SEMESTER I

24UCS401: General Chemistry I

Unit 1: Periodic Table and Periodic Properties

Quantum Numbers, Filling up of atomic orbitals: Pauli's exclusion principle, Aufbau Principle, Hunds rule of maximum multiplicity – electronic configuration. Stability associated with half-filled and completely filled orbitals. Periodic properties of elements – variation of atomic volume, atomic and ionic radii, ionization potential, electron affinity, electro negativity along periods and groups. Pauling scale of electro negativity. Classification of elements into s, p, d and f blocks.

Unit 2: Laboratory Hygiene, Safety Measures and Analytical Methods

Storage and handling of chemicals – Corrosion, flammable, explosive, carcinogenic and toxic chemicals. Simple first aid procedures for accidents involving acids, alkalis, bromine, fire burns and cut by glass. Solubility product, common ion effect, complexation, oxidation-reduction reactions involved in identification of anions and cations – separation of cations into groups – Semi micro analysis of simple salts. Volumetric analysis – preparation of standard solutions – normality, molarity and molality - titrimetric reactions – acid-base, redox, precipitation and complexometric titrations – indicators – effect of change in pH – selection of suitable indicators.

Unit 3: Alkanes, Reactive Intermediates and Methods for Reaction Mechanisms

Introduction: Inductive, mesomeric, electromeric effects and hyper conjugation – structure of organic molecules based on sp3, sp2 and sp hybridization. Alkanes – sources of alkanes – general preparation – general properties – conformational analysis of ethane and n-butane. Homolytic and Heterolytic cleavages of bonds. Free radicals, Carbocations, Carbanions and Carbenes: Generation and stability of reactive intermediates – Correlation of reactivity with structure of reactive intermediates.

Unit 4: Chemistry of Cycloalkanes, Alkenes, Dienes and Alkynes

Preparation of cycloalkanes – Chemical properties – Relative stability of cyclopropane to cyclooctane – Baeyer's Strain theory – Limitations – Mono and di-substituted cyclohexanes. Alkenes: Nomenclature – Petroleum source of alkenes and aromatics – General methods of

preparation of alkenes – Chemical properties – Markovnikov's rule and peroxide effect - Uses – Elimination reactions and its mechanisms (E1, E2). Dienes: Structures and properties – conjugated dienes – stability and resonance – electrophilic addition – 1,2 addition and 1,4 addition. Alkynes: Nomenclature – General methods of preparation – Physical properties – Chemical properties – Uses.

Unit 5: Colloids and Macromolecules

Definition and types of Colloids - preparation, Purification (dialysis, electro dialysis and ultra-filtration) and stability of colloids, gold number. Properties of colloids - kinetic, optical and electrical properties. Emulsions – Types of emulsions, preparation, properties and applications, Donnan membrane equilibrium. Osmosis – reverse osmosis and desalination. Macromolecules-Molecular weight of macromolecules - determination of molecular weight by osmotic pressure and light scattering methods.

TEXT BOOKS:

Unit 1 & 2

1. R.D. Madan, "Modern Inorganic Chemistry", 2nd edition, S. Chand & Company Ltd., 2000.
2. P.L. Soni, "Text book of Inorganic Chemistry", 20th revised edition, Sultan Chand & Sons, 2000.
3. B.R. Puri, L.R. Sharma, K.K. Kalia, Principles of Inorganic Chemistry, 23rd edition, New Delhi, ShobanLalNagin Chand & Co., (1993).

Unit 3 & 4

4. Bahl, B.S. and Bahl, A., Advanced Organic Chemistry, (12th edition), New Delhi, Sultan Chand & Co., (2010).

Unit 5

5. Puri B.R., Sharma L.R. and Pathania M.S. Principles of Physical chemistry, (35th edition), New Delhi: ShobanLal Naginchand and Co. (2013)

24UCH551: VOLUMETRIC AND APPLIED VOLUMETRIC ANALYSIS

Experiments:

I. Volumetric Analysis

1. Estimation of HCl Vs NaOH using a standard oxalic acid solution.
2. Estimation of Na_2CO_3 Vs HCl using a standard Na_2CO_3 solution.
3. Estimation of oxalic acid Vs $KMnO_4$ using a standard oxalic acid solution.
4. Estimation of Iron (II) sulphate by $KMnO_4$ using a standard Mohr's salt solution.
5. Estimation of $KMnO_4$ Vs thio using a standard $K_2Cr_2O_7$ solution.
6. Estimation of Fe (III) by using $K_2Cr_2O_7$ using a standard Mohr's salt solution using internal and external indicators.
7. Estimation of copper (II) sulphate by $K_2Cr_2O_7$ solution.

II. Applied Experiments

1. Estimation of Total Hardness of water
2. Estimation of Bleaching Powder.
3. Estimation of calcium in commercial milk powder by EDTA method.

