

Bhupal Nobles' University, Udaipur

M.Sc. Chemistry (CBCS) Programme

1. Duration of the Course

The Master of Science Chemistry programme will be of four semesters duration under Choice based Credit system which will be conducted in two years. Each semester will be of approximately 5 months (minimum 90 working days in a semester) duration.

2. Eligibility:

Candidates seeking admission to the first semester of M.Sc.(CBCS) Chemistry must have a B.Sc. with Chemistry as one of the optional subjects or as a honours subject (10+2+3 scheme) with minimum 55% marks from a UGC recognized University

3. Admissions:

Admissions to the first semester of M.Sc.(Chemistry) will be made as per admission rules for M.Sc.(CBCS)

4. Medium of Instruction

The medium of instruction and examination shall be English.

5. No. of Seats

Total number of normal fee seats: As per information bulletin

6. Curriculum

The programme shall follow Choice Based Credit System(CBCS) and will be governed by the Common Rules and Regulations of Masters programme under CBCS approved by the Academic Council of the University.

Scheme of Studies

M. Sc. (Chemistry) (CBCS Scheme)

M. Sc. I Semester

S. NO.	PAPER	NOMENCLATURE	COURSE CODE	UNIV. EXAM	INTERNAL ASSESSMENT	MAX. MARKS	L-T-P	CREDITS
1.	Core Course –I	Inorganic Chemistry-I	CHEM-611	70	30	100	3-1-0	4
2.	Core Course –II	Organic Chemistry-I	CHEM- 612	70	30	100	3-1-0	4
3.	Core Course –III	Physical Chemistry-I	CHEM- 613	70	30	100	3-1-0	4
4.	Core Course –IV	Group Theory and Spectroscopy	CHEM-614	70	30	100	3-1-0	4
5.	Core Practical-I	PR-I:Organic Chemistry	CHEM-615	70	30	100	0-0-8	4
6.	Core Practical-II	PR-II: Inorganic and Physical Chemistry	CHEM-616	70	30	100	0-0-8	4
					TOTAL	600		24

The marks distribution of internal assessment-

- Mid Term Examination – 15 marks
- Assignments – 10 marks
- Attendance – 5 marks

M. Sc. II Semester

S. No.	PAPER	NOMENCLATURE	COURSE CODE	UNIV. EXAM	INT. ASSESSMENT	MAX. MARKS	L-T-P	CREDITS
1.	Core Course –V	Inorganic Chemistry-II	CHEM-621	70	30	100	3-1-0	4
2.	Core Course –VI	Organic Chemistry-II	CHEM- 622	70	30	100	3-1-0	4
3.	Core Course –VII	Physical Chemistry-III	CHEM- 623	70	30	100	3-1-0	4
4.	Core Course – VIII	Environmental Chemistry	CHEM-624	70	30	100	3-1-0	4
5.	Core Practical-III	PR-III: Inorganic Chemistry	CHEM-625	70	30	100	0-0-8	4
6.	Core Practical-IV	PR-IV: Organic and Physical Chemistry	CHEM-626	70	30	100	0-0-8	4
7.	Skilled course-I	Skilled course practical (a) Information and communication Technology skill (ICT) (b) Scientific writing skill	CHEM-627 A CHEM-627 B	70	30	100	1-0-3	2
					TOTAL	700		26

The marks distribution of internal assessment-

- a) Mid Term Examination – 15 marks
- b) Assignments – 10 marks
- c) Attendance – 5 marks

M. Sc. III Semester

S. No.	PAPER	NOMENCLATURE	COURSE CODE	UNIV. EXAM	INT. ASSESSMENT	MAX. MARKS	L-T-P	CREDITS
1.	Core Course –IX	Advanced Spectroscopic Techniques	CHEM-631	70	30	100	3-1-0	4
2.	Core Course –X	Bioinorganic, Bioorganic and Biophysical Chemistry	CHEM- 632	70	30	100	3-1-0	4
3.	DSE-I	Discipline Specific Elective-I (a) Inorganic Chemistry (Coordination Chemistry) (b) Organic Chemistry (Modern Interfaces of Organic Chemistry) (c) Physical Chemistry (Chemical Kinetics) (d) Analytical Chemistry (Fundamentals of Analytical Chemistry)	CHEM - 633 A CHEM - 633 B CHEM - 633 C CHEM - 633 D	70	30	100	3-1-0	4
4.	DSE-II	Discipline Specific Elective- II (a) Inorganic Chemistry (Advanced Bioinorganic Chemistry) (b) Organic Chemistry (Chemistry of Heterocyclic compounds) (c) Physical Chemistry (Nuclear and Radiochemistry) (d) Analytical Chemistry (Modern Analytical Methods)	CHEM-634 A CHEM-634 B CHEM-634 C CHEM-634 D	70	30	100	3-1-0	4
5.	Core Practical-V	PR-V:Inorganic Chemistry and Spectral Problems	CHEM-635	70	30	100	0-0-8	4
6.	DSE-I(P)	Discipline Specific Practical- I (a) Inorganic Chemistry (b) Organic Chemistry (c) Physical Chemistry (d) Analytical Chemistry	CHEM-636 A CHEM-636 B CHEM-636 C CHEM-636 D	70	30	100	0-0-8	4
					TOTAL	600		24

The marks distribution of internal assessment-

- a) Mid Term Examination – 15 marks
- b) Assignments – 10 marks
- c) Attendance – 5 marks

M. Sc. IV Semester

S. No.	PAPER	NOMENCLATURE	COURSE CODE	UNIV. EXAM	INT. ASSESSMENT	MAX. MARKS	L-T-P	CREDITS
1.	Core Course –XI	Special methods of Analysis	CHEM-641	70	30	100	3-1-0	4
2.	Core Course –XII	Photochemistry and Supramolecules	CHEM- 642	70	30	100	3-1-0	4
3.	DSE-III	Discipline Specific Elective-I (a) Inorganic Chemistry (Organometallic Chemistry) (b) Organic Chemistry (Medicinal Chemistry) (c) Physical Chemistry (Advanced Photochemistry & Radiation Chemistry) (d) Analytical Chemistry (Analytical Techniques)	CHEM- 643 A CHEM- 643 B CHEM-643 C CHEM-643 D	70	30	100	3-1-0	4
4.	DSE-IV	Discipline Specific Elective-II (a) Inorganic Chemistry (Inorganic Polymers) (b) Organic Chemistry (Chemistry of Natural Products) (c) Physical Chemistry (Solid State Chemistry) (d) Analytical Chemistry (Applied Analytical Methods)	CHEM-644 A CHEM-644 B CHEM-644 C CHEM-644 D	70	30	100	3-1-0	4
5.	Core Practical-VI	PR-VI: Polymer Synthesis and Extraction of Natural Products	CHEM-645	70	30	100	0-0-8	4
6.	DSE-II(P)	Discipline Specific Practical- II (a) Inorganic Chemistry (b) Organic Chemistry (c) Physical Chemistry (d) Analytical Chemistry	CHEM-646 A CHEM-646 B CHEM-646 C CHEM-646 D	70	30	100	0-0-8	4
7.	Skilled course-II	Skilled course (practical) (a) Green Methods in Chemistry (b) Basic Analytical Chemistry (c) Basics in Pharmaceutical Chemistry	CHEM-647 A CHEM-647 B CHEM-647 C	70	30	100	1-0-3	2
					TOTAL	700		26

The marks distribution of internal assessment-

1. Mid Term Examination – 15 marks
2. Assignments – 10 marks
3. Attendance – 5 marks

Syllabus

M.Sc. Chemistry (CBCS) Programme

SEMESTER I

CHEM 611: Inorganic Chemistry

M.M. 70 marks (External)

30 marks (Internal)

Credits = 4

UNIT-I

Stereochemistry and Bonding in Main Group Compounds: VSEPR, Walsh diagrams (tri and penta-atomic molecules), $d\pi-p\pi$ bonds, Bent rule and energetics of hybridization, some simple reactions of covalently bonded molecules

Metal-Ligand Bonding: Limitation of crystal field theory, molecular orbital theory, octahedral, tetrahedral and square planar complexes, π -bonding and molecular orbital theory.

UNIT-II

Metal-Ligand Equilibria in Solution: Stepwise and overall formation constants and their interaction, trends in stepwise constants, 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

UNIT-III

Reaction Mechanism of Transition Metal Complexes: Energy profile of a reaction, reactivity of metal complexes, inert and labile complexes, kinetic application of valence bond and crystal field theories, kinetics of octahedral substitution, acid hydrolysis, factors affecting acid

hydrolysis, base hydrolysis, conjugate base mechanism, direct and indirect evidences in favor of conjugate mechanism, anation reactions, reactions without metal ligand bond cleavage

UNIT-IV

Substitution reactions in square planar complexes, the trans effect, mechanism of the substitution reaction. Redox reactions, electron transfer reactions, mechanism of the substitution reaction, Redox reactions, electron transfer reactions, mechanism of one electron transfer reactions, outersphere type reactions, cross reactions and Marcus-Hush theory, inner sphere type reactions.

UNIT-V

Electronic Spectra and Magnetic Properties of Transition Metal Complexes: Spectroscopic ground states, correlation, Orgel and Tanabe-Sugano diagrams for transition metal complexes (d1-d9 states), Calculations of Dq , B and Δ parameters, charge transfer spectra, spectroscopic method of assignment of absolute configuration in optically active metal chelates and their stereochemical information, anomalous magnetic moments, magnetic exchange coupling and spin crossover.

Books Recommended:

1. Advanced Inorganic Chemistry, F.A.Cotton and Wilkinson, John Wiley
2. Inorganic Chemistry, J.E.Huhey, Harpes & Row
3. Chemistry of the Elements, N.N. Greenwood and A. Earnshaw, Pergamon.
4. Inorganic Electronic Spectroscopy, ABP Lever, Elseview
5. Magnetochemistry, R.L. Carlin, Springer Verlag

SEMESTER-I

CHEM 612: Organic Chemistry

M.M. 70 marks (External)
30 marks (Internal)
Credits = 4

Unit I

Nature of bonding in Organic Molecules:

Delocalized chemical bonding: Conjugation, cross conjugation, resonance by hyperconjugation, bonding in fullerenes, tautomerism.

Aromaticity in benzenoid and non-benzenoid compounds: Alternant and non-alternant hydrocarbons, Huckel's rule, energy level of π -molecular orbitals, annulenes, aromaticity, homoaromaticity, (PMO approach).

Bonds weaker than covalent bonds, addition compounds, crown ether complexes and cryptand, inclusion compounds, cyclodextrins and rotaxanes.

Unit II

Stereochemistry I:

Conformational analysis: Cycloalkanes, decalins, effect of conformation on reactivity, conformation of sugars, steric strain due to unavoidable crowding.

Stereochemistry of the compounds containing nitrogen, sulphur and phosphorus.

Unit III

Stereochemistry II:

Elements of symmetry, chirality, molecules with more than one chiral center, threo and erythro isomers, methods of resolution, optical purity, enantiotopic and diastereotopic atoms, groups and faces, stereospecific and stereoselective synthesis, Asymmetric synthesis. Optical activity in the absence of chiral carbon (biphenyls, allenes and spiranes), chirality due to helical shape.

Unit IV

Reaction Mechanism:

Structure and Reactivity: Types of mechanisms, types of reactions, thermodynamic and kinetic requirements, Kinetic and thermodynamic control. Hammond's postulate, Curtin-Hammett principal, Potential energy diagrams, transition states and intermediates, methods of determining mechanism, isotope effects, Hard and soft acids and bases, Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes and nitrenes, Effects of structure on reactivity resonance and field effects, steric effect, quantitative treatment, The hammett equation and linear free energy relationship, substituent and reaction constants: Taft equation.

Unit V

Pericyclic Reactions:

Molecular orbital symmetry, frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system. Classification of pericyclic reactions. Woodward Hoffman correlation diagrams, FMO and PMO approach.

Electrocyclic Reactions: Conrotatory and disrotatory motions, $4n$, $4n+2$ systems, $2+2$ addition of ketenes, 1,3 dipolar cycloadditions and cheletropic reactions.

Sigmatropic Rearrangements: Suprafacial and antarafacial shifts of H, sigmatropic shifts involving carbon moieties, 3, 3 and 5, 5 sigmatropic shifts.

Rearrangements, Claisen, Cope and aza-cope rearrangements. Fluxional tautomerism, ene reaction.

Suggested Readings:

1. Advanced Organic Chemistry-Reactions, Mechanism and structure, Jerry March, John Wiley.
2. Wiley.
3. Advanced Organic Chemistry, F.A Carey and R.J. Sundberg, Plenum.
4. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
5. Structure and Mechanism in Organic Chemistry, C.K. Ingold, Cornell University press.
6. Organic Chemistry, T.T. Morrison and R.N. Boyd, Prentice-Hall Modern Organic

7. Reactions H.O. House, Benjamin.
8. Principles of Organic Synthesis. R.O.C. Norman and J.M Coxon, Blackie Academic & Professional.
9. Reaction Mechanism in Organic Chemistry S.M. Mukherji and S.P. Singh. Macmillan.
10. Stereochemistry Organic Compounds, D.N. Nasipuri, New Age International.
11. Stereochemistry of organic Compounds, P.S. Kalsi, New Age International.
12. Organic Chemistry Vol. I I.L. Finar, English Language books.
13. Organic Chemistry Vol. II I.L. Finar, English Language books.
14. Pericyclic Reactions, Jagdamba Singh.

SEMESTER-I

CHEM 613: Physical Chemistry

Time: 3 Hrs.

**M.M. 70 marks (External)
30 marks (Internal)
Credits = 4**

ESSENTIAL –All students must have knowledge of these topics of mathematics-

Differentiation and Integration of some simple terms, Differential equations, partial differential equations, series solutions and special functions, linear vector spaces, transformation of coordinate matrix, representation of operators, eigenvalue problem, orthonormal sets, Fourier and Laplace transforms.

UNIT -I

Classical thermodynamics: Brief resume of concepts of laws of thermodynamics, free energy, chemical potential and entropies, partial molar properties, partial molar free energy, partial molar volume and partial molar heat content and their significance, determinations of these quantities.

