	K3(Ap)	Integrative method	Peer Teaching
	2	Application to linear conjugated molecular system. free particles. ring systems.	3	K3(Ap)	Co-operative learrning	MCQ - Quizizz
	3	Harmonic Oscillator wave equation and solution.	3	K2(U)	Collaborative approach	Assignment
	4	Anharmonicity , force constant and its significance.	2	K4(An)	Blended learning	Group discussion
	5	Rigid Rotor wave equation and solution.	2	K2(U)	Collaborative approach	Short test
	6	Calculation of rotational constants and bond length of diatomic molecules.	3	K5(E)	Student - Led teaching	Problem solving

III	**Applications to Hydrogen and Poly electron atoms**					
	1	Hydrogen atom and hydrogen like ions.	2	K3(Ap)	Collaborative approach	Short summary
	2	Hamiltonian wave equation and solutions. radial and angular functions. representation of radial distribution functions.	3	K2(U)	Blended learning	Slip test-Slido
	3	Approximation methods – variation methods: trial wave function. variation integral and application to particle in 1D box.	3	K2(U)	Integrative approach	Group discussion
	4	Perturbation method first order applications.	2	K2(U)	Lecture with Co-operative learning	Student presentation
	5	Hatrefock self-consistent field method. Hohenberg Kohn theorem andKohn Sham equation.	4	K2(U)	Lecture with inquiry based learning	Class test
	6	Helium atom electron spin.	2	K3(Ap)	Blended learing	Assignment
	7	Pauli's exclusion principle and Slater determination.	2	K3(Ap)	Peer teaching	Quiz
IV	**Group theory**					
	1	Groups. sub groups. symmetry elements. operations.	3	K2(U)	Lecture with models	Slip test
	2	Classification axial and nonaxial.	2	K4(An)	Inquiry based approach	MCQ-Nearpod
	3	Dihedral point groups Cn. Cnh. Dn. Dnh. Dnd. Td and Oh.	3	K3(Ap)	Collaborative approach	Assignment
	4	Matrix representation and classes of symmetry operations. reducible irreducible and direct product representation.	4	K2(U)	Blended learning	Class test
	5	The Great orthogonality theorem – irreducible representation and reduction formula.	3	K3(Ap)	Lecture with Co-operative learning	Short summary

	6	Construction of character table for C2v. C2h. C3v and D2h point groups.	3	K6(C)	Lecture method and Student-Led learning	Assignment
V	**Applications of quantum and group theory**					
	1	Hydrogen Molecule - Molecular orbital theory and Heitler London (VB) treatment.	4	K3(Ap)	Inquiry based approach	Class test
	2	Energy level diagram. Hydrogen molecule ion	2	K3(Ap)	Collaborative approach	Peer teaching
	3	Use of linear variation function and LCAO methods.	3	K3(Ap)	Integrative approach	Group discussion
	4	Electronic conjugated system: Huckel method to Ethylene butadiene. Cyclopropenyl- cyclo butadiene and Benzene.	5	K3(Ap)	Lecture with co-operative learning	Assignment
	5	Applications of group theory to molecular vibrations. Electronic spectra of ethylene.	4	K3(Ap)	Blended learning	Short summary

Course Focussing on Employability/ Entrepreneurship/ Skill Development: Employability

Activities (Em/ En/SD):

1. Point group matching - Create flash card with different molecules and match with point groups.

2. Symmetry operation practice - Create models of molecules and performsymmetryoperation

3. Hydrogen spectrum model construction

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

Activities related to Cross Cutting Issues:

Assignment:

1. Construction of character table for C2v. C2h. C3v and D2h point groups.

2. Calculation of rotational constants and bond length of diatomic molecules.

Seminar Topic:

1. Introduction to Quantum mechanics and Blackbody radiation.

2. Photoelecric effect and Hydrogen spectrum

Sample questions

Part A

1. The phenomenon where light behaves as both a wave and a particle is called:

   (a) Duality (b) Diffraction (c) Refraction (d) Reflection

2. The force constant kkk of a harmonic oscillator is significant because it is:

   (a) Directly related to the bond energy (b) Inversely related to the frequency of vibration
   (c) Related to the bond length (d) Used to calculate the potential energy

