RAJAH SERFOJI GOVERNMENT COLLEGE

(AUTONOMOUS)

THANJAVUR – 613 005

PG & RESEARCH DEPARTMENT OF CHEMISTRY

CURRICULUM AND SYLLABUS

FOR

M.Sc. Degree Programme in Chemistry

SEMESTER PATTERN

(Two Years Degree Programme)

Effective from the Academic Year 2026-2027

RAJAH SERFOJI GOVT COLLEGE (AUTONOMOUS), THANJAVUR-5
POST GRADUATE COURSES
SUBJECT: CHEMISTRY
(Applicable to the Students admitted from the academic year 2026-2027 onwards)

SEM	CODE	COURSE	TITLE	HRS / WEEK	MARKS		TOTAL	EXAM HOURS	CREDIT
			I SEMESTER		**IA**	**AE**			
I	**B1PCHC1**	**CC1**	**Organic Reaction Mechanism - I**	6	25	75	100	3	6
	B1PCHC2	**CC2**	**Structure and Bonding in Inorganic Compounds**	6	25	75	100	3	6
	B1PCHC3P	**CC3**	**Organic Chemistry Practical - I**	6	25	75	100	6	6
	B1PCHC4P	**CC4**	**Inorganic Chemistry Practical - I**	6	25	75	100	6	6
	B1PCHEC1	**EC-1**	**Green Chemistry**	6	25	75	100	3	6
		TOTAL		**30**			**500**		**30**
			II SEMESTER						
II	**B2PCHC5**	**CC5**	**Organic Reaction Mechanism - II**	6	25	75	100	3	6
	B2PCHC6	**CC6**	**Physical Chemistry - I**	6	25	75	100	3	6
	B2PCHC7P	**CC7**	**Organic Chemistry Practical - II**	6	25	75	100	6	6
	B2PCHC8P	**CC8**	**Inorganic Chemistry Practical - II**	6	25	75	100	6	6
	B2PCHEC2	**EC2**	**Molecular Spectroscopy**	6	25	75	100	3	6
		TOTAL		**30**			**500**		**30**

SEM	CODE	COURSE	TITLE	HRS / WEEK	MARKS		TOTAL	EXAM HOURS	CREDIT
			III SEMESTER						
III	**B3PCHC9**	**CC9**	**Organic Synthesis and Photochemistry**	6	25	75	100	3	6
	B3PCHC10	**CC10**	**Coordination Chemistry**	6	25	75	100	3	6
	B3PCHC11P	**CC11**	**Physical Chemistry Practical - I**	6	25	75	100	6	6
	B3PCHC12	**CC12**	**Research Methodology**	6	25	75	100	3	6
	B3PCHEC3	**EC3**	**Physical Chemistry – II**	6	25	75	100	3	6
			Internship / Industrial activity	-	-	-	-	-	2
		TOTAL		**30**			**500**		**32**
			IV SEMESTER						
IV	**B4PCHC13**	**CC13**	**Spectroscopy & Organometallic Chemistry**	6	25	75	100	3	6
	B4PCHC14P	**CC14**	**Physical Chemistry Practical -II**	6	25	75	100	6	6
	B4PCHC15	**CC15**	***Project Work***	6	25	75	100	3	6
	B4PCHEC4	**EC4**	**Bio-Inorganic Chemistry**	6	25	75	100	3	6
	B4PCHSE1	**SEC1**	**Medicinal Chemistry**	3	25	75	100	3	3
	B4PCHSE2	**SEC2**	**Nano and Computational Chemistry**	3	25	75	100	3	3
			Extension Activity	-	-	-	-	-	1
		TOTAL		**30**			**600**		**31**
		GRAND TOTAL					**2100**		**123**

	Number of Papers	Credit
Core Courses	**15**	**90**
Elective Courses	**4**	**24**
Internship/ Industrial activity		**2**
Skill Enhancement Courses	**2**	**6**
Extension Activity		**1**
Total	**21**	**123**

For Internship / Industrial Activity (to be submitted at Semester III): The activity should be carried out during the Summer Vacation after 1st Year

Elective Courses

- Green Chemistry
- Molecular Spectroscopy
- Physical Chemistry - II
- Bioinorganic Chemistry

Skill Enhancement Courses

- Medicinal Chemistry
- Nano and Computational Chemistry

Internship will be carried out during the summer vacation of the first year, and marks will be included in the Third Semester Mark Statement
Passing Minimum is prescribed for Internal and External
(a) The Passing minimum for CIA shall be 12 out of 25 Marks
(b)The Passing minimum for Autonomous Examinations shall be 38 out of 75 marks

Component Wise Credit Distribution						
	Credit					
Part	**Sem I**	**Sem II**	**Sem III**	**Sem IV**	**Total**	
Part - A						**Under CGPA Calculation**
Core Papers 1 to 15	24	24	24	18	**90**	
Part - B						
Elective Papers 1 to 4	6	6	6	6	**24**	
Skill Enhancement Papers 1 & 2	-	-	-	6	**6**	**Under Non CGPA Calculation**
Summer Internship/Industrial Training			2		**2**	
Part - C						
Extension Activities				1	**1**	
Total	**30**	**30**	**32**	**31**	**123**	

REGULATIONS ON LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK FOR POSTGRADUATE EDUCATION	
Programme	**M. Sc., Chemistry**
Programme Code	
Duration	**PG – 2YEARS**
Programme Outcomes (Pos)	**PO1: Problem Solving Skill** Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context. **PO2: Decision Making Skill** Foster analytical and critical thinking abilities for data-based decision-making. **PO3: Ethical Value** Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities. **PO4: Communication Skill** Ability to develop communication, managerial and interpersonal skills. **PO5: Individual and Team Leadership Skill** Capability to lead themselves and the team to achieve organizational goals. **PO6: Employability Skill** Inculcate contemporary business practices to enhance employability skills in the competitive environment. **PO7: Entrepreneurial Skill** Equip with skills and competencies to become an entrepreneur. **PO8: Contribution to Society** Succeed in career endeavours and contribute significantly to society. **PO 9 Multicultural competence** Possess knowledge of the values and beliefs of multiple cultures and a global perspective. **PO 10: Moral and ethical awareness/reasoning** Ability to embrace moral/ethical values in conducting one's life.

Programme Specific Outcomes (PSOs)	**PSO1 – Placement** To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions. **PSO 2 – Entrepreneur** To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations. **PSO3 – Research and Development** Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development. **PSO4 – Contribution to Business World** To produce employable, ethical and innovative professionals to sustain in the dynamic business world. **PSO 5 – Contribution to the Society** To contribute to the development of the society by collaborating with stakeholders for mutual benefit.

SEMESTER – I

CC1: Organic Reaction Mechanism – I

Year: 1 **Semester: 1**

Subject Code: B1PCHC1 **Credit: 6**

Instructional Hours: 6 **Exam Hours: 3**

Course Objectives

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

UNIT-I: Methods of Determination of Reaction Mechanism

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

UNIT-II: Aromatic and Aliphatic Electrophilic Substitution

Aromaticity: Aromaticity in benzenoid, non-benzenoid, heterocyclic compounds and annulenes. Aromatic electrophilic substitution: Orientation and reactivity of di- and poly-substituted phenol, nitrobenzene and halobenzene. Reactions involving nitrogen electrophiles: nitration, nitrosation and diazonium coupling; Sulphur electrophiles: sulphonation; Halogen electrophiles: chlorination and bromination; Carbon electrophiles: Friedel-Crafts alkylation, acylation and arylation reactions. Aliphatic electrophilic substitution Mechanisms: S_E2 and S_Ei, S_E1- Mechanism and evidences.

UNIT-III: Aromatic and Aliphatic Nucleophilic Substitution

Aromatic nucleophilic substitution: Mechanisms - S_NAr, S_N1 and Benzyne mechanisms - Evidences - Reactivity, Effect of structure, leaving group and attacking nucleophile. Reactions: Oxygen and Sulphur-nucleophiles, Bucherer and Rosenmund reactions, von Richter, Sommelet- Hauser and Smiles rearrangements. S_N1, ion pair, S_N2 mechanisms and evidences. Aliphatic nucleophilic substitutions at an allylic carbon, aliphatic trigonal carbon and vinyl carbon.S_N1, S_N2 and S_Ni mechanism and evidences, Swain- Scott, Grunwald-Winstein relationship - Ambident nucleophiles.

UNIT-IV: Stereochemistry-I

Introduction to molecular symmetry and chirality – axis, plane, center, alternating axis of symmetry. Optical isomerism due to asymmetric and dissymmetric molecules. Absolute and

relative Configurations D, L system, Cram's and Prelog's rules: R, S-notations (Cahn-Ingold-Prelog rules). Absolute Configurations for allenes, spiranes and biphenyls. Racemic modifications: Racemization by thermal, anion, cation, reversible formation, epimerization and mutarotation.

UNIT-V: Stereochemistry-II

Concept of Conformation and methods of determining the configuration of geometrical isomers, acyclic systems, intramolecular rearrangements, neighbouring group participation, chemical l consequence of conformational equilibrium - Curtin-Hammett Principle. Stability of five and six-membered rings: mono-, di- and poly-substituted cyclohexanes, conformation and reactivity in cyclohexane systems. Fused and bridged rings: bicyclic, poly cyclic systems, decalins and Brett's rule. exo-cyclic alkylidene-cycloalkanes. Topicity and pro-stereoisomerism, chiral shift reagents and chiral solvating reagents. Criteria for optical purity: Resolution of racemic modifications, asymmetric transformations, asymmetric synthesis, destruction. Stereoselective and stereospecific synthesis.

Recommended Text Books

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

Reference Books

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

Online Resources

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

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

Course Learning Outcomes

Students will be able

CLO1: To recall the basic principles of organic chemistry.

CLO2: To understand the formation and detection of reaction intermediates of organic reactions.

CLO3: To predict the reaction mechanism of organic reactions and stereochemistry of organic compounds.

CLO4: To apply the principles of kinetic and non-kinetic methods to determine the mechanism of reactions.

CLO5: To design and synthesize new organic compounds by correlating the stereochemistry of organic compounds.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**
CO 2	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**
CO 4	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 5	**M**	**S**	**M**	**S**	**S**	**M**	**S**	**M**	**S**	**S**

3 – Strong, 2 – Medium, 1 - Low

Level of Correlation between PSO's and CO's

CO /PO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

3 – Strong, 2 – Medium, 1 - Low

Signature of HOD

CC2: Structure and Bonding in Inorganic Compounds

Year: 1 **Semester: 1**

Subject Code: B1PCHC2 **Credit: 6**

Instructional Hours: 6 **Exam Hours: 3**

Course Objectives

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

UNIT-I: Structure of Main Group Compounds and Clusters

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

UNIT-II: Solid State Chemistry – I

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

UNIT-III: Solid State Chemistry – II

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

UNIT-IV: Techniques in Solid State Chemistry

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

and electron microscopy, theory, principle, instrumentation, sampling methods and applications of SEM and TEM.

UNIT-V: Band Theory and Defects in Solids

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

Recommended Text Books

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

Reference Books

1. D. E. Douglas, D.H. McDaniel and J. J. Alexander, Concepts and Models in Inorganic Chemistry, 3rd Ed, 1994.
2. R J D Tilley, Understanding Solids - The Science of Materials, 2nd edition, Wiley Publication, 2013.
3. C N R Rao and J Gopalakrishnan, New Directions in Solid State Chemistry, 2nd Edition, Cambridge University Press, 199.
4. T. Moeller, Inorganic Chemistry, A Modern Introduction; John Wiley: New York, 1982.
5. D. F. Shriver, P. W. Atkins and C.H. Langford; Inorganic Chemistry; 3rd ed.; Oxford University Press: London, 2001.

