ANNAMALAI UNIVERSITY
404 - M.Sc. CHEMISTRY

Programme Structure and Scheme of Examination (under CBCS)
(Applicable to the candidates admitted in Affiliated Colleges for the academic year 2022 -2023 ONLY)

Course Code	Study Components & CourseTitle	Hours/Week	Credit	Maximum Marks		
				CIA	ESE	Total
	SEMESTER – I					
22PCHEC11	Core Course– I: Organic Chemistry -I	4	3	25	75	100
22PCHEC12	Core Course – II: Inorganic Chemistry -I	4	3	25	75	100
22PCHEC13	Core Course– III: Physical Chemistry – I	4	3	25	75	100
22PCHEP14	Core Practical – I: Organic Chemistry Practical – I	6	3	40	60	100
22PCHEP15	Core Practical – II: Physical Chemistry Practical -I	5	3	40	60	100
22PCHEE16	Core Elective – I	4	3	25	75	100
22PCHEO17	Open Elective – I	3	3	25	75	100
	Total	**30**	**21**			**700**
	SEMESTER – II					
22PCHEC21	Core Course–IV: Organic Chemistry -II	4	3	25	75	100
22PCHEC22	Core Course– V: Inorganic Chemistry -II	4	3	25	75	100
22PCHEC23	Core Course– VI: Physical Chemistry – II	4	3	25	75	100
22PCHEP24	Core Practical – III: Organic Chemistry Practical – II	6	3	40	60	100
22PCHEP25	Core Practical – IV: Inorganic Chemistry Practical -I	6	3	40	60	100
22PCHEE26	Core Elective – II	4	3	25	75	100
22PHUMR27	Compulsory Course: Human Rights	2	2	25	75	100
	Total	**30**	**20**			**700**
	SEMESTER – III					
22PCHEC31	Core Course – VII: Organic Chemistry -III	4	3	25	75	100
22PCHEC32	Core Course – VIII: Inorganic Chemistry -III	4	3	25	75	100
22PCHEC33	Core Course – IX: Physical Chemistry – III	4	3	25	75	100
22PCHEC34	Core Course – X: Scientific Research Methodology	4	4	25	75	100
22PCHEP35	Core Practical – V: Inorganic Chemistry Practical -II	6	3	40	60	100
22PCHEP36	Core Practical – VI: Physical Chemistry Practical -II	5	3	40	60	100
22PCHEO37	Open Elective – II (To choose 1 out of 3) MOOC Courses in the above Topic / Open elective	3	3	25	75	100
	Total	**30**	**22**			**700**

	SEMESTER – IV					
22PCHEC41	Core Course – X: Organic Chemistry IV	4	4	25	75	100
22PCHEC42	Core Course – XI: Physical Chemistry – IV	4	4	25	75	100
22PCHEP43	Core Practical–VII: Organic Chemistry Practical -III	4	3	40	60	100
22PCHEP44	Core Practical -VIII: Inorganic Chemistry Practical-III	4	3	40	60	100
22PCHEP45	Core Practical- IX: Physical Chemistry Practical – III	4	3	40	60	100
22PCHEE46	Core Elective – III: (To choose 1 out of 3)	4	4	25	75	100
22PCHED47	Core Project	6	6	25	75	100
	Total	**30**	**27**			**700**
	Grand Total	**120**	**90**			**2800**

List of Core Electives (Choose 1 out of 3 in each Semester)

Semester	Course Code	Course Title	H/W	C	CIA	ESE	Total
I	22PCHEE16-1	Polymer Chemistry	4	3	25	75	100
	22PCHEE16-2	Materials Chemistry	4	3	25	75	100
	22PCHEE16-3	Pharmaceutical Chemistry	4	3	25	75	100
II	22PCHEE26-1	Green Chemistry	4	3	25	75	100
	22PCHEE26-2	Supra Molecular Chemistry	4	3	25	75	100
	22PCHEE26-3	Nano Chemistry	4	3	25	75	100
	22PCHEE46-1	Bioinorganic Chemistry	4	4	25	75	100
	22PCHEE46-2	Industrial Electrochemistry	4	4	25	75	100
	22PCHEE46-3	Advanced Analytical Techniques	4	4	25	75	100

List of Open Electives (Choose 1 out of 3 in each Semester)

Semester	Course Code	Course Title	H/W	C	CIA	ESE	Total
I	22PCHEO17-1	Food Chemistry	3	3	25	75	100
	22PCHEO17-2	Industrial Chemistry	3	3	25	75	100
	22PCHEO17-3	Medicinal Chemistry	3	3	25	75	100
	22PCHEO37-1	Textile Chemistry	3	3	25	75	100
	22PCHEO37-2	Dairy Chemistry	3	3	25	75	100
	22PCHEO37-3	Agricultural Chemistry	3	3	25	75	100

Credit Distribution

Study Components	Papers	Credits	Total Credits	Marks	Total Marks
Core Course	9	3	27	100	900
Core Course	3	4	12	100	300
Core Practical	9	3	27	100	900
Core Electives	2	3	6	100	200
Core Electives	1	4	4	100	100
Open Electives	2	3	6	100	200
Project	1	6	6	100	100
Common Compulsory Paper	1	2	2	100	100
Total	**28**		**90**		**2800**

SEMESTER: I CORE – I	22PCHEC11: ORGANIC CHEMISTRY – I	CREDIT:3 HOURS:3/W

COURSE OBJECTIVE

1) To learn the basic aspects of stereochemistry
2) To gain knowledge about the reactive intermediate and reactions involving free radicals
3) To study the mechanisms of Aliphatic Nucleophilic and electrophilic substitutions
4) To learn the concepts of Aromaticity, Anti aromaticity and Homo aromaticity of Benzenoid and Non- benzenoid compounds
5) To accrue skill of predicting the mechanisms of Aromatic substitution reactions.

UNIT I: Stereochemistry – I **12 hrs**

Optical isomerism - chirality - asymmetry and dissymmetry - enantiotopic and diastereotopic ligands and faces. R, S- notations of molecules with one and two asymmetric centers. Inter conversion of Sawhorse, Newman and Fischer projections. Erythro and threo nomenclature, E and Z nomenclature. Absolute configurations of chiral biphenyls, allenes and spiranes. Asymmetric synthesis - Cram's rule and Felkin- Ahn Modification. Stereospecific and stereoselective reactions.

UNIT II: Reactive intermediates and reactions involving free radicals **12 hrs**

Structure, reactivity, formation, stability and reactions involving carbocations, carbanions, free radicals, carbenes and nitrenes. Long and short-lived free radicals - methods of generation of free radicals - detection of free radicals by ESR - Addition of free radicals to olefinic double bonds – aromatic radical substitutions reactions - decomposition of diazo compounds – phenol coupling - Sandmeyer reaction - Gomberg reaction - Pschorr reaction - Ulmann reaction and Hunsdiecker reaction.

UNIT III: Aliphatic Nucleophilic and Electrophilic Substitutions **12 hrs**

Substitution at saturated reaction center (carbon). S_N1,S_N2,S_{Ni} mechanisms – Reactivity, structural and solvent effects. Neighbouring group participation – substitution in Norbornyl and bridgehead systems – Substitution at carbon doubly bonded to oxygen. Alkylation and acylation of active methylene compounds, hydrolysis of esters. SE_1, SE_2, SE_i mechanisms – reactivity. halogenation of aldehydes and ketones and decarboxylation of aliphatic acids, Hell-Volhard-Zelinsky reaction, Stork – enamine reaction.

UNIT IV: Aromaticity **12hrs**

Aromaticity of benzenoid - non-benzenoid, and heterocyclic compounds - Huckel's rule -Aromatic systems with π electron numbers other than six - non-aromatic (cyclooctatetraene etc,) and anti-aromatic system (cyclobutadiene etc.) - system with more than 10π electrons - Annulenes upto C18 (synthesis of all these compounds is not expected).

UNIT V: Aromatic substitution reactions **12hrs**

Electrophilic substitution reactions: The arenium ion mechanism – Orientation and reactivity – typical reactions – nitration, halogenation, alkylation, acylation and diazonium coupling. Reimer- Tiemann, Vilsmeyer- Hack, Gattermann, Kolbe reactions. Electrophilic substitution of furan, pyrrole, thiophene and pyridine- N-oxide. Nucleophilic substitution reactions: Aromatic Nucleophilic Substitution by S_N1 mechanism through Meisenheimer complex and by Elimination - Addition mechanism. Methods of generation and reactions of aryne intermediate. Aromatic nucleophilic substitution of activated aryl halides, Ziegler alkylation and Chichibabin reaction.

COURSE OUTCOMES

At the end of the course, the student will be able to

1) Describe the concept of Stereochemistry
2) Compare the stabilities of various reactive intermediates.
3) Analyse and propose reasonable mechanism for Substitutions in Aliphatic molecules
4) Compare the stabilities of molecules based on aromaticity
5) Analyze the mechanisms of Aromatic Substitution reactions

Text Books

1) Eliel. E. N. (2008). Stereochemistry of Carbon Compounds, Tata McGraw Hill Ed, Reprint, Noida (UP).
2) Nasipuri. D. (2005). Stereochemistry of Organic Compounds, New Age International (P) Ltd, New Delhi.
3) Kalsi, P. S. (1993). Stereochemistry, Conformation analysis and Mechanism (2nd Edition), Chennai: Wiley Eastern Limited.
4) Clayden, J., Greeves, N., & Warren, S. (2012). Organic Chemistry (2nd Ed.). UK: Oxford University Press.
5) Norman, R. O. C. & Coxon, J. M. (2003). Principles of Organic Synthesis (3rd Ed.). London (UK): Chapman & Hall.
6) Smith, M. B. (2016). March's Advanced Organic Chemistry (7th Ed.). New York: John Wiley & Sons.
7) Carey, F. & Sundberg, R. J. (2007). Advanced Organic Chemistry (5th Ed., Part A and B.). Berlin: Springer Science + Business Media.

Supplementary Reading

1) Graham Solomons, T.W. Craig, B. Fryhle. (2011). *Organic chemistry* (10th edition.). John Wiley & Sons, Inc.
2) Pine, S. H. (1987). *Organic chemistry* (5th edition.). New York: McGraw Hill international edition chemistry series.
3) Seyhan, N. Ege. (1998). *Organic chemistry structure and reactivity* (3rd edition.). New Delhi: A.I.T.B.S.
4) Kalsi, P. S. (2007). *Organic Reactions: Stereochemistry and Mechanism through solved problems* (4th Ed.). New Delhi: New Age International (P) Ltd.

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	**3**	**2**	**3**	**3**	**2**
CO2	**2**	**2**	**3**	**3**	**3**
CO3	**3**	**2**	**2**	**3**	**3**
CO4	**2**	**3**	**3**	**3**	**3**
CO5	**2**	**2**	**3**	**3**	**2**

SEMESTER: I CORE – II	22PCHEC12: INORGANIC CHEMISTRY - I	CREDIT: 3 HOURS: 4/W

COURSE OBJECTIVES

1) To know about the structure and bonding of inorganic compounds and the inorganic polymers.
2) To study the concept of coordination chemistry and stability of the complexes
3) To gain knowledge of metal-ligand orbital overlap, molecular orbital theory and energy level diagrams etc.,
4) To learn about the mechanism of substitution reactions of octahedral complexes.
5) To acquire skill of using substitution reactions of square planar complexes and electron transfer reactions for complexes.

UNIT I: Polymeric Inorganic Compounds **12 hrs**

Chains: Isopolyacids and heteropolyacids – Structure and bonding of isopoly and 6- and 12 Heteropolyanions. **Rings:** Phosphazenes, Linear and Cyclic phosphazenes, Phosphazene Polymers. **Polymers:** Silicates – Structure and Properties – Correlation – Distinction between 2D and 3D silicates, Zeolite types and examples, Shape selectivity in zeolites, Silicones and their applications. **Cages:** Structures and classification of higher boranes, carboranes, metallocarboranes - Wade's rule – Stylx number. **Clusters:** Metal Clusters – Dinuclear, Tetranuclear and hexanuclear clusters – Cubane clusters and Zintl Clusters.

NIT II: Coordination Chemistry-I **12 hrs**

Stability of complexes, thermodynamic aspects of complex formation, factors affecting stability, HSAB approach. Determination of stability constants by spectrophotometric, polarographic and potentiomteric methods. Stereochemical aspects, stereoisomerism in inorganic complexes, isomerism arising out of ligand distribution and ligand conformation, chirality and nomenclature of chiral complexes, optical rotatory dispersion and circular dichroism. Macrocyclic ligands, types, porphyrins, corrins, Schiff bases, crown ethers and cryptates.

UNIT III: Coordination Chemistry – II **12 hrs**

Evidences for metal-ligand orbital overlap, molecular orbital theory and energy level diagrams, concept of weak and strong field ligands, Jahn-Teller distortion, charge - transfer spectra. Russell-Sander's coupling – L-S coupling and micro states – Ground state terms for d^1 – d^{10} ions – Derivation of terms for p^2, p^3, d^1 and d^2 configurations – Hund's rules in the determination of lowest energy states – Selection rules for electronic transitions – charge transfer transitions - d-d transitions, Orgel and Tanabe - Sugano diagrams, nephelauxetic effect, spectral and magnetic characteristics of transition metal complexes.

Unit – IV: Reaction Mechanism – I **12 hrs**

Substitution reactions of octahedral complexes: Labilities, inertness, stability and instability of coordination compounds- Nature of substitution reactions-Theoretical approach to substitution mechanisms-Mechanism of substitution reactions of complexes of cobalt-acid hydrolysis-base hydrolysis of cobalt (III) complexes. Racemisation and isomerisation: Twist mechanisms for isomerisation – Intramolecular mechanisms for racemisation.

Unit – V: Reaction Mechanism – II **12 hrs**

Substitution reactions of square planar complexes: Reactions of Pt (II) complexes- Trans effect- Theories of trans effect-Mechanism of substitution-kinetics of Pt (II) complexes. Electron transfer reactions-Electron Tunneling hypothesis-Marcus-Hush theory. Atoms transfer reaction-one electron and two electron transfer-inner sphere and outer sphere mechanism.

COURSE OUTCOMES

The student will be able to

1) Gain knowledge about the structure and bonding of Inorganic compounds and explain Isopolyacids and hetropolyacids of Vanadium, Chromium, Molybdenum and Tungsten.

2) Illustrates the chemistry of metal clusters and discuss polyhedral boranes, carboranes and metallocarboranes

3) Explain the stability constant of co-ordination complexes and stereo chemistry for co-ordination complexes

4) Apply the molecular orbital theory and energy level diagrams, concept of weak and strong field ligands, Jahn-Teller distortion etc.,

5) Illustrate the Substitution reactions of square planar complexes and electron transfer reactions

Text Books

1) Huheey, J. E. (1993). *Inorganic Chemistry* (IV Edition.). NY: Harper and Collins.
2) Purcell, K. F. & Kotz, J. C. (1977). *Inorganic* Chemistry. USA: WB Saunders Co.
3) Gopalan, R. (2001). *Concise Coordination Chemistry*. Vikas Publishing House.
4) Lee, J. D. (1991). *Concise Inorganic Chemistry*. US: Springer
5) Das, A. K (2016). *Fundamental Concepts of Inorganic Chemistry* (2nd edtion., Vol 1, 2 & 3). CBS publisher and Distribution Pvt. Ltd.
6) Manku, G.S. (1994) *Theoretical Principles of Inorganic Chemistry*. New Delhi: Tata McGraw Hill Publishing Company Ltd.
7) Ray, N. H. *Inorganic Polymers*. Academic Press.

Supplementary Readings

1) Cotton, F. A. & Wilkinson, G.W. (1988). Advanced Inorganic Chemistry – A comprehensive Text. John Wiley & Sons
2) Shrivers, M. C., Atkins, P.W & Langford, CH. (1990). Inorganic Chemistry. Oxford University Press.
3) Greenwood, N. N. & Earnshaw. (1984). Chemistry of the Elements. New York: Pergamon Press,
4) Kettle, S. F. A. (1973). Coordination Chemistry. ELBS.
5) Dogulas, B. E., McDaniel, D. H., & Alexander J. J. (1983). Concepts and Models of Inorganic Chemistry. Oxford IBH.
6) Figgis, B. N. (1966). Introduction to Ligand Fields. Interscience.
7) Mutterties, E.L. (1975). Polyhedral Boranes. New York: Academic Press.
8) Day, M.C. & Selbin, J. (1974). Theoretical Inorganic Chemistry. New York: Van Nostrand Co.
9) Mingos, D. M. P. & Wales, D. J. Introduction to Cluster Chemistry. Prentice Hall.

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	**3**	**2**	**3**	**2**	**3**
CO2	**2**	**2**	**3**	**2**	**3**
CO3	**3**	**2**	**3**	**3**	**2**
CO4	**2**	**3**	**2**	**3**	**2**
CO5	**2**	**3**	**3**	**2**	**2**

SEMESTER: I CORE – III	22PCHEC13: PHYSICAL CHEMISTRY –I	CREDIT:3 HOURS:4/W

COURSE OBJECTIVES

1) To understand the theories of chemical kinetics in reaction mechanisms.
2) To apply the kinetic concepts in homogenous and heterogeneous catalyzed reactions.
3) To study about Surface Chemistry, surface tension and catalysis.
4) To identify the symmetry of elements, symmetry operations and apply the fundamentals of group theory in electronic spectroscopy
5) To appreciate the principals involved in the Rotational and vibrational spectroscopic techniques.

UNIT I: Chemical Kinetics – I **12 hrs**

Theories of reaction rates and factors influencing the reaction rate: ARRT (Eyring's theory), Thermodynamic derivation of ARRT-comparison of ARRT with collision theory (A , $\Delta S^{\#}$, E_a and $\Delta H^{\#}$) – kinetic isotope effects, Marcus electron transfer theory-inner and outer electron transfer. Theory of unimolecular reactions-Lindemann's theory – Steady State approximation-chain reactions-photochemical reaction between hydrogen and halogens (Cl_2 and Br_2) – gas phase auto- oxidations, explosions-hydrogen-oxygen reaction.

UNIT II: Chemical Kinetics – II **12 hrs**

Application of ARRT to solution kinetics-effects of solvents, double sphere model, effect of ionic strength on ionic reactions – influence of pressure on reaction rates in solution-significance of volume of activation-substituent effects – Hammett and Taft equations. Homogeneous catalysis, acid-base catalysis – types and mechanism, derivation of rate law for protolytic acid catalysis and explanation for Arrhenius and van't Hoff intermediates, Bronsted relations- Hammett-Deyrup acidity function – enzyme catalysis-mechanism of single substrate reaction-Michaelis-Menton equation - Influence of pH, concentration and temperature, Line Waver plot and Eddi – Hofstee plot. Fast reactions-study of kinetics by stopped flow technique, relaxation methods, T and P- jump methods, flash photolysis and magnetic resonance method.

UNIT III: Surface Chemistry **12 hrs**

Adsorption–physisorption and chemisorptions – Langumuir, BET & Gibbs adsorption isotherms- surface area determination – Heat of adsorption, determination. Adsorption from solutions - surface films. Surface tension – effect of electrolytes, non-electrolytes and surface-active agents –micelles and reverse micelles. Solublisation, micro emulsions Heterogeneous catalysis – semiconductor catalysis, n-and p-type surfaces – kinetics of surface reactions involving adsorbed species – Langmuir - Hinshelwood mechanism. Langmuir – Rideal mechanism and Rideal - Eley mechanisms.

UNIT IV: Group Theory **12 hrs**

Group theory -symmetry of elements and symmetry of operations, point groups of molecules, properties of a group and sub-group, isomorphism, cyclic, abelian, class- similarity transformation and conjugate, matrix representation – product of symmetry operations, group multiplication tables (C_n, C_{nv} and D_{nh} only) - great orthogonality theorem and its consequences, construction of character tables ($C_{2v}$and C_{3V}). Direct products– reducible and irreducible representation - Wave function as bases for irreducible representation. Transition moment integral – spectroscopic selection rules to IR, Raman (H_2O, NH_3, trans-N_2F_2) and electronic spectroscopy (HCHO). Hybridization schemes of orbitals – (sp, sp^2 and sp^3 for ethylene and butadiene.

