GOVERNMENT ARTS COLLEGE (AUTONOMOUS)
KUMBAKONAM-612002

Department of Chemistry

M.Sc. CHEMISTRY

SYLLABUS

[Students admitted 2024-2025 onwards]

(Course Structure Under CBCS pattern)

GOVERNMENT ARTS COLLEGE (AUTONOMOUS), KUMBAKONAM
Course Structure Under CBCS for PG-CHEMISTRY (2024 - 2025)
P.G. Programme (M.Sc. Chemistry)

SEM	COURSE	Credits	INST. Hours/ week	Marks		Total
				Int.	Ext.	
I	Organic reaction mechanism - I (CC - I)	5	6	25	75	100
	Electrochemistry (Elective - I)	3	6	25	75	100
	Structure & bonding in inorganic compounds (Elective - II)	3	6	25	75	100
	Organic chemistry practical – I (CP - I)	5	6	40	60	100
	Inorganic chemistry practical - I (CP - II)	4	6	40	60	100
Total		**20**	**30**	**Total Marks**		**500**
II	Organic reaction mechanism - II (CC - II)	5	6	25	75	100
	Molecular spectroscopy (Elective - III)	3	4	25	75	100
	Physical chemistry - I (Elective - IV)	3	4	25	75	100
	Chemistry in everyday life (SEC - I)	2	4	25	75	100
	Organic chemistry practical- II (CP - III)	5	6	40	60	100
	Inorganic chemistry practical - II (CP - IV)	4	6	40	60	100
Total		**22**	**30**	**Total Marks**		**600**
III	Organic synthesis, photochemistry & Green chemistry (CC - III)	5	6	25	75	100
	Co-ordination chemistry - I (CC - IV)	5	6	25	75	100
	Bio-inorganic chemistry (CC - V)	5	6	25	75	100
	Pharmaceutical Chemistry (Elective - V)	3	3	25	75	100
	Preparation of consumer products (SEC - II)	2	3	25	75	100
	Physical chemistry practical - I (CP - V)	4	6	40	60	100
	Internship/ Industrial activity	2				
Total		**26**	**30**	**Total Marks**		**600**
IV	Co-ordination chemistry - II (CC - VI)	5	6	25	75	100
	Physical chemistry - II (Elective - VI)	3	4	25	75	100
	Skill Enhancement Course SEC-III (Competitive Exam)	2	4	25	75	100
	Physical chemistry practical - II (CP - VI)	5	6	40	60	100
	Project with viva-voce	7	10	25	75	100
	Extension Activity	1				
Total		**23**	**30**	**Total Marks**		**500**
	Net Total Credits	**91**	**120**	**Net Total Marks**		**2200**

COURSE PATTERN – SUMMARY

Subject	TOTAL PAPERS	CREDITS
Core Course	6	30
Core Practical	6	27
Electives	6	18
Skill Enhancement Course SEC	3	6
Project with viva-voce	1	7
Internship/ Industrial activity	0	2
Extension Activity	0	1
	22	91

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DEPARTMENT OF CHEMISTRY
SYLLABUS FOR THE STUDENTS ADMITTED FROM 2024 – 2025
M.Sc., CHEMISTRY PROGRAM

Title of the Subject: Organic Reaction Mechanism - I (CC - I) **Credits : 5**
Subject Code: 23P1C1 **Contact Hours: 90**
Semester : I **Marks :100**

Course objective:

- 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 polysubstituted 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: SE2 and SEi, SE1- 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 attackingnucleophile. Reactions: Oxygen and Sulphur-nucleophiles, Bucherer and Rosenmund reactions, von Richter, Sommelet- Hauser and Smiles rearrangements. S_N^1, ion pair, S_N^2 mechanisms and evidences. Aliphatic nucleophilic substitutions at an allylic carbon, aliphatic trigonal carbon and vinyl carbon.S_N^1, S_N^2, S_N^i, and S_E^1 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 with C, N, S based chiral centers. Optical purity, prochirality, enantiotopic and diastereotopic atoms, groups, faces, axial and planar chirality, chirality due to helical shape, methods of determining theconfiguration. Racemic modifications: Racemization by thermal, anion, cation, reversible formation, epimerization, mutarotation. D, L system, Cram's and Prelog's rules: R, S- notations, proR, proS, side phase and re phase Cahn-Ingold-Prelog rules, absolute and relative configurations. Configurations of allenes, spiranes, biphenyls, cyclooctene, helicene, binaphthyls, ansa and cyclophanic compounds, exo-cyclic alkylidene-cycloalkanes. Topicityandprostereoisomerism, chiral shift reagents and chiral solvating reagents. Criteria for optical purity: Resolution of racemic modifications, asymmetric transformations, asymmetric synthesis, destruction. Stereoselective and stereospecific synthesis.

UNIT-V: Stereochemistry-II: Conformation and reactivity of acyclic systems, intramolecular rearrangements, neighboring group participation, chemical consequence of conformational equilibrium - Curtin-Hammett Principle. Stability of five and six-membered rings: mono-, di- and polysubstituted cyclohexanes, conformation and reactivity in cyclohexane systems. Fused and bridgedrings: bicyclic, poly cyclic systems, decalins and Brett's rule. Optical rotation and optical rotatory dispersion, conformational asymmetry, ORD curves, octant rule, configuration and conformation, Cotton effect, axial haloketone rule and determination of configuration.

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, 6thed.; Wiley Inter-science: New York, 1988.

Reference 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.

Website and e-learning source:

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

Course Learning Outcomes (for Mapping with POs and PSOs)

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

Strong - 3 **Medium-2** **Low-1**

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

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Title of the Subject: Electrochemistry (EC - I) **Credits :3**
Subject Code : 23P1C2EC **Contact Hours: 90**
Semester : I **Marks :100**

Course objective:

- To understand the behavior of electrolytes in terms of conductance, ionic atmosphere, interactions.
- To familiarize the structure of the electrical double layer of different models.
- To compare electrodes between current density and over potential.
- To discuss the mechanism of electrochemical reactions.
- To highlight the different types of over voltages and its applications in electroanalytical techniques.

UNIT-I: Ionics: Arrhenius theory -limitations, van‟t Hoff factor and its relation to colligative properties. Deviation from ideal behavior. Ionic activity, mean ionic activity and mean ionic activity coefficient-concept of ionic strength, Debye Huckel theory of strong electrolytes, activity coefficient of strong electrolytes Determination of activity coefficient ion solvent and ion-ion interactions. Debye-Huckel Bjerrum model. Derivation of Debye-Huckel limiting law at appreciable concentration of electrolytes modifications and applications. Electrolytic conduction-Debye-Huckel Onsager treatment of strong electrolyte-qualitative and quantitative verification and limitations.

UNIT-II: Electrode-electrolyte interface: Interfacial phenomena -Evidences for electrical double layer, polarizable and non-polarizable interfaces, Electrocapillary phenomena - Lippmann equation electro capillary curves. Electro-kinetic phenomena electro-osmosis, electrophoresis. Structure of double layer: Helmholtz -Perrin, Guoy- Chapman and Stern models of electrical double layer. Zeta potential and potential at zero charge. Applications and limitations.

UNIT-III: Electrodics of Elementary Electrode Reactions: Behavior of electrodes: Standard electrodes and electrodes at equilibrium. Anodic and Cathodic currents, condition for the discharge of ions. Nernst equation, polarizable and non-polarizable electrodes. Model of three electrode system, over potential. Rate of electro chemical reactions: Rates of simple elementary reactions. Butler- Volmer equation-significance of exchange current density, net current density and symmetry factor. Low and high field approximations. symmetry factor and transfer coefficient Tafel equations and Tafel plots.

