PG AND RESEARCH DEPARTMENT OF CHEMISTRY
JAMAL MOHAMED COLLEGE (Autonomous), Tiruchirappalli-620 020
PG Programme – Course Structure under CBCS
(For the candidate admitted from the academic year 2017-2018 onwards)

SEM	Course Code	Course	Course Title	Ins. Hrs / Week	Credit	Marks		Total
						CIA	ESE	
I	17PCH1C1	Core– I	Structure, bonding, Acids-bases and Radioactivity	6	5	25	75	100
	17PCH1C2	Core – II	Nomenclature and Reaction Mechanism	6	5	25	75	100
	17PCH1C3P	Core– III	Inorganic Estimation and Complex Preparations - Practical	6	4	20	80	100
	17PCH1C4P	Core– IV	Organic Estimation and Chromatography-Practical	6	4	20	80	100
	17PCH1CE1A/B	Core Based Elective– I		6	4	25	75	100
	TOTAL			**30**	**22**			**500**
II	17PCH2C5	Core– V	Stereochemistry and Natural Products	6	5	25	75	100
	17PCH2C6	Core– VI	Group Theory and Spectroscopy	6	5	25	75	100
	17PCH2C7P	Core– VII	Inorganic Qualitative Analysis and Colorimetric Estimations - Practical	6	4	20	80	100
	17PCH2C8P	Core– VIII	Organic Preparations and Mixture Analysis - Practical	6	4	20	80	100
	17PCH2CE2A/B	Core Based Elective– II		6	4	25	75	100
	TOTAL			**30**	**22**			**500**
III	17PCH3C9	Core– IX	Inorganic Spectroscopy, Solid State and Bio-Inorganic Chemistry	6	5	25	75	100
	17PCH3C10	Core– X	Organic Spectroscopy and steroids	6	5	25	75	100
	17PCH3C11	Core– XI	Industrial Chemistry	6	4	25	75	100
	17PCH3C12P	Core– XII	Physical Chemistry Non-Electrical Practical	6	4	20	80	100
	17PCH3CE3A/B	Core Based Elective– III		6	4	25	75	100
	17PCH3EC1	Extra Credit Course - I	Analytical Techniques	-	5*	-	100	100*
	TOTAL			**30**	**22**			**500**
IV	17PCH4C13	Core– XIII	Surface Phenomena,Statistical thermodynamics and Phase rule	6	5	25	75	100
	17PCH4C14	Core– XIV	Polymer Chemistry	6	5	25	75	100
	17PCH4C15P	Core– XV	Physical Chemistry Electrical Practical	6	5	20	80	100
	17PCH4CE4A/B	Elective - IV		6	4	25	75	100
	17PCH4PW	Project		6	5	-	100	100
	17PCH4EC2	Extra Credit Course - II	Instrumentation and Separation Techniques	-	5*	-	100	100*
	TOTAL			**30**	**24**			**500**
GRAND TOTAL					**90**			**2000**

***Not considered for grand total and CGPA**

 # Core Based Electives

Semester	Course Code	Core Based Elective
I	17PCH1CE1A	Chemical Kinetics, Electrodics and Quantum Mechanics
	17PCH1CE1B	Quantum chemistry and Spectroscopy
II	17PCH2CE2A	Coordination Compounds and Spectral Characterization
	17PCH2CE2B	Spectroscopy of Inorganic Complexes and Organometallics
III	17PCH3CE3A	Special Topics in Chemistry
	17PCH3CE3B	Material Chemistry
IV	17PCH4CE4A	Nano and Green Chemistry
	17PCH4CE4B	Quality Control and Environmental Chemistry

SEMESTER-I: CORE-I
STRUCTURE, BONDING, ACIDS-BASES AND RADIOACTIVITY

Course Code : 17PCH1C1 **Max. Marks : 100**
Hours/Week : 6 **Internal Marks: 25**
Credit : 5 **External Marks: 75**

Objectives:

- *To study the structure of crystals and defects*
- *To learn the concepts of covalent and co-ordinate bonds*
- *To study, metallurgy, inorganic polymers and rings*
- *To understand modern concepts of acids and bases*
- *To study the detection of radioactivity and nuclear reactions*

UNIT– I **18 hours**

Crystal Structure

1.1 Packing of ions in crystals - Radius ratio rules – Calculation of limiting ratios for coordination number 3 to 6. Classification of ionic structures - AX type (ZnS, NaCl, NiAs, CsCl) and AX_2 type (CaF_2, TiO_2, CdI_2) - structures only.

1.2 Defects in crystals: # Schottky and Frankel defects#- stoichiometric and non-stoichiometric - Metal excess defects - F-Centre. Metal deficiency defects – Positive ion deficiency – extra interstitial negative ions. Semiconductor systems isoelectronic with silicon and their applications – as transistors, as photovoltaic cells. Superconductors – high temperature super conductors.

1.3 Lattice energy - Born - Lande equation – significance, Kapustinski equation.

UNIT– II **18 hours**

Covalent and coordinate bonds

2.1 Covalent bond - M.O. theory – Symmetry and overlap – construction of molecular orbitals in homo and hetero nuclear diatomic molecules. Iso electronic molecules and ions.

2.2 Coordinate bonds -Crystal field theory – Splitting of d-orbitals in O_h Symmetry – Strong and weak fields – CFSE – Calculation. Splitting in T_d symmetry and tetragonal symmetry - Jahn Teller distortion - splitting pattern in square planar. #Factors affecting the magnitude of 10 Dq value# - Nature of the ligands - Spectrochemical series, Jorgensen's relation. π bonding and M.O. theory - Ligands with filled and empty π orbitals – Nephelauxetic effect.

UNIT – III **18 hours**

3.1. **Extraction and Uses of Metals:** Metallurgy of Zr, Ge, Th and U –#uses of their important compounds.#

3.2. **Alloys and Intermetallic Compounds –** Effect of alloying – types of alloys – simple mixtures – solid solutions – substitutional alloys – Industrial alloys – Substitutional alloys - Intermetallic compounds – Hume – Rotherys rules – ferrous alloys , non – ferrous alloys – Al, Mg alloys, amalgams, alloy steels.

3.3. **Inorganic Polymers:** Phosphorus based network polymers, Coordination Polymers (Structure and properties).

3.4. **Rings:** Preparation and Structure of Borazines & Phosphazenes – Craigg and Paddock model - Dewar model – Preparation and Structure of sulphur-nitrogen ring system (S_4N_4, $N_4S_4F_4$)

UNIT-IV **18 hours**

Acids & Bases and solvents

4.1. Non-protonic concepts of acid-base reactions – Lux-Flood concept - Usanowich concept. Hard and soft acids and bases (HSAB Principle) – Classification, acid and base strength of hardness and softness – electro negativity of hardness and softness – applications of HSAB, Symbiosis. Differentiating and leveling solvents.

4.2. Solvents general behavior, P.T of ionizing solvents, classification- protic and aprotic solvent liq. NH_3, SO_2, CH_3COOH, BrF_3 and $^{\#}HF^{\#}$.

UNIT– V **18 hours**

Nuclear Chemistry

5.1. Radioactivity - orbital electron capture, nuclear isomerism, internal conversion.

5.2. Detection and determination of radioactivity: Nuclear radiation – Scintillation and Cherenkov Counter. Particle accelerators: Linear, Cyclotron, Synchrotron, Betatron and Bevatron - $^{\#}$Nuclear reactors$^{\#}$

5.3. Nuclear Reactions: Transmutation, Stripping and pick-up, Spallation, fragmentation and Scattering reactions – Sources of neutrons – Neutron activation and isotopic dilution analysis – applications.

TEXT BOOKS:

1. J. D. Lee – "A New Concise Inorganic Chemistry", 5th Edition, Oxford University Press, 2011.
2. Wahid Malik, G. D. Tuli and R. D. Madan, "Selected Topic in Inorganic Chemistry", S.Chand & Co., Ltd (2011).
3. H.J. Arnikar – "Essential of Nuclear Chemistry", 4th Edition, New Age International Publishers, 2011.

UNIT I : Text Book 1
UNIT II : Text Book 2
UNIT III : Text Book 1, 2
UNIT IV : Text Book 2
UNIT V : Text Book 3

REFERENCES:

1. G. Friedlander, J. W. Kennedy and J.M. Miller -"Nuclear and Radio Chemistry (2000).
2. Cotton and Wilkinson – "Advanced Inorganic Chemistry", 6th Ed., John Wiley & Sons, New York- 2004.

3. James E. Huheey, Ellen A. Keiter and Richard L. Keiter – "Inorganic Chemistry Principles of Structure and Reactivity", 4 th Edn., Pearson Education, 11th Impression, 2011.
4. Bodie E. Douglas and D. McDaniel, " Concepts and Models of Inorganic Chemistry", 3rd Wiley India Pvt. Ltd., New Delhi, 2006.
5. Maheswar Sharon and Madhuri Sharon – "Nuclear Chemistry" Ane books Pvt. Ltd, New Delhi -2009.
6. Peter Atkins, Tina Overton, Jonathan Rourke, Mark Weller and Fraser Armstrong – Inorganic Chemistry, 4th ed. Oxford University Press, New Delhi, 2010.

SEMESTER-I: CORE-II
NOMENCLATURE AND REACTION MECHANISM

Course Code : 17PCH1C2 **Max. Marks : 100**
Hours/Week : 6 **Internal Marks : 25**
Credit : 5 **External Marks : 75**

Objectives:

- *To make the students to know about the nomenclature of organic compounds.*
- *To learn the concepts of various methods of determination of reaction mechanism.*
- *To learn the various types of reactions and synthetic uses of different reagents.*

UNIT– I **18 hours**

1.1 **Nomenclature of organic compounds:** #IUPAC nomenclature of linear and branched alkanes, alkenes, polyenes and alkynes with and without functional groups#.
Nomenclature of alicyclic, bicyclic and tricyclic compounds with and without single functional groups. Heterocyclic systems containing not more than two hetero atoms such as oxygen, nitrogen and sulphur-fused ring systems.

1.2 **Carbohydrates:** Structure and biological importance of disaccharides (lactose, maltose), trisaccharides (raffinose), structural polysaccharides (cellulose, starch)

1.3 **Heterocyclic compounds**: Synthesis and reactions of azoles – Imidazole, Oxazole and Thiazole. Azepine - Oxazine, Thiazine and Pyrazine.

UNIT– II **18 hours**

2.1 **Reaction intermediates**: Singlet oxygen, nitrenes and benzyne – generation, statibility, structure and reactivity – Non-classical carbocations – definition, generation and stability.

2.2 **Methods of determining reaction mechanism:**
Energy profile diagrams - Thermodynamic and kinetic control of organic reactions – intermediate versus transition state - isotopic effects – kinetic and non – kinetic methods of determination of reaction mechanisms – product analysis and its importance – cross over experiment – isotopic labelling studies –stereo chemical studies.

2.3 **Correlation analysis**: Linear free energy relations – Hammett equation – significance of sigma and rho – applications, deviations and limitations –Taft equation and applications.

UNIT– III **18 hours**

3.1 **Aliphatic nucleophilic substitution reaction:**
$^{\#}SN^{1}$, SN^{2} and SN^{i} mechanisms$^{\#}$ - Effect of substrate structure, leaving group, attacking nucleophiles and solvent. Neighbouring group participation - Substitution in norbornyl and bridgehead systems - substitution at allylic and vinylic carbons – substitution by ambident nucleophiles.

3.2 **Aliphatic electrophilic substitution:**
S^{E}_{1}, S^{E}_{2} and S^{E}_{i} mechanism - Reactivity. Effect of substrate, leaving group, attacking

electrophiles and solvent. Keto-enol interconversion, Stark-Enamine reaction, halogenation of aldehydes and ketones and decarboxylation of aliphatic acids.

3.3 **Aromatic nucleophilic and electrophilic substitution:**

Aromatic nucleophilic substitution **-** Unimolecular, bimolecular and benzyne mechanisms. Zeigler alkylation, Sandmayer and Chichibabin reactions. Aromatic nucleophilic substitution –The Arenium ion mechanism- isotope effects- isolation of arenium ion intermediates- SE1 mechanism, orientation & reactivity in monosubstituted benzene rings, ortho/para ratio ipso attack, orientation in benzene rings with more than one substituents.

UNIT– IV **18 hours**

4.1 **Reduction Reactions:**

Reduction of CO to CH_2 in aldehydes and ketones - Wolff-Kishner reduction and Huang-Minlon modification. Ra-Ni, desulfurization of thioketal - Metal hydride reduction- Boron reagents ($NaBH_4$, $NaCNBH_3$,$Na(OAc)_3BH$), Aluminium reagents-$LiAlH_4$,Red Al.

4.2 **Oxidation Reactions:**

Dehydrogenation/oxidation of alcohols to aldehydes and ketones, chromium reagents such as $K_2Cr_2O_7/H_2SO_4$ (Jones reagent), CrO_3- pyridine (Collin's reagent), PCC (Corey's reagent), hypervalent iodine reagents (IBX, Dess-Martin periodinane) DMSO based reagents (Swern oxidation). Oxidation involving C-C bond cleavage using HIO_4, cycloalkanones using CrO_3, Oxidation of C=C using $NaIO_4$ and OsO_4, aromatic rings using RuO_4. Oxidation of aldehydes and ketones with H_2O_2 (Dakin reaction), with peracid(Baeyer-Villiger oxidation). Dess-Martin reagent.