UNIT-V: Rotational and Vibrational Spectroscopy **12 hrs**

Basic aspects of Spectroscopy-characterization of electromagnetic radiation, quantization of energy. Microwave Spectroscopy-Rotation of molecules and selection rules, Diatomic molecules; Rigid and non-rigid rotator, Rotational constant and centrifugal distortion. Techniques and instrumentation. Vibrational spectroscopy-diatomic molecules, Harmonic and a harmonic oscillator, zero-point energy - force constant -fundamental absorption and overtones (hot bands, fermi resonance)- polyatomic molecules-techniques and instrumentation of FTIR.

COURSE OUTCOMES

At the completion of this course, the students will be able to

1) derive the rate equation from mechanistic data and calculation
2) relate microscopic properties of molecules with macroscopic thermodynamic observables
3) gain knowledge about the Surface Chemistry and its mechanisms.
4) apply group theory for molecules like water, ethylene, butadiene etc…
5) imbibe basic aspects of spectroscopy and apply to poly atomic molecule

Text Books

1) Philip Mathews. (2003). *Advanced Physical Chemistry*. New Delhi: Foundation Books.
2) Puri, R., Sharma, L.R., & Pathania, M.S. (2017). *Principles of Physical Chemistry*. Jalandar: Vishal Publishing Co.
3) Raman, K.V. (2000). *Group Theory and its Application to Chemistry*. New Delhi: Tata McGraw-Hill.
4) Aruldhas, G. (2002) *Molecular Structure and Spectroscopy*. New Delhi: Prentice Hall.

Supplementary Readings

1) Cotton, F.A. (2008). *Chemical Applications to Group Theory*. New York: John Wiley and Sons.
2) Carter, R. L (2009). *Molecular symmetry and Group Theory*. New York: John Wiley and Sons.
3) Douglas, B. E. & Hollingsworth, C.A. (2012). *Symmetry in Bonding and Spectra- an Introduction.* Academic Press
4) Silbey, R. J., & Alberty, R. A. (2006). *Physical Chemistry*. New York: John Wiley and Sons.
5) Barrow, G. M. (1964). *Introduction to Molecular Spectroscopy*. New York: McGraw-Hill.
6) Banwell, C.N. & McCash, E.M. (2000). *Fundamentals of Molecular Spectroscopy* (4th Edition.). New Delhi: Tata McGraw-Hill.
7) Raman, K.V., Gopalan, R. & Raghavan, P.S. (2004). *Molecular Spectroscopy*. Singapore: Thomson and Vijay Nicol.
8) Levine, I. N. (1974). *Molecular* Spectroscopy. New York: John Wiley and Sons.
9) Rahman, A. (1986). *Nuclear Magnetic resonance- Basic Principles*. New York: Springer-verlag.

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	**2**	**3**	**3**	**2**	**2**
CO2	**3**	**3**	**3**	**3**	**2**
CO3	**2**	**3**	**2**	**2**	**2**
CO4	**2**	**3**	**2**	**2**	**3**
CO5	**2**	**2**	**2**	**3**	**3**

SEMESTER: I CORE PRACTICAL - I	22PCHEC14: ORGANIC CHEMISTRY PRACTICAL - I	CREDIT: 3 HOURS: 6/W

COURSE OBJECTIVES

To learn to synthesise Organic molecules with the available substrates.

Any Six preparations from the following:

1) p-Nnitroacetanilide from Aniline (Acetylation and Nitration)
2) Acetylsalicylic acid from methyl salicylate (Hydrolysis and Acetylation)
3) 1,3,5-tribromo benzene from aniline (Bromination, Diazotisation and Hydrolysis)
4) p-Bromoacetanilide from aniline (Acetylation and Bromination)
5) p-Bromoaniline from acetanilide (Bromination and Hydrolysis)
6) m-Nitrobenzoic acid from methyl benzoate. (Nitration and Hydrolysis)
7) p-Nitroaniline from acetanilide (Nitration and Hydrolysis)
8) Bezanilide from benzophenone (Rearrangement)
9) m-Nitrobenzoic acid from benzaldehyde (Oxidation and Nitration)

Preparations with Green chemistry procedures:

10) Synthesis of Salicylic acid from Methyl salicylate
11) Bromination of p-Bromoacetanilide from Acetanilide using CAN and KBr.
12) Synthesis of Anisalacetophenone from Acetophenone and p-Methoxy benzaldehyde
13) Synthesis of 3,5-Dimethylpyrazole from Acetylacetone and Hydrazine hydrate.

(Students are expected to submit recrystallized sample of the final products at the time of practical examination for the evaluation by the examiner).

COURSE OUTCOMES

At the end of the course, the student will be able to

1) Acquire basic laboratory skills required to carry out organic reactions.
2) Independently perform two step organic preparations.
3) Analyse the mechanisms of reactions.
4) Gain the expertise to solve specific research problems.
5) Synthesise molecules with green chemistry procedures.

Text Books

1) Vogel, A. I., Tatchell, A. R., Furnis, B. S., Hannaford, A. J., & Smith, P.W.G. (2005). *Vogel's Textbook of Practical Organic Chemistry* (5th Ed.). Chennai: Pearson.
2) Mukherjee, A. (2019). *Organic Chemistry with Green Chemistry*. Chennai: Narosa Publishing House.

Supplementary Readings

1) Ahluwalia, V. K., Bhagat, P., & Aggarwal, R. (2005). *Laboratory Techniques in Organic Chemistry*. New Delhi: I.K. Int.
2) Gnanaprakasam, N. S., & Ramamurthy, G. (2000). *Organic Chemistry Lab Manual*. Chennai**:** S.V. Printers.

SCHEME OF VALUATION

Semester Examination	Marks (60)
Preparation	40
Viva - voce	10
Record	10
Total	60

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	2	3	3	2	3
CO2	3	3	2	2	3
CO3	3	2	2	3	2
CO4	2	2	3	3	2
CO5	3	3	3	3	2

SEMESTER: I CORE PRACTICAL – II	22PCHEC15: PHYSICAL CHEMISTRY PRACTICAL- I	CREDIT: 3 HOURS: 5/W

COURSE OBJECTIVES

To learn the operations of instruments for calculating physical parameters.

1) To impart skills in evaluation of physical parameters by various methods.
2) To adopt different methods for validation of results.

Physical Chemistry Practical-I

1) Determination of cell constant-conductometric method
2) Conductometry-Dissociation constant of weak electrolyte (verification of Ostwald's dilution law)
3) Conductometry-Verification of DHO equation – Equivalent conductance of strong electrolyte
4) Conductometric titration of HCl against NaOH.
5) Conductometric titration of CH_3COOH against NaOH.
6) Conductometric titration of NH_4OH against HCl.
7) Neutral salt effect - Kinetics of reaction between iodide and Persulphate - Effect of ionic strength on rate constant.
8) Polarimetry -Kinetics of inversion of Cane sugar.
9) Kinetics of iodination of acetone.
10) Kinetics of hydrolysis of ester - Comparison of acid strengths.
11) Determination of Arrhenius parameters - Hydrolysis of methyl acetate by acid.
12) Study of the equilibrium constant of the reaction: $KI + I_2 \leftrightarrows KI_3$.
13) Kinetics of decomposition of sodium thiosulphate using 0.5N HCl.

COURSE OUTCOMES

At the end of this course, the students will be able to

1) Interpret the experimental data of various physical parameters
2) Analyse the physical parameters quantitatively and qualitatively
3) Identify the suitable methodology to measure and characterise the physical parameters.

Text Books

1) Levitt, B.P. (1985). *Findlay`s Practical Physical Chemistry*, (9th Ed.). London: Longman
2) Gurtu, J. N., & Kapoor, R. (1987). *Advanced Experimental Chemistry* (Vol.I.). New Delhi: S. Chand & Co
3) Sundaram, Krishnan, Raghavan, (1996). *Practical Chemistry (Part II)* S. Viswanathan andCo. Pvt. Ltd.

Supplementary Readings

1) Shoemaker, D. P., Garland, C. W., & Nibler, J. W. (1989). *Experiments in Physical chemistry* (5th Edition.). McGraw- Hill Book company.

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	2	2	2	2	2
CO2	2	3	3	3	2
CO3	3	2	2	2	3
CO4	3	2	2	3	2
CO5	2	3	3	2	2

SCHEME OF EVALUATION:

UNIVERSITY EXAMINATION	Marks
Procedure	10
Manipulation	15
Result	20
Record	05
Viva voce	10
Total	60

INTERNAL ASSESSMENT	Marks
Attendance / Regularity	20
Results accuracy	20
Total	40

SEMESTER: I CORE ELECTIVE – I	22PCHEE16-1: POLYMER CHEMISTRY	CREDIT: 3 HOURS: 4/W

COURSE OBJECTIVES

1) To provide a thorough understanding of the basic concept of polymers
2) To gain knowledge about the different polymerization mechanisms
3) To learn the molecular weight determination and characterization of polymers.
4) To exploit the polymer processing techniques for various applications.
5) To study the importance of advanced polymers

UNIT I Introduction to polymer science **12 hrs**

Classification - Some basic definitions - Addition and condensation polymerizations and copolymerization -. Molecular forces in polymers - functionality- degree of polymerization- polymers tacticity -Polymerization techniques - Emulsion, bulk, suspension and solution polymerization. High-temperature inorganic polymers - Preparation, properties, structure and applications of silicone polymers.

UNIT II: Kinetics and mechanism of polymerization **12 hrs**

Polymerization - Definition - Types - Chain and step polymerization. Mechanism of ionic, radical, coordination polymerization (Ziegler-Natta catalyst), polycondensation and polyaddition polymerization. Kinetics of ionic and radical polymerization. Kinetic chain length and degree of polymerization. Copolymers - Block and graft copolymers - Kinetics of copolymerization.

UNIT III: Molecular weight and Characterization of polymers **12 hrs**

Molecular weight of polymers - Number average and weight average molecular weight of polymers. Determination of molecular weight of polymers by GPC and Viscometry methods - Thermal analysis of polymers using DSC - Crystalline melting point (Tm) - Glass transition temperature (Tg) - Measurement of Tg - Relation between Tm and Tg - Crystallinity in polymers.

UNIT IV: Polymer processing techniques **12 hrs**

Polymer additives - Fillers, plasticizers, stabilizers, colorants and anti-oxidants, lubricants - functions and examples. Compounding - Processing techniques - Calendaring, die casting, rotational casting, film casting, injection moulding, compression moulding, blow moulding, extrusion moulding, foaming, thermos-foaming, reinforcing and fiber spinning.

UNIT V: Advanced polymers **12 hrs**

Polyelectrolytes - Conducting polymers - Biodegradable polymers - Heat resistant polymers. - Polymer blends - Polymer nanocomposites. Biomedical polymers - Artificial organs - Artificial heart, kidney, skin and cells- Contact lens - Dental polymers - Polymers for controlled drug delivery. Polymers in separation - Polymeric membranes for Reverse Osmosis, Gas separation and liquid separation.

COURSE OUTCOMES

On completion of the course, students should be able to

1) Understand the basic concept of polymers and the chemistry of organic and inorganic polymers
2) Understand the kinetics and mechanism of various polymerization techniques.
3) Choose an appropriate analytical method to characterize polymers.
4) Select an appropriate moulding technique to process a particular polymer.
5) Realize the importance of advanced polymers.

Text Books

1) Billmeyer, F. W. (2010). *Text Book of Polymer Science* (3rd Ed., Unit I to IV.). New Delhi: Gurukripa Enterprises
2) Allock, H. R., Lampe F. W., & Mark J. E. (2005). *Contemporary Polymer Chemistry* (3rd Ed, Unit V.). Pearson Education.
3) Misra, G.S. (2008). *Introductory Polymer chemistry*. New Age International Pvt. Ltd.
4) Kumar. A., & Gupta, R. K. (2003). *Fundamentals of polymer engineering* (revised and expanded edition.). New Delhi: Tata McGraw Hill Publication Ltd.

Supplementary Readings

1) Gowariker, V. R., Viswanathan, N. V. and Sreedhar, J. (2014). *Polymer Science*. New Age International Publishers.
2) Fried, & Joel, R. (2000). *Polymer Science and* Technology. New Delhi: Phi Learning Pvt. Ltd.
3) Mathur G. N., (2000). *Recent Advances in Polymers and Composites*. New Delhi: Allied Publishers.
4) Sinha, R. (2002). *Outlines of Polymer Technology*. New Delhi: Phi Learning Pvt. Ltd.
5) Tager, A. (1972). *Physical Chemistry of* Polymers. MIR Publications.
6) Seymour, R. H., & Charaher, C. E., (2003). *Polymer Chemistry* (6th Ed.). Marcel Dekker Inc.
7) Stuart & Barbara. (2010). *Polymer Analysis*. New Delhi: Wiley India
8) Odian, G. (2007). *Principles of Polymerisation* (IV Edition.). New Delhi: Wiley Student Edition.
9) Arora, M. G., Singh M., & Yadav, M. S. (2003). *Polymer Chemistry* (II revised Edition.). Anmol Publications Pvt. Ltd.

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	3
CO2	3	3	2	3	2
CO3	2	3	3	2	3
CO4	2	3	3	2	2
CO5	3	2	2	3	2

SEMESTER: I CORE ELECTIVE – I	22PCHEE16-2: MATERIALS CHEMISTRY	CREDIT: 3 HOURS: 4/W

COURSE OBJECTIVES

1) To understand the basics of crystal structures and their defects.
2) To learn various crystal growth and thin-film techniques.
3) To study the diffusion and electronic properties of nanometrials
4) To gain knowledge about maganetic properties and dielectric properties of Nanomaterials.
5) To study Nanocomposites and their functional applications

UNIT I: Crystal structures 12hrs

Crystal geometry: crystal lattices, space lattices, basis and crystal structure, unit cell, lattice parameter of a unit cell - Seven crystal systems - Bravais lattices - Crystal directions and crystal planes (Miller indices) - Coordination number, radius ratio, packing factor - Some special crystal structures - Calculation of lattice constant - Crystallographic nomenclature - Determination of crystal structure by X-ray diffraction - Imperfections/defects in crystalline solids.

UNIT II: Crystal Growth and Thin film techniques 12 hrs

Solution growth method, melt growth method - Bridgeman method – Vapour deposition technique. Production of thin films: Thermal evaporation – Chemical vapour deposition – Spray pyrolysis – Spin coating method. Inert gas condensation, Arc discharge, RF- plasma, Plasma arc technique, Ion sputtering, Laser ablation, Laser pyrolysis, DC & RF Sputering, Molecular beam epitaxy (MBE).

UNIT III: Diffusion properties 12 hrs

Laws of diffusion, diffusion mechanism, ionic conductivity, relation between ionic conductivity and diffusion coefficient, experimental determination of diffusion coefficient, applications of diffusion. **Electronic Properties:** Concept of energy band diagram for materials: Conductors, semiconductors and insulators **-** Classification of semiconductors – Electronic conductivity - band gap determination - Hall effect and its determination. **Optical Properties:** Photoluminescence, Jablonski diagram, fluorescence and phosphorescence – Electroluminescence.

UNIT IV: Magnetic properties 12 hrs

Fundamentals of magnetism - Different kinds of magnetism: dia, para, ferro, ferri and anti-ferromagnetic materials - Magnetic hysteresis – Classification of magnetic materials: hard and soft magnetic materials –Super paramagnetism. **Dielectric Properties:** Effect of particles on dielectric properties, Ferro-electrics, piezo-electric, pyro-electric and muti-ferroics. **Mechanical behavior:** Stress-strain behavior, tensile strength, toughness, microhardness, wear resistance of solids materials; **Thermal properties:** Heat capacity of solids, thermal conductivity and thermal expansion of solids.

UNIT-V:Nanocomposites **12 hrs**

Introduction to Nanocomposites, Types of Nanocomposites - Methods for producing Nanocomposites – Properties of Nanocomposites. **Polymer Nanocomposites:** Polymer/ Metal oxide nanocomposites - Polymer/CNTs nanocomposites - Polymer/Nanoclay-based Nanocomposites and their properties and functional applications. **Other Kinds of Nanocomposites: Fractal based** Glass- metal nanocomposites - Core-shell structured nanocomposites - Super hard nanocomposites and its designing and improvements in mechanical properties - Self-cleaning nanocomposites - Metal matrix nanocomposites and their mechanical & corrosion resistance properties and functional applications.

COURSE OUTCOME

On completion of the course the student will be able to

1) Understand the basics of crystal structures and their defects.
2) Understand the different types of crystal growth and thin film technique.
3) Describe the diffusion properties, electronic and optical properties of nanomaterials.
4) Describe various physical properties of solid/Nano- Materials.
5) identify various types of nano composites

Text Books

1) Vijaya, M. S., Rangarajan, G. *Materials Science*. New Delhi: Tata McGraw-Hill publishing company Ltd.,
2) Ragavan V., *Materials Science and Engineering*. New Delhi: Prentice-Hall of India(P) Ltd.
3) Elliott S. R. (1998). *The Physics and Chemistry of Solids* John. England: Wiley & Sons.
4) Mathur, S., & Singh, M. (2008). *Nanostructured Materials and Nanotechnology* (II Eds.). Willey.
5) Tilley, Richard J. D., (2004). *Understanding Solids: The Science of Materials*. John Wiley & Sons.
6) Koch, C. C. (2002). *Nanostructured Materials*. New York: Noyes Publications.
7) Pinnayain, T. J., & Beall, G.W. (2001). *Polymer-Clay Nanocomposites*. New York: Wiley
8) Chung, D. D. L. (2002). *Composite Material*. Springer.

Supplementary Readings

1) Gersten, J. I., Smith, F. W., & Elliott, S. R. (1998). *The Physics and Chemistry of Materials*. New York: John Wiley & Sons.
2) Newnham, R. E. (2005). *Properties of Materials*. Oxford University Press.
3) Meyappan, M. (2005). *Carbon Nanotubes Science and* Applications. CRC Press.
4) Kittel, C. (2004). *Introduction to solid state physics*. New Delhi: Wiley India Pvt. Ltd.

5) Chattopadhyay, K. K., & Banerjee, A. N. (2014). *Introduction to Nanoscience and Nanotechnology*. New Delhi: PHI Learning Private Ltd.

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	**3**	**3**	**2**	**2**	**3**
CO2	**3**	**2**	**2**	**3**	**2**
CO3	**2**	**2**	**3**	**2**	**3**
CO4	**3**	**3**	**3**	**3**	**2**
CO5	**3**	**2**	**3**	**3**	**3**

SEMESTER: I CORE ELECTIVE – I	22PCHEE16-3: PHARMACEUTICAL CHEMISTRY	CREDIT: 3 HOURS: 4/W

COURSE OBJECTIVES

Enable the student to

1) Learn about the drugs and drug targets
2) Observe the mechanism of action of drugs and apply it for the drug design and discovery
3) Understand the pharmacokinetic and pharmacodynamic parameters in the drug development process
4) Gain knowledge about antineoplastic agents
5) Acquire the skill of using cardiovascular drugs for further studies.

Unit I: Drugs and drug targets: An overview **12 hrs**

Definition of drugs, Classification of drugs, Drug targets- cell structure, at molecular level, Intermolecular boding forces- Electrostatic ionic forces, hydrogen bonds, Dipole dipole and ion dipole interactions, repulsive interactions , the role of water and hydrophobic interactions, Pharmacokinetic issues and medicine.

Unit II: Drug discovery, Design and Development **12 hrs**

Roots of administration of drugs, biotransformation, mechanism of action. Factors prolonging action, excretion & toxicity. Development of new drugs, procedures followed in drug design, concepts of lead compound & lead modification, concepts of prodrugs & soft drugs, Structure Activity Relationship (SAR), factors affecting bioactivity, resonance, inductive effects, isosterism, bio isosterism, and spatial considerations. Theories of drug activity: Occupancy Theory, Rate Theory, induced fit theory. Quantitative Structure Activity Relationship (QSAR) - History & development. Concepts of drug receptors. Elementary treatment of drug receptor interactions.

Unit III: Pharmacokinetics **12 hrs**

Introduction to drug absorption, disposition, elimination using pharmacokinetics, important pharmacokinetic parameters in defining drug disposition & in therapeutics. Uses of pharmacokinetics in drug development process. Pharmacodynamics: Introduction, elementary treatment of enzyme stimulation, enzyme inhibition, sulphonamides, membrane active drugs, drug metabolism, xenobiotics, biotransformation, significance of drug metabolism in medicinal chemistry.