UNIT-IV: Electrodics of Multistep Multi Electron System: Rates of multi-step electrode reactions, Butler - Volmer equation for a multi-step reaction. Rate determining step, electrode polarization and depolarization. Transfer coefficients, its significance and determination, Stoichiometric number. Electro-chemical reaction mechanisms-rate expressions, order, and surface coverage. Reduction of I^{3-}, Fe^{2+}, and dissolution of Fe to Fe^{2+}. Overvoltage - Chemical and electro chemical, Phase, activation and concentration over potentials. Evolution of oxygen and hydrogen at different pH.Pourbiax and Evan‟s diagrams.

UNIT-V: Concentration Polarization, Batteries and Fuel cells: Modes of Transport of electro active species - Diffusion, migration and hydrodynamic modes. Role of supporting electrolytes. Polarography-principle and applications. Principle of square wave polarography. Cyclic voltammetry-anodic and cathodic stripping voltammetry and differential pulse voltammetry. Sodium and lithium-ion batteries and redox flow batteries. Mechanism of charge storage: conversion and alloying. Capacitors- mechanism of energy storage, charging at constant current and constant voltage. Energy production systems: Fuel Cells: classification, alkaline fuel cells, phosphoric acid fuel cells, high temperature fuel cells.

Text Books:

1. D. R. Crow, Principles and applications of electrochemistry, 4thedition, Chapman & Hall/CRC, 2014.
2. J. Rajaram and J.C. Kuriakose, Kinetics and Mechanism of chemical transformations Macmillan India Ltd., New Delhi, 2011.
3. S. Glasstone, Electro chemistry, Affiliated East-West Press, Pvt., Ltd., New Delhi, 2008.
4. B. Viswanathan, S. Sundaram, R. Venkataraman, K. Rengarajan and P.S. Raghavan, Electrochemistry-Principles and applications, S. Viswanathan Printers, Chennai,2007.
5. Joseph Wang, Analytical Electrochemistry, 2nd edition, Wiley, 2004.

Reference Books:

1. J.O.M. Bockris and A.K.N. Reddy, Modern Electro chemistry, vol.1 and 2B, Springer, Plenum Press, New York, 2008.
2. J.O.M. Bockris, A.K.N. Reddy and M.G. Aldeco Morden Electro chemistry, vol. 2A, Springer, Plenum Press, New York, 2008.
3. Philip H. Rieger, Electrochemistry, 2nd edition, Springer, New York, 2010.
4. L.I. Antropov, Theoretical electrochemistry, Mir Publishers, 1977.
5. K.L. Kapoor, A Text book of Physical chemistry, volume-3, Macmillan, 2001.

Website and e-learning source:

1. https://www.pdfdrive.com/modern-electrochemistry-e34333229.

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

CO1: To understand the behaviour of electrolytes in solution and compare the structures of electrical double layer of different models.

CO2: To predict the kinetics of electrode reactions applying Butler-Volmer and Tafel equations

CO3: To study different thermodynamic mechanism of corrosion,

CO4: To discuss the theories of electrolytes, electrical double layer, electrodics and activity coefficient of electrolytes

CO5: To have knowledge on storage devices and electrochemical reaction 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

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Title of the Subject: Structure and bonding in inorganic compounds (EC - II)

Credits : 3
Subject Code : 23P1C3EC **Contact Hours: 90**
Semester : I **Marks : 100**

Course objective:

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

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 Bravais 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.

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.

Website and e-learning source:

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

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

CO1: Predict the geometry of main group compounds and clusters.
CO2: Explain about the packing of ions in crystals and apply the radius ratio rule to predict the coordination number of cations.
CO3: Understand the various types of ionic crystal systems and analyze their structural features.
CO4: Explain the crystal growth methods.
CO5: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

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Title of the Subject: Organic Chemistry Practical - I (CP - I)	**Credits : 5**
Subject Code : 23P1CP1	**Contact Hours: 90**
Semester : I	**Marks : 100**

Course objective:

- 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 derivatize them suitably.
- To check the purity of organic compound experimentally
- To prepare organic compounds with green chemistry approach
- To understand the mechanism and procedure to prepare organic compound

UNIT-I: Separation and Analysis of organic mixture of two substances

1. Glucose + Phenol
2. Urea + Tertiary amine
3. Benzoic acid + Nitrobenzene
4. Phenol + Ethyl salicylate
5. Aniline + Acetophenone
6. Resorcinol + Benzaldehyde
7. Cinnamic acid + Nitrobenzene
8. Tertiary amine + Acetophenone
9. Phthalic acid + Benzaldehyde
10. Aniline + Methyl salicylate

UNIT-II: Single stage preparation of organic compounds with green chemistry approach – purification and recrystallization.

1. Preparation of Dibenzalacetone from Benzaldehyde.
2. Preparation of 5-nitro salicyclic acid.
3. Preparation of S-Benzyl isothio uranium chloride.
4. Preparation of Glucosazone from Glucose.
5. Preparation of Salicylic acid from Methyl salicylate.

Text Books

1.Vogel Text book of Practical Organic Chemistry V Edition, Furniss & Brian, 2016

Reference Books:

1.Practical Organic Chemistry IV Edition, Mann & Saunders, 2009

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

CO1: To recall the basic principles of organic separation, qualitative analysis and preparation.

CO2: To explain the method of separation and analysis of separated organic mixtures and convert them as derivatives by suitable preparation method.

CO3: To determine the characteristics of separation of organic compounds by various chemical reactions.

CO4: To develop strategies to separate, analyze and prepare organic compounds.

CO5: To formulate a method of separation, analysis of organic mixtures and design suitable procedure for organic preparations.

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

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Title of the Subject: Inorganic Chemistry Practical - I (CP - II) **Credits : 4**
Subject Code : 23P1CP2 **Contact Hours: 90**
Semester : I **Marks : 100**

Course objective:

- To understand the identification of common and less common cations in inorganic mixture
- To know about the concentration of the coloured solutions.

UNIT-I: Semi-micro qualitative analysis

Analysis of a mixture contains four basic radicals of which two common and two rare earths.

Common Basic radicals

Lead, Copper, Cadmium, Bismuth, Aluminium, Iron, Zinc, Nickel, Calcium, Magnesium and Barium

Rare-earths

Tellurium, Cerium, Selenium, Tungsten, Molybdenum, Thorium, Zirconium, Vanadium and Lithium

UNIT-II: Calorimetric Estimations

1. Estimation of Nickel
2. Estimation of Copper
3. Estimation of Iron

Text Books

1. A. JeyaRajendran, 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 Text book of Inorganic Qualitative Analysis*, 4thed., ELBS, London.

Reference Books:

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 (for Mapping with POs and PSOs)

Students will be able:

CO1: To identify the anions and cations present in a mixture of salts.

CO2: To apply the principles of semi micro qualitative analysis to categorize acid radicals and basic radicals.

CO3: To acquire the qualitative analytical skills by selecting suitable confirmatory tests and spot tests.

CO4: To choose the appropriate chemical reagents for the detection of anions and cations.

CO5: To synthesize coordination compounds in good quality.

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

SEMESTER - II

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Title of the Subject: Organic Reaction Mechanism - II (CC - II) **Credits : 5**
Subject Code : 23P2C4 **Contact Hours: 90**
Semester : II **Marks : 100**

Course objective:

- 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: E2, E1, and E1cB 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, Detection and stability of radicals, characteristics of free radical reactions and free radical, reactions of radicals; polymerization, addition, halogenations, aromatic substitutions, rearrangements. Reactivity: Reactivity on aliphatic, aromatic substrates, reactivity in the attacking radical, effect of solvent.