4.3. Applications of Phase transfer catalysis (PTC), Crown ethers, Merrifield resin and Baker's yeast.

UNIT– V **18 hours**

5.1 **Addition Reactions:**

Addition to carbon – carbon multiple bonds – Electrophilic addition, nucleophilic and free radical additions, orientation and reactivity, Hydroxylation, Hydroboration, Epoxidation, Diels – Alder reaction. Michael addition, Ozonolysis, 1,3 – dipolar addition reaction Stereochemical studies in addition reactions.

5.2 **Elimination Reaction:**

#α-Elimination, β-elimination, E_1, E_2 # and E_1CB mechanism – stereochemistry of elimination – orientation of the double bond – effect of changes in the substrate, base, leaving group and medium on E_1, E_2, E_1CB reactions – elimination vs substitution – pyrolytic cis elimination – Bredt's rule- Chugaev reaction – dehydration of alcohols – dehydrohalogenation.

TEXT BOOKS:

1. Raj K. Bansal, Heterocyclic Chemistry, Wiley, 1990.
2. R. K. Bansal, Organic Reaction Mechanisms, Tata McGraw Hill, 1975.
3. M.K. Jain, S. C. Sharma, Modern Organic Chemistry, Vishal Publishing Company, New Delhi, 2014.

UNIT I : Text Book 1
UNIT II : Text Book 2
UNIT III : Text Book 3
UNIT IV : Text Book 3
UNIT V : Text Book 3

REFERENCES:

1. F.A. Carey and R. J. Sund berg – "Advanced organic chemistry" Vol. I and II– 3rd Ed., (1984), Plenum Publications.
2. S.P. Shukla and G.L.Trivedi – "Modern Organic Chemistry", Millinium Ed., (2000) Rajendran Ravidra Printers Pvt. Ltd., New Delhi.
3. O.P. Agarwal – "Reactions and Reagents in Organic Chemistry", 5th Ed., (2005), Goel Publishing House, Meerut.
4. J.N. Gurtu and R.Kapoor – "Organic Reactions and Reagents", 1st Ed., (1988), Sultan Chand Company Pvt. Ltd.
5. L.A. Pacesetter, Principles of modern heterocyclic chemistry W.A. Benzamin, 1968.

SEMESTER-I: CORE BASED ELECTIVE-I
CHEMICAL KINETICS, ELECTRODICS AND QUANTUM MECHANICS

Course Code: 17PCH1CE1A **Max. Marks : 100**
Hours/Week: 6 **Internal Marks: 25**
Credit: 4 **External Marks: 75**

Objectives:

- *To learn the applications of ARRT to solution kinetics, free energy change in solutions and kinetics and importance of different catalytic processes.*
- *To understand the kinetics of fast reactions.*
- *To study the concepts and applications of electrodics.*
- *To study the fundamentals of quantum chemistry.*

UNIT-I **18 hours**

Kinetics of Solution, Catalysis and Fast reactions

1.1 Factors influencing reaction rates in solution - application of ARRT to solution kinetics, effects of solvents, double sphere and single sphere model and effect of ionic strength - influence of pressure on rates in solution - significance of volume of activation.

1.2 Homogeneous catalysis: Acid-Base catalysis - Hammett-Deyrup acidity function - Bronsted relation - Enzyme catalysis - mechanism of single substrate reactions - Michaelis - Menten law - influence of pH and temperature.

1.3 Fast reactions: Study of kinetics by stopped flow technique, relaxation methods T and P Jump methods, [#]flash photolysis and magnetic resonance methods (NMR & ESR) [#]. (Problems from rate determination)

UNIT- II **18 hours**

Electro Kinetic Phenomena and Electrode Kinetics

2.1 [#]Debye -Huckel -Onsager theory of strong electrolytes, Debye Huckel limiting law[#], activity coefficient at higher concentration - Bjerrum model. Electrical double layer potential – Theory of multiple layers at electrode - Helmholtz, Goy-Chapmann, Stern, Devanathan models, electro kinetic phenomena – electrophoresis, electrosmosis, streaming potential and sedimentation potential - electro capillary phenomena .

2.2. Process at Electrode – Rate of Charge Transfer- Current Density – Butler-Volmer equation – Tafel equation.

2.3 Principles of Electro deposition of Metals, Electro chemical corrosion of Metals – Construction and use of Pourbaiux and Evans diagrams. Prevention of Corrosion – Electro Chemical oxidation and Reduction.

UNIT - III **18 hours**

Introduction to Classical and Quantum Mechanics

3.1. Classical mechanics – General principles, basic assumptions, postulates of classical mechanics, conservation laws, , Lagrange's and Hamilton's equations of motion (no derivation)[#]-Functions-Implict and explicit function-odd and even function- eigen functions and eigen values - orthogonality and normalization.

3.2. Operators - algebra of operators, commutation relations, commutators, linear, angular momentum, Laplacian, Hermitian and Hamiltonian operator, Hermitian property of operators.

3.3. Postulates of quantum mechanics – Solving the Schrodinger wave equation to simple systems viz., particle in a box – one and three dimensional, Bohr's correspondence principle. (Problems from 3.1 & 3.2)

UNIT - IV **18 hours**

Applications of Quantum Mechanics- I

4.1 Setting up Schrödinger wave equation and solving for harmonic oscillator, rigid-rotator, Hydrogen and hydrogen like atoms (He^+ and Li^{2+}), significance of n, l and m, shapes of atomic orbitals – radial and angular probability distribution functions.

4.2 Approximation methods - linear variation principle, application to hydrogen and helium atoms, perturbation method for non degenerate systems, application of perturbation theory to helium atom.

UNIT - V **18 hours**

Applications of Quantum Mechanics-II

5.1 Two electron systems – symmetric and anti-symmetric wave functions, spin of electrons and Pauli's principles and Slater determinant, self consistent field theory - Hartree-Fock Self Consistent field theory, Slater type orbitals – Slater rules, orbital energies.

5.2 Theory of chemical bonding (diatomic molecules) – Born-Oppenheimer approximation, LCAO – MO and VB treatments of the hydrogen molecule, Huckel molecular orbital (HMO) theory and its applications to conjugated systems –ethylene, allyl radical and butadiene(linear), #principle of hybridization – sp, sp^2 and sp^3#.

#_____# Self study.

TEXT BOOKS:

1. John O'M Bockris and Amulya K.N Reddy, "Modern Electrochemistry" Anne Book India, 2008.
2. Laidler, "Chemical Kinetics," 3rd edition, New Delhi TATA McGraw Hill Co., 1984.
3. Kuriacose and Rajaram, "Kinetics and Mechanism of Chemical transformation", Macmillan &Co., 1993.
4. A. K.Chandra, "Introductory Quantum Chemistry" 4th edition, Tata – McGraw Hill, 2010.
5. R. K. Prasad, "Quantum Chemistry", New Delhi, Wiley-Eastern Ltd, 1992.
6. J. M. Anderson, "Mathematics of Quantum Chemistry", I Edition, Massachusetts, W. A. Benjamine Inc. 1966.

UNIT I : Text Book 1,2
UNIT II : Text Book 2,3
UNIT III : Text Book 4,5
UNIT IV : Text Book 4,5
UNIT V : Text Book 5,6

REFERENCES:

1. F. L. Pillar, “Elementary Quantum Chemistry”, Tata-McGraw Hill, 1970
2. I. N. Levine, “Quantum Chemistry”, 4th edition, Prentice Hall OfInia, Pvt. Ltd, 1994.
3. D.A. McQuarrie, “Quantum Chemistry”, University Science Books, 1988.
4. P. W. Atkins, “Molecular Quantum Mechanics”, Clarendon 1973.
5. Anatharaman “Fundamentals of Quantum Chemistry”, McMillan, New Delhi, 2001.
6. D.R. Crow, “Principles and Applications of Electrochemistry”, 3rd edition Chapman and Hall, London, 1985.
7. P. H. Rieger, “Electro Chemistry”, Chapman Hall, U.S.A., 2010.
8. John Albery, “Electrode Kinetics”, Clarendon press, oxford, 1975.

SEMESTER –I: CORE BASED ELECTIVE-I
QUANTUM CHEMISTRY AND SPECTRODCOPY

Course Code : 17PCH1CE1B **Max. Marks : 100**
Hours/Week : 6 **Internal Marks: 25**
Credit : 4 **External Marks: 75**

Objectives:

- *To study the fundamentals and applications of quantum chemistry.*
- *To study the theoretical background of IR, Raman spectra and magnetic resonance spectroscopy.*

UNIT – I **18 hours**

Classical Mechanics and Quantum Mechanics

1.1. Classical mechanics – General principles, basic assumptions, postulates of classical mechanics, conservation laws, D'Alembert's principle, Lagrange's and Hamilton's equations of motion (no derivation). Operators- algebra of operators, commutation relations, commutators, linear, angular momentum, Laplacian, Hermitian, Hamiltonian and Ladder operators, eigen values and eigen functions, Hermitian property of operators, #orthogonality and normalization#.

1.2. Postulates of quantum mechanics – discussion of the Schrödinger wave equation to simple systems viz., particle in a box – one and three dimensional, quantum numbers, harmonic oscillator – zero-point energy, Bohr's Correspondence principle, rigid-rotator- rotational and vibrational quantum numbers, Hydrogen and hydrogen like atoms (He^+ and Li^{2+}), #significance of n, l and m, shapes of atomic orbitals – radial and angular probability distribution functions#.

UNIT-II **18 hours**

Application of Quantum Mechanics to Multi electronic Systems:

2.1. Approximation methods - linear variation principle, application to hydrogen and helium atoms, perturbation method for non degenerate systems, application of perturbation theory to helium atom.

2.2. Two electron systems – symmetric and antisymmetric wave functions, spin of electrons and Pauli's principles and Slater determinant, self consistent field theory - Hartrees theory, Hartree-Fock-Self-Consistent field theory, #Slater type orbitals – slater rules, orbital energies#.

2.3. Theory of chemical bonding (diatomic molecules)-Born-Oppenheimer approximation, LCAO- MO and VB treatments of the hydrogen molecule, Huckel molecular orbital (HMO) theory and its applications to conjugated systems - ethylene, allyl radical and butadiene(linear) principle of hybridization-sp, sp^2 and sp^3

#__# Self study

UNIT-III **18 hours**

3.1. **Theory of IR and Raman spectroscopy:**

Einstein coefficient of absorption and transition probabilities – basics selection rules – representation of spectra – the width and intensity spectral transitions – oscillator strength. Vibration spectra – selection rules – harmonic and anharmonic oscillators – hot band, overtones – Fermi resonance, combination bands, rotation – vibration spectra of diatomic molecules – transition for the rigid rotor – coupling of rotation and vibration– linear and perpendicular bonds – FT-IR spectroscopy. #PQR – branches#.

3.2. **Raman Spectroscopy:**

Raman Effect – elastic and inelastic scattering – selection rules – pure rotational and rotational-vibrational Raman spectra – polarization of light and Raman Effect – mutual exclusion principle –#Fermi resonance – laser Raman spectroscopy#.

UNIT – IV **18 hours**

4.1. **THEORY OF NMR-I**

Behavior of a bar magnet in a magnetic field – Magnetization vectors – resonance condition – relaxation process – Bloch equation – chemical shift and its measurement. Scalar Spin-Spin Coupling Mechanism – Nature of the Coupling, Direct Dipolar Coupling – NMR in Solids – magic angle spinning –#nuclear magnetic resonance imaging (NMRI) – principles and applications#.

4.2. FT-NMR – Principle, Measurements of T1 by FTS, Use of T1 for peak assignment.

UNIT – V **18 hours**

THEORY OF NMR-II

5.1. Second Order Spectra – Introduction, More Complicated Second Order System , Double Resonance and Spin Tickling Experiments - elementary idea, Spectral Simplification. Evaluation of thermodynamic data with NMR – Rate constants and activation energies from NMR – Determination of reaction orders by NMR #some application ofNMR kinetic studies#.

5.2. Two dimensional NMR –Theory of 2D NMR (preliminary)

TEXT BOOKS:

1. A. K. Chandra, "Introductory Quantum Chemistry" 4th edition, Tata – McGraw Hill, 2010.
2. R. K. Prasad, "Quantum Chemistry", New Delhi, Wiley-Eastern Ltd, 1992.
3. J. M. Anderson, "Mathematics of Quantum Chemistry", I Edition, Massachusetts, W. A. Benjamine Inc. 1966.
4. C. N. Banwell and E. M. Mccash, "Fundamentals of Molecular Spectroscopy", Tata McGraw-Hill Publishing Company Limited, New Delhi, 2009.

UNIT I : Text Book 1,2, 3
UNIT II : Text Book 1,2, 3
UNIT III : Text Book 4
UNIT IV : Text Book 4
UNIT V : Text Book 4

REFERENCES :

1. Manas Chanda, Structure and Chemical bonding including molecular spectra, Tata McGraw-Hill Publishing company Ltd., New Delhi-2.
2. G.Aruldhas, Molecular structure and spectroscopy, second edition, PHI learning Pvt. Ltd., New Delhi, 2008.
3. S.C.Rakshit, Physical chemistry, seventh edition – Sarat book distributors, Kolkata, 2004.
4. Rusell S. Drago, Physical Methods in Chemistry, W.B.Saunders Company.
5. F.L.Pillar, "Elementary Quantum Chemistry", McGraw Hill, 1970.
6. David.W.Ball, Physical Chemistry, Cengage Learning India Pvt. Ltd., New Delhi, 2009.

