AC/27.06.2023/RS1

SIES College of Arts, Science & Commerce (Autonomous)

RISE WITH EDUCATION

Sion (West), Mumbai – 400022.

Department of Chemistry

Program: M.Sc.

Course: Chemistry

M.Sc. Part – I or Post Graduate Diploma

Syllabus for M.Sc. Semester I & II

(With effective from 2023 – 2024)

Choice Based Credit System
As per National Education Policy

Proposed Credit Distribution Structure under NEP for Post Graduate Programme for Faculty of Science (Aided/Unaided/Self-financed) as mailed on 25th May 2023 by nodal officer.							
Semester	**Major**		**Research Methodology**	**On Job Training or Field Project**	**Research Project**	**Credits/ Semester**	**Degree / Cumulative Credits**
	Mandatory	**Electives**					
I	6 + 6 + 2 = 14 Credits	4 Credits	4 Credits			22 Credits	**PG Diploma 44**
II	6 + 6 + 2 = 14 Credits	4 Credits		4 Credits		22 Credits	
Total of I & II	**28 Credits**	**8 Credits**	**4 Credits**	**4 Credits**		**44 Credits**	
III	6 + 6 = 12 Credits	4 Credits			6 Credits	22 Credits	**PG Degree 88**
IV	6 + 6 = 12 Credits	4 Credits			6 Credits	22 Credits	
Total of III & IV	**24 Credits**	**8 Credits**			**12 Credits**	**44 Credits**	
Cumulative of four semesters (I+II+III+IV)	**52 Credits**	**16 Credits**	**4 Credits**	**4 Credits**	**12 Credits**	**88 Credits**	
Note: The above proposed structure is for 22 Credits per semester							

Proposed Credit Bifurcation Structure under NEP for Post Graduate Programme for Faculty of Science (Aided/Unaided/Self-financed) as mailed on 25th May 2023 by nodal officer							
Semester	**Major**		**Research Methodology**	**On Job Training or Field Project**	**Research Project**	**Credits/ Semester**	**Degree / Cumulative Credits**
	Mandatory	**Electives**					
I	**6 + 6 + 2 = 14 Credits** (There will be 3 papers, whereby, 2 papers will have 6 credits and 1 paper will have 2 credits) (The distribution of 6 credits will be 4 Credits for Theory and 2 credits for practicals) (The distribution of 2 credits will be only for theory and that paper will not have practicals); note that since it is post graduate programme, therefore the number of credits for practical for mandatory paper have been proposed as 2 Credits	**4 Credits** (There will be only 1 paper of Elective relevant to Major Subject, whereby, the distribution of credits will be 3 credits for Theory and 1 credit for Practical)	**4 Credits** (There will be only 1 paper of Research Methodology, whereby, 3 Credits for Theory for that paper, the theory paper can have 3 units; whereas there will be 1 Credit for Practical for that paper); note that the practical component for research methodology can be writing of review of research paper, writing of abstract of research article, writing of manuscript, preparation and presentation of research poster/paper, etc			**22 Credits**	**MSc Part-I or Post Graduate Diploma 44 Credits**
II	**6 + 6 + 2 = 14 Credits** (There will be 3 papers, whereby, 2 papers will have 6 credits and 1 paper will have 2 credits) (The distribution of 6 credits will be 4 Credits for Theory and 2 credits for practicals) (The distribution of 2 credits will be only for theory and that paper will not have practicals); note that since it is post graduate programme, therefore the number of credits for practical for mandatory paper have been proposed as 2 Credits	**4 Credits** (There will be only 1 paper of Elective relevant to Major Subject, whereby, the distribution of credits will be 3 credits for Theory and 1 credit for Practical)		**4 Credits** (There will not be any theory paper for On Job Training, therefore, 4 Credits will be given as per evaluation criteria to be specially prepared similar to Internship evaluation, for example, regularity and approach towards the on job training, report from the supervisor of the concerned department of the industry or company or institute where the student is doing on job training, observations and maintenance of daily records etc.)		**22 Credits**	
Total of I & II	**28 Credits**	**8 Credits**	**4 Credits**	**4 Credits**		**44 Credits**	

SIES College of Arts, Science and Commerce Sion (W), Mumbai – 400 022
(Empowered Autonomous)
Programme: Master of Science M.Sc.-Chemistry-I (PG Diploma)
2023-24 as per NEP

List of abbreviations:
Cognitive Levels:- R: Remember, U: Understand, Ap: Apply, An: Analyze, E: Evaluate, C:Create

Programme Outcomes (PO)

A student completing M.Sc Chemistry will be able to:

PO1	**Complex Problem-Solving approach:** Use of theory knowledge for solving problems.
PO2	**Critical Thinking:** Think from various perspectives and explore various ideas.
PO3	**Reasoning ability and Rational thinking:** Develop rational thinking on the basis of acquired contextual knowledge
PO4	**Research Aptitude:** Solve the problem individually by applying contextual knowledge and research-based insights within an interdisciplinary framework
PO5	**Social Interactive Skills and team work:** Function effectively as an individual member or leader in diverse teams
PO6	**Societal Awareness and Sustainable development:** Demonstrate awareness as well as concern for environmental issues and societal problems
PO7	**Life-long learning:** Acknowledge the necessity for independent and lifelong learning, equipped with the skills and readiness to adapt to the ongoing changes in technology.

Programme Specific Outcomes (PSO)

A student completing M.Sc-I (PG Diploma) Chemistry will be able to:

PSO 1	Demonstrate a comprehensive knowledge of all disciplines. (inorganic, organic and physical) and its linkages with related disciplinary areas/subjects
PSO 2	To assess and evaluate facts, claims and arguments using their basic and advanced scientific knowledge
PSO 3	Develop a foundational understanding of research methodologies, including literature review, hypothesis formulation, experimental design, data analysis, and interpretation.
PSO 4	To define a problem, analyse, interpret and draw conclusion by planning, implementing and reporting the results of an experiment.
PSO 5	Acquire hands-on experience with advanced chemistry-related equipment and to apply modern research techniques to investigate complex chemical phenomena and solve practical problems.
PSO 6	Demonstrate competence in quality assurance and quality control practices essential for industry.

Course Outcomes (CO)
SEMESTER-I

After completion of this Course, the learner will be able to:……..

PAPER-I Inorganic Chemistry (Core Course)

	Course Outcome	C L
CO1	Recognize the concept of MOT for polyatomic molecules.	R, U, An, E
CO2	Know how the physical properties like melting and boiling points of molecules get affected by chemical forces present in it.	R, U, Ap
CO3	Understand Symmetry operations and Symmetry elements and point groups	R, U, An
CO4	Examine chemical bonding, visualizing molecular orbitals, behaviour of atoms, molecules and solids using group theory.	R, U, Ap
CO5	Know the importance of Material and solid state chemistry and its various forms, shapes or products.	R, U, Ap
CO6	Recognize Stereochemistry of substitution reactions of octahedral complexes	R, U, Ap

Mapping Matrix

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	√	√	___	√	___	√
CO2	√	√	___	√	___	___
CO3	√	___	___	√	___	___
CO4	√	√	___	√	√	___
CO5	√	√	___	√	√	___
CO6	√	√	___	√	√	___

PAPER-II Organic Chemistry (Core Course)

	Course Outcome	C L
CO1	Know the kinetic and thermodynamic requirements of organic reactions and a few methods to determine the reaction mechanisms.	R, U, An, E
CO2	Recognize the factors affecting acidity and basicity.	R, U, Ap
CO3	Understand advanced nucleophilic substitutions with special emphasis on Neighboring Group Participations (NGP) and factors affecting the NGP.	R, U, An
CO4	Identify structural, thermochemical, and magnetic criteria for aromaticity, including NMR characteristics of aromatic systems.	R, U, Ap
CO5	Comprehend the concept of chirality, Molecules with tri- and tetra-coordinate centers, Axial and planar chirality and prochirality.	R, U, An
CO6	Explore the applications of different oxidizing and reducing agents in organic reactions.	R, U, An

Mapping Matrix

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	√	√	___	√	___	√
CO2	√	√	___	√	___	___
CO3	√	___	___	√	___	___
CO4	√	√	___	√	√	___
CO5	√	___	___	___	√	___
CO6	√	√	___	√	√	___

PAPER-III Physical Chemistry (Core Course)

	Course Outcome	C L
CO1	Understand Debye Huckel, Onsager equation and its applications to aqueous and non-aqueous solution.	R, U, Ap, An,
CO2	Know different kinds of fuel cells and its applications.	R, U, Ap, An,
CO3	Understand the concept in Bio-electrochemistry.	R, U, An, E,
CO4	Use wave function as basis for determination of irreducible representations and the Great Orthogonality theorem and its consequence	R, U, Ap
CO5	Know different types of operators and harmonic oscillator.	R, U, Ap, An

Mapping Matrix

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	√	___	___	√	√	___
CO2	√	___	___	√	√	___
CO3	√	___	___	√	___	___
CO4	√	___	___	√	√	___
CO5	√	___	___	___	√	___

PAPER-IV Structural Inorganic Chemistry (Discipline Specific Elective)

	Course Outcome	C L
CO1	Know spectral properties and magnetic measurements of Coordination compounds	R, U, Ap
CO2	Access electronic state and term calculations	U, R
CO3	Know inorganic and metal clusters and their cage compounds	R, U, Ap
CO4	Determine metal-metal bonding and shape of clusters	U, Ap
CO5	Apply spin Resonance and Nuclear Quadrupole Resonance Spectroscopy	U, E

Mapping Matrix

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	√	___	___	___	√	___
CO2	√	___	___	___	√	___
CO3	√	___	___	√	√	___
CO4	√	___	___	√	√	___
CO5	√	___	___	√	√	___

PAPER-V Research Methodology

	Course Outcome	C L
CO1	Understand the different research methods and steps in research	R, U, Ap
CO2	Use critical thinking and analytical skills necessary for identifying research problems and formulating research questions.	U, R
CO3	Apply the strategies for designing experiments, collecting and analyzing data, and interpreting research results.	R, U, Ap
CO4	Foster effective communication skills for presenting research findings orally and inwritten form.	U, Ap
CO5	Promote ethical research practices and awareness of responsible conduct in mathematical research	U, E
CO6	Develop problem solving approach	U, An

Mapping Matrix

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	√	___	___	___	√	___
CO2	√	___	___	___	√	___
CO3	√	___	___	√	√	___
CO4	√	___	___	√	√	___
CO5	√	___	___	√	√	___
CO6	√	___	___	√	√	___

