



**List of Courses Focus on Employability/ Entrepreneurship/  
Skill Development**

**Department : Chemistry**

**Programme Name : B. Sc.**

**Academic Year : 2016-17**

**List of Courses Focus on Employability/ Entrepreneurship/Skill Development**

Sr. No.	Course Code	Name of the Course
01.	CBT-101	Physical Chemistry-I
02.	CBT-201	Organic Chemistry - I
03.	CBT-202	Physical Chemistry-II
04.	CBT-301	Organic Chemistry - II
05.	CBT-401	Physical Chemistry-III
06.	CBT-402	Organic Chemistry - III
07.	CBT-501	Analytical Chemistry
08.	CBT-502	Inorganic Chemistry - III
09.	CBT-503	Organic Chemistry - IV
10.	CBE	Biochemistry
11.	CBT-601	Physical Chemistry-IV
12.	CBT-603	Special Topics In Chemistry
13.	CBE	Polymer Chemistry
14.	CBL-103	Inorganic Chemistry & Physical Chemistry Practical
15.	CBL-203	Compound Identification and Physical Experiments
16.	CBL-303	Quantitative Analysis (Compound Identification and Volumetric Analysis)
17.	CBL-403	Organic Chemistry and Physical Chemistry Practical
18.	CBL-504	Laboratory I: Analytical Chemistry Practical
19.	CBL-505	Laboratory I: Inorganic Chemistry Practical
20.	CBL-506	Laboratory I: Organic Chemistry Practical
21.	CBL-604	Laboratory I: Inorganic Chemistry Practical
22.	CBL-605	Laboratory I: Organic Chemistry Practical
23.	CBL-606	Laboratory I: Physical Chemistry Practical

**सध्यक्ष/Head**  
**रसायन शास्त्र विभाग**  
**Deptt. of Chemistry**



## Scheme and Syllabus

### Semester-I

#### CBT-101- PHYSICAL CHEMISTRY-I

##### Unit-1

**Gaseous State:** Kinetic molecular theory of gases, laws of ideal gas behaviour based on kinetic theory, Deviation of real gases from ideal behaviour, Explanation for the deviation, Compressibility factor, the van der Waal's equation of state, units for van der Waal's gas constants, Critical phenomena-critical constants of a gas and their determination, the van der Waals equation and critical state, determination of critical constants of van der Waals gas, law of corresponding states.

##### Unit-2

**Solid State:** Crystal lattices, space lattice, unit cell, crystal systems, law of rational indices, Miller indices, crystals and x-rays (the Bragg's equation). Crystal structure of NaCl, graphite, and diamond. Types of crystal (molecular, covalent, metallic, ionic). Imperfection in crystals: point defect, Schottky defect and Frankel defect.

##### Unit-3

**Thermodynamics:** First Law of thermodynamics and internal energy, state and path functions, Enthalpy, heat changes at constant volume and constant pressure, heat capacities ( $C_V$ ,  $C_P$ ) and their relationship for ideal gases.

##### Unit-4

**Thermochemistry:** Change in internal energy ( $\Delta U$ ) and enthalpy ( $\Delta H$ ) of chemical reactions, relation between  $\Delta U$  and  $\Delta H$ , variation of heat of reaction with temperature (Kirchhoff's equation), enthalpy of combustion, enthalpy of neutralization, enthalpy of hydration, enthalpy of solution, enthalpy of formation, Hess's law and its applications, bond energy and its applications.

##### Unit-5

**Chemical equilibrium:** The concept of equilibrium state and equilibrium constant, law of mass action, concept of  $K_p$  and  $K_c$  and their relation, temperature dependence on equilibrium constant, van't Hoff equation, Le-Chatelier principle.

##### Books Recommended

1. *Physical Chemistry*, P. Atkins and J. De Paul, 8<sup>th</sup> Edition (2006), International Student Edition, Oxford University Press.
2. *Physical Chemistry*, P. C. Rakshit, 5<sup>th</sup> Edition (1988), 4<sup>th</sup> Reprint (1997), Sarat Book House, Calcutta.
3. *Principles of Physical Chemistry*, B. R. Puri, L. R. Sharma, and M. S. Pathania, 45<sup>th</sup> Edition (1998), Vishal Publishing co., Jalandhar.
4. *Physical Chemistry*, K. J. Laidler and J. M. Meiser, 3<sup>rd</sup> Edition, Houghton Mifflin Comp., New York, International Edition (1999)
5. *A text book on Physical Chemistry*, K. L. Kapoor, 3<sup>rd</sup> Edition, Vol. I-VI, Macmillan publisher India Ltd, New Delhi, (2006).
6. *An Introduction to chemical thermodynamics*, R P Rastogi & R. R. Mishra, 5<sup>th</sup> revised Edition, Vikas publishing house, New Delhi, (1978).



