T.Y.B.Sc. CHEMISTRY (6 UNITS)
To be implemented from the Academic year 2018-2019

SEMESTER V PHYSICAL CHEMISTRY

UNIT I 1.0 MOLECULAR SPECTROSCOPY 15 L

1.1 **Rotational Spectrum**: Introduction to dipole moment, polarization of a bond, bond moment, molecular structure,

.Rotational spectrum of a diatomic molecule, rigid rotor, moment of inertia, energy levels, conditions for obtaining pure rotational spectrum, selection rule, nature of spectrum, determination of internuclear distance and isotopic shift.

1.2 **Vibrational spectrum**: Vibrational motion, degrees of freedom, modes of vibration, vibrational spectrum of a diatomic molecule, simple harmonic oscillator, energy levels, zero point energy, conditions for obtaining vibrational spectrum, selection rule, nature of spectrum.

1.3 **Vibrational-Rotational spectrum of diatomic molecule**: energy levels, selection rule, nature of spectrum, P and R branch lines. Anharmonic oscillator - energy levels, selection rule, fundamental band, overtones. Application of vibrational-rotational spectrum in determination of force constant and its significance. Infrared spectra of simple molecules like H_2O and CO_2.

1.4 **Raman Spectroscopy :** Scattering of electromagnetic radiation, Rayleigh scattering, Raman scattering, nature of Raman spectrum, Stoke's lines, anti-Stoke's lines, Raman shift, quantum theory of Raman spectrum, comparative study of IR and Raman spectra, rule of mutual exclusion- CO_2 molecule.

UNIT II 2.0 CHEMICAL THERMODYNAMICS 10 L

2.1.1**Colligative properties:** Vapour pressure and relative lowering of vapour pressure.

Measurement of lowering of vapour pressure - Static and Dynamic method.

2.1.2 Solutions of Solid in Liquid:

2.1.2.1 Elevation in boiling point of a solution, thermodynamic derivation relating elevation in boiling point of the solution and molar mass of non-volatile solute.

2.1.2.2 Depression in freezing point of a solution, thermodynamic derivation relating the depression in the freezing point of a solution and the molar mass of the non-volatile solute. Beckmann Method and Rast Method.

2.1.3 **Osmotic Pressure :** Introduction, thermodynamic derivation of Van't Hoff equation, Van't Hoff Factor. Measurement of Osmotic Pressure - Berkeley and Hartley's Method, Reverse Osmosis.

2.2 CHEMICAL KINETICS 5 L

2.2.1 **Collision theory of reaction rates** : Application of collision theory to 1. Unimolecular reaction Lindemann theory and

2. Bimolecular reaction.

(derivation expected for both)

2.2.2 Classification of reactions as slow, fast and ultra -fast. Study of kinetics of fast reactions by Stop flow method and Flash photolysis (No derivation expected).

UNIT III 3.0 NUCLEAR CHEMISTRY 15L

3.1. **Introduction**: **B**asic terms-radioactive constants (decay constant, half life and average life) and units of radioactivity

3.2 **Detection and Measurement of Radioactivity:** Types and characteristics of nuclear radiations, behaviour of ion pairs in electric field, detection and measurement of nuclear radiations using G. M. Counter and Scintillation Counter.

3.3 **Application of use of radioisotopes as Tracers :** chemical reaction mechanism, age determination - dating by C^{14}.

3.4 **Nuclear reactions**: nuclear transmutation (one example for each projectile), artificial radioactivity, Q - value of nuclear reaction, threshold energy.

3.5 **Fission Process :** Fissile and fertile material, nuclear fission, chain reaction, factor controlling fission process. multiplication factor and critical size or mass of fissionable material, nuclear power reactor and breeder reactor.

3.6 **Fusion Process :** Thermonuclear reactions occurring on stellar bodies and earth.

UNIT IV 4.1 SURFACE CHEMISTRY 6L

4.1.1 **Adsorption:** Physical and Chemical Adsorption, types of adsorption isotherms . Langmuir’s adsorption isotherm (Postulates and derivation expected).

B.E.T. equation for multilayer adsorption, (derivation not expected). Determination of surface area of an adsorbent using B.E.T. equation.

4.2 COLLOIDAL STATE 9L

4.2.1 **Introduction to colloids -** Emulsions, Gels and Sols

4.2.2 **Electrical Properties** : Origin of charges on colloidal particles, Concept of electrical double layer, zeta potential, Helmholtz and Stern model.

Electro-kinetic phenomena - Electrophoresis, Electro-osmosis, Streaming potential, Sedimentation potential; Donnan Membrane

Equilibrium.
4.2.3 **Colloidal electrolytes :** Introduction, micelle formation,
4.2.4 **Surfactants:** Classification and applications of surfactants in detergents and food industry.