Online Resources

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

Course Learning Outcomes

Students will be able

CLO1: Predict the geometry of main group compounds and clusters.

CLO2: Explain the packing of ions in crystals and apply the radius ratio rule to predict the coordination number of cations.

CLO3: Understand the various types of ionic crystal systems and analyze their structural features.

CLO4: Explain the crystal growth methods.

CLO5: To understand the principles of diffraction techniques and microscopic techniques.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**
CO 2	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**
CO 4	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 5	**M**	**S**	**M**	**S**	**S**	**M**	**S**	**M**	**S**	**S**

3 – Strong, 2 – Medium, 1 - Low

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

3 – Strong, 2 – Medium, 1 – Low

Signature of HOD

CC3: Organic Chemistry Practical – I

Year: 1 **Semester: 1**

Subject Code: B1PCHC3P **Credit: 6**

Instructional Hours: 6 **Exam Hours: 6**

Course Objectives

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

UNIT – I: Separation and Analysis

A. Two-component mixtures.

B. Three-component mixtures.

UNIT – II: Single Stage Preparation of Organic Compounds

(a) Nitration: methyl-m-nitrobenzoate from methyl benzoate.
(b) Addition: Benzophenone oxime from benzophenone.
(c) Chlorination cum diazotization: o-chlorobenzoic acid from anthranilic acid.
(d) Oxidation: p-benzoquinone from hydroquinone.
(e) Diazotisation; Phenlyazo-2-naphthol from aniline.

Reference Books

1. Ganapragasm N S and Ramamurthy C, *Organic Chemistry Lab Manual*, 2nd Edition,

2. Vishwanathan S Printers and Publishers (P) Ltd., Chennai, 2015.

3. Furniss B S, Hannaford A J, Smith P W G, and Tatchell A R, *Vogel's Textbook of Practical Organic Chemistry*, 5th Edition, Pearson publication.

Course Learning Outcomes

Students will be able:

CLO1: To recall the basic principles of organic separation, qualitative analysis and preparation.
CLO2: To explain the method of separation and analysis of separated organic mixtures and convert them as derivatives by a suitable preparation method.
CLO3: To determine the characteristics of the separation of organic compounds by various chemical reactions.
CLO4: To develop strategies to separate, analyze and prepare organic compounds.
CLO5: To formulate a method of separation, analysis of organic mixtures and design a suitable procedure for organic preparations.

CO-PO Mapping (Course Articulation Matrix)

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**
CO 2	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**
CO 4	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 5	**M**	**S**	**M**	**S**	**S**	**M**	**S**	**M**	**S**	**S**

3 – Strong, 2 – Medium, 1 - Low

Level of Correlation between PSO's and CO's

CO /PO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

3 – Strong, 2 – Medium, 1 – Low

Signature of HOD

CC4: Inorganic Chemistry Practical – I

Year: 1 **Semester: 1**

Subject Code: B1PCHC4P **Credit: 6**

Instructional Hours: 6 **Exam Hours: 6**

Course Objectives

- To impart knowledge on Qualitative analysis of Inorganic mixture.
- To gain the depth knowledge in the Colorimetric estimation of different metals.
- To train the students for improving their skill in estimating the amount of ion accurately present in the solution
- To estimate metal ions, present in the given solution accurately without using instruments.

UNIT – I: Analysis of Mixture of Cations

Analysis of a mixture of four cations containing two common cations and two rare cations. Cations to be tested.

Group-I : W, Tl and Pb.

Group-II : Se, Te, Mo, Cu, Bi and Cd.

Group-III : Tl, Ce, Th, Zr, V, Cr, Fe, Ti and U.

Group-IV : Zn, Ni, Co and Mn.

Group-V : Ca, Ba and Sr.

Group-VI : Li and Mg.

UNIT – II: Colorimetric Estimation

a) Copper
b) Iron
c) Nickel
d) Chromium using photo electric colorimeter.

Recommended Text Books

1. A. Jeya Rajendran, Microanalytical Techniques in Chemistry: Inorganic Qualitative Analysis, United global publishers, 2021.

2. V.V. Ramanujam, *Inorganic Semimicro Qualitative Analysis*; 3rded., The National Publishing Company, Chennai, 1974.

3. Vogel's Textbook of Inorganic Qualitative Analysis, 4th ed., ELBS, London.

Reference Books

1. G. Pass and H. Sutcliffe, *Practical Inorganic Chemistry*; Chapman Hall, 1965.

2. W. G. Palmer, Experimental *Inorganic Chemistry*; Cambridge University Press, 1954.

Course Learning Outcomes

Students will be able:

CLO1: To identify the anions and cations present in a mixture of salts.

CLO2: To apply the principles of semi-micro qualitative analysis to categorize acid radicals and basic radicals.

CLO3: Examine a given inorganic mixture and find out the different groups of cations in it.

CLO4: To choose the appropriate chemical reagents for the detection of anions and cations.

CLO5: Investigate the presence of trace metal ions using colorimetry.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**
CO 2	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**
CO 4	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 5	**M**	**S**	**M**	**S**	**S**	**M**	**S**	**M**	**S**	**S**

3 – Strong, 2 – Medium, 1 – Low

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

3 – Strong, 2 – Medium, 1 – Low

Signature of HOD

EC1: Green Chemistry

Year: 1 **Semester: 1**

Subject Code: B1PCHEC1 **Credit: 6**

Instructional Hours: 6 **Exam Hours: 3**

Course Objectives

- To discuss the principles of green chemistry.
- To propose green solutions for chemical energy storage and conversion.
- Propose solutions for pollution prevention in Industrial chemical and fuel production, Automotive industry and Shipping industries.
- Propose green solutions for industrial production of Surfactants, Organic and inorganic chemicals.

UNIT-I: Basics and Principles of Green Chemistry

Introduction- Need for Green Chemistry. Goals of Green Chemistry. Limitations of Green Chemistry. Chemical accidents, terminologies, International green chemistry organizations and Twelve principles of Green Chemistry with examples.

UNIT-II: Green Solvents and Ionic Liquids

Choice of starting materials, reagents, catalysts and solvents in detail, green chemistry in day today life. Designing green synthesis-green reagents: dimethyl carbonate. Green solvents: Water, Ionic liquids-criteria, general methods of preparation, effect on organic reaction. Supercritical carbon dioxide- properties, advantages, drawbacks and a few examples of organic reactions in $scCO_2$. Green synthesis-adipic acid and catechol.

UNIT-III: Green Catalysis

Environmental pollution, Green Catalysis-Acid catalysts, Oxidation catalysts, Basic catalysts, Polymer supported catalysts-Poly styrene aluminum chloride, polymeric super acid catalysts, Poly supported photosensitizers.

UNIT-IV: Phase Transfer Catalysis

Phase transfer catalysis in green synthesis-oxidation using hydrogen peroxide, crown ethers-esterification, saponification, anhydride formation, Elimination reaction, Displacement reaction. Applications in organic synthesis.

UNIT-V: Microwave Synthesis and Sonochemistry

Micro wave induced green synthesis-Introduction, Instrumentation, Principle and applications. Sonochemistry – Instrumentation, Cavitation theory - Ultra sound assisted green synthesis and Applications.

Recommended Text Books

1. Ahluwalia, V.K. and Kidwai, M.R. New Trends in Green Chemistry, Anamalaya Publishers, 2005.
2. W. L. McCabe, J.C. Smith and P. Harriott, Unit Operations of Chemical Engineering,

7th edition, McGraw-Hill, NewDelhi,2005.
3. J. M. Swan and D. St. C. Black, Organometallics in Organic Synthesis, Chapman Hall,1974.
4. V. K. Ahluwalia and R. Aggarwal, Organic Synthesis: Special Techniques, Narosa Publishing House, New Delhi,2001.
5. A. K. De, Environmental Chemistry, New Age Publications, 2017.

Reference Books

1. Anastas, P.T. and Warner, J.K. Oxford Green Chemistry -Theory and Practical, University Press, 1998
2. Matlack, A.S. Introduction to Green Chemistry, Marcel Dekker, 2001
3. Cann, M.C. and Connely, M.E. Real-World Cases in Green Chemistry, American Chemical Society, Washington, 2000
4. Ryan, M.A. and Tinnesand, M., Introduction to Green Chemistry, American Chemical Society Washington, 2002.
5. Chandrakanta Bandyopadhyay, An Insight into Green Chemistry, Books and Allied (P) Ltd, 2019.

Online Resources

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

2. https://www.studyorgo.com/summary.php

Course Learning Outcomes

Students will be able:

CLO1: To recall the basic chemical techniques used in conventional industrial preparations and in green innovations.

CLO2: To understand the various techniques used in chemical industries and in laboratory.

CLO3: To compare the advantages of organic reactions assisted by renewable energy sources and non-renewable energy sources.

CLO4: To apply the principles of PTC, ionic liquid, microwave and ultrasonic assisted organic synthesis.

CLO5: To design and synthesize new organic compounds by green methods.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**
CO 2	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**
CO 4	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 5	**M**	**S**	**M**	**S**	**S**	**M**	**S**	**M**	**S**	**S**

3 – Strong, 2 – Medium, 1 - Low

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

3 – Strong, 2 – Medium, 1 – Low

Signature of HOD

SEMESTER – II

CC5: Organic Reaction Mechanism – II

Year: 1 **Semester: 2**

Subject Code: B2PCHC5 **Credit: 6**

Instructional Hours: 6 **Exam Hours: 3**

Course Objectives

- To understand the concept of aromaticity in benzenoid, non-benzenoid, heterocyclic and annulene compounds.
- To understand the mechanism involved in various types of organic reactions with evidences.
- To understand the applications of synthetically important reagents.
- To correlate the reactivity between aliphatic and aromatic compounds.
- To design synthetic routes for synthetically used organic reactions.

UNIT-I: Elimination and Free Radical Reactions

Mechanisms: E^2, E^1, and E^1CB mechanisms. Syn- and anti-eliminations. Orientation of the double bond: Hoffmann and Saytzeff rules. Reactivity: Effect of substrate, attacking bases, leaving group and medium. Stereochemistry of eliminations in acyclic and cyclic systems, pyrolytic elimination. Long lived and short-lived radicals – Production of radicals by thermal and photochemical reactions, stability of radicals.

UNIT-II: Oxidation and Reduction Reactions

Mechanism of oxidation reactions: Dehydrogenation by quinones, selenium dioxides, lead tetraacetate, permanganate, manganese dioxide, osmium tetroxide, oxidation of saturated hydrocarbons, alkyl groups, alcohols, halides and amines. Reactions involving cleavage of C-C bonds - cleavage of double bonds, oxidative decarboxylation, allylic oxidation, oxidation by chromium trioxide-pyridine, dimethyl sulphoxide - dicyclohexylcarbodiimide (DMSO-DCCD). Mechanism of reduction reactions: Wolff-Kishner, Clemmenson, Rosenmund, reduction with Trialkyl and triphenyltin hydrides, McFadyen-Steven's reduction.