Unit IV: Antineoplastic Agents **12 hrs**

Introduction, classification, cancer chemotherapy, special problems, role of alkylating agents & anti metabolites in treatment of cancer. Carcinolytic antibiotics & mitotic inhibitors. Synthesis of mechlorethamine, cyclophosphamide, melphalan, uracil, mustards & 6-mercaptopurine. Recent developments in cancer chemotherapy. Hormone & Natural products.

Unit V: Cardiovascular Drugs **12hrs**

Introduction - classification of cardiac glycosides, antiarrhythmic drugs, therapeutic uses. Antihypertensive agents, Vasopressor Drugs – Mechanism of Action. Synthesis of verapamil, methyldopa.

COURSE OUTCOMES

1) Identify and extend the applications of drugs and drug target.
2) Explain the mechanism of action drug and analyze theories of drug activity.
3) Interpret pharmacokinetic parameters and appraise the significance of drug metabolism in medicinal chemistry.
4) Classify the antineoplastic agents and integrate the synthesis of drugs to cancer therapy
5) Classify and predict the mechanism of action of cardiovascular drugs.

Text Books

1) Kar, A. (2007). *Medicinal Chemistry* (4th Edn.). New Age International.
2) Satoskar, R. S & Bharkar S. D. (2015). *Pharmacology and Pharmatherapeutics* (24th Edn.). Popular Prakasan.

Supplementary Readings

1) Patrick, G. L. (2009). *An Introduction to Medicinal Chemistry* (4th Edn.). Oxford University Press.
2) Sriram, D & Yogeeswari, P. (2010). *Medicinal Chemistry* (2nd Edn.) Pearson Education.

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	2	3	3	2	2
CO2	2	2	3	2	3
CO3	3	2	2	3	3
CO4	2	3	2	2	2
CO5	2	3	3	3	2

SEMESTER: I OPEN ELECTIVE – I	22PCHEO17-1: FOOD CHEMISTRY	CREDIT: 3 HOURS: 3/W

COURSE OBJECTIVES

1) To understand the principles of food fermentation technology.
2) To study about packaged drinking water.
3) To study importance of beverages and its types.
4) To study about food adulteration
5) To understand about food preservation and packaging.

UNIT-I: Fermented Foods **5 hrs**

Fermentation-Definition, types of fermentation-Fermented foods sauerkraut, cucumber pickles, olive pickles-Oriental fermented foods–soy sauce, tofu-Traditional fermented foods–idli, dosa, etc., fermented meat and milk products.

UNIT-II: Packaged drinking water **10 hrs**

Packaged drinking water-definition types- manufacturing processes of raw and processed water - Quality evaluation of raw and processed water - methods of water treatment-BIS quality standards (for bottled water; mineral water, natural spring water).

UNIT-III: Beverages and its types **10 hrs**

Beverages: Types-Definitions-Types-Manufacturing process and technology-Note on Specialty beverages based on tea coffee- dairy based beverages-Synthetic Beverages–technology of carbonated beverages-Low-calorie and dry beverages-Isotonic and sports drinks-Role of various ingredients of soft drinks-Carbonation of soft drinks.

UNIT-IV: Food adulteration and food poisoning **10 hrs**

Food adulteration - Sources of foods, types, advantages and disadvantages, constituents of foods, carbohydrate, protein, fats and, oils, flavour colour, natural toxicants. Food poisoning -Sources, causes and remedy-Causes and remedies for acidity, gastritis indigestion and constipation.

UNIT-V: Food preservation and processing **10 hrs**

Food Spoilage-definition–Prevention-Food Preservatives-definition-classification- food preservation- Methods of preservation - classification – Low and high temperature -preservatives processing by heating-sterilization, pasteurization - Food Additives-Definition–classification- and their functions.

COURSE OUTCOMES

1) Students will be able to acquire knowledge of fermented food.
2) Acquire knowledge about packaged drinking water.
3) Illustrate the importance of beverages and its types.
4) Acquire knowledge about food adulteration.
5) Illustrate the importance of food preservative

Text Books

1) Sri Lakshmi, B. (2005). *Food Science* (3rd ed.). New Age International Publishers.
2) Meyer, L. H. (2004). *Food Chemistry*. BS Publishers & Distributors.
3) Fox, B. A., & Cameron, A. G. (1995). *Food Science*. London: Nutrition and Health - Edward Arnold.
4) Ramani, A. V. (2021). *Food Chemistry* (1st ed.). MJP Publishers.

Supplementary Readings

1) Sumathi, M. R., & Rajagopal, M. V. *Fundamentals of Foods and Nutrition*. Madras: Wiley Eastern Ltd.
2) Swaminathan, M. *Hand book of Food and Nutrition*. Bangalore: Bangalore Printing and Publishing Co. Ltd.

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	2	2	3	3	3
CO2	3	2	3	3	2
CO3	2	3	2	3	3
CO4	2	2	3	2	2
CO5	3	3	3	2	3

SEMESTER: I Open Elective – I	22PCHEO17-2: INDUSTRIAL CHEMISTRY	CREDIT: 3 HOURS: 3/W

COURSE OBJECTIVES

To understand the

1) To gain knowledge about the principles of industrial fuels.
2) To understand the importance of leather and water industry.
3) To study about small scale industries.
4) To learn the importance of cement and glass industries.
5) To understand the principles of sugar and paper industry.

Unit-I: Industrial fuels **10hrs**

Sources: non-renewable-classification of fuels – solid liquid and gaseous Calorific values of fuels and its determination. Solid fuels: coal-types, properties and uses-lignite-and anthracite-definition and uses. Liquid fuels: Refining of crude petroleum and uses of fractions-Cracking- Octane number. Gaseous fuels: Natural gas and gobar gas – production – composition and uses.

Unit-II: Leather Industry and Water Industry **10hrs**

Leather Industry: Curing-preservation and tanning of hides and skins- Process of dehairing and dyeing - Treatment of tannery effluents. Water Industry: Pollution of water by fertilizers, pesticides and industrial wastes -BOD-COD-thermal pollution. Reverse osmosis- softening of hard water.

Unit-III: Small Scale Chemical Industries **5hrs**

Electro thermal and electrochemical industries: electroplating - surface coating industries - oils, fats and waxes. Match industries and fireworks manufacture of some industrially important chemicals like potassium chlorate- and red phosphorus.

Unit-IV: Cement, Ceramics, Glass **10hrs**

Cement: Manufacture - Wet Process and Dry process. Types- Analysis of major constituents- setting of cement- reinforced concrete. Cement industries in India. Ceramics: Important clays – glazing and verification. Glass: Types, Composition, manufacture of Optical glass, colored glasses, lead glass and neutron absorbing glass.

Unit-V: Sugar and Paper industry **10hrs**

Sugar industry: Double sulphitation process, refining, and grading of sugar. Saccharin: synthesis and uses as a sugar substitute. Ethanol: manufacture from molasses by fermentation. Sugar industries in India. Paper industry: Manufacture of paper: production of sulphite pulp and conversion to paper (bleaching, filling, sizing and calendaring).

COURSE OUTCOMES

1) Students will be able to acquire knowledge of industrial fuels.
2) Illustrate the importance of leather and water industries.
3) Acquire knowledge about small scale industries.
4) Acquire knowledge about cement industries.
5) Acquire knowledge about sugar and paper industries.

Text Books

1) Biswas, A. K. (1989). *Frontiers in Applied Chemistry*. Narosa publishing house.
2) Vermain, O. P & Narula, A. C. (2014). A*pplied chemistry theory and books.* National Publishers.

Supplimentary Readings

1) Shreve, R. N., & Brink, J. A. (1977). *Chemical Process Industries* (4th edn.). Tokyo: McGraw Hill.
2) Chakrabarty, N. (1981). *Industrial Chemistry.* New Delhi: Oxford & Publishing Co.
3) Singh, P. P., Joseph, T. M., & Dhavale, R. G. (1983). *College Industrial Chemistry* (4^{th} edn.). Bombay: Himalaya Publishing House.

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	2	3	2	2	2
CO2	3	3	2	3	2
CO3	3	2	3	2	3
CO4	2	3	2	3	2
CO5	3	2	2	3	2

SEMESTER: I OPEN ELECTIVE – I	22PCHEO17-3: MEDICINAL CHEMISTRY	CREDIT: 3 HOURS: 3/W

COURSE OBJECTIVES

1) Make the students learn the concept of medicinal chemistry
2) To understand the various sources and classification of drugs
3) To learn the importance of Chemotherapy
4) To study about the common body ailments
5) To understand about health promoting drugs.

UNIT-I: Introduction **10hrs**

Common Diseases & their treatments: Insect borne diseases: Malaria, Filarisis & Plague. Air Borne diseases: Diphtheria, Whooping cough, Influenza, Measles mumps, Tuberculosis, Water borne diseases: Cholera, Typhoid & Dysentery. Common disease of the digestive system- jaundice, respiratory system- asthma, nervous system- epilepsy. Some other common diseases- piles, leprosy. First aid for accidents. Common poisons & their antidotes - acid poisoning, alkali poisoning, Poisoning by disinfectants hallucinogens.

UNIT-II: Drugs **10hrs**

The nature and source of drugs, pharmacologically active principles in plants. The terms- Drugs, pharmacology, pharmacognosy, pharmacy, Therapeutics, Toxicology, chemotherapy, pharmacopoeia, first aid –Important rules of first aid - Cuts, Abrasions and Bruises, Fractures, bleeding for blood, maintain breathing. Burns and fainting. First aid box.

UNIT-III: Chemotherapy **10 hrs**

Drugs based on physiological action, definition and two examples each of anesthetics- General and local – analgesics – narcotic and synthetic –Antipyretics and anti-inflammatory agents– antibiotics – Penicillin, Streptomycin, Chloroamphenicol, Antiviral, AIDS – symptoms, prevention, treatment – Cancer (Structure not required).

UNIT-IV: Common body ailments **5hrs**

Diabetes – Causes, hyper and hypoglycemic drugs – Blood pressure – Systolic & Diastolic Hypertensive drugs–Cardio vascular drugs–depressants and stimulants –Lipid 128 profile–HDL, LDL cholesterol lipid lowering drugs. (Structure not required).

UNIT-V: Health promoting drugs **10hrs**

Vitamins A, B, C, D, E and K micronutrients – Na, K, Ca, Cu, Zn and I, Medicinally important in organic compounds of, P, As, Hg and Fe, Examples and applications, Agents for kidney function (Aminohippuric acid). Agents for liver function (Sulfobromophthaein), antioxidants, treatment of ulcer and skin diseases. (Structure not required).

COURSE OUTCOMES

1) Appreciate the importance of medicinal chemistry.
2) Acquire knowledge of classification of drugs.
3) Identify the importance of Chemotherapy.
4) Acquire knowledge of common body ailments.
5) Illustrate the importance of health promoting drugs.

Text Books

1) Ghosh, J. (2014). *Text Book of Pharmaceutical Chemistry* (5th ed.). New Delhi: S. Chand and Company Ltd.
2) Lakshmi, S. (2010). *Pharmaceutical Chemistry* (1sted.). New Delhi: S. Chand and Company Ltd.

Supplementary Readings

1) Kar, A. (1993). *Medicinal Chemistry*. New Delhi: Wiley Eastern Ltd.
2) William, D., & Foyes, T. L. (2013) *Principles of Medicinal Chemistry*. BI Publishers.
3) Nogrady, T., & Weaver, D. F. (2005) *Medicinal Chemistry* (3rd edn.). Oxford University Press

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	2	3	2	3	2
CO2	3	3	2	2	2
CO3	2	3	3	2	3
CO4	2	2	2	2	2
CO5	3	3	2	2	2

SEMESTER: II CORE: IV	22PCHEC21: ORGANIC CHEMISTRY – II	CREDIT: 3 HOURS: 4/W

COURSE OBJECTIVES

1) To learn about the conformations and reactivity of the substituted six membered ring systems
2) To understand the mechanisms of addition and elimination reactions.
3) To learn the name reactions with their mechanisms
4) To learn the synthetic utilities of various oxidation and reduction reactions.
5) To acquire knowledge on the various concepts of reaction kinetics and the HSAB principle.

UNIT I: Stereochemistry– II (Conformational Analysis) 12 hrs

Conformations of some simple 1,2 – disubstituted ethane derivatives - Gauche effect. Conformational analysis of disubstituted cyclohexane and their stereochemical features (geometrical and optical isomerism (if shown) by these derivatives). Conformation and reactivity of substituted cyclohexanol (oxidation and acylation), cyclohexanone (reduction) and cyclohexane carboxylic acid derivatives (esterification and hydrolysis). Conformation and stereochemistry of cis and trans-decalin and 9 - methyldecalin.

UNIT II: Addition Reactions 12hrs

Electrophilic, nucleophilic and free radical mechanisms of addition to carbon-carbon multiple bonds – isolated and conjugated multiple bonds. Hydration, hydroxylation, hydroboration. Stereochemical aspects to be studied wherever applicable. Nucleophilic addition reactions of carbonyl compounds: Perkin, Stobbe, Claisen, Dieckmann, Benzoin condensation. Mannich, Reformatsky, Grignard and Robinson Annulation.

UNIT III: Elimination Reactions 12hrs

E1, E2 and E1cB mechanism - E1, E2 and E1cB spectrum - Orientation of the double bond - Hofmann and Saytzeff rules - Bredt's rule. Competition between elimination and substitution. Typical elimination reactions- dehydration, dehydro halogenation and dehalogenation. Stereochemistry of E2 eliminations in cyclohexane systems. Mechanism of pyrolytic eliminations. Chugaev and Cope eliminations.

UNIT IV: Oxidation and Reduction 12hrs

Mechanism – study of the following oxidation reactions–oxidation of alcohols-use of DMSO in combination with DCC and acetic anhydride in oxidising alcohols - oxidation of methylene to carbonyl, oxidation of aryl methanes – Etard reaction – Formation of C = C bonds by dehydrogenation, dehydrogenation by Quinones, $Hg(OAc)_2$ and $Pb(OAc)_4$. Allylic oxidation-SeO_2, Birch reduction, MPV reduction. Catalytic hydrogenation and Sommelet reaction. Selectivity in reduction of 4-t-

butylcyclohexanone using selecterides. Reduction with $LiAlH_4$, $NaBH_4$, tri tertiary butoxy aluminium hydride, Sodium cyanoborohydride and trialkyl tin hydride.

UNIT V: Quantitative Treatment of Organic Reactions **12 hrs**

Acids and Bases, HSAB, the equilibrium constant, thermodynamic and kinetic control of organic reactions. Hammond postulate, Curtin – Hammett principle. Hammett equation – Application to organic reactions. Methods of determining reaction mechanism –non-kinetic methods- Product of the presence of intermediates-isolation, detection, trapping; cross-over experiments, isotopic labelling and isotope effects, stereo chemical evidences. Kinetic methods - the relation of the rate with the mechanism of the reaction.

COURSE OUTCOMES

At the end of the course the student will be able to,

1) Compare the stability and reactivity of different conformers of Cyclohexane derivatives
2) Solve problems based on additions to Carbon – Carbon and Carbon – Hetero atom multiple bonds.
3) Propose mechanisms and predict the products with proper stereochemistry for various elimination reactions.
4) Have a thorough knowledge of using proper reagents for specific Oxidation and Reduction reactions.
5) Apply HSAB principle to Organic reactions and have sufficient knowledge on reaction kinetics and mechanism.

Text Books

1) Clayden, J., Greeves, N., & Warren, S., (2012). *Organic Chemistry* (2nd Ed.). UK: Oxford University Press.
2) Smith, M. B. (2016). *March's Advanced Organic Chemistry* (7th Ed.). New York: John Wiley & Sons.
3) Norman, R. O. C., & Coxon, J. M. (2003). *Principles of Organic Synthesis* (3rd Ed.). London (UK): Chapman & Hall.
4) Carey, F., & Sundberg, R. J. (2007). *Advanced Organic Chemistry* (5th Ed., Part A & B.). Berlin: Springer Science + Business Media.
5) Sykes, P. (2006). *A Guide book to mechanism in organic chemistry*. Pearson Edition.

Supplementary Readings

1) Solomons, T. W. G., & Fryhle, C. B. (2011), *Organic chemistry* (10th edition.). John Wiley & Sons, Inc.
2) Ingold, C. K. (1994). *Structure and Mechanism in Organic Chemistry* (2nd Ed.). New Delhi: CBS Pub.
3) Bansal, R. K. (1980) *Organic Reaction Mechanism* (2nd ed.). McGraw Hill Education India Pvt Ltd.

4) Mukherji, S. M., & Singh, S. P. (2016). *Reaction Mechanism in Organic Chemistry* (Revised Ed.). New Delhi: Trinity Press.
5) Ahluwalia, V. K., (2012). *Oxidation in Organic Synthesis* (1st Ed.). Florida: CRC Press.
6) Ahluwalia, V. K. (2012). *Reduction in Organic Synthesis* (1st Ed.). Florida: CRC Press.
7) Bruise, P. Y. (2002). *Organic Chemistry* (3rd edition). New Delhi: Pearson education.

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	**3**	**2**	**3**	**2**	**3**
CO2	**2**	**3**	**2**	**3**	**3**
CO3	**3**	**3**	**2**	**2**	**3**
CO4	**2**	**2**	**3**	**3**	**2**
CO5	**3**	**2**	**2**	**3**	**2**

SEMESTER: II CORE: V	22PCHEC22: INORGANIC CHEMISTRY – II	CREDIT: 3 HOURS: 4/W

COURSE OBJECTIVE

1) To make the students knowledgeable in solid state chemistry.
2) To study about stellar energy, nuclear reactions etc and to equip the students for their future career in nuclear industry.
3) To learn the chemistry of lanthanides and actinides
4) To understand the inorganic photochemistry.
5) To gain knowledge about the bioinorganic complexes.

UNIT I: Solid State Structures and Structural Defects **12hrs**

Ionic bonding, Lattice energy, born equation and its derivation, Limiting radius ratio rules, Radius ratio for trigonal, tetrahedral, octahedral and cubic sites. Structures of some ionic crystals (sodium chloride, caesium chloride, rutile, wurtzite, fluorite). Crystal defects: Stoichiometric defects-Schottky and Frenkel defects – colour centres in alkali halide crystals – Non stoichiometric defects- metal excess and metal deficiency defects – extended defects – line and plane defects.

UNIT II:Nuclear Chemistry **12 hrs**

Nuclear properties: nuclear spin and moments, origin of nuclear forces, nuclear models: liquid drop model and nuclear shell model. Modes of radioactive decay: Orbital electron capture, nuclear isomerism, internal conversion. Detection and determination of activity by cloud chamber, nuclear emulsion, bubble chamber, Geiger-Muller, scintillation and Cherenkov counters. Nuclear reactions: Types, cross section, compound nucleus theory, high energy nuclear, direct nuclear, photonuclear and thermonuclear reactions. Stellar energy: synthesis of elements, hydrogen burning, carbon burning. Nuclear reactors: fast breeder reactors, particle accelerators, linear accelerators, cyclotron and synchrotron. Radio analytical methods: Isotope dilution analysis, radiometric titrations, radio immuno assay. Neutron activation analysis.

UNIT III: Chemistry of Lanthanides and Actinides **12 hrs**

General characteristics of lanthanides-Electronic configuration-Oxidation state - Lanthanide contraction-Lanthanide contraction and its consequences-Term symbols for Lanthanide ions (Derivation not required)-Factors that mitigate against the formation of lanthanide complexes-Electronic spectra and magnetic properties of lanthanide complexes- Lanthanide complexes as shift reagents-Difference between 4f and 5f orbitals-Comparative account of coordination chemistry of lanthanides and actinides with special reference to electronic spectra and magnetic properties.

UNIT IV: Photo Inorganic Chemistry **12 hrs**

Excited states of metal complexes-Energy transfer under conditions of weak interaction and strong interaction-exciplex formation. Conditions of the excited states to be useful as redox reactants-photosubstitution, photooxidation and photoreduction- Photochemical reactions involving Ruthenium (II) bipyridyl complex. Application to photovoltaics-water photolysis- carbondioxide reduction.