SEMESTER VI PHYSICAL CHEMISTRY

COURSE CODE: USCH601 **CREDITS: 02**

LECTURES: 60

UNIT I	1.1 ELECTROCHEMISTRY 1.1.1 **Activity and Activity Coefficient:** Lewis concept, ionic strength, Mean ionic activity and mean ionic activity coefficient of an electrolyte, expression for activities of electrolytes. Debye-Huckel limiting law (No derivation). 1.1.2 **Classification of cells:** Chemical cells and Concentration cells. Chemical cells with and without transference, Electrode Concentration cells, Electrolyte concentration cells with and without transference (derivations are expected),	7L
	1.2 APPLIED ELECTROCHEMISTRY 1.2.1 **Polarization**: concentration polarization and it's elimination 1.2.2 **Decomposition Potential and Overvoltage** : Introduction, experimental determination of decomposition potential, factors affecting decomposition potential. Tafel's equation for hydrogen overvoltage, experimental determination of over –voltage	8L
UNIT II	2.0 POLYMERS 2.1 **Basic terms :** macromolecule, monomer, repeat unit, degree of polymerization. 2.2. **Classification of polymers:** Classification based on source, structure, thermal response and physical properties. 2.3. **Molar masses of polymers:** Number average, Weight average, Viscosity average molar mass, Monodispersity and Polydispersity 2.4. **Method of determining molar masses of polymers :** Viscosity method using Ostwald Viscometer. (derivation expected) 2.5. **Light Emitting Polymers :** Introduction, Characteristics, Method of preparation and applications.	15L

	2.6. **Antioxidants and Stabilizers :** Antioxidants , Ultraviolet stabilizers, Colourants, Antistatic agents and Curing agents.	
UNIT III	3.1 BASICS OF QUANTUM CHEMISTRY	10 L
	3.1.1 **Classical mechanics**: Introduction, limitations of classical mechanics, Black body radiation, photoelectric effect, Compton effect. 3.1.2 **Quantum mechanics :** Introduction, Planck's theory of quantization, wave particle duality, de –Broglie's equation, Heisenberg's uncertainty principle. 3.1.3 **Progressive and standing waves-** Introduction, boundary conditions, Schrodinger's time independent wave equation (No derivation expected), interpretation and properties of wave function. 3.1.4 **Quantum mechanics** : State function and its significance, Concept of operators - definition, addition, subtraction and multiplication of operators, commutative and non - commutative operators, linear operator, Hamiltonian operator, Eigen function and Eigen value.	
	3.2 RENEWABLE ENERGY RESOURCES	5L
	3.2.1. **Renewable energy resources** : Introduction.	
	3.2.2 **Solar energy**: Solar cells, Photovoltaic effect, Differences between conductors,semiconductors ,insulators and its band gap, Semiconductors as solar energy converters, Silicon solar cell 3.2.3. **Hydrogen :** Fuel of the future, production of hydrogen by direct electrolysis of water, advantages of hydrogen as a universal energy medium.	
UNIT IV	4.1 NMR -NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY	7L
	4.1.1. Principle : Nuclear spin, magnetic moment, nuclear 'g' factor, energy levels, Larmor precession, Relaxation processes in NMR (spin -spin relaxation and spin - lattice relaxation). **4.1.2. Instrumentation**: NMR Spectrometer 4.2 ELECTRON SPIN RESONANCE SPECTROSCOPY	
	4.2.1. Principle: fundamental equation, g-value -dimensionless constant or electron g-factor, hyperfine splitting. **4.2.2. Instrumentation**: ESR spectrometer, ESR spectrum of hydrogen and deuterium.	8L

INORGANIC CHEMISTRY

SEMESTER V

UNIT-I

1. Molecular Symmetry and Chemical Bonding

1.1Molecular Symmetry (6L)

1.1.1 Introduction and Importance of Symmetry in Chemistry.

1.1.2 Symmetry elements and Symmetry operations.

1.1.3 Concept of a Point Group with illustrations using the following point groups :(i)$C_{\infty V}$ (ii) $D_{\infty h}$ (iii) C_{2V} (iv) C_{3v} (v)C_{2h} and (vi)D_{3h}

1.2 Molecular Orbital Theory for heteronuclear diatomic molecules and polyatomic species (9L)

1.2.1 Comparision between homonuclear and heteronuclear diatomic molecules.

1.2.2. Heteronuclear diatomic molecules like CO, NO and HCl, appreciation of modified MO diagram for CO.

1.2.3 Molecular orbital theory for H_3 and H_3^+ (correlation diagram expected).

1.2.4. Molecular shape to molecular orbital approach in AB_2 molecules. Application of symmetry concepts for linear and angular species considering σ- bonding only. (Examples like : i) BeH_2, ii) H_2O).

UNIT-II

2 SOLID STATE CHEMISTRY

2.1 Structures of Solids (11L)

2.2.1 Explanation of terms viz.crystal lattice, lattice point, unit cell and lattice constants.

2.1.2 Closest packing of rigid spheres (hcp,ccp), packing density in simple cubic, bcc and fcc lattices. Relationship between density, radius of unit cell and lattice parameters.