UNIT-III: Rearrangements

Rearrangements to electron deficient carbon: Pinacol-pinacolone rearrangements, Wagner-Meerwein, Dienone-phenol, and Wolff rearrangements. Rearrangements to electron deficient nitrogen: Hofmann, Curtius, Schmidt, Lossen and Beckmann rearrangements. Rearrangements to electron deficient oxygen: Baeyer-Villiger oxidation rearrangements. Rearrangements to electron rich atom: Favorskii, Stevens, Wittig rearrangements. Intramolecular rearrangements: Claisen, Cope, oxy-Cope Benzidine rearrangements.

UNIT-IV: Addition to Multiple Bonds

Addition to Carbon Multiple Bonds: Mechanisms: (a) Addition to carbon-carbon multiple bonds- Addition reactions involving electrophiles, nucleophiles, free radicals, carbenes and cyclic mechanisms-Orientation and reactivity, hydrogenation of double and triple bonds, Michael reaction, addition of oxygen and Nitrogen; (b) Addition to carbon-hetero atom multiple bonds: Mannich reaction, acids, esters, nitrites, addition of Grignard reagents, Wittig reaction, Prins reaction.

Addition to Carbon-Hetero atom Multiplebonds: Addition of Grignard reagents, organozinc and organolithium reagents to carbonyl. Mechanism of condensation reactions involving enolates –Stobbe reactions.

UNIT-V: Reagents and Name Reactions in Organic Synthesis

Lithium diisopropylamine (LDA), Sodium cyanoborohydride ($NaBH_3CN$), *meta*-Chloroperbenzoic acid (m-CPBA), Dimethyl aminiopyridine (DMAP), Triethyl amine(TEA), Diazobicyclo[5.4.0]undec-7-ene (DBU), Diethyl azo dicarboxylate (DEAD), *N*-bromosuccinimide (NBS), Trifluoroacetic acid (TFA), Tetramethyl piperiridin-1-oxyl (TEMPO), Diethyl maleate (DEM), Copper diacetylacetonate ($Cu(acac)_2$), $TiCl_3$, $NaIO_4$, Pyridinium chlorochromate (PCC), Pyridinium dichromate (PDC), Meisenheimer complex. Suzuki coupling, Heck reaction, Negishi reaction and Baylis-Hillman reaction.

Recommended Text Books

1. J. March and M. Smith, *Advanced Organic Chemistry*, 5th ed., John-Wiley and Sons. 2001.
2. E. S. Gould, *Mechanism and Structure in Organic Chemistry,* Holt, Rinehart and Winston Inc., 1959.
3. P. S. Kalsi, *Stereochemistry of carbon compounds*, 8thedn, New Age International Publishers, 2015.
4. P. Y.Bruice, *Organic Chemistry*, 7thedn.,Prentice Hall, 2013.
5. R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee*Organic Chemistry*, 7th edn., Pearson Education, 2010.

Reference Books

1. S. H. Pine, *Organic Chemistry*, 5thedn, McGraw Hill International Editionn, 1987.
2. L. F. Fieser and M. Fieser, *Organic Chemistry*, Asia Publishing House, Bombay, 2000.
3. E.S. Gould, *Mechanism and Structure in Organic Chemistry*, Holt, Rinehart and Winston Inc., 1959.
4. T. L. Gilchrist, *Heterocyclic Chemistry*, Longman Press, 1989.
5. J. A. Joule and K. Mills, *Heterocyclic Chemistry*, 4thed., John-Wiley, 2010.

Online Resources

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

Course Learning Outcomes

Students will be able:

CLO1: To recall the basic principles of aromaticity of organic and heterocyclic compounds.

CLO2: To understand the mechanism of various types of organic reactions.

CLO3: To predict the suitable reagents for the conversion of selective organic compounds.

CLO4: To correlate the principles of substitution, elimination, and addition reactions.

CLO5: To design new routes to synthesis organic compounds.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**
CO 2	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**
CO 4	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 5	**M**	**S**	**M**	**S**	**S**	**M**	**S**	**M**	**S**	**S**

3 – Strong, 2 – Medium, 1 - Low

Level of Correlation between PSO's and CO's

CO /PO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

3 – Strong, 2 – Medium, 1 – Low

Signature of HOD

CC6: Physical Chemistry – I

Year: 1 **Semester: 2**

Subject Code: B2PCHC6 **Credit: 6**

Instructional Hours: 6 **Exam Hours: 3**

Course Objectives

- To study the fundamental principles and concepts of Quantum chemistry
- To learn about the transport and activity of ions and the electrolyte equilibrium in a solution.
- To gain in-depth knowledge of electrokinetic phenomena.
- To correlate the theories of reaction rates for the evaluation of thermodynamic parameters.
- To study the mechanism and kinetics of reactions.

UNIT-I: Quantum Chemistry

Wave particle duality, Uncertainty principle, Particle wave and Schrodinger wave equation, wave function, properties of wave function. Properties of wave function, Normalized, Orthogonal, orthonormal, Eigen values, Eigen functions, Hermitian properties of operators. Introduction to quantum mechanics-black body radiation, photoelectric effect, hydrogen spectrum. Need for quantum mechanics, Postulates of Quantum Mechanics, Schrodinger wave equation, Time independent and time dependent

UNIT-II: Ionics

Debye Huckel theory of strong electrolytes - asymmetry and electrophoretic effect. Activity and Activity coefficient of strong electrolytes - concept of ionic strength. Determination of activity and activity coefficient – vapour pressure method, solubility method and EMF method. Derivation of Debye-Huckel limiting law at appreciable concentration of electrolytes modifications and applications.

UNIT-III: Electrokinetic Phenomena

Theories of electrical double layer – Electrical double layer potential- theory of multiple layers at electrode electrolyte interface- double layer capacity-enterokinetic phenomena- zeta potential- electro osmosis- sedimentation potential. Processes at the electrodes- the rate of charge transfer- exchange current density- Butler- Volmer equation-Tafel equation. Principles of corrosion electrochemical corrosion- construction and use of Pourbaix and Evans diagram and prevention of corrosion- electrochemical oxidation and reduction. Cyclic-voltammetry – principles and applications.

UNIT-IV: Kinetics of Reactions

Theories of reactions-effect of temperature on reaction rates, collision theory of reaction rates, Unimolecular reactions - Lindeman and Christiansen hypothesis- molecular beams, collision

cross sections, effectiveness of collisions, Potential energy surfaces. Transition state theory-evaluation of thermodynamic parameters of activation-applications of ARRT to reactions between atoms and molecules, time and true order-kinetic parameter evaluation. Factors determine the reaction rates in solution - primary salt effect and secondary salt effect, Homogeneous catalysis- acid- base catalysis-mechanism of acid base catalysed reactions-Bronsted catalysis law, enzyme catalysis-Michelis-Menton catalysis.

UNIT-V: Kinetics of Complex and Fast Reactions

Kinetics of complex reactions, reversible reactions, consecutive reactions, parallel reactions, chain reactions. Chain reactions-chain length, kinetics of $H_2 - Cl_2$ & $H_2 - Br_2$ reactions (Thermal and Photochemical reactions) - Rice Herzfeld mechanism. Study of fast reactions-relaxation methods- temperature and pressure jump methods electric and magnetic field jump methods -stopped flow flash photolysis methods and pulse radiolysis. Kinetics of polymerization-free radical, cationic, anionic polymerization - Polycondensation.

Recommended Text Books

1. J. Rajaram and J.C. Kuriacose, Thermodynamics for Students of Chemistry, 2nd edition,S.L.N.Chand and Co., Jalandhar, 1986.
2. I.M. Klotz and R.M. Rosenberg, Chemical thermodynamics, 6th edition, W.A. BenjaminPublishers, California, 1972.
3. M.C. Gupta, Statistical Thermodynamics, New Age International, Pvt. Ltd., New Delhi, 1995.
4. K.J. Laidler, Chemical Kinetics, 3rd edition, Pearson, Reprint - 2013.
5. J. Rajaram and J.C. Kuriokose, Kinetics and Mechanisms of chemical transformation,M acmillan India Ltd, Reprint - 2011.

Reference Books

1. D.A. Mcqurrie And J.D. Simon, Physical Chemistry - A Molecular Approach, Viva Books Pvt. Ltd., New Delhi, 1999.
2. R.P. Rastogi and R.R. Misra, Classical Thermodynamics, Vikas Publishing, Pvt. Ltd., New Delhi, 1990.
3. S.H. Maron and J.B. Lando, Fundamentals of Physical Chemistry, Macmillan Publishers, New York, 1974
4. K.B. Ytsiimiriski, “Kinetic Methods of Analysis”, Pergamom Press,1996.
5. Gurdeep Raj, Phase rule, Goel Publishing House, 2011.

Online Resources

1. https://nptel.ac.in/courses/104/103/104103112/
2. https://bit.ly/3tL3GdN

Course Learning Outcomes

Students will be able**:**

CLO1: To explain the basics and principles of quantum mechanics.

CLO2: Understand the knowledge on the experimental determination, modification and extension of Debye-Huckel theory and electrode –electrolyte equilibrium.

CLO3: Understand the various theories of the electrical double layer, corrosion and cyclic voltammetry.

CLO4: To evaluate the thermodynamic methods for real gases and mixtures.

CLO5: To compare the theories of reaction rates and fast reactions.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**
CO 2	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**
CO 4	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 5	**M**	**S**	**M**	**S**	**S**	**M**	**S**	**M**	**S**	**S**

3 – Strong, 2 – Medium, 1 - Low

Level of Correlation between PSO's and CO's

CO /PO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

3 – Strong, 2 – Medium, 1 – Low

Signature of HOD

CC7: Organic Chemistry Practical – II

Year: 1 **Semester: 2**

Subject Code: B2PCHC7P **Credit: 6**

Instructional Hours: 6 **Exam Hours: 6**

Course Objectives

- To construct a suitable experimental setup for the organic preparations involving two stages.
- To experiment with the methods for the estimation of various organic compounds by quantitative methods.

UNIT-I: Estimations

a) Estimation of Phenol (bromination)
b) Estimation of Aniline (bromination)
c) Estimation of Ethyl methyl ketone (iodimetry)
d) Estimation of Glucose (redox)
e) Estimation of Ascorbic acid (iodimetry)
f) Estimation of Aromatic nitro groups (reduction)
g) Estimation of Glycine (acidimetry)
h) Estimation of Formalin (iodimetry)
i) Estimation of Acetyl group in ester (alkalimetry)
j) Estimation of Hydroxyl group (acetylation)
k) Estimation of Amino group (acetylation)

UNIT-II: Two stage preparations

a) p-Bromoacetanilide from aniline

b) p-Nitroaniline from acetanilide

c) 1,3,5-Tribromobenzene from aniline

d) Acetyl salicyclic acid from methyl salicylate

e) Benzilic acid from benzoin

f) m-Nitroaniline from nitrobenzene

g) m-Nitrobenzoic acid from methyl benzoate

Reference Books

1. Ganapragasm N S and Ramamurthy C, *Organic Chemistry Lab Manual*, 2nd Edition,

2. Vishwanathan S Printers and Publishers (P) Ltd., Chennai, 2015.

3. Furniss B S, Hannaford A J, Smith P W G, and Tatchell A R, *Vogel's Textbook of Practical Organic Chemistry*, 5th Edition, Pearson publication.

Course Learning Outcomes

Students will be able:

CLO1: To understand the principles of two-stage preparations.

CLO2: To learn the experimental setup for two-stage preparations.

CLO3: To learn various experimental methods for studying quantitative analysis of organic compounds.

CLO4: To develop laboratory skills for accurate determination and measurements.