UNIT V: Bio-inorganic Chemistry **12hrs**

Porphyrin ring system – Metalloporphyrins – hemoglobin and myoglobin – structures and work functions – synthetic oxygen carries – cytochromes – structure and work function in respiration – chlorophyll – structure – photosynthetic sequence – iron-sulphur proteins (non-heme iron protein) – Copper containing proteins – classification – blue copper proteins – structure of blue copper electron transferases – copper proteins as oxidases – Cytochrome.

COURSE OUTCOME

At the end of the course students will be able to

1) Explain the solid-state structures and structural defects
2) Explain the nuclear models, Categorize the nuclear reactions, radio analytical techniqus.
3) Describe chemistry of lanthanides and actinides.
4) Analyze and interpret the photo inorganic chemistry reactions.
5) Describe the chemistry of bioinorganic complexes.

Text Books

1) West, A. R. (1991). Basic solid-state chemistry. John Wiley.
2) Mallik, W. U., Tuli, G. D., & Madan, R. D. (1992). Selected topics in Inorganic Chemistry. New Delhi: S. Chand and Co.
3) Glasstone, S. (1969). Source Book on Atomic Energy, Van Nostrand Co.
4) Arnikar, H. J. (2005). Essentials of nuclear chemistry. New Age International (P) Ltd.
5) Lee, J. D. (1991) Concise Inorganic Chemistry. US: Springer.
6) Pradeep, T. (2007). Nano: The essentials. McGrew Hill Education.
7) Adamson. (1975). Concept of Inorganic Photochemistry. New York: Wiley.
8) Huheey, J. E. (1993). Inorganic Chemistry (5th Edn.). Harper International.
9) Purcell, M. F., & Kotz, C. (1977). Inorganic Chemistry. Saunder.
10) Gopalan, R. (2001). Concise Coordination Chemistry. Vikas Publishing House.

Supplementary Readings

1) Frielander, G., Kennedy, J. W., & Miller, J. M. (1981). *Nuclear and Radiochemistry*. John Wiley and Sons.
2) Cotton, F. A. & Wilkinson, G. W. (1988). *Advanced Inorganic Chemistry – A comprehensive Text*. John Wiley and Sons

3) Shrivers, M. C., Atkins, P. W., & Langford, C. H. (1990). *Inorganic Chemistry*. Oxford University Press.
4) Greenwood, N. N., & Earnshaw. (1984). *Chemistry of the Elements*. New York: Pergamon Press.
5) Mathur, N. (2010). *Nanochemistry*. RBSA publishers.
6) Sergeev, G. B. (2007). *Nanochemistry*. Elsevier Science and Technology.

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	2	2	2	2	2
CO2	2	3	2	2	3
CO3	3	2	3	3	2
CO4	3	2	2	2	2
CO5	2	2	3	3	3

SEMESTER: II CORE: VI	22PCHEC23: PHYSICAL CHEMISTRY - II	CREDIT: 3 HOURS: 4/W

COURSE OBJECTIVES

1) To know the foundations and the physical and mathematical basis of quantum mechanics and to apply the concepts of quantum mechanics to solve problems in microscopic systems.
2) To understand the quantum mechanical approach to the atomic and molecular electronic structure and to know the limitations of quantum chemistry in the evaluation of macroscopic properties
3) To know the mechanisms of photo chemical reaction
4) To know the construction of phase diagram for one, Two and three component systems
5) To understand the catalysis of reactions.

UNIT I: Quantum Chemistry-I **12 hrs**

Mathematical concepts for quantum mechanics – differentiation formula for uv, u/v, (u+v), sinx, cosx, and e^x only – partial differentiation – Euler‟s reciprocal relation, chain rule (statement only) – Integration methods .Inadequacy of classical mechanics-wave particle dualism – deBroglie‟s equation – Uncertainty principle – postulates of quantum mechanics -significance of ψ and ψ^2 ; Schrodinger time independent wave equation-Eigen functions and Eigen values - Operators and their properties – linear and Hermitian, angular momentum operators-commutation relations.- orthogonalization and normalization. Applications of wave mechanics to simple systems – Particle in a box - one and three Dimension, Rigid Rotator-Harmonic oscillator - zero-point energy-Hydrogen atom- shapes and nodal properties of orbitals- Bohr‟s correspondence principle.

UNIT II: Quantum Chemistry – II **12 hrs**

Approximation methods – Variation method-application to one dimensional box, H_2, H_2^+ and Helium atom -Perturbation method - application to one dimensional box and Helium atom- Born Oppenheimer Approximation-Hartree method and Hartree Fock Self-consistent Field method – many electron atoms-Pauli's principle and Slater determinant. LCAO- MO treatment of hydrogen molecular ion and H_2-VB treatment of hydrogen molecule - hybridization of orbitals in BeF_2, BF_3, CH_4. Huckel pi-electron theory and its applications to ethylene, butadiene, benzene and allyl system.

UNIT III: Photochemistry **12 hrs**

Differences between photochemical and thermal reactions-Quantum yield-Photophysical processes in electronically excited molecules – Jablonski diagram-energy transfer processes – Radiative and Non-Radiative transitions – Fluorescence-relation to structure- Phosphorescence- conditions for Phosphorescence emission (spin-orbit coupling)- Photosensitization – Stern - Volmer equation derivation for

quenching of luminescence and quenching of chemical reaction and its applications- Chemiluminescence.

UNIT IV: Phase Equilibrium **12 hrs**

Phase diagrams for ternary mixtures-Phase rule-methods of reading and rules relating to triangular diagrams-three component system having a pair of partially miscible system-acetic acid-chloroform and water system- three component system having two pairs of partially miscible system-Water-phenol and aniline system-three component system having three pairs of partially miscible system-succinic nitrile-water-ether system- recent applications of ternary phase diagrams in pharmaceuticals.

UNIT-V: Catalysis **12 hrs**

Acid - Base catalysis - mechanism of acid - base catalyzed reactions - Bronsted catalysis law. Catalysis by enzymes - Kinetics of enzyme catalyzed reaction - Michaelis - Menten equation and its interpretation. Effect of substrate concentration, pH and temperature on enzyme catalyzed reactions - inhibition of enzyme catalyzed reactions - Competitive, Non-competitive and Uncompetitive inhibition.

COURSE OUTCOMES

At the completion of this course, the students will be able to

1) Identify the application of quantum chemistry in MO and VB theories and construct hybridizationschemes.
2) Derive the equation for one dimensional and two-dimensional boxes.
3) Identify the photo chemical reactions
4) Construct the phase diagram for the Three components system.
5) Illustrate the use of catalysis in reactions.

Text Books

1) Chandra, A. K. (2017). *Introductory Quantum Chemistry*. New Delhi: Tata McGraw-Hill.
2) Raman, K.V. (2000). *Group Theory and its Application to Chemistry*. New Delhi: Tata McGraw-Hill.
3) Aruldhas, G.(2002).*Molecular Structure and Spectroscopy*. New Delhi: Prentice Hall.
4) West, D., & Saunders, N. (2017). *Ternary phase diagrams in materials science* (3rd ed.). CRC press.
5) Singh, D., Deshwal, B., & Vats, S. (2007). *Comprehensive engineering chemistry*.
6) New Delhi: I K International Publishing House.
7) Bahl, B., Bhal, A., & Tuli, G. (2008). *Essentials of physical chemistry*. New Delhi: S. Chand & Company Ltd.

Supplementary Readings

1) Mcquarrie, D. A. (2016). *Quantum Chemistry*. University Science Books.
2) Levine, I. N. (2016). *Quantum Chemistry*. Prentice Hall.
3) Prasad, R.K.(2010).*Quantum Chemistry*. New Delhi: New Age international (P) Ltd.
4) Sen, B. K. (1992). *Quantum Chemistry*. New Delhi: Tata McGraw-Hill.
5) Raman, K.V., Gopalan, R., & Raghavan, P. S. (2004). *Molecular Spectroscopy*. Singapore: Thomson and Vijay Nicol.
6) Levine, I. N. (1974). *Molecular Spectroscopy*. New York: John Wiley and Sons.
7) Rahman, A. (1986). *Nuclear Magnetic resonance- Basic Principles*. New York: Springer-verlag.
8) Kuriakose, J. C., & Rajaram, J. C.(1999). *Thermodynamics*. Jalandar Shoban Lal Co.
9) Silbey, R. J., & Alberty, A. (2006). *Physical Chemistry*. New York: John Wiley and Sons.

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	**3**	**2**	**2**	**2**	**2**
CO2	**3**	**3**	**2**	**2**	**3**
CO3	**2**	**3**	**3**	**3**	**2**
CO4	**2**	**3**	**2**	**2**	**3**
CO5	**2**	**3**	**2**	**3**	**2**

SEMESTER: II CORE:IV PRACTICAL: III	22PCHEC24: ORGANIC CHEMISTRY PRACTICAL - III	CREDIT: 3 HOURS: 6/W

COURSE OBJECTIVES

1) To learn the methods of separating the components of an organic mixture
2) To analyse the organic compounds based on the organic analysis.
3) To identify the whether the compound is saturated or unsaturated and aliphatic or aromatic.
4) Confirm the particular functional group by confirmatory test.
5) To prepare the derivate of that particular functional group.

QUALITATIVE ORGANIC ANALYSIS

Analysis of two component mixture. Separation and systematic analysis of the separated two individual components. Preparation of their derivatives. Determination of b.p. / m.p. for components and m.p. for the derivatives.

COURSE OUTCOMES

At the end of the course, the student will be able to,

1) Gain expertise in separating the components of an organic mixture.
2) Acquire the necessary practical skills to independently analyse organic compounds.
3) Systematically evaluate organic compounds.
4) Apply the knowledge in analysing new samples.
5) Apply the knowledge in synthesizing new molecules

Text Books

1) Vogel, A. I., Tatchell, A. R., Furnis, B. S., Hannaford, A. J., and Smith, P.W.G. (2005). *Vogel's Textbook of Practical Organic Chemistry* (5th Ed.). Prentice Hall. New Delhi.
2) Gnanaprakasam, N. S., & Ramamurthy. (2000). *Organic Chemistry Lab Manual*. Chennai: S.V. Printers.

Supplementary Readings

1) Mohan, J. (2003). Organic Analytical Chemistry, Theory and Practice. New Delhi: Narosa Publishing House.
2) Ahluwalia, V. K., Bhagat, P., & Aggarwal, R. (2005). Laboratory Techniques in Organic Chemistry. New Delhi: I. K. International.

SCHEME OF VALUATION

Semester Examination	Marks (60)
Separation with suitable Solvent	10
Analysis of compound - 1	15
Analysis of compound - 2	15
Viva - voce	10
Record	10
Total	60

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	3
CO2	2	3	2	3	2
CO3	3	3	3	2	2
CO4	2	3	2	3	3
CO5	3	2	3	3	3

SEMESTER: II CORE :V PRACTICAL: IV	22PCHEC25: INORGANIC CHEMISTRY PRACTICAL - I	CREDIT: 3 HOURS: 6/W

COURSE OBJECTIVES

To get the skill in the identification of cations including rare earth metals and to develop the skill in the preparation of metal complexes.

Semi Micro Qualitative Analysis

Mixture containing two common cations and two of the following less familiar cations.

Se, Te, W, Mo, Be, Ti, Ce, Th, Zr, U, V, Tl and Li.

Preparation of the followings:

1) Tris(thiourea)copper (I) chloride
2) Potassium trioxalatoferrate
3) Tetraamminecopper (II) sulphate
4) Microcosmic salt
5) Chrome alum
6) Trans-Diaquadioxalatochromate (III)

COURSE OUTCOMES

At the end of the course, the student will be able to

1) Acquire the necessary practical skills to independently analyze inorganic compounds
2) Gain expertise in the systematic analysis of inorganic compounds.
3) Apply the knowledge in industries.
4) Gain knowledge on the preparation of complexes

Text Books

1) Ramanujam, V, (1988), *Inorganic Semi Micro Qualitative Analysis,* National Pubs. Chennai.
2) Vogel, A.I. (1989), *Text Book of Quantitative Inorganic Analysis*, 5th Ed., Longman, UK.

SCHEME OF VALUATION

Semester examination	Marks (60)
Qualitative Analysis	30
Preparation	10
Viva	10
Record	10

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	**3**	**2**	**3**	**3**	**3**
CO2	**2**	**3**	**2**	**2**	**2**
CO3	**2**	**2**	**2**	**2**	**3**
CO4	**2**	**2**	**2**	**2**	**2**
CO5	**3**	**2**	**3**	**3**	**3**

SEMESTER: II CORE ELECTIVE-II	22PCHEE26 -1: GREEN CHEMISTRY	CREDIT: 3 HOURS: 4/W

COURSE OBJECTIVES

Enable the students to

1) Understand the basic principles and importance of green chemistry for industrial applications
2) Acquire knowledge about the microwave and ultra sound assisted synthesis
3) Understand the concept of phase-transfer catalysis
4) Gain knowledge about ionic liquids, green reagents,
5) Crown ethers and their applications

Unit I: Green Chemistry **12hrs**

Definition, need for green chemistry, basic principles, Explanation of twelve basic principles -atom efficiency process & atom economy- rearrangement, addition, substitution, elimination. Planning green Synthesis- preventing Waste, use of benign solvent, use of catalyst, minimum energy- use of polymer supported reagents. Green Synthesis in water –Wittig - Horner reaction, Heck reaction, Claisen rearrangement, Electrochemical synthesis, Weiss Cook reaction.

Unit II: Microwave Induced Green Synthesis **12 hrs**

Introduction- microwave assisted reactions in water – Hoffmann elimination, hydrolysis, oxidation, reactions in organic solvents- esterification, Diel's Alder reaction, decarboxylation, Baylis-Hillman reaction, Knoevenagel condensation, ortho ester Claisen rearrangement, Synthesis of β- lactams, benzodiazepin-2 ones, jusminaldehyde, isopropylidene glycol and Fries rearrangement. Green reagents: Dimethylcarbamate, polymer supported reagents, Polymer supported catalysts.

Unit III: Ultrasound Assisted Green Synthesis **12 hrs**

Introduction-Instrumentation, The physical aspects, Types of sonochemical reactions, Homogeneous sonochemical reactions, Heterogeneous liquid- liquid reactions, Heterogeneous liquid- solid reactions. Ionic liquids: Introduction, Types of ionic liquids, preparation of ionic liquids, Selection of suitable ionic liquid for a particular reaction- The Baylis- Hillman reaction in ionic liquids, Knoevenagel condensation, Claisen Schmidt condensation, Horner- Wordsworth- Emmons reaction in ionic liquids, applications in organic synthesis - Alkylation, Oxidation, hyrogenation, carbon - carbon double bond forming reactions. advantages & disadvantages of ionic liquids.

Unit IV: Phase transfer catalysts **12 hrs**

Introduction, definition, mechanism of phase transfer catalysed reaction, types and advantages of phase transfer catalysts, types of phase transfer catalysed reactions, preparation of phase transfer catalysts, applications of phase transfer catalysis in organic synthesis- Nitriles, azides, alcohols from alkyl halides and addition to olefins

Unit V: Green Crown ethers **12 hrs**

Introduction, nomenclature, special features, nature of donor site, general synthesis of Crown ethers -synthesis of [12] Crown- 4, [18] Crown -6 and cryptates. Synthetic applications – esterification, saponification, $KMnO_4$ oxidation, Elimination reaction, Generation of carbenes, and O, C-Alkylations. **synthesis in industries:** Synthesis of Adipic acid, synthesis of iburofen, synthesis of methyl methacrylate, Synthesis of sebacic acid, Synthesis of Prednisolone

COURSE OUTCOMES

1) Define green chemistry and explain basic principles
2) Discuss and appraise green reagents and microwave assisted green synthesis
3) Analyse the synthetic applications of ultra sound assisted green synthesis and ionic liquids.
4) Apprise the advantages and applications of phase transfer catalysis in organic synthesis.
5) Suggest crown ethers for different reactions in organic synthesis.

Text Books

1) Aluwalia, V. K. (2021). *Green Chemistry A Text Book* (6th reprint.). Narosa Publications.
2) Ahluwalia, V. K. (2012). *Environmentally Benin reactions* (2nd edn.). Ane Publications.
3) Ahluwalia, V. K., & Kidwai, M. (2012). *New trends in Green Chemistry* (Reprint.). Anamaya Publishers.

Supplementary Readings

1) Ahluwalia, V. K., & Aggarwal, R. (2012). *Organic Synthesis - Special Techniques* (2nd edn reprint.). Narosa Publishers.
2) Sanghi, R. & Srivastava, M. M. (2012). *Green Chemistry: Environmentally Friendly Alternatives* (4th Edn.). Narosa Publishers.

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	2	2	2	3	3
CO2	3	3	3	2	2
CO3	2	2	2	2	2
CO4	2	3	2	3	3
CO5	3	2	2	2	2

SEMESTER: II CORE ELECTIVE-II	22PCHEE26-2: SUPRA MOLECULAR CHEMISTRY	CREDIT: 3 HOURS: 4/W

COURSE OBJECTIVES

1) To enable the students to gain knowledge about supramolecular interactions.
2) To enable the students to understand about the binding of Host molecules and synthesis various supramolecules.
3) To enable the students to visualise the bonding interactions, design, synthesis of crystal engineering of supramolecules.
4) To enable the students to learn the mechanism and function of supramolecules as Molecular devices.
5) To enable the students to acquire knowledge about biological mimics and supramolecular Catalysis.

UNIT I: Supramolecular Interactions 12 hrs

Definition of supramolecular chemistry. Classification of supra molecular host - guest compounds, Cooperativity and chelate effect, preorganisation and complementarity. Nature of binding interactions in supramolecular structures: ion-ion, ion-dipole, dipole-dipole, H-bonding, cation-π, anion π- π, π-π, van der Waals interactions and Closed Shell interactions.

UNITII: Binding of Hosts and Its Synthesis 12hrs

Binding of cationic, anionic, ion pair and neutral Host molecules. Nomenclature of cation binding macrocycles, selectivity of cation complexation, Synthesis- The template effect and High dilution methods, Synthesis and structure of crown ethers, lariat ethers, podands, cryptands, spherands, calixarenes, cyclodextrins, cyclophanes, cryptophanes, carcerands and hemicarcerands.

UNIT III: Crystal Engineering 12 hrs

Introduction, Tectons and synthons, The role of H-bonding and other weak interactions. Self-assembly in synthetic systems: design, synthesis and properties of the molecules, self-assembling coordination commounds, self-assembling by H-bonding, metal-ligand interactions and other weak interactions, metallomacrocycles, catenanes, rotaxanes, helicates and knots.

UNT IV: Molecular Devices 12hrs

Philosophy of molecular devices, Supramolecular photochemistry- mechanism of energy and electron transfer, Bimetallic systems and mixed Valence, Bipyridine and friends as device components, Bipyridyl type Light harvesting devices, Light conversion devices, Information and signals: Semiochemistry and sensing, molecular electronic devices, molecular wires, molecular rectifiers, molecular switches, molecular logic.

UNIT V: Biological Mimics and Supramolecular Catalysis **12 hrs**

Relevance of supramolecular chemistry to mimic biological systems, Characteristics of Biological models, cyclodextrins as enzyme mimics, ion channel mimics, supramolecular catalysis- Abiotic supramolecular catalysis, dynamic combinatorial libraries, Self-replicating systems, Emergence of life. Examples of recent developments in supramolecular chemistry from current literature.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

1) Recognize the various supramolecular interactions.
2) Perceive the binding of Host molecules and apply it for the synthesis of various supramolecules.
3) Comprehend the bonding interactions, to design the synthesis of crystal engineering of supramolecules.
4) Appreciate the role of supramolecular chemistry in the design of molecular device.
5) Identify the role biological mimics and the significant applications of supramolecular catalysis in research.

Text Books

1) Steed, J. W., & Atwood, J. L. (2000). *Supramolecular Chemistry*. John Wiley and Sons.
2) Lehn, J. M. (1995). *Supramolecular Chemistry - Concepts and Perspectives*. Wiley-VCH.
3) Beer, P. D., Gale, P. A., & Smith, D. K. (1999). *Supramolecular Chemistry*. Oxford University Press.