References:

1. Venkateswaran V.; Veeraswamy R.; Kulandivelu A.R. Basic Principles ofPractical Chemistry,2nd ed.; Sultan Chand & Sons: New Delhi, 1997.
2. Nad, A.K., Mahapatra, B.; Ghoshal, A.; An advanced course in Practical Chemistry, 3rd edition, New Central Book Agency, Kolkata, 2007.
3. J. Mendham, R. C. Denney, J. D. Barnes, M. J. K. Thomas, "Vogel's Textbook of Quantitative Chemical Analysis" Longman New Delhi, 2000.

SEMESTER II

24UCS402: General Chemistry II

Unit 1: Chemical Bonding

Ionic bond – formation, variable electro valency – Lattice energy, Born –Haber Cycle. Covalent bond - formation, variable covalency, maximum covalency, covalent character in ionic bond – Fajans' Rule. Polarization – partial ionic character of a covalent bond. VB theory, MO theory – Basic principles of bonding and antibonding orbitals, applications of MOT to H_2, He_2, N_2& O_2 – molecular orbital sequence, comparison of VB & MO Theories. Hybridization – Formation of $BeCl_2$& BCl_3. VSEPR theory of simple inorganic molecules – $BeCl_2$, $SiCl_4$, PCl_5, SF_6, IF_7, XeF_6, BF_3& H_2O. Hydrogen bonding – Intermolecular & Intramolecular H_2 – bonding and consequences.

Unit – 2: Chemistry of s -Block and Zero Group Elements

General characteristics of s - block elements – comparative study of elements – alkali metals and their hydroxides, oxides and halides, alkaline earth metals and their oxides, carbonates and sulphates. Diagonal relationship of Li & Mg, Be & Al, chemistry of NaOH, KI & Mg $(NH_4)PO_4$. Qualitative Inorganic Analysis – Dry Test, flame test, cobalt nitrate test wet confirmatory test for acid radicals, interfering acid radicals – elimination of interfering acid radicals.Zero group elements – position in the periodic table, occurrence, isolation, applications, compounds of Xe - XeF_4, XeF_6 & $XeOF_4$.

Unit – 3: Chemistry of Benzene and Benzenoid Compounds

Aromaticity – Huckle's rule - structure of benzene – Benzenepreparation, chemical properties and uses. Aromatic electrophilic substitution reactions and mechanism – Orientation and reactivity in substituted benzenes. Polynuclear aromatic hydrocarbons – Nomenclature, Naphthalene from coal tar and petroleum – Laboratory preparation, Structure of Naphthalene, Aromatic character, Physical properties, Chemical properties, Uses. Mechanism of Aromatic electrophilic substitution – Theory of orientation and reactivity. Anthracene, Phenanthrene from coal tar and petroleum, Laboratory preparation, Molecular Orbital structures, Aromatic Characters, Physical Properties, Chemical properties and uses. Preparation of biphenyls, Physical and Chemical properties and uses.

Unit – 4: Alkyl and Aryl Halogens

Nomenclature of haloalkanes – structure - general preparations of haloalkanes - physical and chemical properties and uses. Nucleophilic aliphatic substitution reaction mechanisms (SN1 and SN2) – Stereo chemical aspects. Halobenzenes: Theory of orientation and reactivity - general preparation – properties - uses. Electrophilic and nucleophilic aromatic substitution reaction mechanisms.

Unit – 5: Atomic Structure and Basic Quantum Mechanics

Rutherford's and Bohr's model an atom- Bohr's theory and origin of hydrogen spectrum. Somerfield's extension of Bohr's theory. Electromagnetic radiation- definitions for λ, υ and velocity. Dualism of light -Particle nature of radiation- black body radiation and Planck's quantum theory, photoelectric effect and Compton effect of matter. De Broglie hypothesis and

Davisson and Germer experiment. Heisenberg's uncertainty principle. Schrodinger wave equation (Derivation not needed). Physical significance of Ψ and Ψ^2.

Text Books:

1. R.D. Madan, "Modern Inorganic Chemistry", 2nd edition, S. Chand & Company Ltd., 2000.
2. B.R. Puri, L.R. Sharma, K.K. Kalia, Principles of Inorganic Chemistry, 23rd edition, New Delhi, ShobanLalNagin Chand & Co., (1993).
3. Bahl, B.S. and Bahl, A., Advanced Organic Chemistry, (12th edition), New Delhi, Sultan Chand & Co., (2010).
4. Puri B.R., Sharma L.R. and Pathania M.S. Principles of Physical chemistry, (35th edition), New Delhi: ShobanLal Naginchand and Co. (2013)

Reference Books:

1. J.D. Lee, 'Concise Inorganic Chemistry', 20th revised edition, Sultan Chand & Sons, 2000. R. Gopalan, P.S. Subramanian & K. Rengarajan, "Elements of Analytical Chemistry", 2nd edition, Sultan Chand & Sons
2. Morrison, R.T. and Boyd, R.N., Bhattacharjee, S. K. Organic Chemistry (7th edition), Pearson, India, (2011).
3. Jerry March, "Advanced Organic Chemistry, Reaction, Mechanism and Structure", 7th Edition, Wiley Inter Science (2013).
4. Glasstone S. and Lewis D., Elements of Physical Chemistry, London, Mac Millan& Co Ltd.