CLO5: To formulate a method and design a suitable procedure for organic preparations and estimations.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	S	S	S	S	M	S	S	S	S	M
CO 2	M	S	S	S	S	M	S	S	S	S
CO 3	S	S	M	S	S	S	S	M	S	S
CO 4	M	S	S	S	S	M	S	S	S	S
CO 5	M	S	M	S	S	M	S	M	S	S

3 – Strong, 2 – Medium, 1 - Low

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

3 – Strong, 2 – Medium, 1 – Low

Signature of HOD

CC8: Inorganic Chemistry Practical – II

Year: 1 **Semester: 2**

Subject Code: B2PCHC8P **Credit: 6**

Instructional Hours: 6 **Exam Hours: 6**

Course Objectives

- To understand and enhance the visual observation as an analytical tool for the quantitative estimation of ions.
- To recall the principle and theory in preparing standard solutions.
- To train the students to improve their skill in estimating the amount of ion accurately present in the solution
- To estimate the metal ions present in the given solution accurately without using instruments.
- To determine the amount of ions, present in a binary mixture accurately.

UNIT-I: Estimations of Metal Ions in a Binary Mixture

1. Quantitative analysis of a mixture of iron (volumetry) and nickel (gravimetry)
2. Quantitative analysis of a mixture of copper (volumetry) and nickel (gravimetry)
3. Quantitative analysis of a mixture of iron (volumetry) and zinc (gravimetry)
4. Quantitative analysis of a mixture of zinc (volumetry) and copper (gravimetry)
5. Quantitative analysis of a mixture of copper (volumetric) and zinc (gravimetry)

UNIT-II: Preparation of Metal Complexes

a. Preparation of tristhioureacopper(I)sulphate

b. Preparation of potassium trioxalate chromate(III)

c. Preparation of tetramminecopper(II) sulphate

d. Preparation of Reineck's salt

e. Preparation of hexathioureacopper(I) chloridedihydrate

f. Preparation of *cis*-Potassium tri oxalate diaquachromate(III)

g. Preparation of sodium trioxalatoferrate(III)

h. Preparation of hexathiourealead(II) nitrate

Reference Books

1. A. Jeya Rajendran, Microanalytical Techniques in Chemistry: Inorganic Qualitative Analysis, United Global Publishers, 2021.

2. V. V. Ramanujam, *Inorganic Semimicro Qualitative Analysis*; 3rd ed., The National Publishing Company, Chennai, 1974.

3. *Vogel's Textbook of Inorganic Qualitative Analysis,* 4th ed., ELBS, London.
4. G. Pass and H. Sutcliffe, *Practical Inorganic Chemistry*; Chapman Hall, 1965.
5. W. G. Palmer, Experimental *Inorganic Chemistry*; Cambridge University Press, 1954.

Course Learning Outcomes

Students will be able:

CLO1: Understand the principles of gravimetric estimations.

CLO2: Learn the experimental setup and skills of gravimetric analysis.

CLO3: Learn various experimental methods for carrying out the gravimetric estimation.

CLO4: To prepare the inorganic complexes.

CLO5: To synthesize various complexes with maximum yield.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**
CO 2	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**
CO 4	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 5	**M**	**S**	**M**	**S**	**S**	**M**	**S**	**M**	**S**	**S**

3 – Strong, 2 – Medium, 1 – Low

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

3 – Strong, 2 – Medium, 1 – Low

Signature of HOD

EC2: Molecular Spectroscopy

Year: 1 **Semester: 2**

Subject Code: B2PCHEC2 **Credit: 6**

Instructional Hours: 6 **Exam Hours: 3**

Course Objectives

- To understand UV-absorption spectra and interpret IR spectra on basic values of IR-frequencies.
- To interpret the first and second order NMR spectra in terms of splitting and coupling patterns using correlation techniques such as COSY, HETCOR, and NOESY.
- To study the principle of ESR spectroscopy.
- To study the technique and fragmentation of Mass spectroscopy.
- To study the principle of Mossbauer spectroscopy.

UNIT-I: Rotational and Raman Spectroscopy

Rotational spectra of diatomic and polyatomic molecules. Intensities of rotational spectral lines, effect of isotopic substitution. Non-rigid rotators. Classical theory of the Raman effect, polarizability as a tensor, polarizability ellipsoids, quantum theory of the Raman effect, Pure rotational Raman spectra of linear and asymmetric top molecules, Stokes and anti-Stokes lines. Vibrational Raman spectra, Raman activity of vibrations, rule of mutual exclusion, rotational fine structure-O and S branches, Polarization of Raman scattered photons.

UNIT-II: Vibrational Spectroscopy

Vibrations of molecules, harmonic and anharmonic oscillators- vibrational energy expression, energy level diagram, vibrational wave functions and their symmetry, selection rules, expression for the energies of spectral lines, effect of isotopic substitution. Diatomic vibrating rotor, vibrational-rotational spectra of diatomic molecules, P, R branches, breakdown of the Born-Oppenheimer approximation. Vibrations of polyatomic molecules – symmetry properties, overtone and combination frequencies. Influence of rotation on vibrational spectra of polyatomic molecule, P, Q, R branches, parallel and perpendicular vibrations of linear and symmetric top molecules.

UNIT-III: Electronic and Photoelectron Spectroscopy

Electronic spectroscopy: Electronic spectroscopy of diatomic molecules, Frank-Condon principle, dissociation and predissociation spectra. $\pi \rightarrow \pi^*$, $n \rightarrow \pi^*$ transitions and their selection rules.

Photoelectron Spectroscopy: Basic principles, photoelectron spectra of simple molecules, Xray photoelectron spectroscopy (XPS). **Lasers:** Laser action, population inversion, properties of laser radiation, examples of simple laser systems.

UNIT-IV: NMR and EPR Spectroscopy

NMR Spectroscopy: Chemical shift, Factors influencing chemical shifts: Mechanism of shielding and deshielding. Spin systems: First order and second order coupling of AB systems, Simplification of complex spectra. Spin-spin interactions: Homonuclear coupling interactions

- AX, AX2, AB types. Vicinal, germinal and long-range coupling-spin decoupling. Nuclear Overhauser effect (NOE), Factors influencing coupling constants and Relative intensities. ^{13}CNMR and structural correlations, Satellites. Brief introduction to 2D NMR – COSY, NOESY. Introduction to ^{31}P, ^{19}F NMR.

EPR Spectra: EPR spectra of anisotropic systems - anisotropy in g-value, causes of anisotropy, anisotropy in hyperfine coupling, hyperfine splitting caused by quadrupole nuclei. Zero-field splitting (ZFS) and Kramer's degeneracy. Applications of EPR to organic and inorganic systems. Structural elucidation of organic compounds by combined spectral techniques.

UNIT-V: Mass Spectrometry and Mössbauer Spectroscopy

Mass Spectrometry: Ionization techniques- Electron ionization (EI), chemical ionization (CI), desorption ionization (FAB/MALDI), electrospray ionization (ESI), isotope abundance, molecular ion, fragmentation processes of organic molecules, deduction of structure through mass spectral fragmentation, high resolution. Effect of isotopes on the appearance of mass spectrum.

Mössbauer spectroscopy: Principles, Doppler shift, recoil energy. Isomer shift, quadrupole splitting, and magnetic interactions. Applications: Mossbauer spectra of high and low-spin Fe and Sn compounds.

Recommended Text Books

1. C. N. Banwell and E. M. McCash, *Fundamentals of Molecular Spectroscopy*, 4th Ed., Tata McGraw Hill, New Delhi, 2000.
2. R. M. Silverstein and F. X. Webster, *Spectroscopic Identification of Organic Compounds*, 6th Ed., John Wiley & Sons, New York, 2003.
3. W. Kemp, *Applications of Spectroscopy*, English Language Book Society, 1987.
4. D. H. Williams and I. Fleming, *Spectroscopic Methods in Organic Chemistry,* 4th Ed., Tata McGraw-Hill Publishing Company, New Delhi, 1988.
5. R. S. Drago, *Physical Methods in Chemistry*; Saunders: Philadelphia, 1992.

Reference Books

1. P.W. Atkins and J. de Paula, *Physical Chemistry*, 7th Ed., Oxford University Press, Oxford, 2002.
2. I. N. Levine, *Molecular Spectroscopy*, John Wiley & Sons, New York, 1974.
3. A. Rahman, *Nuclear Magnetic Resonance-Basic Principles*, Springer-Verlag, New York,1986.
4. K. Nakamoto, *Infrared and Raman Spectra of Inorganic and coordination Compounds*, PartB: 5th ed., John Wiley& Sons Inc., New York, 1997.
5. J. A. Weil, J. R. Bolton and J. E. Wertz, *Electron Paramagnetic Resonance*; Wiley Interscience, 1994.

Online Resources

1. https://onlinecourses.nptel.ac.in/noc20_cy08/preview

2. https://www.digimat.in/nptel/courses/video/104106122/L14.html

Course Learning Outcomes

The students should be able to

CLO1: To understand the factors affecting UV-absorption spectra, Interpret IR spectra On basic values of IR-frequencies.

CLO2: To outline the NMR, ^{13}C NMR, 2D NMR – COSY, NOESY

CLO3: To evaluate different electronic spectra of simple molecules using ESR spectroscopy.

CLO4: To develop the knowledge on the principle and structural elucidation of simple molecules using Mass Spectrometry.

CLO5: To develop the knowledge on the principle and structural elucidation of simple molecules using Mossbauer Spectroscopy techniques.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**
CO 2	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**
CO 4	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 5	**M**	**S**	**M**	**S**	**S**	**M**	**S**	**M**	**S**	**S**

3 – Strong, 2 – Medium, 1 - Low

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

3 – Strong, 2 – Medium, 1 - Low

Signature of HOD

SEMESTER – III

CC9: Organic Synthesis and Photochemistry

Year: 2 **Semester: 3**

Subject Code: B3PCHC9 **Credit: 6**

Instructional Hours: 6 **Exam Hours: 3**

Course Objectives

- To understand the molecular complexity of carbon skeletons and the presence of functional groups and their relative positions.
- To study various synthetically important reagents for any successful organic synthesis.
- To apply disconnection approach and identifying suitable synthons to effect successful organic synthesis.
- To learn the concepts of pericyclic reaction mechanisms.
- To gain the knowledge of photochemical organic reactions.

UNIT-I: Organic Synthetic Methodology

Retrosynthetic analysis; Alternate synthetic routes. Synthesis of organic mono and bifunctional compounds via disconnection approach. Key intermediates, available starting materials and resulting yields of alternative methods. Convergent and divergent synthesis. Protection of hydroxyl, carboxyl, carbonyl, thiol and amino groups. Illustration of protection and deprotection in synthesis. Control elements: Regiospecific control elements. Stereospecific control elements. Functional group alterations and transposition.

UNIT-II: Pericyclic Reactions – I

Woodward Hoffmann rules: The Mobius and Huckel concept, FMO, PMO method and correlation diagrams. Cycloaddition and retro cycloaddition reactions; [2+2], [2+4], [4+4], Cationic, anionic, and 1,3-dipolar cycloadditions.

UNIT-III: Pericyclic Reactions - II

Cheletropic reactions. Electrocyclization and ring opening reactions of conjugated dienes and trienes. Sigma-tropic rearrangements: (1,3), (1,5), (3,3) and (5,5)-carbon migrations, degenerate rearrangements. Group transfer reactions. Regioselectivity, stereoselectivity and peri selectivity in pericyclic reactions.