SEMESTER-II: CORE-V
STEREOCHEMISTRY AND NATURAL PRODUCTS

Course Code : 17PCH2C5 **Max. Marks : 100**
Hours/Week : 6 **Internal Marks: 25**
Credit : 5 **External Marks: 75**

Objectives:

- *To learn the concepts of stereochemistry and conformational analysis.*
- *To impart knowledge on various types of reactions and their utility.*
- *To know modern synthetic methods and synthetic strategies.*
- *To develop the knowledge in organic photochemistry.*

UNIT– I **18 hours**

Stereochemistry – I

1.1 #Newman, Sawhorse and Fisher projection formulae and interconversion#. Concept of chirality- R,S nomenclature; Enantiotropic and diastereotopic atoms and groups–Enantio and diastereo selective synthesis. Newer methods of asymmetric synthesis including enzymatic and catalytic nexus. E – Z isomerism. Determination of configuration of geometrical isomers.

1.2 D, L and R, S notations of acyclic and cyclic chiral compounds – Stereo chemical features and configurational descriptors (R, S) for the following classes of compounds allenes,spiranes and biaryls. Stereogenic centre. Definition of Prochirality – Asymmetric synthesis – Crams rule – enantiomeric excess (optical purity).

1.3 **Conformational Analysis:** Conformation of some simple 1, 2-disubstituted ethane derivatives. Conformational analysis of disubstituted cyclohexane and their stereo chemical features (geometric and optical isomerism by these derivatives). Conformation of cycliccompounds (3, 4 & 5 membered), cyclohexanone and conformation and stereochemistry of cis and trans decalin.

UNIT– II **18 hours**

Dynamic stereochemistry and Aromaticity

2.1 **Dynamic stereochemistry:** Quantitative correlations between conformation and reactivity. Weinstein-Eliel equation – Curtin-Hammett principle – Conformation and reactivity of mono and di substituted cyclic systems – Saponification of ester – Esterification of an alcohol – Chromic acid oxidation of cyclohexanol – Neighbouring group participation – De-amination of 2-amino cyclohexanol – Sharpless asymmetric epoxidation – stereospecific and stereoselective reactions.

2.2 **Aromaticity of Compounds:**

#Definition of aromaticity – Huckel's# and Craig's Rules – ring currents – Nonbenzenoid aromatic compounds – Aromatic character in 3,5 and 7 membered ring compound – Anti-aromatictity – systems with 2, 4, 6, 8, 10, 14 and 18 electrons - Azulene – Annulenes-Sydnones and fullerenes – Alternant and non alternant hydrocarbons. Homoaromaticity.

UNIT– III **18 hours**

3.1 **Name reactions:** Dieckmanns, Stobbe, Darzen's Glycidic ester condensation, Wittig. Houben –Houshch. Vilmesmier-Haack and Knoevenagal

3.2 **Concerted rearrangements:** Cope (including Oxy-Cope) and Claisen.

3.3 **Cationic rearrangements**: Demjanov, Pummerer, Schmidt and Dienone - phenol.

3.4 **Anionic rearrangements:** Brook, Favorski, Neber, Von Richter, Sommelet – Hauser and Wittig.

UNIT– IV **18 hours**

4.1 **Organic Photochemistry:** Fundamental concepts - Jablonski diagram – energy transfer characteristics of photo reaction, photo reduction and photo oxidation , Norrish type I & II reactions, photochemistry of alkenes and dienes ,photosensitization,Photo additions , Barton reaction, Paterno - Buchi reaction.

4.2 **Pericyclic Reactions:** Concerted reactions, stereochemistry - orbital symmetry, correlation diagram, Frontier molecular orbital approach for electrocyclic and cycloaddition reactions. Woodward Hoffman rules, sigmatropic rearrangements - selection rules with simple examples - 1,3 and 1,5 - hydrogen shifts.

UNIT– V **18 hours**

5.1 **Terpenoids:** Structural elucidation and medicinal uses of α- terpenol, α - Pinene, Camphor, Zingiberene and Squalene.

5.3 **Alkaloids:** Structural elucidation and medicinal values of quinine, reserpine, Papaverine and morphine.

5.4 **Flavones:** Structural elucidation of flavone, flavanol and isoflavone.

TEXT BOOKS:

1. D. Nasipuri, Stereochemistry of organic compounds-Principles and Applications, New Age International, 2nd Edition, 2002.
2. P.S. Kalsi, Stereochemistry, Wiley eastern limited, New Delhi, 1990.
3. V.K. Ahluwalia & Rakesh K. ParasharOrganic Reaction Mechanisms (Fourth Edition), Narosa Publication, 2010.
4. B.B. Grill, MR. Willis. Pericyclic reactions, Chapman & Hall, 1974
5. Gurdeep Chatwal – "Organic Chemistry of Natural Products", Vol. I & II, Revised 5th Edn., (2005), Himalaya Publishing House.

UNIT I : Text Book 1,2
UNIT II : Text Book 1,2
UNIT III : Text Book 3
UNIT IV : Text Book 4
UNIT V : Text Book 5

REFERENCES:

1. F.A. carey and R.J. Sund berg – "Advanced organic chemistry" Vol. I and II– 3rd Ed., (1984),Plenum Publications.
2. S.P. Shukla and G.L.Trivedi – "Modern Organic Chemistry", Millinium Ed., (2000) Rajendran Ravidra Printers Pvt. Ltd., New Delhi.
3. R.O.C. Norman – "Principles of Organic Synthesis" – 2nd Ed., (1986), Chapman and Hall Publications, New York.

SEMESTER-II: CORE-VI
GROUP THEORY AND SPECTROSCOPY

Course Code: 17PCH2C6 **Max. Marks : 100**
Hours/Week: 6 **Internal Marks: 25**
Credit: 5 **External Marks: 75**

Objectives:

- *To understand the symmetry of molecules*
- *To learn the applications of group theory to structure and properties of the molecules.*
- *To study the theoretical background of IR, Raman and magnetic resonance spectroscopy.*

UNIT – I **18 hours**

Elements of Group Theory

1.1 Introduction – Symmetry elements, Symmetry operations , n-fold Proper axis of symmetry, Centre of Symmetry, Plane of Symmetry, n-fold Improper axis of Symmetry, Group, Rules for forming a Group, Finite Group, Infinite Group, Abelian Group, Cyclic Group, Sub Groups, Group Multiplication Table- Class and Similarity transformation.

1.2 Point Group – Method of Assigning Point Group- Schoenflies symbols, Matrix Representation Theory – Matrix Representation of Symmetry operation, Reducible and Irreducible Representation.

1.3 The Great Orthogonality Theorem – Properties of Irreducible Representation Construction of Character Table for C_{2V} and C_{3V} point Groups – Explanation of Character Table- Correlation table (basic idea only).

UNIT – II **18 hours**

Applications of Group Theory -I

2.1 The direct product and its applications, applications of group theory to spectroscopy – vanishing of integrals, symmetry selection rules for vibrational, Raman and electronic spectroscopy.

2.2 Reduction Formula and its applications, determination of symmetries of vibrational modes and their IR and Raman activities in non-linear molecules (H_2O, NH_3 and BF_3) and linear molecules (CO_2 and C_2H_2 - Integration method), mutual exclusion rule, symmetries of electronic transitions in formaldehyde and ethylene.

UNIT – III **18 hours**

Applications of Group Theory -II

3.1 Applications of Group theory - Hybridization schemes for atoms in molecules of different geometry – tetrahedral (CH_4), triangular(BF_3) planar linear(C_2H_2) and non linear (C_2H_4)molecules.

3.2 Symmetry in crystals - Hermann - Mauguin symbols. Space groups of crystals - Translational elements of symmetry - Comparison of crystal symmetry with molecular symmetry.

3.3 Projection Operator – Symmetry Adapted Linear Combination (SALC) procedure. Symmetry factors of secular determinant and its applications to butadiene.

UNIT – IV **18 hours**

Theory of IR and Raman Spectroscopy

4.1 **IR Spectra-** Theory of Rotational-Vibrational spectra – harmonic and anharmonic oscillators – hot band, overtones – Fermi resonance, combination bands, rotation – vibration spectra of diatomic and polyatomic molecules, calculation of force constant, effect of isotopic substitution on vibrational frequencies – transition for the rigid rotor – coupling of rotation and vibration – linear and perpendicular bands – PQR branches – vibration spectra of polyatomic molecules. (Problems- force constant calculation)

4.2 **Raman Spectra-**[#] Polarization of light and Raman Effect– elastic and inelastic scattering[#]– pure rotational and rotational- Vibrational Raman spectra- Lasers-special properties of laser, types of lasers-Laser Raman spectroscopy- theory and advantages-Resonance Raman Spectroscopy- Resonance Raman scattering, surface enhanced Raman scattering- theory and advantages-

UNIT – V **18 hours**

Theory of NMR Spectroscopy

5.1 Behavior of a bar magnet in a magnetic field – Magnetization vectors – resonance condition – relaxation process – effect of quadrupole nuclei on relaxation mechanism- Bloch equation – [#]chemical shift and its measurement[#]-

5.2 Scalar Spin - Spin Coupling Mechanism – Nature of the Coupling, Direct Dipolar Coupling – NMR in Solids – magic angle spinning – nuclear magnetic resonance imaging (NMRI) – principles and applications.

5.3 FT-NMR – Principle, measurements of T_1 by FTS, Use of T_1 for peak assignment, Theory and advantages of 2D NMR

[#]_____[#] **Self study**

TEXT BOOKS:

1. K.V. Raman, "Group theory and its Application to Chemistry", Tata-McGraw –Hill Publishing Company Limited, New Delhi, 2000.
2. K. Veera Reddy, "Symmetry and Spectroscopy of Molecules", New Age International Publishers, 2010.
3. C. N. Banwell and E. M. Mccash, "Fundamentals of Molecular Spectroscopy", Tata McGraw-Hill Publishing Company Limited, New Delhi, 2009.

UNIT I : Text Book 1,2
UNIT II : Text Book 1,2
UNIT III : Text Book 1,2
UNIT IV : Text Book 2,3
UNIT V : Text Book 2,3

REFERENCES:

1. F. A. Cotton, "Chemical Application of Group Theory", 2nd edition, Wiley – Eastern Press, 1995.
2. G. M. Barrow, "Introduction to Molecular Spectroscopy", Tata-McGraw- Hill Edition, 1993.
3. G. Aruldhas, "Molecular Structure and Spectroscopy", Second edition, PHI learning Pvt. Ltd., New Delhi, 2008.
4. Manas Chanda, "Structure and Chemical Bonding including Molecular Spectra", Tata-McGrawHill Publishing company Ltd., New Delhi-2.
5. R. S. Drago, "Physical Methods in Chemistry", New Delhi, East West Press Ltd., 1971.

SEMESTER-II: CORE BASED ELECTIVE-II
COORDINATION COMPOUNDS AND SPECTRAL CHARACTERIZATION

Course Code : 17PCH2CE2A **Max. Marks : 100**
Hours/Week : 6 **Internal Marks: 25**
Credit : 4 **External Marks: 75**

Objectives:

- *To understand reactivity and stability of complexes and organometallic chemistry*
- *To understand the identification of structure of complexes by various spectroscopic technique.*
- *To study the chemistry of lanthanides and actinides.*

UNIT– I **18 hours**

1.1. **Reactivity of Complexes in solutions** – Labile and inert complexes - Ligand displacement Reactions – hydrolysis – acid and base, aquation in O_h complexes. Electron Transfer Reactions, complementary and non-complementary, types – inner and outer sphere processes – Isomerism in square planar complexes – Trans effect – Theories and Applications - Template effect.

1.2. **Stability of coordination compounds:** Detection of complex formation in solution, stability constants, stepwise and overall formation constants, pH metric, #polarographic and photometric methods of determining formation constants#- factors affecting stability - statistical and chelate effects.

UNIT– II

Complexes of π acceptor and donor ligands

2.1. Carbonyls - 18 e^- rule - Structural study of poly nuclear carbonyls. carbonylate anions, carbonyl hydrides, isolobal fragments - Nitrosyl complexes - Preparation. Bridging and terminal nitrosyls, bent and linear nitrosyls. Dinitrogen and dioxygen complexes.

2.2. Carbon π -donor Complexes: Synthesis, Structure and bonding of alkene, alkyne and allyl complexes. Metallocenes – Stability due to structure and properties. #Molecular orbital concept of metallocenes.#

UNIT– III **18 hours**

3.1**. Organometallic Chemistry:** Ligand association and dissociation – oxidative addition and reductive elimination – insertion reactions – Reactions of coordinated ligands in organometallics – Catalysis by Organometallics - Hydrogenation, hydroformylation, polymerisation of alkenes, olefin oxidation (Wacker Process), Fischer – Tropsch synthesis, epoxidation, metathesis.

3.2. **Oxygen Transport and energy transfer of metals proteins:** #Hemoglobin and myoglobin – Oxygen transport and storage#. Electron transfer and Oxygen activation. Ferredoxins and rubredoxins – Copper proteins – Oxidases and reductases – cytochrome oxidase – superoxide dismutase. (Cu, Zn), Urease and hydrogenases – Functions.

UNIT– IV **18 hours**

4.1. **Electronic spectroscopy:** Electronic configuration - Terms, states and microstates of atoms and ions – Derivation of term symbols d^n and arranging the various term according to their energies - spectroscopic terms – L-S coupling and jj coupling – #Racah parameters B and C – selection rules and the breakdown of selection rules – mixing of orbitals#.