3. The Hamiltonian operator for the hydrogen atom includes both the kinetic and _____ energy terms.
4. The point group for a molecule with octahedral symmetry is:

   (a) C_2 (b) D_2h (c) Td (d) Oh

5. The Linear Combination of Atomic Orbitals (LCAO) method helps construct molecular orbitals from atomic orbitals. (True / False)

Part B

1. Differentiate between normalized, orthogonal, and orthonormal wave functions with examples.
2. Explain the concept of degeneracy in a particle in a box model, particularly for two-dimensional and three-dimensional boxes.
3. What are the main ideas behind the first-order perturbation theory? Explain its application to hydrogen-like ions.
4. Differentiate between axial and non-axial symmetry elements. Provide examples.
5. Explain the Molecular Orbital (MO) theory for the hydrogen molecule ion

Part C

1. Discuss the time-dependent Schrödinger wave equation and its significance in quantum mechanics.

2. Explain the harmonic oscillator model in quantum mechanics. Derive the wave equation.

3. Derive the Schrödinger equation for a hydrogen atom, and explain the process of separating the equation into radial and angular parts.

4. Describe the Great Orthogonality Theorem and how it is used in the construction of character tables. Provide an example using the C_2V point group.

5. Apply the Hückel method to determine the molecular orbitals of butadiene.

Course Instructor

Dr. M. Shirly Treasa

Head of the Department

Dr. M. Anitha Malbi

Teaching Plan

Department : Chemistry
Class : II M. Sc Chemistry
Title of the Course: Elective Course VI: a) Polymer Chemistry
Semester : IV
Course Code: CP234EC1

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP234EC1	**4**				**3**	**4**	**60**	**25**	**75**	**100**

Objectives:

- To gain knowledge about applications of polymers.
- To know the importance of various polymerization techniques.
- To study about synthetic polymers.

CO	Upon completion of this course, the students will be able to:	PSO addressed	Cognitive level
CO-1	learn the basic concepts of bonding in chemistry.	PSO - 1	K1(R)
CO-2	understand the importance of polymer chemistry	PSO - 2	K2(U)
CO-3	apply the processing techniques in the manufacture of synthetic polymer	PSO - 3	K3(A)
CO-4	analyze the degradation of polymers.	PSO -2	K4(An)
CO-5	evaluate molecular weight and size of the polymer	PSO - 3	K5(E)

Teaching plan

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

Unit	Module	Topic	Teaching Hours	Cognitive level	Pedagogy	Assessment/ Evaluation
I	**Characterization. Molecular weight and its Determination**					
	1	Primary and secondary bond forces in polymers - cohesive energy- molecular structure-chemical tests	4	K2(U)	Introductory session, Lecture using chalk and talk	Concept explanations
	2	thermal methods-Tg-molecular distribution-stability.	4	K4(An)	Group Discussion	Short summary
	3	Determination of Molecular mass of polymers: Number Average molecular mass (Mn) and Weight average molecular mass (Mw) of polymers.	4	K5(E)	Demonstrative and Problem solving approach	Evaluation through home work
II	**Mechanism and kinetics of Polymerization**					
	1	Chain growth polymerization: Cationic. anionic. free radical polymerization	6	K3(Ap)	Integrative Approach	Assignment
	2	Stereoregular polymers: Ziegler Natta polymerization.	2	K3(Ap)	Lecture using chalk and talk	Short summary
	3	Reaction kinetics. Step growth polymerization. Degree of polymerization.	4	K4(An)	Lecture using chalk and talk	Slip test - quizziz
III	**Techniques of Polymerization and Polymer Degradation**					
	1	Bulk, solution, emulsion, Suspension polymerisation	4	K2(U)	Lecture using videos and ppt	Short summary
	2	Solid. interfacial and gas phase polymerization.	3	K4(An)	Lecture cum Group Discussion	Short test and quiz