SEMESTER III

24UCS403: General Chemistry III

Unit 1: Chemistry of P-Block Elements

General characteristics of p-block elements. Comparative study of elements of p block elements & their compounds. Compounds of boron –boric acid, borax, borazole. Extraction of Al and Pb - alums, alloys of Al. Chemistry of oxides of carbon – CO, CO_2. Allotropic forms of carbon. Compounds of nitrogen and phosphorous – $NH_2.NH_2$, H_2NOH, hydrazoic acid, N_2– Cycle, fixation of N_2, PH_3 and P_2O_5.

Unit 2: Nuclear Chemistry

Introduction, nuclear structure – composition of the nucleus, subatomic particles, nuclear forces, nuclear stability – mass defect and binding energy, whole number rule and packing fraction, n-p ratio, odd even rules, nuclear models – liquid drop and shell models, isobars, isotones and isomers. Isotopes – detection, physical and chemical methods of separation, isotopic constitution of elements. Radioactivity – introduction – radioactive emanations – characteristics of α, β and γ rays, disintegration theory, modes of decay-group displacement law, rate of integration and half-life period, disintegration series, Geiger- Nuttal rule.

Unit 3: Chemistry of Alcohols, Phenols and Ethers

Nomenclature – industrial source of alcohols – preparation of alcohols: hydration of alkenes, oxymercuration, hydroboration, Grignard addition, reduction – physical properties – chemical properties - uses – glycols from dihydroxylation, reduction, substitution reactions and glycerol and their uses. Preparation of phenols including di- and trihydroxy phenols – physical and chemical properties - uses – aromatic electrophilic substitution mechanism – theory of orientation and reactivity. Preparation of ethers: dehydration of alcohols, Williamson's synthesis – silyl ether. epoxides from peracids - Sharpless asymmetric epoxidation – reactions of epoxides– uses – introduction to crown ethers – structures – applications.

Unit 4: Solid State

Solid state chemistry: Ionic bonding - lattice energy - Born equation and its derivation, radius ratio rules - structures of some ionic crystals - Sodium chloride, Zinc blende, Wurtzite, Rutile - derivation of Bragg's equation - defects in solids, non-stoichiometric compounds - semiconductors – superconductors - Structure of solids - classification of solids - amorphous and crystalline solids - Van der waals crystals - covalent crystals - Laws of crystallography - Elements of symmetry - Weiss and Miller indices - crystal systems and Bravais lattices - structure of ionic solids - Crystal defects - Schottky and Frenkel defects – F-center.

Unit 5: Gaseous State

Gases – Boyle's law, Charle's law and Avogadro's law- ideal gas equation. Real Gases- deviation from ideal behavior – van der Waals equation of states- derivation –significance of critical constants- law of corresponding states- compressibility factor. Inversion temperature and liquefaction of gases- Linde and Claude – demagnetization methods. Maxwell's distribution of molecular velocities (Derivation not needed). Types of molecular velocities- mean, most probable and root mean square velocities-Inter relationships. Collision diameters mean free path and collision number.

TEXTBOOKS:

1. R.D. Madan, "Modern Inorganic Chemistry", 2nd edition, S. Chand & Company Ltd., 2000.
2. B.R. Puri, L.R. Sharma, K.K. Kalia, Principles of Inorganic Chemistry, 23rd edition, New Delhi, ShobanLalNagin Chand & Co., (1993).
3. Bahl, B.S. and Bahl, A., Advanced Organic Chemistry, (12th edition), New Delhi, Sultan Chand & Co., (2010).
4. Puri B.R., Sharma L.R. and Pathania M.S. Principles of Physical chemistry, (35th edition), New Delhi: ShobanLal Naginchand and Co. (2013)

REFERENCE BOOKS:

1. J.D. Lee, ‘Concise Inorganic Chemistry’, 20th revised edition, Sultan Chand & Sons, 2000. R. Gopalan, P.S. Subramanian & K. Rengarajan, “Elements of Analytical Chemistry”, 2nd edition, Sultan Chand & Sons
2. Morrison, R.T. and Boyd, R.N., Bhattacharjee, S. K. Organic Chemistry (7th edition), Pearson, India, (2011).
3. Jerry March, “Advanced Organic Chemistry, Reaction, Mechanism and Structure”, 7th Edition, Wiley Inter Science (2013).
4. Glasstone S. and Lewis D., Elements of Physical Chemistry, London, Mac Millan& Co Ltd.

24UCS603: Industrial Chemistry

Unit 1: Basic Ideas and Industrial Wastes

Basics idea about unit operation – flow chart – chemical conversion – batch versus continuous processing – chemical process selection – design – chemical process control. Types of industrial wastes – treatment of wastes or effluent with organic impurities – treatment of wastes or effluent with inorganic impurities.