UNIT-IV: Organic Photochemistry-I

Photochemical excitation: Experimental techniques; electronic transitions; Jablonskii diagrams; intersystem crossings; energy transfer processes; Stern Volmer equation.

Reactions of electronically excited ketones; $\pi \rightarrow \pi^*$ triplets; Norrish type-I and type-II cleavage reactions; photo reductions; Paterno-Buchi reactions.

UNIT-V: Organic Photochemistry-II

Photochemistry of α,β-unsaturated ketones; cis-trans isomerisation. Photon energy transfer reactions, Photo cycloadditions, Photochemistry of aromatic compounds; photochemical rearrangements; photo-stationery state; di-π-methane rearrangement; Reaction of conjugated cyclohexadienone to 3,4-diphenyl phenols; Barton's reactions.

Recommended Text Books

1. F. A. Carey and Sundberg, Advanced Organic Chemistry, 5thed, Tata McGraw-Hill, New York, 2003.
2. J. March and M. Smith, Advanced Organic Chemistry, 5th ed., John-Wiley and sons, 2007.
3. R. E. Ireland, Organic synthesis, Prentice Hall India, Goel publishing house, 1990.
4. Clayden, Greeves, Warren, Organic Chemistry, Oxford University Press, Second Edition, 2016.
5. M. B. Smith, Organic Synthesis 3rd edn, McGraw Hill International Edition, 2011.

Reference Books

1. Gill and Wills, Pericyclic Reactions, Chapman Hall, London, 1974.
2. W. Caruthers, Some Modern Methods of Organic Synthesis 4thedn, Cambridge University Press, Cambridge, 2007.
3. H. O. House. Modern Synthetic reactions, W.A. Benjamin Inc, 1972.
4. Jagdamba Singh and Jaya Singh, Photochemistry and Pericyclic Reactions, New Age International Publishers, New Delhi, 2012.

Online Resources

https://rushim.ru/books/praktikum/Monson.pdf

Course Learning Outcomes

Students will be able:

CLO1: To recall the basic principles of organic chemistry and to understand the various reactions of organic compounds with reaction mechanisms.

CLO2: To understand the versatility of various special reagents and to correlate their reactivity with various reaction conditions.

CLO3: To implement the synthetic strategies in the preparation of various organic compounds.

CLO4: To predict the suitability of reaction conditions in the preparation of tailor-made organic compounds.

CLO5: To design and synthesize novel organic compounds with the methodologies learnt during the course.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**
CO 2	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**
CO 4	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 5	**M**	**S**	**M**	**S**	**S**	**M**	**S**	**M**	**S**	**S**

3 – Strong, 2 – Medium, 1 - Low

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

3 – Strong, 2 – Medium, 1 - Low

Signature of the HOD

CC10: Coordination Chemistry

Year: 2 **Semester: 3**

Subject Code: B3PCHC10 **Credit: 6**

Instructional Hours: 6 **Exam Hours: 3**

Course Objectives

- To gain insights into the modern theories of bonding in coordination compounds.
- To learn various methods to determine the stability constants of complexes.
- To understand and construct correlation diagrams and predict the electronic transitions that are taking place in the complexes.
- To describe various substitution and electron transfer mechanistic pathways of reactions in complexes.
- To evaluate the reactions of octahedral and square planar complexes.

UNIT-I: Modern Theories of Coordination Compounds

Crystal field theory - splitting of d orbitals in octahedral, tetrahedral and square planar symmetries - measurement of 10Dq - factors affecting 10Dq - spectrochemical series - crystal field stabilisation energy for high spin and low spin complexes- evidences for crystal field splitting - site selections in spinels and antispinels - Jahn Teller distortions and its consequences. Molecular Orbital Theory and energy level diagrams concept of Weak and strong fields, Sigma and pi bonding in octahedral, square planar and tetrahedral complexes.

UNIT-II: Spectral Characteristics of Complexes

Term states for d ions - characteristics of d-d transitions - charge transfer spectra - selection rules for electronic spectra - Orgel correlation diagrams - Sugano-Tanabe energy level diagrams - nephelauxetic series - Racha parameter and calculation of inter-electronic repulsion parameter.

UNIT-III: Stability and Magnetic Properties of the Complexes

Stability of complexes: Factors affecting stability of complexes, Thermodynamic aspects of complex formation, Stepwise and overall formation constants, Stability correlations, statistical factors and chelate effect, Determination of stability constant and composition of the complexes: Formation curves and Bjerrum's half method, Potentiometric method, Spectrophotometric method, Ion exchange method, Polarographic method and Continuous variation method (Job's method) Magnetic property of complexes: Spin-orbit coupling, effect of spin-orbit coupling on magnetic moments, quenching of orbital magnetic moments.

UNIT-IV: Kinetics and Mechanisms of Substitution Reactions of Octahedral and Square Planar Complexes:

Inert and Labile complexes; Associative, Dissociative and SNCB mechanistic pathways for substitution reactions; acid and base hydrolysis of octahedral complexes; Classification of metal ions based on the rate of water replacement reaction and their correlation to Crystal Field Activation Energy; Substitution reactions in square planar complexes: Trans effect,

theories of trans effect and applications of trans effect in synthesis of square planar compounds; Kurnakov test.

UNIT-V: Electron Transfer Reactions in Octahedral Complexes

Outer sphere electron transfer reactions and Marcus-Hush theory; inner sphere electron transfer reactions; nature of the bridging ligand in inner sphere electron transfer reactions. Photo-redox, photo-substitution and photo-isomerisation reactions in complexes and their applications.

Recommended Text Books

1. J E Huheey, EA Keiter, RL Keiter and OK Medhi, Inorganic Chemistry – Principles of structure and reactivity, 4th Edition, Pearson Education Inc., 2006
2. G L Meissler and D ATarr, Inorganic Chemistry, 3rd Edition, Pearson Education Inc., 2008
3. D. Bannerjea, Co-ordination Chemistry, TATA Mcgraw Hill, 1993.
4. B. N. Figgis, Introduction to Ligand Fields, Wiley Eastern Ltd, 1976.
5. F.A. Cotton, G. Wilkinson.; C. A. Murillo; M. Bochmann, Advanced Inorganic Chemistry, 6th ed.; Wiley Inter-science: New York, 1988.

Reference Books

1. Keith F. Purcell and John C. Kotz, Inorganic Chemistry, Saunders Publications, USA, 1977.
2. Peter Atkins and Tina Overton, Shriver and Atkins' Inorganic Chemistry, 5th Edition, Oxford University Press, 2010.
3. Basic Inorganic Chemistry, F. A. Cotton, G. Wilkinson, P. L. Guas, John Wiley, 2002, 3rd edn.
4. Concepts and Models of Inorganic Chemistry, B. Douglas, D. McDaniel, J. Alexander, John Wiley, 1994, 3rd edn.
5. Inorganic Chemistry, D. F. Shriver, P. W. Atkins, W. H. Freeman and Co, London, 2010.

Online Resources

https://ocw.mit.edu/courses/5-04-principles-of-inorganic-chemistry-ii-fall-2008/pages/syllabus/

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

CLO1: Understand and comprehend various theories of coordination compounds.

CLO2: Understand the spectroscopic and magnetic properties of coordination complexes.

CLO3: Explain the stability of complexes and various experimental methods to determine the stability of complexes.

CLO4: Predict the electronic transitions in a complex based on correlation diagrams and UV-visible spectral details.

CLO5: Comprehend the kinetics and mechanism of substitution reactions in octahedral and square planar complexes.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**
CO 2	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**
CO 4	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 5	**M**	**S**	**M**	**S**	**S**	**M**	**S**	**M**	**S**	**S**

3 – Strong, 2 – Medium, 1 - Low

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

3 – Strong, 2 – Medium, 1 - Low

Signature of the HOD

CC11: Physical Chemistry Practical - I

Year: 2 **Semester: 3**

Subject Code: B3PCHC11P **Credit: 6**

Instructional Hours: 6 **Exam Hours: 6**

Course Objectives

- To understand the principle of conductivity experiments through conductometric titrations.
- To evaluate the order of the reaction, temperature coefficient, and activation energy of the reaction by following pseudo first order kinetics.
- To construct the phase diagram of two component system forming congruent melting solid and find its eutectic temperatures and compositions.
- To determine the kinetics of adsorption of oxalic acid on charcoal.

UNIT-I: Conductivity Experiments

1. Determination of equivalent conductance of a strong electrolyte & the verification of DHO equation.

2. Verification of Ostwald's Dilution Law & Determination of pKa of a weak acid.

3. Verification of Kohlrausch's Law for weak electrolytes.

4. Determination of solubility of a sparingly soluble salt.

5. Acid-base titration (strong acid and weak acid vs NaOH).

6. Precipitation titrations (mixture of halides only).

UNIT-II: Kinetics

1. Study the kinetics of acid hydrolysis of an ester, determine the temperature coefficient and also the activation energy of the reaction.

2. Study the kinetics of the reaction between acetone and iodine in acidic medium by half-life method and determine the order with respect to iodine and acetone.

UNIT-III: Phase Diagram and Adsorption

Construction of phase diagram for a simple binary system

1. Naphthalene-phenanthrene

2. Benzophenone- diphenyl amine

3. Adsorption of oxalic acid on charcoal & determination of surface area (Freundlich isotherm only).

Recommended Text Books

1. B. Viswanathan and P.S. Raghavan, Practical Physical Chemistry, Viva Books, New Delhi, 2009.

2. Sundaram, Krishnan, Raghavan, Practical Chemistry (Part II), S. Viswanathan Co. Pvt.1996.

3. V.D. Athawale and Parul Mathur, Experimental Physical Chemistry, New Age International (P) Ltd., New Delhi, 2008.

Reference Books

1. J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publishing House, 2001.

2. G.W. Garland, J.W. Nibler, D.P. Shoemaker, Experiments in Physical Chemistry, 8th edition, McGraw Hill, 2009.

3. J. N. Gurthu and R. Kapoor, Advanced Experimental Chemistry, S. Chand and Co., 1987.

4. Shailendra K Sinha, Physical Chemistry: A laboratory Manual, Narosa Publishing House Pvt, Ltd., New Delhi, 2014.

Online Resources

https://web.iitd.ac.in/~nkurur/2015-16/Isem/cmp511/lab_handout_new.pdf

Course Learning Outcomes

Students will be able:

CLO1: To recall the principles associated with various physical chemistry experiments.

CLO2: To scientifically plan and perform all the experiments.

CL**O3**: To observe and record systematically the readings in all the experiments.

CLO4: To calculate and process the experimentally measured values and compare with graphical data.

CLO5: To interpret the experimental data scientifically to improve students' efficiency for societal developments.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	S	S	S	S	M	S	S	S	S	M
CO 2	M	S	S	S	S	M	S	S	S	S
CO 3	S	S	M	S	S	S	S	M	S	S
CO 4	M	S	S	S	S	M	S	S	S	S
CO 5	M	S	M	S	S	M	S	M	S	S

3 – Strong, 2 – Medium, 1 – Low

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

3 – Strong, 2 – Medium, 1 – Low

Signature of the HOD

CC12: Research Methodology

Year: 2 **Semester: 3**

Subject Code: B3PCHC12 **Credit: 6**

Instructional Hours: 6 **Exam Hours: 3**

Course Objectives

- To learn and understand the meaning and concepts of research, scientific methods, literature and scientific metrices.
- To gain skill and knowledge on scientific writing and publication ethics.
- To acquire knowledge on various scientific software, fundamentals of data analysis, statistical and regression analysis
- To understand the modern separation, spectral and microscopic analytical instruments
- To learn and improve the good laboratory skills, safety management in the laboratory, knowledge on project management and intellectual property rights.

