RAJA MAHENDRA PRATAP SINGH STATE UNIVERSITY, ALIGARH (U.P)

Structure of Syllabus for P.G Programmes

Program : M.Sc. Subject : CHEMISTRY

Structure of Syllabus Developed by

Name of BoS Convenor / BoS Members	Designation	Department	College
Dr Subhash Chaudhary Convenor	Associate Professor	Chemistry	D.S College, Aligarh
Dr Renu Singhal	Associate Professor	Chemistry	D.S College, Aligarh
Dr Sangeeta Kumar	Associate Professor	Chemistry	Sri Tikaram Kanya Mahavidyalay, Aligarh
Dr Dalsher Khan	Associate Professor	Chemistry	Ganjdundwara College, Kasganj
Dr V.K Srivastava	Associate Professor	Chemistry	D.S College, Aligarh
Dr Viniti Gupta	Associate Professor	Chemistry	Sri Tikaram Kanya Mahavidyalay, Aligarh
Dr Raj Kumar	Associate Professor	Chemistry	J.B Jain College, Saharanpur
Dr Indrajit Singh	Associate Professor	Chemistry	C.C.R.D College,Muzaffarnagar

M.Sc. CHEMISTRY SYLLABUS SEMESTER WISE

M.Sc. CHEMISTRY SEMESTER VII (Year I)

Course		Paper	CREDITS	T / P	EVALUATION	EVALUATION
Code	**category**	**Title**			**C I E**	**E T E**
RB020701T	Major One	Environmental Science	4	T	25	75
RB020702T	Major Two	Inorganic Chemistry	4	T	25	75
RB020703T	Major Three	Organic Chemistry	4	T	25	75
RB020704T	Major Four	Physical Chemistry	4	T	25	75
RB020705P	Major Five	Chemistry Practical	4	P	25	75
	Minor Elective (six)	Subject Elective from other Faculty	4	T	25	75
	Research Project	Topic selection from the major subjects/review of literature/industrial training/survey	4	R		

M.Sc. CHEMISTRY SEMESTER VIII (Year I)

Course		Paper	CREDITS	T / P	EVALUATION	EVALUATION
Code	**category**	**Title**			**C I E**	**E T E**
RB020801T	Major One	Inorganic Chemistry	4	T	25	75
RB020802T	Major Two	Organic Chemistry	4	T	25	75
RB020803T	Major Three	Physical Chemistry	4	T	25	75
RB02084aT / RB02084bT/ RB02084cT	Major Four Select any one	Research Methodology / Petroleum chemistry / Spectroscopic methods	4	T	25	75
RB020805P	Major Five	Chemistry Practical	4	P	25	75
	Research Project	Research Project Report writing/ Report submission / Evaluation	4	R	50	50

M.Sc. CHEMISTRY SEMESTER IX (Year II)

Course		Paper	CREDITS	T / P	EVALUATION	EVALUATION
Code	**category**	**Title**			**C I E**	**E T E**
RB020901T	Major One	Spectrochemical Analysis	4	T	25	75
RB020902T	Major Two	Chemistry in daily life	4	T	25	75
RB020903T	Major Three	Green chemistry	4	T	25	75
RB02094aT/ RB02094bT/ RB02094cT	Major Four Select any one	General inorganic &Analytical **/** Organic synthesis **/** Physical chemistry	4	T	25	75
RB020905P	Major Five	Chemistry Practical	4	P	25	75
	Research Project	Topic selection from the major subjects/review of literature/industrial training/survey	4	R		

M.Sc. CHEMISTRY SEMESTER X (Year II)

Course		Paper	CREDITS	T / P	EVALUATION	EVALUATION
Code	category	Title			C I E	E T E
RB021001T	Major One	Chemistry of Nanomaterials	4	T	25	75
RB02102aT/ RB02102bT/ RB02102cT	Major Two Select any one	Applications of spectroscopy in inorganic chemistry / Organic Synthesis / Physical Chemistry	4	T	25	75
RB02103aT/ RB02103bT/ RB02103cT	Major Three Select any one	Bioinorganic chemistry / synthesis and Bioorganic chemistry / Physical chemistry	4	T	25	75
RB02104aT/ RB02104bT/ RB02104cT	Major Four Select any one	Industrial Inorganic chemistry / Natural Products and Medicinal chemistry / Biophysical chemistry	4	T	25	75
RB021005P	Major Five	Chemistry Practical	4	P	25	75
	Research Project	Research Project Report writing/ Report submission/ Evaluation	4	R	50	50

M.Sc. Chemistry Semester VII (Year I)
Paper I (Theory)
Course Title: Environmental Science

Course Code :RB020701T Credits: 4

Unit I

Introduction to Environmental Chemistry : Concept and scope of Environmental chemistry, Environmental Terminology and nomenclatures, Environmental segments, The natural cycles of environment (Hydrological, Oxygen, Nitrogen, Phosphorous and Sulphur cycles)

Unit II

(A) Atmosphere :

Regions of the atmosphere, Reactions in atmospheric chemistry, earth radiation balance, particles, ions and radicals and their formation chemical and photochemical reaction in atmosphere smog formation, oxides of N,C, S,O and their effects, Pollution by chemicals, petroleum, minerals, Chloro Fluro hydrocarbons .Green house effect,Chemistry of Ozone layer, acid rain air pollution control and their chemistry.

(B) Chemistry of Soil and Hydrosphere:

Physio-chemical composition of soil, micro and macro nutrients, significance of C:N ratio, Cation exchange capacity (ECE), reactions in soil solution, ion exchange (physio-sorption) ligand exchange (chemisorption), complexation, chelation, precipitation, dissolution.

Unit III

Chemical Toxicology :

Toxic chemicals in the environment, Impact of toxic chemicals on enzymes, biochemical effects of arsenic, cadmium, lead. mercury, carbon monooxides, nitrogen oxides, sulphur oxides, ozone, PAN, Cyanide, pesticides, insecticides and carcinogens.

Unit IV

Environmental Management and Water treatment Techniques :

Methods of environmental management, Radioactive waste management, Environmental impact assessment, Natural resources of energy- consumption and conservation. Water quality parameters, DO, COD, BOD and its kinetics, chemical physical methods of waste water treatment with emphasis on sedimentation, coagulation adsorption, water softening, defluorination and ion exchange process

Recommended Books :

1. G.W. Vanloon, S.J Duffer Environmental Chemistry – A Global Perspective, Oxford University Press, 2000
2. F.W Fifeld and W.P.J Hairens, Environmental Analytical Chemistry 2nd Edition, Black well science Ltd. 2000
3. Colin Baird , Environmental chemistry, W.H Freeman and Company , New York. 1995
4. A.K De, Environmental Chemistry , 4th Edition, New age international Pvt Ltd., 2000

M.Sc. Chemistry Semester VII (Year I)
Paper II (Theory)
Course Title: Inorganic Chemistry

Course Code :RB020702T **Credits :4**

Unit I

Metal Ligand Bonding:

Valence bond theory, Crystal field theory for octahedral, square planar, square pyramidal and trigonal bipyramidal geometries. Crystal field stabilization energy (CFSE). Factors affecting the crystal field parameters weak and strong field complexes. Spectrochemical series. Ligand field theory and adjusted crystal field theory. Molecular orbital theory of tetrahedral and octahedral complexes (including π-bonding).
MLCT and LMCT transition in coordination compounds: John-Teller Effect.

Unit II

Metal Ligand Equilibria in Solution:

Step wise and overall formation constant and their interaction. Trends in step wise constant, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, chelate effect and its thermodynamic origin.
Determination of binary formation constants by pH-metry and spectrophotometry stability correlation Irwing- William's series.

Unit III

Reaction Mechanism of Transition Metal Complexes:

Energy profile of a reaction, reactivity of metal complexes, inert and labile complexes. **A**, **D** and **I** mechanism for metal complexes, kinetics of octahedral substitution, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism, direct and indirect evidences in favour of conjugate mechanism, anation reactions, reactions without metal ligand bond cleavage. Substitution reactions in square planar complexes, the trans-effect, mechanism of substitution reactions, redox reactions, electron transfer reactions, outer sphere type reactions, cross reactions and Marcus Hush theory (M-H theory), inner sphere type reactions.

Unit IV

Metal π-complexes:

Metal carbonyls, structures, bonding, vibrational spectra of metal carbonyls for bonding and structure elucidation, Important reactions of transition metal nitrosyl, dinitrogen and dioxygen complexes. Tertiary phosphine and arsines as ligands, photochemistry of transition metal carbonyls.

Recommended Books

1 B. D. Gupta and A. J. Elias, Basic Organometallic Chemistry: Concepts, Synthesis and Applications 2nd Edition Universities Press (India), 2013

2 Concise Inorganic Chemistry,J.D Lee, Elbswith Chapman and Hall, London

3 P. Powell, Principles of Organometallic Chemistry, 2nd Edition Springer, **2009**

4 Advanced Inorganic Chemistry F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann 6th Edition Wiley **1999**

5 Inorganic Chemistry J. E. Huheey, Ellen A. Keiter, R. L. Keiter, Addison Wesley Longman (Singapore) Pvt. Ltd., **1993**

6 Miessler, G. L and Tarr, D. A. Inorganic Chemistry Pearson Edition, **2011**

7 Basolo F, and Pearson R. G, Mechanism of Inorganic Reactions John Wiley, New York, **1967**

8 Wilkinson G, Gillard, R. D, and McCleverty, J. A Comprehensive Coordination

Chemistry Pergamon Press, **1987**
9 B. N. Figgis Introduction to Ligand Fields. Wiley Eastern Ltd. New Delhi, **1976**

M.Sc. Chemistry Semester VII (Year I)
Paper III (Theory)
Course Title: Organic Chemistry

Course Code :RB020703T **Credits :4**

Unit I

Nature of bonding in organic molecules:

delocalized chemical bonding-conjugation, cross conjugation, resonance, hyperconjugation, bonding in fullerenes, tautomerism. Aromaticity in benzenoid and non-benzenoid compound, alternate and nonalternate hydrocarbon, Huckel rule, energy of p-molecular orbital, annulenes, antiaromaticity, Ψ−aromaticity homoaromaticity, PMO approach. Bond weaker than covalent-addition compound, crown ether complexes and cryptands, inclusion compound, cyclodextrins, catenanes and rotaxane.

Unit II

Stereochemistry:

Conformational analysis of cycloalkanes, declines, effect of conformation on reactivity, conformation of sugars, steric strain due to unavoidable crowding. Element of symmetry, chirality, molecules with more than one chiral center, thro and erythro isomer, methods of resolution, optical purity, enantiotopic and diastereotopic atoms, group of faces, stereospesific and stereoselective synthesis, asymmetric synthesis, optical activity in absence of chiral carbon (biphenyls, allenes and spiranes), chirality due to helical shape. Stereochemistry of compound containing nitrogen, sulphur and phosphorous.

Unit III

Reaction mechanism: structure and reactivity:

Types of mechanism, types of mechanism, thermodynamics and kinetic requirements, kinetic thermodynamic control, Hammonds postulate, Curtin-hammett principle. Potential energy diagram, transition state and intermediates, methods of determining mechanism, isotope effect. Hard and soft acids and bases. Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes Effect of structure on reactivity – resonance and field effect, steric effect, quantitative treatment. The Hammett equation and linear free energy relationship, substituent and reaction constants, Taft equation.

Unit IV

Aliphatic nucleophilic substitution:

The SN_2, SN_1, mixed SN_1 and SN_2 and SET mechanisms. The neighbouring group mechanism, neighbouring group participation by π and σ bonds, anchimeric assistance. Classical and nonclassical carbocations, phenonium ions, norbornyl system, common carbocation rearrangements.