Unit 2: Petroleum and Petrochemicals

Introduction – saturated hydrocarbons from natural gas – uses of saturated hydrocarbons – unsaturated hydrocarbons – acetylene, ethylene, propylene, butylene – aromatic hydrocarbons – toluene and xylene. petrochemicals in India.

Unit 3: Manufacture of Cement

Introduction – types of cement – high alumina cement, water proof cement, slag cement, acid resisting cement, white cement, coloured cement, Pozzolana cement. Setting of cement – properties of cement – testing of cement – uses of cement – concrete – cement industries in India.

Unit 4: Pulp and Paper:

Introduction – manufacture of pulp – types of pulp – sulphate or craft pulp, soda pulp, Rag pulp – beating, refining, filling, sizing and coloring. Calendaring – uses – paper industries in India.

Unit 5: Soaps, Detergents and Perfumes

Introduction – types of soaps – hard and soft soaps – manufacture of soap (hot and continuous process only) – cleansing action of soap – detergents – surface active agents Introduction – production of natural perfumes – flower perfumes – jasmine, rose and lily – production of synthetic perfumes – muscone and nitro-musks.

Text Books:

1. Industrial Chemistry PART 1 & 2" by B.K. Sharma 2023

Reference Books:

1. "Handbook of Industrial Chemistry and Biotechnology" by James A. Kent, Tilak V. Bommaraju, and Scott D. Barnicki
2. "Riegel's Handbook of Industrial Chemistry" by James A. Kent

24UCH553: Organic Qualitative Analysis and Preparation Lab

Experiments:

I Organic Analysis

Analysis of the following organic compounds.

1. Carbohydrate, 2. Amide, 3. Aldehyde, 4. Ketone, 5. Acid 6. Amine

The students should perform specific tests for elements, aliphatic or aromatic, saturated or unsaturated and functional group present, exhibit their solid derivative and record their observations.

II Preparation of Organic Compounds (Any Four)

a. Nitration - picric acid from Phenol
b. Halogenation - p-bromo acetanilide from acetanilide
c. Oxidation - benzoic acid from Benzaldehyde
d. Methyl benzoate to Benzoic acid
e. Salicylic acid from Methyl Salicylate
f. Rearrangement - Benzil to Benzilic Acid
g. Hydrolysis of benzamide to Benzoic Acid

Text Books:

1. N. S. Gnanaprakasam and G. Ramamurthy, Organic Chemistry Lab Manual; S.V. Printers, 1987.
2. Venkateswaran V, Veeraswamy R., Kulandaively A.R., Basic principles of practical chemistry, 2nd edition, New Delhi, Sultan chand & sons, (1997)

References Books:

A. I. Vogel, A. R. Tatchell, B. S. Furniss, A. J. Hannaford and P. W. G. Smith, Vogel's Textbook of Practical Organic Chemistry; 5th Ed., Prentice Hall, 1989.

SEMESTER IV

24UCS404: General Chemistry IV

Unit 1: Chemistry of d - Block Elements

Chemistry of transition elements - electronic configuration - Characteristics of d-block elements with special reference to electronic configuration, variable valence, ability to form complexes, magnetic properties & catalytic properties. Stability of various oxidation states and standard reduction potentials. Comparative treatment of second and third transition series with their 3d analogues and uses. Chemistry of Ti, V, Cr, Mn, Fe and Co in various oxidation states (excluding their metallurgy).

Unit 2: Chemistry of f - Block Elements

Chemistry of Lanthanides: Position in periodic table, electronic structure, oxidation state, ionic and atomic radii- lanthanide contraction- cause and consequences, anomalous behaviour of post lanthanides-complexation- type of donor ligands preferred. Magnetic properties paramagnetism. Colour and spectra, f-f transitions –occurrence and separation– ion exchange method, solvent extraction. Chemistry of actinides- general features – electronic configuration, oxidation state, actinide contraction, colour and complex formation. Comparison with lanthanides.

Unit 3: Stereochemistry

Isomerism – constitutional isomers – stereoisomers - enantiomers - diastereomers – geometrical isomerism - meso and dl compounds used in stereochemistry. D, L notations to express configurations – chirality-optical isomerism – optical activity – polarimeter – specific rotation. Stereo selectivity, stereo specificity in organic reactions with examples. Resolution of racemic mixture – Walden Inversion – conformational analysis of cyclohexane - asymmetric induction.

Unit 4: Chemical Kinetics

Rate of reaction, molecularity and order of reaction, concentration dependence of rates, mathematical characteristic of simple chemical reactions zero order, first order, second order, pseudo-order, halflife and mean life. Determination of the order of reaction differential method, method of integration, half-life method and isolation method.

Theories of chemical kinetics: Effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy. Simple collision theory based on hard sphere model, transition state theory (equilibrium hypothesis).