Non-ideal systems: Excess function for non-ideal solutions.

UNIT-II

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 Lagrange's method of undetermined multipliers) Partition function, translational, rotational, vibrational and electronic partition functions, calculation of thermodynamic properties in terms of partition functions, applications of partition functions. Chemical equilibrium and equilibrium constant in terms of partition functions, Fermi-Dirac statistics, Bose-Einstein statistics, distribution law.

UNIT-III

Chemical dynamics-I : Methods of determining rate laws and mechanism, collision theory of reaction rates, steric factor, activated complex theory, Arrhenius equation and thermodynamic parameters, ionic reactions, kinetic salt effects, steady state kinetics, kinetic and thermodynamic

control of reactions.

UNIT IV

Chemical dynamics-II: Homogeneous catalysis, kinetics of enzyme reactions, chain reactions, photochemical reactions (Hydrogen-bromine and hydrogen-chlorine reactions) oscillatory reactions (Belousov-Zhabotinsky reaction), general features of fast reactions, methods of determining rates in fast reactions.

UNIT V

Macromolecules: Definition, carbon containing macromolecules, diamond, graphite, fullerenes, and carbon nanotubes.

Polymers: types of polymers, electrically conducting, fire resistant and liquid crystal polymers, Biodegradable polymers, kinetics of polymerization, mechanism of polymerization, molecular mass, number and mass average molecular mass, molecular mass determination (osmometry, viscometry, diffusion and light scattering methods, GPC), sedimentation, chain configuration of molecules, calculation of average dimensions of various chain structures. Degradation of polymers.

Books Recommended:

1. Nash, L. K. Elements of Statistical Thermodynamics 2nd Ed., Addison Wesley (1974).
2. Gurtu and Gurtu, Advanced Physical Chemistry, Pragati Prakashan
3. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 8th Ed., Oxford University Press
4. Engel, T. & Reid, P. Physical Chemistry Benjamin-Cummings (2005).
5. McQuarrie, D. A. & Simon, J. D. Physical Chemistry: A Molecular Approach 3rd Ed., Univ. Science Books (2001).
6. Chemical Kinetics, K.J. Laidler, Mcgraw-Hill.
7. Chemical Kinetics, Kali Das, New Age International Publication.
8. Kinetics and Mechanism of Chemical Transformations, J. Rajaraman and J. Kuriacose, McMillan.

SEMESTER-I

CHEM-614: Group Theory and Spectroscopy

Time: 3 Hrs.

**M.M. 70 marks (External)
30 marks (Internal)
Credits 4**

UNIT I

Symmetry and Group theory in Chemistry:

Symmetry elements and symmetry operation, definition of group, subgroup, Conjugacy relation and classes. Point symmetry group, Schonflies symbols, representation of groups by matrices (representation for the C_{nh} , C_{nv} , etc. groups to be worked out explicitly). Characters of a representations, Great orthogonality theorem (without proof) and its importance. Character tables and their use; spectroscopy, Derivation of character table for C_{2v} and C_{3v} point group. Molecular Vibrations in H_2O .

UNIT-II

Unifying Principles: Electromagnetic radiations, Interaction of electromagnetic radiation with matter, absorption, emission, transmission, reflection, refraction, dispersion, polarization and scattering, Uncertainty relation and natural line width and natural line broadening, Factors affecting natural line width, transition probability, results of time dependent perturbation theory, transition moments, selection rules, intensity of spectral lines, Born oppenheimer approximation. Rotational, vibrational and electronic energy levels.

Photoelectron spectroscopy: Franck Condon principle, types of electron spectroscopy, ESCA-theory, instrumentation and applications, Auger emission spectroscopy-Basic idea.

UNIT III

Rotational spectroscopy: classification of molecules, rigid rotator, effect of isotopic substitution on the transition frequencies, intensities, non-rigid rotor, stark effect, nuclear and electron spin interaction and effect of external field, applications.

Vibrational Spectroscopy:

Review of linear harmonic oscillator, Vibrational energies of diatomic molecules, Zero Point energy, force constant and bond strength, anharmonicity, Morse Potential energy diagram, Vibration-rotation spectroscopy, P.Q.R. branches, breakdown of oppenheimer approximation, selection rules, finger print region, Group frequencies and intensities, overtones, hot bands, combination bands and Fermi resonance.

UNIT IV

Raman spectroscopy: Classical and quantum theories of raman effect, Stokes and anti-Stokes lines, Pure rotational, vibrational, rotational- vibrational Raman spectra, Mutual exclusion principle.

IR Spectroscopy (Characterization of functional groups)

Normal modes of vibration, Characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams and conjugated carbonyl compounds), factors affecting the band positions, brief idea of FT-IR.

UNIT V

Ultra-violet and visible spectroscopy:

Various electronic transitions, Beer-lambert law, effect of solvent on electronic transitions, UV spectra of carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes, Woodward-Feiser rules for conjugated dienes and carbonyl compounds, UV spectra of benzene and its derivatives, applications of UV spectroscopy.

Books recommended-

1. Modern Spectroscopy, J.M. Hollas, John Wiley.
2. Chemical Applications of Group Theory, F. A. Cotton.
3. Symmetry and Group theory: Some chemical applications, Ramashankar and Suresh Ameta, Himanshu Publications, Udaipur, Delhi.
4. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw Hill.
5. Basic Principles of Spectroscopy, R. Chang, McGraw Hill.
6. Theory and Applications of UV Spectroscopy, H.H. Jaffe and M. Orchin, IBH- Oxford.
7. Introduction to Photoelectron Spectroscopy, P. K. Ghosh, John Wiley.
8. Introduction to Magnetic Resonance, A Carrington and A.D. Maclachalan, Harper & Row.
9. Physical Methods for Chemistry, R.S. Drago, Saunders Company.
10. Infrared and Raman Spectra: Inorganic and Coordination Compounds, K. Nakamoto, Wiley.
11. Molecular Symmetry in Chemistry Via Group Theory - U.C. Agarwala, Ane books India

SEMESTER-I
CHEM 615: Core practical I
(Organic Chemistry)

M.M. 70 marks (External)
30 marks (Internal)
Credits 4

Time- 8hrs

1. Separation of binary mixture (minimum -8)

Purification and identification of compounds in a binary mixture of two solids and preparation of their suitable derivatives

2. Organic Synthesis (minimum -5)

(One experiment to be performed from the following in the examination)

- I. Acetylation-** Acetylation of Salicylic acid using acetyl chloride
- II. Benzoylation-** Benzoylation of phenol/ aniline/ glycine
- III. Oxidation-** Phenanthroquinone from Phenanthrene
- IV. Sandmeyer Reaction-** o-Chlorotoluene from o-Toluidine
- V. Acetoacetic ester Condensation-** Synthesis of ethyl-n-butylacetoacetate
- VI. Bromination Reaction-** to prepare dibromofluorescein from fluorescein.
- VII. Backmann Rearrangement-** Acetanilide from acetophenone
- VIII. Claisen-Schmidt Condensation-** acetophenone/Benzalacetone/
diBenzalacetone from Benzaldehyde

SEMESTER-I
CHEM 616: Core Practical-II
(Inorganic and Physical Chemistry)

M.M. 70 marks (External)
30 marks (Internal)
Credits 4

Time-8 hrs

1. Qualitative analysis of Inorganic mixture– (minimum -6)

Qualitative analysis of inorganic mixture containing SIX radicals from the following list: (at least three from Group B)

Group A - Carbonate, Sulphite, Sulphate, Sulphide, Nitrite, Acetate, Oxalate, Nitrate, Chloride, Iodide, Phosphate, Fluoride, Borate, Silver, Lead Mercury, Bismuth, Copper, Cadmium, Tin, Arsenic, Antimony, Aluminium, Chromium, Iron, Nickel, Cobalt, Zinc, Manganese, Calcium, Barium, Strontium, Magnesium, Ammonium.

Group B - Thiosulphate, Cyanate, Thiocyanate, Hypochlorite, Chlorate, Perchlorate, Iodate, Persulphate, Silicate, Chromate, Arsenate, Benzoate, Thallium, Tungsten, Molybdenum, Vanadium, Beryllium, Uranium, Thorium, Titanium, Zirconium, Cerium.

2. Kinetics – (minimum -4)

- I. Determine the specific rate constant for the acid catalyzed hydrolysis of methyl acetate by the Initial Rate Method.
- II. Compare the strengths of hydrochloric acid and sulphuric acid by studying rate of hydrolysis of methyl acetate.
- III. Determine the specific reaction rate constant of the potassium persulphate-iodide reaction by the Initial Rate Methods.
- IV. Study the kinetics of the iodination of acetone in the presence of acid by the Initial rate Method.

3. Conductometry – (minimum -4)

- I. Determine the equivalent conductance, degree of dissociation and dissociation

- constant (K_a) of acetic acid and verify Ostwald dilution law.
- II.** Determine the solubility of sparingly soluble salt and its solubility product.
 - III.** Study the conductometric titration of hydrochloric acid with sodium carbonate and determine the concentration of sodium carbonate in a commercial sample of soda ash.
 - IV.** Determine basicity of weak organic acid.
 - V.** Determine the strength of strong and weak acids in a given mixture.

SEMESTER-II
CHEM-621: Inorganic chemistry-II

M.M. 70 marks (External)

30 marks (Internal)

Credits= 4

Time- 8 hrs

UNIT-I

Metal π – complexes I: Carbonyls, structure and bonding, use of vibrational spectra of metal carbonyls for bonding and structure elucidation, types of carbonyls, their preparations and important reactions.

Metal π – complexes II: Preparation, bonding, structure and important reactions of transition metal nitrosyls, dinitrogen and dioxygen complexes.

UNIT-II

Magnetic properties of transition metals: Different types of magnetic behavior, Factors affecting observed magnetic moments, origin of magnetic moments, spin contribution, spin only formulas, orbital contribution, spin-spin coupling, ferromagnetism, anti-ferromagnetism, mechanism of anti-ferromagnetic interaction, spin cross-over, anomalous magnetic moments, applications of magnetic measurements for structure elucidation.

UNIT-III

Boranes: Preparation and important reactions, electron deficient characters of boranes, structure and bonding in boranes, concept of multicentric bonding and M.O. Description, Lipscomb concept of bonding elements, semitopological description of s,t,y and x nomenclature.

Metal Clusters: Higher boranes, carboranes, metalloboranes, Metal carbonyl and halide clusters, compounds with metal-metal multiple bonds.

UNIT-IV

Sulphur-Nitrogen compounds: Preparation, properties of tetrasulphur tetranitride, Disulphur dinitride, polythiazyl and other sulphonitrides, sulphur imides.

Phosphorus-Nitrogen compounds: Linear and cyclic polymers, their synthesis and reactions, structure and bonding Allcock's skeletal π -bonding concept.

UNIT-V

Silicones- Preparation, properties and structure of silicones, types of silicones, their industrial and technical importance.

Isopoly and heteropoly acids and salts- brief idea

Books Recommended:

1. Advanced Inorganic Chemistry, F. A. Cotton and Wilkinson, John Wiley
2. Inorganic Chemistry, J. E. Huhey, Harpes & Row
3. Chemistry of the Elements, N.N. Greenwood and A. Earnshaw, Pergamon
4. Inorganic Electronic Spectroscopy, ABP Lever, Elsevier
5. Magnetochemistry, R.L. Carlin, Springer Verlag

SEMESTER-II
CHEM 622: Organic chemistry- II

M.M. 70 marks (External)
30 marks (Internal)
Credits 4

Time- 8 hrs

UNIT-I

Aliphatic Nucleophilic Substitution

The SN₂, SN₁, mixed SN₁ and SN₂ and SET mechanisms. The neighbouring group mechanism, neighbouring group participation by π and σ bonds, anchimeric assistance.

Classical and non-classical carbocations, phenonium ions, norbornyl system. The SN_i mechanism.

Nucleophilic substitution 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 reaction, Bimolecular reaction mechanisms- SE₂ and SE_i.

The SE₁ mechanism, electrophilic substitution accompanied by double shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity.

UNIT-II

Aromatic Electrophilic Substitution

The arenium ion mechanism, orientation and reactivity, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in other ring systems. Quantitative treatment of reactivity in substrates and electrophiles. Diazonium coupling, Vilsmeier reaction, Gattermann-Koch reaction.

Aromatic Nucleophilic Substitution: The S_NAr SN₁ benzyne and S_{RN}1 mechanisms. Reactivity effect of substrate structure, leaving group and attacking nucleophile. The von Richter, Sommelet-Hauser, and Smiles rearrangements

UNIT-III

Free Radical, Reactions:

Types of free radical reactions, free radical substitution mechanism, mechanism at an aromatic substrate, neighbouring group assistance. Reactivity for aliphatic and aromatic substrates. Reactivity in the attacking radicals. The effect of solvents on reactivity.

Allylic halogenation (NBS), oxidation of aldehydes to carboxylic acids, auto-oxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salts, Sandmeyer reaction and Hunsdiecker reaction.

UNIT-IV

Addition to Carbon-Carbon Multiple Bonds:

Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio- and chemoselectivity, orientation and reactivity. Addition to cyclopropanering. Hydrogenation of double and triple bonds, hydrogenation of aromatic rings. Hydroboration, Michael reaction Sharpless asymmetric epoxidation.

Addition to Carbon-Hetero Multiple Bonds- Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitrites. Addition of Grignard reagents, organozinc and organolithium reagents to carbonyl and unsaturated carbonyl compounds. Wittig reaction. Mechanism of condensation reactions involving enolates Aldol, Knoevenagel, Claisen, Mannish, Benzoin, Perkin and Stobbe reactions. Hydrolysis of esters and amides, ammonolysis of esters.

UNIT-V

Elimination Reactions:

The E1, E2 and E1cB mechanisms and their spectrum, stereochemistry of E1 and E2 reactions and elimination from cyclic compounds. Orientation of the double bond. Reactivity effects of substrate structures, attacking base, the leaving group and the medium. Mechanism and orientation in pyrolytic elimination.

