

Proposed Syllabus of Chemistry (Major & Minor) for 3-Year and 4-Year B.Sc Course

Chemistry Major

Semester-I

Papercode: **CEMMJ-T1 (Organic I)**

(Credit: 03)

Total Lectures: 45

1. Bonding and Physical Properties:

(15L)

VBT: A Fundamental Approach

Concept Of Hybridization, Shapes Of Molecules, Orbital Pictures of Bonding, Bond Polarization And Bond Polarizability, DBE and Formal Charge Calculation.

Electronic Effects: Inductive Effect, Field Effect, Mesomeric Effect, Resonance Energy; Electromeric Effect; Hyperconjugative Effect, Steric Effect, Steric Inhibition of Resonance.

Molecular Orbitals: A Fundamental Approach

Bonding and Antibonding Interactions, Types of Molecular Orbitals: σ , σ^* , π , π^* , n. Overview of Frontier MOs (FMO) - HOMO, LUMO and SOMO. Chemical Reactivity In Terms of FMO Interactions – Basic Applications. Hückel's Rules for Aromaticity. Concepts of Antiaromaticity and Homoaromaticity. Frost Diagram.

Fundamental Physical Properties of Organic Molecules

Impact Of Hybridization On Bond Dissociation Energy, Bond Energy, Bond Distances And Bond Angles. Understanding Different Types of Strains: Angle Strain, Torsional Strain, Strain Due to Non-Bonded Interaction and Dipole-Dipole, Twisting. Impact Of Covalent And Non-Covalent Intermolecular Forces On Melting Point, Boiling Point, and Solubility. Comparison of Stability Through Exp. Data: Heat of Hydrogenation, Heat of Combustion, and Heat of Formation.

2. Reaction Mechanism: Fundamental Aspects

(15L)

Mechanistic Classification Of Reactions (Definition And Examples): Ionic, Radical And Pericyclic. Types Of Reactions (Definition And Examples): Addition, Elimination, Substitution, Rearrangement, Oxidation-Reduction, Tautomerization, Condensation, Polymerization.

Homolytic and Heterolytic Bond Fission, Homogenic and Heterogenic Bond Formation

Types of Reagents. Reactive Intermediates (Generation, Structure, Stability, Electrophilic/Nucleophilic Behavior): Carbocations, Carbanions, Carbon Radicals, Carbenes, Carbenoids, Benzynes and Nitrenes

3. Basic Stereochemistry

(15L)

Chirality & Representation Of Molecules

Concept Of Chirality -Symmetry Elements And Point Groups (C_v , D_h , C_{nh} , C_{nv} , C_n , D_{nh} , D_{nd} , D_n , S_n (C_s , C_i); Molecular Chirality And Centre Of Chirality; Asymmetric And Dissymmetric Molecules;

Enantiomers And Diastereomers; Concept Of Epimers. Fischer, Sawhorse, Flying- Wedge And Newman Projection Formulae And Their Inter Translations.

Relative And Absolute Configuration:

D/L And R/S Descriptors; Erythro/Threo And Meso Nomenclature Of Compounds; Syn/Anti Nomenclatures For Aldols; E/Z Descriptors For C=C, Conjugated Diene, Triene, C=N And N=N Systems; Combination Of R/S- And E/Z- Isomerisms.

Optical activity of Chiral Compounds:

Optical Rotation, Specific Rotation And Molar Rotation; Racemic Compounds, Racemisation (Through Cationic, Anionic, Radical Intermediates And Through Reversible Formation Of Stable Achiral Intermediates); Optical Purity And Enantiomeric Excess.

Reference Books:

1. Clayden, J., Greeves, N. & Warren, S. Organic Chemistry, Second Edition, Oxford University Press, 2012. 2. Smith, J. G. Organic Chemistry, Tata Mcgraw- Hill Publishing Company Limited. 3. Nasipuri, D. Stereochemistry Of Organic Compounds, Wiley Eastern Limited. 4. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 5. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd., (Pearson Education). 6. Fleming, I. Molecular Orbitals And Organic Chemical Reactions, Reference/Student Edition, Wiley, 2009. 7. Eames, J., Peach, J. M. Stereochemistry At A Glance, Blackwell Publishing, 2003. 8. Robinson, M. J., Stereochemistry, Oxford Chemistry Primer, Oxford University Press, 2005.

Paper code: CEMMJ-P1 (Organic I)
(30 Hours)

(Credit: 01)

List of-Experiments

1. Determination Of Boiling Point:

Determination Of Boiling Point Of Common Organic Liquid Compounds E.G., Ethanol, Cyclohexane, Chloroform, Ethyl Methyl Ketone, Cyclohexanone, Acetylacetone, Anisole, Crotonaldehyde, Mesityl Oxide, Etc. [Boiling Point Of The Chosen Organic Compounds Should Preferably Be Less Than 160 °c]

2. Identification Of A Pure Organic Compound By Chemical Test(S): Solid Compounds:

Oxalic Acid, Tartaric Acid, Citric Acid, Succinic Acid, Resorcinol, Urea, Glucose, Cane Sugar, Benzoic Acid And Salicylic Acid.

Liquid Compounds:

Formic Acid, Acetic Acid, Methyl Alcohol, Ethyl Alcohol, Acetone, Aniline, Dimethylaniline, Benzaldehyde, Chloroform And Nitrobenzene.

Papercode: CEMMJ-T2 (Physical I)
Total Lectures: 45

(Credit: 03)

1.Kinetic Theory and Gaseous State:

(15L)

Kinetic Theory of Gases:

Concept Of Pressure And Temperature; Collision Diameter; Collision Number And Mean Free Path; Frequency Of Binary Collisions. Maxwell's Distribution Of Speeds In One, Two And Three Dimensions; Kinetic Energy Distribution On One, Two And Three Dimensions, Average, Root Mean Square And Most Probable Velocities. Principle Of Equipartition Of Energy.

Gaseous State:

Deviation Of Gases From Ideal Behavior; Compressibility Factor; Boyle Temperature; Andrew's And Amagat's Plots; Van Der Waals Equation And Its Features; Its Derivation And Application In Explaining Real Gas Behaviour, Critical State, Critical Constants In Terms Of Van Der Waals Constants; Law Of Corresponding States. Virial Equation Of State.

2. Thermodynamics-I:

(12L)

First Law and Zeroth Law of Thermodynamics:

Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics; First law of thermodynamics; calculations of q , w , U and H for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions; Joule's experiment and its consequence.

Thermochemistry:

Heats Of Reaction; Enthalpy Of Formation; Laws Of Thermochemistry; Bond Energy, Bond Dissociation Energy, Kirchhoff's Equations And Effect Of Pressure On Enthalpy Of Reactions. Adiabatic Flame Temperature, Explosion Temperature

3. Chemical Kinetics I:

(18L)

Rate Law, Order and Molecularity:

Elementary and Non-Elementary Reactions, Rate law Rate constants, Order; Molecularity, First, second and n th order reactions; Pseudo first order reactions Determination of order of a reaction Opposing reactions, consecutive reactions and parallel reactions

Role of Temperature and Theories of Reaction Rate:

Temperature Dependence of Rate Constant; Arrhenius Equation, Energy of Activation; - Steady-State Approximation; Theories of Reaction Rate: Collision Theory; Lindemann Theory of Unimolecular Reaction; Transition State Theory (Classical Treatment).