Upon successful completion of the course, the students will be able to:		
COs	**Course Outcomes**	**Knowledge Level**
CO1	Understand the fundamentals of research, literature, scientific writing, research ethics, computational and statistical tools, modern instruments, laboratory safety, project management and intellectual property rights.	K1, K2
CO2	Apply advanced scientific software and modern instrumental techniques for material analysis.	K3
CO3	Analyse the data using scientific software, output results using the statistical tools, the characters of prepared materials using advanced chromatographic, spectroscopic and microscopic instruments.	K4
CO4	Acquire skills on scientific writing, intellectual honesty, research integrity, citations and referencing	K2, K3
CO5	Learn and implement the skills on laboratory safety and management.	K3
K1 - Remembering; K2 - Understanding; K3 - Applying; K4 – Analyzing; K5 - Evaluating; K6 – Creating		

UNIT – I: Research Fundamentals and Literature Survey

Introduction to Research: Meaning, objectives, significance, and types of research (basic, applied, qualitative, and quantitative).

Scientific Method: Formulating research problems and hypotheses; research design (exploratory, descriptive, and experimental).

Literature Sources: Primary, secondary, and tertiary sources; journals, reviews, monographs, and textbooks.

Literature Search: Using search engines (Google Scholar, Scirus, ChemIndustry) and databases (ScienceDirect, SciFinder, Scopus, Web of Science).

Research Metrics: Understanding impact factors, citation index, h-index, g-index, and i10 index.

UNIT – II: Scientific Writing and Publication Ethics

Technical Writing: Structure of reports, dissertations, theses, and manuscripts; preparation of posters and review articles.

Citations and Referencing: Styles (APA, MLA, ACS), use of footnotes, and reference management software like Zotero or Mendeley.

Research Ethics: Scientific conduct, intellectual honesty, and research integrity.

Publication Misconduct: Definitions of plagiarism, falsification, fabrication, and redundant publications; ethical issues in human and animal research.

UNIT – III: Computational Tools and Statistical Data Analysis

Scientific Software: Introduction to Microsoft Office, ChemDraw, ChemSketch, and Origin for chemical data representation.

Data Analysis Fundamentals: Significant figures, precision, accuracy, and types of errors (determinate and indeterminate).

Statistical Methods: Mean, standard deviation, and confidence intervals; statistical tests including the t-test, F-test, Q-test, and Chi-square test.

Regression Analysis: Least square analysis, correlation coefficients, and linear/non-linear regression.

UNIT – IV: Modern Instrumental Techniques

Chromatographic Techniques: Principles and applications of GC and HPLC; column efficiency and detector types.

Thermal and Electroanalytical Methods: Principles of TGA, DTA, DSC, and Cyclic Voltammetry.

Structural Elucidation: Integrated approach using UV-Vis, IR, NMR (^{1}H and ^{13}C), and Mass spectral techniques to simple aliphatic and aromatic molecules.

Microscopic Techniques: Introduction to surface characterization using SEM, TEM, and AFM.

UNIT – V: Laboratory Safety, Project Management, and IPR

Good Laboratory Practices (GLP): History, principles, and training; safe storage and disposal of hazardous/waste chemicals.

Laboratory Safety: Personal protective equipment (PPE), emergency procedures, first aid, and fire extinguisher use.

Project Management: Development stages, work breakdown structure, and time/risk management.

Intellectual Property Rights (IPR): Definition and types of patents, patent application procedures, and criteria for patenting.

Textbooks and Reference Books

1. C. R. Kothari and Gaurav Garg, *Research Methodology: Methods and Techniques*, New Age International.
2. A. M. Coghill and L. R. Gardson, *The ACS Style Guide: Effective Communication of Scientific Information*, Oxford University Press.
3. D. A. Skoog, D. M. West, and F. J. Holler, *Fundamentals of Analytical Chemistry*, Cengage Learning.
4. R. M. Silverstein and F. X. Webster, *Spectrometric Identification of Organic Compounds*, John Wiley.
5. K. Arora, *The Patents Act, 1970 as amended by the Patents Act 2005*, Professional Book Publishers.
6. Handbook of Good Laboratory Practice (GLP), 2nd Ed., 2008.
7. Ramesh Kumari, *Computers and their Applications to Chemistry*, Alpha Science International.
8. James P. Lewis, *Fundamentals of Project Management*, AMACOM.
9. Jerry March, *Advanced Organic Chemistry: Reactions, Mechanisms, and Structure*, John Wiley & Sons.
10. P. W. Atkins, *Physical Chemistry*, Oxford University Press.
11. B. R. Puri, L. R. Sharma, and K. C. Kalia, *Principles of Inorganic Chemistry*.

Online Resources

1. INFLIBNET: http://www.inflibnet.ac.in
2. SWAYAM: https://swayam.gov.in
3. American Chemical Society (ACS) Publications: http://www.pubs.acs.org
4. Royal Society of Chemistry (RSC): http://www.rsc.org
5. Indian Patent Office: http://www.patentoffice.nic.in/ipr/pa
6. SpringerLink: http://www.springerlink.com

COURSE LEARNING OUTCOMES (CLOs)

Students will be able to:

CLO1: Explain the fundamental concepts of research, scientific methods, literature source and scientific metrices.

CLO2: Understand the structure of reports, use of footnotes, referencing software, research and publication ethics.

CLO3: Aware of scientific software such as chemdraw, chemsketch, origin, statistical tests and various regression analysis.

CLO4: Apply the knowledge of several advanced instrumental techniques.

CLO5: Evaluate the procedure on safety measures in laboratory, maintain good laboratory practices, project management and intellectual property rights.

CO–PO Mapping (Course Articulation Matrix)

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	M	M	M	S	M
CO2	S	S	M	S	M	M	M	M	S	M
CO3	S	S	S	S	M	S	S	S	S	M
CO4	S	S	S	S	S	S	S	S	S	M
CO5	S	S	M	S	M	M	M	M	M	S

3 – Strong, 2 – Medium, 1 – Low

Level of Correlation between PSO's and CO's

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	**15**	**15**	**15**	**15**	**15**
Weighted Percentage of Course Contribution to PSOs	**3.0**	**3.0**	**3.0**	**3.0**	**3.0**

3 – Strong, 2 – Medium, 1 – Low

Signature of HOD

EC3: Physical Chemistry – II

Year: 2 **Semester: 3**

Subject Code: B3PCHEC3 **Credit: 6**

Instructional Hours: 6 **Exam Hours: 3**

Course Objectives

- To understand the essential characteristics of wave functions and need for the quantum mechanics.
- To know the importance of quantum mechanical models of particle in a box, rigid rotor and harmonic oscillator.
- To apply the quantum mechanics to hydrogen and polyelectronic systems.
- To familiarize the symmetry in molecules and predict the point groups.
- To predict the vibrational modes, hybridization using he concepts of group theory.

UNIT-I: Quantum Models

Particle in a one and three-dimensional box, degeneracy, application to linear conjugated molecular system, free particles, ring systems. Harmonic Oscillator-wave equation and solution, anharmonicity, force constant and its significance. Rigid Rotor-wave equation and solution, calculation of rotational constants and bond length of diatomic molecules.

UNIT-II: Applications to Hydrogen and Poly Electron Atoms

Hydrogen atom and hydrogen like ions, Hamiltonian-wave equation and solutions, radial and angular functions, representation of radial distribution functions. Approximation methods – variation methods: trial wave function, variation integral and application to particle in 1D box. Perturbation method - first order applications. Hartrefock self-consistent field method, Helium atom-electron spin, Paulis exclusion principle and Slater determination.

UNIT-III: Group Theory

Groups, sub groups, symmetry elements, operations, classification-axial and non-axial (cubic) groups. Dihedral point groups- C_n, C_{nh}, D_n, D_{nh}, D_{nd}, Td and Oh. Matrix representation and classes of symmetry operations, reducible irreducible and direct product representation. The Great orthogonality theorem – irreducible representation and reduction formula, construction of character table for C_{2v}, C_{2h}, C_{3v} and D_{2h} point groups

UNIT-IV: Applications of Quantum and Group Theory: Hydrogen Molecule-Molecular orbital theory and Heitler London (VB) treatment, Energy level diagram, Hydrogen molecule ion; Use of linear variation function and LCAO methods. SALC procedure. Electronic conjugated system: Huckel method to Ethylene butadiene, cyclopropenyl, cyclo butadiene and Benzene. Applications of group theory to molecular vibrations, electronic spectra of ethylene.

UNIT-V: Surface Phenomena

Adsorption and free energy reaction relation at inter-phase – physisorption and chemisorptions – potential energy diagram – Lannard- Jones plot – BET isotherm – surface area determination – adsorption from solution – Gibb adsorption isotherm- solid liquid interface, wetting and contact angle, solid gas interfaces, soluble and insoluble films. Electrical phenomenon at interfaces including Electrokinetic micelles and reverse micelles – solubilization – micro-emulsion or micellar emulsions.

Recommended Text Books

1. R.K. Prasad, Quantum Chemistry, New Age International Publishers, New Delhi, 2010, 4th revised edition.

2. F. A. Cotton, Chemical Applications of Group Theory, John Wiley & Sons, 2003, 2nd edition.

3. A.Vincent, Molecular Symmetry and Group Theory. A Programmed Introduction to Chemical Applications, John and Willy & Sons Ltd., 2013, 2nd Edition.

4. T. Engel & Philip Reid, Quantum Chemistry and Spectroscopy, Pearson, New Delhi, 2018, 4th edition.

5. G. K. Vemulapalli, Physical Chemistry, Prentice Hall of India Pvt. Ltd. 2001. 6. D.A. McQuarrie, Quantum Chemistry, Viva Books PW. Ltd, 2013, 2nd edition.

6. Puri B R, Sharma L R, (2002), Principles of Physical Chemistry, 38th ed., Vishal Publishing Company, Jalandhar.

Reference Books

1. N. Levine, Quantum Chemistry, Allyn& Bacon Inc, 1983, 4th edition.

2. D.A. McQuarrie and J. D. Simon, Physical Chemistry, A Molecular Approach, Viva Books Pvt. Ltd, New Delhi, 2012.

3. R. P. Rastogi & V. K. Srivastava, An Introduction to Quantum Mechanics of Chemical Systems, Oxford & IBH Publishing Co., New Delhi, 1999.

4. R.L. Flurry. Jr, Symmetry Group Theory and Chemical applications, Prentice Hall. Inc, 1980

5. J. M. Hollas, Symmetry in Molecules, Chapman and Hall, London, 2011, Reprint.

Online Resources

1. https://nptel.ac.in/courses/104101124

2. https://ipc.iisc.ac.in/~kls/teaching.html

Course Learning Outcomes

Students will be able:

CLO1: To discuss the characteristics of wave functions and symmetry functions.

CLO2: To classify the symmetry operation and wave equations.

CLO3: To apply the concept of quantum mechanics and group theory to predict the electronic structure.

CLO4: To specify the appropriate irreducible representations for theoretical applications.