The SNi mechanism. Nucleophilic substituon at an allylic, aliphatic trigonal and a vinylic carbon. Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium, phase transfer catalysis and ultrasound, ambident nucleophile, regioselectivity

Aliphatic electrophilic substitution

Biomolecular mechanism – SE_2 and SE_1. The SE_1 mechanism, electrophilic substitution accompanied by doubled bond shifts. Effect of substrates, leaving group and solvent polarity.

Books/References:

1. Advanced Orgnaic Chemistry-Reactions, Mechanism and Structure, Jerry March, 6th Edition John Wiley.

2. Advanced Organic Chemistry, F.A. Carey and R.J. Sundberg, Plenum.

3. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.

4. Structure and Mechanism in Organic Chemistry, C.K. Ingold, Cornell University Press.

5. Organic Chemistry, J. Clayden, N. Greevs, S. Wawen, P. Wothers, Oxford Press.

6. Modern Organic Reactions, H.O. House, Benjamin.

7. Stereochemistry of Organic Compounds, D. Nasipuri, New Age International. 8. Stereochemistry of Organic Compounds, P.S. Kalsi, New Age Internation

M.Sc. Chemistry Semester VII (Year I)
Paper IV (Theory)
Course Title: Physical Chemistry

Course Code :RB020704T **Credits :4**

Unit I

Quantum chemistry

Introduction to exact quantum mechanical results:

The Schrodinger equation and postulates of quantum mechanics, Linear and Hermitian operator: commutation of operators and uncertainty principle. Discussion of solutions of the Schrodinger equation to the some model systems viz., particle in a box, the harmonic oscillator, rigid rotor,the hydrogen atom.

Approximate Methods:

The variation theorem, linear variation principle, Perturbation theory (first order and non degenerate). Applications of variation method and perturbation theory of the Hydrogen atom

Unit II

Angular momentum:

Ordinary angular momentum**,** generalized angular momentum, Eigen function for angular momentum, eigen values of angular momentum, operator using ladder operators, addition of angular momentum spin, antisymmetry and Pauli exclusion principle.

Electronic structure of atom

Electronic configuration, Russell-Saunders term and coupling schemes, Slater-Condon parameter, term separation energy of pn configuration, term separation energy for the dn configuration, magnetic effects: spin-orbit coupling and Zeeman splitting.

Unit III

Molecular Orbital Theory:

Huckel molecular orbital (HMO) theory of linear and cyclic conjugated systems, Applications ofHMO theory to (i) set up and solve Huckel determent equation; (ii) calculate resonance energy;

(iii) wave functions for molecular orbitals and molecular diagrams for the following :

(a) Ethylene molecule (b) Allyl system (Allyl radical and the related cation and anion) (c) Butadiene; (d) Cyclobutadiene (e) Cyclopropenyl system (cyclopropenyl radical and the relatedcation and anion.

Data analysis

Mean and standard deviation, absolute and relative errors, linear regression covariance, and correlation coefficient

Unit IV

Symmetry and Group Theory in Chemistry:

Symmetry elements & symmetry operation group and its properties, Multiplication table, point symmetry groups. Schonflies symbol, representations of groups by matrices (representation for the Cn, Cnv, Cnh, Dnh etc. groups to be worked out explicitly) Irreducible representation of groups, the great orthogonality theorem (without proof) & its importance, character tables and their use in spectroscopy

Recommended Books:

1. Physical Chemistry, P.W. Atkins, Oxford Press. 7th Edn.
2. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.
3. Quantum Chemistry, Ira N. Levine, Prentice Hall.
4. Coulson's Valence, R. McWeeny, ELBS.
5. Chemical Application of Group Theory, F.A. Cotton Interscience.
6. Methods in Molecular Orbital Theory, A.G. Turner, Prentice Hall of India
7. Group Theory and Symmetry in Chemistry, L.H. Hall, McGraw Hill.
8. Symmetry and Spectroscopy of Molecules, K.V. Reddy, New Age International
9. A. Vincent, Molecular Symmetry and Group Theory, John Wiley & Sons (1977)

M.Sc. Chemistry Semester VII (Year I)
Paper V (Practical)
Course Title: Chemistry

Course Code :RB020705P **Credits :4**

List of Experiments

(A) Inorganic Chemistry

Unit I: Estimation

Separation and determination of the following pairs of two constituents present together by using Gravimetric and Volumetric methods.

(a) Cu and Zn (b) Cu and Ni (c) Cu and Mg (d) Fe and Ni

Unit II:

Inorganic Synthesis

Synthesis and Characterization of the following Compounds by various Spectroscopic and Analytical methods.

(a) Hexa thiourea plumbous nitrate
(b) Tetrammine cupric sulphate
(c) Penta thiourea dicuprous nitrate
(d) Chrome alum
(e) Cuprous chloride from copper
(f) Dipyridine(I) nitrate

Unit III :

Volumetric Methods (Complexometric , Redox and Precipitation Titrations)

(a) Metal –EDTA Titrations using Erichrome Black T/ Xylenol / PAN indicators
(b) Mohr's salt- $K_2Cr_2O_7$ Titration using External indicator.
(c) $AgNO_3$-NaCl Titration (Mohr's Method)

Recommended Books :

1.Vogel Text Book of Quantitative Chemical Analysis, J.Mendham, R.C Daenney, J.D Barnes, ,M.J.K Thomas, 6th edition, Pearson,2006

2. Advanced Practical Inorganic Chemistry, Gurdeep Raj, 29th edition Krishna Prakashan M.(Pvt), 2022

3. Practical Inorganic Chemistry, G.Marr and B.W Rockett, Van Nostrand.Reinhold Company, 1972

(B) Organic Chemistry

Unit I: Qualitative Analysis

Separation, purification and identification of organic compounds of three solids mixture and preparation of their derivatives.

Unit II: Organic Synthesis (Two step synthesis)

Synthesis representing reactions such as:

Acetylation: Acetylation of salicylic acid with acetyl chloride etc.

Aromatic electrophilic substitution: Synthesis of p-nitroaniline and p-bromoaniline from aniline etc.

Grignard reaction: Synthesis of triphenyl methanol from benzoic acid etc.

Friedel craft reaction: β-benzoyl propionic acid from succinic anhydride and benzene etc.

Unit III:

Measurement of optical rotation values, calculation of ee/de ratios and determination of specific rotation of organic compounds.

Recommended Books :

1. College Practical Chemistry, V. K. Ahluwalia, S. Dhingra, A. Gulati, Universities Press 2005.

2. Advanced Practical Organic Chemistry, O. P. Agarwal, Krishna Prakashan, 2014.

3. Vogel book of Practical organic chemistry , Longman scientific & Technical,5th edition 2016

4. Techniques and experiments for Organic Chemistry,Ault A; University Science Books ,1998

5.Practical Organic Chemistry, Mann and Saunders, Pearson, 5th edition ,U.K,2009

(C)Physical Chemistry

Unit I : Chemical Kinetics

(a) Find out the velocity constant of the hydrolysis of an ester (methyl acetae/ethyl acetate) catalyzed by an acid.
(b) Determine the order of saponification of ethyl acetate with methyl alcohol.
(c) Find out the order of reaction between Potassium Bromate and Potassium Iodide
(d) Study the reaction between Acetone and Iodine in presence of acids.

Unit II : Conductometric Titrations

(a) Find out the strength of HCl solution by titrating it against standard NaOH solution.
(b) Find out the strength og hydrochloric acid and acetic acid in a given mixture of both (approximate strength of each acid is N/10)by titrating it against NaOH solution conductometrically.
(c) Titrate a given mixture of sulphuric acid, acetic acid and copper sulphate against 0.1M NaOH solution.
(d) Determine the strength of NaOH and NH_4OH in a given mixture by titrating it against HCl

Recommended Books :

(1) Advanced Physical Chemistry Experiments, J.N Gurtu, Amit Gurtu Pragati Prakashan ,Seventh edition 2017
(2) Advanced Practical Physical Chemistry, J.B Yadav Goel Publishing House,Meerut ,1998

(3) Experimental Physical Chemistry, Das and R.C & Behera Tata Mc Graw-Hill Publishing Co Pvt. Ltd, 1993.
(4) Introductory Practical Physical Chemistry, Burns, D.T & Rattenbury, E.M Pergaman Press ,1966
(5) Experimental Physical Chemistry,V.D Athawale and Parul Mathur, New Age International (P) Ltd Publishers.

M.Sc. Chemistry Semester VIII (Year I)
Paper I (Theory)
Course Title: Inorganic Chemistry

Course Code :RB020801T **Credits :4**

Unit I

Advanced Nuclear Chemistry:

Radioactive decay and equilibrium, nuclear reactions, Q-value, cross-sections, types of reactions, chemical effects of nuclear transformation, fission and fusion, fission products and fission yields, radioactive techniques, tracer techniques. Principles of determination of age of rocks and minerals, radiocarbon dating-hazards of radiation and safety measures.

Unit II

(A) Inner Transition Elements

Features of f-block elements, introduction, occurrence, separation, oxidation states, Lanthanide contraction, coordination number, structures and simple reactions, spectral magnetic properties and analytical applications.

(B) HSAB Concept:

Basis of HSAB concept, acid-base strength, hardness and softness symbiosis, applications and limitations of HSAB concept. Acid-base concept in non-aqueous media, reactions in BrF_3, N_2O_4, anhydrous H_2SO_4, CH_3COOH.

Unit III

Chromatographic Techniques:

Introduction, Classification,Adsorption , partition chromatography, paper chromatography, thin layer, ion exchange and gas chromatography. HPLC size exclusion chromatography, their principles, techniques and important applications.Coupled Techniques ; GC-MS,LC-MS.

Unit IV

Electronic Spectra and Magnetic Properties of Transition Metal Complexes:

Spectroscopic ground states, correlation Orgel and Tanabe-Sugano diagram for transition metal complexes (d^1-d^9), calculation for Dq, B and β parameters, charge-transfer spectra, spectroscopic method for assignments of absolute configuration in optically active metal chelates and their stereochemical information, anomalous magnetic moments, magnetic exchange coupling and spin cross over. Ferromagnetic and anti-ferromagnetic properties. Inorganic photo-chemistry of coordination compounds.

Recommended Books:

1. Inorganic chemistry D.F Shriver, P.W Atkins and C.H Langford 5th Edition ELBS Oxford University Press, **2010**
2. Instrumental Method of Chemical Analysis G.Chatwal and S.Anand
3. Inorganic Electronic Spectroscopy A.B.P Lever 2nd Edition Elsevier **1984**
4. Electronic Absorption Spectroscopy and related techniques D.N Sathyanarayana, University Press **2001**
5. Arnikar H.J Essentials of Nuclear Chemistry 4th Edition New Age International Publishers New Delhi **1995**
6. R.P.W Scott, Techniques and Practice of Chromatography, Marel Dekker Inc, New York
7. Loveland W.D Morrissey, D.J Seaborg, G.T., Modern Nuclear Chemistry, Wiley-VCH Verlag GmbH Co. KGaA, **2006**

M.Sc. Chemistry Semester VIII (Year I)
Paper II (Theory)
Course Title: Organic Chemistry

Course Code :RB020802 T Credits :4

Unit I

Aromatic Electrophilic substitution

The arenium ion mechanism, Orientation and reactivity, energy profile diagram. The ortho / para ratio, ipso attack, orientation in other ring system. Diazonium coupling, Vilsmeir reaction, Gatterman-Koch reaction.

Aromatic Nucleophilic substitution

The SN_{Ar}, SN_1, benzyne and SRN_1 mechanisms. Reactivity-effect of substrates structure, leaving group and attacking nucleophile. The Von Richter, Sommelet–Houser and Smiles rearrangements.

Unit II

Free Radical Reactions

Types of free radical reactions, free radical substitution mechanism, mechanism at an aromatic substrate, neighboring group assistance. Reactivity for aliphatic and aromatic substrates at a bridgehead. Reactivity in attacking radicals. The effect of solvent on reactivity.