	3	Types of polymer degradation. Thermal degradation. mechanical degradation, photodegradation and photo stabilizers.	5	K2(U)	Lecture using chalk and talk	Slip test and class test
IV	**Industrial Polymers**					
	1	Preparation of fibre forming polymers. elastomeric material.	1	K2(U)	Flipped classroom and lecture using chalk and talk	Slip test and concept explanations
	2	Thermoplastics: Polyethylene. Polypropylene. polystyrene. Polyacrylonitrile. Poly Vinyl Chloride.	2	K3(Ap)	Lecture cum Group discussion	Quiz-Nearpod
	3	Poly tetrafluoro ethylene. nylon and polyester.	1	K3(Ap)	lecture using chalk and talk	Problem solving and class test
	4	Thermosetting Plastics: Phenol formaldehyde and epoxide resin.	2	K4(An)	Integrative Approach	Short test
	5	Elastomers: Natural rubber and synthetic rubber- Buna N. BunaS and neoprene.	2	K4(An)	Inquiry based approach	Slip test-slido
	6	Conducting Polymers: Elementary ideas; examples: poly sulphur nitriles. poly phenylene. poly pyrrole and poly acetylene. Polymethylmethacrylate.	2	K3(Ap)	Collaboration approach	Short summary
	7	Polyimides. polyamides. polyurethanes. polyureas. polyethylene and polypropylene glycols.	2	K3(Ap)	Group Discussion	Short summary
V	**Polymer Processing**					

	1	Compounding: Polymer Additives: Fillers. Plasticizers. antioxidants.	3	K2(U)	Lecture using videos and ppt	Slip test and MCQ
	2	Thermal stabilizers. fire retardants and colourants.	2	K4(An)	Lecture using illustrations	Slip test-quizziz
	3	Processing Techniques: Calendaring. die casting. compression moulding. injection moulding. blow moulding and reinforcing.	4	K2(U)	Group discussion and Peer tutoring	Overview
	4	Film casting. Thermo foaming. Foaming.	3	K3(Ap)	Lecture using ppt	Group discussion and slip test

Course Focusing on Employability/ Entrepreneurship/ Skill Development: Employability

Activities (Em/SD): Album preparation for Rubber production

Assignment:

1. Chain polymerization
2. Molecular weight distribution in polymers - Problem solving
3. Polymer degradation - Online assignment

Seminar Topic:

Calendaring - die casting - compression moulding- injection moulding- blow moulding and reinforcing.

Sample questions

Part A

1. The relationship between instrinsic viscosity and molecular weight is

a) $[\eta] = kM^a$ b) $[\eta] = kM$ c) $[\eta] = \frac{k}{M^a}$ d) $[\eta] = \frac{k}{M}$

2. Which of the following act as an initiator in free-radical polymerisation?

(a) Grignard reagent (b) Lewis acids (c) Benzoyl peroxide (d) Potassium amide

3. Protective colloid used in emulsion polymerisation is _____.

(a) polyvinyl alcohol (b) carboxymethyl cellulose (c) gum and casein (d) all the above.

4. Which of the following polymer is produced by extrusion moulding?

(a) PVC (b) polystyrene (c) PF (d) PMMA

5. Terephthalic acid and ethylene glycol undergo polyesterification to form PET. **(True/False)**

6. Photodegradation of polymer is caused by exposure to _____ radiation.

(a) visible (b) UV (c) IR (d) all the above

7. Benzaldehyde is evolved during _____ degradation of polystyrene.

(a) photo (b) oxidative (c) thermal (d) mechanical

8. Name the process that is used for converting bulk polymer into fibre.

(a) compression (b) spinning (c) moulding (d) extrusion

9. Which of the following act as an initiator in free-radical polymerisation?

(a) Grignard reagent b) Lewis acids c) Benzoyl peroxide d) Potassium amide

10. The Ziegler Natta catalyst is formed between _____

a) Triethyl aluminium and titanium halide b) Triethyl aluminium and silver halide

c) Triethyl aluminium and platinum halide d) Triethyl aluminium and carbon halide

Part- B

1. Classify the types of polymers.
2. Differentiate addition and copolymerization.
3. Discuss the casting technique of polymer processing.
4. Explain the role of thermal stabilizers and photo stabilizers in polymers.
5. Discuss briefly number average and weight average molecular weight of polymer.
6. Write short note on post treatment for fibres.
7. Explain the preparation and uses of nitrile rubber and silicone rubber.
8. Discuss the role of thermal stabilizers and photo stabilizers in polymers.