2.1.3 Stoichiometric Point defects in solids (discussion on Frenkel and Schottky defects expected).

2.2 Superconductivity (4L)

2.2.1 Discovery of superconductivity.

2.2.2 Explanation of terms like superconductivity, transition temperature, Meissner effect.

2.2.3 Different types of super conductors viz.conventional superconductors, alkali metal fullerides, high temperature super conductors.

2.2.4 Brief application of superconductors.

UNIT-III

3.0 CHEMISTRY OF INNER TRANSITION ELEMENTS (15L)

3.1 Introduction: Position in periodic table and electronic configuration of lanthanides and actinides.

3.2 Chemistry of Lanthanides with reference to (i) lanthanide contraction and its consequences(ii) Oxidation states (iii) Ability to form complexes (iv) Magnetic and spectral properties

3.3 : Occurrence, extraction and separation of lanthanides by (i) Ion Exchange method and (ii) Solvent extraction method (Principles and technique)

3.4 Applications of lanthanides

UNIT-IV

4. SOME SELECTED TOPICS

4.1 Chemistry of Non-aqueous Solvents (5 L)

4.1.1Classification of solvents and importance of non-aqueous solvents.

4.1.2 Characteristics and study of liquid ammonia, dinitrogen tetra oxide as non-aqueous solvents with respect to : (i) acid-base reactions and (ii) redox reactions.

4.2 Comparative Chemistry of Group 16 (5L)

4.2.1 Electronic configurations, trends in physical properties, allotropy

4.2.2 Manufacture of sulphuric acid by Contact process.

4.3 Comparative Chemistry of Group 17 (5L)

4.3.1Electronic configuration , General characteristics, anamolous properties of fluorine, comparative study of acidity of oxyacids of chlorine w.r.t acidity, oxidising properties and structures(on the basis of VSEPR theory)

4.3.2 Chemistry of interhalogens with reference to preparations, properties and structures (on the basis of VSEPR theory) .

SEMESTER VI

INORGANIC CHEMISTRY

UNIT-I

1.Theories of the metal-ligand bond (I) (15L)

1.1 Limitations of Valence Bond Theory.

1.2 Crystal Field Theory and effect of crystal field on central metal valence orbitals in various geometries from linear to octahedral(from coordination number 2 to coordination number 6)

1.3 Splitting of *d* orbitals in octahedral, square planar and tetrahedral crystal fields.

1.4 Distortions from the octahedral geometry : (i) effect of ligand field and (ii) Jahn-Teller distortions.

1.5 Crystal field splitting parameters Δ ; its calculation and factors affecting it in octahedral complexes, Spectrochemical series.

1.6 Crystal field stabilization energy(CFSE), calculation of CFSE for octahedral complexes with d^0 to d^{10} metal ion configurations.

1.7 Consequences of crystal field splitting on various properties such as ionic radii, hydration energy and enthalpies of formation of metal complexes of the first transition series.

1.8 Limitations of CFT : Evidences for covalence in metal complexes (i) intensities of d-d transitions, (ii) ESR spectrum of $[IrCl_6]^{2-}$ (iii) Nephelauxetic effect.

UNIT-II

2.Theories of the metal-ligand bond (II)

2.1 Molecular orbital Theory for coordination compounds. (4L)

2.1.1 Identification of the central metal orbitals and their symmetry suitable for formation of σ bonds with ligand orbitals.

2.1.2 Construction of ligand group orbitals.

2.1.3 Construction of σ-molecular orbitals for an ML_6 complex.

2.1.4 Effect of π-bonding on complexes .

2.1.5 Examples like $[FeF_6]^{-4}$, $[Fe(CN)_6]^{-4}$, $[FeF_6]^{-3}$, $[Fe(CN)_6]^{-3}$, $[CoF_6]^{-3}$, $[Co(NH_3)_6]^{+3}$

2.2 Stability of Metal-Complexes (4L)

2.2.1 Thermodynamic and kinetic perspectives of metal complexes with examples.

2.2.2 Stability constants: stepwise and overall stability constants and their interrelationship.

2.2.3 Factors affecting thermodynamic stability.

2.3 Reactivity of metal complexes. (4L)

2.3.1 Comparison between Inorganic and organic reactions.

2.3.2 Types of reactions in metal complexes.

2.3.3 Inert and labile complexes : correlation between electronic configurations and lability of complexes.

2.3.4 Ligand substitution reactions : Associative and Dissociative mechanisms.

2.2.5 Acid hydrolysis, base hydrolysis and anation reactions.

2.4 Electronic Spectra. (3L)

2.4.1Origin of electronic spectra

2.4.2 Types of electronic transitions in coordination compounds: intra- ligand,Charge transfer and intra-metal transitions.

2.4.3 Selection rules for electronic transitions.

2.4.4 Electronic configuration and electronic micro states, Terms and Term symbols for transition metal ions, rules for determination of ground state term.