Alicyclic halogenation (NBS), oxidation of aldehyde to carboxylic acid, auto-oxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salt. Sandemeyer reaction. Free radical rearrangement. Hunsdiecker reaction.

Addition to Carbon – Carbon multiple bonds:

Mechanistic and stereochemical aspects of addition reaction involving electrophiles. Nucleophiles and free radicals, regio- and chemoselectivity, orientation and reactivity. Addition to cyclopropane ring. Hydrogenation of double and triple bonds, Hydrogenation of aromatic ring. Hydroboration. Michael's reaction. Sharpless asymmetric epoxidation.

Unit III

Addition to Carbon – Hetero multiple bonds:

Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitriles. Addition of Grignard reagents, Organozinc and organolithium reagents to carbonyl and unsaturated carbonyl compounds. Witting reaction.

Mechanism of condensation reaction involving enolates-aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin and Stobbe reaction.

Hydrolysis of ester and amides, ammonolysis of esters.

Elimination Reactions:

The E2, E1 and E1cB mechanism and their spectrum. Orientation of double bond. Reactivity-effects of substrates structures, attacking base, the leaving group and the medium.Mechanism and orientation in pyrolytic elimination.

Unit IV

Pericyclic Reactions

Molecular orbital Symmetry, Frontier orbital of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system. Classification of pericyclic reactions. Woodward Halfmann correlation diagram, FMO and PMO approach, electrocyclic reaction – conrotatory and disrotatory motion, 4n, 4n+2

and allyl systems. Cycloaddition – antarafacial and suprafacial addition, 4n and 4n+2 systems, 2+2 addition of ketenes, 1,3 dipolar cycloaddition and chelotropic reactions. Sigmatropic rearrangement – Suprafacial and antarafacial shift of H, sigmatropic shift involving corban moieties, 3,3 and 5,5-sigmatropic rearrangement. Claisen, cope and azacope rearrangements. Fluxional tautomerism. Enereaction.

Recommended Books :

1. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley.

2. Advanced Organic Chemistry, F.A. Carey and R.J. Sundberg, Plenum.

3. Organic Chemistry, R.T. Morrison and R.N. Boyd, Prentice-Hall.

4. Modern Organic Reactions, H.O. House, Benjamin.

5. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic & Professional.

6. Pericyclic Reactions, S.M. Mukherji, Macmillan, India.

7. Reaction Mechanism in Organic Chemistry, S. M. Mukherji and S. P. Singh, Macmillan.

8. Organic Chemistry J. Clayden, N. Greavs, S. Warren, P. Wothers.

M.Sc. Chemistry Semester VIII (Year I)
Paper III (Theory)
Course Title: Physical Chemistry

Course Code :RB020803 T Credits :4

Unit I

Chemical dynamic

Effect of temperature on reaction rates, Rate law for opposing reactions of Ist order and IInd order, Rate law for consecutive Ist order reactions, Collision theory of reaction rates and its limitations, steric factor, Activated complex theory, Ionic reactions: single and double sphere models, influence of solvent and ionic strength, the comparison of collision and activated complex theory. Chain reactions: hydrogen - bromine reaction, pyrolysis of acetaldehyde, decomposition of ethane. Photochemical reactions (hydrogen - bromine & hydrogen-chlorine reactions). General treatment of chain reactions (ortho -para hydrogen conversion and hydrogen - bromine reactions), apparent activation energy of chain reactions, chain length, Rice-Herzfeld mechanism of organic molecules, decomposition (acetaldehyde) Branching chain reactions and explosions (H_2 - O_2 reaction). Kinetics of (one intermediate) enzymatic reaction: Michaelis - Menton treatment, evaluation of Michaelis's constant for enzyme-substrate binding by Lineweaver - Burk plot, by Dixon and by Eadie- Hofstae methods. Competitive and non-competitive inhibition.

Unit II

Electrochemistry

Electrolytic conductance of strong electrolytes, Activity, activity coefficient, Debye-Huckel theory for electrolytic solution, determination of activity and activity coefficient, ionic strength. Electrochemistry of solution, Debye-Huckel – Onsager treatment and its extension, ion solvent interaction, Debye Huckel, Bjerrum mode

Electrical phenomenon at interfaces and electrode processes

Thermodynamics of electrified interface equation, deviation of electro-capillary, Lippmann equation (surface excess), methods of determination, structure of electrified interfaces. Guoy Chapman, Stern, Bockris, Devanathan method. Mechanism of electrode reaction, overpotential current, current potential relation, Tafel equation, over-voltage and decomposition potential, Butler Volmer equation Introduction to corrosion, homogenous theory, form of corrosion, corrosion monitoring and prevention methodism.

Unit III

Surface chemistry

A. Adsorption

Surface tension, capillary action, pressure difference across curved surface (Laplace equation), vapor pressure of droplets (Kelvin equation), Gibbs adsorption isotherm, estimation surface area (BET equation), and surface film of liquids (electro –kinetic phenomenon) catalytic activity at surface.

B. Micelle

Surface active agent, classification of surface active agent, micellization, hydrophobic interaction, critical micellar concentration (CMC), factors affecting the CMC of surfactant, counter ion binding to micelles, thermodynamics of micellization – phase separation and moss action models, solubilization, micro emulsion, reverse micelles.

Unit IV

Macromolecules

Polymer –definition, classification of polymer, electrically conducting fire resistant, liquid crystal polymer, kinetics and mechanism of polymerization (Chain reaction and step growth), molecular mass, number and mass average molecular mass, molecular mass determination (osmometry, diffusion and light scattering methods), sedimentation and end group analysis method, chain configuration of macromolecules, calculation of average dimensions of various chain structures.

Recommended Books:

1. Chemical Kinetics Methods, C. Kalidas, New Age International
2. Chemical Kinetics, K.J. Laidler, McGraw Hill.
3. Theory of Absolute Reaction Rates, K.J. Laidler, McGraw Hill
4. Modern Electrochemistry, Vol. I and Vol II, J.O.M. Bockris and A.K.N. Reddy, Plenum.

5. *Catalysis at Surfaces,* Campbell, I. M. Chapman and Hall, New York/London (1988)
6. *Concepts of Modern Catalysis and Kinetics,* Chorkendorff, Ib. & Niemantsverdriet, J. W.,Wiley-VCH (2003)
7. Textbook of Polymer Science, F.W. Billmeyer (Jr), Wiley.
8. Principles of Polymer Chemistry, P J Flory, Cornell University Press.
9. Physical Chemistry of Polymers, A Tager, Mir Publishers, Moscow.
10. Physical Chemistry of Macromolecules, Tanford
11. Polymers: Chemistry & Physics of Modern materials, J.M.G. Cowie, Blackie Academic and Professional.
12. Plastic Materials, J.A. Brydson, Butter worth Heinemann.
13. Principles of Polymerisation, G.Odian, John Willey.
14. Fundamentals of Polymer Processing, S. Middleman..
15. Polymer Science, V.R. Gowariker, N.V. Viswanathan and J. Sreedhar, Wiley-Eastern.
16. Functional Monomers and Polymers, K. Takemoto, Y. Inaki and R.M. Otta
17. S.J. Gregg and K.S.W. Sing, Adsorption, Surface Area and Porosity, Academic Press, London and New York

M.Sc. Chemistry Semester VIII (Year I)
Paper IV (Theory)
Course Title : Research Methodolgy (Elective I)

Course Code :RB02084a T **Credits :4**

Unit I

General Principal of Research : Meaning and importance of research, critical thinking,Formulating

Hypothesis and development of research plan, Review of literature, interpretation of results and discussion

Bibliographic index and research quality parameters : Citation index, impact factor, h index, i 10 index

Etc. Research engines such as google scholar, scopus, web of science etc.

Unit II

Technical and scientific writing : General aspects of scientific writing – Theses, technical papers, reviews, electronic communication, research papers Format of Project report. etc.Poster preparation and presentation ,reporting practical and project work in

dissertation.Reference Management using various softwares such as Endnote, reference manager, Refworks etc. Communication skills-defining communication; type of communication; techniques of communication etc.

Unit III

Information technology and Library resources : The internet and world wide web, classification systems, e –library , Reference management, finding and citing information

Plagiarism : Plagiarism, definition, search engines, regulations, policies and documents/ thesis/ manuscripts checking through softwares, knowing and avoiding Plagiarism during documents, project dissertation/ manuscripts and scientific writing.

Unit IV

Intellectual property Rights : Intellectual property protection (IPP) , Intellectual property rights (IPR), World Trade Organization (WTO), World Intellectual property organization (WIPO), General Agreement on Tariff and Trade (GAAT), Trade related intellectual property Rights (TRIPs), Trade related investment measures (TRIMS) and (General agreement on Trades in services (GATS). Nuts and Bolts of Patenting, technology development/ Transfer commercialization related aspects, Ethics and Values in IP.

Recommended Books:

1.Gupta S (2005) Research Methodology and Statistical Techniques, Deep and Deep Publications New Delhi

2. Kothari, C.R (2008) Research Methodology, New Age International Limited.

3 Web resources : www. Sciencedirect.com for Journal references, www.aip.org and www.aps.org for references Styles.

4 Anderson, Durston and Poole, Thesis ans Assignment writing, Wiley Eastern, 1977.

M.Sc. Chemistry Semester VIII (Year I)
Paper IV (Theory)
Course Title : Petroleum Chemistry (Elective II)

Course Code :RB02084b T **Credits :4**

Unit 1

Petroleum Refining: Fossil fuel and origin of petroleum, Petroleum resources: detection and exploration of petroleum. Nature of extracted crude oil, classification of crude oil, Physicochemical characteristics of crude oil. General processing of crude oil – Fractionation (atmospheric and vacuum) and stripping, solvent method, de-asphalting, Refining.

Unit II

Cracking process: thermal and catalytic. Blending of gasoline, knocking and Octane rating,gasoline additives for Aviation fuel. Diesel oil, Cetane rating, Kerosene. LPG-Composition and uses. Synthetic petrol (Fischer-Tropsch method). Desuplhurization and denitrogenation of gasoline.

Unit III

Petroleum Speciality Products: Raw materials for aliphatic, and inorganic petrochemicals. hydrocarbon solvents, petroleum derived pesticides, refrigeration gases, lubricants and waxes, carbon black, petroleum coke. Methyl tert-butyl ether, polyvinyl acetate, polyvinyl chloride, Teflon, polythene, polypropylene, ethylenepropylene elastomers; Oxo-process.

Unit IV

Petroleum as a raw material for aromatic petrochemicals: Caprolactam, polysterene, terephthalates.Cumene process (Hock process): phenol-acetone production. Chemicals and products from natural gas: Syn-gas, methanol, ammonia; Ammonia-Urea plant; Fertilizer

Recommended Books:

1. Prakash, S., (2010). Petroleum Fuels Manufacturing Handbook. McGraw-Hill.

2. Tissot, B. P., Welte, D. H., (1984). Petroleum Formation and Occurrence. Springer-Verlag.

3. Speight, J. G., (2014). The Chemistry and Technology of Petroleum. CRC Press.

4. Jones, D. S. J., and Pujado, P. R., (2008). Handbook of Petroleum Processing. Springer-Verlag.

M.Sc. Chemistry Semester VIII (Year I)
Paper I (Theory)
Course Title: Spectroscopic Methods (Elective III)

Course Code : RB02084c T **Credits :4**

Unit I

Introduction to spectroscopy, properties of electromagnetic radiation, electromagnetic spectrum, different types of molecular energies, interaction of electromagnetic radiation with matter, theoretical principles of atomic spectroscopy and molecular spectroscopy, solved examples.

Unit II

(A) IR Spectroscopy

Introduction, theory, modes of vibrations of atoms in polyatomic molecules, applications and limitations. FT-IR, advantages, disadvantages and applications.