Part C

1. Discuss the mechanism of ionic polymerization with example.
2. Explain free radical copolymerisation and ionic copolymerization.
3. Discuss briefly about homogeneous polymerisation. Mention some applications.
4. Determine the molecular weight of a polymer by viscometer.
5. How are polymers processed by moulding techniques.

6. Enlist the significance of reinforcing techniques of polymers.

7. Illustrate synthetic rubber with examples.

8. How are the properties of polymer improved by additives?

9. What is the principle of thermal and mechanical degradations? Explain.

Course Instructor **Head of the Department**

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

Teaching Plan

Department : Chemistry
Class : II M. Sc Chemistry
Title of the Course : **Elective Course VII: a) Renewable Energy Sources**
Semester : **IV**
Course Code : **CP234EC4**

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP234EC4	**3**	**1**	**-**	**-**	**3**	**4**	**60**	**25**	**75**	**100**

Pre-requisite

Students should know the basic concepts such as force- energy- work power- electricity and how renewable energy systems operate as well as the principles of sustainability.

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 and understand the importance of various sources of non-conventional energy.	PSO - 1	**K1&K2**
CO-2	apply the principles of renewable energy and sustainability in energy conservation.	PSO - 4	**K3**
CO-3	analyze the advantages and disadvantages of different non conventional energy sources.	PSO - 3	**K4**
CO-4	evaluate solar energy radiation-wind energy data and conversion efficiency of fuel cells.	PSO - 2	**K5**
CO-5	design fuel cells for sustainable energy development.	PSO - 5	**K6**

Teaching plan

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

Unit	Module	Topic	Teaching Hours	Cognitive level	Pedagogy	Assessment/ Evaluation
I	**Introduction to Energy Sources**					
	1	Introduction -Conventional energy sources - coal - oil - gas -agricultural and organic wastes - water power - thermal power and nuclear power.	3	K2(U)	Lecture and interactive Discussion.	Quiz
	2	Principles of renewable energy- energy and sustainable development - fundamentals and social implications - worldwide renewable energy availability- renewable energy availability in India- shale.	3	K3(Ap)	Group Discussion	Assignments
	3	Non-conventional energy sources - solar energy - wind energy- energy from bio-mass and bio-gas - ocean thermal energy	3	K5(E)	Group Discussion	MCQ test
	4	Tidal energy -geothermal energy and hydrogen energy. Advantages of renewable energy. Introduction to Internet of energy (IOE).	3	K4(An)	Group Discussion method	Short summary
II	**Solar Energy**					
	1	Fundamentals - Solar Radiation; Estimation of solar radiation on horizontal and inclined surfaces-Solar radiation Measurements	4	K5(E)	Flipped Classroom	MCQ
	2	Pyrheliometers-Pyrometer-Sunshine Recorder. Solar Thermal systems: Flat	3	K3(Ap)	Group Discussion	Quiz

		plate collector- Solar distillation				
	3	Solar Pond electric power plant. Solar electric power generation- Principle of Solar cell - Photovoltaic system for electric power generation - advantages- Disadvantages and applications of solar photovoltaic system.	5	K4(An)	Lecture using visual representations	short quizzes
III	**Wind Energy**					
	1	Properties of wind- availability of wind energy in India - wind velocity and power from wind	4	K2(U)	Lecture using PPT	Short summary
	2	Major problems associated with wind power. Basic components of wind energy conversion system (WECS) - Classification of WECS-	4	K3(Ap)	Lecture using Chalk and talk	Assignment
	3	Horizontal axis- single-double and multiblade system. Vertical axis- Savonius and darrieus types.	4	K4(An)	Lecture and Group Discussion	Evaluation through short test
IV	**Biomass Energy- Tidal Power and Ocean Thermal Energy Conversion**					
	1	Introduction- Photosynthesis Process; Biofuels-Biomass Resources; -Biomass conversion technologies- fixed dome.	4	K2(U)	Introductory session, and Lecture using Chalk and talk	Short essays
	2	Tides and waves as energy suppliers and their mechanics - fundamental characteristics of tidal power -harnessing tidal energy - advantages and limitations	4	K3(Ap)	Blended Learning	Review
	3	Ocean Thermal Energy Conversion: Principle of working- OTEC power stations in the world-	4	K5(E)	Lecture using Chalk and talk	True/False, MCQ