Unit 5: Acids, Bases and Non- Aqueous Solvents

Concepts of Acids and Bases - Arrhenius concept, Bronsted-Lowry concept, Lewis concept; Relative strengths of acids, bases and dissociation constant; dissociation of poly basic acids, ionic product of water, pH scale, pH of solutions; Degree of dissociation, common ion effect, factors affecting degree of dissociation; acid base indicators, theory of acid base indicators – action of phenolphthalein and methyl orange, titration curves - use of acid base indicators; Solubility product - determination and applications.

Text Books:

1. R.D. Madan, “Modern Inorganic Chemistry”, Revised edition, S. Chand & Company Ltd., (2012)

2. B.R. Puri, L.R. Sharma, K.K. Kalia, Principles of Inorganic Chemistry, 33rd edition, New Delhi, Milestone Publishers & Distributors (2013).
3. Bahl, B.S. and Bahl, A., Advanced Organic Chemistry, 22nd edition), New Delhi, Sultan Chand & Co., (2019).
4. Puri B.R., Sharma L.R. and Pathania M.S. Principles of Physical chemistry, (35th edition), New Delhi: ShobanLal Naginchand and Co. (2013)

Reference Books:

5. J.D. Lee, 'Concise Inorganic Chemistry', 20th revised edition, Sultan Chand & Sons, 2000. R. Gopalan, P.S. Subramanian & K. Rengarajan, "Elements of Analytical Chemistry", 2nd edition, Sultan Chand & Sons
6. Morrison, R.T. and Boyd, R.N., Bhattacharjee, S. K. Organic Chemistry (7th edition), Pearson, India, (2011).
7. Jerry March, "Advanced Organic Chemistry, Reaction, Mechanism and Structure", 7th Edition, Wiley Inter Science (2013).
8. Glasstone S. and Lewis D., Elements of Physical Chemistry, London, Mac Millan& Co Ltd.

24UCH501: Carbonyl and Nitrogen Compounds, Reagents and Rearrangements

Unit 1: Aldehydes & Ketones

Structure- Nomenclature - physical properties – Preparation - Reactions-oxidation-reduction-addition of cyanide, derivatives of ammonia, alcohols,cannizaro reaction, addition of Grignard reagents, Grignard synthesis, Iodoform test-acidity of α-hygrogens-Nucleophilic addition:aldol condensation, crossed aldol condensation, wittig reaction, claisen condensation,crossed claisen condensation

Unit 2: Carboxylic acids and their Derivatives

Structure – Nomenclature -physical properties -Industrial source-preparation-Reactions-acidity of carboxylic acids-Structure of carboxylate ion - Effect of substituents on acidity- Dicrboxylic acids -Derivatives of Carboxylic acids-Structure – Nomenclature-physical properties-Acid chlorides: preparation-reactions-conversion of acid chlorides into acid derivatives-Acid anhydrides: preparation-reactions-Esters: preparation- reactions

Unit 3: Nitrogen Compounds

Nomenclature - nitro alkanes - alkyl nitrites - differences - aromatic nitro compounds - preparation and reduction of nitro benzene under different conditions, TNT. Amines - Structure - Classification - Nomenclature- physical properties- Industrial source- preparation-Synthesis of secondary and tertiary amines-Reactions-basicity of amines-Effect of substituents on basicity of aromatic amines-Quaternary ammonium salts-Ring substitution in aromatic amines-Diazonium salts-preparation and reactions-Sandmeyer reaction, Gatterman reaction-Coupling of diazonium salts Amides: preparation - reactions-hydrolysis-Imides

Unit 4: Reagents for Oxidation and Reduction Reactions:

Oxidation: Osmium tetroxide – Chromyl chloride – Ozone – DDQ – Dioxiranes. Lead tetraacetate - selenium dioxide – DMSO either with Ac_2O or oxalyl chloride – Dess-Martin reagent. Reduction: Catalytic hydrogenation using Wilkinson Catalyst – Reduction with LAH, $NaBH_4$, tri-tertiarybutoxy aluminum hydride, $NaCNBH_3$, hydrazines.

Unit 5: Molecular Rearrangements

Pinacol rearrangement, Wagner Meerwin rearrangement, Hoffmann rearrangement, Curtius rearrangement, Lossen rearrangement, Beckmann rearrangement, Benzilic acid rearrangement – Benzidine rearrangement, Claisen rearrangement, Fries rearrangement.

Text Books

1. Robert Thornton Morrison, Robert Neilson Boyd, Organic Chemistry, 6th Edition, Prentice Hall of India Pvt. Ltd., 2005.
2. Stanley H. Pine, Organic Chemistry, 5th Edition, Tata McGraw-Hill Education Pvt. Ltd., 2007.

Reference Books:

1. Jerry March, Advanced Organic Chemistry, Reaction, Mechanism and Structure,7th Edition, Wiley Inter Science 2013.
2. Arun Bahl, B S Bahl, Advanced Organic Chemistry, Revised Edition, S. Chand and Company Ltd., 2012.