Supplementary Readings

1) Ariga, K., & Kunitake, T. (2006). Supramolecular Chemistry - Fundamentals and applications Advanced text Book. Heidelberg: Springer berlin.
2) Kubik, S. (2021). Supramolecular Chemistry- From concepts to Applications. De gruyter.
3) Das, A. K., & Das. M. (2017). An introduction to Supramolecular Chemistry. CBS Publications

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	2
CO2	2	2	2	2	3
CO3	2	3	3	3	2
CO4	3	2	2	2	3
CO5	2	3	3	3	2

SEMESTER: II CORE ELECTIVE-II	22PCHEE26-3: NANO CHEMISTRY	CREDIT: 3 HOURS: 4/W

COURSE OBJECTIVES

1) To understand the scientific background, classification and properties of nanomaterials
2) To gain knowledge about special nonmaterial's and to identify the bonding in nanostructure
3) To acquire knowledge about various methods of synthesis of nanomaterials
4) To learn characterization techniques used for nanosystems
5) To study various industrial applications of nanotechnology

UNIT I: Introduction to Nanoscience 12 hrs

Introduction, length scale of different structures, definition of Nanoscience and nanotechnology - Electronic structure of various nanostructures - Classification of Nanomaterials: Dimensionality and size dependent phenomena; zero-, one- and two-dimension Nano-structures; Top down and bottom-up synthesis methods - Size dependent variation in mechanical, physical and chemical, magnetic, electronic transport, reactivity etc. - Biological nanostructures, polypeptide nanowires and protein nanoparticles.

UNIT II: Special Nanomaterials 12 hrs

Fullerenes and Carbon nanotubes. Micro and Mesoporous Materials: Core-shell structures; **Bonding in Nanostructures:** Bonding in Graphene – Carbon Nanotubes-Inorganic nanotubes: Silica nanotubes, boron nitride nanotubes, Nanotubes of Chalcogenides, and Nanotubes of several metal oxides – Functionalization of CNTs and Graphene.

UNIT III :Synthesis of Nanomaterials 12 hrs

Chemical precipitation and co-precipitation, Sol-Gel synthesis; Microemulsions synthesis, Hydrothermal, Solvothermal synthesis methods, Microwave assisted synthesis; Sonochemical assisted synthesis, Quantum dot (QDs) synthesis, Bio-synthesis – Exploitation methods for the preparation of 2D Nano-materials.

UNIT IV: Nanostructured materials Characterization Techniques 12 hrs

X-ray diffraction (XRD), SEM, EDAX, TEM, FTIR, UV-Visible spectrophotometer, Laser Raman Spectroscopy, Differential Scanning Calorimeter (DSC), Differential Thermal Analyzer (DTA), Thermo gravimetric Analysis (TGA), TEM, X-ray Photoelectron Spectroscopy (XPS), Atomic force microscopy (AFM), BET alalyzer.

UNIT V: Industrial Applications of Nanotechnology 12hrs

Applications of Nano-adsorbents and photocatalysts for water and wastewater treatment – Nanoparticles for degradation of solvents and organic compounds – Nanotechnology in Textiles, Cosmetics, Defence, Agriculture, and Food industry, Bio-Medical Engineering.

COURSE OUTCOMES

At the end of the course, the student will be able to

1) Discuss on the scientific background on nanomaterials
2) Know various methods of synthesis of nanomaterials
3) Know the characterization techniques used for nanosystems
4) Understand the properties of nanomaterials in depth
5) Acquire knowledge in various industrial applications of nanotechnology

Text Books

1) Viswanathan, B. (2014) *Nano Materials*. Narosa Publishing House Pvt Ltd.
2) Pradeep, T. (2012). *Nano: The Essentials*. Tata MC Graw-Hill Publishing Company limited.
3) Niemeyer, C. M., Mirkin, C. A. (2004). *Nanobiotechnology: Concepts, Applications and Perspectives*. Wiley-VCH Verlag GmbH & Co.
4) Charles Poole, Jr., & Owens, F. J. (2003). *Introduction to Nanotechnology*. John Wiley and Sons.
5) Cao, G., & Wang, Y. (2011). *Nanostructures and nanomaterials: synthesis, properties and applications* (2nd edition.). World Scientific.
6) Kuzma, J., & VerHage, P. (2006). *Nanotechnology in agriculture and food production*. Woodrow Wilson International Centre.
7) Brown, P. J. & Stevens, K. (2007). *Nanofibers and Nanotechnology in Textiles*. Cambridge: Wood head Publishing Limited.

Supplementary Readings

1) Goser, K., Glosekotter, P., & Dienstuhl, J. (2005). Nanoelectronics and nanosystems: from transistors to molecular and quantum devices. Springer.
2) Dresselhaus, M. S., & Dresselhaus, G. (1996). Science of fullerenes and carbon nanotubes. Academic press.
3) Altmann, J., & Routledge. (2006). Military Nanotechnology: Potential Applications and Preventive Arms Control. Taylor and Francis Group.

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	2	2
CO2	2	2	3	2	3
CO3	2	3	3	2	3
CO4	3	2	2	3	2
CO5	2	3	3	2	2

SEMESTER – II	2PHUMR27: HUMAN RIGHTS	CREDIT:2 HOURS:2/W

COURSE OBJECTIVES

1) To understands the conceptual background of Human Rights.
2) To study international and regional norms and institutional mechanisms of Human Rights.
3) To know the international concern for Human Rights.
4) To explores the emerging issues in international human rights.
5) To study the Classification of Human Rights.

UNIT-I: CONCEPTUAL BACKGROUND OF HUMAN RIGHTS

Meaning, Nature and Scope of Human Rights - Need for the Study of Human Rights - Philosophical and Historical foundations of Human Rights - Classification of Human Rights –Major Theories of Human rights.

UNIT-II: INTERNATIONAL HUMAN RIGHTS NORMS AND MECHANISMS

UN Charter - Universal Declaration of Human Rights - International Covenant on Civil and Political Rights - International Covenant on Economic, Social and Cultural Rights - Other Major instruments on Human rights (Conventions on Racial Discrimination. Women and Child Rights. Torture, Apartheid and Refugees) -UN High Commissioner for Human Rights and its Sub-Commissions - Geneva Conventions and Protocols - UN High Commission for Refugees -Humanitarian Interventions of UN

UNIT-III: REGIONAL HUMAN RIGHTS STANDARDS AND MECHANISMS

European Convention on the protection of Human Rights - European Commission on Human Rights -American Convention on Human Rights - American Commission and Court of Human Rights - African Charter on Human and People's Rights -African Commission and African Court for Human Rights- Universal Islamic Declaration of Human rights (198l)

UNIT-IV: ISSUES

Violence against Women and Children - Refugees & Internally Displaced People's rights - Racism - Rights of Prisoners, Rights of Prisoners of War - Rights of Disabled, Aged, and Homeless Persons - Cyber Crimes and Human Rights - Euthanasia Debate- Bio-Technology and Human Rights (Human Cloning. Feticide and Medical Termination of Pregnancy, Surrogate Parenthood, Sale of Human Organs. Drugs and Technologies)

UNIT V: EMERGING DIMENSIONS

Third Generation Human Rights: Right to Water, Food, Health, Clothing, Housing, and Sanitation- Right to Education – Right to Peace and Prosperity - Right to have Clean Environment.

COURSE OUTCOMES

At the end of the course, the student

1) will have knowledge about the conceptual background of Human Rights.
2) can apprise on International Human Rights norms and mechanisms.
3) can understand the emerging dimensions of Human Rights in international forum.
4) can explain about the Third Generation Human Rights
5) can discusses about Right to Clean Environment.

Text Books

1) M.P. Tandon. Anand. V.K. International Law and Human Rights. Haryana. Allahabad Law house, Allahabad, 2013.
2) N. Sanajauba. Human Rights in the New Millennium, New Delhi Manas Publications, 2011.
3) S.K. Kapoor. Human Rights under International Law and Indian Law. Allahabad: Central Law Agency. 2012,
4) Daniien Kings Lurge & Leena Avonius. Ed. Human Rights in Asia, London. Maemillan Publishers. 2016.

Supplementary Readings

1) Todd, Land Man, ed., Human Rights. London. Sage Publications. 2018.
2) G. Van Bueren, The International Law on the Rights of the child. Dordrecht: Martinus Nijhoff Publishers, 2011.
3) B.S. Waghmnre. ed. Human Rights. Problems and Prospects. Delhi. Lalinga Publications. 2011.

OUT COME MAPPING

CO/PO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	2	2	3	3	2
CO2	1	2	2	3	3
CO3	2	2	3	2	2
CO4	2	3	3	2	3
CO5	2	2	2	3	3

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

SEMESTER: III CORE: VII	22PCHE31: ORGANIC CHEMISTRY- III	CREDIT: 3 HOURS: 4/W

COURSE OBJECTIVES

1) To understand the concepts of UV and IR spectroscopic techniques and to apply these techniques in the structural analysis of organic compounds.
2) To learn about the ^{1}HNMR and ^{13}C NMR apply it for the structural elucidation of the compound
3) To study the mass spectroscopic technique.
4) To understand the concept of Photochemical Reactions.
5) To study the concept of Pericyclic Reactions.

UNIT-I: UV and IR Spectroscopy and Their Applications 12 hrs

Ultraviolet spectroscopy: Types of electronic transitions - chromophores and auxochromes - factors influencing the positions and intensity of absorption bands - absorption spectra of dienes, polyenes and unsaturated carbonyl compounds – Woodward - Fieser rules and its applications. Infra-Red Spectroscopy: Vibrational frequencies and factors affecting them -identification of functional groups - intra and inter molecular hydrogen bonding –functional group region- finger print region.

UNIT-II: NMR Spectra and Its Applications 12 hrs

Nuclear spin - magnetic moment of a nucleus - nuclear energy levels in the presence of magnetic field - basic principles of NMR experiments - CW and FT NMR - ^{1}H NMR - Chemical shift and coupling constant - factors influencing proton chemical shift and vicinal proton - proton coupling constant- ^{1}H NMR spectra of simple organic molecules such as CH_3CH_2Cl and CH_3CHO. AX and AB spin systems - nuclear overhauser effect chemical exchange.^{13}C NMR - proton decoupling and Off resonance decoupling spectra - factors affecting ^{13}C NMR chemical shift - ^{13}C NMR spectra of simple organic molecules. Basic Aspects of 2D NMR techniques: Correlation spectroscopy (COSY), HOMO -COSY.

UNIT-III: Physical Methods of Structural Determination 12 hrs

Mass spectroscopy - Principles - measurement techniques - (EI, CI, FD, FAB, SIMS) -presentation of spectral data - molecular ions - isotope ions - fragment ions of odd and even electron types - factors affecting cleavage patterns - simple and multicentre fragmentation –

Mc Lafferty rearrangement - Mass spectra of hydrocarbons, alcohols, phenols, aldehydes and ketones. Spectroscopic identification of organic compounds using data of UV, IR and NMR spectroscopy and mass spectrometry.

UNIT-IV: Organic Photochemistry 12 hrs

Introductory theory of light absorption, photophysical processes- Jablonski diagram, IC, ISC, fluorescence, phosphorescence. Photochemical reactions of Ketones –Norrish type I and II, Paterno Buchi reaction, Photoreduction of Ketones, Photochemistry of α, β unsaturated ketones, Photochemical reactions of olefins –

Cis-trans isomerism, Dimerization reactions, photochemistry of butadiene, Photochemistry of aromatic compounds and photooxidation. Di-Pi methane rearrangement.

UNIT-V: Pericyclic Reactions **12 hrs**

Pericyclic Reactions: Molecular orbital symmetry, Frontier orbitals of ethylene, 1, 3-butadiene, 1, 3, 5- hexatriene. Classification of pericyclic reactions. Electrocyclic reactions – 4n and 4n+2 systems, Woodward –Hoffmann rules, Correlation diagram, FMO and PMO approach [1, 3-dienes and 1, 3, 5-trienes]. Cycloadditions: Antarafacial and suprafacial additions, 4n and 4n+2 systems, 1, 3-dipolar addition, Diel's Alder reaction. Sigmatropic Rearrangements: Suprafacial and antarafacial shifts of hydrogen, Cope and Claisen rearrangement

COURSE OUTCOMES

The student will be able to

1) Visualize the importance of UV-Visible and IR spectroscopy.
2) Acquire knowledge of vibrational transition and identify functional groups
3) Apply the concept of Mass spectroscopy to different compounds
4) Elucidate the structure of organic compounds using NMR
5) Solve photochemical and pericyclic problems

Text Books

1) Carey, F. A., & Sundberg, R. J. (1990). *Advanced organic chemistry* (III Edition.).
2) Issac, N. S. (1987). *Physical organic chemistry*. ELBS publication.
3) Kalsi, P. S. *Spectroscopy of organic compounds*. Chennai: Wiley Eastern Ltd.
4) Silverstein, R. M., Bassler, G. D., & Morril. *Spectrometric identification of organic compounds*, New York: John Wiley and Sons.
5) Mukherji, S. M., & Singh, S. P. (1990). *Organic Reaction Mechanism*. Chennai: MacMillan India Ltd.
6) Morrison, R. T., & Boyd, R. N. (1992). *Organic chemistry* (6th edition.). New Delhi: Prentice Hall of India Limited.

Supplementary Readings

1) Kemp, W. *Spectroscopy*. Macmillan Ltd.
2) Sharma, Y. R. *Structural identification of organic compounds*. S. Chand & Co.
3) Norman, R. O. C., Coxon, J. M. (1994). *Principle of Organic Synthesis*. ELBS Publications.

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	**3**	**3**	**3**	**2**	**2**
CO2	**2**	**3**	**2**	**3**	**3**
CO3	**3**	**2**	**2**	**3**	**3**
CO4	**2**	**3**	**3**	**2**	**3**
CO5	**3**	**2**	**3**	**3**	**2**

SEMESTER: III CORE: VIII	22PCHE32: INORGANIC CHEMISTRY- III	CREDIT: 3 HOURS: 4/W

COURSE OBJECTIVES

1) To analyze and interpret the IR and NMR spectra of Inorganic compounds and coordination complexes.
2) To study the Mossbauer and Photoelectron spectroscopy for metal complexes
3) To gain knowledge about the principle and applications of ESR and NQR
4) To provide the students a thorough understanding of the relationship between the structures, chemical bonds and chemical properties in organo metallic chemistry.
5) To learn about the role of metals in different enzymes

UNIT I: IR and NMR Spectroscopy in The Study of Inorganic Compounds **12hrs**

Application of IR spectra in the study of coordination compounds – application to metal carbonyls and nitrosyls – geometrical and linkage isomerism – detection of inter and intramolecular hydrogen bonding. NMR Spectroscopy: ^{31}P, ^{19}F and ^{15}N – NMR – introduction – applications in structural problem – evaluation of rate constants – monitoring the course of reaction – NMR of fluxional molecules – NMR of paramagnetic molecules – contact shifts and shift reagents.

UNIT II: Mossbauer and Photoelectron Spectroscopy (PES) **12hrs**

Mossbauer spectroscopy: Mossbauer effect resonance absorption – Doppler effect – Doppler velocity – Experimental technique of measuring resonance absorption – isomer shift – magnetic hyperfine splitting application of Mossbauer spectroscopy in the study of iron and tin complexes. Photoelectron spectroscopy: Theory – XPS – UV-PES – Instrumentation evaluation of ionisation potential – Chemical identification of elements – Koopmann's theorem – chemical shift – UPS – XPES of N_2, O_2 and HCl - evaluation of vibrational constants from UPS – spin-orbit coupling.

UNIT III: ESR AND NQR Spectroscopy **12hrs**

ESR Spectroscopy: Principles – presentation of the spectrum -Hyperfine splitting: hyperfine splitting in isotropic systems involving one nucleus and more than one nucleus, hyperfine splitting caused by quadrupole nuclei. g value and the factors affecting g values, anisotropy in g-value, factors causing anisotropy. ESR spectra of systems with more than one unpaired electron: zero-field splitting, causes of ZFS, McConnel's equation, Krammer's theorem. ESR of transition metal complexes of copper, manganese and Vanadyl ions. ESR spectrum of simple organic free radicals. NQR Spectroscopy: - Principle and applications of NQR.

UNIT IV: Organo Metallic Chemistry 12hrs

Synthesis, structure and bonding in metal carbonyls, nitrosyls, dioxygen complexes and dinitrogen complexes – Application of EAN and 18 electron rules-Synthesis, properties, structure and bonding in Ferrocene, Arene, olefin, acetylene and allyl complexes. Oxidative addition – reductive elimination – insertion reaction – catalytic mechanism in the following reactions: hydrogenation of olefins (Wilkinson catalyst) – Tolman catalytic loops – hydroformylation (oxo process) – acetic acid from ethanol – oxidation of alkenes to aldehydes and ketones (Wacker's process) – catalysis in the formation of synthesis of gas-olefin polymerisation (Ziegler – Natta) – Cyclooligomerisation of acetylenes (Reppe's or Wilke's catalysts) – olefin isomerisation using Ni catalyst.

UNIT V: Bio-inorganic Chemistry-II 12hrs

Carboxypeptidase A: structure, function – carbonic anhydrase – inhibition and poisoning – corin ring system – vitamin B12 and B12 coenzymes – *in-vivo* and *in-vitro* nitrogen fixation – essential and trace elements in biological systems – metal ion toxicity and detoxification – molecular mechanism of ion transport across the membrane – sodium and potassium ions pumps – chelate therapy – *cis*platin

COURSE OUTCOMES

The student will be able to

1) Illustrate the different types of reaction of organo metallic compounds and discuss the various catalysis processes in organo metallic chemistry.
2) Analyze and interpret the IR, Raman and NMR spectra of Inorganic compounds and coordination complexes
3) Apply Mossbauer and photo electron spectroscopic data for the structural classification of inorganic compounds.
4) Describe the principle and applications of ESR and NQR for inorganic molecules.
5) Explain about the structure and functions of metalo enzymes and role of trace elements in biological systems.

Text Books

1) Cotton, F.A., & Wilkinson, G. (2017). *Advanced Inorganic* Chemistry (6th Edn.) Singapore: John Wiley & Sons.
2) Purcell, K. P., & Koltz, J. C. (1980). *An introduction to Inorganic Chemistry*. Philadelphia: W.B. Saunders Company.
3) Huheey, J. E., Keitler, E. A., & Keitler, R. L. (1993). *Inorganic Chemistry* (4th Edn.). New York. Harper Collins College Publishers.
4) Gopalan, R. (2001). *Concise Coordination Chemistry*. Vikas Publishing House.
5) Drago, R. S., *Physical Methods in Inorganic Chemistry*. New Delhi: East-West Press Pvt Ltd.
6) Drago, R. S. (1977). *Physical Methods in Chemistry, Saunders Golden Sunburst Series*. London: W.B. Saunders Company.

Supplementary Readings

1) Perez, P. J. (2014). Advances in Organometallic Chemistry. (63rd Edn.). Elsevier
2) Basalo, F. & Pearson, R. G. (1967). Mechanism of Inorganic reaction (2nd Edn.). New York: Wiley.
3) Kettle, S. F. (2013). A Physical Inorganic Chemistry: A Coordination Chemistry Approach. New York: Springer.
4) Meisler, G. L., & Torr, D. A. (2017). Inorganic chemistry (3rd Edition.). Pearson.
5) Rao, C. N. R. (2012). Spectroscopy in Inorganic Chemistry (Vol. 2.). Elsevier

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	**2**	**3**	**3**	**3**	**2**
CO2	**2**	**3**	**3**	**3**	**3**
CO3	**2**	**2**	**2**	**2**	**2**
CO4	**2**	**2**	**2**	**3**	**3**
CO5	**3**	**3**	**2**	**2**	**2**

SEMESTER: III CORE: IX	22PCHE33: PHYSICAL CHEMISTRY-III	CREDIT:3 HOURS:4/W

COURSE OBJECTIVES

1) To know the applications of classical thermodynamics in the evaluation properties.
2) To learn the concepts of statistical thermodynamics for the study of equilibrium reactions and reaction intermediates
3) To derive equations for enthalpy, internal energy, Gibb's energy, entropy in terms partition function.
4) To learn the concepts of surface phenomena
5) To know the applications of Raman and NMR spectroscopy.

UNIT I: Classical Thermodynamics **12 hrs**

Partial molar properties–chemical potential, relationship between partial molar quantities and thermodynamic functions - Gibbs-Duhem equation-calculation of partial molar quantities from experimental data, Thermodynamic properties of real gases-activity- fugacity concept - calculation of fugacity of real gas and activity coefficient –definition and experimental determination of activity coefficients of non-electrolytes.