SEMESTER-II

PAPER-I Inorganic Chemistry (Core Course)

	Course Outcome	C L
CO1	Know inorganic reaction mechanisms involving octahedral and square planar complexes along with stereo chemicsty	R, U, An, E
CO2	Apply organometallic complexes for catalysis	R, U, Ap
CO3	Understand the role of inorganic metal/ complexes in biological system	R, U, An
CO4	Decide role of metals in biological system, medicine, blood coagulation, oxygen storage and transport, photosynthesis and uptake and transport of iron	R, U, Ap
CO5	Classify symmetry elements, point group, Group, sub-group and classes	R, U, An
CO6	Solve problem based on point group, matrix representation and character table	R, U, An

Mapping Matrix

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	√	√	—	√	—	√
CO2	√	√	—	√	—	—
CO3	√	—	—	√	—	—
CO4	√	√	—	√	√	—
CO5	√	—	—	—	√	—
CO6	√	√	—	√	√	—

PAPER-II Organic Chemistry (Core Course)

	Course Outcome	C L
CO1	Apply nucleophilic carbon intermediates reactions for organic synthesis	R, U, An, E
CO2	Understand the reactivity of the carbonyl carbon	R, U, Ap
CO3	Apply the one step synthesis of various organic derivatives using various name reactions and rearrangement reactions	R, U, An
CO4	Recognize the molecular orbital aspect to organic compounds	R, U, Ap
CO5	Understand and apply the principle of stereochemistry	R, U, An
CO6	Interpret the structure of various organic compounds using spectral data	R, U, An

Mapping Matrix

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	√	√	—	√	—	√
CO2	√	√	—	√	—	—
CO3	√	—	—	√	—	—
CO4	√	√	—	√	√	—
CO5	√	—	—	—	√	—
CO6	√	√	—	√	√	—

PAPER-III Physical Chemistry (Core Course)

	Course Outcome	C L
CO1	Understand the chemical kinetics and molecular reaction dynamics for elementary reaction	R, U, Ap, An,
CO2	Know the enzymatic reactions kinetics, and catalysis	R, U, Ap, An,
CO3	Understand the concept of quantum chemistry with respect to rigid rotor and spherical harmonics.	R, U, An, E,
CO4	Apply the Schrödinger equation for electron system	R, U, Ap

Mapping Matrix

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	√	___	___	√	√	___
CO2	√	___	___	√	√	___
CO3	√	___	___	√	___	___
CO4	√	___	___	√	√	___

PAPER-IV Synthetic Organic Chemistry (Discipline Specific Elective)

	Course Outcome	C L
CO1	Use free radical reactions for the organic synthesis	R, U, Ap
CO2	Noethe characterization of the free radical reactions	U, R
CO3	Understand the theoretical concepts behind Enamines, Ylides and A-C-H Functionalization	R, U, Ap
CO4	Apply various Metals / Non-Metals in Organic Synthesis	U, Ap

Mapping Matrix

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	√	___	___	___	√	___
CO2	√	___	___	___	√	___
CO3	√	___	___	√	√	___
CO4	√	___	___	√	√	___

M.Sc. Part – I / Post Graduate Diploma in Chemistry

SEMESTER – I

Contents

Major - Mandatory (6 + 6 + 2 = 14 Credits)		
Paper I **SIPCHCC511**	:	**Inorganic Chemistry (4 Credits)**
SIPCHCC511.1	:	Chemical Bonding and Reactivity
SIPCHCC511.2	:	Organometallic Chemistry – I
SIPCHCC511.3	:	Solid states and Chemistry of Inorganic materials
SIPCHCC511.4	:	Molecular Symmetry and Group Theory – 1
Paper II **SIPCHCC512**	:	**Organic Chemistry (4 Credits)**
SIPCHCC512.1	:	Physical Organic Chemistry
SIPCHCC512.2	:	Nucleophilic substitution reactions and Aromaticity
SIPCHCC512.3	:	Stereochemistry
SIPCHCC512.4	:	Oxidation and Reduction
Paper III **SIPCHCC513**	:	**Physical Chemistry (2 Credits)**
SIPCHCC513.1	:	Electrochemistry
SIPCHCC513.2	:	Quantum Chemistry – I
Practical		
Paper I SIPCHCCP511	:	Inorganic Chemistry Practical **(2 Credits)**
Paper II SIPCHCCP512	:	Organic Chemistry Practical **(2 Credits)**
Paper III		**No practical for Physical Chemistry.**

DSE **SIPCHEL511**	:	**Discipline Specific Elective (DSE)** **Structural Inorganic Chemistry (3 Credits)**
SIPCHEL511.1	:	Characterization of Coordination compounds
SIPCHEL511.2	:	Cluster Chemistry – I
SIPCHEL511.3	:	Electron Spin Resonance and Nuclear Quadrupole Resonance Spectroscopy
Practical		**Discipline Specific Elective (DSE) (1 Credits)**
SIPCHELP511	:	Characterization of Complex Compounds
RM **SIPCHRM511**	:	**Research Methodology (3 Credits)**
SIPCHRM511.1	:	Sources
SIPCHRM511.2	:	Data analysis
SIPCHRM511.3	:	Methods of scientific research and writing scientific papers
Practical		**Research Methodology (1 Credits)**
SIPCHRMP511	:	Writing review of research paper, writing of abstract of research article, and writing of manuscript. Preparation and presentation of research poster/paper.

SEMESTER – II

Contents

Major – Mandatory (6 + 6 + 2 = 14 Credits)		
Paper I **SIPCHCC521**	:	**Inorganic Chemistry (4 Credits)**
SIPCHCC521.1	:	Structure, Bonding, and Stereochemistry of Coordination Compounds
SIPCHCC521.2	:	Organometallic Chemistry – II
SIPCHCC521.3	:	Bioinorganic Chemistry
SIPCHCC521.4	:	Group theory – II
Paper II **SIPCHCC522**	:	**Organic Chemistry (4 Credits)**
SIPCHCC522.1	:	Alkylation of Nucleophilic Carbon Intermediates and Reaction of carbon nucleophiles with carbonyl groups
SIPCHCC522.2	:	Reactions and Rearrangements
SIPCHCC522.3	:	Introduction to Molecular Orbital Theory for Organic Chemistry and Applications of UV and IR spectroscopy
SIPCHCC522.4		NMR spectroscopy and Mass spectrometry
Paper III **SIPCHCC523**	:	**Physical Chemistry (2 Credits)**
SIPCHCC523.1	:	Chemical Kinetics and Molecular Reaction Dynamics
SIPCHCC523.2	:	Quantum Chemistry – II
Practical		
Paper I SIPCHCP521	:	Inorganic Chemistry Practical **(2 Credits)**

Paper II SIPCHCP522	:	Organic Chemistry Practical **(2 Credits)**
Paper III		**No practical for Physical Chemistry.**
DSE **SIPCHEL521**	: :	**Discipline Specific Elective (DSE) (3 Credits)** **Synthetic Organic Chemistry-I**
SIPCHEL521.1	:	Radicals in organic synthesis
SIPCHEL521.2	:	Enamines, ylides and α-C-H functionalization
SIPCHEL521.3	:	Metals / non-metals in organic synthesis
Practical		**Discipline Specific Elective (DSE) (1 Credits)**
DSE SIPCHELP521	: :	Techniques of purification
	:	**On Job Training (4 Credits)**
SIPCHOJ521		Internship Evaluation criteria regularity and approach towards the on job training, report from the supervisor of the concerned department of the industry or company or institute where the student is doing on job training, observations and maintenance of daily records etc.

SEMESTER - I

Course Code: SIPCHCC511

Paper I: Inorganic Chemistry

CREDITS: 4 **LECTURES: 60**

UNIT- I, 1L/week		
LEARNING OBJECTIVES: *1) Application to poly atomic species hydrogen bond and its different types.* *2) To study inorganic reaction mechanism involving octahedral and square planar complexes and their stereochemistry.*		
1	**Chemical Bonding and Reactivity**	**15 L**
1.1	Molecular Orbital Theory for Polyatomic species considering σ bonding for SF_6, CO_2, B_2H_6, I_3^- molecular species.	
1.2	Ligand substitution reactions of: a. Octahedral complexes without breaking of metal-ligand bond (Use of isotopic labelling method) b. Square planar complexes, trans-effect, its theories and applications. Mechanism and factors affecting these substitution reactions. c. Redox reactions: Inner and outer sphere mechanisms, complimentary and non-complimentary reactions.	
1.3	Stereochemistry of substitution reactions of octahedral complexes. (Isomerization and racemization reactions and applications.)	
UNIT- II, 1L/week		
LEARNING OBJECTIVES: *1. To study Organometallic Chemistry of Transition metals in details.*		
2	**Organometallic Chemistry – I**	**15 L**
2.1	Eighteen and sixteen electron rule and electron counting with examples.	
2.2	Structure and bonding of following organometallic compounds: (a) Alkyl and aryl derivatives. (b) Carbenes and carbynes	

	(c) Alkene derivatives of Pd and Pt. (d) Alkyne derivatives of Pd and Pt. (e) Allyl derivatives of nickel. Sandwich compounds of Fe, Cr and Half Sandwich compounds of Cr and Mo.	
2.3	Structure and bonding on the basis of VBT and MOT in the following organometallic compounds: Zeise's salt, bis(triphenylphosphine)diphenylacetyleneplatinum(0) $[Pt(PPh_3)_2(HC{\equiv}CPh)_2]$, diallylnickel(II), ferrocene and bis(arene)chromium(0), tricarbonyl(η^2-butadiene)iron(0).	
UNIT III, 1L/week		
LEARNING OBJECTIVES: *1. To understand the electronic structure of solids and methods for preparation of inorganic solids.* *2. To study crystal defects.*		
3 Solid states and Chemistry of Inorganic materials		**15L**
3.1	Solid State Chemistry: Origin of band gap, Classification of inorganic materials into metals, semiconductors, semi-metals and insulators on the basis of electron energy at Brillouin zone boundaries.	
3.2	Factors affecting the crystal structure of solids. Structure of simple compounds in terms of closed packed array of anions- (i) Sphalerite (ZnS) (ii) Wurtzite (ZnS) (iii) Nickel arsenide (NiAs), (iv) Fluorite (AB_2 for eg CaF_2) and anti-fluorite structures (for eg Li_2O), rutile (TiO_2) structure and layer structure [Cadmium chloride and iodide ($CdCl_2$, CdI_2)]. (v) Perovskite (ABO_3 for eg $BaTiO_3$) (vi) Spinel (AB_2O_4 for eg $CaFe_2O_4$)	
3.3	Crystal defects and non-stoichiometry: Recapitulation: Structures and Defects in solids. Types of Defects and Stoichiometry a) Zero dimensional (point) Defects. b) One dimensional (line) Defects. c) Two dimensional (Planar) Defects. d) Thermodynamics of formation of defects (Mathematical derivation to find concentration of defects and numerical problems based on it	

Unit – IV, 1L/week		
LEARNING OBJECTIVES: *1. To study the primary understanding of Group Theory and Molecular Symmetry.*		
4 Molecular Symmetry and Group Theory		**15 L**
4.1	Recapitulation of Symmetry elements and Symmetry operations. Product of symmetry operations, cartesian coordinate system and symmetry elements. Symmetry classification of molecules: Point groups, mathematical requirements for a point group. A systematic procedure for symmetry classification of molecules.	
4.2	Identification of molecular point groups of molecules having low symmetry, high symmetry and special symmetry. Descent in symmetry of molecules with substitution. Concepts of Groups, Sub-groups, Classes of Symmetry operations, Group Multiplication Tables. Abelian and non-Abelian point groups.	
4.3	Representation of Groups: Matrix representation of symmetry operations, reducible and irreducible representations. The Great Orthogonality Theorem and its application in construction of character tables for point groups C_2v, C_3v and D_{2h}, structure of character tables.	
4.4	Symmetry criteria for optical activity, symmetry restrictions on dipole moment.	