4.2. **Orgel diagram** – characteristics – prediction and assignment of transitions for d^n weak field systems. Tanabe – Sugano diagrams – prediction and assignment of transitions for weak field and strong field – d^n systems - band intensity, band width - band shape-calculation of β and 10 Dq for simple octahedral complexes of Co and Ni- charge transfer spectra.

UNIT– V **18 hours**

5.1. **IR and Raman spectroscopy:** Combined uses of IR and Raman spectroscopy in the structural elucidation of N_2O, H_2O, ClF_3, NO_3^-, ClO_3^{2-} - Effect of coordination on ligand vibrations – uses of group vibrations in the structural elucidation of metal complexes of urea, cyanide, nitrate and sulphate - #Effect of isotopic substitution on vibrational spectra of metal carbonyls#.

5.2. **Mossbauer Spectroscopy:** Mossbauer transition and Doppler Effect - isomer Shift, quadrupole effect – simple application to iron and tin compounds.

5.3. **Lanthanides and Actinides:** Co-ordination compounds of lanthanides - spectral and magnetic properties- synthesis of transuranic elements.

Self study

TEXT BOOKS:

1. R.Gopalan, V.Ramalingam – "Concise Coordination Chemistry", Vikas Publishing House Pvt. Ltd., Newdelhi, 2001.
2. B.D.Gupta, A.J.Elias - "Basic Organometallic Chemistry-Concepts, Syntheses and Applications", University Press, Hyderabad, 2011.
3. R.C.Mehrotra, A.Singh, "Organometallic Chemistry-A Unified Approach", revised 2nd Edn., New Age International Publishers, 2011.
4. Satya Prakash, G.D.Tuli, S.K.Basu, R.D.Madan, "Advanced Inorganic Chemistry Vol-I", S.Chand & Co., Ltd., New Delhi.
5. E.A.V. Ebsworth, W.H. Rankin, Cradock – "Structural Methods in Inorganic Chemistry", ELBS, 1987.

UNIT I : Text Book 1
UNIT II : Text Book 1,2,3,4
UNIT III : Text Book 5
UNIT IV : Text Book 5
UNIT V : Text Book 4

REFERENCES:

1. James E. Huheey, Ellen A. Keiter and Richard L. Keiter – "Inorganic Chemistry Principles of Structure and Reactivity", 4th Ed., pearson Education –sixth impression -2009.
2. W. Kaim and B. Schewederski – Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life: John Wiley & Sons, New York, USA, 2001.
3. Cotton and Wilkinson – "Advanced Inorganic Chemistry", 6th Ed., John Wiley & Sons, New York- 2004.
4. R.H. Crabtree – The Organometallic Chemistry of the Transition Metals: John Wiley & Sons, New York (2000).
5. S.E. Kegley and A.R. Pinhas – Problems and Solutions in Organometallic Chemistry: University Science Books, Oxford University Press, 2002.
6. P. Powell – Principles of Organometallic Chemistry, 2nd Edn.: Chapman and Hall, London,2003.

SEMESTER-II: CORE BASED ELECTIVE-II
SPECTROSCOPY OF INORGANIC COMPLEXES AND ORGANOMETALLICS

Course Code : 17PCH2CE2B **Max. Marks : 100**
Hours/Week : 6 **Internal Marks: 25**
Credit : 4 **External Marks: 75**

Objectives:

- *To understand the structural character of complexes by spectroscopic techniques*
- *To learn the concepts of metallurgy*
- *To understand reactivity of complexes*
- *To know the importance of bioinorganic complexes*

UNIT– I **18 hours**

1.1 **Electronic spectroscopy:** Electronic configuration - Terms, states and microstates of atoms and ions – Derivation term symbols (p^2 and d^2) and arranging the various term according to their energies spectroscopic terms – L-S coupling and JJ coupling – #effect of interelectronic repulsion and spin-orbit coupling #– Racah parameters B and C – selection rules and the breakdown of selection rules – mixing of orbitals.

1.2 Orgel diagram – characteristics – prediction and assignment of transitions for dn weak field systems. Tanabe – Sugano diagrams – prediction and assignment of transitions for weak field and strong field – dn systems band intensity, band widths- band shapes-calculation of β and 10 Dq for simple octahedral complexes of Co and Ni- charge transfer spectra.

UNIT– II **18 hours**

2.1 **IR and Raman spectroscopy:** Combined use of IR and Raman spectroscopy in the structural elucidation of N_2O, H_2O, ClF_3, NO_3^-, ClO_3^- - Effect of coordination on ligand vibrations – uses of group vibrations in the structural elucidation of metal complexes of urea, cyanide, nitrate and sulphate – #Effect of isotopic substitution on the vibrational spectra of molecules – vibrational spectra of metal complexes#.

2.2 **Mossbauer Spectroscopy:** Mossbauer transition and Doppler Effect – isomer shift quadrupole effect – magnetic effect on spectra – simple application to iron and tin compounds.

2.3 **Lanthanides and Actinides:** co-ordination compounds of lanthanides- spectral and magnetic properties of Lanthanides and Actinides, synthesis of transuranic elements

UNIT– III **18 hours**

3.1 **Extraction and Uses of Metals:** Metallurgy of Zr, Ge, Th and U –# uses of their important compounds.#

3.2 **Alloys and Intermetallic Compounds –** Effect of alloying – types of alloys – simple mixtures – solid solutions – substitutional alloys – Industrial alloys – Substitutional alloys - Intermetallic Compounds – Hume – Rotherys rules – ferrous alloys , non-ferrous alloys – Al, Mg alloys, amalgams, alloy steels.

3.3 **Inorganic Polymers and Rings:** Phosphorus based network polymers, Coordination Polymers (Structure and properties). Preparation and Structure of Borazines & Phosphazenes – Craigg and Paddock model - Dewar model – Preparation and Structure of sulphur-nitrogen ring system (S_4N_4, $N_4S_4F_4$)

UNIT– IV **18 hours**

4.1 **Reactivity of Complexes** – Kinetics and Mechanisms of reactions in solutions: Labile and inert complexes – Ligand displacement Reactions – hydrolysis – acid & base, aquation in O_h complexes. Electron Transfer Reactions, complementary and non-complementary types – inner and outer sphere processes – Isomerism in square planar complexes – Trans effect – Theories and Applications. Template effect and synthesis of macrocyclic ligands.

4.2 **Stability of coordination compounds:** Detection of complex formation in solution, stability constants, stepwise and overall formation constants pH metric, #polarographic and photometric methods of determining formation constants# - factors affecting stability – statistical and chelate effects.

UNIT– V **18 hours**

5.1 **Organometallic Chemistry:** 16 and 18 electron rule - Catalysis by Organometallics- Ligand association and dissociation – oxidative addition and reductive elimination – insertion reactions – reactions of coordinated ligands in organometallics – Hydrogenation, hydroformylation, polymerisation of alkenes, olefin oxidation (Wacker Process), Fischer–Tropsch synthesis, epoxidation, metathesis.

5.2 **Oxygen Transport and energy transfer of metals proteins:** # Hemoglobin and myoglobin – Oxygen transport and storage#. Electron transfer and Oxygen activation. Ferredoxins and rubredoxines – Copper proteins – classification – Electron transfer, oxygen transport. Oxidases and reductases – cytochrome oxidase – superoxide dismutase (Cu, Zn), Urease and hydrogenases.

Self study

TEXT BOOKS:

1. R.Gopalan, V.Ramalingam – "Concise Coordination Chemistry", Vikas Publishing House Pvt. Ltd., Newdelhi, 2001.
2. B.D.Gupta, A.J.Elias - "Basic Organometallic Chemistry-Concepts, Syntheses and Applications", University Press, Hyderabad, 2011.
3. R.C.Mehrotra, A.Singh, "Organometallic Chemistry-A Unified Approach", revised 2nd Edn., New Age International Publishers, 2011.
4. Satya Prakash, G.D.Tuli, S.K.Basu, R.D.Madan, "Advanced Inorganic Chemistry Vol-I", S.Chand & Co., Ltd., New Delhi.
5. W. Kaim and B. Schewederski – Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life: John Wiley & Sons, New York, USA, 2001.

UNIT I : Text Book 1
UNIT II : Text Book 1,2,3,4
UNIT III : Text Book 4
UNIT IV : Text Book 1
UNIT V : Text Book 5

REFERENCES:

1. James E. Huheey, Ellen A. Keiter and Richard L. Keiter – "Inorganic Chemistry Principles of Structure and Reactivity", 4th Ed., pearson Education –sixth impression -2009.
2. Cotton and Wilkinson – "Advanced Inorganic Chemistry", 6th Ed., John Wiley & Sons, New York- 2004.
3. Gurdeepraj – Advanced Inorganic Chemistry: Goel publishing house, Meerut.
4. W. Kaim and B. Schewederski – Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life: John Wiley & Sons, New York, USA, 2001.
5. R.H. Crabtree – The Organometallic Chemistry of the Transition Metals: John Wiley & Sons, New York (2000).
6. S.E. Kegley and A.R. Pinhas – Problems and Solutions in Organometallic Chemistry: University Science Books, Oxford University Press,2002.
7. P. Powell – Principles of Organometallic Chemistry, 2nd Edn.: Chapman and Hall,London,2003.
8. E.A.V. Ebsworth, W.H. Rankin, Cradock – "Structural Methods in Inorganic Chemistry", ELBS, 1987.

SEMESTER-III: CORE-IX
INORGANIC SPECTROSCOPY, SOLID STATE AND BIO-INORGANIC CHEMISTRY

Course Code : 17PCH3C9 **Max. Marks : 100**
Hours/Week : 6 **Internal Marks : 25**
Credit : 5 **External Marks : 75**

Objectives:

- *To study the theoretical concepts and applications of NMR, ESR and photo electron spectroscopy*
- *To learn photochemistry of coordination compounds and magnetic properties*
- *To know about medicinal bio inorganic chemistry, metal clusters and solid state*

UNIT-I **18 hours**

1.1. **NMR Spectroscopy:** Chemical shift and coupling constant (spin - spin coupling) involving different nuclei (^{1}H, ^{13}C, ^{19}F and ^{31}P) interpretation and applications to inorganic compounds. Effect of quadrupolar nuclei (^{2}H and ^{14}N) on the ^{1}H NMR spectrum. NMR of paramagnetic molecules - isotopic shifts, contact and pseudocontact interactions - Lanthanide shift reagents - stereochemistry of non - rigid molecules

1.2. **ESR Spectroscopy:** Basic principles – presentation of spectra – hyperfine splitting – isotropic and anisotropic hyperfine coupling constants - McConnell relation – g value – factors affecting the magnitude of g values – #calculation of unpaired electron density on an atom in delocalized system#. Factors affecting the g values of transition metal ions – dependence of spin-orbit coupling and crystal field effects – zero field splitting and Kramer's degeneracy – EPR spectra of transition metal complexes – spectrum of bis(salicylaldiminecopper(II)) – peroxo complex of cobalt – spin dilution.

UNIT-II **18 hours**

2.1. **Photoelectron spectroscopy:** Basic principles - UPES, XPES and AES - valence and core binding analysis - Koopmans theorem - ESCA and Auger spectroscopy - applications.

2.2. **Photochemistry of coordination compounds:** Photochemical reactions - Organo-metallic compounds - photo oxidation - reduction, substitution and photoisomerisation reactions.

2.3. **Magnetic properties:** #Types of magnetism - dia, para, ferro# and antiferro magnetism - magnetic properties of free ions - first and second order Zeeman effects.

UNIT – III **18 hours**

3.1. **Solid state:** Difference between point group and space group – screw axis – glide plane - symmetry elements – crystal systems – unit cell - Bravais lattices# – equivalent positions - relationship between molecular symmetry and crystallographic symmetry – The Concept of reciprocal lattice – X-ray diffraction by single crystal – rotating crystal – powdered diffraction.

3.2. **Crystal Growth methods:** From melt and solution (hydrothermal, Gel methods)

3.3. **Neutron diffraction:** Elementary treatment – comparison with X-ray diffraction. Electron diffraction- Basic principles.

UNIT – IV **18 hours**

4.1. **Metals at the centre of photosynthesis:** #Primary processes - PS-I and II - Charge separation and electron transport# - Manganese catalysed oxidation of water to O_2 Complexes of alkali and alkaline earth metal ions with macrocycles – Polyethers, spherands, cryptands - ion channels - ion pumps (K^+, Na^+, Ca^{2+}).

4.2. **Metal Clusters:** Dinuclear clusters – Structure of Re_2Cl_8 – quantitative MO diagrams - quadruple bond – polynuclear clusters, polyacids – iso and heteropolyacids of V, Mo and W – Structure – Keggin's theory.

UNIT-V **18 hours**

5.1. **Medicinal Bioinorganic Chemistry:** Bioinorganic Chemistry of toxic metals - Lead, Cadmium, Mercury, Chromium. Detoxification by metal chelation.

5.2. **Chemotherapy:** Cisplatin – #Cancer therapy – cytotoxic compounds of other Metals# - Gold containing drugs as antirheumatic agents – Lithium in psychopharmacological drugs.

5.3. **Radiotherapy:** Radioisotopes of Th, Co, Ra, I_2, and Na.