Reference Books:

1. Atkins, P. W. & Paula, J. de Atkins' Physical Chemistry, Oxford University Press. 2. Castellan, G. W. Physical Chemistry, Narosa. 3. McQuarrie, D. A. & Simons, J. D. Physical Chemistry: A Molecular Approach, Viva Press. 4. Engel, T. & Reid, P. Physical Chemistry, Pearson. 5. Levine, I. N. Physical Chemistry, Tata McGraw-Hill. 6. Maron, S. & Prutton Physical Chemistry. 7. Ball, D. W. Physical Chemistry, Thomson Press. 8. Mortimer, R. G. Physical Chemistry, Elsevier. 9. Laidler, K. J. Chemical Kinetics, Pearson. 10. Glasstone, S. & Lewis, G. N. Elements of Physical Chemistry. 11. Rakshit, P. C., Physical Chemistry Sarat Book House. 12. Zemansky, M. W. & Dittman, R. H. Heat and Thermodynamics, Tata- McGraw-Hill. 13. Rastogi, R. P. & Misra, R. R. An Introduction to Chemical Thermodynamics, Vikas. 14. Clauze & Rosenberg, Chemical Thermodynamics.

Papercode: CEMMJ-P2 (Physical I)

(Credit: 01)

(30 Hours)

List of Experiments

1. Determination Of Ph Of Unknown Solution (Buffer), By Colour Matching Method.
2. Study Of Kinetics Of Acid-Catalyzed Hydrolysis Of Methyl Acetate.
3. Study Of Kinetics Of Decomposition Of H_2O_2
4. Determination Of Heat Of Neutralization Of A Strong Acid By A Strong Base.

1. Introduction

(3L)

Strategies of Analytical Chemistry and its interdisciplinary applicability. Protocol of sampling. Variability and validity of analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.

2. Complexometry

(6L)

Complexometric titrations, Chelation, Chelating agents, use of indicators. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.

3. Soil Analysis

(3L)

Composition, pH of soil samples, estimation of calcium and magnesium content.

4. Analysis of water

(7L)

Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods. Determination of pH, acidity and alkalinity of a water sample. Determination of Biological Oxygen Demand (BOD).

5. Analysis Of Food Products

(7L)

Nutritional value of foods, ideas about food processing and food preservatives and adulteration. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc. Analysis of preservatives and colouring matter.

6. Chromatography

(6L)

Definition, general introduction on principles of chromatography, paper chromatography, TLC etc. Paper chromatographic separation of mixture of metal ion (Fe^{3+} and Al^{3+}). To compare paint samples by TLC method.

6. Ion-exchange

(7L)

Column, ion-exchange chromatography etc. 2. Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible).

7. Analysis of cosmetics

(6L)

Major and minor constituents and their function,m

Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate. Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration

Semester-II

Papercode: **CEMMJ-T3 (Organic 2)**

(Credit: 03)

Total Lectures: 45

1. Chemistry of Alkenes & Alkynes

(15L)

Addition To C=C: Mechanism (With Evidence Wherever Applicable), Reactivity, Regioselectivity (Markownikoff And Anti-Markownikoff Additions) And Stereoselectivity; Reactions: Hydrogenation, Halogenation, Hydrohalogenation, Hydration, Oxymercuration- Demercuration, Hydroboration-Oxidation, Epoxidation, Syn And Anti-Hydroxylation, Ozonolysis, Addition Of Singlet And Triplet Carbenes; Simmons-Smith Cyclopropanation Reaction; Electrophilic Addition To Diene (Conjugated Dienes And Allene); Radical Addition: Hbr Addition; Mechanism Of Allylic And Benzylic Bromination In Competition With Brominations Across C=C; Use Of Nbs; Birch Reduction Of Benzenoid Aromatics; Interconversion Of E- & Z- Alkenes; Contra-Thermodynamic Isomerization Of Internal Alkenes.

Addition To C≡C (In Comparison To C=C): Mechanism, Reactivity, Regioselectivity (Markownikoff & Anti-Markownikoff Addition) And Stereoselectivity; Reactions: Hydrogenation, Halogenations, Hydrohalogenation, Hydration, Oxymercuration- Demercuration, Hydroboration-Oxidation, Dissolving Metal Reduction Of Alkynes (Birch); Reactions Of Terminal Alkynes By Exploring Its Acidity; Interconversion Of Terminal And Non-Terminal Alkynes.

2. Reaction Mechanism-II

(15L)

Reaction thermodynamics: Free energy and equilibrium, enthalpy and entropy factor, calculation of enthalpy change via BDE, intermolecular & intramolecular reactions.

Concept of organic acids and bases: Effect of structure, substituent and solvent on acidity and basicity; proton sponge; gas-phase acidity and basicity; comparison between nucleophilicity and basicity; HSAB principle; application of thermodynamic principles in acid-base equilibria.

Tautomerism: Prototropy (keto-enol, nitro - aci-nitro, nitroso-oximino, diazo- amino and enamine-imine systems); valence tautomerism and ring-chain tautomerism; composition of the equilibrium in different systems (simple carbonyl; 1,2- and 1,3-dicarbonyl systems, phenols and related systems), factors affecting keto-enol tautomerism; application of thermodynamic principles in tautomeric equilibria.

Reaction kinetics: Rate constant and free energy of activation; concept of order and molecularity; free energy profiles for one-step, two-step and three-step reactions; catalyzed reactions: electrophilic and nucleophilic catalysis; kinetic control and thermodynamic control of reactions; isotope effect: primary and secondary kinetic isotopic effect (k_H/k_D); principle of microscopic reversibility; Hammond's postulate.

3. Aromatic Substitutions:

(8L)

Electrophilic aromatic substitution: mechanisms and evidences in favour of it; orientation and reactivity; reactions: nitration, nitrosation, sulfonation, halogenation, Friedel-Crafts reaction; one-carbon electrophiles (reactions: chloromethylation, Gatterman-Koch, Gatterman, Houben- Hoesch, Vilsmeier-Haack, Reimer-Tiemann, Kolbe-Schmidt); Ipso substitution.

Nucleophilic aromatic substitution: addition-elimination mechanism and evidences in favour of it; S_NAr mechanism; cine substitution (benzyne mechanism), structure of benzyne.