UNIT II: Statistical Thermodynamics – I **12 hrs**

Probability – types of events-theories of probability- multiplicative nature of probability- permutations and combinations – Stirling's Approximation. Statistical mechanics – calculation of thermodynamic probability of system – Assembly, ensembles, phase space-definition of micro and macro states - different methods of counting macro and micro states – distinguishable and indistinguishable particles-classical statistics - derivation of Maxwell Boltzmann distribution law- Its application to gaseous system – energy, velocity distribution - concept of negative Kelvin temperature. Quantum statistics-Bose Einstein and Fermi Dirac statistics-comparison with Maxwell- Boltzmann statistics – application of BE statistics to photon gas-Application of FD statistics to electron gas and to thermionic emission – derivation of thermionic energy.

UNIT III: Statistical Thermodynamics– II **12 hrs**

Partition function – characteristics - translational, rotational, vibrational, electronic partition function - expression for enthalpy, internal energy, Gibbs energy, entropy (Sackur – Tetrode equation), work function and equilibrium constant in terms of partition functions – partition function of mono atomic and diatomic molecules. Heat capacity of solids –Derivation of Einstein's equation and its limitations, Debye T - cubed law and its significance. Non-equilibrium thermodynamics, Steady-State-phenomenological laws and Onsager‟s reciprocal relations.

Unit IV: Raman and NMR Spectroscopy **12 hrs**

Raman spectroscopy - Raman and Rayleigh scattering - Quantum and classical theories of Raman effect - Pure rotational Raman spectra – Stokes and anti-stokes lines - Vibrational Raman Spectra-Mutual exclusion rule - Polarised and depolarized Raman lines - Techniques and instrumentation. NMR - Hydrogen nuclei - Chemical shift and spin - spin splitting – Coupling constant (*J*). Splitting with and without chemical exchange-instrumentation- Interaction between spin and magnetic field - Gyromagnetic ratio - FT NMR.

UNIT V: ESR Spectroscopy **12 hrs**

ESR-Principle-Position of ESR absorptions - *g* value - Hyperfine splitting -Zero field splitting -ESR spectrum of free radicals and copper salicylaldehyde complexes. Mossbauer spectroscopy -principles of Mossbauer spectroscopy, Doppler shift, recoil energy, isomer shift, quadrupole splitting- applications to various compounds.

COURSE OUTCOMES

At the completion of this course, the students will be able to

1) Calculate the thermodynamic and kinetic properties
2) Relate microscopic properties of molecules with macroscopic thermodynamic observables
3) Derive the rate equation from mechanistic data
4) Utilise the Raman and NMR spectroscopy
5) Apply the ESR and Mossbauer spectroscopy for various compounds.

TEXT BOOKS

1) Gupta, M.C. (1998). *Statistical Thermodynamics* (Unit -II, III.). New Delhi: Wiley Eastern Ltd., New Age International.
2) Rastogi, R. P., & Mishra, R. R. (2000) *An introduction to Chemical Thermodynamic* (Unit -I, II, III.). New Delhi: VikasPublishing House.
3) Puri, B. R., Sharma, L. R., & Pathania, M. S. (2017). *Principles of Physical Chemistry* (Unit –IV, V.). Jalandar: Vishal PublishingCo.
4) Mathews, P. (2003.). *Advanced Physical Chemistry* (Unit I-V.). New Delhi: Foundation Books.

SUPPLEMENTARY READINGS:

1) Atkins, P., & Paula, J. D. (2018). *Physical Chemistry*. Oxford University Press.
2) Laidler, K. J. (2003) *Chemical Kinetics*. New Delhi: Tata McGraw-Hill,
3) Frost, A. A. & Pearson, R. G. (1961). *Kinetics and Mechanisms*. New York: John Wiley & Sons.
4) Amdur, I. & Hammes, G. G. (1966). *Chemical Kinetics – Principles and Selected Topics*. New York: McGraw Hill.

5) Steinfeld, J. I., Francisco, J. S., & Hase, W. L. (1999). *Chemical Kinetics and Dynamics*. NewJersey: Prentice Hall.
6) Metiu, H. (2006). *Physical Chemistry-Kinetics*. New York: Taylor and Francis.
7) Dave, R. K. (2000). *Chemical Kinetics*. Campus Books.
8) Mcquarrie, D. A. (2016.). *Quantum Chemistry*. University Science Books.
9) Levine, I. N. (2016). *Quantum Chemistry*. Prentice Hall.
10) Prasad, R. K. (2010). Quantum Chemistry. New Delhi: New Age international (P) Ltd.
11) Sen, B. K. (1992). Quantum Chemistry. New Delhi: Tata McGraw-Hill.
12) Engel, T., & Reid, P. (2013). *Physical Chemistry*. New Delhi: Pearson Education.

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	**2**	**2**	**2**	**2**	**2**
CO2	**2**	**3**	**3**	**3**	**2**
CO3	**3**	**2**	**2**	**3**	**3**
CO4	**3**	**3**	**2**	**2**	**2**
CO5	**2**	**2**	**3**	**2**	**3**

SEMESTER: III CORE: X	22PCHE34: SCIENTIFIC RESEARCH METHODOLOGY	CREDIT: 4 HOURS: 4/W

COURSE OBJECTIVES

1) To understand the importance of research and literature sources.
2) To gain knowledge about the Chemical Abstract search in Chemical research.
3) Acquire knowledge on choosing a research problem and science writing.
4) Adequate knowledge on assessing the quality of analytical data.
5) Working knowledge on Computer aided literature search.

UNIT I: Literature Survey **12 hrs**

Source of chemical information – primary, secondary, tertiary sources-literature survey-Indexes and abstracts in science and technology – Applied science and technology index, chemical abstracts, chemical titles, current chemical reactions, current contents and science citation index. Classical and comprehensive reference works in chemistry-synthetic methods and techniques, treatises, reviews, patents and monographs.

UNIT II: Chemical Abstracts **12 hrs**

Current awareness searching: CA weekly issues, CA issue indexes. Retrospective searching: CA volume indexes-general subject index, chemical substance index-formula index, index of ring systems, author index, patent index. CA collective indexes: collective index (CI), decennial index (DI). Access points for searching CA indexes- Index guide, general subject, terms, chemical substance names, molecular formulas, ring systems, author names, patent numbers. Locating the reference: finding the abstract, finding the original document chemical abstract - service source index.

UNIT III: Choosing a Research Problem and Scientific Writing **12 hrs**

Identification of research problem – assessing the status of the problem - guidance from the supervisor – actual investigation and analysis of experimental results – conclusions. Scientific writing-research reports, thesis, journal articles and books. Steps to publishing a scientific article in a journal – types of publications-communications, articles, reviews, when to publish, where to publish, specific format required for submission. Documenting- Abstracts-indicative (or) descriptive abstracts, informative abstract, footnotes, end notes, referencing styles-bibliography-journal abbreviations (CASSI), abbreviation used in scientific writing.

UNIT IV: Conduct of Research Work **12 hrs**

Physical properties useful in analysis and methods of separation prior to analysis - Isolation techniques - extraction - Soxhlet extraction, crystallization, sublimation - methods for vacuum sublimation and distillation under reduced pressure.

Data analysis - Report. Errors in chemical analysis – classification of errors – determination of accuracy of methods – improving accuracy of analysis – significant

figures – mean, standard deviation – comparison of results: "t" test, "f" test, Q test and "chi" square test – rejection of results – presentation of data.

UNIT V: Computer Searches and Literature **12 hrs**

ASAP–Alerts, CA Alerts, scifinder, chemport, science direct, STN international, journal home pages. Plagiarism and intellectual property rights - Online browsing of research articles–online submission of research papers in various Journals (ACS, RSC, Elsevier, Springer etc.)–Instructions to the authors – Impact factors. Writing project proposal to funding agencies (UGC, DST etc.).

COURSE OUTCOMES

1) The students will be able to acquire knowledge of Literature survey
2) Acquire knowledge about thesis writing.
3) Acquire knowledge about Research work.
4) Identify the importance of errors involved chemical analysis.
5) Illustrate the importance of online browsing of literature.

TEXTBOOKS

1) Bottle, R. T. (1969). The use of Chemical literature. Butter worth's.
2) Durston, A. J. Thesis and assignment writing.
3) Bullet, R. O. Preparing thesis and other manuscripts.
4) Dominoswki, R. L. (1981). Research Methods. Prentice Hall.
5) Best, J. W. (1981). Research in Education (4th ed.). New Delhi: Prentice Hall of India.
6) Ebel, H. F., Bliefert, C., & Russey, W. E. (1988). The Art of Scientific Writing, Weinheim: VCH.
7) Cain, B. E. (1988). The Basis of Technical Communicating. Washington, D.C: ACS.
8) Kanare, H. M. (1985). Writing the Laboratory Notebook Washington, DC: American Chemical Society.
9) Khopkar, S. M. Basic concepts of analytical chemistry.

Supplemetary Readings

1) Dodd, J. S. (Ed.). (1985). *The ACS Style Guide: A Manual for Authors and Editors* Washington, DC: American Chemical Society
2) Gibaldi, J., Achtert, W. S. (1987). *Handbook for writers of Research Papers* (2nd ed.). Wiley Eastern.
3) Joseph, A. (1986). *Methodology for Research*. Bangalore: Theological Publications.
4) http://www.dst.gov.in/whats_new/whats_new07/tsd-format.pdf
5) www.ugc.ac.in/pdfnews/7716504_12th-plan-guidelines.pdf
6) Pavia, D. L., Lampman, G. M., & Kniz G. S. Jr. *Introduction to spectroscopy – A guide for students of organic chemistry*.
7) Willard, H., Merrit, L. Jr., & Dean, A. *Instrumental methods of analysis*.
8) Skoog, D. A., & West, M. *Principles of instrumental analysis*.

9) Sharma, B. K. *Instrumental methods of chemical analysis*.
10) Skoog, D. A. & West, M. *Fundamentals of analytical chemistry*.
11) Dick, J. D. *Analytical chemistry*.

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	**3**	**2**	**3**	**2**	**3**
CO2	**2**	**2**	**2**	**2**	**2**
CO3	**3**	**3**	**2**	**3**	**2**
CO4	**2**	**3**	**2**	**2**	**3**
CO5	**2**	**2**	**3**	**3**	**2**

SEMESTER: III CORE PRACTICAL:V	22PCHEP35: INORGANIC CHEMISTRY PRACTICAL – II	CREDIT: 3 HOURS: 6/W

COURSE OBJECTIVE

To know the colorimetric estimation of metal ions and to understand the complexometric titrations.

Colorimetric analysis:

Colorimetric estimations of copper, nickel, iron and chromium using photoelectric colorimeter.

Complexo metric Titrations:

1) Standardization of EDTA.
2) Determination of Mg^{2+}, Zn^{2+}, Ni^{2+} and Ca^{2+}

Water Analysis

i. Estimation of total alkalinity of water sample
ii. Estimation of dissolved oxygen in waste water
iii. Estimation of chloride content in water sample
iv. Estimation of hardness in water sample by EDTA method
v. Chemical oxygen demand (COD)

COURSE OUTCOMES

At the end of the course, the student will be able to

1) Understand the colorimetric estimations of metal ions. .
2) Evaluate the water quality that will be useful in environmental aspect.
3) Understand the complexometric titrations.
4) Calculate the hardness of water sample.

TEXT BOOKS

1) Ramanujam, V. (1988). *Inorganic Semi Micro Qualitative Analysis*. India: National Pubs.
2) Vogel, A. I. (1989). *Text Book of Quantitative Inorganic Analysis* (5^{th} Ed.). UK: Longman.

UNIVERSITY EXAMINATION	MARKS (60)	INTERNAL ASSESSMENT	MARKS (40)
Complexometric Estimation		Attendance	20
Estimation	15	Results in regular practical's	20
Procedure	05		
Colorimetric Estimation			
Estimation	20		
Viva	10		
Record	10		

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	**3**	**2**	**3**	**2**	**3**
CO2	**2**	**2**	**2**	**2**	**2**
CO3	**3**	**3**	**2**	**3**	**2**
CO4	**2**	**3**	**2**	**2**	**3**
CO5	**2**	**2**	**3**	**3**	**2**

SEMESTER: III CORE PRACTICAL: VI	22PCHEP36: PHYSICAL CHEMISTRY PRACTICAL – II	CREDIT: 3 HOURS: 5/W

COURSE OBJECTIVES

1) To analyze physical parameters using some instrumental techniques.
2) To understand the principle behind the qualitative and quantitative measurements.
3) To impart skill in the measurement of physical parameters.

EXPERIMENT.

1) Potentiometric titration of strong acid vs strong base
2) Potentiometric titration of mixture of acid vs NaOH.
3) Partition coefficient of iodine between two immiscible solvents
4) Determination of second-order rate constant for saponification of ethyl acetate by conductivity method.
5) Conductometric acid-base titration - mixture of acids against NaOH.
6) Conductometric titration of mixture of alkali against HCl.
7) Determination of solubility product by Conductometric method.
8) Phase diagram of Simple eutectic system.
9) Potentiometry-dissociation constant of weak acid vs NaOH
10) Freundlich's Adsorption Isotherm - Adsorption of acetic acid/oxalic acid by charcoal.
11) Ternary phase diagram involving chloroform-acetic acid-water
12) Ternary phase diagram involving potassium chloride-glucose-water
13) Potentiometry-solubility of sparingly soluble salt.

COURSE OUTCOMES

At the end of this course, the students will be able

1) To handle different instruments such as conductometer and potentiometer.
2) To carry out qualitative analysis and quantitative estimations.

TEXT BOOKS

1) Levitt, B.P. (1985) Findlay`s Practical Physical Chemistry (9th Ed.). London: Longman.
2) Gurtu, J. N., & Kapoor, R. (1987). Advanced Experimental Chemistry (Vol. I.). New Delhi: S. Chand & Co.
3) Sundaram. Krishnan. & Raghavan. (1996). Practical Chemistry (Part II.). S. Viswanathan and Co. Pvt.

Supplementary Readings

1) Shoemaker, D. P., Garland, C. W., & Nibler, J. W. (1989). *Experiments in Physical Chemistry* (5th Edn.). McGraw- Hill Book company.

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	**2**	**3**	**2**	**2**	**3**
CO2	**2**	**2**	**3**	**2**	**2**
CO3	**2**	**3**	**3**	**3**	**2**
CO4	**3**	**3**	**3**	**2**	**2**
CO5	**2**	**3**	**2**	**3**	**3**

SEMESTER: III Open Elective – II	22PCHEO37-1: TEXTILE CHEMISTRY	CREDIT: 3 HOURS: 3/W

COURSE OBJECTIVES

1) To make the students learn the concept of textile chemistry
2) To understand about Preparatory process.
3) To learn about dyeing.
4) To study about printing.
5) To understand about finishes given to fabrics.

UNIT I: Properties of textile materials **10hrs**

Classification of textile fibers – chemical structure, production, physical and chemical properties of textile fibers – cotton, wool, silk, viscose, rayon, synthetic fibers.

UNIT II: Preparatory Processes **10hrs**

Impurities in raw cotton and greycloth, wool and silk – general principles of the removal – Brief outline on desizing, singeing and mercerisation, scouring – bleaching with hypochlorites and peroxides.

UNIT III: Dyeing **10hrs**

Preparation of simple dyes and intermediates. Introduction to theory of dyeing. Dyeing of wool and silk–Fastness properties of dyed materials–dyeing of nylon, Terylene and other synthetic fibers. Application of direct, vat, azoic, reactive, disperse and acid dyes.

UNIT IV: Printing **5hrs**

Stages involved in printing – printing paste ingredients, styles and methods of printing. Outline on printing of cotton fabrics with reactive dyes, polyester fabrics with disperse dyes.

UNIT V: Finishing **10hrs**

Finishes given to fabrics - Classification – calendering, crease proofing and shrink proofing. Mechanical finishes on cotton, wool and silk, method used in process of mercerizing– Anti-crease and Anti-shrink finishes–Water proofing.

COURSE OUTCOMES

1) Appreciate the importance of textile chemistry
2) Acquire knowledge of synthetic fibres.
3) Identify the importance dyeing.
4) Acquire knowledge of printing.
5) Illustrate the importance of finishes given to fabrics.

Text Books

1) Nuntak, B. (1987). The Identification of Textile Fibres. London.
2) Maryory., Joseph, L. (1986). Introduction to Textile Science (3rd ed.).
3) Peters, R. H. (1975). Dyeing and chemical Technology of Textile fibres (5th ed.). Elsevier scientific publishing company.
4) Trotman, E.R. (1983). Chemistry of dyes & Principles of Dyeing (4th edn.). Mumbai: Shenai, Sevak Publications.

Supplementary Readings

1) Gopalakrishnan, D., & Karthik, T. (2016). Basics of Textile Chemical Processing. ASTRAL Publishers.
2) Arora, V. (2011). Technology of Textile Chemistry. Sunrise Book Publishers.
3) Menachemlewin, Lewin, & Stephen, B. (1984). Chemical processing of Fibers and Fabrics. Epitome Publishers.
4) Mishra, S. P. (2020). Science and Technology of Textile dyeing and colouration (2nd edn.). New age international publications.

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	3	2
CO2	2	2	2	3	2
CO3	2	3	2	2	3
CO4	3	2	3	3	2
CO5	2	2	3	2	2

SEMESTER: III OPEN ELECTIVE – II	22PCHEO37-2: DAIRY CHEMISTRY	CREDIT:3 HOURS:3/W

COURSE OBJECTIVES

1) To make the students learn about dairy chemistry.
2) To understand the importance of milk-lipids, proteins, carbohydrates and vitamins.
3) To understand the importance of condensed milk and cream.
4) To learn the importance of butter and cheese.
5) To understand the importance of the ice-cream and milk product.

UNIT I: Milk **10 hrs**

Present status of milk & milk products in India and abroad; market milk- Composition of milk of various species, quality evaluation and testing of milk, procurement, transportation and processing of market milk, cleaning & sanitization of dairy equipments. Special milks such as flavored, sterilized, recombined & reconstituted toned & double toned.

UNIT II: Nutrients of Milk **10 hrs**

Milk lipids-terminology and definitions -Milk proteins: Physical properties of milk proteins-Electrical properties and hydration, solubility. Reaction of milk proteins with formaldehyde and ninhydrin. - Milk Carbohydrate-Lactose-Estimation of lactose in milk. -Milk vitamins-water and soluble vitamins, effect of heat and light on vitamins.

UNIT III: Condensed milk and Cream **10 hrs**

Condensed milk- Definition, methods of manufacture, evaluation of condensed & evaporated milk, dried milk- Definition, methods of manufacture of skim & whole milk powder, instantiation, physiochemical properties, evaluation, defects in dried milk powder. Cream: Definition, classification, composition, cream separation, sampling, neutralization, sterilization, pasteurization & cooling of cream, evaluation, defects in cream.

UNIT IV: Butter and Cheese **5 hrs**

Butter- Definition, composition, classification, methods of manufacture, theories of churning, evaluation, defects in butter.

Cheese: Definition, composition, classification, methods of manufacture, cheddar, Swiss, cottage and processed cheese, evaluation, defects in cheese.

UNIT V: Ice cream **10 hrs**

Ice cream- Definition, composition and standards, nutritive value, classification, methods of manufacture, evaluation, defects in ice cream and technology aspects of softy manufacture. Indigenous milk products - Present status, method of manufacture of yoghurt, Dahi, khoa, burfi, kalakand, gulab jamun, Rasogulla, shrikhand, Paneer, ghee, lassi etc; probiotic milk products.

COURSE OUTCOME

1) Identify the importance of dairy chemistry.
2) The students will be able to understand the nutrients of milk.
3) Acquire knowledge of milk nutrients.
4) Appreciate the importance of butter and cheese.
5) Acquire knowledge of ice – creams and milk products.

Text Books

1) Aneja, R. P., Mathur, B. N., Chandan, R. C. & Banerjee, A. K. (2002). *Technology of Indian Milk Products*. Dairy India Publications.
2) Setal, R. N. (2008). *Fundamentals of Dairy Technology Theory & Practices*. Himanshu Publishers.