SEMESTER - II

CBT 201: ORGANIC CHEMISTRY - I

UNIT - 1

**Structure and Bonding:** Classification, nomenclature and general structure of organic compounds. Hybridization, orbital representation of methane, ethane, ethylene, acetylene and benzene. Bond energy, bond length and bond angles. Polarity of covalent bonds - Inductive, resonance, hyperconjugation and steric effects and their influence on acidity and basicity of organic compounds.

UNIT - 2

**Mechanism of Organic reactions:** Curved arrow notation, drawing electron movements with arrows, half-headed and double headed arrows. Homolysis and heterolysis of carbon-carbon bonds; Reactive species e.g. Carbocations, carbanions, free radicals and their stability. Nucleophiles and electrophiles and their uses in substitution and addition reactions.

UNIT - 3

**Alkanes and Alkenes:** Preparation of alkanes. Wurtz reaction. Conformation of ethane and n-butane. Mechanism of chlorination of methane.

General methods for the preparation of alkenes, Reactions of alkenes: Addition reactions (Electrophilic and free radical), Hydration, Hydroxylation, Hydroboration, Epoxidation and Ozonolysis.

UNIT - 4

**Dienes and Alkynes:** Conjugated and isolated Dienes; 1,2- versus 1,4-addition. Diels-Alder reaction of dienes.

Preparation, properties and reactions of alkynes, Electrophilic addition, acidity and metal acetylides.

UNIT - 5

**Alkyl halides:** Nucleophilic substitution -  $S_N1$  and  $S_N2$  mechanisms; Elimination reaction:  $E1$  and  $E2$  mechanisms, Elimination vs. Substitution reactions; energy profile diagrams - transition states, intermediates (general considerations) Grignard reagents: preparation and synthetic applications.

Books Recommended:

1. "Organic Chemistry", R. T. Morrison and R. N. Boyd, 6th Edition (1992), Prentice-Hall of India (P)Ltd., New Delhi.
2. "Organic Chemistry", S. M. Mukherjee, S. P. Singh, and R. P. Kapoor, 1st Edition (1985), New Age International (P) Ltd. Publishers, New Delhi.
3. "Organic Chemistry", I. L. Finar, [Vol. I, 6th Edition (1973), Reprinted in 1980 & Vol. II, 5th Edition (1975), Reprinted in 1996], ELBS and Longman Ltd., New Delhi.
4. "Organic Chemistry - Structure and Reactivity", Seyhan N. Ege, 3rd Edition (1998), AITBS Publishers and Distributors, Delhi.
5. "Organic Chemistry", Paula Y. Bruice, 2nd Edition, Prentice-Hall, International Edition (1998).
6. "Organic Chemistry", G. Solomon, Willey India, Paper Back, 9<sup>th</sup> Edition.
7. "Modern Organic Chemistry", M. K. Jain and S. C. Sharma, Vishal Publishing CO. Jalandhar, India, 4<sup>th</sup> Edition (2012).



CBT-202: PHYSICAL CHEMISTRY-II

Unit-1

**Liquid State:** Physical properties of liquids: Vapor pressure, Measurement of vapor pressure, Surface tension of liquids - capillary action, Surface energy, temperature effect on surface tension. Viscosity of liquids, and its variation with temperature, The Reynolds number.

Unit-2

**Solution of non-electrolytes:** Solution of liquids in liquids, Raoult's law, Vapor pressure of ideal solutions, vapor pressure of non-ideal solution, vapor pressure composition and boiling point composition curves of completely miscible binary solutions, fractional distillation of binary liquid solutions, Azeotropic mixtures, solubility of partially miscible liquids, phenol- water system, aniline-hexane system, solution of gases in liquids, factors influencing solubility of a gas, Henry's law and Raoult's law.

Unit-3

**Chemical Kinetics:** The rate equation and rate constant, Order and molecularity of chemical reactions, Zero-Order, first order and second order rate kinetics, half life time of a reaction, methods of determining order of a reaction, Effect of temperature on rate of reaction, concept of activation energy and Arrhenius equation, Theory of absolute reaction rate and collision theory of rates of bimolecular reactions.