UNIT-II: Oxidation and Reduction Reactions: Mechanisms: Direct electron transfer, hydride transfer, hydrogen transfer, displacement, addition-elimination, oxidative and reductive coupling reactions. Mechanism of oxidation reactions: Dehydrogenation by quinones, selenium dioxides, ferricyanide, mercuric acetate 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, DMSO-Oxalyl chloride (Swern oxidation) and Corey-Kim oxidation, dimethyl sulphoxide- dicyclohexyl carbodiimide (DMSO-DCCD). Mechanism of reduction reactions: Wolff-Kishner, Clemmenson, Rosenmund, reduction with Trialkyl and triphenyltin hydrides, McFadyen-Steven‟s reduction, Homogeneous hydrogenation, Hydroboration with cyclic systems, MPV and Bouveault-Blanc reduction.

UNIT-III: Rearrangements: Rearrangements to electron deficient carbon: Pinacol-pinacolone and semi-pinacolone rearrangements -applications and stereochemistry, Wagner-Meerwein, Demjanov, Dienone-phenol, Baker-Venkataraman, Benzilic acid and Wolff rearrangements. Rearrangements to electron deficient nitrogen: Hofmann, Curtius, Schmidt, Lossen, Beckmann and abnormal Beckmann rearrangements. Rearrangements to electron deficient oxygen: Baeyer-Villiger oxidation and Dakin rearrangements. Rearrangements to electron rich atom: Favorskii, Quasi-Favorskii, Stevens, [1,2]-Wittig and [2,3]-Wittig rearrangements. Fries and Photo Fries rearrangement. Intramolecular rearrangements – Claisen, abnormal Claisen, Cope, oxy-Cope Benzidine rearrangements.

UNIT-IV: 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, Prinsreaction. Stereochemical aspects of addition reactions. Addition to Carbon-Hetero atom Multiplebonds: Addition of Grignard reagents, organozinc and organolithium reagents to carbonyl and unsaturated carbonyl compounds. Mechanism of condensation reactions involving enolates –Stobbe reactions. Hydrolysis of esters and amides, ammonolysis ofesters.

UNIT-V: Reagents and Modern Synthetic Reactions: Lithium diisopropylamine (LDA), Azobisisobutyronitrile (AIBN), Sodium cyanoborohydride ($NaBH_3CN$), *meta*-Chloroperbenzoic acid (m-CPBA), Dimethyl aminiopyridine (DMAP), n-Bu_3SnD, Triethylamine (TEA), Diazobicyclo[5.4.0]undec-7-ene(DBU), Diisopropylazodicarboxylate (DIAD), Diethylazodicarboxylate (DEAD), *N*-bromosuccinimide (NBS), Trifluoroacetic acid (TFA),

Tetramethyl piperiridin-1-oxyl (TEMPO), Phenyltrimethylammonium tribromide (PTAB). Diazomethane and Zn-Cu, 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, Baylis-Hillman reaction.

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*, 7thedn., 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.

Website and e-learning source:

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

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

CO1: To recall the basic principles of aromaticity of organic and heterocyclic compounds.
CO2: To understand the mechanism of various types of organic reactions.
CO3: To predict the suitable reagents for the conversion of selective organic compounds.
CO4: To correlate the principles of substitution, elimination, and addition reactions.
CO5: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

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Title of the Subject: Molecular spectroscopy (EC - III) **Credits : 3**
Subject Code : 23P2C5EC **Contact Hours: 60**
Semester : II **Marks : 100**

Course objective:

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

UNIT-I: Rotational, Raman Spectroscopy and Vibrational Spectroscopy:
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, 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.
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.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-II: Electronic 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. Woodward and Fieser rules for calculating λ_{max} value; Dienes, alicyclic dienes, polyenes, enones, dienones and other organic compounds. Photoelectron Spectroscopy: Basic principles, photoelectron spectra of simple molecules, X-ray photoelectron spectroscopy (XPS).

UNIT-III: NMR spectroscopy: Chemical shift, Factors influencing chemical shifts: electronegativity and electrostatic effects; Mechanism of shielding and deshielding. Spin systems: First order and second order coupling of AB systems, Simplification of complex spectra. Spin-spin interactions: Vicinal, germinal and long-range coupling-spin decoupling. Nuclear Overhauser effect (NOE), ^{13}CNMR and structural correlations. Brief introduction to 2D NMR – COSY, NOESY. Introduction to ^{31}P and ^{19}F NMR.

UNIT-IV: Mass Spectroscopy: 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.

UNIT-V: EPR and Mossbauer Spectroscopy: ESR spectroscopy Characteristic features of ESR spectra, line shapes and line widths; ESR spectrometer. The g value and the hyperfine coupling parameter (A), origin of hyperfine interaction. Interpretation of ESR spectra and structure elucidation of organic radicals using ESR spectroscopy; Spin orbit coupling and significance of g-tensors, zero/non-zero field splitting, Kramer's degeneracy, application to transition metal complexes (having one to five unpaired electrons) including biological molecules and inorganic free radicals. Principle of Mossbauer spectroscopy: Doppler shift, recoil energy. Isomer shift, quadrupole splitting, magnetic interactions. Applications: Mossbauer spectra of high and low-spin Fe and Sn compounds.

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.

Website and e-learning source:

1. https://onlinecourses.nptel.ac.in/noc20_cy08/preview
2. https://www.digimat.in/nptel/courses/video/104106122/L14.html

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

CO1: To understand the importance of rotational and Raman spectroscopy.
CO2: To apply the vibrational spectroscopic techniques to diatomic and polyatomic molecules.
CO3: To evaluate different electronic spectra of simple molecules using electronic spectroscopy.
CO4: To outline the NMR, ^{13}C NMR, 2D NMR – COSY, NOESY, Introduction to ^{31}P, ^{19}F NMR and ESR spectroscopic techniques.
CO5: To develop the knowledge on principle, instrumentation and structural elucidation of simplemolecules using Mass Spectrometry, EPR and 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

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Title of the Subject: Physical Chemistry-I (EC - IV) **Credits : 3**
Subject Code : 23P2C6EC **Contact Hours: 60**
Semester : II **Marks : 100**

Course objective:

- To recall the fundamentals of thermodynamics and the composition of partial molar quantities.
- To understand the classical and statistical approach of the functions
- To compare the significance of Maxwell-Boltzman, Fermi-Dirac and Bose-Einstein
- To correlate the theories of reaction rates for the evaluation of thermodynamic parameters.
- To study the mechanism and kinetics of reactions.

UNIT-I: Classical Thermodynamics: Partial molar properties-Chemical potential, Gibb‟s- Duhem equation-binary and ternary systems. Determination of partial molar quantities. Thermodynamics of real gases - Fugacity- determination of fugacity by graphical and equation of state methods- dependence of temperature, pressure and composition. Thermodynamics of ideal and non-ideal binarymixtures, Duhem - Margulus equation applications of ideal and non-ideal mixtures. Activity and activity coefficients-standard states - determination-vapour pressure, EMF and freezing point methods.

UNIT-II: Statistical thermodynamics I: Introduction of statistical thermodynamics concepts of thermodynamic and mathematical probabilities-distribution of distinguishable and non- distinguishable particles. Assemblies, ensembles, canonical particles. Maxwell - Boltzmann, Fermi Dirac & Bose-Einstein Statistics- comparison and applications. Partition functions-evaluation of translational, vibrational and rotational partition functions for monoatomic, diatomic and polyatomic ideal gases.

UNIT-III: Statistical thermodynamics II: Thermodynamic functions in terms of partition functions-calculation of equilibrium constants. Statistical approach to Thermodynamic properties: pressure, internal energy, entropy, enthalpy, Gibb's function, Helmholtz function residual entropy, equilibrium constants and equipartition principle. Heat capacity of solids-Einstein and Debye models.