CLO5: To develop skills in evaluating the energies of molecular spectra.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**
CO 2	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**
CO 4	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 5	**M**	**S**	**M**	**S**	**S**	**M**	**S**	**M**	**S**	**S**

3 – Strong, 2 – Medium, 1 - Low

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to POs	3.0	3.0	3.0	3.0	3.0

3 – Strong, 2 – Medium, 1 – Low

Signature of the HOD

SEMESTER – IV

CC13: Spectroscopy and Organometallic Chemistry

Year: 2 **Semester: 4**

Subject Code: B4PCHC13 **Credit: 6**

Instructional Hours: 6 **Exam Hours: 3**

Course Objectives

- To identify or predict the structure of coordination compounds using spectroscopic tools.
- To understand the structure and bonding in coordination complexes.
- To evaluate the spectral characteristics of selected complexes.
- To recognize the fundamental concepts and structural aspects of organometallic compounds.
- To learn reactions of organometallic compounds and their catalytic behaviour.

UNIT-I: Inorganic Spectroscopy -I

IR spectroscopy: Effect of coordination on the stretching frequency-sulphato, carbonato, sulphito, aqua, nitro, thiocyanato, cyano, thiourea, DMSO complexes; IR spectroscopy of carbonyl compounds. **NMR spectroscopy**- Introduction, applications of 1H, 15N, 19F, 31P-NMR spectroscopy in structural identification of inorganic complexes, fluxional molecules, quadrupolar nuclei- effect in NMR spectroscopy.

UNIT-IV: Inorganic Spectroscopy-II

Introductory terminologies: g and A parameters-definition, explanation and factors affecting g and A; Applications of ESR to coordination compounds with one and more than one unpaired electrons – hyperfine and secondary hyperfine splitting and Kramer's doublets; ESR spectra of V(II), Mn(II), Fe(II), Co(II), Ni(II), Cu(II) complexes and bis(salicylaldimine)copper(II).

UNIT-V: Photo Electron Spectroscopy

Theory, Types, origin of fine structures - shapes of vibrational fine structures – adiabatic and vertical transitions, 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. Koopman's theorem- applications and limitations.

UNIT-IV: 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 – Examples and MO approach to bonding in metallocenes; fluxional isomerism. Metal – carbonyl complexes: MO diagram of CO; Structure and bonding − bonding modes, MO approach of M-CO bonding, π-acceptor nature of carbonyl group.

UNIT-V: Reactions and Catalysis of Organometallic Compounds

Reactions of organometallic compounds: Oxidative addition, reductive elimination (α and β eliminations), migratory insertion reaction and metathesis reaction. Organo-metallic catalysis: Hydrogenation of olefins (Wilkinson's catalyst), hydroformylation of olefins using cobalt or rhodium catalysts (oxo process), oxidation of olefin (Wacker process), cyclo-oligomerisation of acetylenes using Reppe's catalysts.

Recommended Text Books

1. J E Huheey, EA Keiter, RL Keiter and OK Medhi, Inorganic Chemistry – Principles of structure and reactivity, 4th Edition, Pearson Education Inc., 2006
2. G L Meissler and D ATarr, Inorganic Chemistry, 3rd Edition, Pearson Education Inc., 2008
3. D. Bannerjea, Co-ordination Chemistry, TATA Mcgraw Hill, 1993.
4. B D Gupta and A K Elias, Basic Organometallic Chemistry: Concepts, Syntheses and Applications, University Press, 2013.
5. F. A. Cotton, G. Wilkinson.; C. A. Murillo; M. Bochmann, Advanced Inorganic Chemistry, 6th ed.; Wiley Inter-science: New York, 1988.

Reference Books

1. Crabtree, Robert H. The Organometallic Chemistry of the Transition Metals. 3rd ed. New York, NY: John Wiley, 2000.
2. P Gütlich, E Bill, A X Trautwein, Mossbauer Spectroscopy and Transition Metal Chemistry: Fundamentals and Applications, 1st edition, Springer-Verlag Berlin Heidelberg, 2011.
3. Concepts and Models of Inorganic Chemistry, B. Douglas, D. McDaniel, J. Alexander, John Wiley, 1994, 3rd edn.
4. K. F. Purcell, J. C. Kotz, Inorganic Chemistry; Saunders: Philadelphia, 1976.
5. R. S. Drago, PhysicaI Methods in Chemistry; Saunders: Philadelphia, 1977.

Online Resources

https://archive.nptel.ac.in/courses/104/101/104101100/

Course Learning Outcomes

Students will be able:

CLO1: Understand and apply 18 and 16 electron rule for organometallic compounds

CLO2: Understand the structure and bonding in olefin, allyl, cyclopentadienyl and carbonyl containing organometallic compounds

CLO3: Understand the reactions of organometallic compounds and apply them in CO4: understanding the catalytic cycles

CLO4: Identify / predict the structure of coordination complexes using spectroscopic tools such as IR, NMR, and ESR techniques.

CLO5: Identify / predict the structure of coordination complexes using spectroscopic tools such as Mossbauer and optical rotatory dispersion studies to interpret the structure of molecules by various spectral techniques.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**
CO 2	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**
CO 4	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 5	**M**	**S**	**M**	**S**	**S**	**M**	**S**	**M**	**S**	**S**

3 – Strong, 2 – Medium, 1 - Low

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

3 – Strong, 2 – Medium, 1 - Low

Signature of the HOD

CC14: Physical Chemistry Practical - II

Year: 2 **Semester: 4**

Subject Code: B4PCHC14P **Credit: 6**

Instructional Hours: 6 **Exam Hours: 6**

Course Objectives

- To understand the principle of conductivity experiments through conductometric titrations.
- To evaluate the strength of acids and bases.
- To measure the pH of the solutions.
- To determine the inversion of light by polarimeter.
- To estimate the amount of Na and K ions by flame photometer.

UNIT-I: Conductometric and Potentiometric Titrations

1. Conductometric titration of NH_4Cl Vs NaOH.
2. Conductometric titration of CH_3COONa Vs HCl.
3. Potentiometric titration of a mixture of HCl and CH_3COOH Vs NaOH
4. Determination of pK_a of weak acid by EMF method.
5. Potentiometric titration of FAS Vs $K_2Cr_2O_7$
6. Potentiometric titration of KI Vs $KMnO_4$.
7. Potentiometric titration of a mixture of Chloride and Iodide Vs $AgNO_3$.

UNIT-II: Determination of pH and Other Analytical Experiments

1. Determination of the pH of buffer solution by EMF method using Quinhydrone and Calomel electrode.
2. Study of the inversion of cane sugar in the presence of acid by Polarimetric method.
3. Estimation of Na and K by flame photometric method.
4. Determination of spectrophotometrically the mole ratio of the ferrithiocyanate complex and equilibrium constant for the complex formation.
5. Estimation of the amount of sulphate present in the given solution using Nephelometric turbidimeter.
6. Estimation of the amount of nitrate present in the given solution using spectrophotometric method.
7. Heavy metal analysis in textiles and textile dyes by AAS
8. Determination of caffeine in soft drinks by HPLC
9. Analysis of water quality through COD, DO, BOD measurements.
10. Assay of Riboflavin and Iron in tablet formulations by spectrophotometry
11. Estimation of chromium in steel sample by spectrophotometry
12. Separation of (a) mixture of Azo dyes by TLC (b) mixture of metal ions by Paper chromatography
13. Estimation of chlorophyll in leaves and phosphate in waste water by colorimetry.

Recommended Text Books

1. B. Viswanathan and P.S. Raghavan, Practical Physical Chemistry, Viva Books, New Delhi, 2009.

2. Sundaram, Krishnan, Raghavan, Practical Chemistry (Part II), S. Viswanathan Co. Pvt., 1996.

3.V.D. Athawale and Parul Mathur, Experimental Physical Chemistry, New Age International (P) Ltd., New Delhi, 2008.

Reference Books

1. J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publishing House, 2001.

2. G.W. Garland, J.W. Nibler, D.P. Shoemaker, Experiments in Physical Chemistry, 8th edition, McGraw Hill, 2009.

3. J. N. Gurthu and R. Kapoor, Advanced Experimental Chemistry, S. Chand and Co., 1987.

4. Shailendra K Sinha, Physical Chemistry: A laboratory Manual, Narosa Publishing House Pvt, Ltd., New Delhi, 2014.

Online Resources

https://web.iitd.ac.in/~nkurur/2015-16/Isem/cmp511/lab_handout_new.pdf

Course Learning Outcomes

Students will be able:

CLO1: To recall the principles associated with various physical chemistry experiments.

CLO2: To scientifically plan and perform all the experiments.

CLO3: To observe and record systematically the readings in all the experiments.

CLO4: To calculate and process the experimentally measured values and compare with graphical data.

CLO5: To interpret the experimental data scientifically to improve students' efficiency for societal developments.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	S	S	S	S	M	S	S	S	S	M
CO 2	M	S	S	S	S	M	S	S	S	S
CO 3	S	S	M	S	S	S	S	M	S	S
CO 4	M	S	S	S	S	M	S	S	S	S
CO 5	M	S	M	S	S	M	S	M	S	S

3 – Strong, 2 – Medium, 1 – Low

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

3 – Strong, 2 – Medium, 1 – Low

Signature of the HOD

CC15: Project Work

Year: 2 **Semester: 4**

Subject Code: B4PCHC15 **Credit: 6**

Instructional Hours: 2 **Lab Practice: 8**

Course Objectives

- To gain the depth knowledge in laboratory Field
- To understand the basic principles of research
- To study the methodology of the research work
- To apply the various spectra for compound interpretation
- To know the knowledge of presenting project work

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

- **CLO1:** Gain of background knowledge in specific area of chemical sciences
- **CLO2:** Learn the steps involved in solving a problem
- **CLO3:** Understand the formatting of table work
- **CLO4:** Enter in the first step of research aptitude
- **CLO5:** Visualize the steps of project work presentation

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	S	S	S	S	M	S	S	S	S	M
CO 2	M	S	S	S	S	M	S	S	S	S
CO 3	S	S	M	S	S	S	S	M	S	S
CO 4	M	S	S	S	S	M	S	S	S	S
CO 5	M	S	M	S	S	M	S	M	S	S

3 – Strong, 2 – Medium, 1 – Low

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

3 – Strong, 2 – Medium, 1 – Low

Signature of the HOD

EC4: Bio-Inorganic Chemistry

Year: 2 **Semester: 4**

Subject Code: B4PCHEC4 **Credit: 6**

Instructional Hours: 6 **Exam Hours: 3**

Course Objectives

- To understand the role of metal ions in biological systems.
- To understand the biological significance of iron, sulpur.
- To study the toxicity of metals in medicines.
- To have knowledge on diagnostic agents.
- To discuss on various metalloenzymes properties.

UNIT-I: Essential Metal Ions and Their Role in Biological Systems

Selective transport and storage of metal ions: Ferritin, Transferrin and sidorphores; Sodium and potassium transport, Calcium signalling proteins. Oxygen carriers - Haemoglobin and myoglobin - Structure and oxygenation, Bohr Effect. Binding of CO, NO, CN– to Myoglobin and Haemoglobin.

UNIT-II: Transport Proteins

Biological redox system: Cytochromes-Classification, Cytochrome a, b and c. Cytochrome P-450. Non-heme oxygen carriers-Hemerythrin and hemocyanin. Iron-sulphur proteins-Rubredoxin and Ferredoxin- Structure and classification.

UNIT-III: Nitrogen Fixation

Introduction, types of nitrogen fixing microorganisms. Nitrogenase enzyme - Metal clusters in nitrogenase- redox property - Dinitrogen complexes transition metal complexes of dinitrogen - nitrogen fixation via nitride formation and reduction of dinitrogen to ammonia. Photosynthesis: photosystem-I and photosystem-II-chlorophylls structure and function.