4. Chemistry of Alcohols, Ethers and Phenols

(7L)

- a. **Alcohols:** (up to 5 Carbons). Preparation: 1°-, 2°- and 3°- alcohols: using Grignard reagent, reduction of aldehydes, ketones, carboxylic acid and esters; Reactions: With sodium, HX (Lucas test), oxidation (alkaline KMnO_4 , acidic dichromate, concentrated HNO_3); Oppenauer oxidation;
- b. **Diols:** Preparation (with OsO_4); pinacol- pinacolone rearrangement (with mechanism) (with symmetrical diols only).
- c. **Phenols:** Preparation: cumene hydroperoxide method, from diazonium salts; acidic nature of phenols; Reactions: electrophilic substitution: nitration and halogenations; Reimer-Tiemann reaction, Houben-Hoesch condensation, Schotten-Baumann reaction, Fries rearrangement and Claisen rearrangement.
- d. **Ethers:** Preparation: Williamson's ether synthesis; Reaction: cleavage of ethers with HI.

Reference Books:

1. Clayden, J., Greeves, N., Warren, S. Organic Chemistry, Second edition, Oxford University Press 2012. 2. Sykes, P. A guidebook to Mechanism in Organic Chemistry, Pearson Education, 2003. 3. Smith, J. G. Organic Chemistry, Tata McGraw-Hill Publishing Company Limited. 4. Carey, F. A., Giuliano, R. M. Organic Chemistry, Eighth edition, McGraw Hill Education, 2012. 5. Loudon, G. M. Organic Chemistry, Fourth edition, Oxford University Press, 2008. 6. Norman, R.O. C., Coxon, J. M. Principles of Organic Synthesis, Third Edition, Nelson Thornes, 2003. 7. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 8. Finar, I. L. Organic Chemistry (Volume 1), Pearson Education. 9. Graham Solomons, T.W., Fryhle, C. B. Organic Chemistry, John Wiley & Sons, Inc. 10. March, J. Advanced Organic Chemistry, Fourth edition, Wiley. 11. Jenkins, P. R., Organometallic Reagents in Synthesis, Oxford Chemistry Primer, Oxford University Press. 12. Ward, R. S., Bifunctional Compounds, Oxford Chemistry Primer, Oxford University Press

Papercode: CEMMJ-P3 (Organic 2)
(30 Hours)

(Credit: 01)

List of Practicals

Organic Preparations-I:

A. The following reactions are to be performed, noting the yield of the crude product:

1. Nitration of aromatic compounds
2. Condensation reactions
3. Hydrolysis of amides/imides/esters
4. Acetylation of phenols/aromatic amines
5. Benzoylation of phenols/aromatic amines

B. Purification of the crude product is to be made by crystallization from water/alcohol, crystallization after charcoal treatment, or sublimation, whichever is applicable.

C. Melting point of the purified product is to be noted.

Papercode: CEMMJ-T4 (Inorganic 1)

(Credit: 03)

Total Lectures: 45

1. Atomic Structure:

(15 L)

Bohr's theory, its limitations and atomic spectrum of hydrogen atom; Sommerfeld's Theory. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's

wave equation, significance of ψ and ψ^2 . Quantum numbers and their significance. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of s, p, d and f orbitals. Pauli's Exclusion Principle, Hund's rules and multiplicity, Exchange energy, Aufbau principle and its limitations, Ground state Term symbols of atoms and ions for atomic number upto 30.

2. Chemical Periodicity:

(15 L)

Modern IUPAC Periodic table, Effective nuclear charge, screening effects and penetration, Slater's rules, atomic radii, ionic radii (Pauling's univalent), covalent radii, lanthanide contraction. Ionization potential, electron affinity and electronegativity (Pauling's, Mulliken's and Allred Rochow's scales) and factors influencing these properties, group electronegativities. Group trends and periodic trends in these properties in respect of s-, p- and d-block elements. Secondary periodicity, Relativistic Effect, Inert pair effect.

3. Acid and bases:

(15 L)

Acid-base concept: Arrhenius concept, theory of solvent system (in H_2O , NH_3 , SO_2 and HF), Bronsted-Lowry's concept, relative strength of acids, Pauling's rules. Lux-Flood concept, Lewis concept, group characteristics of Lewis acids, solvent levelling and differentiating effects. Thermodynamic acidity parameters, Drago-Wayland equation. Hammett acidity function. Super acids, Gas phase acidity and proton affinity; HSAB principle. Acid-base equilibria in aqueous solution (Proton transfer equilibria in water), pH, buffer, salt hydrolysis. Acid-base neutralization curves; indicator, choice of indicators.

Recommended Text Books and Reference Books:

1. Lee, J. D. Concise Inorganic Chemistry, 5th Ed., Wiley India Pvt. Ltd., 2008.
2. Atkins, Overton, Rourke, Weller, Armstrong; Shriver & Atkins' Inorganic Chemistry, 5th Ed., Oxford University Press (2010).
3. G. L. Miessler, D. A. Tarr, Inorganic Chemistry, 3rd Edition, Pearson India, 2008
4. R. Sarkar, General and Inorganic Chemistry Part-I New Central Book Agency 2014
5. A. G. Sharpe, C. E. Housecroft, Inorganic Chemistry 3rd Edition, Pearson India, 2002
6. J. E. Huheey, E. A. Keiter, R. L. Keiter, Okhil K. Medhi, Principles of Structure and Reactivity, 5th Edition, Pearson India, 2022

Papercode: CEMMJ-P4 (Inorganic 1)

(Credit: 01)

(30 Hours)

List of Practicals

Acid – Base Titration:

1. Estimation Of Na_2CO_3 And NaOH In A Mixture.
2. Estimation Of NaHCO_3 And Na_2CO_3 In A Mixture.
3. Estimation Of Alkali Content Of Antacid Tablet.
4. Estimation Of Acetic Acid Content Of Commercial Vinegar.

Basics Of Qualitative Inorganic Analysis:

Only dry tests and confirmatory tests of simple water soluble single salts like $(\text{NH}_4\text{Cl}/(\text{NH}_4)_2\text{SO}_4)$, $\text{Pb}(\text{NO}_3)_2$, CuSO_4 , $\text{Cr}_2(\text{SO}_4)_3$, $\text{Al}_2(\text{SO}_4)_3$, FeSO_4 , $\text{NiCl}_2/\text{NiSO}_4$, ZnSO_4 , $\text{MnCl}_2/\text{MnSO}_4$, $\text{CoCl}_2/\text{CoSO}_4$, CaCl_2 , $\text{BaCl}_2/\text{Ba}(\text{NO}_3)_2$, $\text{SrCl}_2/\text{Sr}(\text{NO}_3)_2$, NaCl , KCl , $\text{MgCl}_2/\text{MgSO}_4$.

1. Chemistry in Food and Beverages: (6L)

Dairy Products: Composition Of Milk And Milk Products. Analysis Of Fat Content, Minerals In Milk And Butter. Estimation Of Added Water In Milk. **Beverages:** Analysis Of Caffeine In Coffee And Tea, Detection Of Chicory In Coffee, Chloral Hydrate In Toddy, Estimation Of Methyl Alcohol In Alcoholic Beverages.

Food Additives, Adulterants And Contaminants. Food Preservatives Like Benzoates, Propionates, Sorbates, Disulphites.