24UCH402: Coordination and Organometallic Chemistry

Unit 1: Basics of Coordination Compounds

Coordination compounds – definition, classification. Double salts and Coordination Compounds. Types of Ligands (monodentate, bidentate, polydentate) and chelate effect. Coordination number and geometry – octahedral, tetrahedral and square planar complexes. Nomenclature of coordination compounds – IUPAC rules. Isomerism in coordination compounds – structural isomerism (ionization, hydrate, linkage) and stereoisomerism (geometrical and optical isomerism).

Unit 2: Bonding and Stability of Coordination Compounds

Valence Bond Theory (VBT) – postulates, hybridization, geometry, inner orbital and outer orbital complexes. Crystal Field Theory (CFT) – splitting of d-orbitals in octahedral and tetrahedral fields, crystal field stabilization energy (CFSE), factors affecting crystal field splitting. Ligand Field Theory (LFT) – basic concepts. Spectrochemical series – strong and weak field ligands.

Unit 3: Properties and Applications of Coordination Compounds

Stability of coordination compounds – thermodynamic and kinetic stability, factors affecting stability Colour of coordination compounds – d–d transitions and charge transfer transitions. Magnetic properties – paramagnetism, diamagnetism and spin-only magnetic moment. Stability constants and factors influencing stability. Applications of coordination compounds – biological importance (hemoglobin, chlorophyll), medicinal applications (cisplatin), analytical applications (EDTA titrations), and industrial applications.

Unit 4: Fundamentals of Organometallic Chemistry

Introduction – definition, scope and importance of organometallic chemistry. Nature of metal–carbon bond, ionic vs covalent character – Classification of ligands – σ-bonded and π-bonded ligands, concept of hapticity (η^n) – Electron counting in reactions and 18-electron rule, Effective Atomic Number (EAN) Rule, Wade's Rule – Oxidation states and coordination number in organometallic compounds Metal alkyls, aryls and hydrides – structure, bonding and stability

Unit 5: Reactions and Catalysis of Organometallic Compounds

Elementary reactions of organometallic compounds – ligand substitution reactions .Oxidative addition and reductive elimination – Migration (Insertion) reactions and elimination reactions – Nucleophilic and electrophilic addition and abstraction – Applications of organometallic compounds.

Text Books:

1. J.D. Lee (2010), Concise Inorganic Chemistry, 5th edition, New Delhi, Wiley India.
2. Robert H. Crabtree (2005), The Organometallic Chemistry of the Transition Metals, 4th edition, New Jersey, Wiley.
3. F.A. Cotton and G. Wilkinson (1999), Advanced Inorganic Chemistry, 6th edition, New York, Wiley.

Reference Books:

1. R. Gopalan, P.S. Subramanian & K. Rengarajan (2012), Inorganic Chemistry, 3rd edition, New Delhi, Vikas Publishing House.
2. B.D. Gupta and Anil J. Elias (2013), Basic Organometallic Chemistry, 2nd edition, Hyderabad, Universities Press.
3. G.A. Lawrance (2010), Introduction to Coordination Chemistry, New York, Wiley.

24UCH503: Fundamental Concepts in Physical Chemistry

Unit 1: Thermodynamics I

First law of Thermodynamics, Work & heat, Expansion Work, Work of compression, Reversible & Irreversible Transformation, Relationship between C_P & C_V, Dependence of the heat of reaction on Temperature. Second law ofThermodynamics, The carnot cycle, The Efficiency of Heat Engine, Thermodynamic Temperature Scale, Definition of Entropy, Clausius Inequality

Unit 2: Thermodynamics II

Third law of Thermodynamics, Entropy as a function of Temperatre & Volume, Entropy as a function of Temperatre & Pressure, Entropy changes in Ideal Gas, Entropy changes in Chemical Reactions, Conditions for Equilibrium & Spontanity under constraints, Thermodynamic Equation of state, Properties of A, Properties of G, Temperature dependence of the Gibbs energy, Lachatelier principle, Gibbs Duhem Equation

Unit 3: Solutions

Characteristics of the Ideal Solution, The Chemical Potential in Ideal Solution, Binary Solutions, The Lever Rule, Azeotropes, The Ideal Dilute Solutions, Benzene- Toluene, Acetone Chloroform, Colligative properties, relative lowering of vapour pressure, osmosis, law of osmotic pressure, derivation of elevation of boiling point and depression in freezing point. Application- determination of molecular mass by Rast method only.

Unit 4: Phase Equilibria

Stability of the phase of a pure substance, The Clapeyron Equation, Phase Diagram of Water, Phase Diagram of Sulfur, Phase Rule, Simple Eutectic System, Lead Antimony System, Thermal Analysis Compounds having Incongruent Melting point, Sodium Sulfate Water system, Partial miscibility in Solid state, Double Salt formation.