		problems associated with OTEC.				
V	**Green Energy**					
	1	Introduction- Fuel cells: Classification of fuel cells H2; Operating principles - Zero energy Concepts	4	K3(Ap)	Group Discussion	Simple definitions
	2	Benefits of hydrogen energy- hydrogen production technologies (electrolysis method only)	4	K4(An)	Lecture using Chalk and Talk,	Evaluation through short test
	3	Hydrogen energy storage - applications of hydrogen energy – problems associated with hydrogen energy.	4	K5(E)	Lecture using PPT	Sort essays, MCQ

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

Activities (Em/ En/SD): Exhibition of models of Renewable Energy Sources.

Poster presentation on harnessing tidal energy - advantages and limitations

Assignment: Tides and waves as energy suppliers and their mechanics.

Seminar Topic:

Ocean Thermal Energy Conversion: Principle of working- OTEC power stations in the world- problems associated with OTEC.

Sample questions

Part A

1. Coal,oil,uranium are examples for
   a) primary energy sources b) secondary fuels c) supplementary sources

   d)none of the above
2. Solar energy, wind energy, water energy etc. are examples of _____ sources of energy.
3. Assertion (A): It is difficult to classify solar energy under primary energy source.

   Reason (R) :Because of the dilute nature of solar energy.

   a) A and R are true,R is the correct explanation of A
   b) A and R are true ,R is not the correct explanation of A

c) Both A and R are true

d) Both A and R are false

4. Assertion(A): Fuel cells can be distinguished from battery.

Reason (R) :It operates with comtinuous replenishment of the fuel and the oxidant at the active electrode and does not require recharging.

a) A and R are true, R is the correct explanation of A
b) A and R are true, R is not the correct explanation of A
c) Both A and R are true
d) d)Both A and R are false

5.. The independent primary sources that provide energy to the earth are

a) sun
b) geothermal forces
c) planetary motion in the solar system
d) All the above

Part B

1. Distinguish conventional energy sources from non-conventional energy sources.
2. Classify the three categories of biomass?
3. Discuss the two factors which cause winds.
4. Enlist the characteristics of wind energy.
5. List the types of wind mill.
6. Discuss the aerodynamic forces acting on the blades.
7. Draw a neat diagram and explain the horizontal axis machine.
8. Outline the main components of a floating drum type biogas plant.
9. Discuss the significance of temperature in the biogas generation process.
10. Explain the role of feedstock selection in biogas production efficiency.

Part C

1. Discuss in detail about the renewable energy sources and its advantages.
2. What are the obstacles in the implementation of renewable energy sources?
3. Discuss in detail about the prospects of renewable energy sources.
4. Evaluate the advantages and disadvantages of concentrating collectors over flat plate type collectors.
5. Discuss the following terms
   (i)solar radiation constant (ii) solar radiation geometry (iii)solar radiation data (iv)solar radiation at earth's surface
6. With a neat diagram, explain how wind energy can be converted into electrical energy.
7. Discuss the advancements in biogas technology and their potential future applications.

8. Describe the role of government policies and incentives in promoting biogas technology.
9. Discuss the potential of hydrogen and fuel cell technology in addressing climate change.
10. Describe the future trends and challenges in the development and commercialization of hydrogen energy and fuel cells.