Reagents in organic synthesis: Use of the following reagents in organic synthesis and functional group transformation, Gilman's reagent (LDA), dichlorohexylcarbodiimide, trimethyl silyl iodide, tributyltin hydride, DDQ, 1,3-dithiane, selenium oxide, osmium tetroxide.

Suggested Readings:

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. 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, R.T. Morrison and R.N. Boyd, Prentice-Hall Modern Organic Reactions, H.O. House, Benjamin.
6. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic & Professional.
7. Organic Reactions, Mechanism, P.S Kalsi, New Age International.
8. Organic Reaction Mechanism Ahluwalia, Parasar, Narossa Publishing House.
9. Organic Chemistry, Clayden, Greeves, Oxford University Press.
10. Organic Chemistry Vol. I I.L. Finar, English Language books.
11. Organic Chemistry Vol. II I.L. Finar, English Language books

SEMESTER-II
CHEM 623: Physical Chemistry-II

M.M. 70 marks (External)
30 marks (Internal)
Credits 4

UNIT-I

Quantum chemistry: The Schrodinger equation and the postulates of quantum mechanics, solutions of the Schrodinger equation to some model system viz. particle in a box, the harmonic oscillator. Rigid rotor, hydrogen atom.

Approximate methods: First order time-independent perturbation theory for non- degenerate states. Variation theorem and variational methods. Use of these methods illustrated with some examples (particle in a box with a finite barrier, anharmonic oscillator)

UNIT-II

Angular momentum: Ordinary angular momentum, generalized angular momentum, eigen functions and eigen values of angular momentum, operators, algebra of operators, ladder operators, addition of angular momenta, spin, antisymmetry and Pauli's exclusion principle.

Electronic structure of atoms: Electronic configuration, Russell-Saunders' terms and coupling schemes, molecular orbital theory, Huckel theory of conjugated systems, bond order and charge density calculations, application to ethylene and butadiene.

UNIT-III

Nuclear Chemistry: Introduction, Radioactivity, laws of radioactivity decay, Soddy fajan group displacement law, rate of nuclear decay and half life, mean life, kinetics of radioactive decay, Radioactive series, artificial radioactivity, detection and measurement of radioactivity, nuclear fission and fusion, Application of radioisotopes. Carbon dating.

UNIT-IV

Surface chemistry - Surface tension, Gibbs adsorption isotherm, estimation of surface area (BET equation), surface films on liquids (Electrokinetic phenomenon), catalytic activity at surfaces. Surface active agents, classification of surface active agents, micellization, hydrophobic interaction, critical micellar concentration (CMC), factors affecting the CMC of surfactants, counter ion binding to micelles, thermodynamics of micellization, solubilization, micro-emulsion, reverse micelles.

UNIT-V

Electrochemistry: Activity, activity coefficient. Debye-Huckel theory, determination of activity and activity coefficients, ionic strength.

Debye-Huckel-Onsager treatment and its extension, ion-solvent interactions, Debye-Huckel-Jerum mode, derivation of electro-capillarity, Lippmann equations (surface excess), methods of determination, structure of electrified interfaces, Guoy-Chapman, Stern, Graham-Devanathan-Mottwatts, Tobin, Bockris, Devanathan models, over potentials, exchange current density, derivation of Butler-Volmer equation, Tafel plot, semiconductor interfaces, theory of double layer at semiconductor, electrolyte - solution interfaces, structure of soluble layer interfaces, effect of light at semiconductor solution interface. Bioelectrochemistry, Electrocatalysis.

Book Recommended:

1. Modern Electrochemistry Vol. I and Vol.II, J.O.M. Bockris and A.K.N. Reddy, Plenum
2. Silbey, R. J., Alberty, R. A. & Bawendi, M. G. Physical Chemistry 4th Ed. Wiley
3. Physical Chemistry, P.W Atkins, ELBS
4. Micelles, Theoretical and Applied Aspects, V. Moroi, Plenum
5. Lowe, J. P. & Peterson, K. Quantum Chemistry Academic Press (2005).
6. McQuarrie, D. A. Quantum Chemistry Viva Books Pvt. Ltd.: New Delhi (2003).
7. Mortimer, R. G. Mathematics for Physical Chemistry 2nd Ed. Elsevier (2005).
8. Pilar, F. L. Elementary Quantum Chemistry 2nd Ed., Dover Publication Inc.: N.Y. (2001).
9. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 8th Ed., Oxford University Press
10. Levine, I. L Quantum Chemistry 5th Ed., Prentice-Hall Inc.: New Jersey (2000).
11. Engel, T. & Reid, P. Physical Chemistry Benjamin-Cummings (2005).
12. Negi, Anand A Text book of Physical Chemistry, New Age International.
13. N.B. Singh, S.S.Das, Physical Chemistry, New Age International

SEMESTER-II
CHEM 624: Environmental Chemistry

M.M. 70 marks (External)

30 marks (Internal)

Time: 3 Hrs.

Credits 4

UNIT I

Environment- Introduction. Composition of atmosphere, vertical temperature, heat budget of the earth, atmospheric system, vertical stability temperature, Biogeochemical cycles of C, N, P, S and O. Biodistribution of elements.

Hydrosphere- Chemical composition of water bodies- lakes, streams, rivers and wet lands etc. Hydrological cycle.

Aquatic pollution- inorganic, organic, pesticide, agricultural, industrial and sewage, detergents, oil spills and oil pollutants. Water quality parameters- dissolved oxygen, biochemical oxygen demand, solids, metals, content of chloride, sulphate, phosphate, nitrate and micro-organisms. Water quality standards. Analytical methods for measuring BOD, DO, COD, F, Oils, metals (As, Cd, Cr, Hg, Pb, Se, etc.), residual chloride and chlorine demand.

Purification and treatment of water.

UNIT II

Soils - Composition, micro and macro nutrients, Pollution- fertilizers, pesticides, plastics and metals, Waste treatment.

Atmosphere - Chemical composition of atmosphere- particles, ions and radicals and their formation. Chemical and photochemical reactions in atmosphere, smog formation, oxides of N, C, S, O and their effect, pollution by chemicals, petroleum, minerals, chlorofluorohydrocarbons. Green house effect, acid rain, air pollution controls and their chemistry. Analytical methods for measuring air pollutants. Continuous monitoring instruments.

UNIT III

Industrial Pollution - Cement, sugar, distillery, drug, paper and pulp, thermal power plants, nuclear power plants, metallurgy. Polymers, drugs etc. Radionuclide analysis. Disposal of wastes and their management.

UNIT IV

Environmental Toxicology - Chemical solutions to environmental problems, biodegradability, principles of decomposition, better industrial processes.

Bhopal gas tragedy, Chernobyl, Three Mile Island, Sewozo and Minamata Disasters.

UNIT V

Principle and concepts of Green Chemistry:-Introduction, definition, principles, atom economy, atom economic and atom uneconomic reaction.

Green Solvents: Organic solvents, solvent-free systems, controlling of solvent-free reactions, supercritical fluids (H_2O and CO_2), fluoruous biphasic solvents.

Green Synthesis: examples of greener reagents, catalyst, biocatalyst and phase transfer catalyst classification and applications of Green Synthesis including Microwave Assisted Synthesis green synthesis of polycarbonates, paracetamol, ibuprofen, citral, urethane, adipic acid, styrene, α , β -unsaturated nitro alkenes. polymer supported reagents, solid state polymerization.

Books Recommended:

1. Environmental Chemistry, S. E. Manahan, Lewis Publishers.
2. Environmental Chemistry, Sharma & Kaur, Krishna Publishers.
3. Environmental Chemistry, A. K. De, Wiley Eastern.
4. Environmental Pollution Analysis, S.M. Khopkar, Wiley Eastern
5. Standard Method of Chemical Analysis, F.J. Welcher Vol. III, Van Nostrand Reinhold Co.
6. Environmental Toxicology, Ed. J. Rose, Gordon and Breach Science Publication.

7. Elemental Analysis of Airborne Particles, Ed. S. Landsberger and M. Creatchman, Gordon and Breach Science Publication.
8. Environmental Chemistry, C. Baird, W. H. Freeman.
9. Green Chemistry: An Introductory Text, Mike Lancaster, Royal Society of Chemicals, Cambridge,
10. Green Chemistry: Frontiers in Benign Chemical Synthesis and Processes, Edited by Paul T. Anastas & Tracy C. Williamson, Oxford University Press.
11. Green Chemical Syntheses and Processes: Edited by Paul T. Anastas, Lauren G. Heine & Tracy C. Williamson, ACS Symposium Series.
12. Green Chemistry: Environment Friendly Alternatives, Edited by Rashmi Sanghi, M. M. Srivastava, Narosa Publishing House, New Delhi.
13. Green Chemistry: Microwave Synthesis, K. R. Desai, Himalaya Publishing House.
14. Green Chemistry: A Teaching Resource, Dorothy Warren, Royal Society of Chemicals, 2001.
15. Green Chemistry: Williams, Charlotte.

SEMESTER-II
CHEM 625: Core Practical-III
(Inorganic Chemistry)

M.M. 70 marks (External)
30 marks (Internal)

Time 8h

Credits 4

A. Water Analysis - (minimum -5)

1. Determination of dissolved oxygen (DO) of water sample.
2. Determination of chemical oxygen demand (COD) of water sample.
3. Determination of biological oxygen demand BOD of water sample.
4. Determination of Residual Chloride in water sample by Argentometric Method
5. Determination of available chlorine in bleaching powder
6. Determination of Fluoride (F⁻) in water sample by
 - a. Ion Selective Electrode Method
 - b. Sodium 2-(parasulphophenyl azo)-1,8-dihydroxy-3,6- Naphthalene Disulphonate
 - c. (SPADNS) Method
7. Determination of Total hardness of water by EDTA Titrate metric Method.

B. Miscellaneous:

1. Complexometric determination of Copper, Nickel, Iron, Chromium and Barium.
2. Determination of Iodide/ Tin by Potassium Iodate.
3. Separations of Cations and anions by Paper Chromatography.

SEMESTER-II
CHEM 626: Core practical-IV
(Organic and Physical Chemistry)

M.M. 70 marks (External)
30 marks (Internal)
Credits 4

Time 8h

1. Distribution law

- I. Complex formation between copper sulphate and ammonia
- II. Equilibrium constant of the reaction between iodine and potassium iodide

2. Conductometry – (minimum -4)

- I. Determine the equivalent conductance at infinite dilution for acetic acid by applying Kohlrausch's law of independent migration of ions.
- II. Determination of velocity constant and order of the reaction for saponification of ethyl acetate by sodium hydroxide conductometrically.
- III. Study the stepwise neutralization of a polybasic acid e.g. oxalic acid, citric acid, succinic acid by conductometric titration and explain the variation in the plots.
- IV. Study the estimation of potassium sulphate solution by conductometric titration. Titrate a mixture of copper sulphate, acetic acid and sulphuric acid with Sodium hydroxide.

3. Quantitative Analysis (minimum -2)

- I. Determination of equivalent weight of an acid by silver salt method
- II. Estimation of phenol/ aniline using Bromate-Bromide solution or by acetylation method
- III. Estimation of glucose by titration using Fehling's solution/ Benedict solution
- IV. Estimation of carbonyl group by using 2, 4-dinitrophenylhydrazine.

4. Analysis of oils and fats (minimum -2)

- I. Determination of saponification value of oil.

II. Determination of iodine value of oil.

III. Determination of acid value of oil.

5. Chromatography of amino acids and carbohydrates:

I. Separation of components by TLC

II. Separation of components by adsorption paper chromatography

SEMESTER-III
CHEM 631: Advanced Spectroscopic Techniques

M.M. 70 marks (External)
30 marks (Internal)
Credits = 4

Time: 3 Hrs.

UNIT-I

Mass Spectrometry: Introduction, ion production - EI, CI, FD and FAB, factors affecting fragmentation, ion analysis, ion abundance. Mass spectral fragmentation of organic compounds, common functional groups, molecular ion peak, metastable peak, McLafferty rearrangement. Retro Diel-Alder reaction, Nitrogen rule. High resolution mass spectrometry. Examples of mass spectral fragmentation of organic compounds with respect to their structure determination.

UNIT II

Nuclear Magnetic Resonance Spectroscopy: General introduction and definition, chemical shift, spin-spin interaction, shielding mechanism, mechanism of measurement, 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 (second order spectra), virtual coupling. Stereochemistry, hindered rotation, Karplus curve-variation of coupling constant with dihedral angle. Simplification of complex spectra-nuclear magnetic double resonance, contact shift reagents, solvent effects. Fourier transform technique, nuclear Overhauser effect (NOE). Resonance of other nuclei-¹⁹F, ³¹P.

Carbon-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.

UNIT III

Electron Spin Resonance Spectroscopy: Hyperfine coupling, spin polarization for atoms and

transition metal ions, spin-orbit coupling and significance of g-tensors, application to transition metal complexes (having one unpaired electron) including biological systems and inorganic free radicals such as PH_4 , F_2 and $[\text{BH}_3]$.

UNIT IV

X-ray Diffraction: Bragg condition, -Miller indices, Laue method, Bragg method, Debye-Scherer method of X-ray structural analysis of crystals, index reflections identification of unit cells from systematic absences in diffraction pattern. Structure of simple lattices and X-ray intensities, structure factor and its relation to intensity and electron density, phase problem. Description of the procedure for an X-ray structure analysis, absolute configuration of molecules, Ramchandran diagram.

Electron Diffraction: Scattering intensity vs. scattering angle, Wierl equation, measurement technique, elucidation of structure of simple gas phase molecules. Low energy electron diffraction and structure of surfaces. Neutron Diffraction: Scattering of neutrons by solids and liquids, magnetic scattering, measurement techniques. Elucidation of structure of magnetically ordered unit cell.

UNIT V

Mössbauer Spectroscopy: Basic principles, spectral parameters and spectrum display. Application of the technique to the studies of (1) bonding and structures of Fe^{+2} and Fe^{+3} compounds including those of intermediate spin, (2) Sn^{+2} and Sn^{+4} compounds - nature of M-L bond, -coordination number, structure (3) detection of oxidation state and equivalent MB atoms.