2.4.5 Determination of Terms for p^2 and d^1 electronic configurations.

UNIT-III

3 ORGANOMETALLIC CHEMISTRY (15L)

3.1 Organometallic Compounds of main group metal (6L)

3.1.1General characteristics of various types of organometallic compounds, viz.ionic, σ-bonded and electron deficient compounds.

3.1.2 General synthetic methods of organometallic compounds : (i) Oxidative-addition, (ii)Metal-metal exchange(transmetallation), (iii) Carbanion-halide exchange, (iv) Metal-hydrogen exchange(metallation) and (v) Methylene-insertion reactions.

3.1.3 Some chemical reactions of organometallic compounds:

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(i) Reactions with oxygen and halogens, (ii) Alkylation and arylation reactions (iii) Reactions with protic reagents, (iv) Redistribution reactions and (v) Complex formation reactions.

3.2 Metallocenes (5L)

Introduction, Ferrocene : Synthesis, properties, structure and bonding on the basis of VBT.

3.3 Catalysis (4L)

3.3.1 Comparison between homogeneous and heterogeneous catalysis

3.3.2 Basic steps involved in homogeneous catalysis

3.3.3 Mechanism of Wilkinson's catalyst in hydrogenation of alkenes.

UNIT-IV

4 SOME SELECTED TOPICS (15L)

4.1 Metallurgy (7L)

4.1.1 Types of metallurgies,

4.1.2 General steps of metallurgy; Concentration of ore, calcinations, roasting,reduction and refining.

4.1.3 Metallurgy of copper: occurrence, physicochemical principles, Extraction of copper from pyrites& refining by electrolysis.

4.2 Chemistry of Group 18 (5L)

4.2.1 Historical perspectives

4.2.2 General characteristics and trends in physical and chemical properties

4.2.3 Isolation of noble gases

4.2.4 Compounds of Xenon (oxides and fluorides) with respect to preparation and structure (VSEPR)

4.2.5 Uses of noble gases

4.3 Introduction to Bioinorganic Chemistry. (3L)

4.3.1Essential and non essential elements in biological systems.

4.3.2 Biological importance of metal ions such as Na^+,K^+,Fe^{+2}/Fe^{+3} and Cu^{+2}(Role of Na^+ and K^+ w.r.t ion pump)

T.Y.B.Sc – Organic Chemistry

Unit I

1.1 Mechanism of organic reactions

(10 L)

1.1.1 The basic terms & concepts: bond fission, reaction intermediates, electrophiles & nucleophiles,ligand, base, electrophilicity vs. acidity & nucleophilicity vs basicity.

1.1.2 Neighbouring group participation in nucleophilic substitution reactions**:** participation of lonepair of electrons, kinetics and stereochemical outcome.

1.1.3 Acyl nucleophilic substitution (Tetrahedral mechanism): Acid catalyzed esterification ofcarboxylic acids ($A_{AC}2$) and base promoted hydrolysis of esters ($B_{AC}2$).

1.1.4 Pericyclic reactions, classification and nomenclature

1.1.4.1 Electro cyclic reactions (ring opening and ring closing), cycloaddition, sigma tropic Rearrangement, group transfer reactions, cheletropic reaction (definition and one example of each type)

1.1.4.2 Pyrolytic elimination: Cope, Chugaev, pyrolysis of acetates

1.2 Photochemistry

(5 L)

1.2.1 Introduction: Difference between thermal and photochemical reactions. Jablonski diagram, singlet and triplet states, allowed and forbidden transitions, fate of excited molecules, photosensitization.

1.2.2 Photochemical reactions of olefins: photoisomerization, photochemical rearrangement of 1,4- dienes (di- π methane)

1.2.3 Photochemistry of carbonyl compounds: Norrish I, Norrish II cleavages. Photo reduction (e.g. benzophenone to benzpinacol)

Unit II

2.1 Stereochemistry I

(5 L)

2.1.1 Molecular chirality and elements of symmetry: Mirror plane symmetry, inversion center,roation -reflection (alternating) axis.

2.1.2 Chirality of compounds without a stereo genic center: cummulenes and biphenyls.

2.2 Agrochemicals

(4 L)

2.2.1 General introduction & scope, meaning & examples of insecticides, herbicides, fungicide,rodenticide, pesticides, plant growth regulators.

2.2.2 Advantages & disadvantages of agrochemicals

2.2.3 Synthesis & application of IAA (Indole Acetic Acid) & Endosulphan,

2.2.4 Bio pesticides – Neem oil & Karanj oil.

2.3 Heterocyclic chemistry:

(6 L)

2.3.1 Reactivity of pyridine-N-oxide, quinoline and iso-quionoline.

2.3.2 Preparation of pyridine-N-oxide, quinoline (Skraup synthesis) and iso-quinoline (Bischler-Napieralski synthesis).

2.3.3 Reactions of pyridine-N-oxide: halogenation, nitration and reaction with $NaNH_2$/liq.NH_3,n-BuLi.

2.3.4 Reactions of quinoline and isoquinoline; oxidation,reduction,nitration,halogenation andreaction with $NaNH_2$/liq.NH_3,n-BuLi.