SUGGESTED REFERENCE

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25. Semiconductor Nanomaterials, Challa S.S.R. Kumar, ISBN: 978-3-527-32166-7, WILEY-VCH Verlag GmbH and Co. KGaA, Weinheim, 2010.

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27. P.W. Atkins, T. Overton, J. Rourke, M. Weller and F. Armstrong; Shriver and Atkins: Inorganic Chemistry, 4th ed. Oxford University Press, 2006.

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SEMESTER – I

Course Code: SIPCHCC512

Paper II: Organic Chemistry

CREDITS: 4 **LECTURES: 60**

UNIT- I , 1L/week		
LEARNING OBJECTIVES: *1. Understand the principles of kinetics and thermodynamics as applied to rates and equilibrium positions of chemical reactions.* *2. To describe how experimental verification in the presence of an intermediate or a product in a chemical reaction helps in determining a given reaction mechanism.* *3. Understand the basic concept of acidity and basicity.*		
1 Physical Organic Chemistry		**15 L**
1.1	Thermodynamic and kinetic requirements of a reaction: rate and equilibrium constants, reaction coordinate diagram, transition state (activated complex), nature of activated complex, Hammond postulate, reactivity *vs* selectivity, Curtin-Hammett Principle, microscopic reversibility, kinetic *vs* thermodynamic control of organic reactions.	
1.2	Determining mechanism of a reaction: Product analysis, kinetic studies, use of isotopes (Kinetic isotope effect – primary and secondary kinetic isotope effect). Detection and trapping of intermediates, crossover experiments and stereo- chemical evidence.	
1.3	Acids and Bases: Factors affecting acidity and basicity: electronegativity and inductive effect, resonance, bond strength, electrostatic effects, hybridization, aromaticity and solvation. Comparative study of acidity and basicity of organic compounds on the basis of pKa values, leveling effect and non-aqueous solvents. Acid and base catalysis – general and specific catalysis with examples.	
UNIT- II, 1L/week		
LEARNING OBJECTIVES: *1. To study different types of substitution reactions in aliphatic and aromatic substrates.* *2. To understand the concept of aromaticity, anti-aromaticity and homoaromaticity in annulenes, charged rings, fused ring systems and heterocycles.*		
2 Nucleophilic substitution reactions and Aromaticity		**15 L**
2.1	Nucleophilic substitution reactions: Aliphatic nucleophilic substitution: S_N1, S_N2, S_N^i reactions, mixed S_N1 and S_N2 and SET mechanisms. S_N reactions involving NGP - participation by aryl rings, σ- and pi-bonds. Factors affecting these reactions: substrate, nucleophilicity, solvent, steric effect, hard-soft interaction, leaving group. Ambident	

	nucleophiles. S_NcA, S_N1' and S_N2' reactions. S_N at sp^2 (vinylic) carbon.	
2.2	Aromatic nucleophilic substitution: S_NAr, S_N1, benzyne mechanisms. Ipso, cine, tele and vicarious substitution. Ester hydrolysis: Classification, nomenclature and study of all eight mechanisms of acid and base catalyzed hydrolysis with suitable examples.	
2.3	Aromaticity: Structural, thermochemical and magnetic criteria for aromaticity, including NMR characteristics of aromatic systems. Delocalization and aromaticity. Application of HMO theory to monocyclic conjugated systems. Frost-Musulin diagrams. Huckel's (4_{n+2}) and 4n rules. Aromatic and antiaromatic compounds up to 18 carbon atoms. Homoaromatic compounds. Aromaticity of all benzenoid systems, heterocycles, metallocenes, azulenes, annulenes, aromatic ions and Fullerene (C_{60}).	
UNIT III, 1L/week		
LEARNING OBJECTIVES: 1. *To study the Stereochemistry of different organic molecule with chirality.*		
3 Stereochemistry		**15L**
3.1	Concept of Chirality: Recognition of symmetry elements.	
3.2	Molecules with tri- and tetra-coordinate centers: Compounds with carbon, silicon, nitrogen, phosphorous and sulphur chiral centers, relative configurational stabilities.	
3.3	Molecules with two or more chiral centers: Constitutionally unsymmetrical molecules: erythro-threo and syn-anti systems of nomenclature. Interconversion of Fischer,Sawhorse, Newman and Flying wedge projections. Constitutionally symmetrical molecules with odd and even number of chiral centers: enantiomeric and meso forms, concept of stereogenic, chirotopic, and pseudoasymmetric centres. R-S nomenclature for chiral centres in acyclic and cyclic compounds.	
3.4	Axial and planar chirality: Principles of axial and planar chirality. Stereochemical features and configurational descriptors (R, S) for the following classes of compounds: allenes, alkylidene cycloalkanes, spirans, biaryls (buttressing effect) (including BINOLs and BINAPs), ansa compounds, cyclophanes, trans-cyclooctenes.	
3.5	Prochirality: Chiral and prochiral centres, prochiral axis and prochiral plane. Homotopic, heterotopic (enantiotopic and diastereotopic) ligands and faces. Identification using substitution and symmetry criteria. Nomenclature of stereoheterotopic ligands and faces. Symbols for stereoheterotopic ligands in molecules with i) one or more prochiral centres ii) a chiral as well as a prochiral centre, iii) a prochiral axis iv) a prochiral plane v) pro-pseudo asymmetric centre. Symbols for enantiotopic and diastereotopic faces.	
Unit – IV, 1L/week		
LEARNING OBJECTIVES: *1. To study the primary understanding of Group Theory and Molecular Symmetry.*		
4 Oxidation and Reduction		**15 L**

4.1	Oxidation: General mechanism, selectivity, and important applications of the following: 4.1.1. Dehydrogenation: Dehydrogenation of C-C bonds including aromatization of six membered rings using metal (Pt, Pd, Ni) and organic reagents (chloranil, DDQ). 4.1.2. Oxidation of alcohols to aldehydes and ketones: Chromium reagents such as $K_2Cr_2O_7/H_2SO_4$ (Jones reagent), CrO_3-pyridine (Collin's reagent), PCC (Corey's reagent) and PDC (Cornforth reagent), hypervalent iodine reagents (IBX, Dess-Martin periodinane). DMSO based reagents (Swern oxidation), Corey-Kim oxidation - advantages over Swern and limitations; and Pfitzner-Moffatt oxidation-DCC and DMSO and Oppenauer oxidation. 4.1.3. Oxidation involving C-C bonds cleavage: Glycols using HIO_4, cycloalkanones using CrO_3; carbon-carbon double bond using ozone, $KMnO_4$, CrO_3, $NaIO_4$ and OsO_4; aromatic rings using RuO_4 and $NaIO_4$. 4.1.4. Oxidation involving replacement of hydrogen by oxygen: oxidation of CH_2 to CO by SeO_2, oxidation of arylmethanes by CrO_2Cl_2 (Etard oxidation). 4.4.5 Oxidation of aldehydes and ketones: with H_2O_2 (Dakin reaction), with peroxy acid (Baeyer-Villiger oxidation)	
4.2	Reduction: General mechanism, selectivity, and important applications of the following reducing reagents: 4.2.1. Reduction of CO to CH_2 in aldehydes and ketones- Clemmensen reduction, Wolff-Kishner reduction and Huang-Minlon modification. 4.2.2. Metal hydride reduction: Boron reagents ($NaBH_4$, $NaCNBH_3$, diborane, 9-BBN, $Na(OAc)_3BH$, aluminium reagents ($LiAlH_4$, DIBAL-H, Red Al, L and K-selectrides). 4.2.3. NH_2NH_2 (diimide reduction) and other non-metal based agents including organic reducing agents (Hantzsch dihydropyridine). 4.2.4. Dissolving metal reductions: using Zn, Li, Na, and Mg under neutral and acidic conditions, Li/Na-liquid NH_3 mediated reduction (Birch reduction) of aromatic compounds and acetylenes.	

SUGGESTED REFERENCE

1. Physical Organic Chemistry, Neil Isaacs
2. Modern Physical Organic Chemistry, Eric V. Anslyn and Dennis A. Dougherty
3. Comprehensive Organic chemistry, Barton and Ollis, Vol 1
4. Organic Chemistry, J. Claydens, N. Greeves, S. Warren and P. Wothers, Oxford University Press.
5. Advanced Organic Chemistry, F.A. Carey and R.J. Sundberg, Part A and B, Plenum Press.
6. Stereochemistry: Conformation and mechanism, P.S. Kalsi, New Age International, New Delhi.

7. Stereochemistry of carbon compounds, E.L Eliel, S.H Wilen and L.N Manden, Wiley.
8. Stereochemistry of Organic Compounds- Principles and Applications, D. Nasipuri. New International Publishers Ltd.
9. March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure, Michael B. Smith, Jerry March, Wiley.
10. Advanced Organic Chemistry: Reactions and mechanism, B. Miller and R. Prasad, Pearson Education.
11. Advanced Organic Chemistry: Reaction mechanisms, R. Bruckner, Academic Press.
12. Understanding Organic Reaction Mechanisms, Adams Jacobs, Cambridge University Press.
13. Writing Reaction Mechanism in organic chemistry, A. Miller, P.H. Solomons, Academic Press.
14. Principles of Organic Synthesis, R.O.C. Norman and J.M Coxon, Nelson Thornes.
15. Advanced Organic Chemistry: Reactions and mechanism, L.G. Wade, Jr., Maya Shankar Singh, Pearson Education.
16. Mechanism in Organic Chemistry, Peter Sykes, 6th edition onwards.
17. Modern Methods of Organic Synthesis, W. Carruthers and Iain Coldham, Cambridge University Press.
18. Organic Synthesis, Jagdamba Singh, L.D.S. Yadav, Pragati Prakashan.