Supplimentary Readings

1) Web, B. H., Johnson, A. H., & Lford, J. A. (1987). *Fundamental of Dairy Chemistry*. (3rd ed.). AVI Publishers.
2) Spreer, E. (1993). *Milk and Dairy Products*. Marcel Dekker.
3) Walstra, P. (1999). *Dairy Technology*. Marcel Dekker.

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	2	3
CO2	2	3	2	3	2
CO3	2	2	3	2	2
CO4	3	2	3	2	3
CO5	2	3	3	2	2

SEMESTER: III OPEN ELECTIVE – II	22PCHEO37-3: AGRICULTURAL CHEMISTRY	CREDIT: 3 HOURS: 3/W

COURSE OBJECTIVES

1) To make the students aware of different soils.
2) To understand the classification of manures
3) To make the students to learn about the different types of fertilizers.
4) To understand the usage of pesticides and insecticides.
5) To learn the importance of fungicide and herbicide.

UNIT I: Soils **10 hrs**

Classification and properties of soils – soil water, soil temperature, soil minerals, soil structure- bulk density – porosity – consistence – soil color - soil acidity and soil testing.

UNIT II: Manures **5 hrs**

Bulky organic manures – green manure – compost manure–Farmyard manure– handling and storage. Oil cakes. Blood meal – fish manures.

UNIT III: Fertilizers **9hrs**

Effect of Nitrogen, potassium and phosphorous on plant growth – commercial methods of preparation of urea, triple super phosphate. Complex fertilizers and mixed fertilizers – their manufacture and composition. Secondary nutrients – micronutrients – their function in plants.

UNIT IV: Pesticides and Insecticides **10 hrs**

Pesticides – classification of Insecticides, fungicides, herbicides as organic and inorganic – general methods of application and toxicity. Safety measures when using pesticides. Insecticides: Plant products– Nicotine, pyrethrin – Inorganic pesticides – borates. Organic pesticides – D.D.T. and BHC.

UNIT V: Fungicides and Herbicides **10 hrs**

Fungicide: Sulphur compounds, Copper compounds, Bordeaux mixture. Herbicides: Acaricides– Rodenticides. Attractants– Repellants. Preservation of seeds.

COURSE OUTCOMES

The student will be able to

1) Analyze the characteristics of different soils.
2) Acquire knowledge on the various types of manures.
3) Differentiate between different types of fertilizers.
4) Appreciate the usage of different pesticides with caution.
5) Illustrate the importance of types of herbicides and preservation of seeds.

TEXT BOOKS:

1) Austin shreve, G. T. (1984). *Chemical Process Industries* (5th ed.). Mc-Graw-Hill.
2) Yagodin, B. A, (1976). *Agricultural Chemistry* (Vol. 2). Moscow: Mir Publishers.
3) Sharma, R. L. (2022). *Agricultural Chemistry* (1st ed.). Evince Publishing.

Supplementary Readings

1) Rajeswari, R. (2014). *Elements of Agricultural Chemistry*. Satish Serial Publishing.
2) Tolanur, S. *Solid Science and Agricultural Chemistry* (2nd edn.). CBS Publishers.
3) Fraps, C. S. (2020). *Principles of Agricultural chemistry* (2nd edn.). Kopykitab Publishers.
4) Yasshona, D. S., & Aher, S. B. (2021). *Soil Science and Agricultural Chemistry*. NIPA Publishers.

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	3	2
CO2	2	2	2	3	2
CO3	2	3	2	2	3
CO4	3	2	3	3	2
CO5	2	2	3	2	2

SEMESTER: IV CORE: X	22PCHEC41: ORGANIC CHEMISTRY- IV	CREDIT: 4 HOURS: 4/W

COURSE OBJECTIVES:

1) Develop problem solving skills requiring application of chemical reaction.
2) To understand the different reagents and their applications.
3) To learn the importance of Proteins and nucleic acid
4) To learn the chemistry of terpenes and alkaloids and their importance.
5) To study about the mechanisms of different rearrangements

UNIT I: Modern Synthetic Methods, Reactions and Reagents 12 hrs

Synthesis of simple organic molecules using acetylation and alkylation of enamines, Retrosynthetic Analysis: Basic principles and terminology of retrosynthesis, one group and two group C-X disconnections, one group C-C and two group C-C disconnections, amine and alkene synthesis. Protection and deprotection of functional groups (R-OH, R-CHO, RCO-R, R-NH2 and R-COOH). Uses of the following reagents: DCC, Trimethylsilyl iodide, 1,3-Dithiane (Umpolung), and diisobutyl aluminium hydride (DIBAL).

UNIT II: Important Reagents and Name reactions 12 hrs

Chemistry of enolates and enamines, Kinetic and Thermodynamic enolates, Lithium and boron enolates in Aldol and Michael reactions, Alkylation and acylation of enolates, Nucleophilic additions to carbonyls; Organolithium, Organomagnesium, Organozinc, Organocopper reagents (restricted to 1,4-addition) in synthesis, Name reactions under carbanion chemistry - Knoevenegal, Acyloin condensations, Shapiro reaction, Peterson olefination,Julia olefination. Ylids: Chemistry of Phosphorous and Sulfur ylids - Wittig and related reactions.

UNIT III: Proteins and Nucleic Acids 12 hrs

Proteins - peptides and their synthesis - synthesis of tripeptide - Merrifield synthesis -determination of tertiary structure of protein - biosynthesis of proteins - nucleic acids -types - DNA & RNA polynucleotide chain - components - biological functions – structure and role of (genetic code) DNA and RNA (nucleotides only).

UNIT IV: Terpenes and Alkaloids 12 hrs

Introduction - classification - isoprene rule - structural determination of terpenoids -Citral, geraniol - linalool - farnesol - α-pinene and camphor.

Introduction - isolation of alkaloids - total synthesis of quinine - morphine and reserpine. Biosynthesis of Cholesterol.

UNIT V: Molecular Rearrangements 12hrs

A detailed study with suitable examples of the mechanism of the following rearrangements: Wagner - Meerwein, Pinacol - Pinacolone, Demjanov, Dienone - Phenol, Favorskii, Baeyer - Villiger, Dakin, Hofmann- Lofler-Freytag – Sommlet-Hauser-Stevens and Von Richter, and Wolff Rearrangements.

COURSE OUTCOMES

The student will be able to

1) Develop problem solving skills requiring application of chemical reaction.
2) Use important reagents in the modern synthetic methods
3) Acquire knowledge of terpenes and alkaloids.
4) Elucidate the structure of proteins and nucleic acids.
5) Solve problems related to rearrangements.

Text Books

1) Conn, E. E., Stumpf, P. R., Bruening, G., & Dole, R. H. *Outlines of Biochemistry*. (5th Edn.). John Wiley and Sons.
2) Warren, S. *Work book for organic synthesis, The Disconnection Approach*. Asia: John Wiley & Sons Pvt. Ltd.
3) Finar, I. L. *Organic Chemistry* (5th edn., Vol. II.). ELBS publication.
4) March, J. *Advanced organic reaction mechanism and structure*. Tata McGraw Hill.

Supplementary Readings

1) Smith, L., Hill, R. L., Lehman, I. R., Lefkowitz, R. J., Handlar, P., & White, A. *Principles of Biochemistry General Aspects* (VII Edition.). McGraw Hill Int.
2) Stryer, L. *Biochemistry*. New York: Freeman and Co.,
3) Agarwal O. P. *Chemistry of Organic Natural Products*. Meerut: Goel Publishing House.
4) Parmer, V. S., & Chawla, H. M. *Organic reaction mechanisms*, S. Chand and Co.
5) Mukherji, S. M., & Singh, S. P. (1990). *Organic Reaction Mechanism*. Chennai: MacMillan India Ltd.

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	**3**	**3**	**2**	**3**	**2**
CO2	**3**	**3**	**3**	**3**	**3**
CO3	**2**	**2**	**3**	**3**	**3**
CO4	**3**	**3**	**2**	**2**	**3**
CO5	**2**	**2**	**3**	**2**	**2**

SEMESTER: IV CORE: XI	22PCHEC42: PHYSICAL CHEMISTRY- IV	CREDIT: 4 HOURS: 4/W

COURSE OBJECTIVES

1) To understand the behavior of electrolytes in solution and to familiarize the structure of the electrode surface and the applications of electrode processes.
2) To differentiate electrode kinetics from other types of kinetic studies
3) To know the applications of electro analytical Techniques
4) To understand the electronic spectroscopy
5) To know the applications of Laser devices

UNIT I: Electrochemistry-I **12 hrs**

Debye-Huckel-Onsager theory and its derivation –Debye –Falkanhagen and Wein's effects – extension to Debye-Huckel Onsager theory. Activity of ions in solutions-mean ionic activity coefficients-experimental determination – Debye-Huckel limiting law-modification for higher concentrations – Bjerrum model. Electrochemical cells-Electrode –Electrolyte equilibrium-thermodynamic quantities from emf data -Nernst equation for electrode potential and emf of a cell – classification of electrodes (electrodes of I kind, II kind, redox and membrane) – electrolyte concentration cells (with and without transference) – liquid junction potential – its elimination – applications of concentration cells. Electrochemical energy storage systems- primary and secondary cells-Fuel cells (efficiency-advantage-types)

UNIT II: Electrochemistry – II **12 hrs**

Electrical double layer – theory of multiple layers at electrode- (Guoy Chapman, Stern and Helmholtz model) – double layer capacity – Electrokinetic phenomena, zeta potential and electro osmotic velocity, zeta potential and streaming potential – determination of zeta potential and interpretation of zeta potential values. Process at electrodes-Butler-Volmer equation-high and low field approximation-Tafel equation Electrochemical corrosion of metals, constructions and use of Pourbaix and Evans Diagrams and prevention of corrosion.

Unit III: Electro Analytical Techniques **12 hrs**

Polarography - Experimental set up - Advantages of dropping mercury electrode Supporting electrolyte - Maxima suppressor - Residual current - Migration current -Diffusion current -Polarogram, half wave potential - Ilkovic equation (derivation is not required) - Outline of applications (Polarogram of Zn^{2+} and Cd^{2+})- Cyclic voltametry, Principle, Experimental set up -Cyclic voltammogram of Fe^{2+} in H_2SO_4 - Anodic peak current - Cathodic peak current -Electrochemically reversible couple - Cathodic peak potential - Electrochemically irreversible couple - Outline of applications.

UNIT IV: Electronic Spectroscopy **12 hrs**

Electronic spectra - Electronic spectra of diatomic molecules - Born - Oppenheimer approximation- vibrational coarse structure- Franck – Condon Principle-, Dissociation energy and dissociation products - rotational fine structure of electronic vibration -vibration transition -Fortrate Diagram. Electronic angular momentum in diatomic molecules-spectrum of Molecular hydrogen - Molecular photoelectron spectroscopy - UV photo electron spectroscopy and X-ray photo electron spectroscopy.

UNIT V: Laser Devices and Their Applications **12 hrs**

Principle - pumping He-Ne laser Carbon dioxide laser, semic onductor laser holography recording and reconstruction-applications laser induced fusion process- stimulated Raman scattering laser in isotope separation lidar-laser tracking- lasers in industry and medicine.

COURSE OUTCOMES

At the end of this course, the students will be able

1) To analyse the fundamental concepts of atoms and molecules and their arrangements indifferent energy levels by statistical approach.
2) To apply the mathematical concepts in chemical systems at molecular level.
3) To predict the application of electrical energy in chemical phenomena.
4) To understand the laser devices and applications.

Text Books

1) Silbey, R. J., Alberty, R. A. (2006). *Physical Chemistry*. New York: John Wiley and Sons.
2) Barrow, G. M. (1964). *Introduction to Molecular Spectroscopy*. New York: McGraw-Hill.
3) Banwell, C. N. & McCosh, E. M. (2000). *Fundamentals of Molecular Spectroscopy* (4th Edition.). New Delhi: TataMcGraw-Hill.
4) Raman, K. V., Gopalan, R . , & Raghavan, P. S. (2004). *Molecular Spectroscopy* Singapore: Thomson and VijayNicol.
5) Puri, B. R., Sharma, L. R., & Pathania, M. S. (2017). *Principles of Physical Chemistry*. Jalandar: Vishal Publishing Co.,

SUPPLEMENTARY READINGS

1) Berry, R. S., Rice, S. A., & Ross, J. (2000). *Physical Chemistry*. New York: Oxford University Press.
2) Sears, F.W. (1972). *Thermodynamics, "Kinetic theory of Gases and statistical mechanics*" (2nd Edition.). Wesley.
3) Metiu, H. (2006). *Physical chemistry- Thermodynamics*. Taylor and Francis.
4) Atkins, P., & Atkins, J. D. P. (2018). *Physical Chemistry*. Oxford: Oxford University Press.
5) Castellan, G.W. (2002). *Physical Chemistry*. New Delhi: Narosa Publishing House.

6) Silbey, R. J., Alberty, R. A. (2006). *Physical Chemistry*. New York: John Wiley and Sons.
7) Mathews, P. (2003). *Advanced Chemistry.* New Delhi: Foundation Books.
8) GlasstSone, S. (2006). *Introduction to Electrochemistry*. New Delhi: Prentice Hall.
9) Crow, D. R. (1994). *Principles and Applications of Electrochemistry*. London: Chapman and Hall.

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	**2**	**2**	**3**	**2**	**3**
CO2	**2**	**2**	**3**	**3**	**2**
CO3	**3**	**2**	**2**	**2**	**2**
CO4	**2**	**3**	**2**	**3**	**3**
CO5	**2**	**2**	**3**	**2**	**3**

SEMESTER: IV CORE :VII PRACTICAL: III	22PCHEP43: ORGANIC CHEMISTRY PRACTICAL III	CREDIT: 3 HOURS: 4/W

Course Objectives

Enable the students to,

1) Estimate quantitatively the amount of phenol, aniline, glucose present in the given solutions & unsaturation of oils
2) Analyze the RM value of butter, saponification / Iodine values of oils
3) Extract the active constituents of milk and tea
4) Elucidate the structure using spectral data

1. Estimations:

Estimation of phenol, aniline, methyl ketone, glucose & unsaturation.

2. Analysis of Oils

Reichart-Meissel value, Iodine value, Saponification value & Acetyl value.

3. Extraction & Estimation of Active Constituents

i) Lactose from milk
ii) Caffeine from tea
iii) Citric acid or ascorbic acid from a tablet or from a natural source.

4. Interpretation of Spectra of selected organic compounds

Spectral interpretation of organic Compounds using UV, IR, PMR and Mass Spectra of the following compounds

1) 1,3,5- Trimethyl benzene
2) Pinacolone
3) Benzyl bromide
4) Phenyl acetone
5) Acetone
6) Isopropyl alcohol
7) 2-N, N-Dimethylamino ethanol
8) Pyridine
9) 4-Picoline
10) 1,3-dibromo - 1, 1- dichloropropene
11) Cinnamaldehyde

COURSE OUTCOMES

The student will be able to

1) Experiment and estimate quantitatively the amount of phenol, aniline and glucose in the given solution.
2) Examine the degree of unsaturation in butter and oils.
3) Elucidate the structure of organic compound using spectral data.
4) Separate Caffeine from tea.
5) Extract citric acid from natural source.

Text Book

1) Mann, F. G. & Saunders, B.C. (2009). *Practical Organic Chemistry* (4th Edn.). Pearson Education.
2) Jeffery, G. H., Bassett, J., Mendham, J., & Denney, R. C. (2009). *Vogel's Text Book of Quantitative Chemical Analysis* (6th Edn.). Pearson Education.

SCHEME OF VALUATION:

Semester Examination	**Marks (60)**
Estimation	30
Spectra	10
Viva - voce	10
Record	10
Total	60

OUTCOME MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	**2**	**3**	**3**	**3**	**2**
CO2	**3**	**3**	**2**	**2**	**3**
CO3	**3**	**2**	**3**	**3**	**2**
CO4	**3**	**2**	**3**	**3**	**3**
CO5	**2**	**3**	**2**	**3**	**3**

SEMESTER: IV CORE:VIII	22PCHEP44: INORGANIC CHEMISTRY PRACTICAL III	CREDIT: 4 HOURS: 3/W

COURSE OBJECTIVES

To develop skills in the determination of a metal ion in presence of another by appropriate techniques.

Quantitative analysis

1) Determination of Ba^{2+} and Ca^{2+} ions
2) Determination of Cu^{2+} and Ni^{2+} ions
3) Determination of Cu^{2+} and Zn^{2+} ions
4) Determination of Cu^{2+} and SO_4^{2-} ions
5) Determination of Ca^{2+} and Mg^{2+} ions
6) Analysis of pyrolusite

LIST OF SPECTRA TO BE GIVEN FOR INTERPRETATION.

1) 31p NMR Spectra of methylphosphate
2) 31p NMR Spectra of HPF_2
3) 19F NMR Spectra of CIF_3
4) 1H NMR Spectra of Tris (ethylthioacetanato) cobalt (III)
5) Explain high resolution I H NMR spectra of (N-propylisonitrosoacetylacetoneuninato) (acetylacetonato) Nickel (II)
6) ESR Spectra of the aqueous $ON(SO_3)^{2-}$ ion.
7) ESR Spectra of the H atoms in CaF_2.
8) ESR Spectra of the $[Mn\ (H_2O)_6]^{2+}$.
9) ESR Spectra of the bis (salicylaldiminato) copper (II)
10) IR Spectra of the sulphato ligand.
11) IR Spectra of the dimethylglyoxime ligand and its Nickel (II) complex.
12) IR Spectra of carbonyls
13) Mossbauer spectra of $FeSO_4\ 7H_2O$
14) Mossbauer spectra of $FeCl_3$.
15) Mossbauer spectra of $[Fe\ (CN)_6]^{3-}$
16) Mossbauer spectra of $[Fe\ (CN)_6]^{4-}$

COURSE OUTCOMES:

At the end of the course, the student will be able to

1) Acquire the necessary practical skills to independently determine inorganic ions.
2) Gain expertise in the systematic analysis of inorganic compounds.
3) Apply the knowledge in industries.

TEXT BOOK:

1) Vogel, A. I., (2015), *Quantitative Inorganic Analysis,* 5th Ed., Prentice Hall.US.

Scheme Of Evaluation

UNIVERSITY EXAMINATION	**MARKS (60)**	**INTERNL ASSESSMENT**	**MARKS (40)**
Estimation of mixture containing two metal ions		Results in regular practical's	20
Gravimetric	10	ATTENDENCE	20
Volumetric	15		
Procedure	05		
Spectra	10		
Viva	10		
Record	10		

OUTCOME MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	**3**	**2**	**2**	**3**	**2**
CO2	**3**	**2**	**2**	**2**	**3**
CO3	**2**	**3**	**3**	**2**	**3**
CO4	**3**	**2**	**3**	**2**	**3**
CO5	**2**	**3**	**2**	**3**	**2**

SEMESTER: IV CORE:IX	22PCHEP45: PHYSICAL CHEMISTRY PRACTICAL - III	CREDIT: 3 HOURS: 4/W

COURSE OBJECTIVES

1) To analyze physical parameters using some instrumental techniques.
2) To understand the principle behind the qualitative and quantitative measurements.
3) To impart skill in the measurement of physical parameters.

EXPERIMENTS

1) Persulphate – iodide kinetics – clock reaction – Primary salt effects
2) Potentiometric redox titration of $KMnO_4$ with KI or Fe^{2+} or Ce^{4+} and determination of standard redox potential.
3) Determination of activity and activity coefficient of ions
4) Conductometric estimation of the components of buffer.
5) Conductometric precipitation titration of $BaCl_2$ with $MgSO_4$ and K_2SO_4.
6) Potentiometric estimation of mixture of weak and strong acids.
7) Evaluation of E_a by studying the kinetics of acid catalysed hydrolysis of ethyl acetate.
8) Determination of molecular weight by Rast method.
9) Determination of critical solution temperature of phenol-water system and study of the effect of NaCl on miscibility temperature.
10) Determination of pH of buffer solution-Potentiometry
11) pH metry- dissociation constant of monobasic acid
12) pH metry- dissociation constant of dibasic acid
13) pH metry- dissociation constant of tribasic acid

COURSE OUTCOMES

At the end of this course, the students will be able

1) To handle different instruments such as conductometer and potentiometer.
2) To carry out quantitative estimations.