Unit-4

**Colloidal state:** Classification of colloids, Lyophobic and Lyophilic colloids, preparation of colloidal solution, properties of colloidal systems: optical, electrical and kinetic properties, coagulation of colloidal solution, stability of sols, Gold number, Gel, emulsions, Surfactants, importance and application of colloids.

Unit-5

**Electrolytic conductance and transference:** Electrolytic conductance, specific conductance, equivalent conductance, molar conductance, cell constant, Hittorf's theoretical device, transport number, determination of transport number by Hittorf's method, Kohlrausch's law, application of Kohlrausch's law, Ostwald's dilution law.

Books Recommended

1. *Physical Chemistry*, P. C. Rakshit, 5th Edition (1985), 4th Reprint (1997), Sarat Book House, Calcutta.
2. *Principles of Physical Chemistry*, B. R. Puri, L. R. Sharma, and M. S. Pathania, 37th Edition (1998), Shoban Lal Nagin Chand & Co., Jalandhar.
3. *Physical Chemistry*, K. J. Laidler and J. M. Meiser, 3rd Edition, Houghton Mifflin Comp., New York, International Edition (1999).
4. *A Text Book on Physical Chemistry*, K. L. Kapoor, 3rd Edition, Vol. I-VI, Macmillan Publisher India Ltd, New Delhi, 2006.



5. *Physical Chemistry*, W. J Moore, 5th Edition, Orient Blackswan publisher, 1999.
6. *Physical Chemistry*, P. Atkins and J. De Paul, 8th Edition (2006), International Student Edition, Oxford University Press.

### SEMESTER – III

#### CBT 301: ORGANIC CHEMISTRY – II

##### UNIT – 1

**Alcohols and ethers:** General properties of alcohols and ethers. Synthesis of alcohols from alkenes, via hydroboration-oxidation, oxymercuration- demercuration, Reactions of alcohols: Comparative study of dehydration and oxidation of primary, secondary and tertiary alcohols. Synthesis and reactions of ethers.

##### UNIT – 2

**Aldehydes and Ketones:** Preparation of carbonyl compounds. Nucleophilic addition reactions, Condensation reactions: aldol condensation, Cannizzaro reaction, benzoin oxidation and reduction and Haloform reaction.

##### UNIT – 3

**Carboxylic acids & its Derivatives:** General method for the preparation of carboxylic acids, Relative reactivity of carboxylic acids and their chemical reactions.  
Chemistry of acid halides, amides and esters. Concept of active methylene compounds (EAA and DEM).

##### UNIT – 4

**Stereochemistry:** Plane-polarized light and optical activity. Elements of Symmetry, Chirality and Enantiomers. Fischer, Newman and Sawhorse Projection Formula, Absolute configuration: The R, S and D, L configuration descriptions, Compounds containing more than one Chiral centres, Diastereoisomers and meso compounds, resolution of a racemic mixture.

##### UNIT – 5

##### Carbohydrates:

Introduction, monosaccharides, glycoside bond formation, mutarotation. Reactions of aldoses and ketoses (oxidation and reductions). Killiani synthesis, Osazone formation. Glucose-structure (including cyclic structure), Fructose (reactions only). Degradation of monosaccharides: Ruff degradation. Importance of polysaccharides in daily life.

##### Books Recommended

1. *Organic Chemistry*, R. T. Morrison and R. N. Boyd, 6th Edition (1992), Prentice-Hall of India (P) Ltd., New Delhi.
2. *Organic Chemistry*, S. M. Mukherjee, S. P. Singh, and R. P. Kapoor, 1st Edition (1985), New Age International (P) Ltd. Publishers, New Delhi.



momenta,  $p^2$  or  $d^2$  case, spin-orbit coupling  $p^2$  case, determining ground state terms-Hund's rule, Hole formulation. Derivation of term symbol for a  $d^2$  configuration.