Semester I

Course Code: SIPCHCC513

Paper III: Physical Chemistry

CREDITS: 2 **LECTURES: 30**

UNIT- I , 1L/week		
LEARNING OBJECTIVES: *1 To understand Debye Huckel, Onsager equation and its applications to aqueous and non-aqueous solution.* *2 To study different kinds of fuel cells and its applications.* *3 To introduce the learner to concept in Bio-electrochemistry.*		
1 Physical Chemistry – Electrochemistry		**15 L**
1.1	Debye-Hückel theory of activity coefficient, Debye-Hückel limiting law and it's extension to higher concentration (derivations are expected).	
1.2	Electrolytic conductance and ionic interaction, relaxation effect. Debye-Hückel-Onsager equation (derivation expected). Validity of this equation for aqueous and non- aqueous solution, deviations from Onsager equation, Debye-Falkenhagen effect (dispersion of conductance at high frequencies), Wien effect.	
1.3	Batteries: Alkaline fuel cells, Phosphoric acid fuel cells, High temperature fuel cells [Solid –Oxide Fuel Cells (SOFC) and Molten Carbonate Fuel Cells]	
1.4	Bio-electrochemistry: Introduction, cells and membranes, membrane potentials, theory of membrane potentials, interfacial electron transfer in biological systems, adsorption of proteins onto metals from solution, electron transfer from modified metals to dissolved protein in solution, enzymes as electrodes, electrochemical enzyme-catalysed oxidation of styrene. Goldmann equation. (derivations are expected)	
UNIT- II, 1L/week		
LEARNING OBJECTIVES: *1. To learn the need for quantum mechanics.* *2. Application of Schrodinger wave equation.* *3. To study different types of operators and harmonic oscillator.*		
2 Quantum Chemistry – I		**15 L**
2.1	Classical Mechanics, failure of classical mechanics: Need for Quantum Mechanics.	

2.2	Particle waves and Schrödinger wave equation, wave functions, properties of wave functions, Normalization of wave functions, orthogonality of wave functions.	
2.3	Operators and their algebra, linear and Hermitian operators, operators for the dynamic variables of a system such as, position, linear momentum, angular momentum, totalenergy, eigen functions, eigen values and eigen value equation, Schrödinger wave equation as the eigen value equation of the Hamiltonian operator, average value and the expectation value of a dynamic variable of the system, Postulates of Quantum Mechanics, Schrodinger's Time independent wave equation from Schrodinger's time dependent wave equation**.**	
2.4	Application of quantum mechanics to the following systems: a) Free particle, wave function and energy of a free particle. b) Particle in a one, two and three dimensional box, separation of variables, Expression for the wave function of the system, expression for the energy of the system, conceptof quantization, introduction of quantum number, degeneracy of the energy levels. c) Harmonic oscillator, approximate solution of the equation, Hermite polynomials, expression for wave function, expression for energy, use of the recursion formula.	

SUGGESTED REFERENCE

1. Ira N. Levine, Quantum Chemistry, 5th Edn., Pearson Education (Singapore) Pte. Ltd., Indian Branch, New Delhi, 2000.
2. Thomas Engel and Philip Reid, Physical Chemistry, 3rd Edn., Pearson Education Limited 2013.
3. D.N. Bajpai, Advanced Physical Chemistry, S. Chand 1st Edn., 1992.
4. Bockris, John O'M, Reddy, Amulya K.N., Gamboa-Aldeco, Maria E., Modern Electrochemistry, 2A, Plenum Publishers, 1998.
5. Physical Chemistry by Gurtu and Gurtu.
6. A Text book of Physical Chemistry by K L Kapoor Vol 5, 2nd Edn
7. B.K. Sen, Quantum Chemistry including Spectroscopy, Kalyani Publishers, 2003.
8. A.K. Chandra, Introductory Quantum Chemistry, Tata McGraw – Hill, 1994.
9. R.K. Prasad, Quantum Chemistry, 2nd Edn., New Age International Publishers, 2000.
10. S. Glasstone, Thermodynamics for Chemists, Affiliated East-West Press, New Delhi, 1964.

Semester I

Course Code: SIPCHEL511

Structural Inorganic Chemistry (Discipline Specific Elective) (DSE)

CREDITS: 3 **LECTURES: 45**

UNIT- I, 1L/week		
LEARNING OBJECTIVES: 1. *To study the spectral properties of Coordination compounds.*		
1 Characterization of Coordination compounds		**15 L**
1.1	Stability studies of coordination complexes using potentiometry.	
1.2	Electronic states and term calculations (D and F term), Spectral calculations using Orgel and Tanabe-Sugano diagram, calculation of electronic parameters such as Δ, β, C, Nephelauxetic ratio.	
1.3	Electronic spectral and magnetic measurements using IR and ESR spectroscopic methods.	
UNIT- II, 1L/week		
LEARNING OBJECTIVES: 1. *To study the concepts of inorganic and metal clusters and their cage compounds*		
2 Cluster Chemistry - I		**15 L**
2.1	**Inorganic cluster and cage compounds** (i) Introduction (ii) Bonding in boranes (iii) Heteroboranes (iv) Carboranes (v) Cluster compounds (vi) Electron precise compounds and their relation to clusters.	
2.2	**Chemistry** of **Metal clusters** (a) Metal-Metal Bonding and Metal Clusters. (b) Electron Count and Structures of Clusters. (c) Isolobal Analogy.	
UNIT III, 1L/week		
LEARNING OBJECTIVES: 1. *To learn ESR and NQR spectroscopy.*		

3 Electron Spin Resonance and Nuclear Quadrupole Resonance Spectroscopy		15L
3.1	**Electron Spin Resonance Spectroscopy** (a) Electron behaviour, interaction between electron spin and magnetic field. (b) Relaxation processes and Line width in ESR transitions: (i) Spin polarization for atoms and transition metal ions. (ii) Spin-orbit coupling and significance of 'g' tensors. (c) Application to transition metal complexes (having one unpaired electron).	
3.2	**Nuclear Quadrupole Resonance Spectroscopy** Quadrupole nuclei, quadrupole moments, electric fields gradient, coupling constant, splitting, application	

SUGGESTED REFERENCE

1. Gary Wulfsberg, Inorganic Chemistry; Viva Books PA Ltd., New Delhi; 2002.
2. F.A. Cotton and Wilkinson, Advanced Inorganic Chemistry, 3rd edition.
3. James E. Huheey, Inorganic Chemistry, 3rd edition, Harper and Row, Publishers, Asia, Pte Ltd., 1983.
4. W.W. Porterfield, Inorganic Chemistry-An Unified Approach, Academic press (1993);
5. D.F. Shriver, P.W. Atkins and C.H. Langford, Inorganic Chemistry,3rd edition Oxford University Press, 1999.
6. Asim K. Das, Fundamental Concepts of Inorganic Chemistry, (Volumes-I, II and III)CBS Pub.(2000)
7. N.N. Greenwood and A. Earnshaw, Chemistry of Elements, Pergamon, 1984.
8. J.M.Hollas, Symmetry in Chemistry, Chapman and Hall Ltd., NY, 1972.
9. F.A.Cotton, Chemical Applications of Group Theory, 2nd edition, Wiley Eastern Ltd., New Delhi, 1976.
10. C.J. Ballhausen and H.B.Gray, Molecular Orbital Theory, McGraw-Hill, New York, 1965.
11. H. Sisler, Chemistry in Non-aqueous Solvents: New York Reinhold Publ. 1965.
12. J.J. Lagowski, The Chemistry of Non-aqueous Solvents, Academic press, New York and London.
13. C.M. Day and Joel Selbin, Theoretical Inorganic Chemistry, Affiliated East West Press Pvt. Ltd., 1985.

14. F. Basolo and R.G. Pearson, Mechanisms of Inorganic Reactions, Wiley, New York, 1967.

15. J.D. Lee, Concise Inorganic Chemistry, 5th edition, Blackwell Science Ltd., 2005.

16. R.H. Crabtree, The Organometallic Chemistry of the Transition Metals, Wiley-Interscience, New York,

17. G.W. Parshall and S.D. Ittel, Homogeneous Catalysis, 2nd edition, John Wiley and sons, Inc., New York.

18. Gary O. Spessard and Gary L. Miessler, Organometallic Chemistry, Prentice-Hall, (1997).

29. R.C. Mehrotra and A. Singh, Organometallic Chemistry-A Unified Approach, 2nd ed., New Age International Pvt. Ltd., 2000.

20. B. Douglas, D.H. McDaniel and J.J. Alexander, Concepts and Models of Inorganic Chemistry, 2nd edition, John Wiley and Sons,1983.

21. James E. Huheey, Inorganic Chemistry-Principles of structure and reactivity, edn Harper and Row Publishers (1972).

22. F. A. Cotton, G. Wilkinson, C. Murillo and M. Bochmann, Advanced Inorganic Chemistry, 6th ed., John Wiley, New York, 1999.

23. F.A. Cotton and R.A. Walton, Multiple Bonds between Metal Atoms, 2nd edition, Claranden Press, Oxford, 1993.

24. P.L. Soni, Vandana Soni, Ane Books Pvt., Ltd.

25. D. Harvey, Modern Analytical Chemistry, The McGraw-Hill Pub, 1st Edition (2000);

26. John H. Block, E.B. Roche, T.P.Spine and Charles O.Wilson, Inorganic Medicinal and Pharmaceutical Chemistry, Lea and Febiger, 1974.