Course Instructor

Dr. S. Lizy Roselet

Head of the Department

Dr. M. Anitha Malbi

Teaching Plan

Department : Chemistry
Class : II M. Sc Chemistry
Title of the Course : **Skill Enhancement Course III: Business Skills For Chemists**
Semester : **IV**
Course Code : **CP234SE1**

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP234SE1	**3**	**1**	**-**	**-**	**2**	**4**	**60**	**25**	**75**	**100**

Pre-requisites:

Students should know the basic skills in Chemistry.

Learning Objectives:

1. To understand the business fundamentals including finance, marketing, operations, and management.
2. To develop communication skills among the students.

Course outcomes

CO	Upon completion of this course, the students will be able to:	PSO addressed	Cognitive level
CO-1	understand financial statements, including balance sheets, income statements, and cash flow statements.	PSO - 1	**K1&K2**
CO-2	apply financial principles to analyze the economic viability of chemical projects and make informed business decisions.	PSO - 4	**K3**
CO-3	identify market opportunities and develop strategies for product commercialization and market penetration.	PSO - 3	**K4**
CO-4	assess market demand for chemical products and technologies.	PSO - 2	**K5**
CO-5	cultivate a professional network within the chemical industry and negotiate effectively to achieve business objectives and foster collaboration.	PSO - 5	**K6**

Teaching plan

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

Unit	Module	Topic	Teaching Hours	Cognitive level	Pedagogy	Assessment/ Evaluation
I	**Introduction to Business Skills for Chemists**					
	1	Overview of Business Skills Integration-Importance of Business Skills in Chemistry-Integration of Business and Scientific Expertise-Understanding Career Pathways-Industry vs. Academia:	4	K2(U)	Lecture and interactive Discussion.	Quiz
	2	Career Prospects-Identifying Transferable Skills-Basic Principles of Business Communication-Clarity and Precision in Communication-	4	K4(An)	Group Discussion	Assignments
	3	Tailoring Messages to Different Audiences-Professional Etiquette and Networking-Professionalism in Various Settings-Effective Networking Strategies	4	K3(Ap)	Group Discussion	MCQ test
II	**Communication Skills for Chemists**					
	1	Effective Written Communication-Crafting Clear and Concise Emails-Writing Professional Reports and Proposals.	4	K5(E)	Flipped Classroom	Review
	2	Oral Communication and Presentation Skills-Structuring Engaging Presentations-Effective Speaking and Delivery Techniques	3	K3(Ap)	Group Discussion	Quiz
	3	Interpersonal Communication and Conflict Resolution-Active	5	K4(An)	Lecture using visual representations	short quizzes

		Listening and Empathy-Strategies for Resolving Conflicts Professionally.				
III	**Project Management for Chemists**					
	1	Project Management Fundamentals-Defining Project Scope and Objectives-Establishing Realistic Timelines and Milestones-Planning and Scheduling Techniques	4	K3(Ap)	Lecture using PPT	Short summary
	2	Work Breakdown Structure (WBS)-Gantt Charts and Critical Path Analysis-Resource Allocation and Budgeting-Identifying Project Resources	4	K4(An)	Lecture using Chalk and talk	Assignment
	3	Budget Development and Cost Control-Risk Management Strategies-Identifying and Assessing Project Risks-Mitigation and Contingency Planning.	4	K5(E)	Lecture and Group Discussion	Evaluation through short test
IV	**Intellectual Property and Patents**					
	1	Intellectual Property Rights Overview-Patents, Trademarks, and Copyrights-Importance of Intellectual Property in Chemistry-.	4	K2(U)	Introductory session, and Lecture using Chalk and talk	Short essays
	2	Patenting Process and Strategies-Patent Search Techniques-Drafting and Filing Patent Applications-Protection of Intellectual Property-Confidentiality	4	K3(Ap)	Blended Learning	Review
	3	Agreements and NDAs-Licensing and Technology Transfer-Patent Searching Techniques-Online Databases and Search Strategies-Analyzing Patent Documents	4	K5(E)	Flipped Classroom	True/False, MCQ
V	**Entrepreneurship and Commercialization**					