Books Recommended:

1. Physical Methods for Chemistry, R.S. Drago, Saunders Company.
2. Structural Methods in Inorganic Chemistry, E. A. V. Ebsworth, D.W.H. Rankin and S. Craddock, ELBS
3. Infrared and Raman Spectra: Inorganic and Coordination Compounds, K. Nakamoto, Wiley.
4. Progress in Inorganic Chemistry vol., 8, ed., F.A. Cotton, vol., 15, ed. S.J. Lippard, Wiley.

5. Transition Metal Chemistry edi R.L. Carlin vol. 3, Dekker
6. Inorganic Electronic Spectroscopy, A.P.B. Lever, Elsevier.
7. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R.V. Parish, Ellis Norwood.
8. Practical NMR Spectroscopy, M.L. Martin, J.J. Delpeuch and G.J. Martin, Heyden.
9. Spectrometric Identification of Organic Compounds, R. M. Silverstein, G. C. Bassler and T. C. Morrill, John Wiley
10. Introduction to NMR Spectroscopy, R. J. Abraham, J. Fisher and P. Loftus, Wiley.
11. Application of Spectroscopy of Organic Compounds, J. R. Dyer, Prentice Hall.
12. Spectroscopic Methods in Organic Chemistry, D. H. Williams, I. Fleming, Tata McGraw-Hill.
13. Modern Spectroscopy, J.M. Hollas, John Wiley.
14. Applied Electron Spectroscopy for Chemical Analysis Ed. H. Windawi and F.L. Ho, Wiley Interscience.
15. NMR, NQR, EPR and Msssbauer Spectroscopy in Inorganic Chemistry, R.V. Parish, Ellis Harwood.
16. Physical Methods in Chemistry, R.S. Drago, Saunders College.
17. Chemical Applications of Group Theory, F. A. Cotton.
18. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw Hill.
19. Basic Principles of Spectroscopy, R. Chang, McGraw Hill.
20. Theory and Applications of UV Spectroscopy, H.H. Jaffe and M. Orchin, IBH-Oxford.
21. Introduction to Photoelectron Spectroscopy, P. K. Ghosh, John Wiley.
22. Introduction to Magnetic Resonance, A Carrington and A.D. Maclachalan, Harper & Row.

SEMESTER-III

CHEM 632: Bioinorganic, Bioorganic and Biophysical Chemistry

M.M. 70 marks (External)

30 marks (Internal)

Credits 4

Time: 3 Hrs.

UNIT I

Metal Ions in Biological Systems

Essential and trace metals. Na/K⁺ Pump, Role of metals ions in biological processes.

Electron transfer in biology: Structure and functions of electron transfer proteins, Cytochromes and respiratory chain, iron sulphur proteins rubredoxin and ferridoxins.

Photosynthetic pigments: Photosynthesis, Chlorophyll molecule, Photosystem-I and Photosystem-II.

UNIT II

Transport and Storage of Dioxygen: Heme proteins and oxygen uptake, structure and function of hemoglobin, myoglobin, hemocyanins and hemerythrin, model synthetic complexes of iron, cobalt and copper.

UNIT III

Enzyme and Mechanism of Enzyme Action: Introduction of enzymes, enzyme action, Transition-state theory, orientation and steric effect, acid-base catalysis, covalent catalysis, strain or distortion. Examples of some typical enzyme mechanisms for chymotrypsin, ribonuclease, lysozyme and carboxypeptidase A.

UNIT IV

Co -Enzyme Chemistry: Cofactors as derived from vitamins, coenzymes, prosthetic groups, apoenzymes. Structure and biological functions of coenzyme A, thiamine pyrophosphate,

pyridoxal phosphate, NAD⁺, NADP⁺, FMN, FAD, lipoic acid, vitamin B12. Mechanisms of reactions catalyzed by the above cofactors.

UNIT V

Bioenergetics: Standard free energy change in biochemical reactions, exergonic, endergonic. Hydrolysis of ATP, synthesis of ATP from ADP, muscular contraction and energy generation in mechanochemical system.

Cell Membrane and Transport of Ions: Structure and functions of cell membrane, ion transport through cell membrane, irreversible thermodynamic treatment of membrane transport. Nerve conduction.

Books recommended:

1. Bioorganic Chemistry: A Chemical Approach to Enzyme Action, Hermann Dugas and C. Penny, Springer-Verlag.
2. Understanding Enzymes, Trevor Palmer, Prentice Hall.
3. Enzyme Chemistry: Impact and Applications, Ed. Collin J Suckling, Chapman and Hall.
4. Enzyme Mechanisms Ed, M. I. Page and A. Williams, Royal Society of Chemistry.
5. Fundamentals of Enzymology, N.C. Price and L. Stevens, Oxford University Press.
6. Immobilized Enzymes: An Introduction and Applications in Biotechnology, Michael D. Trevan, John Wiley.
7. Enzymatic Reaction Mechanisms, C. Walsh, W. H. Freeman.
8. Enzyme Structure and Mechanism, A Fersht, W.H. Freeman.
9. Biochemistry: The Chemical Reactions of Living Cells, D. E. Metzler, Academic Press. Principles of Biochemistry, A. L. Lehninger, Worth Publishers.

10. Biochemistry, L.Stryer, W.H.Freeman.
11. Biochemistry, J. David Rawn, Neil Patterson.
12. Biochemistry, Voet and Voet, John Wiley.
13. Supramolecular and Bioinorganic Chemistry, Rekha Dashora and A. K. Goswami, Pragati Prakashan.
14. Outlines of Biochemistry, E. E. Conn and P. K. Stumpf, John Wiley.
15. Macromolecules: Structure and Function, F. Wold, Prentice Hall.
16. Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books.
17. Bioinorganic Chemistry, I. Bertini, H.B. Gray, S.J. Lippard and J.S. Valentine, University Science Books.
18. Inorganic Biochemistry volume I and II. ed. G.L. Eichhorn, Elsevier.
19. Progress in Inorganic Chemistry, Volume 18 and 38 ed. J.J. Lippard, Wiley.

SEMESTER-III
CHEM 633 A : Coordination Chemistry

Time: 3 Hrs.

M.M. 70 marks (External)

30 marks (Internal)

Credits = 4

UNIT-I

Isomerism of Coordination Compounds: Isomerism and stereochemistry, Classification of isomers. Study of constitutional and configurational isomerism.

UNIT-II

Optical activity of coordination compounds, symmetry requirements for optical activity, study of ORD, circular dichroism, cotton effect with special reference to complexes of Cr, Co, Ni and Pt.

UNIT-III

Magnetic properties of coordination compounds, paramagnetism, ferromagnetism and anti-ferromagnetism, effect of temperature, measurements of magnetic susceptibility.

UNIT-IV

Inorganic Photochemistry- Ligand field excited state, charge transfer excited state, ligand to metal, metal to ligand, charge transfer to solvent, tetra ligand state, metal to metal state, the xi state and DOSENCO state.

Photochemical reactions of coordination compounds- Chromium (III) complex, Cobalt (III) complexes, Radium (III) complexes, complex of transition elements.

UNIT-V

Mixed ligand complexes: Stabilities of ternary complexes, Dynamics of formation of ternary complexes Reaction of coordinated ligand in ternary complexes.

Books Recommended :

1. Principle and Applications of Organotransition Metal Chemistry, J.P. Coliman, L.S Hedges, J.R. Norton and R.G. Finke, University Science Books.
2. The Organometallic Chemistry of the Transition Metals, R.H. Crabtree, John Wiley.
3. Metallo-Organic Chemistry, A.J. Pearson, Wiley
4. Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books
5. Bioinorganic Chemistry, I. Bertini, H.B. Gray, S.J. Lippard and J.S Valentine, University, Science Books
6. Inorganic Biochemistry Volume I and II. Ed G.L. Eichhorn, Elsevier
7. Progress in Inorganic Chemistry, Volume 18 and 38 Ed. J.J. Lippard, Wiley

SEMESTER-III
CHEM 634 A: Advanced Bio-inorganic chemistry

M.M. 70 marks (External)
30 marks (Internal)
Credits = 4

Time: 3 Hrs.

UNIT-I

Fundamentals of inorganic biochemistry, geo-chemical effects on life systems essential and non-essential elements in bio-systems, Role of alkali/alkaline earth metals in bio-systems. Role of 3d block elements and non-metals in bio-systems.

UNIT –II

Role of metal ions in oxygen carriers and synthetic oxygen carriers. Designing of chelating agents and metal chelates as medicines. Fixation of dinitrogen biologically and abiologically, biotransformation of nonmetallic inorganic compounds.

UNIT-III

Environmental bioinorganic chemistry: Metal ions as probes for locating active sites. Anti-oxidants. Metal ions as antioxidants, metal ion enhancing catalytic activity of enzymes (Biocatalysts). Inhibitions as competitive and non-competitive metals and metalloproteins. Metal complexes of polynucleotides, nucleosides and nucleic acids (DNA & RNA) Template temperature, stability of DNA.

UNIT-IV

Role of metal ions in replication and transcription process of nucleic acids, Biochemistry of dioxygen, bioinorganic chips and biosensors. Biochemistry of calcium as hormonal messenger, muscle contraction blood clotting neurotransmitter, calcification reclaiming of barren land.

UNIT-V

Metals in the regulation of biochemical events. transport and storage of metal ions in vivo. Metal complexes as probes of structure and reactivity with metal substitution. Fundamentals of Toxicity and Detoxification, Nuclear medicines.

Books Recommended:

1. Supramolecular and Bioinorganic chemistry, Rekha Dashora and A. K. Goswami, Pragati Prakashan.

SEMESTER-III
CHEM 633 B: Modern Interfaces of Organic Chemistry

Time: 3 Hrs.

M.M. 70 marks (External)
30 marks (Internal)
Credits = 4

UNIT-I

Selective organic name reactions: Hoffmann-Loffer-Fretag reaction, chichibabin reaction, Sharpless, asymmetric epoxidation, Barton reaction, ene reactions, Stork enamine reaction, Aldol, Perkin, Stobbe, Dieckmann, Condensation, Michael addition, Mannich reaction.

UNIT-II

Disconnection approach: Elementary idea of disconnection, an introduction to synthons, synthetic equivalents, functional group one and two group C-x & C-C disconnection). Interconversions, Chemoselectivity, Diels-Alder reaction, 1,3-and 1,5 difunctionalised compounds, α , β -unsaturated carbonyl compounds, Michael reaction, Robinson annelation.

Protecting group: Principle of protection of hydroxy, amine and carbonyl groups

UNIT-III

Oxidation: Introduction, different oxidative processes, hydrocarbons (alkenes aromatic rings, activated and inactivated saturated C - H groups), alcohols, diols aldehydes, ketones, ketals and carboxylic acids, singlet oxygen, ruthenium tetroxide and Tl (III) nitrate as oxidizing agent, Provost reaction, Wacker's process Barbier-Wieland degradation

UNIT-IV

Reduction: Introduction, different reductive processes, hydrocarbons (cyclo alkanes, alkenes, conjugated system, alkynes and aromatic rings), carbonyl compounds, nitro, azo and oxime compounds, hydrogenolysis, reductions using Wilkinson's catalyst, Meerwein -Pondrof - Verley reduction.

UNIT-V

Applications of the following in the organic synthesis: Phase transfer catalysts, polymer supported reagents, Biocatalysts, microwave and ultrasound induced reactions.

Chemistry of fullerenes: Structure bonding physical and chemical properties, compounds of fullerenes.

Books Recommended:

1. Modern Synthetic Reactions, H.O. House, W.A Benjamin
2. Some Modern Methods of Organic Synthesis, W. Carruthers, Cambridge Univ. Press.
3. Principles of Organic Synthesis, R.O.C Norman and J.M. Coxon, Blackie Academic & Professional
4. Advanced Organic Chemistry, F.A Carey and R.J. Sundberg.
5. The Disconnection Approach- An art of organic synthesis, Suresh Ameta and P. B. Punjabi, Sadguru Publications, Udaipur.
6. Organic Synthesis-Concept, Methods and Starting Materials, J. Fuhmop and G. Penzillin
7. Guide Book to Organic Synthesis, R.K. Mackie & D.M. Smith, ELBS.
8. Organic Synthesis, V.K. Ahuwalia and Renu Agarwal, Narosa
9. Synthesis, Approaches in Organic Chemistry, R.K. Bansal, Narosa
10. Advanced Organic Chemistry -Reactions, Mechanism and Structure, Jerry March, John Wiley.

SEMESTER III
CHEM 634 B : Chemistry of Heterocyclic Compounds

Time: 3 Hrs.

M.M. 70 marks (External)

30 marks (Internal)

Credits = 4

UNIT-I

Nomenclature of heterocycles: Replacement and systematic nomenclature (Hantzsch-Widman system) for monocyclic, fused and bridged heterocyclic.

Aromatic heterocycles: General Chemical behaviour of aromatic heterocyclic, classification (structural type), criteria of aromaticity (bond lengths, ring current and chemical shifts in ¹H-NMR spectra. Empirical resonance energy, delocalization energy, Dewar resonance energy and diamagnetic susceptibility exaltations).

UNIT-II

Small ring heterocycles: Three membered heterocycles with one and two heteroatoms synthetic methods, physical, spectroscopic and chemical properties of aziridines, oxiranes, Thiiranes, diaziridines, diazirines, oxaziridines. Four membered heterocyclic compounds synthetic methods, physical, spectroscopic and chemical properties of azetines, azetidines, oxetanes, thietanes and their carbonyl derivatives.

UNIT-III

Benzo-fused five membered heterocycles: Synthetic methods, physical and chemical properties of benzopyrroles, benzofuranes and benzothiophenes.

Six-membered heterocycles: Synthetic methods, physical and chemical properties of pyrilium salts, pyrones, quinolizinium salts, pyridazines, pyrimidines, pyrazines, acridines and phenanthridines, diazines and triazines

UNIT-IV

Seven and large membered heterocycles: Synthetic methods, physical and chemical properties of azepines, oxepines, thiepines and diazepins.