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 catalyzed 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.

Text Books

1. J. Rajaram and J.C. Kuriacose, Thermodynamics for Students of Chemistry, 2nd edition,S.L.N.Chandand 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,Macmillan 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.

Website and e-learning source:

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

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

CO1: To explain the classical and statistical concepts of thermodynamics.
CO2: To compare and correlate the thermodynamic concepts to study the kinetics of chemical reactions.
CO3: To discuss the various thermodynamic and kinetic determination.
CO4: To evaluate the thermodynamic methods for real gases ad mixtures.
CO5: To compare the theories of reactions 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

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Title of the Subject: Chemistry in Every Day Life (SEC - I) **Credits : 2**
Subject Code : 23P2C7SEC **Contact Hours: 60**
Semester : II **Marks : 100**

Course objective:

- To learn the Textile chemistry other materials.
- Such as soaps, detergent, cosmetics & polymers dyes.

Unit – I: Textile Fiber

Definition, Classification of textile fibers – vegetable fibers, animal fibers, properties, uses and features of cotton, wool, silk and jute fibers. Genetically modified cotton: Its merit and demerits. Viscose fiber, chemical structure, production of viscose fiber, properties and uses.

Unit – II: Soaps

Introduction, cleaning action of soap. Toilet soap, bathing bars, washing soaps, liquid soap manufacture – Batch process, cold process, hot process – semi boiled process, boiled process.Additives, fillers and flavors. Significances of acidity and alkalinity

Unit – III: Detergents

Introduction, Detergent action, types of detergents – cationic, anionic, amphiphilic detergents. Common detergent chemicals. Additives, excipients colors and flavors. Enzymes used in commercial detergents. Environmental Hazards.

Unit – IV: Cosmetics

Introduction, classification – bathing oils. Face creams, Face powder, skin products, dental cosmetics, hair dyes, shaving cream, shampoo. General formation for each type. Toxicology of cosmetics.

Unit – V: Material Chemistry

Lubricants- Definition, classification, properties application of each type – synthetic lubricants. Adhesive- Definition, adhesive action- important adhesives- epoxy resin (Araldite)
Dyes and Dyeing process: Difference between dye and pigment -Witt‟s colour theory, classification of dyes based on application (Direct, Vat, Acid, Reactive, Mordant and Disperse). Important food dyes.

Text Books

1. T.P. Coultate, Food – The Chemistry of its components. Royal Society of Chemistry London.
2. Shashi Chowls, Engineering Chemistry, Darpat Rai Publication, Meerut, India.

Reference Books:

1. B.K. Sharma, Industrial Chemistry, Goel Publications, Meerut, India.
2. CNR Rao, Understanding Chemistry, Universities Press. Hyderabad, India.
3. Engineering Chemistry by Jain & Jain.

Website and e-learning source:

https://bit.ly/3tL3GdN

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:
CO1: To learn the concepts of fibre.
CO2: To acquire information and awareness about soaps.
CO3: To acquire information and awareness about detergents.
CO4: To get knowledge about cosmetics.
CO5:To learn about the lubricants, dyes and its applications.

CO-PO Mapping (Course Articulation Matrix)

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

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Title of the Subject: Organic Chemistry Practical - II (CP - III) **Credits : 5**
Subject Code : 23P2CP3 **Contact Hours: 90**
Semester : II **Marks : 100**

Course objective:

- To know the accuracy of estimation of compounds
- To check the purity of organic compound experimentally
- To prepare organic compounds with green chemistry approach
- To understand the mechanism and procedure to prepare organic compound

Unit – I: Organic Estimations

1. Estimation of Phenol
2. Estimation of Aniline
3. Estimation of Ethyl methyl ketone
4. Estimation of Glucose
5. Estimation of Saponification value of an Oil

UNIT-II: Double stage preparation of organic compounds

1. Hoffmann rearrangement of aromatic amides with household bleach and acetylation of the resultant amines with acetic anhydride.
2. Hoffmann rearrangement of aromatic amides with household bleach and bromination of the resultant amines.
3. N-Bromination of acetanilide with Br_2/NaOH mixture; and the Orton rearrangement of respective N-bromoacetanilide.
4. N-Acetylation of aromatic amines and bromination of the resultant product.

Text Books

1.Vogel Text book of Practical Organic Chemistry V Edition, Furniss & Brian, 2016

Reference Books:

1.Practical Organic Chemistry IV Edition, Mann & Saunders, 2009

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

CO1: To recall the basic principles of organic separation, qualitative analysis and preparation.
CO2: To explain the method of separation and analysis of separated organic mixtures and convert them as derivatives by suitable preparation method.
CO3: To determine the characteristics of separation of organic compounds by various chemical reactions.
CO4: To develop strategies to separate, analyze and prepare organic compounds.
CO5: To formulate a method of separation, analysis of organic mixtures and design suitable procedure for organic preparations.

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

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Title of the Subject: Inorganic Chemistry Practical - II (CP - IV) **Credits : 4**
Subject Code : 23P2CP4 **Contact Hours: 90**
Semester : II **Marks : 100**

Course objective:

- To estimate the amount of inorganic ions present in the whole of the given solution.
- To enrich to the knowledge in inorganic preparation

UNIT-I: Gravimetric & Volumetric analysis

1. Estimation of Copper Volumetrically & Barium Gravimetrically
2. Estimation of Copper Volumetrically & Nickel Gravimetrically
3. Estimation of Calcium Volumetrically & Magnesium Gravimetrically
4. Estimation of Copper Volumetrically & Zinc Gravimetrically

UNIT-II: Preparations

Preparation of simple complexes

1. Hexathioureaplumbus nitrate
2. Potassium tri oxalate chromate [III]
3. Thiourea copper(I) sulphate
4. Tetrammine copper (II) sulphate

Text Books

1. A. JeyaRajendran, 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 Text book of Inorganic Qualitative Analysis,* 4thed., 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 (for Mapping with POs and PSOs)

Students will be able:

CO1: To identify the anions and cations present in a mixture of salts.
CO2: To apply the principles of semi micro qualitative analysis to categorize acid radicals and basic radicals.
CO3: To acquire the qualitative analytical skills by selecting suitable confirmatory tests and spot tests.
CO4: To choose the appropriate chemical reagents for the detection of anions and cations.
CO5: To synthesize coordination compounds in good quality.

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

SEMESTER - III

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Title of the Subject: Organic Synthesis, Photochemistry and Green Chemistry (CC-III)

Credits : 5
Subject Code : 23P3C8 **Contact Hours: 90**
Semester : III **Marks : 100**

Course objective:

- 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.
- To obtain basic knowledge about green chemistry

UNIT-I: Organic Synthetic Methodology

Retrosynthetic analysis; Alternate synthetic routes. Synthesis of organic mono and bifunctional compounds via disconnection approach. Protection of hydroxyl, carboxyl, carbonyl, thiol and amino groups. Illustration of protection and deprotection in synthesis. Use of protective groups, activating groups, and bridging elements. Stereospecific control elements. Functional group alterations and transposition. Name reactions: Brich reduction, Mitsunobu reaction (DEAD), Olefination – Peterson olefination, Julia olefination and Corey-Winter olefination.