27. R. S. Drago, Physical Methods in Inorganic Chemistry, John-Wiley Pub., 1975.

28. M. Drescher and G. Jeschke, (Eds), EPR Spectroscopy: Applications in Chemistry and Biology, Springer-Verlag Berlin, Heidelberg 2012

29. Graham Smith; David Keeble. Introduction to Modern EPR Spectroscopy CRC Press 2013.

30. R. V. Parish. NMR, NQR, EPR and mössbauer spectroscopy in inorganic chemistry. Ellis Horwood, Chichester, 1990,

31. A. Syamal R.L. Dutta, Elements of Magnetochemistry, East West Press, 2nd Edition, 2004.

Semester I
Course Code: SIPCHRM511

Research Methodology (RM)

CREDITS: 3 **LECTURES: 45**

UNIT- I , 1L/week		
LEARNING OBJECTIVES: 1. *To learn research methodology for research data analysis and scientific writing.* 2. *To study the chemical safety and ethical handling of chemicals.* 3. *To learn writing skills in scientific research project/ practical work.*		
1 Sources		**15 L**
1.1	**Print**: Primary, Secondary and Tertiary sources.	
1.2	**Journals:** Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, textbooks, current contents, Introduction to Chemical Abstracts and Beilstein, Subject Index, Substance Index, Author Index, Formula Index, and other Indices with examples.	
1.3	**Digital:** Web sources, E-journals, Journal access, TOC alerts, Hot articles, Citation Index, Impact factor, H-index, E-consortium, UGC infonet, E-books, Internet discussion groups and communities, Blogs, preprint servers, Search engines, Scirus, Google Scholar, ChemIndustry, Wiki-databases, ChemSpider, Science Direct, SciFinder, Scopus.	
1.4	**Information Technology and Library Resources:** The Internet and World wide web, Internet resources for Chemistry, finding and citing published information.	
UNIT- II, 1L/week		
LEARNING OBJECTIVES: 1. *To analyze research data*		
2 Data Analysis		**15 L**
2.1	**The Investigative Approach:** Making and recording Measurements, SI units and their use, Scientific methods, and design of experiments.	
2.2	**Analysis and Presentation of Data:** Descriptive statistics, choosing and using statistical tests, Chemometrics, Analysis of Variance (ANOVA), Correlation and regression, curve fitting, fitting of linear equations,	
	simple linear cases, weighted linear case, analysis of residuals, general polynomial fitting, linearizing transformations, exponential function fit, r and its abuse, basic aspects of multiple linear regression analysis.	

UNIT III, 1L/week		
LEARNING OBJECTIVES: *1. To understand the methods of scientific paper writing.*		
3 Methods of Scientific Research and Writing Scientific Papers		**15 L**
3.1	**Methods of Scientific Research:** Reporting practical and project work, writing literature surveys and reviews, organizing a poster display, giving an oral presentation.	
3.2	**Writing Scientific Papers:** Justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work, writing ethics, avoiding plagiarism.	

SUGGESTED REFERENCE

1 Hibbert, D. B. & Gooding, J. J. (2006) *Data Analysis for Chemistry* Oxford University Press.

2 Harris, D. C. (2007) *Quantitative Chemical Analysis* 6th Ed., Freeman Chapters 3-5

3 Levie, R. De. (2001) *How to use Excel in Analytical Chemistry and in general scientific data analysis* Cambridge University Press.

4 Topping, J., (1984) *Errors of Observation and their Treatment* 4th Ed., Chapman Hill, London.

SEMESTER – I

PRACTICALS

Course Code: SIPCHCCP511

Practical Paper I: Inorganic Chemistry Practical

CREDITS: 2

	(4L/Week)
1	**Ores and Alloys** 1) Analysis of Devarda's alloy. 2) Analysis of Cu – Ni alloy. 3) Analysis of Tin Solder alloy. 4) Analysis of Limestone. **Instrumentation** 1) Estimation of Copper using Iodometric method Potentiometrically. 2) Estimation of Fe^{+3} solution using Ce (IV) ions Potentiometrically. **Reference:** 1. Advanced experiments in Inorganic Chemistry., G. N. Mukherjee., 1st Edn., 2010., U.N.Dhur and Sons Pvt Ltd. 2. The Synthesis and Characterization of Inorganic Compounds by William L. Jolly. 3. Inorganic Chemistry Practical under UGC Syllabus for M.Sc. by: Dr. Deepak Pant.

SEMESTER – I

PRACTICALS

Course Code: SIPCHCCP512

Practical Paper II: Organic Chemistry Practical

CREDITS: 2

	(4L/Week)
1	**One step preparations (1.0 g scale)** 1. Bromobenzene to *p*-nitrobromobenzene. 2. Anthracene to anthraquinone. 3. Benzoin to benzil. 4. Anthracene to Anthracene maleic anhydride adduct. 5. Ethyl acetoacetate to 3-methyl-1-phenylpyrazol-5-one. 6. *o*-Phenylenediamine to 2-methylbenzimidazole. 7. Urea and benzil to 5,5-diphenylhydantoin. **Learning points:** 1. Planning of synthesis, effect of reaction parameters including stoichiometry, and safety aspects including MSDS should be learnt. 2. Purify the product by crystallization. Formation and purity of the product should be checked by TLC. 3. Report mass and melting point of the purified product.

SEMESTER – I

PRACTICALS

Course Code: SIPSCHELP511

Characterization of Complex Compounds Practical (Discipline Specific Elective)

CREDITS: 1

	(2L/Week)
1	**Characterization of Complex Compounds (Analysis and Characterization)** **Analysis** 1. Analysis of fasting salt for chloride. 2. Analysis of Zinc Blende. **Instrumentation** 1. Determination of Stability constant of $[Ag(en)]^{+}$ by potentiometry. 2. Determination of CFSE values of hexa-aqua complexes of Ti^{3+} and Cr^{3+}. 3. Determination of Racah parameters for complex $[Ni(H_2O)_6]^{2+}$ and $[Ni(en)_3]^{2+}$. 4. Spectral interpretation by ESR and NQR studies. **Reference:** 1. A. I. Vogel's, Quantitative Inorganic Analysis. 2. J. D. Woolins, Inorganic Experiments. 3. G. Raj, Advanced Practical Inorganic Chemistry. 4. J. E. House, Inorganic chemistry, Academic press, 2nd edition, (2013). 5. R. V. Parish. NMR, NQR, EPR and Mössbauer spectroscopy in inorganic chemistry.Ellis Horwood, Chichester, 1990 6. A. Syamal R.L. Dutta, Elements of Magnetochemistry, East West Press, 2nd Edition, 2004.

Course Code: SIPSCHRMP511

Practical: Research Methodology (RM) CREDITS: 1

(2L/Week)

Learning Objectives:

1. *To study* writing of review of research paper, abstract of research article and writing of manuscript.
2. *To learn the* preparation and presentation of research poster/paper.

1 **Research Methodology Practical Session**

1. Writing of review of research paper.
2. Writing abstracts of research article and writing of manuscript.
3. Preparation and presentation of research poster/paper.

Note:

1. The candidate is expected to submit a journal and project certified by the Head of the Department /institution at the time of the practical examination.
2. A candidate will not be allowed to appear for the practical examination unless he/she produces a certified journal or a certificate from the Head of the Institution / department stating that the journal is lost, and the candidate has performed the requirednumber of experiments satisfactorily. The list of the experiments performed by the candidate should be attached with such a certificate.
3. Use of non-programmable calculator is allowed both at the theory and the practical examination.

Reference:

1. Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J., & Jones, A., (2011), *Practical skills in Chemistry,* 2nd Ed., Prentice Hall, Harlow.

2. Hibbert, D. B. & Gooding, J. J. (2006) *Data Analysis for Chemistry* Oxford University Press.

3. Harris, D. C. (2007) *Quantitative Chemical Analysis* 6th Ed., Freeman Chapters 3-5.

4. Levie, R. De. (2001) *How to use Excel in Analytical Chemistry and in general scientific data analysis* Cambridge University Press.

5. Topping, J., (1984) *Errors of Observation and their Treatment* 4th Ed., Chapman Hill, London.

SEMESTER - II

Course Code: SIPCHCC521

Paper I: Inorganic Chemistry

CREDITS: 4 **LECTURES: 60**

UNIT- I , 1L/week		
LEARNING OBJECTIVES: *1. To study inorganic reaction mechanism involving octahedral and square planar complexes and their stereochemistry.*		
Structure, Bonding, and Stereochemistry of Coordination Compounds		**15L**
1.1	Structure, Bonding, and Stereochemistry of Coordination Compounds (a) Structure and Bonding: i) Molecular Orbital Theory for Complexes with coordination number 4 and 5 for the central ion (sigma as well as pi bonding) (ii) Angular Overlap Model for octahedral and tetrahedral complexes for sigma and pi bond. (b) Stereochemistry of Coordination Compounds: (i) Chirality and Fluxionality of coordination compounds with higher coordination numbers. (ii) Geometries of coordination compounds from coordination number 6 to 9.	
UNIT- II, 1L/week		
LEARNING OBJECTIVES: *1. To study Organometallic Chemistry of Transition metals in details.*		
2 Organometallic Chemistry - II		**15L**
2.1	**Applications of Organometallic Compounds** (a) Catalysis-Homogenous and Heterogeneous Catalysis: Comparison, Fundamental Reaction Steps. (b) Organometallics as Catalysts in Organic Reactions: (i) Hydrosilylation (ii) Hydroboration (iii) Water gas Shifts reaction (iv) Wacker process (oxidation of alkenes) (v) Alcohol carbonylation. (c) Coupling reactions: (i) Heck reaction (ii) Suzuki reaction.	
UNIT III, 1L/week		
LEARNING OBJECTIVES: *1. To study the principle of Bioinorganic Chemistry.*		

3 Bioinorganic Chemistry - I		**15L**
3.1	Biological oxygen carriers; hemoglobin, hemerythrene and hemocyanine- structure of metal active center and differences in mechanism of oxygen binding, Differences between hemoglobin and myoglobin: Cooperativity of oxygen binding in hemoglobin and Hill equation, pH dependence of oxygen affinity in hemoglobin and myoglobin and its implications.	
3.2	Activation of oxygen in biological system with examples of mono-oxygenases, and oxidases- structure of the metal center and mechanism of oxygen activation by these enzymes.	
3.3	Copper containing enzymes- superoxide dismutase, tyrosinase and laccase: catalytic reactions and the structures of the metal binding site.	
3.4	Nitrogen fixation - nitrogenase, hydrogenases.	
3.5	Metal ion transport and storage: Ionophores, transferrin, ferritin and metallothionins.	
3.6	Medicinal applications of cis - platin and related compounds.	
UNIT IV, 1L/week		
LEARNING OBJECTIVES: 1. *To study the applications of group theory*		
4 Group Theory – II		**15L**
4.1	Applications of Group Theory (a) Symmetry adapted linear combinations (SALC), symmetry aspects of MO theory, sigma bonding in AB_n (Ammonia, CH_4) molecule. (b) Determination of symmetry species for translations and rotations. (c) Mulliken's notations for irreducible representations. (d) Reduction of reducible representations using reduction formula. (e) Group-subgroup relationships. Descent and ascent in symmetry correlation diagrams showing relationship between different groups.	
4.2	**Applications of group theory to electronic structures** (a) Transformation Properties of Atomic Orbitals. (b) Sigma and pi- molecular orbitals for AB_4 (tetrahedral) and AB_6 (octahedral) molecules. (c) Ligand Field Theory: Electronic structures of free atoms and ions, Splitting of levels and terms in a chemical environment, Construction of energy level diagrams, Direct product, Correlation diagrams for d^2 ions in octahedral and tetrahedral ligand field, Methods of Ascending and Descending Symmetry, Hole formalism.	