Artificial Sweeteners: Aspartame, Saccharin, Dulcin, Sucralose And Sodium Cyclamate. Flavours: Vanillin, Alkyl Esters (Fruit Flavours) And Monosodium Glutamate.

Artificial Food Colourants: Coal Tar Dyes And Non-Permitted Colours And Metallic Salts. Analysis Of Pesticide Residues In Food.

2. Fuels: (6L)

Classification Of Fuels, Octane Number, Cetane Number, Flash Point, Anti-Knock Compounds, Conventional And Non-Conventional Energy Sources, Calorific Values Of Fuels Like Kerosene, Coal, Coal Gas, Petrol, Liquefied Petroleum Gas, Biogas.

3. Drugs And Pharmaceuticals: (6L)

Drugs And Their Classification. Therapeutic Action Of Different Classes Of The Drugs viz. Analgesics, Antibiotics, Antacids, Antihistamines, Antimicrobials, Contraceptives, Antipyretics, Antiseptics And Neurologically Active Drugs Preparation, Structure And Functions: Aspirin, Paracetamol, Ibuprofen, Sulphadiazine, Quinine, Phenobarbital, Phenacetin And Metronidazole.

4. Perfumes and Flavors: (12L)

Classification Of Perfumes. Perfume Ingredients Listed As Allergens. Deodorants, Antiperspirants And Artificial Flavours. Essential Oils And Their Importance In Cosmetic Industries With Reference To Eugenol, Geraniol, Sandalwood Oil, Eucalyptus, Rose Oil, 2-Phenyl Ethyl Alcohol, Jasmone, Civetone, Muscone. Volatile Oils: Volatile Oils Of Mentha, Lemon Peel, Orange Peel, Lemon Grass, Eucalyptus, Musk, SandalWood

5. Oils, Fats, Soaps And Detergents: (5L)

Constituents, Mode Of Action, Iodine Value, Saponification Value, Hydrogenation Of Unsaturated Oils, Production And Uses Of Washing Soap, Liquid Soap And Toilet Soap, Detergent Powder And Enzyme-Based Detergent.

6. Insecticides: (4L)

Definition, Classification According To The Mode Of Action. Preparation And Uses Of D.D.T., B.H.C, Aldrin, Dithion And Dithiocarbamate.

7. Polymer: (6L)

Classification, Difference Between Natural And Synthetic Fibres, Manufacture And Uses Of Viscose Rayon. Nylon 66 And Terylene. Silicone Rubber, Difference Between Natural And Synthetic Rubber, Vulcanisation. Manufacture, Properties And Uses Of Buna-S, Neoprene, Foam Rubber And Thermocol.

Preparation and applications of plastics – thermosetting (phenol-formaldehyde, Polyurethanes) and thermosoftening (PVC, polythene);

Semester-III

Papercode: **CEMMJ-T5** (Inorganic 2)

(Credit: 03)

Total Lectures: 45

1. Redox Reactions and Precipitation Reactions: (15 L)

Ion-electron method of balancing equation of redox reaction. Elementary idea on standard redox potentials with sign conventions, Nernst equation (without derivation). Influence of complex formation, precipitation and change of pH on redox potentials; formal potential. Feasibility of a redox titration, redox potential at the equivalence point, redox indicators. Redox potential diagram (Latimer and Frost diagrams) of common elements and their applications. Disproportionation and comproportionation reactions (typical examples). Solubility product principle, common ion effect and their applications to the precipitation and separation of common metallic ions as hydroxides, sulfides, phosphates, carbonates, sulfates and halides.

2. Chemical Bonding-I: (15 L)

Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its application and limitations. Packing of ions in crystals. Born- Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy. Defects in solids (elementary idea). Solubility energetics of dissolution process.

Covalent bond: Polarizing power and polarizability, ionic potential, Fajan's rules. Lewis structures, formal charge. Valence Bond Theory. The hydrogen molecule (Heitler-London approach), directional character of covalent bonds, hybridizations, equivalent and nonequivalent hybrid orbitals, Bent's rule, Dipole moments, VSEPR theory, shapes of molecules and ions containing lone pairs and bond pairs (examples from main groups chemistry) and multiple bonding (σ and π bond approach).

3. Chemical Bonding-II: (15L)

Molecular orbital concept of bonding (The approximations of the theory, Linear combination of atomic orbitals (LCAO)) (elementary pictorial approach): sigma and pi-bonds and delta interaction, multiple bonding. Orbital designations: gerade, ungerade, HOMO, LUMO. Orbital mixing, MO diagrams of H_2 , Li_2 , Be_2 , B_2 , C_2 , N_2 , O_2 , F_2 , and their ions wherever possible; Heteronuclear molecular orbitals: CO, NO, NO^+ , CN^- , HF, BeH_2 , CO_2 and H_2O . Bond properties: bond orders, bond lengths.

Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators.

Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole- dipole interactions, induced dipole interactions, Instantaneous dipole- induced dipole interactions. Repulsive forces, Intermolecular forces: Hydrogen bonding (theories of hydrogen bonding, valence bond treatment), receptor-guest interactions, Halogen bonds. Effects of chemical force, melting and boiling points.

Recommended Text Books and Reference Books:

1. Lee, J. D. Concise Inorganic Chemistry, 5th Ed., Wiley India Pvt. Ltd., 2008.
2. Atkins, Overton, Rourke, Weller, Armstrong; Shriver & Atkins' Inorganic Chemistry, 5th Ed., Oxford University Press (2010).
3. G. L. Miessler, D. A. Tarr, Inorganic Chemistry, 3rd Edition, Pearson India, 2008

4. R. Sarkar, General and Inorganic Chemistry Part-I New Central Book Agency 2014
5. A. G. Sharpe, C. E. Housecroft, Inorganic Chemistry 3rd Edition , Pearson India ,2002
6. J. E. Huheey, E. A. Keiter, R. L. Keiter, Okhil K. Medhi , Principles of Structure and Reactivity, 5th Edition ,Pearson India,2022

Papercode: CEMMJ-P5 (Inorganic 2)
(30 Hours)

(Credit: 01)

List of Practicals

Redox Titration:

1. Dichromatometric estimation of Fe(II) in Fe(II) salt.
2. Dichromatometric estimation of Fe(III) in ferric alum.
3. Permanganometric estimation of oxalic acid and sodium oxalate in a given mixture.
4. Iodometric estimation of copper in solution of cupric salt.
5. Estimation of vitamin C (reduced L-ascorbic acid) by iodimetry.

Papercode: CEMMJ-T6 (Physical 2)

(Credit: 03)

Total Lectures: 45

1. Thermodynamics II:

(15L)

Second law and Entropy: Need for a Second law, Carnot cycle, statement of the second law of thermodynamics, Kelvin –Planck and Clausius statements;; The thermodynamic temperature scale, Carnot cycle with an ideal gas, Efficiency of Carnot engine and Carnot refrigerator; Definition of Entropy (with mathematical formulation) , The Clausius inequality; (T, V) and (T,P) dependence of entropy, Physical concept of Entropy, Entropy change of systems and surroundings for various processes and transformations, Trouton's rule.