Self study

TEXT BOOKS

1. E.A.V. Ebsworth, W.H. Rankin, Cradock – "Structural Methods in Inorganic Chemistry", ELBS, 1987
2. A. Abdul Jameel – "Application of Physical Methods to Inorganic Compounds", Jan Publications, (2007).
3. H. Kaur – "Spectroscopy", 3rd Ed., Pragati Prakasan Publications, Meerut, 2006.
4. James E. Huheey, Ellen A. Keiter and Richard L. Keiter – "Inorganic Chemistry Principles of Structure and Reactivity", 4 th Edn., Pearson Education, 11th Impression, 2011.

UNIT I : Text Book 1, 2
UNIT II : Text Book 1, 3
UNIT III : Text Book 1, 2
UNIT IV : Text Book 4
UNIT V : Text Book 4

REFERENCES:

1. A.D.P. Lever, Inorganic Electronic Spectroscopy, 2nd Edition, Elsevier, London, 1984.
2. Anthony P. West, solid state Chemistry and its applications, John Wiley, New York, 2000.
3. W.Kaim, B.Schwederski, " Bioinorganic Chemistry: Inorganic Elements in the chemistry of life-An Introduction and Guide", Wiley India Pvt. Ltd., 2012.

SEMESTER-III: CORE- X
ORGANIC SPECTROSCOPY AND STEROIDS

Course Code : 17PCH3C10 **Max. Marks : 100**
Hours/Week : 6 **Internal Marks : 25**
Credit : 5 **External Marks : 75**

Objectives:

- *To study the different types of spectroscopic methods and it's applications in structural identification.*

UNIT – I **18 hours**

1.1 **Ultraviolet and Visible Spectroscopy:** #Basic principles of electronic transitions - correlation of energy change with electronic transitions. Applications of UV – Visible spectroscopy # - Woodward - Fieser - Scott rules -applications to conjugated dienes, trienes, polyenes, unsaturated carbonyl compounds, conjugated cyclic ketones and acetophenones - benzene and its substituted derivatives, Stereochemical factors affecting electronic spectra of biphenyl and binaphthyl, cis and trans isomers – angular distortion and cross conjugation, charge transfer spectra.

1.2 **Infrared Spectroscopy:** Types of stretching and bending vibrations – characteristics group frequencies – Fermi resonance - organic structure determination. Finger print region, factors affecting IR frequency -identification of functional groups – hydrogen bonding (intermolecular and intramolecular) - conformational aspects in cyclic 1,2- diols and 1,3-diols, trans annular interaction in UV and IR - Determination of reaction rates and mechanisms of reactions employing IR and UV spectroscopy (basic aspects).

UNIT – II **18 hours**

Proton NMR Spectroscopy

2.1 Theory of NMR- Chemical and magnetic equivalence, non-equivalence , chemical shift - internal standard and solvents used - factors influencing δ values – first and second order spectra, spin-spin splitting, restricted rotation around C-N, Pascal's triangle, coupling constant - dependence of J on dihedral angle, vicinal and geminal coupling, Karplus curve and equation, Long range coupling.

2.2 Influences of stereo chemical factors on chemical shift of protons - simplification of complex spectra - double resonance technique, high field strength and lanthanide shift reagents. NOE phenomena, Chemical spin decoupling of rapid exchangeable protons (DH, SH, COOH, NH_2.)

2.3 Continuous wave (CW) NMR and Fourier Transform (FT) NMR. Some important NMR spectra - Phenyl acetylene, n-propanol, m-cresol, benzaldehyde and acetaldehyde. Applications of NMR spectroscopy.

UNIT – III **18 hours**

^{13}C NMR Spectroscopy and ORD

3.1 Principle, comparison of ^{13}C- NMR and ^{1}H NMR, Chemical shift, simplification of ^{13}C-NMR - broad band decoupling and off-resonance decoupling.

3.2 α, β and γ - effect of substituents (Straight and branched chain alkanes) and effect of hybridization. Calculation of chemical shifts for simple aliphatic and aromatic compounds. Magnetic Resonance Imaging (MRI-scan), Techniques of 2D NMR - COSY, NOSEY and #ROSY#.

3.3 **Optical rotatory dispersion and circular dichroism:** Theory and terminology. Cotton effects and ORD curves, Axial haloketone rule and octant rule- applications.

UNIT – IV **18 hours**

4.1 **Mass Spectroscopy:** #Basic principle, base peak, isotopic peak, metastable peak, parent peak#, modes of ionization – EI, CI, FAB and ESI, recognition of molecular ion peak and isotopic peak - determination of molecular formula, nitrogen rule, fragmentation pattern for compounds containing CH_3, OH, CHO, COOH and NH_2 , McLafferty rearrangement, importance of metastable peaks.

4.2 **Electron spin resonance spectroscopy:** Basic principles - comparison between ESR and NMR spectra, hyperfine splitting - factors affecting the magnitude of g values. Applications to simple organic free radicals.

4.3 Combined spectral problem of organic compounds (UV, IR, ^{1}H, ^{13}C NMR and Mass).

UNIT – V **18 hours**

5.1 **Steroids:** Classification – Structural elucidation and medicinal values of cholesterol, oestrone, progesterone, ergosterol, stigmasterol and equilenin (synthesis not required), stereochemistry of steroids.

5.2 **Carotenoids:** Introduction – Classification, structural elucidation of α-carotene, β- carotene and xanthophylls.

5.3 **Lipids**: Classification and biological importance of fatty acids and lipids.

_____# Self study

TEXT BOOKS:

1. Y.R. Sharma, Elementary Organic Spectroscopy: Principles and Chemical Applications, S.Chand Publications, New Delhi, 2012.
2. Jag Mohan, Organic Spectroscopy (Principles and Applications), alpha sciences.
3. I.L. Finar, Organic Chemistry, Vol. II, 5th Edition ELBS, 1975.

UNIT I : Text Book 1,2
UNIT II : Text Book 1,2,
UNIT III : Text Book 1,2
UNIT IV : Text Book 1,2
UNIT V : Text Book 3

REFERENCES:

1. Willam Kemp, organic spectroscopy; ELBS, Macmillan, 1991.
2. P.M. Silvertein, G.C. Bassler and T.C. Morrill, spectroscopic Identification of organic compounds, 3rd Edition, 1974.
3. J.R. Dyer, Application of Absorption spectroscopy of organic compounds, Prentice Hall, 1965.

SEMESTER-III: CORE-XI

INDUSTRIAL CHEMISTRY

Course Code : 17PCH3C11 **Max. Marks : 100**
Hours/Week : 6 **Internal Marks: 25**
Credit : 4 **External Marks: 75**

Objectives:

- *To impart knowledge on fermentation, pigments, oils and fats.*
- *To understand the industrial applications of chemistry.*
- *To give an idea about Adhesives and explosives.*

UNIT – I **18 hours**

Industrial Processes

1.1 Fermentation: Introduction - Historical - Conditions favorable for fermentation- Characteristics of enzymes – Manufacture and uses of beer, spirit, wine, vinegar, power alcohol and ethyl alcohol.

1.2. Industrial organic synthesis- manufacture and uses of methanol, ethanol, acetic acid and acetone.

1.3. Pulp and Paper – Introduction, manufacture of - sulphate, soda and rag pulp. Manufacture of paper, calendaring – uses of paper.

UNIT – II **18 hours**

Pigments and Surface coating Materials

2.1. Pigments- Definition, composition, characteristics, manufacture and uses of white pigments, white lead, Zinc oxide Lithopone and TiO_2. Characteristics and uses Blue pigments – Ultra marine blue, Red pigments, red lead, Green pigments, chrome green, Guigwet's green, Black pigments, Yellow pigments.

2.2. Paints - definition – classification of paints based on their Applications, constituents, requisites of a good paint – emulsion paints - constituents.
Varnishes - Definition, types, constituents, characteristics of a good varnish – manufacture and uses.

2.3. Dyes – Colour and constitution, classification – mode of application – chemical constitution, preparation, properties and uses of congo red, malachite green, rosaniline, eosin – fluorescent brightening agents – non textile uses of dyes.

UNIT – III **18 hours**

Glass and Cement:

3.1. Glass – General properties of glass, types of glasses, manufacture of glass. Ceramics, manufacture, properties, classification –constituents-applications of colour to pottery.

3.2. Refractories - Definition, classification, properties, manufacture and uses of fire clay bricks high alumina refractories, silicon carbide refractories.

3.3. Portland cement – definition, composition, types, manufacture, setting of cement – factors affecting the setting of cement.

UNIT – IV **18 hours**

Adhesive and explosives

4.1. Adhesives- definition, classification - preparation and uses of animal glue, starch adhesives, rubber based adhesive, protein adhesives and synthetic resin adhesives.

4.2. Lubricants – properties, classification, substance used as lubricants, additive of lubricating oils – synthetic lubricants – greases, lubricating greases – chemical properties –test for lubricants.

4.3. Explosives- Introduction, Classification, characteristics - preparation and uses of Nitro cellulose, DNB, TNB, TNT, Cyclonite, Picric acid, Gun Powder, Cordite and Dynamite.

UNIT – V **18 hours**

Oils and Fats

5.1. Oils and fats- Definition – differences. Saponification value, Iodine value, Acid value and RM value- definition-determination.

5.2. Vegetable oils- Manufacture of cotton seed oil and soybean oil- Refining of crude vegetable oils- coconut oil- palm oil- peanut oil- olive oil- #castor oil-and safflower oil#.

5.3. Waxes - classification – properties – manufacture of candles. Manufacture of soap, toilet and transparent soap – composition and mechanism.

#_____# Self study

TEXT BOOKS:

1. B.N. Charabarthy – "Industrial Chemistry", 1st Ed., Oxford and IBh Publishing, New Delhi.
2. B.K. Sharma – "Industrial Chemistry", 1st Ed., (1983), Goel Publication, Meerut..

UNIT I : Text Book 1,2
UNIT II : Text Book 1,2
UNIT III : Text Book 1,2
UNIT IV : Text Book 1,2
UNIT V : Text Book 1,2

REFERENCES:

1. Krishnamoorthy, P. Vallinayagan & K. Jaya Subramanian – "Applied Chemistry", 2nd Ed., (1999, 2001), Tata MaGraw-HillPublishing Co. Ltd., New Delhi.

SEMESTER-III: CORE BASED ELECTIVE - III

SPECIAL TOPICS IN CHEMISTRY

Course Code: 17PCH3CE3A | **Max. Marks :100**
Hours/Week : 6 | **Internal Marks : 25**
Credit : 4 | **External Marks : 75**

Objectives:

- *To study about the sono chemistry and retrosynthesis*
- *To give a basic idea for the student about special topics of chemistry nano and green chemistry*
- *To bring the knowledge for student about solvent free reaction*

UNIT-I **18 hours**

Retrosynthesis: Synthons – Synthetic equivalents – Convergent and Linear synthesis – Retrosynthetic tree - Guidelines to a good disconnection – Functional Group -Interconversions – One group and two group C-X disconnections – One group C-C disconnections – 1,1 C-C and 1,2 C-C disconnections to synthesise alcohols and carbonyl compounds – Regioselectivity – Michael and Wittig reactions – Use of acetylenes and aliphatic nitro compounds in organic synthesis – Two group C-C disconnections – Diels-Alder reaction – its stereochemical aspects – Robinson annelation. Guidelines for solving the problem of chemoselectivity – #Umpolung reagents – Protecting groups for alcohols, amines and carbonyl compounds – Deprotection #.

UNIT-II **18 hours**

Sono Chemistry: Instrumentation – Physical aspects – Types - Homogeneous liquid phase – Heterogeneous solid-liquid reactions. Synthetic applications – Esterification – Saponification – Hydrolysis/Solvolysis – alkylation – oxidation and reduction reactions – Bouveault reaction.

Supramolecular Chemistry: Introduction – molecular forces, molecular recognition - basic concepts of host - guest complexation with examples from ionophore chemistry – non-covalent interactions - molecular receptors for different types of molecules, design and synthesis of co-receptor molecules, triangular, square, #rectangular supramolecules #.

UNIT-III **18 hours**

Drugs: Drug definition, nature and source of drugs - important terminologies - pharmacology, pharmacy, pharmacodynamics, pharmacokinetics, molecular pharmacology, pharmacophore, metabolites, antimetabolites, pharmacopoeia, pharmacognosy, toxicology, pharmacotherapeutics, LD50, ED50, therapeutic index - Assay of drugs – chemical, biological and #immunological assay#. Storage of pharmaceutical substances – types of storage, encapsulation – hard and soft gelatin capsule.

Drugs – mechanism of action- actions of cellular and extra cellular sites, metabolism of

drugs – #phase I reactions#. Mechanism of different types of drug action , #physical and chemical properties of drugs#-absorption of drugs – routes of administration – factors affecting absorption – digestion and absorption of protein and fat.

UNIT-IV **18 hours**

Drug Design

Development of new drugs – factors affecting development of new drugs – concept of quantitative structure activity relation (QSAR), QSAR methods – Hansch approach and #Wilson method#. Relation between the chemical structure and pharmacological activity - Effect of unsaturation - chain length – isomerism – halogens – amino group – acidic group – hydroxyl group – alkyl group, structure activity relationship (SAR) of penicillin and #streptomycin#.

Drug synthesis

Structure and synthesis: Cardiovascular drugs – Nifedipine and Clofibrate, Analgesic and Antipyretic drugs – Mefenamic acid, Diclofenac, #Paracetamol and Asprin#, Psychoactive drugs – Diazepam and Alprazolam.

UNIT-V **18 hours**

Diagnostic aids

Determination of serum glucose - Folin & Wu's and *o*-toluidine methods , Determination of serum cholesterol - Sackett's method, Diagnostic tests for salt in serum and urine, Detection of diabetics and anemia, #Estimation of hemoglobin#.