SUGGESTED REFERENCE

Unit I

1. P. Atkins, T. Overton, J. Rourke, M. Weller and F. Armstrong, Inorganic Chemistry, 5th Ed., Oxford University Press, 2010.
2. D. Banerjea, Coordination Chemistry, Tata McGraw Hill, 1993.
3. W. H. Malik, G. D. Tuli and R. D. Madan, Selected Topics in Inorganic Chemistry, 8th Ed., S. Chand and Company Ltd.
4. M. L. Tobe and J. Burgess, Inorganic Reaction Mechanism, Longman, 1999.
5. S. Asperger, Chemical kinetics and Inorganic Reaction Mechanism, 2nd Ed., Kluwer Academic/ Plenum Publishers, 2002
6. Gurdeep Raj, Advanced Inorganic Chemistry-Vol.II, 12th Edition, Goel publishing house, 2012.
7. B. R. Puri, L. R. Sharma and K. C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers, 2013-2014.
8. F. Basalo and R. G. Pearson, Mechanism of Inorganic Reactions, 2nd Ed., Wiley, 1967.
9. R. Gopalan and V. Ramlingam, Concise Coordination chemistry, Vikas Publishing house Pvt Ltd., 2001.
10. Robert B. Jordan, Reaction Mechanisms of Inorganic and Organometallic Systems, 3rd Ed., Oxford University Press 2008.

Unit II

1. R.C Mehrotra and A. Singh, Organometallic Chemistry- A unified Approach, 2nd revisededition, New Age International Pvt. Ltd., 2020.
2. R.H Crabtree, The Organometallic Chemistry of the Transition Metals, 6th edition, Wiley International Pvt., Ltd. 2014.
3. B. Doughlas, D.H McDaniel and J.J Alexander. Concepts and Models of Inorganic Chemistry, 3rd edition, John Wiley and Sons. 1994.
4. Organometallic Chemistry by G.S Sodhi, Ane Books Pvt. Ltd.

Unit III

1. Environmental Chemistry 5th edition, Colin Baird Michael Cann, W. H. Freeman and Company, New York, 2012.
2. Environmental Chemistry 7th edition, Stanley E. Manahan, CRC Press Publishers,
3. Environmental Contaminants, Daniel A. Vallero, ISBN: 0-12-710057-1, Elsevier Inc., 2004.
4. Environmental Science 13th edition, G. Tyler Miller Jr. and Scott E. Spoolman, ISBN- 10: 0-495-56016-2, Brooks/Cole, Cengage Learning, 2010.
5. Fundamentals of Environmental and Toxicological Chemistry 4th edition, Stanley E.

Manahan, ISBN: 978-1-4665-5317-0, CRC Press Taylor and Francis Group, 2013.

6. Living in the Environment 17th edition, G. Tyler Miller Jr. and Scott E. Spoolman, ISBN-10: 0-538-49414-X, Brooks/Cole, Cengage Learning, 2011
7. Poisoning and Toxicology Handbook, Jerrold B. Leikin, Frank P. Paloucek, ISBN: 1- 4200-4479-6, Informa Healthcare USA, Inc.
8. Casarett and Doull's Toxicology - The Basic Science of Poisons 6th edition, McGraw- Hill, 2001.

Unit IV

1. R. W. Hay, *Bioinorganic Chemistry*, Ellis Harwood, England, 1984.
2. I. Bertini, H. B. Gray, S. J. Lippard and J.S. Valentine, Bioinorganic Chemistry, First SouthIndian Edition, Viva Books, New Delhi, 1998.
3. J. A. Cowan, *Inorganic Biochemistry-An introduction*, VCH Publication, 1993.
4. S. J. Lippard and J. M. Berg, *Principles of Bioinorganic Chemistry*, University Science Publications, Mill Valley, Caligronic, 1994.
5. G.N. Mukherjee and A. Das, Elements of Bioinorganic Chemistry, Dhuri and Sons, Calcutta, 1988.
6. J. Chem. Educ. (Special issue), November 1985.
7. E. Frienden, J. Chem. Educ., 1985, 62.
8. Robert R. Crechton, Biological Inorganic Chemistry – An Introduction, Elsevier
9. J. R. Frausto da Silva and R. J. P. Williams, *The Biological Chemistry of the Elements*,Clarendon Press, Oxford, 1991.
10. JM. D. Yudkin and R. E. Offord *A Guidebook to Biochemistry*, Cambridge University Press, 1980.

SEMESTER – II

Course Code: SIPCHCC522

Paper II: Organic Chemistry

CREDITS: 4 **LECTURES: 60**

UNIT- I , 1L/week		
LEARNING OBJECTIVES: *1. To study the alkylation of nucleophilic carbon intermediates*		
1 Alkylation of Nucleophilic Carbon Intermediates and Reaction of carbon nucleophiles with carbonyl groups		**15L**
1.1	Alkylation of Nucleophilic Carbon Intermediates: 1.1.1. Generation of carbanion, kinetic and thermodynamic enolate formation, regioselectivity in enolate formation, alkylation of enolates. 1.1.2. Generation and alkylation of dianion, medium effects in the alkylation of enolates, oxygen versus carbon as the site of alkylation. 1.1.3. Alkylation of aldehydes, ketones, esters, amides and nitriles. 1.1.4. Nitrogen analogs of enols and enolates- Enamines and Imines anions, alkylation of enamines and imines. 1.1.5 Alkylation of carbon nucleophiles by conjugate addition (Michael reaction).	
1.2	Reaction of carbon nucleophiles with carbonyl groups 1.2.1 Mechanism of Acid and base catalyzed Aldol condensation, Mixed Aldol condensation with aromatic aldehydes, regiochemistry in mixed reactions of aliphatic aldehydes and ketones, intramolecular Aldol reaction and Robinson annulation. 1.2.2 Addition reactions with amines and iminium ions; Mannich reaction. 1.2.3 Amine catalyzed condensation reaction: Knoevenagel reaction. 1.2.4 Acylation of carbanions.	
UNIT- II, 1L/week		
LEARNING OBJECTIVES: *1. To study and understand the principals involved in reactions and rearrangements with respect to their mechanism and stereochemistry.*		
2 Reactions and Rearrangements		**15L**
2.1	Mechanisms, stereochemistry (if applicable) and applications of the following	

	Reactions: Baylis - Hilman reaction, McMurry Coupling, Corey-Fuchs reaction, Nef reaction, Passerini reaction.	
2.2	Concerted rearrangements: Hofmann, Curtius, Lossen, Schmidt, Wolff.	
2.3	Cationic rearrangements: Tiffeneau-Demjanov, Pummerer, Dienone-phenol, Rupe, Wagner Meerwein.	
2.4	Anionic rearrangements: Brook, Neber, Wittig, Payne.	
UNIT III, 1L/week		
LEARNING OBJECTIVES: 1. *To study the MOT in organic molecules using LCAO method and introduction to FMO and its application.* 2. *To understand the basic concept of ultraviolet and infrared spectroscopy and its application for structural determination of organic compounds.*		
3 Introduction to Molecular Orbital Theory for Organic Chemistry and Applications of UV and IR spectroscopy		**15L**
3.1	**Introduction to Molecular Orbital Theory for Organic Chemistry:** 3.1.1. Molecular orbitals: Formation of σ- and π-MOs by using LCAO method. Formation of π MOs of ethylene, butadiene, 1, 3, 5-hexatriene, allyl cation, anion and radical. Concept of nodal planes and energies of π-MOs 3.1.2. Introduction to FMOs: HOMO and LUMO and significance of HOMO-LUMO gap in absorption spectra as well as chemical reactions. MOs of formaldehyde: The effect of electronegativity perturbation and orbital polarization in formaldehyde. HOMO and LUMO (π and π* orbitals) of formaldehyde. A brief description of MOs of nucleophiles and electrophiles. Concept of 'donor-acceptor' interactions in nucleophilic addition reactions on formaldehyde. Connection of this HOMO-LUMO interaction with 'curved arrows' used in reaction mechanisms. The concept of hardness and softness and its application to electrophiles and nucleophiles. Examples of hard and soft nucleophiles/ electrophiles. Identification of hard and soft reactive sites on the basis of MOs. 3.1.3 Application of FMO concepts in (a) S_N^2 reaction, (b) Lewis acid base adducts (BF_3- NH_3 complex), (c) ethylene dimerization to butadiene, (d) Diels-Alder cycloaddition, (e) regioselective reaction of allyl cation with allyl anion (f) addition of hydride to formaldehyde.	
3.2	**Applications of UV and IR spectroscopy:** 1.2.1 Ultraviolet spectroscopy: Recapitulation, UV spectra of dienes, conjugated polyenes (cyclic and acyclic), carbonyl and unsaturated carbonyl compounds, substituted aromatic compounds. Factors affecting the position and intensity of UV bands – effect of conjugation, steric factor, pH, and solvent polarity. Calculation of absorption maxima for above classes of compounds by Woodward-Fieser rules (using Woodward-Fieser tables forvalues for substituents). 1.2.2 Infrared spectroscopy: Fundamental, overtone and combination bands, vibrational	

	coupling, factors affecting vibrational frequency (atomic weight, conjugation, ring size, solvent and hydrogen bonding). Characteristic vibrational frequencies for alkanes, alkenes, alkynes, aromatics, alcohols, ethers, phenols, amines, nitriles and nitro compounds. Detailed study of vibrational frequencies of carbonyl compounds, aldehydes, ketones,esters, amides, acids, acid halides, anhydrides, lactones, lactams and conjugated carbonyl compounds.	
UNIT IV, 1L/week		
LEARNING OBJECTIVES: 1. *To understand the principle and application of Nuclear Magnetic Resonance and Mass spectroscopy.*		
4 NMR spectroscopy and Mass spectrometry		**15L**
4.1	Proton magnetic resonance spectroscopy: Principle, Chemical shift, Factors affecting chemical shift (Electronegativity, H-bonding, Anisotropy effects). Chemical and magnetic equivalence, Chemical shift values and correlation for protons bonded to carbon and other nuclei as in alcohols,phenols, enols, carboxylic acids, amines, amides. Spin-spin coupling, Coupling constant (J),Factors affecting J, geminal, vicinal and long range coupling (allylic and aromatic). First order spectra, Karplus equation.	
4.2	^{13}C NMR spectroscopy: Theory and comparison with proton NMR, proton coupled and decoupled spectra, off-resonance decoupling. Factors influencing carbon shifts, correlation of chemical shifts of aliphatic, olefin, alkyne, aromatic and carbonyl carbons.	
4.3	Mass spectrometry: Molecular ion peak, base peak, isotopic abundance, metastable ions. Nitrogen rule, Determination of molecular formula of organic compounds based on isotopic abundance and HRMS. Fragmentation pattern in various classes of organic compounds (including compounds containing hetero atoms), McLafferty rearrangement, Retro-Diels-Alder reaction, ortho - effect.	
4.4	Structure determination involving individual or combined use of the above spectral techniques.	