(B) Raman Spectroscopy:

Introduction, properties and intensity of Raman lines mechanism of Raman effect. Difference between Raman and IR spectra, applications.

Unit III

(A) NMR Spectroscopy:

General introduction and definition, chemical shift, spin-spin interaction, shielding mechanism, chemical shift values and correlation for protons bonded to carbon (aliphatic, olefinic, aldehydic and aromatic) and other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides & mercapto), chemical exchange, effect of deuteration, complex spin-spin interaction between two, three four and five nuclei (first order spectra), virtual coupling. Stereochemsitry, hindered rotation, Karplus curve-variation of coupling constant with dihedral angle. Simplification of complex spectra nuclear magnetic double resonance, contact shift regents, solvent effects. Fourier transform technique, nuclear Overhauser effect (NOE). Resonance of another nuclei-F, P.

(B) C-13 NMR Spectroscopy:

General considerations, chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbon) coupling constants, two-dimension NMR spectroscopy- COSY, NOESY, DEPT, INEPT, APT and INADEQUATE techniques.

(C) Optical Rotatory Dispersion (ORD) and Circular Dichroism (CD).

Unit IV

(A) UV- Visible Spectroscopy:

Introduction, Lambert's Beer's Law, theory, Woodward-Fisher rule and applications.

(B) Electron Paramagnetic Resonance (EPR) Spectroscopy:

Introduction, Zeeman interaction, experimental consideration, spectral presentation, anisotropy and spin orbit coupling components, hyperfine and super hyperfine splitting, application.

Recommended Books:

1. Introduction to Spectroscopy D,L Pavia, G.M Lampman G.S Kriz, 4th Edition Cengage Learning **2008**
2. R. S Macomber, A Complete Introduction to Modern NMR Spectroscopy Wiley, **1997**
3. NMR, NQR, EPR and Mössbaur Spectroscopy R.V Parish, Ellis Harwood
4. Instrumental Methods of Chemical Analysis 5th Ed. G. W McGraw Hill Education (India) New Delhi, **2013**
5. Spectrochemical Analysis by Atomic Absorption and Emission 2nd Ed. Lauri H.J. Lajunen Royal Society of Chemistry, **1992**
6. Practical NMR Spectroscopy, M.L. Martin, J.J. Delpeuch and G.J. Martin Heyden
7. Introduction to NMR Spectroscopy, R.J. Abraham J. Fisher and P. Loftus, Wiley
8. Rouessac,F Rouessac :A Chemical Analysis Modern Instrumentation Methods and Techniques 4th Ed. John Wiley and Sons **1998**
9. Infrared and Raman Spectra K. Nakamoto Wiley
10. D.Nasipuri Stereochemistry of Organic Compounds Principle and Applications New Age International New Delhi 2011

M.Sc. Chemistry Semester VIII (Year I)
Paper V (Practical)
Course Title: Chemistry

Course Code :RB020805P Credits :4

(A) Inorganic Chemistry

Unit I : Estimation and Spectral Studies

(I) Separation and determination of the following pairs of three constituents present together by using Gravimetric and Volumetric analysis.

(a) Cu, Ni and Zn (b) Fe,Ni and Zn (c) Cu ,Ni and Mg (d) Ag ,Cu and Ni

(2) Determination of Concentration of Transition metal ions e.g Cu, Fe, Ni etc. in the given samples by Spectrophotometric Methods.

Unit II : Inorganic Preparations

Synthesis and Characterization of the following Compounds on the basis of available Physico-chemical and Spectral methods.

(a) Prussian Blue
(b) Tris thiourea Cuprous (I)Sulphate
(c) Nickel(dmg)2
(d) Cuprous mercuri-iodide
(e) o-and p- hydroxy phenol mercury (II) chloride
(f) Potassium trioxalatoCobaltate (III)

Unit III: Chromatographic Techniques

Separation of a mixture of cations and anions by Paper and TLC chromatographic techniques

Using aqueous and Non aqueous media

(a) Pb^{++} and Ag^{+} (b) Cd^{++} and Bi^{+++} (c) As+++ and Sb^{+++} (d)Cl^{-} and I^{-} (e)Br^{-} and I^{-}

Recommended Books :

1.Vogel Text Book of Quantitative Chemical Analysis, J.Mendham, R.C Daenney, J.D Barnes, ,M.J.K Thomas, 6th edition, Pearson,2006

2. Advanced Practical Inorganic Chemistry, Gurdeep Raj, 29th edition Krishna Prakashan M.(Pvt), 2022

3. Practical Inorganic Chemistry,G.Marr and B.W Rockett, Van Nostrand Reinhold Companu,1972

(B) Organic Chemistry

Unit I: Qualitative Analysis

Separation, purification and identification of organic compounds of three solids mixture and preparation of their derivatives

Unit II: Organic Synthesis (Two step synthesis)

Synthesis representing name reactions such as:

Aldol condensation: Dibenzyl acetone from benzaldehyde etc.

Sandmeyer reaction: P-chlorotoluene from p-toludine etc.

Cannizzaro reaction: Benzyl alcohol and benzoic acid from benzaldehyde etc.

Unit III: Quantitative analysis

(a) Determination of the percentage of number of hydroxyl groups in an organic compound by acetylation method.

(b) Estimation of amines/phenols using bromate bromide solution/or acetylation method.

Recommended Books :

1. College Practical Chemistry, V. K. Ahluwalia, S. Dhingra, A. Gulati, Universities Press. 2005

2. Advanced Practical Organic Chemistry, O. P. Agarwal, Krishna Prakashan. 2014

3. Vogel book of Practical organic chemistry , Longman scientific & Technical,5th edition 2016

4. Techniques and experiments for Organic Chemistry,Ault A; University Science Books ,1998

5.Practical Organic Chemistry, Mann and Saunders, Pearson, 5th edition ,U.K,2009

(C) Physical Chemistry

Unit I pH-metric Titrations

(a) Find out the strength of the given HCl solution (approximate strength N/10) by titrating it against NaOH solution.
(b) Find out the strength of HCl and CH3COOH in a mixture of both (approximate strength of each acid is N/10) by titrating it against NaOH solution.
(c) Find out the strength of ammonia solution by titrating it against HCl solution.
(d) Determine the dissociation constant of weak acid acetic acid using pH meter.

Unit II Polarimeter

(a) Find out the specific rotation of cane sugar polarimetrically and also find out the concentration of the unknown solution.
(b) Find out the order of reaction and velocity constant for the inversion of cane sugar by acid Polarimetrically.
(c) Find out the percentage of d-sugar and d-tartaric acid in a given solution Polarimetically.
(d) Determine the intrinsic solution of a solution of cane sugar Polarimetrically.

Recommended Books :

(1) Advanced Physical Chemistry Experiments, J.N Gurtu, Amit Gurtu Pragati Prakashan , Seventh edition 2017

(2) Advanced Practical Physical Chemistry, J.B Yadav Goel Publishing House,Meerut ,1998

(3) Experimental Physical Chemistry, Das and R.C & Behera Tata Mc Graw-Hill Publishing Co Pvt. Ltd, 1993.

(4) Introductory Practical Physical Chemistry, Burns, D.T & Rattenbury, E.M Pergaman Press ,1966

(5) Experimental Physical Chemistry,V.D Athawale and Parul Mathur, New Age International (P) Ltd Publishers.

M.Sc. Chemistry Semester IX (Year II)
Paper I (Theory)
Course Title: Specrochemical Analysis

Course Code :RB020901T **Credits :4**

Unit I

Atomic Absorption Spectroscopy:

Introduction, Principle, Interferences- spectral, ionization, physical and Refractory compound formation,Applications.

Unit II

Mass Spectrometry:

Introduction, ionization method, instrumentation, factors affecting fragmentation, ion analysis, ion abundance. Mass spectral fragmentation of organic compounds, common functional groups, molecular ion peak, metastable peak, McLafferty rearrangement. Nitrogen rule.

Unit III

Mössbauer Spectroscopy:

Basic principle, selection rule, recoilless emission and absorption, hyperfine interaction, chemical isomer shift, magnetic hyperfine and quadrupole interaction and applications.

Unit IV

X-Ray Spectroscopy:

XRF, chemical analysis by X-ray spectrometers, energy dispersive and wavelength, dispersive techniques, evaluation methods, matrix effects and applications.

Recommended Books:

1. Solid State Chemistry and its Applications A.R. West, John Wiley and Sons
2. Instrumental Approach to Chemical Analysis A.K. Srivastava & P.C. Jain S. Chand & Company New Delhi
3. Instrumental Methods of Analysis 7th Ed. Willard Merritt, Dean and Settle CBS Publishers **1986**
4. G. Aruldhas Molecular Structure and Spectroscopy, Prentice Hall of India Pvt. Ltd., New Delhi **2001**
5. Skoog, D.A., Holler, F.J. Nieman, T.A., Principles of Instrumental Analysis, 5th Ed. Thomson Books/Cole,
   1998
6. Atomic Absorption Spectroscopy third edition Bernhard welz, Michael Sperling Wiley-VCH verlag GmbH, 1998
7. Practical Organic Mass Spectroscopy K.R. Dass & E.P. James, IBH New Delhi **1976**
8. Spectroscopy by H. Kaur, A Pragati Prakashan 9th Ed., **2014**
9. Stout, G.H and Jensen L.H Xray structure determination Apractical Guide Jhon Wiley and sons ,1989

M.Sc. Chemistry Semester IX (Year II)
Paper II (Theory)
Course Title: Chemistry in Daily Life

Course Code :RB020902T Credits :4

Unit I

(A) Carbohydrates

Definition and importance, classification, sources, functions, physico-chemical properties, functional properties of sugars and polysaccharides in foods. Dietary fibre and food applications. Effect of processing on nutritional quality of carbohydrates.

(B) Water:

Water in foods, Types of water in foods: Water activity-Definition, measurement of water activity, role and importance of water activity in foods.

Unit II

Lipids: Rancidity and flavour reversion; Mechanism of lipid oxidation; Prooxidants; Measurement of lipid oxidation; Role of fats in body; Health problems associated with fats; Trans fats; Bioactivity of fatty acids; Recommendations for fat intake; Fat replacement strategies Vitamins: Sources, requirements and functions of different vitamins

Unit III

Proteins: Functional properties; Major source of food proteins; Methods of protein characterization and analysis; Protein quality/Biological value of proteins; Chemical and biological methods for evaluation of protein quality; Processing induced physicochemical changes in proteins; Chemical and enzymatic modification of proteins.

Unit IV

(A)Minerals : General functions of minerals; specific function and requirements of Ca, P,Mg,Fe, Cu,Pb,Zn, Se and As pigments : Myoglobin; chlorophyll,carotenoids, Anthocyanins,Betalains Browing reactions: Enzymatic and Non Enzymatic browning of foods.

(B) Antioxidents : Natural antioxidants, Mechanism of action, Techniques of evaluation of Antioxidant.Activity Flavour: Nature of Flavour components,Applications, Importance of Aroma Compound.

Recommended Book:

1. Fennema OR.1996. Food Chemistry. Marcel Dekker.
2. Meyer LH. 1987. Food Chemistry. CBS.
3. Belitz HD.1999. Food Chemistry. Springer Verlag.
4. DeMan JM. 1976. Principles of Food Chemistry. AVI.

5. Bamji MS, Rao NA & Reddy V. 2003. Textbook of Human Nutrition.Oxford & IBH.
6. Swaminathan M. 1974. Essentials of Foods and Nutrition. Vol. II. Ganesh & Co

M.Sc. Chemistry Semester IX (Year II)
Paper III (Theory)
Course Title: Green Chemistry

Course Code :RB020903T **Credits:4**

UNIT I

Green Chemistry:
Green Chemistry and Sustainability : History, need and goals. Dimensions of Sustainability, Limitations/ Obstacles in pursuit of the goals of Green Chemistry. Opportunities for the next generation of materials designers to create a safer future.Basic Principle of Green Chemistry and their illustration with examples.