Spontaneity and Equilibrium: General condition for spontaneity and equilibrium, Conditions for spontaneity and equilibrium under constraints: Helmholtz energy (A), Gibbs free energy (G), their physical significance; Fundamental Equations of thermodynamics and Maxwell's relations, Thermodynamic equation of state and its applications; Properties of A and G, fugacity and fugacity coefficient, Gibbs-Helmholtz equation.

2. Application of Thermodynamics I:

(20L)

Partial properties and Chemical potential: Changes of thermodynamic state properties with variation of composition, Partial Molar quantities and additivity rule; Gibb's energy of a mixture, Chemical potential of pure ideal gas and mixture of ideal gases, Gibb's energy and entropy of mixing.

Chemical Equilibrium: Thermodynamic conditions for equilibrium, Chemical equilibrium in a mixture, degree of advancement; Variation of free energy with degree of advancement (ξ), General behaviour of G as a function of ξ .; Chemical equilibrium in a mixture of ideal gases, The equilibrium constants, K_p , K_x and K_c ; Standard Gibbs energy of formation, Temperature dependence of equilibrium constant and Gibbs-Helmholtz equation, Le Chatelier Principle and its derivation; The Gibbs-Duhem equation.

Nernst's distribution law: Application- (finding out K_{eq} using Nernst distribution law for $KI + I_2 = KI_3$ and dimerization of benzene).

3. Surface phenomenon

(10L)

Surface tension and energy: Surface tension, surface energy, excess pressure, capillary rise and surface tension; Work of cohesion and adhesion, spreading of liquid over other surface; Vapour pressure over curved surface; Temperature dependence of surface tension.

Adsorption: Physical and chemical adsorption; Freundlich and Langmuir adsorption isotherms; multilayer adsorption and BET isotherm (no derivation required); Gibbs adsorption isotherm and surface excess; Heterogeneous catalysis (single reactant); Zero order and fractional order reactions.

Colloids: Lyophobic and lyophilic sols, Origin of charge and stability of lyophobic colloids, coagulation and Schultz-Hardy rule, Zeta potential and Stern double layer (qualitative idea), Tyndall effect; Electrokinetic phenomena (qualitative idea only); Determination of Avogadro number by Perrin's method; Stability of colloids and zeta potential; Micelle formation.

Reference Books:

1. Atkins, P. W. & Paula, J. de Atkins' Physical Chemistry, Oxford University Press. 2. Castellan, G. W. Physical Chemistry, Narosa. 3. McQuarrie, D. A. & Simons, J. D. Physical Chemistry: A Molecular Approach, Viva Press. 5. Levine, I. N. Physical Chemistry, Tata McGraw-Hill. 6. Rakshit, P.C., Physical Chemistry Sarat Book House. 7. Kapoor, K. L., A Text Book of Physical Chemistry, 6th Edn, McGraw-Hill.

Papercode: CEMMJ-P5 (Physical 2)

(Credit: 01)

List of Practicals

1. Determination of K_{eq} for $KI + I_2 = KI_3$, using partition coefficient between water and CCl_4
 2. Determination of partition coefficient for the distribution of I_2 between water and CCl_4
- Or
2. Determination of partition coefficient of benzoic acid between benzene and water.
 3. Determination of surface tension of a liquid using Stalagmometer.
 4. Determination of CMC from surface tension measurements.

Paper Code: CEMMJ-SEC-III (IT Skills for Chemists & Introduction to Nanotechnology)

Total Lectures: 45

(Credit: 03)

1. Introduction to Computer:

(5L)

Components, Classification, Input and Output Devices, Memory unit, storage devices; Hardware and Software, Computer languages, programming, Operating systems, Number systems (conversion of binary, decimal, octal, hexadecimal and their inter-conversion), Computer softwares used in basic chemistry (name and uses).

2. Basic Mathematics for Chemists

(10L)

Mathematical functions, polynomial expressions, logarithms, the exponential function, constants and variables, basic rules of differentiation, maxima and minima, applications in chemistry, plotting graphs. Exact and inexact differential, Taylor and McLaurin series, Fourier series and Fourier Transform, Laplace transform, partial differentiation, definite and indefinite integrals, Gamma function. Vectors, dot, cross and triple products.

3. Statistical Methods of Data Analysis:

(12L)

Errors: Definition, classification, causes and minimization; propagation of errors, Accuracy and precision, Methods of expressing precision: mean, median, mode, range, standard deviation, relative standard deviation and variance. Test of significance: Student's t-test, F-test, Chi-square test, rejection of a result (Q-test); confidence interval, confidence limits. Distribution of Experimental Results: Gaussian curve, histogram.

4. Basics of Nanoscience and Technology:

Background of Nano-Technology:

(3L)

Emergence Of Nano-Technology, Challenges in Nanotechnology, Carbon Age: New Forms Of Carbon (From Graphene To CNT).

Nucleation

(6L)

Influence Of Nucleation Rate On Size Of The Crystals, Macroscopic And Microscopic Crystals And Nano Crystals, Large Surface To Volume Ratio, Top-Down And Bottom-Up Approaches, Self-Assembly Process, Grain Boundary Volume In Nanocrystals, Defects In Nanocrystals, Surface Effects On The Properties.

Types Of Nano-Structures & Applications:

(9L)

Definition of nano system, types of nanocrystals: One Dimensional (1D), Two Dimensional (2D), Three Dimensional (3D); Nanostructured materials, Quantum dots, Quantum wire, Quantum core/shell structures. Molecular electronics and nanoelectronics, Quantum Electronic Devices,, CNT based Transistor and Field Emission Display, Biological Applications, Biochemical Sensor, Membrane Based Water Purification

Reference Books

1. McQuarrie, D. A. Mathematics for Physical Chemistry University Science Books (2008). 2. Mortimer, R. Mathematics for Physical Chemistry. 3rd Ed. Elsevier (2005). 3. Steiner, E. The Chemical Maths Book Oxford University 6. Levie, R. de, How to use Excel in analytical chemistry and in general scientific data analysis, Cambridge Univ. Press (2001) 487 pages. 7. Noggle, J. H. Physical chemistry on a Microcomputer. Little Brown & Co. (1985). 8. Kreyszig Erwin, Advanced Engineering Mathematics, Wiley, 10th Edition. 9. Nabakumar Bera, Subhasree Ghosh, Paulami Ghosh, Mathematics and Statistics for Chemists, Techno World. 10. Essentials of Physical Chemistry; A. Bhal, B.S. Bhal, G.D. Tuli; S. Chand and Company Limited. 11. Analytical Chemistry; G.D. Christian, P.K. Dasgupta, K.A. Schug; An Indian Adaptation (Wiley). 12. Fundamentals of Analytical Chemistry (Ninth Edition); D.A. Skoog, D.M. West, F.J. Holler, S.R. Crouch; Brooks/Cole

Semester-IV

Papercode: **CEMMJ-T7 (Organic 3)**

(Credit: 03)

Total Lectures: 45

1. Carbonyl Chemistry:

(15 L)

Addition To C=O: Structure, Reactivity And Preparation Of Carbonyl Compounds; Mechanism (With Evidence), Reactivity, Equilibrium And Kinetic Control; Formation Of Hydrates, Cyanohydrins And Bisulphite Adduct; Nucleophilic Addition-Elimination Reactions With Alcohols, Thiols and Nitrogen-Based Nucleophiles; Reactions: Benzoin Condensation, Cannizzaro And Tischenko Reactions, Reactions With Ylides: Wittig And Corey-Chaykovsky Reaction; Rupe Rearrangement, Oxidations And Reductions: Clemmensen, Wolff-Kishner, LiAlH_4 , NaBH_4 , Mg , Oppenauer, Bouveault-Blanc, Acyloin Condensation; Oxidation Of Alcohols With PDC And PCC ; Periodic Acid And Lead Tetraacetate Oxidation Of 1,2-Diols.