SUGGESTED REFERENCE

1. Organic Chemistry, J. Claydens, N. Greeves, S. Warren and P. Wothers, Oxford University Press.
2. Advanced Organic Chemistry, F.A. Carey and R.J. Sundberg, Part A and B, Plenum Press.
3. March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure, Michael B. Smith, Jerry March, Wiley.
4. Organic Chemistry, R.T. Morrison, R.N. Boyd and S.K. Bhattacharjee, Pearson Publication (7^{th} Edition)
5. Advanced Organic Chemistry: Reactions and mechanism, B. Miller and R. Prasad,

Pearson Education.

6. Advanced Organic Chemistry: Reaction mechanisms, R. Bruckner, Academic Press.
7. Understanding Organic Reaction Mechanisms, Adams Jacobs, Cambridge University Press.
8. Writing Reaction Mechanism in organic chemistry, A. Miller, P.H. Solomons, Academic Press.
9. Principles of Organic Synthesis, R.O.C. Norman and J.M Coxon, Nelson Thornes.
10. Advanced Organic Chemistry: Reactions and mechanism, L.G. Wade, Jr., Maya Shankar Singh, Pearson Education.
11. Mechanism in Organic Chemistry, Peter Sykes, 6th
12. Molecular Orbital and Organic chemical reactions, Ian Fleming Reference Edition, Wiley
13. Introduction to Spectroscopy, Donald L. Pavia, Gary M. Lampman, George S. Kriz, Thomson Brooks.
14. Spectrometric Identification of Organic Compounds, R. Silverstein, G.C Bassler and T.C. Morrill, John Wiley and Sons.
15. Organic Spectroscopy, William Kemp, W.H. Freeman and Company.
16. Organic Spectroscopy-Principles and Applications, Jagmohan, Narosa Publication.
17. Organic Spectroscopy, V.R. Dani, Tata McGraw Hill Publishing Co.
18. Spectroscopy of Organic Compounds, P.S. Kalsi, New Age International Ltd.
19. Organic Reaction Mechanisms, V.K. Ahluwalia, R.K. Parasher, Alpha Science International, 2011.
20. Reactions, Rearrangements and Reagents by S. N. Sanyal
21. Name Reactions, Jie Jack Li, Springer
22. Name Reactions and Reagents in Organic Synthesis, Bradford P. Mundy, M.G. Ellerd, and F.G. Favaloro, John Wiley and Sons.

Semester II

Course Code: SIPCHCC523

Paper III: Physical Chemistry

CREDITS: 2 **LECTURES: 30**

UNIT- I , 1L/week		
LEARNING OBJECTIVES: *1. Describe Elementary reactions in solution, Enzymes and reactions in solid.*		
1 Chemical Kinetics and Molecular Reaction Dynamics		**15 L**
1.1	Elementary Reactions in Solution: Solvent Effects on reaction rates, Reactions between ions influence of solvent Dielectric constant, influence of ionic strength, Linear free energy, relationships enzyme action.	
1.2	Kinetics of reactions catalyzed by enzymes - Michaelis-Menten analysis, Lineweaver - Burk and Eadie Analysis.	
1.3	Inhibition of Enzyme action: Competitive, Noncompetitive and Uncompetitive Inhibition. Effect of pH, Enzyme activation by metal ions, Regulatory enzymes.	
1.4	Kinetics of reactions in the Solid State: - Factors affecting reactions in solids.	
1.5	Rate laws for reactions in solid: The parabolic rate law, The first order rate Law, the contracting sphere rate law, Contracting area rate law, some examples of kinetic studies.	
UNIT- II, 1L/week		
LEARNING OBJECTIVES: *1. To understand the concept of quantum chemistry with respect to rigid rotor, quantization of rotational energy, spherical harmonics.* *2. To study the applications of Schrödinger equation for electron system*		
2 Quantum Chemistry – II		**15 L**

2.1	Rigid rotor, spherical coordinates Schrödinger wave equation in spherical coordinates, separation of the variables, the phi equation, wave function, quantum number, the theta equation, wave function, quantization of rotational energy, spherical harmonics.	
2.2	Hydrogen atom, the two particle problem, separation of the energy as translational and potential, separation of variables, the R the θ* and the ϕ equations, solution of the requation, introduction of the four quantum numbers and their interdependence on the basis of the solutions of the three equations, total wave function, expression for theenergy, probability density function, distances and energies in atomic units, radial and angular plots, points of maximum probability, expressions for the total wave function for 1s, 2s, 2p and 3d orbitals of hydrogen.	
2.3	Application of the Schrödinger equation to two electron system, limitations of the equation, need for the approximate solutions, methods of obtaining the approximatesolution of the Schrödinger wave equation.	
2.4	Hückel Molecular Orbitals theory for ethylene, 1, 3-butadiene and benzene.	

SUGGESTED REFERENCE

1. Peter Atkins and Julio de Paula, Atkin's *Physical Chemistry*, 7th Edn., Oxford University Press, 2002.
2. K.J. Laidler and J.H. Meiser, *Physical Chemistry*, 2nd Ed., CBS Publishers and Distributors, New Delhi, 1999.
3. Robert J. Silby and Robert A. Alberty, *Physical Chemistry*, 3rd Edn., John Wiley and Sons (Asia) Pte. Ltd., 2002.
4. Ira R. Levine, *Physical Chemistry*, 5th Edn., Tata McGraw-Hill New Delhi, 2002.
5. G.W. Castellan, *Physical Chemistry*, 3rd Edn., Narosa Publishing House, New Delhi, 1983.
6. S. Glasstone, *Text Book of Physical Chemistry*, 2nd Edn., McMillan and Co. Ltd., London, 1962.
7. Principles of Chemical Kinetics, 2nd Ed., James E. House, ELSEVIER, 2007.
8. B.K. Sen, *Quantum Chemistry including Spectroscopy*, Kalyani Publishers, 2003.
9. A.K. Chandra, *Introductory Quantum Chemistry*, Tata McGraw – Hill, 1994.
10. R.K. Prasad, *Quantum Chemistry*, 2nd Edn., New Age International Publishers, 2000.
11. W.G. Davis, *Introduction to Chemical Thermodynamics – A Non – Calculus Approach*, Saunders, Philadelphia, 19772.
12. Ira N. Levine, *Quantum Chemistry*, 5th Edn., Pearson Education (Singapore) Pte. Ltd., Indian Branch, New Delhi, 2000.

SEMESTER – II

Discipline Specific Elective (DSE)

Course Code: SIPCHEL521

Synthetic Organic Chemistry – I

CREDITS: 3 **LECTURES: 45**

UNIT- I , 1L/week		
LEARNING OBJECTIVES: *1) Describe organic free radical and their importance in organic synthesis.*		
1 Radicals in Organic Synthesis		**15 L**
1.1	**Introduction:** Generation, stability, reactivity structural and stereochemical properties of free radicals, Persistent and charged radicals, Electrophilic and nucleophilic radicals.	
1.2	**Radical Initiators**: azobisisobutyronitrile (AIBN) and dibenzoyl peroxide.	
1.3	**Characteristic reactions** - Free radical substitution, addition to multiple bonds. Radical chain reactions, radical halogenation of hydrocarbons (Regioselectivity), radical cyclizations, autoxidations: synthesis of cumene hydroperoxide from cumene.	
1.4	**Radicals in synthesis**: Inter and intra molecular C-C bond formation via mercuric hydride, tin hydride, thiol donors. Cleavage of C-X, C-Sn, C-Co, C-S, O-O bonds. Oxidative coupling, C-C bond formation in aromatics: S_NAr reactions.	
1.5	Hunsdiecker reaction, Pinacol coupling, McMurry coupling, Sandmeyer reaction, Acyloin condensation.	
UNIT- II, 1L/week		
LEARNING OBJECTIVES: *1. Explain the applications of enamines, ylides and α C-H functionalization in organic synthesis.*		
2 Enamines, Ylides and A-C-H Functionalization		**15 L**
2.1	**Enamines:** Generation and application in organic synthesis with mechanistic pathways, Stork enamine reaction. Reactivity, comparison between enamines and enolates. Synthetic reactions of enamines including asymmetric reactions of chiral enamines derived from	

	chiral secondary amines.	
2.2	**Phosphorus, Sulfur and Nitrogen Ylides:** Preparation and their synthetic applications along with their stereochemical aspects. Wittig reaction, Horner-Wadsworth-Emmons Reaction, Barton-Kellogg olefination.	
2.3	**α-C-H functionalization:** By nitro, sulfoxide, sulfone and phosphonate groups: generation of carbanions by strong bases (LDA/n-butyl lithium) and applications in C-C bond formation. Bamford-Stevens reaction, Julia olefination and its modification, Seyferth–Gilbert homologation, Steven's rearrangement.	
UNIT III, 1L/week		
LEARNING OBJECTIVES: 1. *Apply the applications of organometallic compounds in organic synthesis.*		
3 Metals / Non-Metals in Organic Synthesis		**15 L**
3.1	**Mercury in organic synthesis:** Mechanism and regiochemistry of oxymercuration and demercuration of alkenes, mercuration of aromatics, transformation of aryl mercurials to aryl halides. Organomercurials as carbene transfer reagents.	**3 L**
3.2	**Organoboron compounds:** Mechanism and regiochemistry of hydroboration of alkenes and alkynes, asymmetric hydroboration using chiral boron reagents, 9-BBN hydroboration, oxazaborolidine (CBS catalyst) and functional group reduction by diborane.	**3 L**
3.3	**Organosilicons:** Salient features of silicon governing the reactivity of organosilicons, preparation and important bond-forming reactions of alkyl silanes, alkenyl silanes, aryl silanes and allyl silanes. β-silyl cations as intermediates. Iodotrimethylsilane in organic synthesis.	**3 L**
3.4	**Silyl enol ethers:** Application: As nucleophiles (Michael reaction, Mukaiyama aldol reaction), in ring contraction reactions.	**2 L**
3.5	**Organotin compounds**: Preparation of alkenyl and allyl tin compounds; application in C-C bond formation, in replacement of halogen by H at the same C atom.	**2 L**
3.6	**Selenium in organic synthesis:** Preparation of selenols/selenoxide, selenoxide elimination to create unsaturation, selenoxide and seleno acetals as α-C-H activatinggroups.	**2 L**

SUGGESTED REFERENCE

1. 1. Advanced Organic Chemistry, Part A and Part B: Reaction and Synthesis, Francis A. Carey, Richard J. Sundberg, 5th Edition, Springer Verlag
2. Modern Methods of Organic Synthesis, 4th Edition, W. Carruthers and Iain Coldham, Cambridge University Press, 2004.