Unit III

3.1 IUPAC

(5 L)

IUPAC Systematic nomenclature of the following classes of compounds (including compounds upto two substituents / functional groups):

3.1.1 Bicyclic compounds – spiro, fused and bridged (upto 11 carbon atoms) – saturatedand unsaturated compounds.

3.1.2 Biphenyls

3.1.3 Cummulenes with upto 3 double bonds

3.1.4 Quinolines and isoquinolines

1. Nomenclature of Organic Chemistry**:** IUPAC recommendations and preferred Names 2013,RSC publication.
2. IUPAC nomenclature by S.C.Pal.

3.2 Synthesis of organic compounds

(10L)

3.2.1 Introduction: Linear and convergent synthesis, criteria for an ideal synthesis, concept of chemoselectivity and regioselectivity with examples, calculation of yields.

3.2.2 Multicomponent Synthesis: Mannich reaction and Biginelli reaction. Synthesis with examples(no mechanism)

3.2.3 Green chemistry and synthesis:

Introduction: Twelve principles of green chemistry, concept of atom economy and E-factor, calculations and their significance, numerical examples.

i) Green reagents: dimethyl carbonate.
ii) Green starting materials : D-glucose
iii) Green solvents : supercritical CO_2
iv) Green catalysts: Bio catalysts.

3.2.4 Planning of organic synthesis

i) synthesis of nitroanilines. (*o&p*)
ii) synthesis of halobenzoic acid.(*o&p*)

- iii) Alcohols (primary / secondary / tertiary) using Grignard reagents.
- iv) Alkanes (using organo lithium compounds)

Unit IV

4.1 SpectroscopyI(5 L)

4.1.1 Introduction: Electromagnetic spectrum, units of wavelength and frequency

4.1.2 UV – Visible spectroscopy: Basic theory, solvents, nature of UV-Visible spectrum, concept of chromophore, auxochrome, bathochromic and hypsochromic shifts, hyperchromic and hypochromic effects, chromophore-chromophore and chromophore-auxochrome interactions.

4.1.3 Mass spectrometry: Basic theory. Nature of mass spectrum. General rules of fragmentation. Importance of molecular ion peak, isotopic peaks, base peak, nitrogen rule, rule of 13 for determination of empirical formula and molecular formula. Fragmentation of alkanes and aliphatic carbonyl compounds.

4.2 Natural Products:(10L)

4.2.1. Terpenoids: Introduction, Isoprene rule, special isoprene rule and the gem-dialkyl rule.

4.2.2 Citral:

- a) Structural determination of citral.
- b) Synthesis of citral from methyl heptenone
- c) Isomerism in citral. (cis and trans form).

4.2.3. Alkaloids Introduction and occurrence.

Hofmann's exhaustive methylation and degradation in**:** simple open chain and N – substituted monocyclic amines.

4.2.4 Nicotine:

- a) Structural determination of nicotine. (Pinner's work included)
- b) Synthesis of nicotine from nicotinic acid
- c) Harmful effects of nicotine.

4.2.5 Hormones:

Introduction, structure of adrenaline (epinephrine), physiological action of adrenaline.

Synthesis of adrenaline from

- a) Catechol
- b) p-hydroxybenzaldehyde(Ott's synthesis)
- c)

Unit I

1.1 Stereochemistry II

(10 L)

1.1.1 Stereoselectivity and stereospecificity: Idea of enantioselectivity (ee) and diastereoselectivity(de) , Topicity : enantiotopic and diasterotopic atoms, groups and faces.

1.1.2 Stereochemistry of –

- i) Substitution reactions : S_{Ni} (reaction of alcohol with thionyl chloride)
- ii) Elimination reactions: E_2–Base induced dehydrohalogenation of 1-bromo-1,2-diphenylpropane.
- iii) Addition reactions to olefins:

a) bromination (electrophilic anti addition)
b) syn hydroxylation with O_sO_4 and $KMnO_4$
c) epoxidation followed by hydrolysis.

1.2 Amino acids & Proteins (5 L)

1.2.1 α-Amino acids: General Structure, configuration, and classification based on structure and nutrition. Properties: pH dependency of ionic structure, isoelectric point and zwitter ion. Methods of preparations: Strecker synthesis, Gabriel phthalamide synthesis.

1.2.2 Polypeptides and Proteins: nature of peptide bond. Nomenclature and representation of polypeptides (di-and tri-peptides) with examples Merrifield solid phase polypeptide synthesis.

.Protiens:general idea of primary,secondary,tertiary & quaternary structure

Unit II

2.1 Molecular Rearrangements (5 L)

Mechanism of the following rearrangements with examples and stereochemistry wherever applicable.

2.1.1 Migration to the electron deficient carbon: Pinacol-pinacolone rearrangement.
2.1.2 Migration to the electron deficient nitrogen: Beckmann rearrangement.
2.1.3 Migration involving a carbanion : Favorski rearrangement.
2.1.4 Name reactions: Michael addition, Wittig reaction.