Exploitation of acidity of α -H of C=O: formation of enols and enolates; kinetic and thermodynamic enolates; reactions (mechanism with evidence): halogenation of carbonyl compounds under acidic and basic conditions, Hell-Volhard-Zelinsky (H. V. Z.) reaction, nitrosation, SeO_2 (Riley) oxidation; condensations (mechanism with evidence): Aldol, Tollens', Knoevenagel, Claisen-Schmidt, Claisen ester including Dieckmann, Stobbe; Mannich reaction, Perkin reaction, Favorskii rearrangement; alkylation of active methylene compounds; preparation and synthetic applications of diethyl malonate and ethyl acetoacetate; specific enol equivalents (lithium enolates, enamines and silyl enol ethers) in connection with alkylation, acylation and aldol type reaction.

Nucleophilic Addition To α,β -Unsaturated Carbonyl System: General Principle And Mechanism (With Evidence); Direct And Conjugate Addition, Addition Of Enolates (Michael Reaction), Stetter Reaction, Robinson Annulation.

Substitution at sp^2 carbon (C=O system): mechanism (with evidence): $\text{B}_{\text{AC}2}$, $\text{A}_{\text{AC}2}$, $\text{A}_{\text{AC}1}$, $\text{A}_{\text{AL}1}$ (in connection to acid and ester); acid derivatives: amides, anhydrides & acyl halides (formation and hydrolysis including comparison).

2. Organic Spectroscopy-I: UV-Vis Spectroscopy

(5 L)

UV Spectroscopy: Types of electronic transitions, λ_{max} , Lambert-Beer's law and its limitations, Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; Application of Woodward rules for calculation of λ_{max} for the following systems: α,β the unsaturated aldehydes: ketones, carboxylic acids and esters; Conjugated dienes: alicyclic, homoannular and heteroannular; Extended conjugated systems (aldehydes, ketones and dienes); distinction between cis and trans isomers.

3. Enzymes - Fundamental Aspects

(10L)

Introduction, classification and characteristics of enzymes. Salient features of active site of enzymes. Mechanism of enzyme action (taking trypsin as example), factors affecting enzyme action, coenzymes

and cofactors and their role in biological reactions, specificity of enzyme action (including stereo specificity), enzyme inhibitors and their importance, phenomenon of inhibition (competitive, uncompetitive and non-competitive inhibition including allosteric inhibition). Introduction to metabolism (catabolism and anabolism). Overview of catabolic pathways of fat and protein. Interrelationship in the metabolic pathways of protein, fat and carbohydrate

Reference Books

1. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 2. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 3. Sykes, P. A guidebook to Mechanism in Organic Chemistry, Pearson Education, 2003. 4. Carey, F. A., Giuliano, R. M. Organic Chemistry, Eighth edition, McGraw Hill Education, 2012. 5. Loudon, G. M. Organic Chemistry, Fourth edition, Oxford University Press, 2008. 6. Norman, R.O. C., Coxon, J. M. Principles of Organic Synthesis, Third Edition, Nelson Thornes, 2003. 7. Clayden, J., Greeves, N. & Warren, S. Organic Chemistry, Second edition, Oxford University Press, 2012. 8. Graham Solomons, T.W., Fryhle, C. B. Organic Chemistry, John Wiley & Sons, Inc. 9. Smith, J. G. Organic Chemistry, Tata McGraw-Hill Publishing Company Limited. 10. March, J. Advanced Organic Chemistry, Fourth edition, Wiley. 11. Jenkins, P. R., Organometallic Reagents in Synthesis, Oxford Chemistry Primer, Oxford University Press. 12. Ward, R. S., Bifunctional Compounds, Oxford Chemistry Primer, Oxford University Press. 13. Essentials Of Bio-Organic Chemistry Vinay And Prabha Sharma Vinay And Prabha Sharm, Pragati Prakashan

Papercode: CEMMJ-P7 (Organic 3)
(30 Hours)

(Credit: 01)

List of Practicals

Organic Preparations-II:

A. The following reactions are to be performed, noting the yield of the crude product:

1. Bromination of anilides using green approach (Bromate-Bromide method)
2. Redox reaction including solid-phase method
3. Green 'multi-component-coupling' reaction
4. Selective reduction of m-dinitrobenzene to m-nitroaniline

B. Purification of the crude product is to be made by crystallization from water/alcohol, crystallization after charcoal treatment, or sublimation, whichever is applicable.

C. Melting point of the purified product is to be noted.

Papercode: CEMMJ-T8 (Inorganic III)

(Credit: 03)

Total Lectures: 45

1. Radioactivity:

(15 L)

Nuclear stability and law of radioactive decay, nuclear binding energy. Nuclear forces: meson exchange theory. Mass defect, mode of decay, radioactive series, elementary idea on nuclear models (liquid drop model and shell model): Concept of nuclear quantum number, magic numbers.

Nuclear Reactions: Artificial radioactivity, transmutation of elements, fission, fusion and spallation. Nuclear energy and power generation. Separation and applications of radioisotopes.

Radiochemical methods: principles of determination of age of rocks and minerals, radio carbon dating; hazards, detection (Wilson Cloud Chamber, Geiger-Muller Counter, Scintillation Counter) and measurement of radiation and safety measures.

2. Coordination chemistry – I:

(9 L)

Coordinate bonding: double and complex salts. Werner's theory of coordination complexes, Classification of ligands, Ambidentate ligands, chelates, Coordination numbers, IUPAC nomenclature of coordination complexes (up to two metal centers), Isomerism in coordination compounds, constitutional and stereo-isomerism, Geometrical and optical isomerism in square planar and octahedral complexes.

3. Non-aqueous solvents:

(5 L)

General characteristics and reactions in non-aqueous solvents with reference to liquid NH_3 , acetic acid, liquid SO_2 and liquid HF , advantages and disadvantages.