3. Chem.Rev. 2002, 102, 2227-2302, Rare Earth Metal Triflates in Organic Synthesis, S. Kobayashi, M. Sugiura, H. Kitagawa, and W.W.L. Lam.
4. Organic Chemistry, Clayden Greeves Warren and Wothers, Oxford Press (2001).
5. Moder Organic Synthesis: An Introduction, G.S. Zweifel and M.H. Nantz, W.H. Freeman and Company, (2007).
6. Advanced Organic Chemistry: Reaction Mechanism, R. Bruckner, Academic Press (2002).
7. Principles of Organic Synthesis, R.O.C. Norman & J. M. Coxon, 3rd Edn., Nelson Thornes
8. Organic Chemistry, 7th Edn, R. T. Morrison, R. N. Boyd, & S. K. Bhattacharjee, Pearson
9. Strategic Applications of Name Reactions in Organic Synthesis, L. Kurti & B. Czako (2005), Elsevier Academic Press
10. Advanced Organic Chemistry: Reactions & Mechanisms, 2nd Edn., B. Miller & R. Prasad, Pearson
11. Organic reactions and their mechanisms, 3rd revised edition, P.S. Kalsi, New Age International Publishers
12. Organic Synthesis: The Disconnection Approach, Stuart Warren, John Wiley & Sons, 2004
13. Name Reactions and Reagents in Organic Synthesis, 2nd Edn., Bradford P. Mundy, Michael G. Ellard, and Frank Favoloro, Jr., Wiley-Interscience
14. Name Reactions, Jie Jack Lie, 3rd Edn., Springer
15. Organic Electrochemistry, H. Lund, and M. Baizer, 3rd Edn., Marcel Dekker.

SEMESTER – II

Course Code: SIPSCHOJ521:

On Job Training

CREDITS: 4

On Job Training		
1	**On Job Training**	
	There will not be any theory paper for On Job Training, therefore, 4 Credits will be given as per evaluation criteria to be specially prepared similar to Internship evaluation, for example, regularity and approach towards the on job training, report from the supervisor of the concerned department of the industry or company or institute where the student is doing on job training, observations and maintenance of daily records etc.	

SEMESTER-II

PRACTICALS

Course Code: SIPCHCCP521

Practical Paper I: Inorganic Chemistry Practical

CREDITS: 2

	(4L/Week)
1	**Inorganic Preparations (Synthesis and Characterization)** 1) Bis-(tetraethylammonium) tetrachloro Cuprate (II) $(Et_4\ N)_2[CuCl4]$ 2) Bis-(tetraethylammonium) tetrachloro Nickelate (II) $(Et_4\ N)_2\ [NiCl_4]$ 3) Bis-(tetraethylammonium) tetrachloro Cobaltate (II) $(Et_4\ N)_2[CoCl_4]$ (**Any two** from the above preparations) 4) Tetrammine monocarbanato Cobalt (III) Nitrate $[Co(NH_3)_4CO_3]NO_3$ 5) Bis (ethylenediammine) Copper (II) Sulphate $[Cu(en)_2]SO_4$ 6) Hydronium dichloro bis(dimethylglyoximato) Cobaltate(III) $H[Co(dmgH)_2Cl_2]$ **Instrumentation** 1) Determination of equilibrium constant by Slope intercept method for Fe^{+3}/ SCN^- system. 2) Determination of Electrolytic nature of inorganic compounds by Conductance measurement. **Reference:** 1. Advanced experiments in Inorganic Chemistry., G. N. Mukherjee., 1st Edn., 2010., U.N. Dhur and Sons Pvt. Ltd 2. The Synthesis and Characterization of Inorganic Compounds by William L. Jolly. Inorganic Chemistry Practical under UGC Syllabus for M.Sc. in all India Universities By: Dr Deepak Pant.

SEMESTER-II

PRACTICALS

Course Code: SIPCHCCP522

Practical Paper II: Organic Chemistry Practical

CREDITS: 2

	(1P/Week)
1	**Separation of Binary mixture using micro-scale technique** 1. Separation of binary mixture using physical and chemical methods. 2. Characterization of one of the components with the help of chemical analysis and confirmation of the structure with the help of derivative preparation and its physical constant. 3. Purification and determination of mass and physical constant of the second component. The following types are expected: (i) Water soluble/water insoluble solid and water insoluble solid. (ii) Non-volatile liquid-Non-volatile liquid (chemical separation). (iii) Water insoluble solid-Non-volatile liquid. **A minimum of three mixtures from each type and a total of ten mixtures are expected.** **Reference:** 1. Systematic Qualitative organic analysis, H. Middleton (Orient Longman) 2. A Handbook of Organic Analysis, H.T. Clark (Orient Longman) 3. Systematic Identification of organic compounds, R.L. Shriner (John Wiley, New York) 4. Practical Organic Chemistry by Mann and Saunders. 5. Advance Practical Organic Chemistry, N.K. Vishnoi, Vikas Publication.

SEMESTER-II

PRACTICALS

Course Code: SIPCHELP521

Practical : Techniques of purification Practical – (DSE)

CREDITS: 1

	(2L/Week)
1	**Techniques of Purification** 1. Steam distillation 2. Vacuum distillation 3. Column Chromatography **Learning points: Techniques of purification** 1. Students are expected to perform a purification technique using a known mass or volume of the given substance. 2. Check the purity of the purified compound by TLC, measure its mass and physical constant. **Reference:** 1. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis- V.K. Ahluwalia and Renu Aggarwal, Universities Press India Ltd., 2000 2. Advanced Practical Organic Chemistry – N. K. Vishnoi, Third Addition, Vikas Publishing House PVT Ltd 3. Systematic Laboratory Experiments in Organic Synthesis- A. Sethi, New Age International Publications 4. Systematic Identification of Organic compounds, 6th edition, R. L. Shriner, R. C. Fuson and D.Y. Curtin Wiley, New York. 5. Vogel's Textbook of Quantitative Analysis, revised, J. Bassett, R. C. Denney, G. H. Jeffery and J. Mendham, ELBS 6. Experiments and Techniques in Organic Chemistry, D. Pasto, C. Johnson and M. Miller, Prentice Hall 7. Macro-scale and Micro-scale Organic Experiments, K. L. Williamson, D. C. Heath. 8. Systematic Qualitative Organic Analysis, H. Middleton, Adward Arnold. 9. Handbook of Organic Analysis- Qualitative and Quantitative, H. Clark, Adward 10. Vogel's Textbook of Practical Organic Chemistry, Fifth edition,2008, B.S.Furniss, A. J.Hannaford, P. W. G. Smith, A. R. Tatchell, Pearson Education. 11. Laboratory Manual of Organic Chemistry, Fifth edition, R K Bansal, New Age Publishers. 12. Organic structures from spectra, L. D. Field, S. Sternhell, John R. Kalman, Wiley, 4th ed., 2011.

Note:

The candidate is expected to submit a journal certified by the Head of the Department /institution at the time of the practical examination. 2. A candidate will not be allowed to appear for the practical examination unless he/she produces a certified journal or a certificate from the Head of the institution/department stating that the journal is lost, and the candidate has performed the required number of experiments satisfactorily. The list of the experiments performed by the candidate should be attached with such a certificate. 3. Use of a non-programmable calculator is allowed both at the theory and the practical examination.

Examination pattern for NEP-compliant MSc semester 1 - 2023-2024

Paper No. /Paper Name	Total Credits	Theory Credits	Practical Credits	Internal (Total Marks)	Semester end exam (Total Marks and duration)	Practical (Total Marks and Duration)
Paper I Inorganic Chemistry	6	4	2	40 M	60 M 2h 30 min	50 M 4 hours
Paper II Organic Chemistry	6	4	2	40 M	60 M 2h 30 min	50 M 4 hours
Paper III Physical Chemistry	2	2	Nil	20 M	30 M 1h 15 min	NA
Discipline Specific Elective (DSE) Structural Inorganic Chemistry	4	3	1	25 M	50 M 2 hours	25 M 2 hours
Research Methodology (RM)	4	3	1	25 M	50 M 2 hours	25 M 2 hours

Note:

The candidate is expected to submit a journal certified by the Head of the Department /institution at the time of the practical examination. 2. A candidate will not be allowed to appear for the practical examination unless he/she produces a certified journal or a certificate from the Head of the institution/department stating that the journal is lost, and the candidate has performed the required number of experiments satisfactorily. The list of the experiments performed by the candidate should be attached with such a certificate. 3. Use of a non-programmable calculator is allowed both at the theory and the practical examination.

Examination pattern for NEP-compliant MSc semester 2 - 2023-2024

Paper Name	Total Credits	Theory Credits	Practical Credits	Internal (Total Marks)	Semester end exam (Total Marks and duration)	Practical (Total Marks and Duration)
Paper I Inorganic Chemistry	6	4	2	40 M	60 M 2h 30 min	50 M 4 hours
Paper II Organic Chemistry	6	4	2	40 M	60 M 2h 30 min	50 M 4 hours
Paper III Physical Chemistry	2	2	Nil	20 M	30 M 1h 15 min	NA
Synthetic Organic Chemistry (DSE)	4	3	1	25 M	50 M 2 hours	25 M 2 hours
On Job Training (OJT)	4	3	1	25 M	50 M 2 hours	25 M 2 hours