Coupling reactions: Stille, Hiyama, Sonogashira, Suzuki, Negishi, Kumada and Heek coupling. Reagents: Gilman reagent, Iodo-lactonization, Epoxidation (m-CpBA/Sharpless asymmetric/CF_3COOH/H_2O_2, NaOH/DMSO) and BuLi (with or without TMEDA)

UNIT-II: Pericyclic Reactions:

Woodward Hoffmann rules: The Mobius and Huckel concept, FMO, PMO method and correlation diagrams. Cycloaddition and retrocycloaddition reactions; [2+2], [2+4], [4+4], cationic, anionic, and 1,3-dipolar cycloadditions. Cheletropic reactions. Electrocyclization and ring opening reactions of conjugated dienes and trienes. Sigmatropic rearrangements: (1,3), (1,5), (3,3) and (5,5)-carbon migrations, degenerate rearrangements. Ionic sigmatropic rearrangements. Group transfer reactions. Regioselectivity, stereoselectivity and periselectivity in pericyclic reactions.

UNIT-III: Organic Photochemistry-I:

Introduction to organic photochemistry; Photochemical excitation: electronic transitions- Types of electronic transitions- Jablonskii diagrams- fluorescence, phosphorescence - quenching of fluorescence - Stern Volmer equation. Photosensitation – Photosynthesis.

Photochemical reactions: Types- Norrish type-I and type-II photolysis of cyclic ketones (Norrish type-III) cleavage reactions; photolysis of compounds containing nitrogen reductions- Barton‟s reactions. Photochemical reduction reaction.

UNIT-IV: Organic Photochemistry-II:

Photo cycloaddition reaction - Paterno-Buchi reactions; Photochemistry of α,β-unsaturated ketones; Photochemistry of alkenes; photodimerisation, cis-trans isomerisation. Photochemistry of aromatic compounds; photochemical rearrangements- 1,4 and 1,5 diene rearrangement- di-π-methane rearrangement: photo-stationary state. Lasers: Laser action, population inversion, properties of laser radiation, examples of simple laser systems.

UNIT-V: Green Chemistry:

Twelve principles of Green Chemistry with examples of starting materials, reagents, catalysts and solvents in detail, green chemistry in day today life. Green solvents: Water, Ionic liquids-criteria, general methods of preparation, effect on organic reaction.

Environmental pollution, Green Catalysis-Acid catalysts, Oxidation catalysts, Basic catalysts, and Polymer supported catalysts. Micro wave induced green synthesis-Introduction, Principle, Instrumentation and applications. Sonochemistry – Instrumentation, Cavitation theory - Ultra sound assisted green synthesis and Applications.

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.
6. Ahluwalia, V.K. and Kidwai, M.R. New Trends in Green Chemistry, Anamalaya Publishers, 2005.

Reference Books

1. Gill and Wills, Pericyclic Reactions, Chapman Hall, London, 1974.
2. J.A. Joule, G.F. Smith, Heterocyclic Chemistry, Garden City Press, Great Britain, 2004.
3. W. Caruthers, Some Modern Methods of Organic Synthesis 4thedn, Cambridge University Press, Cambridge, 2007.
4. H. O. House. Modern Synthetic reactions, W.A. Benjamin Inc, 1972.
5. Jagdamba Singh and Jaya Singh, Photochemistry and Pericyclic Reactions, New Age International Publishers, New Delhi, 2012.

Website and e-learning source:

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

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

CO1: To recall the basic principles of organic chemistry and to understand the various reactions of organic compounds with reaction mechanisms.

CO2: To understand the versatility of various special reagents and to correlate their reactivity with various reaction conditions.

CO3: To recall the basic principles of organic photo chemistry.

CO4: To understand the various photochemical reactions and their reaction mechanisms.

CO5: To understand the various techniques used in chemical industries and in laboratory using green chemistry.

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

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Title of the Subject: Co-ordination chemistry - I (CC - IV) **Credits : 5**
Subject Code : 23P3C9 **Contact Hours: 90**
Semester : III **Marks : 100**

Course objective:

- 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 an octahedral, tetrahedral and square planar symmetries -measurement of 10Dq - factors affecting 10Dq - spectrochemical series - crystal field stabilization energy for high spin and low spin complexes - evidences for crystal field splitting - site selections in spinel and anti-spinel - 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^1-d^{10} ions - characteristics of d-d transitions - charge transfer spectra - selection rules for electronic spectra - Orgel correlation diagrams - Sugano-Tanabe energy level diagrams - nephelauxetic series - Racah parameter and calculation of inter-electronic repulsion parameter.

UNIT-III: Stability and Magnetic property of 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 exchangemethod, Polorographic 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: Mechanisms of substitution reactions:
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.

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, 6thed.; 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.

Website and e-learning source:

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:

CO1: Understand and comprehend various theories of coordination compounds.

CO2: Understand the spectroscopic and magnetic properties of coordination complexes.

CO3: Explain the stability of complexes and various experimental methods to determine the stability of complexes.

CO4: Predict the electronic transitions in a complex based on correlation diagrams and UV-visible spectral details.

CO5: 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

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Title of the Subject: BIO INORGANIC CHEMISTRY (CC-V) **Credits : 5**
Subject Code : 23P3C10 **Contact Hours: 90**
Semester : III **Marks : 100**

Objectives of the course

- To understand the role of trace elements.
- 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 trace elements: Selective transport and storage of metal ions: Ferritin, Transferrin and siderophores; Sodium and potassium transport, Calcium signaling proteins. Metalloenzymes: Zinc enzymes–carboxypeptidase and carbonic anhydrase. Iron enzymes–catalase, peroxidase. Copper enzymes – superoxide dismutase, Plastocyanin, Ceruloplasmin, Tyrosinase. Coenzymes - Vitamin-B12 coenzymes.

UNIT-II: Transport Proteins: Oxygen carriers -Hemoglobin and myoglobin - Structure and oxygenation. Bohr Effect. Binding of CO, NO, CN– to Myoglobin and Hemoglobin. 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- chlorophyll 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: Enzymes -Introduction nomenclature, classification and properties. Enzyme kinetics, free energy of activation and the effects of catalysis. Michelis - Menton equation - Effect of pH and temperature on enzyme reactions. Factors contributing to the efficiency of enzyme.

Text Books:

1. Williams, D.R. –Introduction to Bioinorganic chemistry.
2. F.M. Fiabre and D.R. Williams– The Principles of Bioinorganic Chemistry, Royol Soceity ofChemistry, 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.

Website and e-learning source:

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 (for Mapping with POs and PSOs)

Students will be able:

CO1: The students will be able to analyses trace elements.

CO2: Students will be able to explain the biological redox systems.

CO3: Students will gain skill in analyzing the toxicity in metals.

CO4: Students will have experience in diagnosis.

CO5: 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

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Title of the Subject: Pharmaceutical Chemistry (EC - V) **Credits : 3**
Subject Code : 23P3C11EC **Contact Hours: 45**
Semester : III **Marks : 100**

Course objective:

- To understand the advanced concepts of pharmaceutical chemistry.
- To recall the principle and biological functions of various drugs.
- To train the students to know the importance as well the consequences of various drugs.
- To have knowledge on the various analysis and techniques.
- To familiarize on the drug dosage and its structural activities.

UNIT-I: Pharmaceutical chemistry: Introduction to pharmaceutical chemistry, Role of chemistry in Pharmacy. Important terminologies- Pharmacodynamics, Pharmacokinetics, Pharmacognosy, Toxicology, Pharmacopoeia, Pharmacophore - effect of functional groups on physiological activity of drugs: hydroxy, acidic, alkyl, aldehyde, ketone, cyano, halogens, ether and ester groups with examples.

UNIT-II: Physicochemical properties of Drugs: Effect of solubility, Partition coefficient, ionization constant, surface active agents, chelation, hydrogen bonding, stereoisomers on the pharmacological action of drugs (specific example of API). Drug action, Drug metabolism- significance of drug metabolism. Phase I, Phase II pathways with reactions. Factors on which drug metabolism depends. Assay of drugs- Chemical, biological and immunological assay.