4. Chemistry of s and p Block Elements:

(16 L)

Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses. Beryllium hydrides and halides. Boric acid and borates, boron nitrides, borohydrides (diborane) and graphitic compounds, silanes, Oxides and oxoacids of nitrogen, phosphorus, sulphur and chlorine. Peroxo acids of sulphur, sulphur- nitrogen compounds, interhalogen compounds, polyhalide ions, pseudohalogens, Fluorocarbons and basic properties of halogens.

Recommended Text Books and Reference Books:

1. Lee, J. D. Concise Inorganic Chemistry, 5th Ed., Wiley India Pvt. Ltd., 2008.
2. Atkins, Overton, Rourke, Weller, Armstrong, Shriver & Atkins' Inorganic Chemistry, 5th Ed., Oxford University Press (2010).
3. Greenwood, N.N. & Earnshaw A. Chemistry of the Elements, Butterworth-Heinemann, 1997
4. R. Sarkar, General and Inorganic Chemistry Part-I&II New Central Book Agency 2014
5. H. J. Arnikar, Essentials of Nuclear Chemistry, 5th Edition, New Age International Pvt, Ltd., 2022
6. J. E. Huheey, E. A. Keiter, R. L. Keiter, Okhil K. Medhi, Principles of Structure and Reactivity, 5th Edition, Pearson India, 2022
7. The Chemistry of the p-Block Elements. A. J. Elias The Orient Blackswan; First Edition (1 January 2019)

Papercode: CEMMJ-P8 (Inorganic 3)

(Credit: 01)

(30 Hours)

List of Practicals

Complexometric EDTA Titration:

1. Estimation of Zn(II) ions with standard EDTA solution.
2. Estimation of Ca(II) and Mg(II) ions in a mixture by complexometry.
3. Determination of hardness of water.
4. Estimation of Al(III) using EDTA following back titration with zinc acetate/zinc sulphate.

Total Lectures: 45

1. Transport Processes: (6L)

Fick's law: Flux, force, phenomenological coefficients & their interrelationship (general form), different examples of transport properties.

Viscosity: General features of fluid flow (streamline flow and turbulent flow); Newton's equation, viscosity coefficient; Poiseuille's equation; Principle of determination of viscosity coefficient of liquids by falling sphere method; Temperature variation of viscosity of liquids and comparison with that of gases.

2. Electrochemistry I (8L)

Conductance and transport number: Ion conductance; Conductance and measurement of conductance, cell constant, specific conductance and molar conductance; Variation of specific and equivalent conductance with dilution for strong and weak electrolytes; Kohlrausch's law of independent migration of ions; Equivalent and molar conductance at infinite dilution and their determination for strong and weak electrolytes; Debye-Huckel theory of Ion atmosphere (qualitative)-asymmetric effect, Ostwald's dilution law; Ionic mobility; Application of conductance measurement (determination of solubility product and ionic product of water); Conductometric titrations. Transport number, Principles of Hittorf's and Moving-boundary method.

3. Ionic equilibria: (9L)

Chemical potential of an ion in solution; Activity and activity coefficients of ions in solution; Debye-Huckel limiting law brief qualitative description of the postulates involved, qualitative idea of the model, the equation (without derivation) for ion-ion atmosphere interaction potential. Estimation of activity coefficient for electrolytes using Debye-Huckel limiting law; Derivation of mean ionic activity coefficient from the expression of ion-atmosphere interaction potential; Applications of the equation and its limitations.

4. Chemical Kinetics II: (5L)

Homogeneous Catalysis:

Homogeneous catalysis with reference to acid-base catalysis; Primary kinetic salt effect; Enzyme catalysis; Michaelis-Menten equation, Lineweaver-Burk plot, turn-over number. Autocatalysis.

4. Application of Thermodynamics – II (17 L)

Colligative properties: Vapour pressure of solution; Ideal solutions, ideally dilute solutions and colligative properties; Raoult's law; Thermodynamic derivation using chemical potential to derive relations between the four colligative properties [(i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) Osmotic pressure and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution; Abnormal colligative properties.

Phase Rule: Definitions of phase, component and degrees of freedom, Stability of the phases of a pure substance, Clapeyron equation, Clausius-Clapeyron equation - derivation

and use; Phase rule and its derivations; Definition of phase diagram; Phase diagram for water, CO₂, Sulphur. First order phase transition ; Liquid vapour equilibrium for two component systems; Phenol- water system. Three component systems, water-chloroform-acetic acid system, triangular plots.

Reference Books:

1. Atkins, P. W. & Paula, J. de Atkins' Physical Chemistry, Oxford University Press. 2. Castellan, G. W. Physical Chemistry, Narosa. 3. McQuarrie, D. A. & Simons, J. D. Physical Chemistry: A Molecular Approach, Viva Press. 5. Levine, I. N. Physical Chemistry, Tata McGraw-Hill. 6. Rakshit, P.C., Physical Chemistry Sarat Book House. 7. Kapoor, K. L., A Text Book of Physical Chemistry, 6th Edn, McGraw-Hill.

Paper code: CEMMJ-T9 (Physical 3)
(30 Hours)

Credit:01

List of Practicals

1. Conductometric titration of an acid (strong, weak/ monobasic, dibasic) against strong base.
2. Study of kinetics of the reaction between potassium iodide and potassium peroxodisulphate solutions and salt effect on the kinetics.

or

2. Conductometric titration of mixture of halides.
3. Verification of Ostwald's dilution law and determination of K_a of weak acid.
4. Study of viscosity of unknown liquid (glycerol, sugar) with respect to water

Chemistry Minor

CHEMMN-1T (Minor A/B) Semester I/II

(Credit:0 3)

(Inorganic Chemistry – I + Organic Chemistry I)

Total Lecture: 45

Inorganic Chemistry – I

1. Atomic Structure

(7L)

Bohr's theory for hydrogen atom (simple mathematical treatment); Atomic spectra of hydrogen and Bohr's model; Sommerfeld's model; Quantum numbers and their significance; Pauli's exclusion principle; Hund's rule; Electronic configuration of many-electron atoms, Aufbau principle and its limitations.

2. Chemical Periodicity

(7L)

Classification of elements based on electronic configuration; General characteristics of s-, p-, d- and f-block elements. Positions of hydrogen and noble gases in the periodic table. Atomic and ionic radii, ionization potential, electron affinity, and electronegativity; periodic and group- wise variation of above properties in respect of s- and p- block elements.

3. Acids and Bases

(5L)

Acid-Base Theories and Concepts, conjugate acids and bases, relative strengths of acids and bases. Lewis acid-base concept, classification of Lewis acids and bases. Hard and soft acids and bases (HSAB concept)

4. Redox Reactions

(3L)

Balancing of equations by oxidation number and ion-electron method, Standard electrode potential, formal potential, redox indicator, and redox titrations.

Organic Chemistry I

1. Fundamentals of Organic Chemistry

(3L)

Electronic displacements: Inductive effect, resonance and hyperconjugation; cleavage of bonds: homolytic and heterolytic; structure of organic molecules based on VBT; nucleophiles and electrophiles; reactive intermediates: carbocations, carbanions and free radicals.