2.2 Carbohydrates (10 L)

2.2.1 Introduction: classification, reducing and non-reducing sugars, DL notation
2.2.2 Structures of monosaccharides: Fischer projection (4-6 carbon monosaccharides)and Haworth formula (furanose and pyranose forms of pentoses and hexoses)

Interconversion: open chain and Haworth forms of monosaccharides with 5 and 6 carbons.Chair conformation with stereochemistry of D-glucose, Stability of chair form of D-glucose

2.2.3 Stereoisomers of D-glucose: enantiomer, diastereomers, anomers, epimers.
2.2.4 Mutarotation in D-glucose with mechanism
2.2.5 Chain lengthening & shortening reactions: Modified Kiliani-Fischer synthesis (D-arabinose toD-glucose and D-mannose), Wohl method (D-glucose to D-arabinose)
2.2.6 Reactions of D-glucose and D-fructose:
  (a) Osazone formation (b) reduction: Hi/Ni, $NaBH_4$ (c) oxidation: bromine water, HNO_3, HIO_4
  (d) acetylation (e) methylation:(d) and (e) with cyclic pyranose forms
2.2.7 Glycosides: general structure

Unit III

3.1 Spectroscopy II

(10 L)

3.1.1 IR Spectroscopy: Basic theory, nature of IR spectrum, selection rule, fingerprint region.

3.1.2 PMR Spectroscopy: Basic theory of PMR, nature of PMR spectrum, chemical shift (δ unit), standard for PMR, solvents used. Factors affecting chemical shift: (1) inductive effect (2)anisotropic effect (with reference to C=C, C≡C, C=O and benzene ring). Spin-spin coupling and

coupling constant. application of deuterium exchange technique. application of PMR in structure determination.

3.1.3 Spectral characteristics of following classes of organic compounds, including benzene and monosubstituted benzenes, with respect to IR and PMR: (1) alkanes (2) alkenes (3) alkynes (4) haloalkanes (5) alcohols (6) carbonyl compounds (7) ethers (8) amines (broad regions characteristic of different groups are expected).

Problems of structure elucidation of simple organic compounds using individual or combined use of UV-Vis, IR, Mass and NMR spectroscopic technique are expected. (Index of hydrogen deficiency should be the first step in solving the problems).

3.2 NucleicAcids(5 L)

Controlled hydrolysis of nucleic acids. sugars and bases in nucleic acids. Structures of nucleosides and nucleotides in DNA and RNA. Structures of nucleic acids (DNA and RNA) including base pairing.

Unit IV

4.1 Polymer

(8 L)

4.1.1 Introduction: terms monomer, polymer, homopolymer, copolymer, thermoplastics and thermosets.

4.1.2 Addition polymers: polyethylene, polypropylene, teflon, polystyrene, PVC, Uses.

4.1.3 Condensation polymers: polyesters, polyamides, polyurethanes, polycarbonates, phenolformaldehyde resins.Uses

4.1.4 Stereochemistry of polymers: Tacticity, mechanism of stereochemical control of polymerizationusing Ziegler Natta catalysts.

4.1.5 Natural and synthetic rubbers: Polymerisation of isoprene: 1,2 and 1,4 addition(cis and trans), Styrene butadiene copolymer.

4.1.6 Additives to polymers: Plasticisers, stabilizers and fillers.

4.1.7 Biodegradable polymers: Classification and uses. polylactic acid structure, properties

anduse for packaging and medical purposes.

(Note : Identification of monomer in a given polymer & structure of polymer for a given monomer is expected. condition for polymerization is not expected)

4.2 Catalysts and Reagents

(7 L)

Study of the following catalysts and reagents with respect to functional group transformations and selectivity (no mechanism).

4.2.1 Catalysts: Catalysts for hydrogenation:

a. Raney Nickel
b. Pt and PtO_2 (C=C, CN, NO_2, aromatic ring)
c. Pd/C : C=C, COCl→CHO (Rosenmund)
d. Lindlar catalyst: alkynes

d.2.2 Reagents**:**

a. $LiAlH_4$ (reduction of CO, COOR, CN,NO_2)
b. $NaBH_4$ (reduction of CO)
c. SeO_2 (Oxidation of CH_2 alpha to CO)
d. mCPBA (epoxidation of C=C)
e. NBS (allylic and benzylic bromination)

T.Y.B.Sc - Paper IV Analytical Chemistry

UNIT I :INTRODUCTION TO QUALITY CONCEPTS,CHEMICAL CALCULATIONS AND SAMPLING (3 & 6 UNITS)

1.1 Quality in Analytical Chemistry 05 L

1.1.1 Concepts of Quality, Quality Control and Quality Assurance

1.1.2 Importance of Quality concepts in Industry

1.1.3 Chemical Standards and Certified Reference Materials; Importance in chemical analysis

Quality of material: Various grades of laboratory reagents

1.2 Chemical Calculations (Numericals and word problems are expected) 04 L

Inter conversion of various concentration units.