UNIT-III: Drug dosage and product development: Introduction to drug dosage forms & Drug delivery system - Definition of common terms. Drug regulation and control, sources of drug, drug nomenclature, routes of administration of drugs products, need for a dosage form, classification of dosage forms. Drug dosage and product development.

UNIT-IV: Development of new drugs: Introduction, procedure followed in drug design, the research for lead compounds, molecular modification of lead compounds. Structure-Activity Relationship (SAR): Factors effecting bioactivity, resonance, inductive effect, isoterism, bioisosterism, spatial considerations, theories of drug activity, occupancy theory, rate theory, induced-fit theory.

UNIT-V: Anti-infective agents: Antiseptics and disinfectants- 8-hydroxy quinoline derivatives and acridines - synthesis and disinfectant properties. Antimalarials: Life cycle of parasite, drug acting on different stages- Quinine, Chloroquine, Primaquine - their structures and antimalarial behaviors. Newer antibacterial agents: Quinoline carboxylic acids such as Ciprofloxacin, Temafloxacin - structure and activities. Local anaesthetics: Cocaine, Benzocaine, Procaine (MA), Lidocaine - structure and activities.

Text books:

1. Text Book of Physical Pharmaceutics, 2nd edition, Vallabh Prakashan-. C.V.S. Subramanyam.
2. Medicinal Chemistry (Organic Pharmaceutical Chemistry), G.R Chatwal, Himalaya Publishing house.
3. Instrumental method of Analysis: Hubert H, Willard, 7th edition.
4. Textbook of Pharmaceutical Chemistry by, Jayshree Ghosh, S. Chand & company Ltd. Pharmaceutical Chemistry by Dr. S. Lakshmi, Sultan chand& Sons.

Reference Books

1. Physical Pharmacy and Pharmaceutical Sciences by Martins, Patrick J. Sinko, Lippincott. William and Wilkins.
2. Cooper and Gunn‟s Tutorial Pharmacy, 6th edition by S.J. Carter, CBS Publisher Ltd.
3. Ansels pharmaceutical Dosage forms and Drug Delivery System by Allen Popvich and Ansel, Indian edition-B.I. Publication Pvt. Ltd.

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:
CO1: To identify the suitable drugs for various diseases.

CO2: To apply the principles of various drug action and drug design.

CO3: To acquire the knowledge on product development based on SAR.

CO4: To apply the knowledge about various real time drugs.

CO5: To synthesize new drugs after understanding the concepts SAR.

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

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Title of the Subject: Preparation of Consumer Products (SEC II) **Credits : 2**
Subject Code : 23P3C12SEC **Contact Hours: 45**
Semester : III **Marks : 100**

Course objective:

- To understand the basic knowledge in consumer product Chemistry and modern trends in the industry
- To provide the practical training to the students in consumer product analysis
- To recall the principle.
- To train the students to know
- To have knowledge
- To familiarize**.**

UNIT-I: Cosmetics
Cosmetics- types - lipsticks, shampoo, cold cream, vanishing cream, sunscreens, tooth paste, hair dyes, hair smoothing products, tanning products, lotions.

UNIT-II: Cleansing Agents
SOAPS – types Saponification of oils and fats - manufacture of soaps. Formulation of toilet soaps- ingredients - functions - medicated soaps- herbal soap- mechanism of action of soaps. Soft soaps. Shaving soaps and creams

UNIT-III: Detergents
Detergents – types- anion detergents- cation detergents **–** non-ionic detergents, biodegradable-natural & organic- white vinegar, lemon, baking soda, hydrogen peroxide, soapberry. Inorganic compounds- builder and other additives- phosphate, zeolite.

UNIT-IV: Cosmetic Preparations
Face and skin powders- Ingredients- functions- types -snow and face creams. Chemical ingredients used - Antiperspirants - Sun screen preparations. UV absorbers- skin bleaching agents. Depilatories. Turmeric and Neem preparations. Vitamin oil- nail polish and remover preparation.

UNIT-V: Common Cleaning agents
Preparation, properties and uses of Hypochlorite, alcohols, chlorine dioxide, hydrogen peroxide, quaternary ammonium compounds,
Herbal based cleansing agents- aluvera gel, neem, turmeric, Multani.

References

1. GobalaRao.S, Outlines of chemical technology, Affiliated East West press,1998
2. Kafaro, Wasteless chemical processing, Mir publishers, 1995.
3. Sawyer.W, Experimental cosmetics, Dover publishers, New york, 2000.
4. Thankamma Jacob, A Textbook of Applied Chemistry: For Home Science and Allied Sciences, Macmillan Publishers India Limited, 1979.

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:
CO1: To identify the suitable drugs for various diseases.

CO2: To apply the principles of various drug action and drug design.

CO3: To acquire the knowledge on product development based on SAR.

CO4: To apply the knowledge on applications of computers in chemistry.

CO5: To synthesize new drugs after understanding the concepts SAR.

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

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Title of the Subject: Physical Chemistry practical – I (CP-V)	**Credits : 5**
Subject Code : 23P3CP5	**Contact Hours: 90**
Semester : III	**Marks : 100**

Course Outcomes: Students learn various experiments in couductometry and potentiometry. The lists of experiments are provided from which suitable experiments can be selected as convenient.

Electrical Experiments

Conductometric Titrations

1. Determination of strength of strong acid (Strong acid Vs Strong base)
2. Determination of strength of weak acid (Weak acid Vs Strong base)
3. Determination of strength of weak acid (Weak acid Vs Weak base)
4. Determination of strength of Mixture of acids (Strong acid + Weak acid Vs Strong base)
5. Verification of Ostwald‟s dilution law
6. Verification of Onsager‟s equation

Potentiometric Titrations

7. Determination of strength of strong acid (Strong acid Vs Strong base)
8. Determination of strength of weak acid (Weak acid Vs Strong base)
9. Determination of strength of Mixture of acids (Strong acid + Weak acid Vs Strong base)
10. Determination of single electrode potential
11. Determination of pH of the buffer using Quinhydrone electrode
12. Determination of pKa of weak acid using Std.NaOH solution
13. Determination of strength of FAS using Redox titration (FAS Vs $KMnO_4$)

References

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.
4. E.G. Lewers, Computational Chemistry: Introduction to the Theory and Applications of Molecular and Quantum Mechanics, 2nd Ed., Springer, New York, 2011.

Course Learning Outcomes (for Mapping with POs and PSOs)
Students will be able:
CO1: To recall the principles associated with various physical chemistry experiments.
CO2: To scientifically plan and perform all the experiments.
CO3: To observe and record systematically the readings in all the experiments.
CO4: To calculate and process the experimentally measured values and compare with graphical data.
CO5: 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

SEMESTER - IV

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Title of the Subject: Co-ordination chemistry - II (CC-VI) **Credits : 5**
Subject Code : 23P4C13 **Contact Hours: 90**
Semester : IV **Marks : 100**

Course objective:

- To recognize the fundamental concepts and structural aspects of organometallic compounds.
- To learn reactions of organometallic compounds and their catalytic behaviour.
- 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.

UNIT-I: Chemistry of organometallic compounds:
Types of ligands-hepticity-18 electron rule and its limitation- Structure and boding in metal- carbonyls (MO approach of M-CO bonding), metal nitrosyl, metal alkene (example: Ziese's salt), metal-acetylene and metal-allyl complexes; Metal-cyclopentadienyl complexes – Examples and MO approach to bonding in metallocenes; fluxional isomerism. Isolobal analogy and its applications- Carbonyl clusters: Low nuclearity and high nuclearity carbonyl clusters – Structures based on polyhedral skeleton electron pair theory or Wade's rule.