Books References:

1. "Basic Inorganic Chemistry", F. A Cotton, G. Wilkinson, and Paul L. Gaus, 3rd Edition (1995), John Wiley & Sons, New York.
2. "Concise Inorganic Chemistry", J. D. Lee, 5th Edition (1996), Chapman & Hall, London.
3. "Inorganic Chemistry", A. G. Sharpe, 3rd International Student Edition (1999), ELBS / Longman, U.K.
4. "Inorganic Chemistry", D. F. Shriver and P. W. Atkins, 3rd Edition (1999), ELBS, London.
5. "Inorganic Chemistry" Keith F. Purcell and John C. Kotz W. B. Saunders Com. (1987), Hong Kong.
6. "Principles of Inorganic Chemistry" Puri Sharma and Kalia Vishal Publishing House.
7. "General and Inorganic Chemistry" (Part-I); R P Sarkar; New Central Book Agency (P) Ltd.
8. "General and Inorganic Chemistry" (Part-II); R P Sarkar; New Central Book Agency (P) Ltd.
9. "Selected Topic in Inorganic Chemistry" W. U. Malik, G. D. Tuli, R. D. Madan (1994) S. Chand and Company Ltd.

Semester-I V

C B T-401: Physical Chemistry III

Unit-1

**Thermodynamics:** Second Law of Thermodynamics, statement of second law of thermodynamics, Carnot cycle, entropy, entropy changes in reversible and irreversible processes and of universe, physical concept of entropy, entropy changes of an ideal gas in different processes, entropy of an ideal gas, entropy changes in mixture of gases

Unit-2

**Free energy and Chemical equilibrium:** Free energy and its concept, Gibbs and Helmholtz free energies and their relationship, Free energy and equilibrium constant. Gibbs-Helmholtz equation, Criteria for reversible and irreversible processes based on entropy and free energy, Maxwell's relations, Partial molar quantities, chemical potential, Gibbs-Duhem equation.

Unit-3

**Phase Equilibria:** Thermodynamics of phase transition-Clapeyron-Clausius equation and its applications. Phase rule, phase, component, degree of freedom, thermodynamic derivation of phase rule, phase diagrams of one-component system: water, two component systems: lead-silver, The distribution law, applications to cases of dissociation and association of solutes in one of the phases.

Unit-4

**Electrochemical Cells:** Reactions in reversible cells, free energy and EMF of reversible cell. Single electrode potential (Nernst equation), its measurement and sign convention. Standard electrode



potential. EMF of reversible cell from electrode potentials, Types of reversible electrode, reference electrodes. Applications of EMF measurements: determination of ionic activities, pH, and equilibrium constant. Concentration cells with and without transference, Liquid junction potential and its elimination.

#### Unit-5

**Photochemistry:** Basic principles, Lambert-Beer's law, molar extinction coefficient, Laws of photochemistry, Photo chemical rate law, Kinetics of photochemical reactions like HCl Energy transfer in photochemical reactions, quenching of Fluorescence, Chemiluminescence.

#### Books Recommended

1. *Physical Chemistry*, P. Atkins and J. De Paul, 8th Edition (2006), International Student Edition, Oxford University Press.
2. *Physical Chemistry*, P. C. Rakshit, 5th Edition (1985), 4th Reprint (1997), Sarat Book House, Calcutta.
3. *Principles of Physical Chemistry*, B. R. Puri, L. R. Sharma, and M. S. Pathania, 37th Edition (1998), Shoban Lal Nagin Chand & Co., Jalandhar.
4. *Physical Chemistry*, K. J. Laidler and J. M. Meiser, 3rd Edition, Houghton Mifflin Comp., New York, International Edition (1999).
5. *A text book on Physical Chemistry*, K. L. Kapoor, 3rd Edition, Vol. I-VI, Macmillan India Ltd, New Delhi (2005).
6. *An Introduction to Chemical Thermodynamics*, R P Rastogi & R. R. Mishra, 5th revised edition, Vikas publishing house, New Delhi (1978).
7. *Physical Chemistry*, W. J Moore, 5th Edition,, Orient Blackswan publisher (1999).

### SEMESTER - IV

#### CBT 402: ORGANIC CHEMISTRY - III

#### UNIT - 1

**Aromatic Compounds:** Introduction, nomenclature of benzene derivatives, the Kekule structure of benzene, Valence bond & molecular orbital theories of the structure of benzene, Huckel's rule:  $(4n+2)$   $\pi$  electron rule, Anti-aromatic compounds, Aromatic compounds in biochemistry, spectroscopy of Aromatic compounds.

#### UNIT - 2

**Reactions of Aromatic Compounds:** Electrophilic substitution reactions ( $S_EAr$ ), A general mechanism for electrophilic aromatic substitution - Arenium ions, Halogenation, Nitration and sulphonation of benzene, Friedel-Crafts alkylation and its limitations, Friedel-Crafts acylation, synthetic applications of Friedel-Crafts acylation; Clemmenson's reduction, effect of substituent's on reactivity and orientation.