Unit 5: Photochemistry and Group Theory

Laws of Photochemistry, Consequences of Light Absorption- Jablonski Diagram, Quantum Yield, Photochemistry Reaction- Photosensitization and Quenching, fluorescence,

phosphorescence. Group Theory- Operations and symmetry elements, The symmetry classification of Molecules, Some immediate consequences of symmetry, Character tables and symmetry labels, Vanishing integrals and orbital overlap, Vanishing integrals and selection rules.

Text Books

1. Gilbert W. Castellan, Physical Chemistry, 3rd edition, Pearson Education, 2010.
2. Principles and Applications of Photochemistry -Brian Wardle- John Wiley & Sons, Ltd- 2009.
3. Peter Atkins, Julio de Paula, Physical chemistry- 8th edition, Oxford University, 2006.

Reference Books

1. Puri, Sharma & Pathania, Physical Chemistry, 8th edition, Pearson Education, 2010.
2. J. Rajaram and J. C. Kuriacose, Thermodynamics for Students of Chemistry - Classical, Statistical and Irreversible; Pearson Education, New Delhi, 2013.
3. K. K. Rohatgi-Mukherjee, Fundamentals of Photochemistry; 3rd Ed., New Age International Pvt. Ltd., New Delhi, 2014.

24UCS405: Analytical Chemistry

Unit 1: Data Analysis

Accuracy and precision - Determinate errors - Indeterminate errors - Siginifacant figures - Rounding off – way of expressing accuracy - Standard deviation - Propagation of errors – Confidence limit - Rejection of result - Linear least squares – Correlation Coefficient and Coefficient of determination

Unit 2: Separation and Purification Techniques

Solvent extraction of metals – Solid phase extraction – Principles of chromatography Separation – Gas chromatography – Liquid chromatography - Ion exchange Chromatography – Thin layer chromatography

Unit 3: Gravimetric Analysis

Introduction – Conditions - Digestion – Impurities in precipitates – Washing and filtering – Drying or igniting – Gravimetric calculations - Examples of Gravimetric analysis – Organic Precipitates – Inorganic Precipitates.

Unit 4: Electroanalytical and Thermoanalytical Methods

Electrogravimetry – Electrolytic Separation of metals - coulometry analysis – Amperometry titration – TGA - Principle, Instrumentation – TGA Analysis – DTA – Principle , Instrumentation – Factor affecting of TGA and DTA

Unit 5: Analytical Chemistry in Consumer Protection

Role of analytical chemistry in consumer protection and quality assurance - Food analysis: detection of adulterants in milk, edible oils, spices, and beverages using classical and instrumental methods. Determination of food additives, preservatives, and contaminants (pesticides, heavy metals) using chromatographic and spectroscopic techniques. Water quality analysis: physicochemical parameters (pH, hardness, alkalinity, dissolved oxygen, BOD, COD) and determination of toxic metals using atomic absorption spectroscopy (AAS).

Text Books

1. Gary D. Christian, Purnendu K. Dasgupta, Kevin A. Achug, Analytical Chemistry, 7th Edition, Wiley, 2014.
2. David Harvey, Modern Analytical Chemistry, McGraw-Hill Higher Education, 2000

Reference Books

1. H. H. Willard, L. L. Merritt, J. A. Dean and F. A. Settle, Instrumental Methods of Analysis, 6th Ed., CBS Publishers and Distributors, Chennai, 1986.
2. D. A. Skoog, D. M. West and D. J. Holler, Fundamentals of Analytical Chemistry, 7th Ed., Harcourt College Publishers, Singapore, 2004.

24UCH555: Physical Chemistry Non-Electrical Lab

Syllabus:

1. Critical Solution Temperature
2. Effect of impurity on Critical Solution Temperature
3. Transition Temperature
4. Rast Method
5. Phase Diagram (Simple eutectic system)
6. Kinetics of Ester Hydrolysis
7. Partition Co-efficient of iodine between water and carbon tetrachloride.

Text Book:

Venkateswaran V, Veeraswamy R., Kulandaively A.R., Basic Principles of Practical Chemistry, 2nd Edition, New Delhi, Sultan Chand & sons,1997.

Reference Books

1. Arthur W. Adamson, *A Textbook of Physical Chemistry*, 2nd Edition, Academic Press, 1973.
2. G. W. Castellan, *Physical Chemistry*, 3rd Edition, Narosa Publishing House, 1983.