UNIT-V

Meso-ionic heterocycles: Synthetic methods, properties of 1,3-oxazolium-4-olates, 1,3-oxathiolium-4-olates, 1,3-diazolium-4-olates, 1, 2, 3,-oxadiazolium-5-olates and 1, 2-diathiolium-4-olates.

Books Recommended-

1. Heterocyclic Chemistry, R.R Gupta, M. Kumar and V. Gupta, Springer Verlag.
2. The Chemistry of Heterocycles, T. Eicher and S. Hauptmann, Thieme.
3. Heterocyclic Chemistry, R. K. Bansal, New Age International Publishers.
4. Heterocyclic Chemistry, J.A Joule, K. Mills and G.F. Smith Chapman and Hall
5. Heterocyclic Chemistry, T.L. Gilchrist, Longman Scientific Technical
6. An Introduction to the Heterocyclic Compounds, R. M. Acheson, John Wiley.
7. Comprehensive Heterocyclic Chemistry, A.R Kartritzky and C.W Rees.
8. Stereoselective Synthesis: A Practical Approach, M. Nogradi

SEMESTER-III
CHEM 633 C: Chemical Kinetics

Time: 3 Hrs.

M.M. 70 marks (External)
30 marks (Internal)
Credits = 4

UNIT-I

Methods for determining rate of reaction, reaction mechanism and rate law.

Principles of reactivity: Significance of entropy, enthalpy and Gibb's free energy, Arrhenius equation, uses of activation parameters, nature of activation barrier in chemical reaction

UNIT II

Structure effect on rate: Linear free energy relationship, Hammett equation, substitution constants, theories of substituent effect, interpretation of σ values and reaction constant ρ , deviation from Hammett equation, the Taft model, σ_I and σ_R scales, steric acceleration, molecular measurements of steric effect upon rates.

UNIT-III

Solvation and solvent effect on rate: Factors affecting reaction rate in solution, effect of solvation on reaction rate, solvent effect on ion - ion, ion - dipole and dipole - dipole reactions, and preliminary idea about diffusion - controlled reactions.

UNIT-IV

Electron transfer processes in solution: Inner-sphere, outer sphere, bridged transition states, Marcus theory and its modifications, one equivalents and two equivalent exchange reactions, reactions of solvated electron with metal ions.

Kinetic isotope effect: Theory of isotope effects, primary and secondary kinetic effect, heavy atom isotope effect, tunneling effect, solvent isotope effect.

UNIT-V

Reaction on surfaces: Adsorption isotherm, structure of solid surface and adsorbed layers, mechanism of surface reactions, unimolecular and bimolecular surface reactions, transition state theory of surface reactions, surface chemistry in industrial processes.

Gas phase reaction: Hydrogen-oxygen reaction, combustion of hydrocarbons decomposition of N_2O_5 and acetaldehyde, Gold, Finger- Lettort –Ni clause rule and inhibition mechanism.

Books Recommended:

1. Surface activity and Detergency, K. Durham, Ed. Mc Millan.
2. Emulsion and Foams, S. Berkman and G. Egloff, Reinhold.
3. Surface Chemistry, J. B. Bikeman, Academic
4. Chemical Kinetics, K. J. Laidler
5. Chemical Kinetics and Mechanism, A. A Frost and R.G. Pearson

SEMESTER-III
CHEM 634 C: Nuclear and Radiochemistry

Time: 3 Hrs.

M.M. 70 marks (External)
30 marks (Internal)
Credits = 4

UNIT I

Stability of the nucleus, Mass Energy relationship for nuclear reactions, Properties of nucleus, Nuclear Models (The shell model, the liquid drop model, the Fermi gas model, the collective model and the optical model)

UNIT II

Nuclear reactions: Specific nuclear reactions, photonuclear reactions and thermonuclear reactions, Interaction of radiation with matter; passage of neutrons through matter;

UNIT III

Measurement of Radiation: Counting techniques, Radiation Detectors

Gas ionization detectors- Principle, ion chamber- proportional counter, G M counter Scintillation Detector- Principle, features, Inorganic and organic Scintillators, Solid state detectors,

UNIT IV

Radiochemical principles and uses of tracers: Reaction mechanism, structure determination, Surface area of a powder

UNIT V

Neutron activation analysis, Isotope dilution analysis, radiometric titration,

Applications in chemical investigations and synthesis in physiochemical analysis, in age determination and in prospecting of natural resources

Books Suggested:

1. Source Book of atomic Energy, Glasstone, East West Edition
2. Essentials of Nuclear chemistry, H. J. Arniker
3. Introduction to Nuclear Science, M. W. Sarton, West East Edition
4. Theory of Nuclear Structure, M. K. Pal, East West Edition

SEMESTER- III
CHEM 633 D: Fundamentals of Analytical Chemistry

Time: 3 Hrs.

M.M. 70 marks (External)
30 marks (Internal)
Credits = 4

UNIT-I

Basic tools and operations of analytical chemistry- Role of analytical chemistry, types of analysis, analysis methods, classical and instrumental, selecting an analytical method, laboratory operations and practices , Analytical balance, volumetric glass wares, calibration of glassware, sample dissolution and decomposition , selecting and handling of reagents, preparation of solution of analytic. Laboratory safety measurements.

UNIT-II

Data Handling in analytical chemistry: Accuracy and precision, central value and its measurement, errors, determinant and indeterminant errors. Standard derivation. Reporting analytical data, Statistical evaluation of data significant figure and its rounding off. Test of significance, rejecting of a result Q-test.

UNIT-III

Use of spreadsheets in analytical chemistry: Spreadsheets and their use, control charts, Statistics for small data sets, linear least square method, plotting right standard straight line, correction coefficient and coefficient of determination. Use of spreadsheet for plotting calibration, --- slops and intercepts and coefficient of determination LINSET for additional statics

UNIT-IV

Environmental sampling and qualitative analysis: Getting a meaningful sample, air sample collection and qualitative analysis, water sample collection and qualitative analysis, soil sample sediment sample. Sample preparation for trace organic contaminated land sites, EPA (Environmental protection agencies)- methods and performance based analysis.

UNIT-V

Thermal methods of analysis- Thermometric titration, thermogravimetric analysis, Activation analysis.

Books recommended:

1. Vogels textbook of quantitative analysis, sixth edition, Pearson education.
2. Analytical chemistry, 7th edition by Skoog, West and Holler, Harcourt college publishers
3. Quantitative chemical Analysis, Eighth edition by Daniel C. Harris, Publish by Clany Marshall

SEMESTER-III
CHEM 634 D: Modern analytical methods

Time: 3 Hrs.

M.M. 70 marks (External)
30 marks (Internal)
Credits = 4

UNIT-I

Electrochemical methods of analysis: Electrochemical reduction and oxidation, electrode materials, cathode materials, Polarisable and non Polarisable electrodes. Theory of electrochemical oxidations and reductions possible path for electroreduction reactions, Conductometry and high frequency titrations

UNIT- II

Refractometric and interferometric: Principle of refractometric, parameters influencing refraction, significance of critical angle during measurement, refractometer, Qualitative and quantitative analysis

Interferometer: Principle and application

UNIT- III

Chemiluminescence, Atomic fluorescence and ionization spectroscopy- luminescence, Chemiluminescence, measurement of Chemiluminescence quantitative analysis thermoluminescence titrations, chemiluminescence of liquids, electro Chemiluminescence,

Atomic fluorescence principle and applications instruments for Atomic fluorescence, ionization spectroscopy, laser enhanced ionization spectroscopy.

UNIT-IV

Chemical sensor/biosensor: Classification of sensors, sensitivity and limits of detection, signal and noise, significance of sensors. Electrochemical sensors, Gas sensor, voltametric sensor, solid

state electrode sensor, optical sensor, thermal sensor, bio sensor, bio catalytic bio sensor, mass sensitive sensor, efficiency of sensor

UNIT – V

Flow Injection analysis: Characteristics of physical parameters of a flow injection analysis system, Single line FIA spectrometric determination of chloride, three line FIA spectrometric determination of phosphate.

Books recommended:

1. Vogels' textbook of quantitative analysis, sixth edition, Pearson education.
2. Analytical chemistry, 7th edition by Skoog, West and Holler, Harcourt college publishers
3. Quantitative chemical Analysis, Eighth edition by Daniel C. Harris, Publish by Clany Marshall

SEMESTER-III
CHEM 635: Core practical-V
(Inorganic Chemistry and Spectral Problems)

M.M. 70 marks (External)
30 marks (Internal)
Credits 4

Time 8h

1. Inorganic preparation (minimum -10)

- I. $\text{Na}[\text{Cr}(\text{NH}_3)_2(\text{SCN})_4]$
- II. $\text{Mn}(\text{acac})_3$
- III. $\text{K}_3[\text{Fe}(\text{C}_2\text{O}_4)_3]$
- IV. Prussian Blue, Turnbull's Blue.
- V. $\text{Co}[(\text{NH}_3)_6][\text{NO}_2]_6$
- VI. $\text{Cis-}[\text{Co}(\text{trien})(\text{NO}_2)_2]\text{Cl}\cdot\text{H}_2\text{O}$
- VII. $\text{Hg}[\text{Co}(\text{SCN})_4]$
- VIII. $[\text{Co}(\text{Py})_2\text{Cl}_2]$
- IX. $[\text{Ni}(\text{NH}_3)_6]\text{Cl}_2$
- X. $\text{Ni}(\text{dmg})_2$
- XI. $[\text{Cu}(\text{NH}_3)_4]\text{SO}_4\cdot\text{H}_2\text{O}$
- XII. $\text{VO}(\text{acac})_2 \cdot \text{TiO}(\text{C}_9\text{H}_8\text{NO})_2 \cdot 2\text{H}_2\text{O}$
- XIII. $\text{Cis-K}[\text{Cr}(\text{C}_2\text{O}_4)_2(\text{H}_2\text{O})_2]$

2. Spectral problems- (Minimum -15)

Identification of organic and inorganic compounds by the analysis of their spectral data (UV, NMR, IR and Mass)

3. Titrimetric estimation of drugs: (minimum 3)

Paracetamol, Ascorbic acid, Aspirin, Sulpha drugs, Benzocaine etc.

SEMESTER-III
CHEM 636 A: DSE-I (P)
(Inorganic Chemistry)

M.M. 70 marks (External)
30 marks (Internal)
Credits 4

Time 8 h

1. Quantitative analysis I (Minimum-5)

Volumetric determination of two components (binary) mixture containing any two of the following;

- I. Copper and Zinc
- II. Tin and Lead
- III. Lead and Cadmium
- IV. Tin and Cadmium
- V. Chromium and Iron
- VI. Calcium and Magnesium, etc.

2. Quantitative analysis II (minimum-4)

Volumetric determination of ores and alloys such as dolomite, pyrolusite, marble solder, brass, Zinc Sludge etc.

3. Spectrophotometry II (minimum-4)

- I. Study of Complex formation by Jobs, Mole ratio and slope ratio method
- II. Stability constant by Bjerrum's method.
- III. Stability constant by Turner-Anderson method

4. Chromatographic separations

- I. Cadmium and zinc

II. Zinc and magnesium

III. Thin layer chromatography; Separation of nickel, manganese, cobalt and zinc,

a. Determinations of R_f values.

IV. Separation and identification of the sugars present in the given mixture of

a. glucose, fructose and sucrose by the paper chromatography and determination of R_f values

5. Magnetochemistry (one exercise) -

I. Determination of magnetic susceptibility and moment by Gouy's method.

SEMESTER-III
CHEM 636 B: DSE-I (P)
(Organic Chemistry)

M.M. 70 marks (External)
30 marks (Internal)
Credits 4

Time 8 h

1. Qualitative Analysis (Minimum-5)

Separation, Purification and identification of compounds in a ternary mixture of three organic compounds (three solids or two solids one liquid), Separation by ether, NaHCO_3 , dil NaOH, Preparation of their suitable derivatives wherever possible

2. Organic Synthesis (Minimum-3)

The exercise should illustrate the use of organic reagents and may involve purification of the products by Chromatographic technique

I. Photochemical Reaction

II. Benzophenone- Benzpinacol- Benzpinacolone

III. Beckmann Rearrangement-

Benzophenone- Benzophenone Oxime- Benzanilide- Benzoic Acid Acetophenone- Acetophenone Oxime- Acetanilide- p- Nitroacetanilide, p-Bromoacetanilide

IV. Hoffmann and Sandmeyer Reaction

Phthalic anhydride- Phthalimide- Anthranilic acid- o-Chlorobenzoic acid Benzilic Acid Rearrangement Benzoin- Benzil- Benzilic Acid

3. Spectrophotometric Estimation (Minimum-4)

I. Amino Acids

II. Proteins

III. Carbohydrates

IV. Cholesterol

V. Ascorbic Acid

VI. Aspirin

VII. Caffeine

SEMESTER-III
CHEM 636 C: DSE-I (P)
(Physical Chemistry)

M.M. 70 marks (External)
30 marks (Internal)
Credits 4

Time 8 h

1. Chemical Kinetics

I. Study the reaction between potassium persulphate and potassium iodide and find out the order of reaction also effect of Temperature and Concentration of salt.

II. Study the kinetics of reaction between glycolic acid and ceric ammonium sulphate and find out the order of reaction with respect to ceric ammonium sulphate and glycolic acid and find out effect of Temperature and Concentration of salt.

III. Determination of the rate constant for the oxidation of iodide ions by hydrogen peroxide (the kinetics of an iodine clock reaction.)

2. Potentiometry

I. Determination of the valency of mercurous ions potentiometrically

II. Determine the strength of strong and weak acids in a given mixture using a potentiometer/pH meter

III. Determination of the dissociation constant of acetic acid in DMSO, DMF, acetone and dioxane by titrating it with KOH.

IV. Determination of the dissociation constant of monobasic or dibasic acid.

V. Determine the dissociation constant of acetic acid potentiometrically.

VI. Titrate a mixture of strong acid (hydrochloric acid) and dibasic acid (oxalic acid) versus sodium hydroxide.

VII. Titrate a solution of Mohr's salt against potassium permanganate/potassium dichromate

potentiometrically.