Radiopharmaceuticals for scintigraphy, types of radiopaques - radiopaques substances - radiographic procedure, Iopanoic acid – structure, functions and mode of action.

#_____# Self study

TEXT BOOKS:

1. Stuart Waren, Organic Synthesis, methods and startingmaterials, the disconnections approach, John Wiley & Sons – 1992.
2. Jagadamba Singh and L.D.S.Yadav, Organic synthesis, 4th edn., Pragathi Prakashan, 2009.
3. V.K.Ahluwalia and Renu Aggarwal, Organic synthesis, 2nd edition, Narosa, 2006.
4. P.S. Kalsi & J.P Kalsi –Bioorganic and supra molecular chemistry – New Age International Publishers – 2010.
5. Jayashree Ghose – Text book of Pharmaceutical chemistry, 2nd Edn., S. Chand, New Delhi, reprinted 2008.
6. V.K.Ahluwalia, Drugs, Ane books private Ltd., New Delhi, 1st Edition, 2010.

UNIT-I : Text Book 1, 2
UNIT-II : Text Book 3, 4
UNIT-III : Text Book 5, 6
UNIT-IV : Text Book 5, 6
UNIT-V : Text Book 5, 6

REFERENCES:

1. Futhrhop, Penzlin, organic synthesis concepts, methods and starting materials, Verlag chemie 1983.
2. P.S. Kalsi & J.P Kalsi – Bioinorganic, Bioorganic & supra molecular chemistry – New Age International Publishers – 2010.
3. Mathew George and Lincy joseph , Text book of pharmaceutical chemistry, Abe books, New Delhi, 2009.
4. S.Lakshmi, Pharmaceutical Chemistry, 3rd Edn., Sulthan Chand and Sons, New Delhi,2004.

SEMESTER-III: CORE BASED ELECTIVE – III

MATERIAL CHEMISTRY

Course Code: 17PCH3CE3B	**Max. Marks :100**
Hours/Week : 6	**Internal Marks : 25**
Credit : 4	**External Marks : 75**

Objectives:

- *To study about the synthesis of synthesis of materials and solid electrolytes*
- *To give a basic idea for super conductors and inorganic liquid crystals*
- *To bring the knowledge for student about inorganic photochemistry and X-ray diffraction study*

UNIT-I **18 hours**

Synthesis of inorganic materials

1.1. Synthesis of materials – the formation of bulk material – methods – direct synthesis – solution method – chemical deposition

1.2 Defects and ion transport : extended defects – atom and ion diffusion.

1.3 Solid Electrolytes – cationic electrolytes- anionic electrolytes- #Mixed ionic electronic conductors#- properties, structure and uses.

UNIT-II **18 hours**

Superconductors and Inorganic pigments

2.1. Superconductors – high temperature super conductors – meissner effect – types – superconducting oxides - properties – colossal magnato resistance – structure – properties – rechargeable battery materials – $LiCoO_2$, $LiMnO_4$ – properties and uses.

2.2 Inorganic pigments: Coloured solids – inorganic phosphorous – Properties- uses – white and black pigments – properties and uses.

UNIT-III **18 hours**

Molecular material Chemistry

3.1 Molecular material Chemistry – one dimensional metals – properties and uses – molecular inorganic magnetic materials – properties and uses..

3.2 Inorganic liquid crystals – types – calamitic –discotic – properties and uses

3.3 Fullerides – solid carbon C_{60} – properties and uses.

UNIT-IV **18 hours**

Inorganic Photochemistry

Inorganic Photochemistry: Electronic transitions in metal complexes, metal centred and charge-transfer transitions- various photophysical and photochemical processes of coordination compounds. Unimolecular charge transfer photochemistry of cobalt (III) complexes- mechanism of CTTM, photoreduction- ligand field photochemistry of chromium (III) complexes- Adamson's rule, photoactive excited states, V-C model- photo physics and photochemistry of ruthenium- polypyridine complexes, emission and redox properties. Photochemistry of organometallic compounds- metal carbonyl compounds- compounds with metal-metal bonding- Reinecke's salt chemical actinometer.

UNIT-V X-ray diffraction by single crystal method **18 hours**

X-ray diffraction by single crystal method: Space groups- systematic absences in X-ray data and identification of lattice types, glide planes and screw axes- X-ray intensities- structure factor and its relation to intensity and electron density- phase problem- structure solution by heavy atom method and direct method- determination of absolute configuration of molecules-a brief account of Cambridge structural database (CSD) and protein data bank(PDB). Electron diffraction by gases- scattering intensity vs.scattering angle, wierl equation- measurement techniques. Neutron diffraction by crystals – magnetic scattering- measurements techniques- elucidation of structure of magnetically ordered unit cell.

TEXT BOOKS:

1. Shriver and Atkins , Inorganic chemistry , 5th edn., Oxford university press, India , 2011.
2. A.W.Adamson, Concept of Inorganic Photochemistry; John Wiley and sons, New York, 1975.
3. A. Abdul Jameel – "Application of Physical Methods to Inorganic Compounds", Jan Publications, 2007.

UNIT-I : Text Book 1
UNIT-II : Text Book 1
UNIT-III : Text Book 1
UNIT-IV : Text Book 2
UNIT-V : Text Book 3

REFERENCES:

1. Stuart Warren organic synthesis, methods and starting materials, the disconnections approach John, Wiley & sons-1992.
2. Futhrhop, Penzlin, organic synthesis concepts, methods and starting materials, Verlag chemie 1983.
3. Shriver and Atkins, Inorganic chemistry, 5th edn., Oxford university press, India , 2011.

SEMESTER-III: EXTRA CREDIT - I
ANALYTICAL TECHNIQUES

Course Code	**: 17PCH3EC1**	**Max. Marks**	**: 100***
Hours/Week	**: --**	**Internal Marks**	**: --**
Credit	**: 5***	**External Marks**	**: 100***

Objectives:

- *To understand the concepts of Analytical chemistry*
- *To gain an idea about purification techniques*
- *To learn the theories and importance of electro analytical techniques*

UNIT-I

1.1 **Analytical chemistry** - chemical analysis – Advantages and limitations of chemical methods- types of chemical analysis- Instrumental methods- Advantages and Limitations of Instrumental methods- Analytical methods on the basis of Sample size – Sampling- sampling methods- sampling in different physical states- Sampling statistics- source of error in sampling- dangers during sampling.

1.2 **Techniques of Analysis** – Introduction- Classification of analytical techniques- classification of instrumental methods of analysis - factors affecting the choice of analytical methods- interferences- typical separation procedures- sensitivity and detection limits.

1.3 **Statistical Analysis of Data:**
Various types of errors – Precision and Accuracy – significant figures, mean value, variance and standard deviation.

UNIT-II

2.1 **Solvent extraction**: Principle, types of extractant systems- Extraction of liquids – Batch extraction process, continuous extraction process – Extraction by chemically active solvents- Extraction of solids – Drying agents- $MgSO_4$, anhydrous $CaCl_2$, anhydrous K_2CO_3, anhydrous $CaSO_4$ - Distillation theory – Steam distillation- fractional at atmospheric pressure- Vacuum/reduced pressure distillation.

2.2 **Recrystallisation** – solvent selection – Handling of flammable solvents – Use of decolourising Carbon – Difficulties in recrystallisation – recrystallisation at very low temperature – semi micro and micro recrystallisation – Drying of recrystallised materials.

UNIT-III

3.1 **Fluorimetry**: Fluorescence – mechanism – Fluorimetry – theory – Instrumentation and application - comparison of absorption and fluorescence methods, spectrofluorimeters – principle – Instrumentation and applications.

3.2 **Turbidimetry and Nephelometry**: Theory - Instrumentation and applications.

3.3 **Flame photometry and Phosphorimetry** – Principle - instrumentation - working - Applications.

UNIT-IV

4.1 **Colorimetry**: principles, laws of colorimetry, instrumentation for visual and photocolorimetry, types of photo colorimeters – single beam and double beam-working – advantages - colorimetric estimation of Ni, Cu and Fe.

4.2 **Polarography**: Introduction – principle – Ilkovic equation – Instrumentation – working and advantages of DME – evaluation of polarographic curves – applications of polarography – pulse polarography.

4.3. **Thermo analytical methods:** thermo gravimetric analysis – principle – instrumentation – TG curve – factors affecting TGA - applications – Differential thermal analysis – DTA curves – applications – Differential Scanning Calorimetry – Thermometric titrations – principle – applications.

UNIT-V

5.1 **Voltammetry:** Instrumentation, capacitive current, linear potential sweep (dc) voltammetry – cyclic voltammetry, potential step methods – normal pulse, differential pulse and square wave voltammetry, stripping voltammetry – principles, electrodes used for stripping analysis, anodic and cathodic stripping voltammetry, voltammetry applications.

5.2 **Amperometry:** Amperometric titrations, principles, titrations with dropping mercury electrode (DME), apparatus, biamperometric titrations, advantages and applications of amperometric titrations.

5.3 **Coulometry:** Introduction – coulometric titrations – detection of end points – applications in titrimetric analysis – potentiostatic coulometry – advantages.

TEXTBOOKS:

1. H. Kaur - "Instrumental methods of Chemical Analysis", 6th edition, (2010), Pragati prakasan Publications, Meerut.
2. Willard, Meeritt, Dean and Settle – "Instrumental Methods of Analysis", 7th Ed., (1983), CBS Publishers.
3. B.K. Sharma – "Instrumental methods of Analysis", (2000), Goel Publications.
4. S.M. Khopkar, "Basic Concepts of Analytical Chemistry", Revised edition (2006) Wiley Eastern Ltd.,

UNIT I : Text Book 1,3,4
UNIT II : Text Book 2,3
UNIT III : Text Book 1,2,34
UNIT IV : Text Book 2,3,4
UNIT V : Text Book 2,3

REFERENCES:

1. R.A. Day and A.L. Underwood – "Quantitative Analysis", (1999), Prentice - Hall of India Pvt., Ltd., New Delhi.
2. B.S. Furniss, A.J. Hannaford, P.W.G. Smith and A.R. Tatchell – "Vogel's Text book of Practical Organic Chemistry", first Indian reprint, (2004), Pearson Education Publisher.
3. L.Pavia – "Spectroscopy" cengage learning India Pvt. Ltd, (2010).
4. Harald Guther, "NMR Spectroscopy", Wiley india (p) Ltd, 2nd Edn, (2010).

SEMESTER-IV: CORE-XIII
SURFACE PHENOMENA, STATISTICAL THERMODYNAMICS AND PHASE RULE

Course Code : 17PCH4C13 **Max. Marks : 100**
Hours/Week : 6 **Internal Marks : 25**
Credit : 5 **External Marks : 75**

Objectives:

- *To learn the theories and importance of surface chemistry*
- *To understand the thermodynamics of equilibrium and non-equilibrium systems.*
- *To inculcate interest in solving thermodynamic quantities by statistical and quantum mechanical approach.*

UNIT-I **18 hours**

Surface Phenomena

1.1 B.E.T. isotherms - Surface area determination - Heat of adsorption and its determination Adsorption from solution, Gibbs adsorption isotherm - solid - liquid interfaces - wetting and contact angle - solid gas interfaces - soluble and insoluble film.

1.2 Surface tension - methods of measuring surface tension - electrical phenomenon at Interfaces, including electro kinetic, micelles and reverse micelles, Solubilisation, Micro - emulsions. (Problems from 5.1 & 5.2)

1.3 Role of surface in catalysis - #semiconductor catalysis, n and p type surfaces - kinetics of surface reactions involving adsorbed species - Langmuir -Hinshelwood mechanism#.

UNIT – II **18 hours**

Classical Thermodynamics:

2.1 Thermodynamics of systems of variable composition - partial molar property – partial molar quantities of E, V, H, A, G and S, chemical potential, physical significance of chemical potential, variation of chemical potential with respect to T and P, chemical potential in terms of U and H, partial molar quantities from experimental data – direct method, apparent molar properties, intercepts method and general methods.

2.2. Calculation of thermodynamic properties of real gases - fugacity concept, variation of fugacity with T and P – calculation of fugacity of real gases, determination of fugacity – graphical method, equation of state method, determination of fugacity in gas mixtures – Lewis-Randall rule.

2.3. Activity of non-electrolytes – definition, activity coefficient, standard states of sol vent and solute for liquids and solids, dependence of activity on T and P, experimental determination of activity (solvent and solute) – vapour pressure method, #cryoscopic method and EMF method#. (Problems from activity coefficient)

UNIT - III **18 hours**

Statistical Mechanics

3.1. Basic Concepts and Classical Statistics – introduction of statistical mechanics, mathematical probability, thermodynamic probability, relation between mathematical probability and thermodynamic probability of a system, Boltzmann-Planck's equation, Phase space, Ensembles – types of ensembles, definition of micro and macro states, different methods of counting macro states, postulates, Ergodic hypothesis, distinguishable and indistinguishable particles, Stirling's approximation

3.2. Classical statistics – derivation of Maxwell–Boltzmann statistics and distribution law, partition functions – definition, derivation of translational, rotational, vibrational and electronic partition functions, principle of equi-partition of energy.

