

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

Chemistry Major

Semester-IV

Paper Code: **CEMMJ-T7 (Organic Chemistry - III)**

(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 , MPV, 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 Chymotrypsin as Example), Factors Affecting Enzyme Action, Coenzymes and Cofactors and Their Role in Biological Reactions, Specificity of Enzyme Action (Including Stereo Specificity) - example of chymotrypsin, trypsin & carboxypeptidases, Enzyme Inhibitors and Their Importance, Phenomenon of Inhibition (Competitive, Uncompetitive And Non-Competitive Inhibition Including Allosteric Inhibition).

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

Paper Code: CEMMJ-P7(Organic Chemistry - III PRAC)

(Credit: 01)

(30 Hours)

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.

Paper Code: CEMMJ-T8 (Inorganic Chemistry - 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)
8. A. K. Das, Fundamental Concepts of Inorganic Chemistry, (Vol. 3, Second Edition), CBS Publishers & Distributors Pvt. Ltd.
9. Principles of Inorganic Chemistry (33rd Edition), B.R. Puri, L.R. Sharma, K.C. Kalia, Vishal Publishing Co.
10. R. L. Dutta, Inorganic Chemistry, Part –II, 5th Edn., The New Book Stall.
11. G. Wulfsberg, Inorganic Chemistry, Viva Books Private Ltd., New Delhi, 2001.

Paper Code: CEMMJ-P8 (Inorganic Chemistry - III PRAC)
(30 Hours)

(Credit: 01)

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.

Reference Books:

1. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas and B. Sivasankar, Vogel's Text Book of Quantitative Chemical Analysis (6th Edition), Pearson.
2. Chemistry in Laboratory (New Revised Edition), S. Ghosh, M. Das Sarma, D. Majumdar, S. Manna; Santra Publication Pvt. Ltd.
3. A. K. Nad, B. Mahapatra & A. Ghosal, An Advanced Course in Practical Chemistry, New Central Book Agency (P) Ltd. Advanced Practical Chemistry (3rd Edition), S.C. Das

Paper Code: CEMMJ-T9 (Physical Chemistry - III)

(Credit: 03)

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

(17L)

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, 6thEdn, McGraw-Hill.

Paper Code: CEMMJ-P9 (Physical Chemistry - III PRAC)
(30 Hours)

Credit:01

List of Practical:

1. Conductometric titration of an acid (strong, weak/ monobasic, dibasic) against strong base.
2. Verification of Ostwald's dilution law and determination of K_a of weak acid.
3. Study of viscosity of unknown liquid (glycerol, sugar) with respect to water.