VIII. Titrate potentiometrically solutions of mixture of $\text{KCl} + \text{KBr} + \text{KI}$ and determine the composition of each component

IX. Determination of the formation constant of copper - ammonia complex and stoichiometry of the complex potentiometrically

X. Determination of activity and activity coefficient of electrolytes

SEMESTER-III
CHEM 636 D:DSE-I (P)
(Analytical Chemistry)

M.M. 70 marks (External)
30 marks (Internal)
Credits 4

Time 8 h

1. Estimation of Ca, Na and K by Flame photometry
2. Separation of amino acids by ion exchange and chromatographic method
3. Analysis of oils and fats and determine saponification value and iodine values
4. Determination of fats, protein and solid in milk
5. Polarimetric estimation of sugar
6. Analysis of HCl extract of fusion with Na_2CO_3 for Al, Fe, Ca, Mg, P and K
7. Analysis of fertilizers
8. Estimation of lead and tin in solder or bismuth, cadmium and lead in low melting alloys such as Woods metal using EDTA (Volumetrically)
9. Analysis of German silver (copper, zinc and nickel).

Books recommended:

1. Experiments in chemistry by D.V. Jahagirdar, Himalaya Publishing House
2. Instrumental Methods of Chemical Analysis B. K. Sharma

SEMESTER IV
CHEM 641: Special Methods of Analysis

Time: 3 Hrs.

M.M. 70 marks (External)

30 marks (Internal)

Credits = 4

UNIT-I

- (a) **Thermo Gravimetry Analysis (TGA) and Derivative.** Thermogravimetry (DTG): Principle, instrumentation and application, factor affecting TG curves,
- (b) **Differential Thermal Analysis (DTA):** Principle, instrumentation and application, factor affecting TA curves
- (c) **Differential Scanning Calorimeter (DSC):** Principle, instrumentation and application, factor affecting DC curves, comparison with DTA.

UNIT-II

- (a) **D.C.Polarography:** Basic principle, types of currents, experimental technique, Illovic equation (no derivation) and application of polarography
- (b) Principle, technique and application of
- (i) Voltametric and cyclic voltametry
- (ii) Amperometry
- (iii) Anodic stripping voltametry

UNIT-III

- (a) **High Performance Liquid Chromatography (HPLC):** Introductory knowledge of adsorption basic principle, instrumentation and applications of HPLC, comparison with gas liquid chromatography
- (b) **Gas Liquid Chromatography:** Principle, instrumentation and applications

(c) **Gel Permeation or Size Exclusion Chromatography:** Introduction, theory and application

UNIT-IV

(a) **Ion Exchange:** Introduction, types-cationic, anionic, chelating and liquid ion exchangers, preparation, action and properties of exchangers and applications of ion exchangers

(b) Solvent Extraction, ion association complexes

(c) **Gel Electrophoresis:** Introduction, Factors affecting ionic migration, detection of separated components and applications of Gel electrophoresis.

UNIT-V

(a) **Radioactive Technique:** Tracer technique, neutron activation analysis, counting technique such Geiger-Muller, ionization and proportional counters

(b) **Light Scattering Techniques:** Principle, instrumentation and applications of nephelometry and Raman spectroscopy.

Books recommended:

1. Ion exchange separations in Analytical Chemistry. O.Samuelson, John Wiley
2. Exchangers and Solvent Extractions, J.A.Marinsky and Y.Parcus, Marcel Dekker
3. Polagraphic Techniques, I.Metes, Interscience
4. Gel Chromatography, Tibor Kremmer and Laszol Boross, Wiley.

SEMESTER IV
CHEM 642: Photochemistry and Supramolecules

Time: 3 Hrs.

M.M. 70 marks (External)

30 marks (Internal)

Credits = 4

UNIT-I

Basic of Photochemistry: Photochemical laws, quantum yield, electronic excitation and molecular orbital view of excitation, excited states and fate of excited molecules (modified Jablonski diagram).

Photochemistry of alkenes: Intramolecular reactions of the olefinic bond-geometrical isomerism, cyclisation reactions, rearrangement of 1, 4-and 1, 5-dienes.

UNIT-II

Photochemistry of carbonyl compounds: Intramolecular reactions of carbonyl compounds - saturated, cyclic and acyclic, β , γ - unsaturated and α,β -unsaturated compounds, cyclohexadienones, intermolecular cycloaddition reactions- dimerisations and oxetane formation.

Photochemistry of aromatic compounds: Isomerisations, additions and substitutions.

Unit III

Miscellaneous Photochemical Reactions: Photo-Fries reactions of anilides. Photo Fries rearrangement, Barton reaction, Hoffmann-Loeffler-Freytag reaction, Singlet molecular oxygen reactions, Photochemical formation of smog, Photo degradation of polymers, Photochemistry of vision.

UNIT-IV

Supramolecular Chemistry: Concepts: Definition and development, nature of supramolecular interactions, Cation binding hosts: Crown ethers, cryptands and spherands - synthesis and properties, binding of anions: biological anion receptors and organometallic receptors, Templates

and selfassembly-tennis balls and soft balls, catenanes and rotaxanes, Supramolecular chemistry of Fullerene, fullerene as guests, fullerene as hosts and fullerene as superconducting intercalation compounds, supramolecular photochemistry.

UNIT-V

Nanochemistry

Introduction, Synthesis of nanomaterials: Chemical methods. Dendrimers. Nanostructured materials: Carbon Nanotubes (CNTs) : Single walled carbon nanotubes (SWNTs), Multiwalled carbon nanotubes (MWNTs), Graphenes. Characterization techniques for Nanomaterials: Optical Microscopy: Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Scanning tunnel microscopy (STM).

Books Recommended:

1. Photochemistry, J.G.Cavert and J.N.Pitts, Wiley
2. Molecular Photochemistry, N.J.Turro, Benjamin
3. Fundamentals of Photochemistry, K.K. Rohatgi Mukherji, New Age
4. Photochemistry, R.P. Wayne, Butterworth
5. Analytical Chemistry of Macrocyclic and Supramolecular compounds, S.M. Khopkar
6. Supramolecular Chemistry, J.M. Lehn VCH
7. Supramolecular Chemistry, J.W Stead and J.I. Atwood, John Wiley. G. Timp, Ed. Nanotechnology: Springer-Verlag: N.Y. (1999)
8. Nanochemistry, G.B. Sergeev, Elsevier (2006)
9. Supramolecular and Bioinorganic Chemistry, Rekha Dashora and A. K. Goswami, Pragati Prakashan.

SEMESTER IV
CHEM 643 A: Organometallic Chemistry

Time: 3 Hrs.

M.M. 70 marks (External)
30 marks (Internal)
Credits = 4

UNIT-I

Introduction

Classification and Nomenclature and general Characteristics of Organometallic Compounds

UNIT-II

Organometallic Compounds of transition metals- Introduction and nature of bonding, σ bonded Organometallics, π bonded Organometallics

UNIT-III

Fluxional organometallic compounds: Classification of fluxional organometallic Compounds, Some simple example of non-rigid molecule in different coordination geometries.

UNIT-IV

Synthetic and catalytic aspects of Organometallic Chemistry: General Introduction, Transition metal organometallics as catalytic and synthetic reagents

UNIT-V

Biological application and environmental aspect of organometallic compounds: Organometallics in medicine, Organometallics in Industry, Environmental aspects of Organometallic Compounds.

Books Recommended:

1. Principle and Applications of Organotransition Metal Chemistry, J.P. Coliman, L.S Hegsdus, J.R. Norton and R.G. Finke, University Science Books.

2. The Organometallic Chemistry of the Transition Metals, R.H. Crabtree, John Wiley.
3. Metallo-Organic Chemistry, A.J. Pearson, Wiley
4. Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books
5. Bioinorganic Chemistry, I. Bertini, H.B. Gray, S.J. Lippard and J.S. Valentine, University, Science Books
6. Inorganic Biochemistry Volume I and II. Ed G.L. Eichhorn, Elsevier
7. Progress in Inorganic Chemistry, Volume 18 and 38 Ed. J.J. Lippard, Wiley

SEMESTER-IV
CHEM 644 A: Inorganic polymers

Time: 3 Hrs.

M.M. 70 marks (External)

30 marks (Internal)

Credits = 4

UNIT-I

Inorganic polymers: Introduction, Classification, Preparation, General Characteristics of Inorganic Polymers.

UNIT II

Silicon Polymers: General preparation, properties and application of silazanes, polysilazanes, organo-siloxy and poly-carbosilanes

UNIT III

Phosphorus nitrogen polymers: Synthesis and important properties of organometallic polyphosphazenes, Liquid crystalline high refractive index polyphosphazenes, poly carbophosphazenes, polynitrophosphazenes

UNIT IV

Metal chelate polymers and Ferrocenes: Synthetic methods, linking of ligands with metal ions, Reactions with chelates containing fluxional groups, Synthesis of Ferrocenes containing polyamides and polyurea polymers

UNIT V

Applications of Phosphorous, Nitrogen, Silicon and Ferrocene as well as other metal chelate polymers in industry such as advanced elastomers and biomedical materials.

SEMESTER-IV
CHEM 643 B: Medicinal Chemistry

Time: 3 Hrs.

M.M. 70 marks (External)

30 marks (Internal)

Credits = 4

UNIT I

Drug Design: Development of new drugs, procedures followed in drug design, concepts of lead compound and lead modification, concepts of prodrugs and soft drugs, structure-activity relationship (SAR), factors affecting bioactivity, resonance, inductive effect, isosterism, bio-isosterism, spatial considerations. Theories of drug activity- occupancy theory, rate theory, induced fit theory. Elementary idea of Quantitative structure activity relationship, Concepts of drug receptors. Elementary treatment of drug receptor interactions. Physico-chemical parameters: lipophilicity, partition coefficient, electronic ionization constants, steric, Free-Wilson analysis, Hansch analysis, LD-50, ED-50 (Mathematical derivations of equations excluded).

UNIT II

Pharmacokinetics: Introduction to drug absorption, disposition, elimination using pharmacokinetics, important pharmacokinetic parameters in defining drug disposition and in therapeutics. Mention of uses of pharmacokinetics in drug development process.

Pharmacodynamics: Introduction, elementary treatment of enzyme stimulation, enzyme inhibition, sulphonamides, membrane active drugs, drug metabolism, xenobiotics, biotransformation, significance of drug metabolism in medicinal chemistry.

UNIT III

Antineoplastic Agents: Introduction, cancer chemotherapy, special problems, role of alkylating agents and antimetabolites in treatment of cancer. Mention of carcinolytic antibiotics and mitotic inhibitors.

Synthesis of mechlorethamine, cyclophosphamide, melphalan, uracil, mustards, and 6-mercaptopurine. Recent development in cancer chemotherapy. Hormone and natural products.

Cardiovascular Drugs: Introduction, cardiovascular diseases, drug inhibitors of peripheral sympathetic function, central intervention of cardiovascular output. Direct acting arteriolar dilators. Synthesis of amyl nitrate, sorbitrate, diltiazem, quinidine, verapamil, methyldopa, atenolol, oxyprenolol.

UNIT IV

Local Antiinfective Drugs: Introduction and general mode of action. Synthesis of sulphonamides, furazolidone, nalidixic acid, ciprofloxacin, norfloxacin, dapsone, amino salicylic acid, isoniazid, ethionamide, ethambutal, fluconazole, econazole, griseofulvin, chloroquin and primaquin. Antibiotics Cell wall biosynthesis, inhibitors, (3-lactam rings, antibiotics inhibiting protein synthesis. Synthesis of penicillin G, penicillin V, ampicillin, amoxycillin, chloramphenicol, cephalosporin, tetracyclin and streptomycin.

UNIT V

Psychoactive Drugs (The Chemotherapy of Mind): Introduction, neurotransmitters, CNS depressants, general anaesthetics, mode of action of hypnotics, sedatives, anti-anxiety drugs, benzodiazepines, buspirone, neurochemistry of mental diseases. Antipsychotic drugs - the neuroleptics, antidepressants, butyrophenones, serendipity and drug development, stereochemical aspects of psychotropic drugs. Synthesis of diazepam, oxazepam, chlorazepam, alprazolam, phenytoin, ethosuximide, trimethadione, barbiturates, thiopental sodium, glutethimide

Books Recommended:

1. Introduction to Medicinal Chemistry, A Gringuage, Wiley-VCH.
2. Wilson and Gisvold's Text Book of Organic Medicinal and Pharmaceutical Chemistry, Ed Robert F. Dorge.

3. An Introduction to Drug Design, S. S. Pandeya and J. R. Dimmock, New Age International.
4. Burger's Medicinal Chemistry and Drug Discovery, Vol-1 (Chapter-9 and Ch-14), Ed. M. E. Wolff, John Wiley.
5. Goodman and Gilman's Pharmacological Basis of Therapeutics, McGraw-Hill.
6. The Organic Chemistry of Drug Design and Drug Action, R. B. Silverman, Academic Press.
7. Strategies for Organic Drug Synthesis and Design, D. Lednicer, John Wiley.

SEMESTER IV
CHEM 644 B: Chemistry of Natural Products

Time: 3 Hrs.

M.M. 70 marks (External)

30 marks (Internal)

Credits = 4

UNIT-I

Terpenoids and carotenoids: Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule, structure determination, stereochemistry, biosynthesis and synthesis of the following representative molecules - Citral, Geraniol, α -Terpineol, Menthol, Farnesol, Zingiberene, Santonin, Phytol, Abietic acid and β -Carotene

UNIT-II

Alkaloids: Definition, nomenclature and physiological action, occurrence, isolation, general methods of structure elucidation, degradation, classification based on nitrogen heterocyclic ring, role of alkaloids in plants, structure, stereochemistry, synthesis and biosynthesis of following - Ephedrine, (+) - Coniine, Nicotine, Atropine, Quinine and Morphine.