3.3. Molar partition function and molecular partition function, partition functions and thermodynamic quantities - Internal energy (E), heat capacity (Cv), work function (A), pressure (P), #heat content (H), Gibb's free energy(G) and entropy(S), entropy of mono atomic gases (Sackur–Tetrode equation)#. (Problems from 2.3)

UNIT –IV **18 hours**

Quantum Statistics

4.1. Quantum statistics – Bose–Einstein and Fermi–Dirac statistics and distribution function, comparison of them with Maxwell-Boltzmann statistics,

4.2. Application of B.E.statistics - photon gas and super fluidity of liquid helium, concept of negative Kelvin temperature, application of F.D.statistics - electron gas and thermionic emission.

4.3. Heat capacities of solids – Dulong and Petit's law, classical theory and its limitations, Einstein's theory and its limitations, Debye's theory and its limitations.

UNIT-V **18 hours**

5.1. **Irreversible Thermodynamics:**

Non-equilibrium thermodynamics – definition, types of irreversibility of a process, postulates, entropy production - entropy production and rate in a chemical reaction, Onsagar relations - linear law, reciprocal relation and applications, stationary–state.

5.2. **Phase rule-Three component system:**

Maximum number of phases, maximum number of F, Roozeboom triangle- Types- formation of one pair partially miscible liquids (acetic acid-chloroform-water), formation of two pairs of partially liquids (water-phenol-aniline) and formation of three pairs of partially miscible liquids (succinic nitrile- water- ether).

5.3. **Solid liquid systems**: Ammonium chloride - Ammonium nitrate - Water system, #H_2O - Na_2SO_4 – NaCl system and $MgCl_2$, $CaCl_2.H_2O$ system#.

_____ # **Self study**

TEXT BOOKS:

1. Laidler, "Chemical Kinetics," 3rd edition, New Delhi Tata-McGraw Hill Co., 1984.
2. K. Kuriacose and J. C. Rajaram, "Thermodynamics for Students of Chemistry", Shoban Lalnagin Chand and Co.Delhi, 2002.
3. Gurdeep Raj, "Thermodynamics Statistical Thermodynamics & Irreversible Thermodyanics", Goel Publishing House, Meerut, 1998.
4. M. C. Gupta, "Statistical Thermodynamics", New Delhi, East-West Affiliated Pvt.Ltd., 1969.

UNIT I : Text Book 1
UNIT II : Text Book 2,3
UNIT III : Text Book 2,3
UNIT IV : Text Book 3
UNIT V : Text Book 4

REFERENCES:

1. F. W. Sears, "Statistical Mechanics", 2nd Edition, Addison Wesley, 1972.
2. H. W. Zemansky, "Heat and Thermodynamics", Tata- McGraw Hill, 1975.
3. P. W. Atkins, Physical Chemistry E.L.B.S. 6th Ed.1998.
4. Samuel Glasstone, "Textbook of Physical Chemistry" 2nd Edition, MacMillan India, 1981.
5. K. L. Kapoor, "A Text Book of Physical Chemistry", Volume-4 S. M.Yogan at Macmillan India Press, Chennai, 2009.

SEMESTER-IV: CORE- XIV
POLYMER CHEMISTRY

Course Code: 17PCH4C14 **Max. Marks : 100**
Hours/Week : 6 **Internal Marks : 25**
Credit : 5 **External Marks : 75**

Objectives:

- *To understand the basic concepts of polymers*
- *To know the different types of polymerization techniques*
- *To learn the various techniques of polymer processing*
- *To know the applications of synthetic polymers*

UNIT-I **18 hours**

Basic Concepts of Polymers

1.1 Monomer, polymer, characteristics of polymer, degree of polymerization, Classification – based on sources, reactions, structure and functionality. Stereo regular polymers.

1.2 Kinetics and mechanism: Free radical, Cationic, Anionic, Coordination and co-polymerization.

UNIT-II **18 hours**

Polymerization Techniques and Characterization

2.1 Polymerization Techniques - Bulk, Solution, Suspension and Emulsion polymerizations.

2.2 Characterization - number, weight and viscosity average molecular weight concepts - Polydispersity and molecular weight distribution - Practical significance of molecular weight - Determination of molecular weight of polymers by light scattering, osmometry and ultracentrifugation methods.

2.3 Characterization of polymer by IR, SEM and XRD

UNIT-III **18 hours**

Properties of Polymers

3.1 Physical properties - Hardness, tensile strength, fatigue, impact, tear resistance and abrasion resistance. Polymer structure and property relationship - melting point (T_m), effect of chain flexibility and other steric factors. Glass transition temperature (T_g), factors influencing T_g, relationship between T_g and T_m.

3.2 Degradation of polymers - thermal, photo, mechanical and oxidative degradations. #Preventing methods of polymer degradation#

UNIT-IV **18 hours**

Polymer Processing

4.1 Elastomers, plastics and fibres - thermosetting and thermoplastics - Compounding and vulcanization of elastomers.

4.2 Processing techniques: Calendering, die casting, rotational casting, film casting, injection moulding, blow moulding, extrusion moulding, thermoforming, foaming, #reinforcing and fibre spinning#.

UNIT-V **18 hours**

Commercial polymers and their applications

5.1 Preparation, properties and applications of Teflon, Polyamides - Nylon-6,6, nylon-6,10, polymethylmethacrylate (PMMA), phenolic resins, epoxy resins, Buna-S, Buna-N, and butyl rubber.

5.2 Speciality polymers - Fire retarding polymers and conducting polymers, Types - electron, proton and ion conducting polymers.

5.3 Biomedical polymers - contact lens, dental, artificial heart, artificial kidney, #artificial skin and artificial blood cells#

#_____# Self study

TEXT BOOKS:

1. V. R. Gowariker N. V. Viswanathan and J. Sreedhar, "Polymer Science", New Age International, New Delhi, 2003.
2. F. W. Billmeyer, "Text Book of Polymer Science", 3rd Edition, John Wiley & Sons, New York, 2003.
3. Alka L. Gupta, "Polymer Chemistry", 4th Edition, A Pragati Edition, Meerut, 2015.
4. M.S. Bhatnagar, "A Text book of Polymers (Basic Concepts)", Vol.-I, S.Chand & Company Ltd. New Delhi.

UNIT I: Text Book 1,3,4
UNIT II: Text Book 1,2
UNIT III: Text Book 1,2,3,4
UNIT IV: Text Book 1,3,4
UNIT V: Text Book 1,3,4

REFERENCES:

1. Charles E. Carraher Jr. "Introduction to Polymer Chemistry", 2006 Third Edition, CRC Press, Taylor & Francis group.
2. Robert J. Young, Peter A. Lovell "Introduction to Polymers", Third Edition, CRC Press, Taylor & Francis group.

SEMESTER-IV: CORE BASED ELECTIVE- IV

NANO AND GREEN CHEMISTRY

Course Code	**: 17PCH4CE4A**	**Max. Marks**	**:100**
Hours/Week	**: 6**	**Internal Marks**	**: 25**
Credit	**: 4**	**External Marks**	**: 75**

Objectives:

- *To impart a basic idea on nano and green chemistry*
- *To bring the knowledge for student about solvent free reaction*
- *To study about the sono chemistry*

UNIT-I **18 hours**

Nano Materials:

Introduction – Historical milestones- Nanomaterials - classification – properties – Optical, electrical, mechanical and magnetic properties – Applications. Nanoparticles - Synthesis – Hydrothermal method- Sol- gel method – Solvothermal methods – Bottom up- Top down – Methods. #SEM, TEM and AFM -Principle – applications#.

UNIT-II **18 hours**

Carbon nanotubes:

CNT –definition- Classification –Single wall CNT- Multiwall CNT- Preparation - arc method – laser ablation method – Chemical vapour deposition method – Electro-deposition method- Ball milling method. SWCNT and MWCNT – Properties- applications – fullerenes – properties – uses. Nan composites – Classification – Properties - uses.

UNIT-III **18 hours**

Green Chemistry:

Definition- Need for green chemistry- Twelve principles of green chemistry- concept of atom economy – efficiency of reaction – percentage yield – Theoretical yield – Atom economy in substitution reaction- elimination reaction – addition reaction and rearrangement reaction - #Atom economy calculation of ethylene oxide and Ibuprofen#.

UNIT-IV **18 hours**

Green reactions: Green solvents –definition- super critical carbon dioxide - role of Ionic liquids –Use of water as solvent- applications of zeolites in green chemistry – uses of microwave and sonication – Designing a green synthesis – choice of starting material - choice of reagents – choice of catalysts –Choice of solvents- #PTC catalyzed reaction#.

UNIT-V **18 hours**

Green Synthesis: Adipic acid – catechol- methyl methacrylate, acetaldehyde, Ibuprofen, Paracetamol- Microwave assisted reaction in water- Definition – Hofmann eliminations – Hydrolysis- Oxidation- Microwave assisted reaction in organic solvents- Esterification – Fries rearrangement – Decarboxylation- #Diels – Alder reaction#. **Ultrasound assisted reaction:** Definition- Cannizaro reaction – Strecker synthesis – Reformatsky reaction.

#_____# Self study

TEXT BOOKS:

1. Sulabha K. Kulkarni Nanotechnology: Principles and practices (capital Pvt. Co.)-2002
2. R.Sanghi and M.M srivastva, Green chemistry, Narosa P ublications, 2003.

UNIT I : Text Book 1
UNIT II : Text Book 1
UNIT III : Text Book 2
UNIT IV : Text Book 2
UNIT V : Text Book 2

REFERENCES:

1. Nanoscale materials in chemistry, Wiley interscience, Kenneth, J.Klaburde, 2002.

2. M. M. Srivastva and R.Sanghi, Chemistry for green environment, Narosa, 2005.

3. S, Delvin Green chemistry, IVY publication house, 2006.

4. F.J. Ownes Introduction to Nano technology John Wiley and New Jersey, 2003.

SEMESTER- IV: CORE BASED ELECTIVE-IV
QUALITY CONTROL AND ENVIRONMENTAL CHEMISTRY

Course Code: 17PCH4CE4 B **Max. Marks :100**
Hours/Week: 6 **Internal Marks : 25**
Credit : 4 **External Marks: 75**

Objectives:

- *To acquire knowledge on pollution and recycling techniques.*
- *To understand the application of chemistry in quality control measurements.*
- *To study about the energy sources.*

UNIT – I **18 hours**

Quality Control Measurements

Moisture, ash, crude protein, fat, crude fibre, carbohydrates, calcium, potassium, sodium and phosphate – Food adulteration – common adulterants in food, contamination of food stuffs – Microscopic examination of foods for adulterants – Pesticides analysis in food products – analysis of toxic metals in food (Mercury, cadmium, cobalt, tin and chromium) – Determination of iodine, Saponifiction and acid value of an oil – #Food standards – ISI and Agmark#.

UNIT – II **18 hours**

Energy Sources – Non Conventional

Solar energy – Technologies based on capture of heat from sun light – solar water heating systems – solar air conditioning. Technologies for converting solar energy to electricity – heat engines, photo voltaic – principle and operation. Wind energy – wind mills – wind farm siting and properties – storage. Tidal energy – advantages and limitations of tidal power generation. Environmental impact of renewable energy sources. Bio mass energy sources – advantages – #Fuel cell – hydrogen-oxygen fuel cell, Hydrocarbon-oxygen fuel cell#.

UNIT –III **18 hours**

Water Pollution and its Control Analysis of Water Pollution

Sources of water pollution – domestic – industrial – agricultural – soil and radioactive wastes as sources of pollution. Water pollutants and their effects. Objectives of analysis – parameter for analysis-colour – turbidity – total solids – conductivity – acidity – alkalinity – hardness – chloride – sulphate – fluoride – silica – phosphates, different forms of nitrogen, DO, BOD, COD Heavy metal pollution-public health significance of cadmium – chromium – copper – lead – zinc – manganese –# mercury and arsenic#. Prevention and control its measures.

UNIT –IV **18 hours**

Radioactive and Thermal Pollution

Radioactivity and kinds of radiation – Sources of radioactive pollution – Radio waste generated by nuclear power plants – Harmful effects of radiation – Dangerous from nuclear power plants –

#Disposal methods of radioactive wastes#. Source of thermal pollution – Thermal power plant pollution – Hazardous effect – Prevention and control of thermal pollution.

UNIT – V **18 hours**

Wealth from Waste (Recycling):

Introduction – Recycling Technique – Construction materials from waste – Medicines from agricultural waste – Liquid fuels from agricultural – Urban waste and bagasse for electricity – Agriculture waste for biomass into cheap and efficient fuel – Bacteria for paper making – Waste into objects of daily use – #Garbage into fuel – How to use garbage to generate power#.

#_____# Self study

TEXT BOOKS:

1. B.K. Sharma and H. Kaur, "Environmental chemistry" ,Goel Publishing House, Meerut, 2008.
2. B.K. Sharma - "Instrumental Methods of Chemical Analysis", Goel Publishing House, Meerut. 2001.
3. B.K. Sharma – "Industrial Chemistry", Goel Publishing House, Meerut, 2015.

UNIT I: Text Book 1,2
UNIT II: Text Book 1,3
UNIT III: Text Book 1,2,3
UNIT IV: Text Book 3
UNIT V: Text Book 2,3

REFERENCES:

1. S.A. Abbasi and Naseema Abbasi – "Renewable energy sources and their environmental impact", Prentice-Hall, New Delhi,2002.
2. H. Kaur, Pragati Prakashan, Meerut – "Instrumental Methods of Chemical Analysis", 2001.