Text Books

1) Levitt, B.P. (1985). *Findlay`s Practical Physical Chemistry*. (9th Ed.). London: Longman.
2) Gurtu, J. N. & Kapoor, R. (1987). *Advanced Experimental Chemistry* (Vol. I). New Delhi: S. Chand & Co.
3) Sundaram., Krishnan., & Raghavan. (1996). *Practical Chemistry* (Part II) S. Viswanathan and Co. Pvt.

SUPPLEMENTARY READINGS:

1) Shoemaker, D. P., Garland, C. W., & Nibler, J. W. (1989). *Experiments in Physical Chemistry* (5th Edn.). McGraw- Hill Book company.

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	2	3	2	2	3
CO2	2	2	3	2	2
CO3	2	3	3	3	2
CO4	3	3	3	2	2
CO5	2	3	2	3	3

SEMESTER: IV CORE ELECTIVE-III	22PCHEP46-1: BIOINORGANIC CHEMISTRY	CREDIT:4 HOURS:4/W

COURSE OBJECTIVES:

1) To have a knowledge about protein metallo biomolecules and the role of metal ions in biological process.
2) To learn about essential and trace metal ions in biochemical system
3) To learn about respiratory proteins and model compounds for oxygen carriers in biological system
4) To learn about the nitrogen fixation, biological redox reaction and photosynthesis
5) To learn about medicinal bio-inorganic chemistry/chelation therapy.

UNIT I: Essential and Trace Metal Ions 12hrs

Alkali and alkaline earth and transition metal cations. Crown ethers, Na & K ion transport, Metal ion toxicity in biochemical system. Bio membranes and calcium carriers.

UNIT II: Respiratory Proteins 12 hrs

Heme-oxygen carrier: Introduction, Models for transports Heme iron proteins, porphyrin system, substituent effects. Oxygen carriers- Haemoglobin, Myoglobin-structural characteristics and Bohr effect. Non-heme oxygen carriers: Hemerythrin and hemocyanin, Model compounds for oxygen carriers- Cobalt Schiff base, Vaska's complexes.

UNIT III: Metalloenzymes (Redox and Non-Redox) / Metal Ion Transport and Storage 12 hrs

Hydrolases: Carboxypeptidase, carbonic anhydrase, alkaline phosphatase and other dinuclear phosphatases and hydrolases. Electron Transfer Proteins: Blue copper, Iron-Sulphur proteins – Ferridoxins & Rubredoxin, and cytochromes. Redox enzymes: Cu, Zn, SOD and Cytochrome P450, Manganese enzyme and xanthine oxidase. Haem enzymes- peroxidase and catalase.

UNIT IV: Nitrogen Fixation and Photosynthesis 12 hrs

Nitrogenase enzyme: Introduction, Types of nitrogen fixing microorganism, metal clusters in nitrogenase. Nitrogen fixation pathway. Transition metal complexes: Dinitrogen complexes. Biological redox reactions. Photosynthesis and chlorophyll.

UNIT V: Medicinal Bio-Inorganic Chemistry/Chelation Therapy 12hrs

Pt-complexes in cancer therapy: Cisplatin and its mode of action, cytotoxic compounds of other metals. Gold containing drugs as antirheumatic agents and their mode of action, Lithium in psychopharmacological drugs. Metal complexes as probes of nucleic acid: Function of metal ions in genetic regulation, Metal DNA and RNA interactions – potential binding sites.

COURSE OUTCOMES

1) To enable the students to understand the importance of trace elements in biological system and also the toxicity of metal ions
2) To enable the students to understand the importance of transport heme iron proteins and non heme oxygen carriers
3) To enable the students to understand the structure and functions of various types of metallo enzymes and the importance of transport and storage protein in biological systems.
4) To enable the students to understand the structure and functions of nitrogenase enzyme and structure of chlorophyll
5) To enable the students to understand the importance of medicinal bioinorganic chemistry and chelation therapy.

Text Books

1) Hay, R. W. (1984). *Bioinorganic chemistry*. Halsted Press.
2) Lippard, S. J., & Berg, J. M. *Principles of Bioinorganic Chemistry* (2nd Ed.). Panima Publishing Corporation.
3) Cotton, F.A. & Wilkinson G. W. (1988). *Advanced Inorganic Chemistry* (5th Ed.). John Wiley & Sons.

Supplementary Readings

1) Huheey, J. E., & Keiter, E. A. (1993). *Inorganic Chemistry*, *Principles of Structure and Reactivity*. (4th Ed.) Harper Collins.
2) Hughes, M. N. (1985). *Inorganic Chemistry of Biological Processes* (2nd Edition.). John Wiley & Sons.
3) Kaim, W. & Schwederski, B. (1994). *Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life (An Introduction and Guide)*. John Wiley and Sons.

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	**3**	**2**	**2**	**2**	**3**
CO2	**2**	**3**	**3**	**2**	**2**
CO3	**2**	**2**	**2**	**3**	**2**
CO4	**3**	**2**	**2**	**3**	**2**
CO5	**2**	**3**	**2**	**2**	**3**

SEMESTER: IV CORE ELECTIVE :III	22PCHEE46-2 : INDUSTRIAL ELECTROCHEMISTRY	CREDIT: 4 HOURS: 4/W

COURSE OBJECTIVES

1) To enable the students to gain knowledge in corrosion and its control
2) To enable the students to understand about batteries and Fuel Cells.
3) To Study the electro plating methods and inorganic conversion coatings.
4) To learn the methodologies involved in electro metallurgy and electro chemicals.
5) To acquire knowledge in photo electrochemistry and its applications.

Unit I: Corrosion and Its Control **12 hrs**

Basic aspects of corrosion - Importance of corrosion studies- EMF and Galvanic series- classification of corrosion- theories of corrosion- corrosion kinetics- Pourbaix diagram for Fe-H_2O system – Passivation- High temperature corrosion. Forms of corrosion- Atmospheric corrosion- Biological and marine corrosion – Corrosion monitoring techniques. Cathodic and Anodic Protection - Anodic protection – Corrosion inhibitors- vapour phase Inhibitors-Green inhibitors-oil well inhibitors (Acidizing inhibitors).

Unit II: Industrial Metal Finishing **12 hrs**

Principles of Electroplating- Metal deposition from solutions of simple and complex salts – measurement of current density, throwing power- and current efficiency of electroplating bath – surface preparation for electroplating. Electroplating of Nickel and copper. Electroless plating and its advantages and limitations - Alloy plating of brass and Pb-Sn alloy- Composite deposition – **Inorganic conversion coatings:** phosphating and chromating - Anodizing: principle, types of anodizing, colouring of anodized aluminium, applications. Electro-polishing and its advantages.

Unit III: Batteries and Fuel Cells **12hrs**

Primary Batteries: Basic electrochemical reactions and performance characteristics of the following primary batteries such as Laclanche dry cell, Metal-air cells, bottom cells (Alk.MnO_2/Zinc, Mercury oxide cell and Li-cells; Reserve batteries: Water activated batteries such as Mg/AgCl and Mg/CuCl systems. Secondary Batteries: Lead acid, Ni-Cd, Ni-Metal hydride, Li-ion batteries- Zn-ion batteries; Electrochemical supercapacitors- EDLC, Pseudo, and hybrid supercapacitors. Fuel Cells: Proton exchange membrane fuel cells (PEMFC); Alkaline fuel cell, Phosphoric fuel cell and molten carbonate fuel cell, Direct methanol fuel cells (DMFC); Solid-oxide fuel cells (SOFC).

Unit IV: Electrometallurgy and Electro chemicals **12 hrs**

Electro-hydrometallurgy: Electro winning - Electro refinning – Electrolytic production of metal powders-Electroforming - Secondary metal recovery by electrochemical process - Electrochemical machining - Electrochemical Etching; **Electro-pyrometallurgy:** Production of Mg, Al, Ca, Li, Na; **Electro polymerization**: Anodic and cathodic polymerization – Electrochemical preparation of conducting polymers; Electrolytic production of hydrogen- Electrolytic synthesis of chlorates, perchlorates, hypochlorites - Chlor-alkali industry- Electrochemical fluorination – Electro-organic reduction –Electro-organic oxidation.

UNIT V: Photo-electrochemical systems **12 hrs**

Principles of Photo electrochemical cells - Types of Photo electrochemical cells- Organic photovoltaic cells, Dye Sensitized Solar Cells, Quantum dot (QD) Sensitized Solar Cells (QD-SSC), Perovskite solar cell - Photoelectro catalysts for water and waste water treatment and degradation of organic and organic compounds - Photoelectro catalysts for Hydrogen production.

COURSE OUTCOMES

At the end of the course, the student will be able to

1) Acquire knowledge in corrosion and its control.
2) Apply the electroplating methods, eletroless plating and inorganic conversion coating.
3) Develop an understanding of batteries and Fuel Cells.
4) Acquire broad knowledge in electro metallurgy and electrochemical.
5) Develop an understanding on basic principles of photo electrochemistry and its applications.

Text books

1) Bockris, J. O., & Reddy, A. K. N. (1998). *Modern Electrochemistry*. (Vol. I, IIa, Vol. IIB.). New York: Plenum Publication.
2) Bokaris, J. O., & Srinivasan, S. (1969). *Fuel Cells: Their electrochemistry*. New York: McGraw Hill Book Company.
3) Tiwari, A., Hihara, L., & Rawlins, J. (2014). *Intelligent coating for corrosion control* (1st edn.). Elsevier Publishers.
4) Bard, A. J., & Faulkner, L. R., (2000). *Electrochemical methods: Fundamentals and Applications* (2nd Edn.). John Wiley & Sons. Inc.
5) Linden Ed, D. (1995). *Handbook of Batteries* (2nd edn.). New York: McGraw-Hill.
6) Rifi, M. R., & Covitz, F. H. (1974). *Industrial Electrochemistry*. New York: Marcel Dekker Inc.
7) Popov, K. I., Djokic, S. S., & Grgur, B. N. (2002). *Fundamentals of Electrometallurgy*. Kluwer Academic Publishing.
8) Bard, J., & Faulkner, L. R. (2001). *Electrochemical methods - Fundamentals and Applications* (3rd Edn.). John Wiley & Sons.

Supplementary readings

1) Warren, S. (1979). *Designing Organic Synthesis*. India: John Wiley & Sons.
2) Nazri, G. A., & Pistoia, G. (2004). *Lithium Batteries: Science and Technology*. Dordrecht, Netherlands: Kulwer Acdemic Publishers.
3) Larmine, J., & Dicks, A. (2000), Fuel *Cell System Explained.* New York: John Wiley.
4) Manthiram, A. (2000). Science *and Technology of Lithium Batteries-Materials Aspects: An Overview*. Kulwer Academic Publisher.
5) Wakihara, M., & Yamamoto, O. (Eds.) (1998). *Lithium-Ion Batteries: Fundamentals and Performance*. Wein heim: Wiley –VCH.

CO- PO Mapping Table

	PO1	PO2	PO3	PO4	PO5
CO1	**3**	**2**	**2**	**2**	**3**
CO2	**2**	**3**	**3**	**2**	**2**
CO3	**2**	**2**	**2**	**3**	**2**
CO4	**3**	**2**	**2**	**3**	**2**
CO5	**2**	**3**	**2**	**2**	**3**

SEMESTER: IV CORE ELECTIVE:III	22PCHEE46-3: ADVANCED ANALYTICAL TECHNIQUES	CREDIT: 4 HOURS: 4/W

COURSE OBJECTIVES

The main outcomes of this course are to:

1) Know various methods involved in analytical techniques
2) Learn qualitative and quantitative measurements in the spectroscopy analysis.
3) Learn the separation process using various chromatographic technique.
4) Acquire knowledge in electro-analytical techniques.
5) Gain knowledge about TGA, DSC, DMA and TMA.

UNIT I: Spectroscopy Techniques 12 hrs

Photo Luminescent Spectroscopy and Laser Raman Spectroscopy - Fluorescence spectroscopy Atomic Spectroscopy – Sources of Atomic and Emission Absorption Spectra. Atomic spectroscopy based on flame atomization – flame atomizers, properties of flames, quantitative analysis. Flame Atomic Absorption Spectroscopy – Introduction, sources, instrumentation. Inductively Coupled flame atomic emission spectroscopy (ICP-AES).

UNIT II: Microscopy Techniques 12 hrs

Principle, Instrumentation applications of Scanning Electron Microscopy: SEM and FESEM -Transmission Electron Microscopy (TEM) – HRTEM- Scanning Tunneling Microscopy (STM), Atomic Force Microscopy AFM)- Optical and Confocal microscopy- Fluorescence Microscopy. Dynamic Light Scattering (DLS) technique.

UNIT III: Chromatography Technique 12 hrs

Solvent extraction – principles of ion exchange, paper, thin-layer and column chromatography techniques – columns, adsorbents, methods, R_f values, McReynold's constants and their uses – HPTLC, HPLC techniques – adsorbents, columns, detection methods, estimations, preparative column – GC-MS techniques – methods, principles and uses. **Super Critical Fluid Chromatography (SFC):** Characteristics of super critical fluids, Comparison of SFC with HPLC & GLC, Applications of SFC.

UNIT IV: Electroanalytical Techniques 12 hrs

Controlled current micro-electrode techniques: Comparison with controlled potentials methods, chrono potentiometry, theory ad applications. **Bulk Electrolysis Methods:** Controlled potential coulometry, Controlled Coulometry; Voltametric **techniques:** Irreversible - quasi-reversible voltammetry - linear scan and cyclic voltammetry- Stripping voltammetry- Hydrodynamic voltammetry - Use of RDE and RRDE. - Electrochemical impedance spectroscopy. **Bioelectrochemistry**: Bioelectrodics, Electrical conductance in biological organism: Enzymes as electrodes.

UNIT V: Thermo-analytical Techniques **12 hrs**

Principle, instrumentation and applications of thermogravimetry analysis (TGA), Differential Thermal Analysis (DTA), TGA & DTA curves of $CuSO_4.5H_2O$, $MgC_2O_4.H_2O$ & Ca $(OOCCH_3)_2.H_2O$ - Simultaneous DTA-TGA curves of $SrCO_3$ in air & $CaC_2O_4.H_2O$ in air & CO_2. Factors affecting TGA & DTA curves. ESCA- Basic principles, sources, instrumentation, applications and Differential Scanning Calorimetry (DSC). - Dynamic Mechanical Analysis (DMA) - Thermo-mechanical analysis (TMA).

COURSE OUTCOMES

At the end of this course, the students will be able

1) Apply HPLC, GC and SFC chromatographic techniques to identify the components.
2) Relate the concepts of SEM, FESM, TEM, HRTEM, HTM, AFM to identify the ultra-structure of molecules.
3) Infer the principle, instrumentation of coulometry, chronopotentiometry and bioelectrodes.
4) Classify thermo analytical techniques and to assess the thermal stability of a chemical compound
5) Perceive the principle, instrumentation and applications of thermoanalytical techniques.

Text Books

1) Skoog, D. A., West, D. M., Holler, F. J., & Crouch, S. R., (2012). *Fundamentals of Analytical Chemistry (*9th Edn.). Thomson Brooks/Cole Pub.
2) Sivasankar, B. (2014). *Instrumental Methods of Analysis*. Oxford University Press.
3) Bard, A. J. & Faulkner, L. R. (2001). *Electrochemical methods-Fundamentals and Applications* (3rd Edition.). John Wiley & Sons.
4) Thomas, S., Thomas, R., Zachariah, A. K., & Mishra, R. K. (2017). *Spectroscopic methods for nanomaterials characterization.* Amsterdam, Netherlands: Elsevier.
5) Srivastava, V. K. & Srivastava, K. K. (1985), Introduction *to Chromatography* (2nd Ed.). New York: Holden Day.
6) Kaur, H. (2008). *Instrumental methods of Chemical Analysis* (4th Edn.). Pragathi Publications.

Supplimentary Reading

1) Svehla, G., Suehla, G., Vogel, A. I. (2014). *Vogel's Quantitative Inorganic Analysis* (7th Edn.). Pearson Education.
2) Fifield, F.W., & Kealey, D. (2004). *Principles and Practice of Analytical Chemistry* (1st Indian Reprint.). Blackwell Pub.
3) Bockris, J. O'M., & Reddy, A. K. N. *Modern Electrochemistry* (Vol. I, IIa, Vol. IIB.). New York: Plenum Publication.

4) Willard, H. H., Merritt, L. L., Dean, J. A., & Settle, F. A. (2004). *Instrumental Methods of Analysis* (7thRevised edition.). Wadsworth Publishing Company.
5) Braithwaite, A. & Smith, J. F. (1995). *Chromatographic Methods* (5th Ed.). Germany: Springer.
6) Sharma, A., Schulman, S. G. (1999). *Introduction to Fluorescence Spectroscopy*. New York: Wiley-Interscience.
7) Banwell, C. N., & McCash, E. M. (1994). *Fundamentals of Molecular Spectroscopy* (4th Ed.). New Delhi: Tata McGraw-Hill.
8) Barsoukov, E., & Macdonald, J. R. (Editors). (2000). *Impedance Spectroscopy: Theory, Experiment, and Applications*. John Wiley & Sons (P) Ltd.
9) Flegler, S. L., Heckman, J. W., & Klomparens, K. L. (1993). *Scanning and Transmission Electron Microscopy: An Introduction*. WH Freeman & Co.

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	**2**	**3**	**2**	**3**	**2**
CO2	**3**	**2**	**3**	**3**	**2**
CO3	**2**	**3**	**2**	**3**	**3**
CO4	**3**	**3**	**3**	**3**	**2**
CO5	**3**	**2**	**3**	**2**	**2**

SEMESTER: IV	22PCHEP47: CORE PROJECT	CREDIT:6 HOURS: 6/W

Project with Viva Voce
Credit: 6
Duration: 3 Months **Total: 100 Marks**

CIA: 25 Marks
ESE: 75 Marks

COURSE OBJECTIVES

Make the students to

1) Understand the importance of experimental analysis, scientific approach in solving problems related to the environment and society
2) Educate and train the students to write scientific papers.

Individual Project and Viva Voce

Each faculty will be allotted 2/3 students. A specific problem will be assigned to the students or they will be asked to choose a problem/area of interest. The topic/area of work will be finalized at the end of III semester, allowing scope for the students to gather relevant literature during the vacation. The research work can be carried out in the college or at any other organization approved by the guide and the HOD. Viva Voce/presentation will be conducted by a panel comprising of HOD, internal / external examiners. A power point presentation by the student before the audience will be evaluated on the basis of student's response to the questions.

Suggested areas of work

Synthetic Organic Chemistry, Coordination Chemistry, Corrosion Studies, Environmental Chemistry, Polymer Chemistry, Phytochemistry, Nanochemistry, Physical Chemistry.

Methodology

Each project should contain the following details:

1) Brief introduction on the topic
2) Review of Literature
3) Materials and Methods
4) Results and Discussions – evidences in the form of figures, tables and photographs
5) Conclusion / Summary
6) Bibliography

Evaluation - Total - 100 Marks (Internal – 25 marks, External – 75 marks)

Internal Total - 25 marks

I Review – Selection of the field of study, Topic & Literature collection - 5 marks

II Review – Research Design and Data Collection - 10 marks

III Review – Analysis & Conclusion, Preparation of rough draft - 10 marks

External Total – 75 marks

Project Total – 60 marks

Relevance of the topic to the academic / society - 10 Marks

Objectives - 10 Marks

Experimental design - 20Marks

Expression of results and discussion - 20 Marks

Viva Voce Total – 15 marks

Presentation - 10 Marks

Discussion - 5 Mar3ks

PROGRAMME OUTCOME

1) To demonstrate systematic and coherent understanding of the fundamental concepts in physical Chemistry, Organic Chemistry, Inorganic Chemistry and all the other related chemistry subjects
2) Identify chemical formulae and acquire ability and skills to become expertise over solving both theoretical and applied chemistry pattern
3) Apply laboratory skills to solve unseen chemical problems both qualitative and quantitative by interpretation and manipulation of experimental data.
4) Ability to function as responsible individuals with ethical values, accountable to the community and to follow the correct procedures and regulations for safe handling and usage of chemicals.
5) Communicate effectively various aspects of chemistry to present chemical research results to a technically literate audience by means of an oral presentation, scientific poster or a written report.