UNIT-III

Plant pigments: Occurrence, nomenclature and general methods of structure determination, isolation and synthesis of Apigenin, Luteolin, Quercetin, Myrcetin, Quercetin-3-glucoside, Vitexin, Diadzein, Butein, Aureusin, Cyanidin-7, arabinoside, Cyanidin and Hirsutidin.

Biosynthesis of flavonoids: acetate pathway and shikimic acid pathway.

Porphyrins: Structure and synthesis of hemoglobin and chlorophyll.

UNIT-IV

Steroids: Occurrence, nomenclature, basic skeleton, Diel's hydrocarbon and stereochemistry, isolation, structure determination and synthesis of Cholesterol, Bile acids, Androsterone, Testosterone, Estrone, Progesterone, Aldosterone, biosynthesis of steroids.

UNIT-V

Prostaglandins: Occurrence, nomenclature, classification, biogenesis and physiological effects, synthesis of PGE₂ and PGF_{2α}

Pyrethroids and Rotenones: Synthesis and reactions of pyrethroids and rotenones.

Books Recommended-

1. New Trends in Natural Products Chemistry, Atta-ur-Rahman and M.I. Choudhary.
2. Chemistry of Natural Products, S.N. Bhat
3. Organic Chemistry Vol.-II, I.L. Finar

SEMESTER-IV
CHEM 643 C: Advanced Photochemistry and Radiation Chemistry

Time: 3 Hrs.

M.M. 70 marks (External)

30 marks (Internal)

Credits = 4

UNIT-I

Photochemistry: Molecular photochemistry: An overview: Transitions between states (Chemical, classical and quantum dynamics, vibronic states). Potential energy surfaces; transitions between potential energy surfaces, The Franck-Condon Principle and radiative transitions. A classical model of radiative transitions. The absorption and emission of light - state mixing, spin-orbit coupling and spin forbidden radiative transitions, absorption complexes, delayed fluorescence and phosphorescence.

UNIT-II

Photophysical radiation less transitions: Wave mechanical interpretation of radiationless transitions between state factors that influence the rate of vibrational relaxation. Energy transfer: Theory of radiation less energy transfer, energy transfer by electron exchange: An overlap or collision mechanism. The role of energetic in energy transfer mechanism. Diffusion controlled quenching. The Perrin formulation. Triplet- triplet, triplet-singlet, singlet-triplet energy transfer. Multiphoton energy transfer processes, reversible energy transfer.

UNIT-III

Radiation Chemistry: An overview, G-value. The mechanism of interaction of high energy radiation with matter, Photoelectric effect, Compton effect, Pair production, total absorption coefficient, excitation and ionization, Stopping power and linear energy transfer.

UNIT-IV

Radiation dosimetry: Radiation dose and its measurement, standard free air chamber method, chemical dosimeter (Frick's Dosimeter). Short lived intermediates (ions, excited molecules, free

radicals: Various mechanisms of their formation and energy transfer processes).

UNIT-V

Flash photolysis: Principle and its applications. Radiolysis of water and aqueous solutions. Radiolysis of molecules of biological interest (carbohydrates, amino acids, peptides, and nucleic acids).

Books Recommended:

1. Turro, N. J. Modern Molecular Photochemistry Univ. Science Books (1991).
2. Gilbert, A. & Baggot, J. Essentials of Molecular Photochemistry Blackwell Scientific (1990)
3. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 8th Ed., Oxford University Press (2006).
4. McQuarrie, D. A. & Simon, J. D. Physical Chemistry: A Molecular Approach 3rd Ed., Univ. Science Books (2001).

SEMESTER-IV
CHEM 644 C: Solid State Chemistry

Time: 3 Hrs.

M.M. 70 marks (External)

30 marks (Internal)

Credits = 4

UNIT I

General principles and experimental procedures to study solid state reactions

Difference between reactions in solution, gaseous and solid state phase

UNIT II

Crystal Defects-perfect and imperfect crystals, intrinsic and extrinsic defect, point defects, line and plane defects, Thermodynamics of Schottky and Frenkel defect formation, color centers.

UNIT III

Electronic Properties and Band Theory of metals, insulators and semiconductors, band theory of solids (qualitative treatments), band structure of metals, insulators and semiconductors, p-n junctions

UNIT IV

Superconductors, magnetic properties, persistent current and BCS theory of Superconductors,

Optical properties- photoconduction

UNIT V

Magnetic Properties: Classification of materials, Magnetic domains, hysteresis loop.

Electrically conducting organic solids, organic charge transfer complex, new superconductors

Books Recommended:

1. Solid State Chemistry and its Applications, A. R. West, Plenum.

2. Principles of the Solid State, H. V. Keer, Wiley Eastern.
3. Solid State Chemistry, N. B. Hannay.
4. Solid State Chemistry, D. K. Chakrabarty, New Age International

SEMESTER-IV
CHEM 643 D : Analytical Techniques

Time: 3 Hrs.

M.M. 70 marks (External)

30 marks (Internal)

Credits = 4

UNIT- I

Food analysis: Reason for analysis of food, analysis of moisture in food materials, analysis of ash, crude fibers, fats, proteins and carbohydrates in food. analysis of calcium and sodium, adult erants and contaminants in food, microscopic examination of food, extraction, purification and estimation of pesticides samples in food by HPLC, TLC for chlorinated pesticides in food products, gel chromatic analysis of food products for orgnophosforos

UNIT-II

Cement: Introduction raw material for cement, Portland cement, weathering of cement and concrete, other types of cement, chemical admixture of concrete, analysis of constituents of cement by various methodology

UNIT-III

Analysis of polymers: Introduction, types of polymers and their uses, chemical analysis of polymers spectroscopic methods for polymer analysis X-ray diffraction analysis, microscopy, thermal analysis of polymers, physical testing of polymers

UNIT-IV

Electrogravimetric analysis: Principles involving electrogravimetric analysis, current voltage relationship during electrolysis, effect of experimental variables, anodic deposition, instrumentations electrolysis at constant current principle and instrumentation, estimation of copper and cobalt by constant current electrolysis, electrolysis at constant potential, principle instruments and application determination copper lead and tin in brass sample by control potential method, electrolysis using mercury electrode principle and applications

UNIT-V

Voltametry: Principle and application of voltametric analysis, Amperometric analysis

Books recommended:

1. Analytical Chemistry by Gurdeep R. Chatwal, Himalaya Publishing House
2. Analytical chemistry, 6th edition by Gary D. Christian, Wiley student Edition.
3. Analytical Chemistry by S.M. Khopkar, New Age International.

SEMESTER-IV
CHEM 644 D: Applied Analytical Methods

Time: 3 Hrs.

M.M. 70 marks (External)
30 marks (Internal)
Credits = 4

UNIT- I

Soil analysis: Introduction, type of soils, analysis of moisture, determination of pH, total nitrogen, phosphorous, silica, magnesium, manganese, lime, sulphur and salts in soil. Quantitative estimation

UNIT-II

Analysis of water pollutants: Water pollution, water pollutants, origin and source of water pollutions effect of water pollutants, Analysis of water, colour turbidity, TDS, total solids, conductivity, acidity/ alkalinity and hardness, Chloride, sulphate and fluoride in water, analysis of silica phosphate and heavy metals pollutants in water. Determination of DO, BOD, COD

Separation and estimation of herbicides as water pollutants, water quality standards, drinking water standards

UNIT-III

Fuel analysis

Fuels types and classifications, solid, liquid and gaseous fuels, producer gas, natural gas, calorific value of fuel, analysis of coal, proximate analysis, ultimate analysis, grading of coal, aniline point, flash point and free point, octane number and its significance

UNIT-IV

Clinical analysis:

Composition of blood, collection and preservation of samples immunoassay principal of radioimmunoassay (RIA) and its applications serum electrolytes, test for carbohydrates, blood glucose blood urea uric acid blood urea nitrogen total serum proteins, serum albumin, non-protein nitrogen (serum creatinine), serum phosphate, alkaline phosphatase, bilirubin, serum cholesterol, trace elements in body

UNIT-V

Drug analysis: Introduction, sources of drugs, dangerous drug, narcotics, classification of drugs, assay of drugs, drug screening by gas chromatography, thin layer chromatography of drugs, analysis of drugs by spectrophotometric methods

Books recommended:

4. Analytical Chemistry by Gurdeep R. Chatwal, Himalaya Publishing House
5. Analytical chemistry, 6th edition by Gary D. Christian, Wiley student Edition.
6. Analytical Chemistry by S.M. Khopkar, New Age International.

SEMESTER-IV

CHEM - 645: Core Practical - VI
(Polymer synthesis, Extraction of natural products and coal analysis)

Time 8h

M.M. 70 marks (External)

30 marks (Internal)

Credits 4

1. Extraction of organic compounds from natural sources (Minimum-5)

I. Isolation of caffeine from tea leaves.

II. Isolation of casein from milk (the students are required to try some typical colour reactions of proteins).

III. Isolation of lactose from milk (purity of sugar should be checked by TLC and PC and R_f value reported).

IV. Isolation of nicotine dipicrate from tobacco.

V. Isolation of piperine from black pepper.

VI. Isolation of lycopene from tomato.

2. Polymer synthesis (Minimum-5)

I. Preparation of Urea formaldehyde

II. Preparation of Phenol formaldehyde

resins III. Preparation of Thiol rubber

IV. Preparation of Condensation polymer V. Preparation of Epoxy resin

VI. Preparation of Polymerisation of acrylonitrile

VII. Preparation of Solution polymerization of vinyl acetate

VIII. Preparation of free radical polymer

3. Coal Analysis

I. Moisture contents/Volatile matter-C-Coal Analysis

II. Ash contents

III. Fixed carbon

SEMESTER-IV
CHEM 646 A : DSE- II (P)
(Inorganic Chemistry)

Time 8h

M.M. 70 marks (External)
30 marks (Internal)
Credits 4

1. Quantitative analysis by Spectrophotometry (minimum-4)

- I. Iron/Manganese/Chromium/Vanadium in steel sample by spectrophotometric method
- II. Nickel/Molybdenum/Tungsten/Vanadium/Uranium by extractive spectrophotometric method.
- III. Fluoride/Nitrite/Phosphate.
- IV. Barium/Sulphate by turbidimetric method

2. Quantitative analysis I (one)

- I. Volumetric determination of three components (ternary) mixture from synthetic mixture, Ores and minerals, Alloys like German Silver, Cement etc.
- II. Simultaneous estimation of Cr(III) and Fe(III) by EDTA titration, Ca^{+2} and Zn^{+2} , Pb^{+2} and Mg^{+2}

3. Solvent extraction (any one)

- I. Uranyl nitrate from thorium nitrates with the help of tributyl phosphate
- II. Separation of metal from a mixture
- III. Study of the solvent extraction of Hg and Al with 8-hydroxyquinoline.

4. Atomic absorption Spectroscopy (any one)

- I. Determination of components of Soil, Cement and industrial wastes etc.

5. Study of thermal properties (two)

- I. Interpretation of TGA, DTA, DSC etc curves

SEMESTER-IV
CHEM 646 B : DSE-II (P)
(Organic Chemistry)

Time 8 h

M.M. 70 marks (External)
30 marks (Internal)
Credits 4

1. Quantitative Analysis

- I. To estimate the percentage of Nitrogen in the given organic sample by Kjeldahl's method.
- II. To estimate Halogen in the given sample by Alkaline Reduction method (Modified Stepenow method).
- III. To estimate the percentage of Sulfur in the given organic sample by Messenger's method.

2. Synthesis of Organic Compounds

- I. Fisher- Indole Synthesis-**
Preparation of 2-phenylindole or 2-methylindole or 1, 2, 3, 4-tetrahydro carbazole
- II. Enzymatic Reduction-**
Reduction of ethyl acetoacetate using Baker's yeast to yield enantiomeric excess of S(+) ethyl-3-hydroxy butanoate and to determine its optical purity.
- III. Synthesis using microwaves-** Benzoic acid, Chalcones, Coumarin, synthesis of simple heterocyclic compound
- IV. Synthesis using phase transfer catalyst-** Alkylation of diethyl malonate or ethyl acetoacetate with alky halides.
- V. Diels Alder reaction**
- VI. Ultrasound assisted reaction-** Esterification, saponification

3. Miscellaneous experiments

- I.** Estimation of glycine (Sorensens method)
- II.** Estimation of formaldehyde
- III.** Estimation of cane sugar

SEMESTER-IV
CHEM 646 C : DSE –II (P)
(Physical Chemistry)

Time 8h

M.M. 70 marks (External)
30 marks (Internal)
Credits 4

1. Surface Tension

- I. Determination of atomic Parachor value of Hydrogen, Carbon and Oxygen
- II. To study surface tension-concentration relationship for solutions (Gibb's equation)
- III. Compare different commercial available detergents by surface tension study.

2. Spectrophotometry

- I. Determine the concentrations of KMnO_4 and $\text{K}_2\text{Cr}_2\text{O}_7$ in a mixture by the MLRA method.
- II. Determine the dissociation constant of an indicator spectrophotometrically.
- III. Study the kinetics of reaction between acetone and iodine in presence of acid.
- IV. Record the U.V. spectrum of a given compound (acetone) in cyclohexane
- A. Assign the transitions by recording spectra in solvents of different polarities (H_2O , CH_3OH , CHCl_3 , CH_3CN and 1, 4-dioxane). Comment on the energy of hydrogen bonding.
- B. Calculate the energy involved in the electronic transition in different units, i.e. cm^{-1} , Joules/mol, cal/mol. & eV.
- C. Calculate the oscillator strength/ transition probability.

3. Phase equilibrium

- I. Determination of congruent composition and temperature of a binary system (e.g. diphenylamine-benzophenone system).
- II. Determination of glass transition temperature of a given salt (e.g CaCl_2) conductometrically.