1.2.1 (Conversion of concentration from one unit to another unit with examples)

1.2.2 Percent composition of elements in chemical compounds

1.3 Sampling 06 L

1.3.1 Purpose, significance and difficulties encountered in sampling

1.3.2 Sampling of solids: Sample size – bulk ratio, size to weight ratio, multistage and sequential sampling, size reduction methods, sampling of compact solids, equipments and methods of samplingof compact solids, sampling of particulate solids, methods and equipments used for sampling of particulate solids.

1.3.3 Sampling of liquids: Homogeneous and heterogeneous, Static and flowing liquids.

1.3.4 Sampling of gases: Ambient and stack sampling: Apparatus and methods for sampling of gases.

1.3.5 Collection, preservation and dissolution of the sample.

UNIT II : CLASSICAL METHODS OF ANALYSIS (TITRIMETRY) (3 & 6 UNITS)

2.1 Redox Titrations (Numerical and word Problems are expected) 08 L

2.1.1 Introduction

2.1.2 Construction of the titration curves and calculation of E_{system} in aqueous medium in case of:

(1) One electron system
(2) Multielectron system

2.1.3 Theory of redox indicators, Criteria for selection of an indicator
Use of diphenyl amine and ferroin as redox indicators

2.2 Complexometric Titrations **07 L**

2.2.1 Introduction, construction of titration curve

2.2.2 Use of EDTA as titrant and its standardisation, absolute and conditional formation constants of metal EDTA complexes, Selectivity of EDTA as a titrant.
Factors enhancing selectivity with examples.
Advantages and limitations of EDTA as a titrant.

2.2.3 Types of EDTA titrations.

2.2.4 Metallochromic indicators, theory, examples and applications

UNIT III: OPTICAL METHODS(6 UNITS)

3.1 Atomic Spectroscopy: Flame Emission spectroscopy(FES) and Atomic Absorption Spectroscopy(AAS) **07 L**

3.1.1 Introduction, Energy level diagrams, Atomic spectra, Absorption and Emission Spectra

3.1.2 Flame Photometry – Principle, Instrumentation (Flame atomizers, types of Burners, Wavelength selectors, Detectors)

3.1.3 Atomic Absorption Spectroscopy – Principle, Instrumentation (Source, Chopper, Flame and Electrothermal Atomiser)

3.1.4 Quantification methods of FES and AAS – Calibration curve method, Standard addition method and Internal standard method.

3.1.5 Comparison between FES and AAS

3.1.6 Applications, Advantages and Limitations

3.2 Molecular Fluorescence and Phosphorescence Spectroscopy **04L**

3.2.1 Introduction and Principle

3.2.2 Relationship of Fluorescence intensity with concentration

3.2.3 Factors affecting Fluorescence and Phosphorescence

3.2.4 Instrumentation and applications

3.2.5 Comparison of Fluorimetry and Phosphorimetry

3.2.6 Comparison with Absorption methods

3.3 Turbidimetry and Nephelometry 04 L

3.3.1 Introduction and Principle

3.3.2 Factors affecting scattering of Radiation:
Concentration, particle size, wavelength, refractive index

3.3.3 Instrumentation and Applications

UNIT IV: METHODS OF SEPARATION – I (6 UNITS)

4.1 Solvent Extraction 06 L

4.1.1 Factors affecting extraction: Chelation, Ion pair formation and Solvation

4.1.2 Graph of percent extraction versus pH.

Concept of $[pH]_{1/2}$ and its significance (derivation not expected)

4.1.3 Craig's counter current extraction: Principle, apparatus and applications

4.1.4 Solid phase extraction: Principle, process and applications with special reference to water and industrial effluent analysis.

4.1.5 Comparison of solid phase extraction and solvent extraction.

4.2 High Performance Liquid chromatography (HPLC) 06L

4.2.1 Introduction and Principle

Instrumentation- components with their significance: Solvent Reservoir, Degassing system, Pumps-(reciprocating pumps, screw driven- syringe type pumps, pneumatic pumps, advantages and disadvantages of each pump), Precolumn,Sample injection system, HPLC Columns, Detectors(UV – Visible detector, Refractive index detector)

4.2.2 Qualitative and Quantitative Applications of HPLC

4.3 High Performance Thin Layer Chromatography (HPTLC) 03 L

4.3.1 Introduction and Principle

Stationary phase, Sample application and mobile phase

4.3.2 Detectors

a) Scanning densitometer- Components.