2. Stereochemistry

(5L)

Different types of isomerism; geometrical and optical isomerism; concept of chirality and optical activity (up to two carbon atoms); asymmetric carbon atom; elements of symmetry (plane and centre); interconversion of Fischer and Newman representations; enantiomerism and diastereomerism, meso

compounds; threo and erythro, D and L, cis and trans nomenclature; CIP Rules: R/S (upto 2 chiral carbon atoms) and E/Z nomenclature.

3. Nucleophilic Substitution and Elimination Reactions (6L)

Nucleophilic substitutions: S_N1 and S_N2 reactions; eliminations: E1 and E2 reactions (elementary mechanistic aspects); Saytzeff and Hofmann eliminations; elimination vs substitution.

4. Aliphatic Hydrocarbons (9L)

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structures.

Alkanes (up to 5 Carbons).

Preparation: catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent.

Reactions: mechanism for free radical substitution: halogenation.

Alkenes: (up to 5 Carbons)

Preparation: elimination reactions: dehydration of alcohols and dehydrohalogenation of alkyl halides; cis alkenes (partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alkaline $KMnO_4$) and trans-addition (bromine) with mechanism, addition of HX [Markownikoff's (with mechanism) and anti-Markovnikov's addition], hydration, ozonolysis, oxymercuration-demercuration and hydroboration-oxidation reaction.

Alkynes: (up to 5 Carbons).

Preparation: acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetrahalides and dehydrohalogenation of vicinal dihalides. Reactions: formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alkaline $KMnO_4$.

Recommended Text Books:

1. Lee, J. D. Concise Inorganic Chemistry, 5th Ed., Wiley India Pvt. Ltd., 2008.
2. Atkins, Overton, Rourke, Weller, Armstrong; Shriver & Atkins' Inorganic Chemistry, 5th Ed., Oxford University Press (2010).
3. Finar, I. L. Organic Chemistry (Volume 1), 6th Edition, Pearson Education, 2002
4. Sykes, P. A guidebook to Mechanism in Organic Chemistry, Pearson Education, 2003.
5. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)

CHEMMN-1P (Minor A/B) Sem I/II

(Credit:0 1)

(Inorganic Chemistry 1 + Organic Chemistry 1)

Inorganic

1. Estimation of sodium hydroxide and sodium carbonate present in a mixture.
2. Estimation of oxalic acid by titrating it with $KMnO_4$.
4. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$

Organic

1. Detection of special elements (N, Cl, and S) in organic compounds.
2. Detection of functional groups: Aromatic-NO₂, Aromatic-NH₂, -COOH, carbonyl (no distinction of -CHO and >C=O needed), -OH (phenolic) in solid organic compounds.

CHEMMN-2T (Minor A/B) Semester: III/IV

(Credit:03)

(Physical Chemistry -1 + Inorganic Chemistry-2)

Total lecture: 45

Physical Chemistry-1

1.. Kinetic Theory of Gases and Real Gases

(9L)

- a. Concept of pressure and temperature; Collision of gas molecules; Collision diameter; Collision number and mean free path; Frequency of binary collisions (similar and different molecules); Rate of effusion
- b. Nature of distribution of velocities, Maxwell's distribution of speed and kinetic energy; Average velocity, root mean square velocity and most probable velocity; Principle of equipartition of energy and its application to calculate the classical limit of molar heat capacity of gases
- c. Deviation of gases from ideal behavior; compressibility factor; Boyle temperature; Andrew's and Amagat's plots; van der Waals equation and its features; its derivation and application in explaining real gas behaviour; Existence of critical state, Critical constants in terms of van der Waals constants; Law of corresponding states
- d. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only)

2. Liquids

(4L)

Definition of Surface tension, its dimension and principle of its determination using stalagmometer; Viscosity of a liquid and principle of determination of coefficient of viscosity using Ostwald viscometer; Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only)

3. Solids

(4L)

Forms of solids, crystal systems, unit cells, Bravais lattice types, Symmetry elements; Laws of Crystallography - Law of constancy of interfacial angles, Law of rational indices; Miller indices of different planes and interplanar distance, Bragg's law; Structures of NaCl, KCl and CsCl (qualitative treatment only); Defects in crystals; Glasses and liquid crystals.

4. Chemical Kinetics

(6L)

- a) Introduction of qualitative rate law, order and molecularity; Extent of reaction; rate constants; Rates of First, second and nth order reactions and their Differential and integrated forms (with derivation); Pseudo first order reactions; Determination of order of a reaction by half-life and differential method; Opposing reactions, consecutive reactions and parallel reactions

b) Temperature dependence of rate constant; Arrhenius equation, energy of activation; Collision theory; Lindemann theory of unimolecular reaction; outline of Transition State theory (classical treatment)

Inorganic Chemistry-2

1. Chemical Bonding and Molecular Structure

(14L)

a. Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born- Landé equation for calculation of lattice energy, Born-Haber cycle; Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

b. Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples from s and p block elements of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.

c. MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules and heteronuclear diatomic molecules such as CO, NO. Comparison of VB and MO approaches.

2. Comparative study of p-block elements

(8L)

Group trends in electronic configuration, modification of pure elements, common oxidation states, inert pair effect, and their important compounds in respect of the following groups of elements:

- i. B-Al-Ga-In-Tl
- ii. C-Si-Ge-Sn-Pb
- iii. N-P-As-Sb-Bi
- iv. O-S-Se-Te
- v. F-Cl-Br-I

Recommended Text Books:

1. Lee, J. D. Concise Inorganic Chemistry, 5th Ed., Wiley India Pvt. Ltd., 2008.
2. Atkins, Overton, Rourke, Weller, Armstrong; Shriver & Atkins' Inorganic Chemistry, 5th Ed., Oxford University Press (2010).
3. Levine, I. N. Physical Chemistry, 6th Edition McGraw-Hill India, 2011
4. Castellan, G. W. Physical Chemistry, Narosa, 2004
5. Atkins, P. W. & Paula, J. de, Atkins' Physical Chemistry, 11th Edition, Oxford University Press, 2018
6. G. L. Miessler, D. A. Tarr, Inorganic Chemistry, 3rd Edition, Pearson India, 2008

Physical Chemistry

1. Surface tension measurement (use of organic solvents excluded)
 - a. Determination of the surface tension of a liquid or a dilute solution using a Stalagmometer
2. Viscosity measurement (use of organic solvents excluded)
 - a. Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer
3. Study of kinetics of acid catalyzed hydrolysis of methyl acetate.

Inorganic Chemistry

Qualitative semi-micro analysis of mixtures containing three radicals. Emphasis should be given to the understanding of the chemistry of different reactions.

Acid Radicals: Cl^- , Br^- , I^- , NO_2^- , NO_3^- , S^{2-} , SO_4^{2-} , PO_4^{3-} , BO_3^{3-} .

Basic Radicals: Na^+ , K^+ , Ca^{2+} , Sr^{2+} , Ba^{2+} , Cr^{3+} , Mn^{2+} , Fe^{3+} , Ni^{2+} , Cu^{2+} , NH_4^+