SEMESTER-IV: EXTRA CREDIT – II
INSTRUMENTATION AND SEPARATION TECHNIQUES

Course Code : 17PCH4EC2 | **Max. Marks: 100***
Hours/Week : -- | **Internal Marks : --**
Credit : 5* | **External Marks : 100***

Objectives:

- *To understand the concepts of Spectroscopy.*
- *To gain an idea about separation techniques*
- *To learn the theories and importance of conductometry and potentiomentry*

UNIT-I

UV- Visible spectroscopy- Instrumentation- sources, filters and monochromators, slits, grating, cuvete, radiation detectors and indicators, photoelectric spectrophotomer - types, sources of errors during recording, calibration- presentation of spectral data

Infrared Spectroscopy: Dispersive infrared spectrometer- source (Nernst, Globar) monochromater, detector, double-beam spectrophotometer - presentation of spectra- sample preparation techniques for IR, FT-IR- simple diagram of a Fourier transform infrared spectrometer- working mode – advantages.

Raman spectroscopy: Instrumentation- source of light, filters, sample holders, spectrograph, detectors, Sample preparation.

UNIT-II

Nuclear Magnetic Resonance (NMR): Instrumentation - magnet, magnetic field sweep, radio frequency source, signal detector and recording system, sample holder, sample probe.

Electron Spin Resonance (ESR): Instrumentation - electromagnet, source of micro wave radiation, sample cavity, choice of solvent, crystal detectors and recorder-double resonance spectrometers.

Mass Spectrometry: Instrumentation - sample preparation, generation of ions, analyzer, ion collector and measuring system, resolution- representation of mass spectrum – double focusing mass spectrometer.

UNIT-III

Conductometry: Introduction, laws and definitions of conductance, effects of dilution, conductance measurements, conductometric titrations - apparatus, types and advantages.

Potentiometry: electrochemical series, reference electrodes – hydrogen electrode, calomel and silver-silver chloride electrode, measurement of pH – glass indicating electrode, potentiometric titrations, variations in potentiometric titrations, its advantages.

Atomic Absorption Spectroscopy: Introduction, principle of AAS, classification of atomic spectroscopic methods, measurement of atomic absorption, instrumentation – application. Atomic Emission spectroscopy – Introduction, origin of spectra, principle of emission spectroscopy, Instrumentation, measurement of light intensity and applications.

UNIT-IV

Column Chromatography: Definition, Types, Principles of column chromatography. Experimental techniques – Adsorption column – Packing of column – Adsorbents – Characteristics of good adsorbent – developers – Techniques of separation – Detectors, applications of column chromatography.

Thin Layer Chromatography: Principle, types, experimental techniques of TLC, applications of TLC.

Paper Chromatography: Principle, types, experimental techniques of Paper chromatography, applications.

Ion Exchange Chromatography: Principle, Ion exchanger and its types, experimental techniques of IEC, applications.

UNIT-V

Gas Chromatography: Principle, types (GSC, GLC), Instrumentation of GC, applications of GC. **GC-MS:** Principle, instrumentations, applications of GC-MS.

High Performance Liquid Chromatography (HPLC): Introduction, principle, characteristic features of HPLC, instrumentation, applications of HPLC.

Exclusion Chromatography: Principle, Types, Gel chromatography, Experimental techniques of GPC.

Electrophoresis: Introduction, Types of Paper electrophoresis, Techniques of Paper electrophoresis, thin layer electrophoresis, Zone electrophoresis, Electro dialysis, applications of Electrophoresis.

TEXT BOOKS:

1. H. Kaur - "Instrumental methods of Chemical Analysis", 6th edition, (2010), Pragati prakasan Publications, Meerut.
2. G.Aruldhas –"Molecular structure & Spectroscopy", PHI learning Pvt.Ltd.2nd Edition,-2008.
3. B.K. Sharma-"Instrumental Methods of Analysis", (2000), Goel Publications, Meerut.
4. S.M. Khopkar, "Basic Concepts of Analytical Chemistry", Revised edition (2006) Wiley Eastern Ltd.

UNIT I : Text Book 2
UNIT II : Text Book 2
UNIT III :Text Book 1,3,4
UNIT IV : Text Book 1,3,4
UNIT V :Text Book 1,3,4

REFERENCES:

1. Willard, Meeritt, Dean and Settle – "Instrumental Methods of Analysis", 7th Edn., (2006), CBS Publishers.
2. R.A. Day and A.L. Underwood – "Quantitative Analysis", (1999), Prentice-Hall of India Pvt., Ltd., New Delhi.
3. B.S. Furniss, A.J. Hannaford, P.W.G. Smith and A.R. Tatchell – "Vogel's Text book of Practical Organic Chemistry", 5th edition, 2009, Pearson Education Publisher.
4. L. Pavia – "Spectroscopy" cengage learning India Pvt. Ltd - 2010.
5. Harald Guther, "NMR Spectroscopy", Wiley india (p) Ltd, 2nd Edn. 2010.
6. Colin N.Banwell – "Fundamentals of Molecular structure Spectroscopy" Mc.Graw – Hill publishing company Ltd. 4th edition, 1995.

SEMESTER- I: CORE – III
INORGANIC ESTIMATION AND COMPLEX PREPARATIONS-PRACTICAL

Course Code : 17PCH1C3P **Max. Marks : 100**
Hours/Week : 6 **Internal Marks : 20**
Credit : 4 **External Marks : 80**

Objectives:

- *To learn quantitative separation of metal ions in binary mixtures.*
- *To learn simple single stage preparations of some inorganic complex.*

Volumetry, Gravimetry / Complexometric and complex preparations:

Estimation of the following elements by volumetric and gravimetric / complexometric methods:

1. Cu (V) Ni (G/C)
2. Cu (V) Zn (G/C)
3. Cu (V) Mg (G/C)
4. Zn (V) Cu (G/C)
5. Fe (V) Zn (G/C)

Note: V - Volumetric
G - Gravimetric
C - Complexometric

Preparations:

1. Tetramminecopper(II)sulphate
2. Potassiumtrioxalatochromate(III)
3. Hexathiourealead(II)nitrate
4. Potassiumtrioxalatoaluminate(III)
5. Tristhioureacopper(I)chloride
6. Tristhioureacopper(II)sulphate

Scheme of valuation

Procedure writing	-10 marks
Viva	-10 marks

Results:

1-2% -	60 marks
2-3% -	50 marks
3-4% -	40 marks
>4% -	30 marks

REFERENCES:

1. Vogel A I, A Text Book of Quantitative Inorganic Analysis, 3rd Edn., London, Longman Group.

SEMESTER- I: CORE – IV
ORGANIC ESTIMATIONS AND CHROMATOGRAPHY-PRACTICAL

Course Code: 17PCH1C4P | **Max. Marks : 100**
Hours/Week : 6 | **Internal Marks : 20**
Credit : 4 | **External Marks : 80**

Objectives:

- *To understand the organic qualitative separation and identification*
- *To know the concept of Thin Layer Chromatography*

1. Estimation of the following: **60 Marks**

Phenol, Aniline, Ethyl methyl ketone, Glucose, Ascorbic acid.

2. Chromatographic Technique **10 Marks**
Thin Layer Chromatography

3. Viva-voce **10 Marks**

Scheme of valuation for estimation:

Procedure writing - 10 marks

Results:

1-2% - 50 marks
2-3% - 40 marks
3-4% - 30 marks
>4% - 20 marks

REFERENCES:

1. Vogel s text book of practical Organic Chemistry., 5th Edition, 1989.

SEMESTER- II: CORE –VII

INORGANIC QUALITATIVE ANALYSIS AND COLORIMETRIC ESTIMATIONS - PRACTICAL

Course Code : 17PCH2C7P | **Max. Marks : 100**
Hours/Week : 6 | **Internal Marks : 20**
Credit : 4 | **External Marks: 80**

Objectives:

- *To learn the technique of inorganic qualitative analysis.*
- *To understand the concept of common ion effect and solubility product.*
- *To learn colorimetric analysis.*

Semi-micro Qualitative Analysis: **(50 Marks)**

Analysis of two common and two rare earth elements in a given inorganic mixture
***Common*:** Pb, Cu, Bi, Cd, Zn, Co, Ni, Ca, Ba, Sr
***Rare*:** W, Se, Te, Mo, Ce, Zr, Th, V, Li

Colorimetric Estimations: **(25 Marks)**

Cu, Fe, Mn, Ni, Cr, Co

Viva-voce: 5 Marks

Scheme of Valuation:

Procedure Writing - 10 Marks
Viva - 10 marks

Analysis:

4 radicals correct with suitable tests: 40 marks
3 radicals correct with suitable tests: 30 marks
2 radicals correct with suitable tests: 20 marks
1 radical correct with suitable tests: 10 marks

Colorimetric Estimations:

1-2%	-	20 marks
2-3%	-	15 marks
3-4%	-	10 marks
>4%	-	05 marks

REFERENCES:

1. Vogel A I, A Text Book of Quantitative Inorganic Analysis, 3rd Edn., London, Longman Group.

SEMESTER-II: CORE –VIII
ORGANIC PREPARATIONS AND MIXTURE ANALYSIS-PRACTICAL

Course Code : 17PCH2C8P | **Max. Marks : 100**
Hours/Week : 6 | **Internal Marks : 20**
Credit : 4 | **External Marks: 80**

Objectives:

- *To learn technique of organic qualitative analysis.*
- *To learn some double stage organic preparations.*

Separate the following types of mixture and analyze only one of the components present as desired by the Teacher / Examiner.

1. Mixture Analysis:

1. Soluble and insoluble
2. Acidic and Neutral
3. less acidic and neutral
4. Basic and neutral

2. Two Stage Preparations:

1. Acetylsalicylicacid from methylsalicylate
2. 1,3,5 – Tribromobenzene from Aniline
3. *p*-Nitroaniline from acetanilide
4. *p*-Bromoaniline from acetanilide
5. Benzilic acid from benzoin
6. Benzaldehyde to chalcone epoxide via chalcone
7. Cyclohexanone to caprolactone via cyclohexanone oxime

3. Viva-voce: 10 Marks

Scheme of valuation

Organic analysis	**: 50**	
Organic preparation	**: 20**	
Procedure Writing	-	10 marks
Pilot separation	-	10 marks
Special elements present / absent	-	8 marks
Aromatic/ aliphatic	-	6 marks
Saturated/ unsaturated	-	6 marks
Functional group present	-	10 marks
Derivative	-	10 marks

REFERENCES:

1. Vogels text book of practical Organic Chemistry., 5th Edition, 1989.

SEMESTER- III: CORE-XII
PHYSICAL CHEMISTRY NON ELECTRICAL - PRACTICAL

Course Code : 17PCH3C12P | **Max. Marks : 100**
Hours/Week : 6 | **Internal Marks : 20**
Credit : 4 | **External Marks : 80**

Objectives:

- *To understand Phase diagram and kinetics*
- *To learn the instrumental techniques*

Non- Electrical

1. Phase diagram of a binary system (Eutectic formation)
2. Phase diagram of a two-component system forming compound (with congruent melting point).
3. Phase diagram of a three component liquid system (with one partially miscible pair) (CH_2Cl_2/$CHCl_3$/Toluene/Water-Acetic acid).
4. Heat of solution of benzoic acid in water.
5. Comparison of strengths of three acids from kinetic study (Iodination of acetone)
6. Rast micro method of determining kf and molecular weight.
7. Determination of E_a and A (for the hydrolysis of ethyl acetate at different temperatures)
8. Primary salt effect (on the kinetics of reaction between $S_2O_8^{2-}$ and I^-).
9. Verification of Freundlich adsorption isotherm (Adsorption of oxalic acid on Charcoal).
10. Estimation of KI by partition method.

Scheme of valuation

Procedure with formula	-	10 marks
Viva	-	10 marks
Up to 5%	-	60 marks
05-10%	-	50 marks
10-15%	-	40 marks
>15%	-	30 marks

REFERENCES:

1. Daniels., Experimental Physical Chemistry, (7th edition), NewYork, McGraw Hill, (1970).
2. Findlay, A., Practical Physical Chemistry, (7th edition), London, Longman (1959).

SEMESTER- IV: CORE-XIV
PHYSICAL CHEMISTRY ELECTRICAL-PRACTICAL

Course Code: 17PCH4C15P **Max. Marks : 100**
Hours/Week : 6 **Internal Marks : 20**
Credit : 5 **External Marks : 80**

Objectives:

- *To understand the principles of conductometry and potentiometry*
- *To learn the instrumental techniques*

CONDUCTOMETRY:

1. Estimation of mixture of acids.
2. i. Determination pKa – Ostwald's dilution law.
   ii.Determination of solubility product-Kohlrausch's law.
3. Estimation of mixture of halides.
4. Determination of hydrolysis constant (for aniline hydrochloride)
5. i. Saponification of ethyl acetate (Kinetics study).
   ii. Determination of critical micelle concentration by conductometric method.

POTENTIOMETRY:

1. Estimation of mixture of acids.
2. Determination of solubility product
   a. Galvanic cell method.
   b. Concentration cell method.
3. Estimation of mixture of halides.
4. Determination of E^O Zn / Zn and Estimation of Zn
5. Determination of hydrolysis constant (for aniline hydrochloride)

Scheme of valuation

Procedure with formula	: 10 marks
Practical	: 60 marks
Viva	: 10 marks

<1%	-	60 marks
1-2%	-	50 marks
2-3%	-	40 marks
3-4%	-	30 marks
>4%	-	20 marks

REFERENCES:

1. Daniels, Experimental Physical Chemistry, (7th edition), New York, Mc Graw Hill, (1970).
2. Findlay, A., Practical Physical Chemistry, (7th edition), London, Longman (1959).