Types of densitometer- Single beam and Double beam

b) Fluorometric Detector

4.3.3 Advantages, disadvantages and applications

4.3.4 Comparison of TLC and HPTLC

SEMESTER VI

ANALYTICAL CHEMISTRY

COURSE CODE: USCH604 CREDITS: 02 LECTURES: 60

UNIT I: ELECTRO ANALYTICAL TECHNIQUES(3 & 6 UNITS)

1.1 Polarography (Numerical and word problems are expected) 11L

1.1.1 Difference between potentiometry and voltammetry, Polarizable and non-polarizable electrodes

1.1.2 Basic principle of polarography
H shaped polarographic cell, DME (construction, working, advantages and limitations)

1.1.3 DC polarogram: Terms involved - Residual current, Diffusion current, Limiting current, Half-Wave Potential
Role and selection of supporting electrolyte, Interference of oxygen and its removal, polarographic Maxima and Maxima Suppressors
Qualitative aspects of Polarography: Half wave potential $E_{1/2}$, Factors affecting $E_{1/2}$
Quantitative aspects of polarography: Ilkovic equations: various terms involved in it (No derivation)

1.1.4 Quantification

1) Wave height – Concentration plots (working plots/calibration)
2) Internal standard (pilot ion) method
3) Standard addition method

1.1.5 Applications advantages and limitations

1.2 Amperometric Titrations 04L

1.2.1 Principle, Rotating Platinum Electrode(Construction, advantages and limitations)

1.2.2 Titration curves with example

1.2.3 Advantages and limitations

UNIT II: METHODS OF SEPARATION - II (3 & 6 UNITS)

2.1 Gas Chromatography (**Numerical and word problems are expected**) **09 L**

2.1.1 Introduction, Principle, Theory and terms involved

2.1.2 Instrumentation: Block diagram and components,types of columns, stationary phases in GSC and GLC, Detectors: TCD, FID, ECD

2.1.3 Qualitative, Quantitative analysis and applications

2.1.4 Comparison between GSC and GLC

2.2 Ion Exchange Chromatography **06 L**

2.2.1 Introduction, Principle.

2.2.2 Types of Ion Exchangers , Ideal properties of resin

2.2.3 Ion Exchange equilibria and mechanism, selectivity coefficient and separation factor

Factors affecting separation of ions

2.2.4 Ion exchange capacity and its determination for cation and anion exchangers.

2.2.5 Applications of Ion Exchange Chromatography with reference to Preparation of demineralised water, Separation of amino acids

UNIT III:FOOD AND COSMETICS ANALYSIS(6 UNITS)

3.1 Introduction to food chemistry **10 L**

3.1.1 Food processing and preservation:

Introduction, need, chemical methods, action of chemicals(sulphur dioxide, boric acid, sodium benzoate, acetic acid, sodium chloride and sugar) and pH control

Physical methods (Pasteurization and Irradiation)

3.1.2 Determination of boric acid by titrimetry and sodium benzoate by HPLC.

3.1.3 Study and analysis of food products and detection of adulterants

1) Milk:

Composition & nutrients, types of milk (fat free, organic and lactose milk)
Analysis of milk for lactose by Lane Eynon’s Method

2) Honey:

Composition
Analysis of reducing sugars in honey by Coles Ferricyanide method

3) Tea:

Composition, types (green tea and mixed tea)
Analysis of Tannin by Lowenthal’s method

4) Coffee:

Constituents and composition, Role of Chicory
Analysis of caffeine by Bailey Andrew method

3.2 Cosmetics 05 L

3.2.1 Introduction and sensory properties

3.2.2 Study of cosmetic products –

1) Face powder:

Composition
Estimation of calcium and magnesium by complexometric titration

2) Lipstick:

Constituents
Ash analysis for water soluble salts: borates, carbonates and zinc oxide

3) Deodorants and Antiperspirants:

Constituents, properties
Estimation of zinc by gravimetry

UNIT IV:THERMAL METHODS AND ANALYTICAL METHOD VALIDATION

(6 UNITS)

4.1 Thermal Methods 12 L

4.1.1 Introduction to various thermal methods

(TGA, DTA and Thermometric titration)

4.1.2 Thermogravimetric Analysis(TGA)
Instrumentation-block diagram,thermobalance (Basic components: balance, furnace, temperature measurement and control, recorder)

Thermogram (TG curve)for$CaC_2O_4..H_2O$ and $CuSO_4.5H_2O$

Factors affecting thermogram-Instrumental factors and Sample characteristics

Applications:
Determination of drying and ignition temperature range
Determination of percent composition of binary mixtures (Estimation of Calcium and Magnesium oxalate)

4.1.3 Differential Thermal Analysis (DTA):
Principle, Instrumentation, and Reference material used

Differential thermogram (DTA curve) CaC2O4 .H2O and CuSO4.5H2O

Applications
Comparison between TGA and DTA.

4.1.4 Thermometric Titrations – Principle and Instrumentation
Thermometric titrations of :

1) **HCl v/s NaOH**
2) **Boric acid v/s NaOH**
3) **Mixture of Ca+2 and Mg+2 v/s EDTA**
4) **Zn+2 with Disodium Tartarate.**

4.2 Analytical Method Validation **03L**

4.2.1 Introduction and need for validation of a method

4.2.2 Validation Parameters: Specificity, Selectivity, Precision, Linearity, Accuracy and Robustness