UNIT-II: Reactions and catalysis of organometallic compounds:
Reactions of organometallic compounds: Oxidative addition, reductive elimination (α and β eliminations), migratory insertion reaction, coordinated ligand reaction. Organometallic catalysis: Hydrogenation of olefins (Wilkinson's catalyst), Hydroformylation of olefins using cobalt or rhodium catalysts (oxo process), oxidation of olefin by palladium (Wacker process), Acetic acid synthesis (Monsonto process), olefin isomerisation, water gas shift reaction, cyclo-oligomerisation of acetylenes using Reppe's catalysts.

UNIT-III: Inorganic spectroscopy-I:
IR spectroscopy: Selection rule- Group vibration concept and its limitations-Effect of coordination on the stretching frequency-sulphato, carbonato, sulphito, aqua, nitro, thiocyanato, cyano, thiourea,DMSO complexes, IR spectroscopy of carbonyl complexes. NMR spectroscopy: Introduction, applications of ^{1}H, ^{15}N, ^{19}F, ^{31}P-NMR spectroscopy in structural identification of inorganic complexes, fluxional molecules, quadrupolar nuclei- effect in NMR spectroscopy.

UNIT-IV: Inorganic spectroscopy-II: Introductory terminologies: 'g' and 'A' parameters- definition, Isotropy and anisotropy- hyperfine splitting examples: methyl benzene and naphthyl radicals, bis(salicylaldimine) copper(II) - explanation and factors affecting 'g and A'; Applications ofESR to coordination complexes with more than one unpaired electrons – Zero field splitting and Kramer's degeneracy; ESR spectra of V(II), Mn(II), Fe(II), Co(II), Ni(II), Cu(II) complexes, and $[(NH_3)_5Co\text{-}O_2\text{-}Co(NH_3)_5]^{5+}$. Mossbauer spectroscopy – Mossbauer effect, Recoil energy, Mossbauer active nuclei, Doppler shift, Isomer shift, quadrupole splitting and magnetic interactions. Applicationsof Mössbauer spectra to Fe and Sn compounds.

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) – evaluation of vibrational constants of the above molecules. Koopman's theorem- applications and limitations. Optical Rotatory Dispersion – Principle of CD and ORD; Δ and λ isomers in complexes, Assignment of absolute configuration using CD and ORD techniques, Cotton effect, Octant, axial-halo ketone rule.

References

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, 6thed.; 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.

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:
CO1: Understand and apply 18 and 16 electron rules for organometallic compounds
CO2: Understand the structure and bonding in olefin, allyl, cyclopentadienyl and carbonyl containing organometallic compounds
CO3: Understand the reactions of organometallic compounds and apply them in
CO4: understanding the catalytic cycles
CO5: Identify / predict the structure of coordination complexes using spectroscopic tools such as IR, NMR, ESR, 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

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Title of the Subject: Physical chemistry - II (EC - VI) **Credits : 3**
Subject Code : 23P4C14EC **Contact Hours: 60**
Semester : IV **Marks : 100**

Course objective:

- 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 poly electronic systems.
- To familiarize the symmetry in molecules and predict the point groups.

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

UNIT-II: Quantum models: Particle in a box- one dimensional, two dimensional and three-dimensional, 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-III: 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 one dimensional box. Perturbation method - first order applications. Hartree- fock self-consistent field method, Hohenberg-Kohn theorem and Kohn-Sham equation, Helium atom-electron spin, Pauli‟s exclusion principle and Slater determination.

UNIT-IV: Group theory: Groups, sub groups, symmetry elements, operations, classification-axial and non-axial. Dihedral point groups- C_n, C_{nv}, 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-V: Applications of quantum and group theory: Hydrogen Molecule-Molecular orbital theory and Heitler London (VB) treatment, Energy level diagrams. Hydrogen molecule ion- Use of linear variation function and LCAO methods. Electronic conjugated system: Huckel method to Ethylene, butadiene, cyclo butadiene and Benzene. Applications of group theory to molecular vibrations, electronic spectra of ethylene.

References

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.

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

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

CO1: To discuss the characteristics of wave functions and symmetry functions.
CO2: To classify the symmetry operation and wave equations.
CO3: To apply the concept of quantum mechanics and group theory to predict the electronic structure.
CO4: To specify the appropriate irreducible representations for theoretical applications.
CO5: 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

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Title of the Subject: Competitive Exam (SEC-III) **Credits : 2**
Subject Code : 23P4C15SEC **Contact Hours: 45**
Semester : IV **Marks : 100**

UNIT-I
ORGANIC CHEMISTRY-I

Stereochemistry: Introduction to molecular symmetry and chirality – axis, plane, center, alternating axis of symmetry. Optical isomerism due to asymmetric and dissymmetric molecules with C, N, S based chiral centers. Criteria for optical purity: Resolution of racemic modifications, asymmetric transformations, asymmetric synthesis, destruction. Stereoselective and stereospecific synthesis, absolute and relative configurations. Configurations of allenes, spiranes, biphenyls, cyclooctene, helicene, binaphthyls, ansa and cyclophanic compounds, exo-cyclic alkylidene-cycloalkanes. Conformation and reactivity of acyclic systems, intramolecular rearrangements, neighbouring group participation, chemical consequence of conformational equilibrium - Curtin-Hammett Principle. Stability of five and six-membered rings: mono-, di- and polysubstituted cyclohexanes, conformation and reactivity in cyclohexane systems.

Aromaticity: Aromaticity in benzenoid, non-benzenoid, heterocyclic compounds and annulenes. **Aromatic electrophilic substitution**: Orientation and reactivity of di- and polysubstituted 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, S_E1 and S_Ei, - Mechanism and evidences.

Aromatic nucleophilic substitution: Mechanisms - S_NAr, S_N1 and Benzyne mechanisms - Evidences – Reactivity.

Aliphatic nucleophilic substitutions at an allylic carbon, aliphatic trigonal carbon and vinyl carbon.S_N1, S_N2, S_Ni, mechanism and evidences.

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,

Elimination reaction Mechanisms: E2, E1, and E1cB 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.

UNIT- II
ORGANIC CHEMISTRY-II

Organic reactive intermediates: Generation, stability and reactivity of carbocations, carbanions, free radicals, carbenes, benzynes and nitrenes.

Pericyclic Reactions: Woodward Hoffmann rules; The Mobius and Huckel concept, FMO, PMO method and correlation diagrams. Cycloaddition and retrocycloaddition reactions; [2+2], [2+4], [4+4, Cationic, anionic, and 1,3-dipolar cycloadditions. Cheletropic reactions; Electrocyclization and ring opening reactions of conjugated dienes and trienes. Sigmatropic rearrangements: (1,3), (1,5), (3,3)and (5,5)-carbon migrations, degenerate rearrangements. Ionic sigmatropic rearrangements. Group transfer reactions. Regioselectivity, stereoselectivity and periselectivity in pericyclic reactions.

Heterocyclic Compounds: Benzofused five membered rings: Indole, isoindole, benzofuran and benzothiophene, Preparation and properties. Benzofused six membered rings: Quinoline and isoquinoline: Preparation by ring closure reactions, Reactions: Mechanism of electrophilic and nucleophilic substitutions, oxidation and reduction reactions.