SEMESTER-IV
CHEM 646 D :DSE-II (P)
(Analytical Chemistry)

Time 8h

M.M. 70 marks (External)
30 marks (Internal)
Credits 4

1. Determination of Ca, Mo, Zn, Cu, phosphate and silica contents of soil samples
2. Analysis of sludge obtained from Zinc Smelter
3. Analysis of cement
4. Determination of water in mixture by Karl-Fisher method
5. Colorimetric estimation of fluoride, Fe in drinking waters
6. Analysis of aspirin, sulpha drugs and vitamin C
7. Potentiometric estimation of Ni, Zn, etc.
8. Analysis of Lime, Brass and gun metal
9. Estimation of soluble salts in soils by conductometric method
10. Separation and identification of most common acidic and basic drugs by TLC

Books recommended:

1. Instrumental Methods of analysis, 7th edition, CBS Publishers and distributors
2. Instrumental Methods of chemical analysis, 3rd edition by Galen W. Ewing, International student edition.
3. Principles and practice of Analytical chemistry by F.W. Fifeild and D. Kealey, Blackwell Publishing.

Skilled Enhancement course- I

CHEM-627 A: Information and communication Technology skill (ICT)

Practical training of following topics and to acquire the skills mentioned must be provided to the participants of the course

Use of video and Online Resources: 10 hrs

Assignments/ Self study: 60 hrs

Skill test and presentations: 10 hrs

Topics	Lab work and skills
Identification of various components of a computer system	Identify mother board, CPU, Memory, various pots and connectors, drives, keyboards, mouse, types of monitors and its connection to computer, hardware specifications Skill: Identification of various components of a PC and writing specification of a computer
Operating a computer system	Desktop, using help, My computer, folders and files, word pad, copy, save and print Skill: Operation of a PC
Word Processing	Creating, New documents, Entering Text, saving, closing and opening files, editing & formatting, Cut, copy and paste, search and replace, insert page number, date, picture, page layout, spell and grammar check, Headers and footer. Footnoting, table of contents, table, mail merge, mailing labels using menu items etc. Skill: Preparation of a given document
Spreadsheet	Creating and editing a Workbook using charts, managing workbook. Candidates should be trained to create, enter and edit data, save and close workbook, change column width, moving, centering and merging cells, using formulae, using functions, formatting worksheet, creating charts, printing Skill: Preparation of Invoice, balance sheet, plotting selected columns of a table etc.
Database Management System	Creating a database, modifying table, creating forms, queries and reports. Candidates should be trained in creating, data entry, close and open table and database. Customizing and inserting fields, sorting, form wizard, adding records, using queries, creating and printing reports. Skill: Prepare Telephone directory, catalogue and making
Presentation Graphics	Creating, modifying and refining presentation, using advanced presentation features. Skill: Prepare a good presentation on given topic

Internet and Personal Information Management	Internet and Intranet, Browsers and finding information, URL's, search services, e-mail, checking internet connection. Using calendar for appointment, creating and managing task, address book and its management. Skill: Creation of mailing list, preparing appointment and tasks
Web Authoring and IT work	Creating a web page using HTML editor, Modifying and refining web page, inserting hyperlink, changing theme and layout, inserting images, publishing web page Skill: Creating and Publishing a web page Installation of software including antivirus software, Printer and other devices, Installing of Software including antivirus software. Printer and other devices, Installing and using image scanner, CD writing, creating PDF files, Using FTP, using Google Drive Skill: Preparing a PC for office by installing necessary software

CHEM-627 B : Scientific Writing Skill

Practical training of following topics and to acquire the skills mentioned must be provided to the participants of the course

Lab Work & Lecture: 30 hrs

Use of video and Online Resources: 20 hrs

Assignments/ Self study: 60 hrs

Skill test and presentations: 10 hrs

Topics	Lab work and skills
Unit I- Know the language (Basic : English Course)	Choosing the right word, using a dictionary and thesaurus, basic elements of a sentence, clauses, true sentence, tenses, active and passive verbs, punctuation and parallelogram, Paragraphs, logic and organization. Organizational strategies, art of precise writing Reading material will be given Assignments <ol style="list-style-type: none"> 1. Take a science article and reduce it to 1/10th length and make a brief abstract 2. Make a press release for the general masses about a scientific event in your city Skilled learned: writing proper sentences with clarity and brevity.
Unit II Ground work for effective scientific writing	Using web based search engines, authenticating the information, editing in MS office, style analysis programs, data entry and working knowledge of excel, creating tables, figures

	<p>, graphs, photographs and other documentary illustrations, explanatory artwork. An introductory idea about use of abode, photoshop and coral making powerpoint presentation, making and refining presentations using advanced presentation features, making a poster, using a library, indexing systems available for various science streams, e-resources, e-journals, INFLIBNET and Shodhganga</p> <p>Field work: visit to the library</p> <p>Assignments:</p> <ol style="list-style-type: none">1. Make a review of an instrument, technique or technology2. Make a powerpoint presentation on topic of your choice3. Make a poster on selected topic <p>Skill learned: using e-resources and library, making powerpoint presentation and poster</p>
Unit III Start Writing (Part-I)	<p>Introduction –Overview of scientific writing, how is scientific writing different from general writing, know your audience, writing for general public, science reporting, Science news, explanatory writing, lengthy magazine article, popular articles and popular lectures.</p> <p>Reading material: Popular science magazine, articles</p> <p>Assignments:</p> <ol style="list-style-type: none">1. Convert the assignment 3 for general public2. Collect few science news, science magazine articles, popular

	<p>on science and read them in class and critically discuss them.</p> <p>3. Make a report of a practical exercise or a field visit</p> <p>Skill learned: science reporting and writing for common masses.</p>
Unit-IV Start Writing (Part II)	<p>Writing for scientific community, types of paper (short communication, original research article, review), the various components for each type and the content of each components (title, author, affiliation, abstract, key words, introduction, material and methods, results and discussion, conclusion, references and bibliography, citation. Ethics in writing, Plagiarism, plagiarism checker on line.</p> <p>Publishing work: selection of journal, impact factors, h-index, following author guidelines, on line submission, proof reading of a manuscript, understanding the symbols, reviewing of a manuscript, making corrections and answering reviewers query, galey proof reading</p> <p>Assignments:</p> <ol style="list-style-type: none">1. Write a short communication on the given selected practical exercise in given selected journal.2. Peer review the article written by your class mates wit proof reading

	<p>Symbols and on line review tool. Skill learned: writing for scientific community and research journals.</p>
Unit V Start Writing (Part III)	<p>Writing research grant proposal, Book review, write up mini profiles of prominent scientists, letters to editor, opinion writing, interview of a scientist, career in scientific writing</p> <p>Assignments:</p> <ol style="list-style-type: none">1. Frame questions for interview of a well known scientist /or on campus scientists.2. Make a small research grant proposal3. Write a mini profile of a prominent scientist. <p>Skill learned writing research grant, mini profile and drafting interview.</p>

Skill Enhancement Course -II

CHEM-647 A: Green methods in chemistry

Tools of Green chemistry, twelve principles of Green chemistry, with examples.

The following Real world Cases in Green Chemistry should be discussed:

1. A green synthesis of ibuprofen which creates less waste and fewer byproducts (Atom economy)
2. Surfactants for Carbon Dioxide – replacing smog producing and ozone depleting solvents with CO₂ for precision cleaning and dry cleaning of garments.
3. Environmentally safe antifoulant
4. CO₂ as an environmentally friendly blowing agent for the polystyrene foam sheet packaging market.
5. Using a catalyst to improve the delignifying (bleaching) activity of hydrogen peroxide.
6. A new generation of environmentally advanced preservative: getting the chromium and arsenic out of pressure treated wood.
7. Rightfit pigment: synthetic azopigments to replace toxic organic and inorganic pigments.
8. Development of a fully recyclable carpet: cradle to cradle carpeting.

List of experiments (minimum 10)

1. Preparation of acetanilide
2. Synthesis of dibenzalpropanone
3. Bromination of *trans*-stilbene
4. Diels-Alder reaction between furan and maleic acid
5. Benzil-Benzilic acid rearrangement
6. Thiamine hydrochloride catalyzed synthesis of benzoin
7. Clay catalyzed solid state synthesis of 7-hydroxy-4-methylcoumarin

8. Nitration of phenol
9. Bromination of acetanilide
10. Photoreduction of benzophenone to benzopinacol
11. Preparation of benzopinacolone
12. Rearrangement of diazoaminobenzene to *p*-aminoazobenzene
13. Preparation of 1, 1-bis-2-naphthol
14. Synthesis of adipic acid
15. Synthesis of dihydropyrimidinone
16. Microwave-assisted ammonium formate-mediated Knoevenagel reaction
17. Preparation of Manganese (III) acetylacetonate, $\text{Mn}(\text{acac})_3$ or $\text{Mn}(\text{C}_5\text{H}_7\text{O}_2)_3$
18. Preparation of Iron (III) acetylacetonate, $\text{Fe}(\text{acac})_3$ or $\text{Fe}(\text{C}_5\text{H}_7\text{O}_2)_3$
19. Synthesis of tetrabutylammonium tribromide (TBATB)
20. Preparation of ionic liquid, $[\text{pmlm}]\text{Br}$
21. Preparation of 2- phenylbenzothiazoles catalyzed by ionic liquid, $[\text{pmlm}]\text{Br}$

Reference Books:

1. Green Chemistry Experiments A Monograph, R. K. Sharma, Indu Tucker and Mihir K. Chaudhuri, Tucker Prakashan, New Delhi.
2. Manahan S.E. (2005) Environmental Chemistry, CRC Press
3. Miller, G.T. (2006) Environmental Science 11th edition. Brooks/cole
4. Mishra A. (2005) Environmental Studies. Selective and Scientific Books, New
5. Green chemistry: Fundamentals and Applications, Suresh C. Ameta and Rakshit Ameta, Apple Academic Press

CHEM-647 B : Basic Analytical Chemistry

Introduction: Introduction to Analytical Chemistry and its interdisciplinary nature. Concepts of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.

List of experiments (minimum 10):

Analysis of soil: Composition of soil, Concept of pH and pH measurement, Complexometric titration, Chelation, Chelating agents, use of indicators.

- a. Determination of pH of soil samples.
- b. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.

Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods.

- a. Determination of pH, acidity and alkalinity of a water sample.
- b. Determination of dissolved oxygen (DO) of a water sample.

Analysis of food products: Nutritional value of foods, idea about food processing and food preservation and adulteration.

- a. Identification of adulterants in some common food items like coffee powder, asafetida, chilli powder, turmeric powder, coriander powder and pulses, etc.
- b. Analysis of preservatives and colouring matter.

Chromatography: Definition, general introduction on principles of chromatography, paper chromatography, TLC etc.

- a. Paper chromatographic separation of mixture of metal ion(Fe^{+3} and Al^{+3})

b. To compare paint samples by TLC method.

Ion exchange: Column, ion-exchange chromatography etc.

Determination of ion exchange capacity of anion/cation resin (using batch procedure if use of column is not feasible)

Analysis of cosmetics: Major and minor constituents and their function

a. Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate.

b. Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration.

Suggested Applications (Any one):

a. To study the use of phenolphthalein in trap cases.

b. To analyze arson accelerants

c. To carry out analysis of gasoline.

Suggested Instrumental demonstrations:

a. Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry.

b. Spectrophotometric determination of Iron in Vitamin/Dietary Tablets

c. Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in soft Drink.

References:

1. Willard, H.H. *Instrumental Methods of Analysis*, CBS publishers.

2. Skoog & Leery. *Instrumental Methods of Analysis*, Sanders College publications, New York.

3. Skoog, D.A.; West, D.M. & Holler, F.J. *Fundamentals of Analytical Chemistry* 6th Ed. Saunders College Publishing, Fort worth (1992).
4. Harris, D.C. *Quantitative Chemicals Analysis*, W.H. Freeman.
5. Dean, J.A. *Analytical Chemistry*, Notebook, McGraw Hill
6. Day, R. A. & Underwood, A.L. *Quantitative Analysis*, Prentice Hall of India.
7. Freifelder, D. *Physical Biochemistry* 2nd Ed., W.H. Freeman and Co., N.Y. USA (1982).
8. Cooper, T.G. *The Tools of Biochemistry*, John Wiley and Sons, N.Y. USA. 16 (19770).
9. Vogel, A.I. Vogel's *Qualitative Inorganic Analysis* 7th Ed., Prentice Hall.
10. Vogel A.I. Vogel's *Quantitative Chemical Analysis* 6th Ed., Prentice Hall.
11. Robinson, J.W. *Undergraduate Instrumental Analysis* 5th ED. Marcel Dekker, Inc., New York (1995).

CHEM 647 C : Basics in Pharmaceutical Chemistry

Drugs and Pharmaceuticals:

Drug discovery, Design and development; Basic retrosynthetic approach. Synthesis of the representative drugs of the following classes; analgesic agents, antipyretic agents, anti-inflammatory agents(aspirin, paracetamol, ibuprofen); antibiotics (chloramphenicol); antibacterial and antifungal agents (sulphonamide; sulphanethoxazol, sulphacetamide, trimethoprin); antiviral agent (acyclovir), central nervous system agent (Phenobarbital, diazepam), cardiovascular (glyceryl trinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT-Zidovudine).

Fermentation

Aerobic and anaerobic fermentation. Production of (i) Ethyl alcohol and citric acid, (ii) antibiotics; penicillin, Cephalosporin, chloromycetin and streptomycin, (iii) Lysin, Glutamic acid, Vitamin B2, Vitamin B12 and Vitamin C.

List of experiments (minimum 2 from each group I/II/III/IV, maximum 10):

I. To carry out the identification tests with the following pharmaceutical aids:

1. Ammonium Chloride (expectorant diuretic)
2. Boric acid (anti-infective)
3. Calamine (mild astringent)
4. Magnesium Sulfate (Cathartic)
5. Zinc Oxide (astringent soothing)

6. Potassium Permanganate (protective)

7. Iodine

II. To carry out the quantitative analysis of following agents- (assay) (as per I.P.)

1. Aspirin

2. Paracetamol

3. Isoniazid

4. Borax

5. Ascorbic acid

III. To determine the % purity of following drugs through spectroscopy

1. Aspirin (colorimetry)

2. Paracetamol (calibration curve method)

3. Ibuprofen

IV. To synthesize following medicinal compounds:

1. Aspirin

2. Sulphonamides

3. Acetaminophen

References:

Pharmacopoea of India 2007