24UCH701: Advanced Concepts in Chemistry

Unit 1: Green Chemistry

Introduction: Definition, importance, and 12 principles of green chemistry - Atom economy and green metrics (E-factor – basic idea) - Green solvents: water, supercritical CO_2, ionic liquids (overview) - Simple green synthesis methods (microwave, solvent-free reactions)

Unit 2: Supramolecular Chemistry

Definition and scope - Non-covalent interactions: hydrogen bonding, van der Waals forces - Host–guest chemistry: crown ethers and cyclodextrins (basic idea) - Applications in drug delivery and sensors

Unit 3: Metal–Organic Frameworks

Definition and basic structure (metal nodes and linkers) - Simple methods of synthesis (concept only) - Properties: porosity and surface area - Applications: gas storage and catalysis

Unit 4: Energy Conversion

Renewable energy sources: solar and hydrogen - Fuel cells: working principle - Batteries: lithium-ion batteries - Solar cells: photovoltaic principle

Unit 5: Computational Chemistry

Introduction and scope - Molecular modeling (basic idea) - Quantum chemistry: qualitative idea of Schrödinger equation - Applications: drug design and prediction of properties

Text Books:

1. Paul T. Anastas and John C. Warner, Green Chemistry: Theory and Practice, 1st Edition, Oxford University Press, 1998.
2. Jean-Marie Lehn, Supramolecular Chemistry: Concepts and Perspectives, 1st Edition, Wiley-VCH, 1995.
3. Stefan Kaskel (Ed.), The Chemistry of Metal-Organic Frameworks: Synthesis, Characterization, and Applications, 1st Edition, Wiley-VCH, 2016.
4. Allen J. Bard and Larry R. Faulkner, Electrochemical Methods: Fundamentals and Applications, 2nd Edition, John Wiley & Sons, 2001.
5. Christopher J. Cramer, Essentials of Computational Chemistry: Theories and Models, 2nd Edition, John Wiley & Sons, 2004.

Reference Books:

1. V. K. Ahluwalia and M. Kidwai, New Trends in Green Chemistry, 2nd Edition, Anamaya Publishers, 2004.

2. Jonathan W. Steed and Jerry L. Atwood, Supramolecular Chemistry, 2nd Edition, John Wiley & Sons, 2009.
3. J. L. C. Rowsell and O. M. Yaghi, Metal–Organic Frameworks: A New Class of Porous Materials, Journal of the American Chemical Society (Review Article), 2004.
4. Ryan O'Hayre, Suk-Won Cha, Whitney Colella, and Fritz B. Prinz, Fuel Cell Fundamentals, 3rd Edition, John Wiley & Sons, 2016.
5. Andrew R. Leach, Molecular Modelling: Principles and Applications, 2nd Edition, Pearson Education, 2001.

24UCH751: Essential Laboratory Techniques

1. Determination of melting point and boiling point of organic compounds
2. Calibration of glassware (pipette, burette, volumetric flask)
3. UV–Visible spectrophotometric determination of a colored compound

Textbook

Arthur I. Vogel**,** *Vogel's Textbook of Practical Organic Chemistry*, 5th Edition, Pearson Education, 2005.

Reference Books

1. Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch**,** *Fundamentals of Analytical Chemistry*, 9th Edition, Cengage Learning, 2014.
2. Gary D. Christian, *Analytical Chemistry*, 6th Edition, John Wiley & Sons, 2004.

24UCH755: Teaching Chemistry

Syllabus

Module I: Planning of Instruction (Lesson Planning)

- Preparation of 5–10 lesson plans
- Clear learning objectives (cognitive, affective, psychomotor)
- Selection of appropriate teaching methods
- Use of teaching aids and activities
- Integration of evaluation techniques

Module II: Microteaching Sessions

- Skill of explanation (laws, principles, derivations)
- Skill of questioning (conceptual, analytical, numerical)
- Skill of reinforcement (positive feedback)
- Skill of blackboard usage (diagrams, graphs, ray diagrams)
- Skill of stimulus variation (voice, gestures, interaction)

Module III: Classroom Teaching Practice

- Teaching peers and real students
- Use of interactive strategies (discussion, demonstration, problem-solving)
- Classroom management techniques
- Addressing diverse learners and misconceptions

Module IV: Demonstration and Laboratory Work

- Demonstration of at least 3–5 experiments
- Conducting student-centered lab activities
- Maintenance of lab records and safety measures
- Linking experiments with theory

Module V: Preparation and Use of Teaching Aids

- Charts (laws, formulas, diagrams)
- Models (working/non-working models)
- ICT tools (PPTs, Simulations, Virtual labs, AI tools)
- Improvised/low-cost teaching aids

Module VI: Assessment and Evaluation

- Formative assessment (oral questions, quizzes, observation)
- Summative assessment (tests, exams, practical)
- Assignments, lab reports, and projects
- Diagnostic testing and remedial teaching
- Peer and self-assessment
- Use of rubrics and grading criteria

Module VII: Pedagogical Analysis of Chemistry Content

- Breaking topics into teachable units
- Identifying key concepts, laws, and principles
- Anticipating student difficulties and misconceptions
- Sequencing content logically

Module VIII: Professional Skills and Reflective Practice

- Self-evaluation of teaching
- Maintaining teaching diary/records
- Feedback from supervisors
- Continuous improvement in teaching methods

Reference Books

- Kochhar S.K., *Methods and Techniques of Teaching*, Sterling Publishers Pvt. Ltd., New Delhi,
- Sharma K. K. , *Teaching of Physical Science*, Vikas Publishing House Pvt. Ltd., New Delhi,