UNIT II

Green Solvents and Green Analytical Methods:
Aqueous medium: Enhancement of selectivity, efficiency and industrial applicability. Ionic liquids, super critical fluids, Solvent free reactions,Flourous phase reactions, Green Analytical methods.

UNIT III

Green Catalysis and Future trends in Green Chemistry :
Heterogeneous Catalysis; Biocatalysis, Oxidation –reduction reagents and catalysis; Biomimetic,multifunctional reagents; Combinatorial green Chemistry; Proliferation of Solventless reactions; Noncovalent derivatization; Biomass Conversion.

UNIT IV

Applications of Green Chemistry:
Green Synthesis of ibuprofen design and use of CO_2- Surfactants for precision cleaning in industries, environmentally preferable marine antifoulant, use of molting accelerators in place of toxic and harmful insecticides, oxidant activators to replace chlorine based delignification process in paper and pulp industry, Green chemistry process for Polyster regeneration, Bio catalytic promiscuity of enzymes for C-C bond formation. Recent applications of ionic liquids as solvent and catalysis in Chemical industry

Recommended Books :

1.Green Chemistry, Paul T,Anastas and John C.Warner. Oxford University Press. Indian Edition ,2008
2 Green Chemistry Environmentally Benign reactions, V.k Ahulwalia Ane Books, India 2006
3 Green Solvents , V.K Ahulwa and R.S Verma Narosa Publishing Ist Edition,2009
4 M.Lancaster, Green Chemistry, A Introductory Text, Royal Society of Chemistry.

M.Sc. Chemistry Semester IX (Year II)
Paper IV (Theory)

Course Title: General Inorganic and Analytical (Elective I)

Course Code :RB02094aT Credits:4

Unit I

Transition metal π-complexes with unsaturated organic molecules, alkenes, alkynes, allyl, diene, dienyl arene and trienyl complexes, preparations, properties, nature of bonding and structural features. Important reactions relating to nucleophilic and electrophilic attack on ligand to organic synthesis. Transition metal compounds with band to hydrogen.

Unit II

(A) Excited states of metal complexes comparison with organic compounds, electronically excited stateof complexes, charge transfer spectra, charge transfer excitations, methods for obtaining charge transfer spectra.
(B) Synthesis, reactions and structures of sulphur Nitrogen compounds : Tetra sulphur tetranitride,disulphur dinitride and polythiazyl $S_x N_y$ compounds. Sulphur-Phosphorous compounds : Molcular sulphides such as P_4S_3, P_4S_7, P_4S_9 and P_4S_{10}, Phosphorous-Nitrogen Compounds : Phosphazines,cyclo and linear phosphazines

Unit III

Thermal Methods of Analysis:

Theory, methodology and applications of Thermo-Gravimetric Analysis (TGA), Differential Thermal Analysis (DTA) and Differential Scanning Colorimetry (DSC).

Unit IV

Metal Clusters:

Higher boranes,carboranes,metalloboranes and metallocarboranes. Metal compounds with metal-metal multiple bonds, preparation,properties and structure of $Re_2Cl_8^{2-}$, $Mo_2Cl_8^{4-}$, $Re_2(RCOO)_4X_2$, $CrCl_9^{3-}$, $ReCl_{12}^{3-}$, $Mo_6Cl_8^{4-}$ $NbCl_{12}^{2+}$, $Ta_6X_{12}^{2+}$

Recommended Books:

1. Industrial Chemistry B.K. Sharma Goel Publishing House Meerut.
2. Organometallic Chemistry of Transition metals R.H. Crabtree, John Wiley
3. Principles and Applications of Organo-transition Metal Chemistry, Collman J.P., Hegedus L.S., Norton J.R and Finke R.G, University Science Books
4. Fundamentals of Analytical Chemistry Douglas A., Skoog, Donald M., West F. James Holler 7th Ed. Harcourt College Publications
5. Modern Methods of Chemical Analysis R.L. Pecsok, L.D. Shields, T. Carins and L.C. Mc William 2nd Ed
   John wiley ;New York

M.Sc. Chemistry Semester IX (Year II)
Paper IV (Theory)
Course Title: Organic Synthesis (Elective II)

Course Code :RB02094bT **Credits :4**

Unit I

Organometallic Reagents

Principle, preparations, properties and applications in organic synthesis with mechanistic details of organometallic compounds of: Li, Mg, Hg, Cd, Zn.

Transition elements - Cu, Pd, Ni and Rh. Other elements- S, Si, B and I

Unit II

Oxidation:

Introduction. Different oxidative processes. Oxidation of alkenes, aromatic rings, Saturated C-H groups (activated and inactivated). Alcohols, diols, aldehydes, ketones, ketals and carboxylic acids. Amines, hydrazines and sulphides. Oxidation with ruthenium tetraoxide, iodobenzene diacetate and thallium(III) nitrate.

Unit III

Reduction:

Introduction. Different reductive processes. Reduction of alkenes, alkynes, aromatic rings, aldehydes, ketones, acids and their derivatives. Epoxides, nitro, nitroso, azo and oxime groups.

Rearrangements:

General Mechanistic considerations: nature of migration, migratory aptitude, and memory effects. A detailed study of the following rearrangements: - Pinacol-pinacolone, Wagner-Meerwein, Demjanov, Benzil-Benzilic acid, Favorskii, Arndt- Eistert synthesis, Neber, Beckmann, Hofman, Curtius, Chichibaben, Wittig, Schmidt, Baeyer Villiger, Shapiro reaction.

Protecting Groups

Principle of protection of alcohol, amine, carbonyl and carboxyl group

Recommended Books :

1. Modern Synthetic Reactions, H.O. House, W.A. Benjamin.

2. Some Modern Methods of Organic Synthesis, W. Carruthers, Cambridge Univ. Press.

3. Advanced Organic Chemistry, Reactions Mechanisms and Structure, J. March, JohnWilley. 4. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic & Professional.

5. Advanced Organic Chemistry Part B, F.A. Carey and R.J. Sundberg, Plenum Press.

6. Rodds Chemistry of Carbon Compounds, S. Coffey, (2nd Edition) Elsevier.

7.Organic Synthesis: Special Techniques, V.K. Ahluwalia & Rennu Aggarwal, Narosa Publishing House. M.SC. SE.

M.Sc. Chemistry Semester IX (Year II)
Paper IV (Theory)
Course Title: Physical Chemistry (Elective III)

Course Code :RB020904cT **Credits:4**

Unit I

Molecular Spectroscopy

1. Time dependent states and spectroscopy: absorption and emission of radiation. Selection rules. Line shapes and widths. Fourier transform spectroscopy
2. Rotation and Vibration of Diatomic Molecules: Rigid Rotor and harmonic oscillator wave functions and energies. Selection rules. A review of MW and IR spectroscopy. Diatomic molecule wave functions symmetry properties and nuclear spin effects. Raman effect: Rotational and vibration-rotational transitions. Vibration of polyatomic molecules–normal coordinates. Polarization of Raman lines. Resonance Raman and CARS spectroscopy.
3. Electronic spectroscopy: electronic spectroscopy of diatomic molecules. Franck- Condon factor. Dissociation and pre-dissociation. Rotational fine structure. Lasers and laser spectroscopy.
4. Magnetic Resonance: Review of angular momentum. Commutation relations. Basic principles and relaxation times. Magnetic resonance spectrum of hydrogen. First-order hyperfine energies. NMR in liquids: Chemical shifts and spin-spin couplings First order Spectra: A3X, AX and AMX systems. Second order spectra: AB system. Equivalent nuclei. A2B2 system

Unit II

Classical Thermodynamics

Free energy, chemical potential and entropies. Partial molar properties; Partial molar freeenergy, partial molar volume and partial molar heat content and their significances.

Determination of these quantities. Concept of fugacity and determination of fugacity. Application of phase rule to three component systems

Unit III

Statistical Thermodynamics:

Concept of distribution, thermodynamic probability and most probable distribution. Ensemble averaging, postulates of ensemble averaging. Canonical, grand canonical and microcanonical ensembles, corresponding distribution laws (using Langrange's method of undetermined multiplier). Partition functions – translational, rotational, vibrational andelectronic partition functions, calculation of thermodynamic properties in terms of partition functions. Application of partition functions.

Unit IV

Equilibrium and Non- equilibrium Thermodynamics:

Properties of non-ideal solutions - deviations (negative and positive) from ideal behavior, excess functions for non ideal solutions, Third Law of thermodynamics: Nernst heat theorem, variation of entropy with temperature, determination of absolute entropy of liquids and gases, residual entropy. Entropy production in irreversible processes, fluxes and forces, linear phenomenological relations, Onsager's reciprocity relations, thermodynamic theory of membrane permeability, reverse osmosis and electro kinetic phenomena.

Recommended Books:

1. Modern Spectroscopy, J.M. Hollas, John Wiley.
2. Applied Electron Spectroscopy for Chemical Analysis Ed. H. Windawi and F.L. Ho, Wiley Interscience.
3. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R.V. Parish, EllisHarwood.
4. Physical Methods in Chemistry, R.S. Drago, Saunders College.
5. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw Hill.
6. Basic Principles of Spectroscopy, G.M. Barrow, McGraw Hill.
7. Physical Chemistry, P.W. Atkins, Oxford Press. 7th Edn.
8. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.
9. Quantum Chemistry, Ira N. Levine, Prentice Hall. 4. Coulson's Valence, R. McWeeny,ELBS.
10. Physical Chemistry, P. W. Atkins, 7th & 8th Editions, Oxford University Press, New York.
11. Introduction of Thermodynamics of irreversible Processes, I. Prigogine

M.Sc. Chemistry Semester IX (Year II)
Paper V (Practical)
Course Title: Chemistry

Course Code :RB020905P Credits :4

(A) Inorganic Chemistry :

Unit I : Synthesis of Metal Complexes

Synthesis and structural elucidation of the following complexes by available physico-chemical and
Spectral methods.

(a) Hexa-ammine Nickel (II) Chloride (b) Hexammino Cobaltic Chloride (c) Sodium Cobaltinitride

(d)cis and trans- Potassium Dioxalato Diaquo Chromate ((e) Pot. trioxalato Ferrate

(f) Sodium trioxalato ferrate trihydrate

Unit II : Volumetric Methods

(a) To determine the amount of Chloride Ions present in the given KCl Solution Conductometrically.

(b) Percentage of Available Chlorine in Sample of Bleaching Powder.

(c) Determination of dissolved oxygen in water sample.(Winkler's Method)

(d) Cerimetric Titration

Unit III: **Spectral Analysis**

(a) Determination of the concentration of cations and anions in the given samples by spectrophotometric and analytical methods.

(1) Cr^{+++} (b) Mg^{++} (c) Sb^{+++} (d) NO_2^- (e) S^{--}

(b) Determination of Formula and the Stability constant of a complex by Spectrophotometrically

Unit IV : Analysis of Ores, Minerals and Alloys

(a) Analysis of Brass
(b) Analysis of Nickel Coin
(c) Analysis of Silver Coin
(d) Analysis of Iron in the given Iron Ore Solution

Recommended Books:

1. Vogel's Qualitative Inorganic Analysis-VII th EditionRevised byG.Svehla Pearson Education Ltd.1996.
2. Integrated Approach to Coordination Chemistry: An Inorganic Laboratory Guide R.A Marusak, Kate Doan, S.D Cummins,2007,Wiley, NY
3 Advanced Practical Inorganic Chemistry, Gurdeep Raj, 29th edition Krishna Prakashan M.(Pvt),2022.