Rearrangements: Rearrangements to electron deficient carbon: Pinacol-pinacolone and semi-pinacolone rearrangements -applications and stereochemistry, Wagner-Meerwein, Demjanov, Dienone-phenol, Baker-Venkataraman, Benzilic acid and Wolff rearrangements. Rearrangements to electron deficient nitrogen: Hofmann, Curtius, Schmidt, Lossen, Beckmann and abnormal Beckmann rearrangements. Rearrangements to electron deficient oxygen: Baeyer-Villiger oxidation and Dakin rearrangements. Rearrangements to electron rich atom: Favorskii, Quasi-Favorskii, Stevens, [1,2]-

Wittig and [2,3]-Wittig rearrangements. Fries and Photo Fries rearrangement. Intramolecular rearrangements – Claisen, abnormal Claisen, Cope, oxy-Cope Benzidine rearrangements.

Photochemical excitation: Experimental techniques; electronic transitions; Jablonski 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; Photochemistry of α,β-unsaturated ketones; cis-trans isomerization. Photon energy transfer reactions, Photo cycloadditions, Photochemistry of aromatic compounds; photochemical rearrangements; di-π-methane rearrangement;

Organic Synthetic Methodology: Retrosynthetic analysis; Alternate synthetic routes. Synthesis of organic mono and bifunctional compounds via disconnection approach.

Structure determination of organic compounds by IR, UV-Vis, ^{1}H & ^{13}C NMR and Mass spectroscopic techniques.

Unit IV

Inorganic Chemistry-I

Chemical periodicity

Structure and bonding in homo- and heteronuclear molecules, including shapes of molecules (VSEPR Theory).

Concepts of acids and bases, Hard-Soft acid base concept, non-aqueous solvents.

Main group elements and their compounds: Allotropy, synthesis, structure and bonding, industrial importance of the compounds.

Transition elements and coordination compounds: structure, bonding theories, spectral and magnetic properties, reaction mechanisms. Inner transition elements: spectral and magnetic properties, redox chemistry, analytical applications.

Organometallic compounds: synthesis, bonding and structure, and reactivity. Organometallics in homogeneous catalysis.

Cages and metal clusters.

Unit IV

Inorganic Chemistry-II

Analytical chemistry- separation, spectroscopic, electro- and thermos analytical methods.

Bioinorganic chemistry: photosystems, porphyrins, metalloenzymes, oxygen transport, electron-transfer reactions; nitrogen fixation, metal complexes in medicine.

Characterization of inorganic compounds by IR, Raman, NMR, EPR, Mössbauer, UV-vis, NQR, MS, electron spectroscopy and microscopic techniques.

Nuclear chemistry: nuclear reactions, fission and fusion, radio-analytical techniques and activation analysis.

Unit V

Physical Chemistry:

1. Basic principles of quantum mechanics: Postulates; operator algebra; exactly-solvable systems: particle-in-a-box, harmonic oscillator and the hydrogen atom, including shapes of atomic orbitals; orbital and spin angular momenta; tunneling.
2. Approximate methods of quantum mechanics: Variational principle; perturbation theory up to second order in energy; applications.
3. Atomic structure and spectroscopy; term symbols; many-electron systems and anti-symmetryprinciple.
4. Chemical bonding in di atomics; elementary concepts of MO and VB theories; Huckel theory forconjugated π-electron systems.
5. Chemical applications of group theory; symmetry elements; point groups; character tables; selection rules.
6. Molecular spectroscopy: Rotational and vibrational spectra of diatomic molecules; electronic spectra; IR and Raman activities – selection rules; basic principles of magnetic resonance.
7. Chemical thermodynamics: Laws, state and path functions and their applications; thermodynamic description of various types of processes; Maxwell's relations; spontaneity and equilibria; temperature and pressure dependence of thermodynamic quantities; Le Chatelier principle; elementary description of phase transitions; phase equilibria and phase rule; thermodynamics of ideal and non-ideal gases, and solutions.
8. Statistical thermodynamics: Boltzmann distribution; kinetic theory of gases; partition functions and their relation to thermodynamic quantities – calculations for model systems.

9. Electrochemistry: Nernst equation, redox systems, electrochemical cells; Debye-Huckel theory; electrolytic conductance – Kohlrausch's law and its applications; ionic equilibria; conductometric and potentiometric titrations.

10. Chemical kinetics: Empirical rate laws and temperature dependence; complex reactions; steady state approximation; determination of reaction mechanisms; collision and transition state theories of rate constants; unimolecular reactions; enzyme kinetics; salt effects; homogeneous catalysis; photochemical reactions.
11. Colloids and surfaces: Stability and properties of colloids; isotherms and surface area; heterogeneous catalysis.
12. Solid state: Crystal structures; Bragg‟s law and applications; band structure of solids.
13. Polymer chemistry: Molar masses; kinetics of polymerization.
14. Data analysis: Mean and standard deviation; absolute and relative errors; linear regression; covariance and correlation coefficient.

Reference 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.
6. Keith F. Purcell and John C. Kotz, Inorganic Chemistry, Saunders Publications, USA, 1977.
7. Peter Atkins and Tina Overton, Shriver and Atkins' Inorganic Chemistry, 5th Edition, Oxford University Press, 2010.
8. Basic Inorganic Chemistry, F. A. Cotton, G. Wilkinson, P. L. Guas, John Wiley, 2002, 3rd edn.
9. Concepts and Models of Inorganic Chemistry, B. Douglas, D. McDaniel, J. Alexander, John Wiley, 1994, 3rd edn.
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11. D.A. Mcqurrie And J.D. Simon, Physical Chemistry - A Molecular Approach, Viva Books Pvt. Ltd., New Delhi, 1999.
12. R.P. Rastogi and R.R. Misra, Classical Thermodynamics, Vikas Publishing, Pvt. Ltd., New Delhi, 1990.
13. S.H. Maron and J.B. Lando, Fundamentals of Physical Chemistry, Macmillan Publishers, New York, 1974
14. K.B. Ytsiimiriski, "Kinetic Methods of Analysis", Pergamom Press,1996.
15. Gurdeep Raj, Phase rule, Goel Publishing House, 2011.

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SYLLABUS FOR THE STUDENTS ADMITTED FROM 2024 – 2025
M.Sc., CHEMISTRY PROGRAM

Title of the Subject: Physical Chemistry practical – II (CP-VI) **Credits : 5**
Subject Code : 23P4CP6 **Contact Hours: 90**
Semester : IV **Marks : 100**

Course Outcomes: Students learn the experiments in thermodynamics, colligative properties, phase rule, surface phenomenon, chemical equilibrium and chemical kinetics. List of experiments isprovided from which suitable experiments can be selected as convenient.

NON-ELECTRICAL EXPERIMENTS

1. Comparison of relative strength of two acids from hydrolysis of an ester
2. Determination of energy of activation for first order kinetics
3. Determine rate of the reaction between potassium per sulphate Vs potassium iodide (2^{nd} order kinetics)
4. Primary salt effect on 2^{nd} order kinetics
5. Determination of molecular weight by transition temperature method
6. Determine the CST of phenol – water system and study the effect of impurity
7. Verification of Freundlich adsorption isotherm
8. Study the effect of ionic strength on the rate of saponification of an ester
9. Determine the molecular weight of benzoic acid in benzene and find the degree of association
10. Construct the phase diagram – simple eutectic system
11. Determination of partition coefficient of iodine
12. The study of equilibrium reaction between potassium iodide and iodine

References

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.
4. E.G. Lewers, Computational Chemistry: Introduction to the Theory and Applications of Molecular and Quantum Mechanics, 2^{nd} Ed., Springer, New York, 2011.

Course Learning Outcomes (for Mapping with POs and PSOs)
Students will be able:
CO1: To recall the principles associated with various physical chemistry experiments.
CO2: To scientifically plan and perform all the experiments.
CO3: To observe and record systematically the readings in all the experiments.
CO4: To calculate and process the experimentally measured values and compare with graphical data.
CO5: 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