	1	Introduction to Entrepreneurship-Characteristics of Successful Entrepreneurs-Identifying Market Opportunities-Market Evaluation and Feasibility	4	K3(Ap)	Group Discussion	Simple definitions
	2	Market Research Methods-Assessing Market Potential and Competition-Business Models and Funding Options-Types of Business Models in Chemistry	4	K4(An)	Lecture using Chalk and Talk,	Evaluation through short test
	3	Sources of Funding for Startups Commercialization Strategies-Product Development and Launch-Marketing and Distribution Channels.	4	K5(E)	Lecture using PPT	Sort essays, MCQ

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

Activities (Em/ En/SD): Interactive Discussion - Characteristics of Successful Entrepreneurs-Identifying Market Opportunities-Market Evaluation and Feasibility.

Assignment: Effective Written Communication-Crafting Clear and Concise Emails-Writing Professional Reports and Proposals.

Seminar Topic: Types of Business Models in Chemistry- Sources of Funding for Startups-Commercialization Strategies-Product Development and Launch-Marketing and Distribution Channels

Sample questions

1. Assertion (A): Communication skills are essential for chemists in business.
   Reason (R): Effective communication allows chemists to explain technical details clearly to non-specialists.
   a) Both A and R are true, and R is the correct explanation of A.
   b) Both A and R are true, but R is not the correct explanation of A.
   c) A is true, but R is false.

d) A is false, but R is true.

2. Assertion (A): Intellectual property rights are crucial for chemists in protecting their innovations.
   Reason (R): Patents prevent others from legally using, selling, or making an invention.
   a) Both A and R are true, and R is the correct explanation of A.
   b) Both A and R are true, but R is not the correct explanation of A.
   c) A is true, but R is false.
   d) A is false, but R is true.

3. In project management, a Gantt chart is used to:
   a) List project risks.
   b) Track project timelines and progress.
   c) Identify intellectual property.
   d)Calculate financial statements.

4. Conflict resolution skills are unnecessary in a professional chemistry setting.(True or False)
5. In marketing, understanding the competition in the market is part of _____.

6. A confidentiality agreement ensures that sensitive information disclosed between parties is kept secure.(True or False)

7. A ____ agreement is often used to protect intellectual property when sharing sensitive project information with potential collaborators.

8. Project scope defines the boundaries and deliverables of a project.(True or False:)

9. The key purpose of a balance sheet is to show a company's _____.

10. Assertion (A): Entrepreneurs must understand market demand to launch successful products.
    Reason (R): Conducting feasibility studies helps assess the product's potential in the market.
    a) Both A and R are true, and R is the correct explanation of A.
    b) Both A and R are true, but R is not the correct explanation of A.
    c) A is true, but R is false.
    d) A is false, but R is true.

Part B

1. Explain why business communication is essential for chemists working in industry.
2. Describe the primary components of a balance sheet.
3. Outline the steps in the patent application process.

4. What are the benefits of establishing a professional network in the chemical industry?
5. Define "market research" and explain its role in business.
6. Describe the Work Breakdown Structure (WBS) and its importance in project management.
7. What are Gantt charts, and how are they used in managing projects?
8. Differentiate between patents, copyrights, and trademarks.
9. Explain the concept of risk management in project management.
10. Describe how conflict resolution skills benefit chemists in the workplace.

Part C

1. Discuss the role of intellectual property rights in protecting chemical innovations and how chemists benefit from them.
2. Describe in detail the skills necessary for effective communication in a business environment.
3. Explain how project management techniques, such as WBS and Gantt charts, are used to control a project's timeline and resources.
4. Outline the importance of professional networking for chemists and provide examples of effective networking strategies.
5. Describe the patent application process, including key steps in drafting, filing, and securing patents.
6. Explain the major types of business models applicable in the chemical industry and provide examples of each.
7. Discuss the different sources of funding available for startups in the chemical industry.
8. Explain how to conduct a market evaluation and feasibility study for a new chemical product.
9. Describe the role of budgeting in project management and explain various techniques used in developing and controlling a project budget.
10. Discuss the key considerations for a chemist planning to start a business, from market research to product commercialization.

Course Instructor | **Head of the Department**

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