(B) Organic Chemistry

Unit I. Advanced Organic synthesis (Multi step synthesis)

(i) Benzophenone → benzopinacol → benzopinacolone

(ii) Benzaldehyde → benzoin → benzil → benzilic acid

(iii) Skraup synthesis: quinoline from aniline

(iv) Reduction of ethylacetoacetate using baker yeast to yield enantiomeric excess of ethyl-3hydroxy butanoate

(v) And other suitable multi-step synthesis

Unit II: Isolation of natural products

(i) Isolation of caffeine from tea leaves

(ii) Isolation of piperene from black pepper

(iii) Isolation of β-carotene from carrots

(iv) Isolation of lycopene from tomatoes

(v) Isolation of casein from milk

(vi) Isolation of lactose from milk

(vii) Isolation of Cystine from human hair

(viii) Isolation of DNA from Onion/ Strawberries

Unit III:

(i) Separation of active single component and mixture of components from pharmaceutical tablets; identification of components by m.p., functional groups and spectral data

(ii) Quantitative estimation of the components in pharmaceutical tablets

(iii) Application of TLC/Paper chromatography

Recommended Books :

1. College Practical Chemistry, V. K. Ahluwalia, S. Dhingra, A. Gulati, Universities Press. 2005

2. Advanced Practical Organic Chemistry, O. P. Agarwal, Krishna Prakashan.2014

3. Vogel book of Practical organic chemistry , Longman scientific & Technical,5th edition 2016

4. Techniques and experiments for Organic Chemistry,Ault A; University Science Books ,1998

5.Practical Organic Chemistry, Mann and Saunders, Pearson, 5th edition ,U.K,2009

(C) Physical Chemistry

(a) Determine the degree of hydrolysis and hydrolysis constant of (i) CH_3COONa (ii) NH_4Cl
Using conductivity meter.
(b)Determine the critical micelle concentration (CMC) of CTAB by surface tension measurement.

(c) Find out the molecular surface energy and association factor of ethyl alcohol by surface tension method.
(d) Study the kinetic of decomposition of the complex formed between sodium

sulphate and sodium nitroprusside spectrophotometrically and also determine order and rate constant of the reaction.

(e) Determine the composition of a binary mixture of aurine and crystal violet spectrophotometrically.

(f) Determine the dissociation constant of a indicator (Methyl Red) by spectrophotometric method.

(g) Study the kinetics of the reaction between Acetone and Iodine in presence of an acid.

(h) Titrate the given solution of HCl and NaOH by Polarimeter using quinhydrone as an indicator.

Recommended Books:

(1) Advanced Physical Chemistry Experiments, J.N Gurtu, Amit Gurtu Pragati Prakashan , Seventh edition 2017

(2) Advanced Practical Physical Chemistry, J.B Yadav Goel Publishing House,Meerut ,1998

(3) Experimental Physical Chemistry, Das and R.C & Behera Tata Mc Graw-Hill Publishing Co Pvt. Ltd, 1993.

(4) Introductory Practical Physical Chemistry, Burns, D.T & Rattenbury, E.M Pergaman Press ,1966

(5) Experimental Physical Chemistry,V.D Athawale and Parul Mathur, New Age International (P) Ltd Publishers.

M.Sc. Chemistry Semester X (Year II)
Paper I (Theory)
Course Title: Chemistry of Nano materials

Course Code :RB021001T **Credits: 4**

Unit I

Introduction to Nano materials : Size effects difference between bulk and Nano materials , Definition of Nanomaterials, Classification of Nanomaterials : Nanoparticles, Nanocrystals, 0-DQuantum dots, Nanostructured materials (1-D Wire and rods, 2-D thin film, 3-d structures)-Carbon nanotubes (CNTs): Single walled carbon nanotubes , Multi walled carbon nanotubes-Graphene. Some important recent discoveries in nanoscience and technology.

Unit II

Techniques in Nanochemistry:

Techniques for characterization of nano materials(Basic aspects): Atomic force Microscopy(AFM)-Transmission electron microscopy (TEM)-Resolution and Scanning transmission electron microscopy (STEM) ,Scanning Tunneling Microscopy (STM) Scanning near field optical microscopy(SNOM) and Surface plasmon Spectroscopy(SPS).

Unit III

Synthesis of nanomaterials :

Chemical methods in preparation of nanomaterials: Sol-Gel technique, Co precipitat--on hydrolysis, Sonochemical methods, Combustion technique, Colloidal Precipitation-template process.

Inorganic Nanoparticles and Nanoporous Materials:

Oxide nanoparticles-Oxymolybdates-Nanocatalysis-Porous silicon-Transition and Non transition metal phosphates.

Unit IV

Applications of nanomaterials:

Applications of Nanoparticle in various fundamental research,industries, medical field and environmental issue, toxicity,biosafety and ethical issue in application of Nanoparticles.

Recommended Books:

1. Text Book of Nanoscience and Nano technology, B.S Murthy, Universities press, 2011
2. Nanochemistry : Achemical approach to Nano materials, Ozin Geoffrey A. and Andre C. Arsenault, Royal Society of Chemistry Publication, 2005
3. C.P Poole and F.J Owens, Introduction to Nano technology, John Wiley and Sons, Singapore, 2003
4. Renewable Energy Resources, J.Twidell and T.Weir, E and F N Spon Ltd , 1986
5. C.N.R Rao and A. Govindraj " Nano tubes and Nano wires"RSC Publication 2005

M.Sc. Chemistry Semester X (Year II)
Paper II (Theory)
Course Title: Applications of spectroscopy in Inorganic Chemistry
(Elective I)

Course Code :RB02102aT **Credits: 4**

Unit I

Infrared (IR) and Raman Spectroscopy:

Applications of vibrational spectroscopy in investigating: (**a**) Symmetry and shapes of simple AB_2, AB_3, AB_4, AB_5 and AB_6 molecules on the basis of spectral data. (**b**) Mode of bonding of ambidentate ligands (thiocyanate, nitrate, sulphate and urea), ethylenediamine and diketonato complexes, applications resonance Raman spectroscopy particularly for the study of active site of metalloprotein.

Unit II

Electron Spin Resonance Spectroscopy:

Hyperfine coupling spin polarization for atoms and transition metal ions, spin orbit coupling and significance of g- tensors, applications to transition metal complexes (having one unpaired electron) including biological systems and to inorganic free radicals. Such as PH_4^+, F_2 and $[BH_3]^-$.

Unit III

NMR of Paramagnetic Substance in Solution:

The contact and pseudo contact shifts, factors affecting nuclear relaxation, some applications including biochemical systems an overview of NMR of metal nuclides with emphasis on ^{11}B, ^{19}F, ^{31}P, ^{125}Te, ^{119}Sn, and ^{195}Pt NMR.

Unit IV

Flame photometry:

Introduction, principle, instrumentation and applications.

Recommended Books:

1. K. Veera Reddy Symmetry and Spectroscopy of Molecules New Age International Pvt. Ltd., New Delhi
   1999
2. K. Nakamoto, Infrared and Raman Spectra of Inorganic and coordination Compounds 4th Ed. John Wiley& Sons, New York **1986**
3. E.A.V EBS Worth, D.W.H Rankin and S. Cradock Structural Methods in Inorganic Chemistry Ist Ed. Blackwell Scientific Publications Oxford London **1987**
4. Inorganic Electronic Spectroscopy A.B.P Lever Elsevier
5. Transition Metal Chemistry Ed. R.L Carlin Vol. 3 Dekker
6. NMR, NQR, EPR and Mössbauer Spectroscopy in Inorganic Chemistry, R.V. Parish, Ellis, Horwood

M.Sc. Chemistry Semester X (Year II)
Paper II (Theory)
Course Title: Organic Synthesis II
(Elective II)

Course Code :RB02102bT **Credits: 4**

Unit I Photochemistry

Photophysical processes:

Jablonskii diagram, energy pooling, exciplexes, excimers, photosensitization, quantum yield, solvent effects, Stern-Volmer plot, delayed fluorescence, etc.

Photochemistry of alkenes:

cis-trans isomerization, non-vertical energy transfer; photochemical additions; reactions of 1,3- 1,4- and 1,5-dienes; dimerizations.

Unit II

Photochemistry of carbonyl compounds:

Norrish type I & II reactions (cyclic and acyclic); α,β-unsaturated ketones; β,γ-unsaturated ketones; cyclohexenones (conjugated); cyclohexadienones (cross-conjugated & conjugated); Paterno–Buchi reactions; photoreductions.

Photochemical Reactions

Photo-Fries rearrangement. Barton reaction. Hoffmann-Loeffler-Freytag reaction, Di-Pi methane (DPM) rearrangement.

Unit III Heterocyclic chemistry

Introduction to heterocycles:

Nomenclature, spectral characteristics, reactivity and aromaticity

Synthesis and chemical reactions of pyrrole, furan, thiophene, and pyridine

Synthesis and reactions of three and four membered heterocycles, e.g., aziridine, azirine, azetidine, oxiranes, thiarines, oxetenes and thietanes.

Five membered rings with two heteroatoms: pyrazole, imidazole, oxazole, thiazole, isothiazole and benzofused analogs.

Unit IV

Synthesis and reactions of benzofused five membered heterocycles with one heteroatom, e.g. indole, benzofuran, benzothiophene.

Chemistry of bicyclic compounds containing one or more heteroatoms.

Synthesis and reactions of benzofused six membered rings with one, two and three heteroatoms: benzopyrans, quinolines, isoquinolines, quinoxazalines, acridines, phenoxazines, phenothiazines, benzotriazines, pteridines.

Recommended Books :

1. Horspool, W. M. Aspects of Organic Photochemistry Academic Press (1976).

2. Lowry, T. H. & Richardson, K. S. Mechanism and Theory in Organic Chemistry Addison-Wesley Educational Publishers, Inc. (1981).

1. Fundamental of Photochemistry, K. K. Rohtagi- Mukherji, Wily- Eastern.

3. Carey, F.A. & Sundberg, R. J. Advanced Organic Chemistry, Parts A & B, Plenum: U.S. (2004). 64

4. Carruthers, W. Modern Methods of Organic Synthesis Cambridge University Press (1971).

5. Acheson, R. M. Introduction to the Chemistry of Heterocyclic Compounds John Wiley & Sons (1976).

6. Heterocyclic Chemistry Vol. 1-3, R. R. Gupta, M. Kumar and V. Gupta, Springer Verlag.

7. The Chemistry of Heterocycles, T. Eicher and S. Hauptmann, Thieme.

8. Heterocyclic Chemistry, J.A. Joule, K. Mills and G.F. Smith, Chapman and Hall.

9. Organic Chemistry, J. Clayden, N. Greevs, S. Wawen, P. Wothers, Oxford Press.

M.Sc. Chemistry Semester X (Year II)
Paper II (Theory)
Course Title: Physical Chemistry
(Elective III)

Course Code :RB02102cT **Credits: 4**

Unit I

Solid State Reactions:

Solid state reactions: experimental procedures, factors influencing solid state reactions. Characterization of solids: Physical techniques diffraction methods; X-rays diffraction, electron diffraction and neutron diffraction; microscopic techniques; SEM and TEM

Unit II

X- ray Diffraction & Crystal Structure:

Diffraction of X-rays by crystals: The Laue equations and Bragg's law, Definitions related to crystal structure, crystallographic direction and crystallographic phases. X-ray diffraction experiments: The powder method and the single crystal method. Reciprocal lattice. Structure factor and its relation to intensity and Electron density. The phase problem. Description of procedure for an X-ray structure analysis

Phase Transitions:

Thermodynamic and Burger's classification of phase transition, Kinetics of phase transition-nucleation and growth, T-T-T diagrams, Factors influencing kinetics of phase transition, Martensitic and order-disorder transitions.