UNIT-IV: Metals in Medicine

Metal Toxicity of Hg, Cd, Zn, Pb, As, Sb. Therapeutic Compounds: Vanadium-Based Diabetes Drugs; Platinum-Containing Anticancer Agents. Chelation therapy; Cancer treatment. Diagnostic Agents: Technetium Imaging Agents; Gadolinium MRI Imaging Agents. temperature and critical magnetic Field.

UNIT-V: Metalloenzymes

Definition and scope of metalloenzymes, importance in biological systems, Zinc enzymes–carboxypeptidase and carbonic anhydrase. Iron enzymes–catalase, peroxidase. Copper enzymes – superoxide dismutase, Ceruloplasmin. Coenzymes - Vitamin-B12 coenzymes.

Recommended Text Books

1. Williams, D.R. – Introduction to Bioinorganic chemistry.
2. F.M. Fiabre and D.R. Williams– The Principles of Bioinorganic Chemistry, RoyolSoceity of Chemistry, Monograph for Teachers-31
3. K.F. Purcell and Kotz., Inorganic chemistry, WB Saunders Co., USA.
4. G.N. Mugherjea and Arabinda Das, Elements of Bioinorganic Chemistry - 1993.
5. R. Gopalan, V. Ramalingam, *Concise Coordination Chemistry*, S. Chand, 2001.

Reference Books

1. M. Satake and Y.Mido, Bioinorganic Chemistry- Discovery Publishing House, New Delhi (1996)
2. M.N. Hughes, 1982, The Inorganic Chemistry of Biological processes, II Edition, Wiley London.
3. R. W. Hay, Bio Inorganic Chemistry, Ellis Horwood, 1987.
4. R. M. Roat-Malone, Bio Inorganic Chemistry, John Wiley, 2002.
5. T. M. Loehr, Iron carriers and Iron proteins, VCH, 1989.

Online Resources

1. https://www.pdfdrive.com/instant-notes-in-inorganic-chemistry-the-instant-notes-chemistry-series-d162097454.html
2. https://www.pdfdrive.com/shriver-and-atkins-inorganic-chemistry-5th-edition-d161563417.html

Course Learning Outcomes

Students will be able:

CLO1: The students will be able to identify metal ions in biological systems.

CLO2: Students will be able to explain the biological redox systems.

CLO3: Students will gain skill in analyzing the toxicity in metals.

CLO4: Students will have experience in diagnosis.

CLO5: Learn about the nitrogen fixation and photosynthetic mechanism.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	S	S	S	S	M	S	S	S	S	M
CO 2	M	S	S	S	S	M	S	S	S	S
CO 3	S	S	M	S	S	S	S	M	S	S
CO 4	M	S	S	S	S	M	S	S	S	S
CO 5	M	S	M	S	S	M	S	M	S	S

3 – Strong, 2 – Medium, 1 - Low

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

3 – Strong, 2 – Medium, 1 - Low

Signature of the HOD

SEC1: Medicinal Chemistry

Year: 2 **Semester: 4**

Subject Code: B4PCHSE1 **Credit: 3**

Instructional Hours: 3 **Exam Hours: 3**

Course Objectives

- To study the chemistry behind the development of pharmaceutical materials.
- To gain knowledge on mechanism and action of drugs.
- To understand the need of antibiotics and usage of drugs.
- To familiarize with the mode of action of diabetic agents and treatment of diabetes.
- To identify and apply the action of various antibiotics.

UNIT-I: Introduction to Receptors

Introduction, targets, Agonist, antagonist, partial agonist. Receptors, Receptor types, Theories of Drug – receptor interaction, Drug synergism, Drug resistance, physicochemical factors influencing drug action.

UNIT-II: Antibiotics

Introduction, Targets of antibiotics action, classification of antibiotics, enzyme-based mechanism of action, SAR of penicllins and tetracyclins, clinical application of penicillins, cephalosporin.Current trends in antibiotic therapy.

UNIT-III: Antihypertensive Agents and Diuretics: Classification of cardiovascular agents, introduction to hypertension, etiology, types, classification of antihypertensive agents, classification and mechanism of action of diuretics, Furosemide, Hydrochlorothiazide, Amiloride.

UNIT-IV: Analgesics, Antipyretics and Anti-inflammatory Drugs

Introduction, Mechanism of inflammation, classification and mechanism of action and paracetamol, Ibuprofen, Diclofenac, naproxen, indomethacin, phenylbutazone and meperidine. Medicinal Chemistry of Antidiabetic Agents Introduction, Types of diabetics, Drugs used for the treatment, chemical classification, Mechanism of action, Treatment of diabetic mellitus. Chemistry of insulin, sulfonyl urea.

UNIT-V: Herbal Drugs

Study of pharmacognostic of a crude drug. Biosynthesis: Shikimic acid pathway and acetate pathway. Systematic analysis of Crude drugs. Standardization of Herbal drugs. WHO guidelines, Sampling of crude drug, Methods of drug evaluation. Determination of foreign matter, moisture Ash value. Phytochemical investigations-General chemical tests.

Recommended Text Books

1. Wilson and Gisvold's textbook of organic medicinal and pharmaceutical chemistry,
2. Wilson, Charles Owens: Beale, John Marlowe; Block, John H, Lipincott William, 12th edition, 2011.

3. Graham L. Patrick, An Introduction to Medicinal Chemistry, 5th edition, Oxford University Press, 2013. Jayashree Ghosh, A text book of Pharmaceutical Chemistry, S. Chand and Co. Ltd, 1999,1999 edn.
4. O. LeRoy, Natural and synthetic organic medicinal compounds, Ealemi, 1976.
5. S. Ashutosh Kar, Medicinal Chemistry, Wiley Eastern Limited, New Delhi, 1993, New edn.
6. Jeffrey B. Harborne (2012), Phytochemical methods: A Guide to Modern Techniques of Plant Analysis, 4th edition, Indian reprint, Springer.

Reference Books

1. Foye's Principles of Medicinal Chemistry, Lipincott Williams, Seventh Edition, 2012
2. Burger's Medicinal Chemistry, Drug Discovery and Development, Donald J. Abraham, David P. Rotella, Alfred Burger, Academic press, 2010.
3. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry, John M. Beale Jr and John M. Block, Wolters Kluwer, 2011, 12th edn.
4. P. Parimoo, A Textbook of Medical Chemistry, New Delhi: CBS Publishers.1995.
5. S. Ramakrishnan, K. G. Prasannan and R. Rajan, Textbook of Medical Biochemistry, Hyderabad: Orient Longman. 3rd edition, 2001.

Online Resources

1. https://www.ncbi.nlm.nih.gov/books/NBK482447/
2. https://training.seer.cancer.gov/treatment/chemotherapy/types.html
3. https://www.classcentral.com/course/swayam-medicinal-chemistry-12908

Course Learning Outcomes

Students will be able:

CLO1: Predict a drugs properties based on its structure.

CLO2: Describe the factors that affect its absorption, distribution, metabolism, and excretion, and hence the considerations to be made in drug design.

LO3: Explain the relationship between drug's chemical structure and its therapeutic properties.

CLO4: Designed to give the knowledge of different theories of drug actions at molecular level.

CLO5: To identify different targets for the development of new drugs for the treatment of infectious and GIT.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**S**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO2	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**
CO3	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**S**
CO4	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**
CO5	**S**	**M**	**S**	**M**	**S**	**S**	**M**	**S**	**M**	**S**

3 – Strong, 2 – Medium, 1 – Low

Level of Correlation between PSO's and CO's

CO /PO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

3 – Strong, 2 – Medium, 1 - Low

Signature of HOD

SEC2: Nano and Computational Chemistry

Year: 2 **Semester: 4**

Subject Code: B4PCHSE2 **Credit: 3**

Instructional Hours: 3 **Exam Hours: 3**

Course Objectives

- To learn the fundamental concepts of nano science and technology
- To know the various classes of nanomaterials.
- To learn the Carbon Clusters and Nanostructures
- To gain the depth knowledge in computer with chemistry.
- To know the system software and computer networks.

Unit I: Introduction of Nanomaterials

What is nano –Why nano –Nanomaterials characteristic differences over bulk materials – Synthesis of nanomaterials, Bottom – up vs. top – down approaches – RF Plasma, Chemical methods, Thermolysis, Pulse laser methods- Micro Electro Mechanical Systems[MEMS] & Nano Electro Mechanical System (NEMS).

Unit II: Classification of Nanomaterials

Different classes of nanomaterials- Metal and Semiconductors, Nanomaterials. Quantum Dots, Wells and Wires, Characterization – Crystallography (XRD), Transmission Electron Microscopy (TEM), Scanning Microscopy (SEM, STM & AFM).

Unit III: Carbon Clusters and Nanostructures

Nature of carbon bond − new carbon structures − carbon clusters – discovery of C_{60}−alkali doped C_{60}−superconductivity in C_{60}−larger and smaller fullerenes.Carbon nanotubes – synthesis − single walled carbon nanotubes − structure and characterization − mechanism of formation − chemically modified carbon nanotubes −doping − functionalizing nanotubes − applications of carbon nanotubes. Nanowires −synthetic strategies − gas phase and solution phase growth – growth Control − properties.

Unit IV: Introduction to Computers and Networking

Basic organization of a computer-CPU- main memory-secondary storage-I /O devices-software- system and application software-high- and low-level languages- computers-algorithms and flowcharts.

Networking: computer networks-network components-hubs, switches, repeaters, routers, bridges-routers and gateways- network topologies- star, bus and ring-LAN, WAN, Intranet and Internet- world wide web-internet for chemists-online search of chemistry data bases- search engines for chemistry-chemweb-e-journals**.**

Unit V: Computational Chemistry

What you can do with computational chemistry, The tools of computational chemistry, Putting it all together, The philosophy of computational chemistry. The concept of the Potential Energy Surface-Perspective, Stationry Points, The Born-Oppenheimer approximation, Geometry optimization, Stationary points and normal- mode vibrations: ZPE, Symmetry.

Recommended Text Books

1. B.K Sharma, Industrial Chemistry, Goel Publishing House, Meerut (2003).

2. P.P.Singh, T.M.Joseph, R.G.Dhavale, College Industrial Chemistry, 4th edition, Himalaya Publishing House, Bombay (1983).

3. B.N. Chakrabarty, Industrial Chemistry, Oxford & IBH Publishing Co., New Delhi (1981).

Reference Books

1. Dr.G.S.Gugale, Dr. R.A.Pawar, Dr.A.V.Nagawade, Dr.R.R.Kale, Industrial chemistry, Nirali Prakashan Publications (2018).

2. Dr.B.K.Sharma, Industrial Chemistry, Goel Publishing House, 19th edition, Krishna Prakashan Media (P) Ltd., (2016).

Course Learning Outcomes

The students should be able to

CLO1: Understand the various synthetic procedures of nanomaterials.
CLO2: Understand the classification and characterization of nanomaterials.
CLO3: Understand the tools and philosophy of nanomaterials.
CLO4: Understand the basic organization of computer, network topologies, and internet sources.
CLO5: Understand computer network and basic organization of a computer.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**
CO 2	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**
CO 4	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 5	**M**	**S**	**M**	**S**	**S**	**M**	**S**	**M**	**S**	**S**

3 – Strong, 2 – Medium, 1 – Low

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

3 – Strong, 2 – Medium, 1 - Low

Signature of the HOD