Unit III

Electronic Properties and Band Theory:

Electronic structure of solids- band theory, Refinement of simple band theory- k-space and Brillouin Zones, Band structure of metals, insulators and semiconductors, Intrinsic and extrinsic semiconductors, Doped semiconductors, p-n junctions. Superconductors Meissner effects, Basic concepts of BCH theory, Josephson devices.

Magnetic Properties:

Classification of solid materials: Quantum theory of paramagnetics. Cooperative phenomena. Magnetic domains. Hysteresis

Unit IV

Biopolymer interactions and Thermodynamics of Macromolecular solutions:

Non-covalent interaction, Electrostatic: dipole-dipole interaction, Dispersion force interaction, hydrophobic interaction. Multiple Equilibria and various types of binding processes in biological systems. Thermodynamics of biopolymer solutions, Flory-Huggins model of macromolecular solvation, Osmotic pressure and Donnan membrane equilibrium.

Recommended Books:

1. A.R. West, Solid State Chemistry and its Applications, John Wiley and Sons, Singapore(1984).
2. L.V. Azaroff, Introduction to Solids, Tata McGraw-Hill, New Delhi (1977)
3. L. Smart and E Moore, Solid State Chemistry, Chapman & Hall, Madras (1992).
4. H. V. Keer, Principles of Solid State, Wiley Eastern (1993)
5. Biophysical Chemistry Part I, II, III – Charles R Cantor, Paul R. Schimmel, W. H. Freeman of Company.
6. 6. Biophysical Chemistry – P.S. Kalsi and N. Mahanta New Age International Publishers.
7. Textbook of Biophysical Chemistry- U N Dash Macmillan India

M.Sc. Chemistry Semester X (Year II)
Paper III (Theory)
Course Title: Bioinorganic Chemistry
(Elective IV)

Course Code :RB02103aT **Credits: 4**

Unit I

Metal Ions in Biological Systems:

Essential and trace elements, Na^+/K^+ pump role of metal ions in biological systems. Transport and storage of dioxygen, hemeproteins and oxygen uptake. Structure and function of hemoglobin, myoglobin, hemocyanin and hemerythrin. Model synthetic complexes of Iron, cobalt and copper.

Unit II

(A) Bioenergetics and ATP Cycle:

DNA Polymerization, glucose storage, metal complexes in transmission of energy chlorophylls, photosystem-I and photosystem-II in cleavage of water model system.

(B) Electron Transfer in Biology:

Structure and function in metalloproteins in electron transport process- cytochromes and Iron Sulphur proteins, synthetic models.

(C) Nitrogenase:

Biological nitrogen fixation, molybdenum nitrogenase, spectroscopic and other evidence, other nitrogenase model systems.

Unit III

(a) Biomineralization, ferritin, transferrin and siderophores

(b) Metalloenzymes:

Zinc enzymes- carboxypeptidase , carbonic anhydrase and alkaline phosphatase. Iron enzymes- catalases, peroxidases and cytochrome P-450. Copper enzymes- superoxide dismutase. Molybdenum ezymes- Nitrate reductase,Xanthine oxidase and Xanthine dehydrogenase.

Unit IV

Medicinal Inorganic Chemistry:

(a) Metals in Medicine: Metal deficiency and disease, toxic effects of metals, metals used for diagnosis and chemotherapy with particular reference to anticancer drugs.
(b) Platinum anticancer drugs, Ruthenium complexes, Lithium drugs, Gold antiarthritic drugs. Silver and Mercury antimicrobial agents. Radio-pharmaceuticals (T_c) diagnostic (role of Gd in MRI) and therapeutic agents.

(c)Metal Nucleic interaction

Recommended Books:

1. R.W Hay "Bioinorganic Chemistry" Ellis Horwood Chichester, **1984**
2. B.N Hughes "The Inorganic Chemistry of Biological Process" 2nd Ed. Wiley (Inter Science) New York **1984**
3. B.I Bertini, H.B Gray, S.J Lippard and J.S Valentine "Bioinorganic Chemistry" University Science Books, Mill Valley, C.A **1984**
4. Alessio, E. Bioinorganic Medicinal Chemistry Ist Ed. Wiley-VCH Verlag GmbH Co. KGaA, **2012**
5. Kaim W. and Schwederski B., Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life, John Wiley and Sons, New York USA, **2013**
6. Inorganic Biochemistry Vol. I and II Ed. G.L Eichhorn Elsevier
7. The Coordination Chemistry of Metalloenzymes L. Bertini, R.S Drago, C. Luchinat Springer
8. Nucleic Acid Metal Ion Interaction Vol. 14 RSC Biomolecular Sciences, Nicholas V Hud.

M.Sc. Chemistry Semester X (Year II)
Paper III (Theory)
Course Title: Synthesis and Bio-organic Chemistry
(Elective V)

Course Code :RB02103bT Credits: 4

Unit I

Structure determination of organic compounds by spectroscopic techniques

Application of UV-Visible, IR, NMR Spectroscopy, and Mass spectrometry.

Protecting Groups

Principle of protection of alcohol, amine, carbonyl and carboxyl group

Unit II

Disconnection approach to syntheses of organic molecules

An introduction to synthons and synthetic equivalents, conversion and interconversions of functional groups, selective reactions (Chemo-, regio- and stereoselective), formation of C-C, C-O and C-N bonds

(a) One Group C-C Disconnection:

Alcohols and carbonyl compounds, consideration of regioselectivity. Alkene synthesis and uses of acetylenes in organic synthesis.

(b) Two Group C-C Disconnection:

Diels Alder reaction, 1,3-difunctionalised compounds, α, β-unsaturated carbonyl compounds, 1,5-difunctionalised compounds. Michael addition and Robinson annulation.

Unit III Bioorganic

Enzymes

Introduction, Nomenclature and classification. Catalysis, Types of catalysis (with example of enzymes): acid-base catalysis, electrostatic catalysis, metal ion catalysis, covalent catalysis (electrophilic and nucleophilic catalysis).

Unit IV

Cofactor as derived from vitamins, coenzymes, prosthetic groups, apoenzymes. Enzyme catalysed reactions of coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, NAD^+, NADP, FMN, FAD, lipoic acid, vitamin B_{12}.

Recommended Books :

1. Organic Chemistry, Paula Yurkanis Bruice, Pearson Education.

2. Bioorganic Chemistry: Chemical approach to enzyme action, Hermann Dugas and C. Penny, Springer-Velag, 1981.

3. Enzyme structure and Mechanism, A. Fersht, W. H. Freeman, 1995.

4. Practical NMR Spctroscopy, M.L. Martin, J.J. Delpeuch and G.J. Martin, Heyden.

5. Spectrometric Identification of Organic Compounds, R.M. Silverstein, G.C. Bassler and T.C. Morrill, John Wiley.

6. Advanced Organic Chemistry Part B, F.A. Carey and R.J. Sundberg, Plenum Press.

7. Application of Spectroscopy of Organic Compounds, J.R. Dyer, Prentice Hall.

8. Designing Organic Synthesis, S. Warren, Wiley

M.Sc. Chemistry Semester X (Year II)
Paper III (Theory)
Course Title: Physical Chemistry
(Elective VI)

Course Code :RB02103cT Credits: 4

Unit I

Electrochemistry of Corrosion:

Electrode reactions, electrode potentials, electrochemical cell

formation, Nernst equation, exchange current density, polarization of electrode (resistance, concentration and activation), mixed potential theory, polarization diagrams, pourbaix diagrams,corrosion rate expression and weight loss method for corrosion rate, galvanic series.

Electrochemical techniques to study corrosion –Measurement Cell, Galvanostatic and potentiostatic techniques, Stern –Geary equation, Tafel slopes, measurement of corrosion potential and corrosion current density, Tafel extrapolation and Linear polarization resistancemethods, recording and interpretation of anodic and cathodic polarization curves

Unit II

Polarography

General principles of polarography, the limiting current and its types, diffusion

current, linear diffusion and spherical diffusion, derivation of Ilkovic equation and its consequences, Koutecky's equation for diffusion current, half-wave potential, equations for reversible cathodic, anodic, and cathodic-anodic waves, analysis of reversible polarographic wave, factors(ionic strength & pH) affecting the half-wave potential, reversible processes controlled by diffusion of complex ions , Amperometric titrations,Approximate and rigorous Treatment of Irreversible electrode processes ,electrogravimetry & its application, coulometry atconstant potential and its application ,cyclic voltammetry(Technique& applications).

Unit III

Polymers

Molecular shape, structure and configuration; Crystallinity; Mechanical properties - stress-strainbehaviour; Thermal behaviour - glass transition; Polymer types and their applications; Conducting, luminescent and ferroelectric polymers.

Liquid crystals

Mesomorphic behaviour - thermotropic and lyotropic phases; Ordering in liquid crystals - thedirector field and order parameters; Nematic and smectic phases - phase transitions; Chiralnematics - cholesteric-nematic transition - optical properties - twisted nematic effect; Structurephaserelations.

Nanomaterials

Preparation techniques; Scanning probe and electron microscopy; Novel physical phenomena in the nano domain – size effects; Electronic, photonic, magnetic and catalytic applications; Nanocomposites; Carbon nanotubes; Graphene; Molecular nanomaterials.

Unit IV

Ionic Liquids:

The thermal dismantling of an ionic lattice, characteristics of ionic liquids, the

fundamental problems in the study of pure liquid electrolytes, models of simple ionic liquids: lattice oriented models (the vacancy model, the hole model), quantification of the hole model, the Furth approach to the work of hole formation, distribution function for the sizes of the holesand the average size of a hole.

Recommended Books :

1. Electrochemistry-by Glasstone
2. Modern Electrochemistry vol.1 and vol 2A, 2B J.O.M.Bockris and A.K.N.Reddy,Plenum
3. *Principles of Electrochemistry,* Koryta, J. Dvorak, J. & Kavan, L., John Wiley, NY (1993)
4. H. V. Keer, Principles of the Solid State
5. L. E. Smart and E. A. Moore, Solid State Chemistry: an Introduction
6. M. T. Weller, Inorganic Materials Chemistry

7. K. J. Klabunde, Nanoscale Materials in Chemistry
8. W. D. Callister, Materials Science and Engineering, An Introduction
9. C. Kittel, Introduction to Solid State Physics
10. Principles of Polarography by J. Heyrovsky & J. Kuta, Academic Press
11. Polarographic Technique, L. Maites
12. Introduction to Polarography, Kamla Jutshi, New Age International
13. Polarography Technique, Kapoor & Aggarwal
14. Physical Chemistry by Maron & Prutton, The Macmillan company
15. Electroanalytical chemistry (Applications by J. Lingane), John Wiley & Sons.

M.Sc. Chemistry Semester X (Year II)
Paper IV(Theory)
Course Title: Industrial Inorganic Chemistry
(Elective VII)

Course Code :RB02104aT **Credits: 4**

Unit I:

Special Materials for Electronic Industry. Recent trends in sensor technology, film sensors, Semiconductor IC technology, micro-electro mechanical systems (MEMS), nanosensors. Applications of Sensors: automobile sensors, home appliance sensor, aerospace sensors, sensors for manufacturing medical diagnostic sensors, sensors for environmental monitoring. High purity silicon, germanium, gallium arsenide (GaAs), indium phosphide (InP) etc.

Unit II :

Fertilizer Industries:

General principles of plant nutrition: essential plant nutrients, functions of the essential elements, classification of commercial nitrogenous fertilizers. Manufacturing of ammonium sulphate, urea, ammonium nitrate, commercial phosphatic fertilizers. Manufacturing process and properties of phosphatic fertilizers, single super phosphate, triple super phosphate. Biofertilizers: classification,

demands and production, present status of fertilizer industries in India.

Unit III

Metal Finish Technology: Basics of electrodeposition, electroplating principles and practice, electrochemistry applied to electroplating, electroplating of metals chromium, cadmium, nickel, copper, silver, gold, purpose of metal electroplating composition and condition of plating bath, applications waste treatment and metal recovery.

Unit-IV

Glass, Ceramics and Paints: Physical and chemical properties of glasses, raw materials, manufacturing of special glasses. Ceramics and their properties, raw materials, manufacturing of ceramics, applications of colours to pottery, use of ceramics.Components of Paints, pigments,thinner,binder, types of paints, water based Paints, drying of paints.

Recommended Books:

1. Keer, H. V. *Principles of the solid state*. New Age International 1993
2. West, A. R. *Solid State Chemistry and its applications*. JohnWiley and Sons 2003
3. Sharma, B. K. *Engineering chemistry*. Krishna Prakashan Media.2014
4. Lowenheim, F. A., *Electroplating ,MC Graw Hill* Book Company 1978.
5. Gable, D. *Principal of metal Treatment and Protection* Pergaman Press Oxford 1987
6. Burke, J. E., *Progess in ceramic science Vol. IV*. PergamonPress.1966
7. Ash, M. and Ash I., Formulary of paints and other coating.Vol. I, Chemical Punlising Press 2000
8. Shukla S. D. and Pandey, G. N. *A text book of chemical technology*. Vikas Publishing House.1979

M.Sc. Chemistry Semester X (Year II)
Paper IV(Theory)
Course Title: Natural Products and Medicinal Chemistry
(Elective VIII)

Course Code :RB02104bT Credits: 4

Unit I Natural Products

Terpenoids: Classification, nomenclature, occurrence, isolation, isoprene rule. Structure determination, synthesis of the following representative molecules: Citral, Geraniol,

α-Pinene, biogenesis of terpenoids.

Prostaglandins: Introduction, nomenclature of prostaglandins; approaches to prostaglandin synthesis (Corey's synthesis of prostaglandins E and F).

Unit II

Alkaloids: Introduction, Structure elucidation of alkaloids – a general account; Structure, synthesis, and stereochemistry of Quinine and Morphine, biogenesis of alkaloids.

Steroids: Introduction, Diel's hydrocarbon, nomenclature of steroids, synthesis of Cholesterol and Aldosterone.

Unit III Medicinal Chemistry

Structure and activity: Drugs and drug targets, Relationship between chemical structure and biological activity (SAR). Receptor Theories.

Antibiotics: β-Lactam ring, structure and synthesis of penicillin-G, penicillin-V, chloramphenicol.

Unit IV

Synthetic drug: A general study of: Sulpha drug: Sulphanilamide, sulphathiazole, Sulphadiazine, Antimalarials: 4- Aminoquinoline, chloroquine, santoquine, pamaquine, 8-aminoquinoline.

Recommended Books :

1. Nitya Anand, J.S. Bindra and S. Ranganathan, Art in Organic Synthesis, 2nd Edition (1970), Holden Day, San Francisco.
2. S.W. Pelletier, Chemistry of the Alkaloids, Van Nostrand Reinhold Co., New York (1970).
3. K.W. Bentley, The Alkaloids, Vol. I., Interscience Publishers, New York (1957).
4. I. L. Finar, Organic Chemistry, Vol. II, 5th Edition (1975) Reprinted in 1996, ELBS and Longman Ltd, New Delhi
5. J.W. Apsimon, Total Synthesis of Natural Products, Vol. 1-6, Wiley-Interscience Publications, New York.
6. J.S. Bindra and R. Bindra, Creativity in Organic Synthesis.
7. J.S. Bindra and R. Bindra, Prostaglandins Synthesis.
8. K. C. Nicolaou, Classics in Total Synthesis of Natural Products, Vol. I & II.
9. J. Clayden, N. Greeves, S. Warren, and P. Wothers, Organic Chemistry, Chapter 30, Oxford University Press, Oxford (2001)
10. Daniel Lednicer Stretegies for organic drug synthesis and design, John Wiley & Sons, New York.
11. An Introduction to Drug Design, S.S. Pandeya and J.R. Dimmock, New Age International.
12. Goodman and Gilman’s Pharmacological Basis of Therapeutics, McGraw-Hill

M.Sc. Chemistry Semester X (Year II)
Paper IV (Theory)
Course Title: Bio Physical Chemistry
(Elective IX)

Course Code :RB02104cT **Credits: 4**

Unit 1:

Biopolymer interactions and Thermodynamics of Macromolecular solutions:

Non-covalent interaction, Electrostatic: dipole-dipole interaction, Dispersion force interaction, hydrophobic interaction. Multiple Equilibria and various types of binding processes in biological systems. Thermodynamics of biopolymer solutions, Flory-Huggins model of macromolecular solvation, Osmotic pressure and Donnan membrane equilibrium.

Unit 2:

Statistical Mechanics and Bio-molecular simulations:

Chain configuration of macromolecule, Random walk model and statistical distribution of end to end dimension. Calculation of average dimension of various chain structures. Conformational transitions: Helix-coil transition, Protein folding problem. Molecular mechanics and dynamics**:** Basic principles – molecular representations – force fields – atom-atom pair potentials – bond length and bond angle and torsion angle potential – van der Waals and electrostatic potential concepts of molecular dynamics – introduction to time-step integration algorithms and force fields.

Unit 3:

Photophysical Kinetics of Bimolecular Processes. Kinetic & optical collisions, Biomolecular collision in gases & mechanism of fluorosence quenching, collision in solution, Stern-Volmer equation Concentration dependence of quenching, quenching by foreign substances.

Unit 4:

Photochemical Primary Processes. Classification of photochemical reaction, rate constants & lifetimes of reactive transition states, light intensity and rate of photochemical reactions, Types of photochemical reaction.

Recommended Books :

1. Biophysical Chemistry Part I, II, III – Charles R Cantor, Paul R. Schimmel, W. H. Freeman of Company.
2. Biophysical Chemistry – P.S. Kalsi and N. Mahanta New Age International Publishers.
3. Textbook of Biophysical Chemistry- U N Dash Macmillan India.
4. Textbook of Biophysical Chemistry- U N Dash Macmillan India
5. Principles of Physical Chemistry, P.W. Atkins, Oxford Press.
6. Physical Chemistry, Thomas Engel, Philip Reid, Pearson Education (2006)
7. Fundamental of photochemistry, K. K. Rohatgi – Mukherjee, New Age International, 2008.

M.Sc. Chemistry Semester X (Year II)
Paper V (Practical)
Course Title: Chemistry

Course Code :RB021005P **Credits :4**

(A) Inorganic Chemistry

Unit I : Synthesis of Cordination Compounds

Synthesis, Separation and Purification of Inorganic complexes and characterizedby various spectroscopic and Analytical methods.

(a) Potassium trioxalato chromate (III) (b) Potassium trioxalato Aluminate

(c) Carbonatotetra- ammine Cobalt (III) nitrate (d) Potassium trioxalato Manganate

(e) Hexammine Co (III) Sulphate Penta hydrate (f) Tris (ethylendiammine) Ni (II) Chloride

Unit II: Chromatographic Separation

Separation of following cations and anions by Paper and TLC methods

(a) Ca^{++},Sr^{++} and Ba^{++} (b) Cu^{++}, Fe^{++} and Ni^{++} (c) Cl^{-} ,Br^{-} and I^{-}

Unit III :

(a) Spectral Studies :

Determination of following cations and anions in the different samples by spectroscopic methods.

(a) Al^{+++} (b) Mn^{++} (c) Bi^{+++} (d) PO_4^{---} (e) NO_3^{-} etc.

(b) **Flame Photometry :**

Determination of Sodium and Potassium in the samples by Flame Photometry.

Unit IV : Industrial Chemical Analysis

(a) Estimation of Calcium in Milk Power by Complexometry

(b) Analysis of Water Samples by COD method.

(c) Analyse the Coal Samples by Proximate Analysis

(d) Analysis of Fertilizers : Ammonical, Phosphate and Nitrate fertilizers

(e) To estimate amounts of halides in the given solution using $AgNO_3$ Conductometrically .

Recommended Books :

.

1 Vogel's Qualitative Inorganic Analysis-VII th EditionRevised byG.Svehla Pearson Education Ltd.1996.

2 Integrated Approach to Coordination Chemistry: An Inorganic Laboratory Guide R.A Marusak, Kate Doan, S.D Cummins,2007,Wiley, NY

3 Advanced Practical Inorganic Chemistry, Gurdeep Raj, 29th edition Krishna Prakasha M.(Pvt),2022

4 . Palmer W.G, Experimental Inorganic Chemistry Cambridge University Press 1965

5 Commercial methods of Analysis Foster Dee Snee and Frank M. Griffin, Mc Graw Hill Book Co.

(B)Organic Chemistry

Unit I. Advanced Organic synthesis (Multi step synthesis)

(i) Benzaldehyde → chalcone → chalcone epoxide

(ii) Chalcone → chalcone dibromide → a-bromochalcone

(iii) Cyclohexanone → cyclohexanone oxime → caprolactone

(iv) Fischer-Indole synthesis: 2-phenylindole from phenylhydrozine

(v) Hydroquinone→ Hydroquinone Diacetate → 2,5 -Dihydroxyacetophenone → 2, 5 Dibenzoxyacetophenone

(vi) Organic synthesis in water (Preparation of Hydroxy methyl benzotriazole)

(vii) And other suitable multi-step synthesis

Unit II: Quantitative analysis

(i) Estimation of glucose by chemical methods

(ii) Estimation of amino acids by chemical/UV methods

(iii) Estimation of Aspirin by UV/VIS spectra

(iv) Estimation of protein, caffeine and glucose by UV/VIS spectra

(v) Estimation of ascorbic acid by chemical/UV methods

(vi) And other possible estimations

Unit III:

(i) Application of spectral data (IR, UV, NMR and mass) for structural elucidation.

(ii) Application of column chromatography HPLC, GC etc.

Recommended Books :

1. College Practical Chemistry, V. K. Ahluwalia, S. Dhingra, A. Gulati, Universities Press. 2005

2. Advanced Practical Organic Chemistry, O. P. Agarwal, Krishna Prakashan. 2014

3. Vogel book of Practical organic chemistry , Longman scientific & Technical,5th edition 2016

4. Techniques and experiments for Organic Chemistry,Ault A; University Science Books ,1998

5.Practical Organic Chemistry, Mann and Saunders, Pearson, 5th edition ,U.K,2009

(C) <u>Physical Chemistry</u> :

(a) Determine the equivalence conductance of strong electrolyte KCl
. at several concentrations & verify the onsagar's equation
(b)Find out the degree of dissociation and dissociation constant of monochloro acetic acid by conductivity measurements

(c) Determine the order of reaction of saponification of ethyl acetate by NaOH also determine the rate constant at different temperatures and from them calculate the energy of activation of the reaction.

(d) Determine the hydrolysis constant of aniline chloride by e.m.f method.

(e)Determine the solubility and solubility product of a sparingly soluble salt.

(f)To plot a polarogram for a mixed solution of Cd++, Zn++ and Mn++ ions in 0.1M KCl solution.

(g)Determine the Half-Wave potential of Zn++ and Cd++ ions in 0.1 KCl solution.

(h)Find out the formation constant of copper glycinate complex polarographically.

Recommended Books:

(1) Advanced Physical Chemistry Experiments, J.N Gurtu, Amit Gurtu Pragati Prakashan , Seventh edition 2017

(2) Advanced Practical Physical Chemistry, J.B Yadav Goel Publishing House,Meerut ,1998

(3) Experimental Physical Chemistry, Das and R.C & Behera Tata Mc Graw-Hill Publishing Co Pvt. Ltd, 1993.

(4) Introductory Practical Physical Chemistry, Burns, D.T & Rattenbury, E.M Pergaman Press ,1966

(5) Experimental Physical Chemistry,V.D Athawale and Parul Mathur, New Age International (P) Ltd Publishers.