#### UNIT - 3

Aryl Halogen Compounds: Chlorobenzene, electrophilic and nucleophilic aromatic substitutions ( $S_NAr$ ) □ bimolecular mechanism ( $A_ND_N$ ), benzyne mechanism ( $D_NA_N$ ). Side chain chlorination of toluene. Structure and application of DDT and BHC.

#### UNIT - 4

Phenols: General methods of preparation and reactions of phenol. Relative acidity of phenol, alcohol and carboxylic acid. Reimer-Tiemann and Kolbe reactions.

#### UNIT - 5

Nitrogen Containing Compounds: Nitrobenzene and reduction products. Amines and amides. Comparative basicity of aliphatic and aromatic amines, Diazonium salts: preparation (Diazo reaction) and synthetic applications (Sandmeyer reactions)

Books Recommended:

1. "Organic Chemistry", R. T. Morrison and R. N. Boyd, 6th Edition (1992), Prentice-Hall of India (P) Ltd., New Delhi.
2. "Organic Chemistry", S. M. Mukherji, S. P. Singh, and R. P. Kapoor, 1st Edition (1985), 5<sup>th</sup> Reprint (1999), New Age International (P) Ltd. Publishers, New Delhi.
3. "Organic Chemistry – Structure and Reactivity", Seyhan N. Ege, AITBS publishers, Delhi (1998).
4. "Organic Chemistry", Paula Y. Bruice, 2nd Edition, Prentice-Hall International Inc, New Jersey, International Edition (1998).
5. Organic Chemistry, J. Clayden, N. Greeves, S. Warren, and E. Wothers, Oxford Univ. Press, Oxford (2001).
6. "Organic Chemistry", G. Solomon, Wiley India, Paper Back, 9<sup>th</sup> Edition.
- 7.

Semester- V

### CBT 501 ANALYTICAL CHEMISTRY

#### UNIT- 1

Statistical Evaluation: Determinate and Indeterminate errors. Accuracy and Precision, relative and standard deviation. Methods for minimizing errors. Significant figures.

#### UNIT-2

Instrumental Methods of Chemical Analysis: Principle, instrumentation and applications of nuclear magnetic resonance, infra-red spectroscopy and electron spin resonance.

#### UNIT-3

Solvent Extraction: Distribution law, Craig concept of counter-current distribution, important solvent extraction systems.





#### UNIT-4

Chromatography: Classification of chromatographic methods, general principle and application of adsorption, partition, ion-exchange, thin layer and paper chromatography.

#### UNIT-5

Spectrophotometry: Lambert-Beer's law and its limitations, nomenclature and units. spectrophotometric determination of one component (iron, chromium, manganese, nickel, titanium and phosphorus), spectrophotometric determinations of dissociation constants of an indicator, photometric errors.

#### Books Recommended

1. "Analytical Chemistry", G. D. Christian, 4th Edition (1986), John Wiley & Sons, New York.
2. "Modern Methods of Chemical Analysis", R. L. Pecsok, L. D. Shields, T. Cairns, and I. C. McWilliam, 2nd Edition (1976), John Wiley
3. "Principles of Instrumental Analysis", D.A. Skoog, 5th Edition (1998), Saunders College Publishing, Philadelphia, London, New York.
4. "Basic Concepts of Analytical Chemistry", S. M. Khopkar, 2nd Edition (1998), New Age International Publications, New Delhi.
5. "Environmental Chemistry", A. K. De, 3rd Edition (1994), Wiley Eastern, New Delhi.
6. "Instrumental Methods of Analysis", H. H. Willard, L. L. Merritt, and J. A. Dean, 6th Edition (1986), CBS Publishers & Distributors, Shahdara, Delhi.

### CBT 502 INORGANIC CHEMISTRY-III

#### Unit-1

Magnetic Properties of Transition Metal Complexes: Types of magnetic behaviour, methods of determining magnetic susceptibility, L-S and J-J coupling, orbital contribution to magnetic moments. Correlation of magnetic moment data and stereochemistry of Co(II) and Ni(II) complexes; anomalous magnetic moments.

#### Unit-2

Theories of Metal- Ligand bonding: Limitations of valence bond theory; Crystal-field theory and crystal-field splitting in octahedral, tetrahedral and square planar complexes. Jahn-Teller Distortion. Factors affecting the crystal-field parameters.



### Unit-3

Thermodynamic and Kinetic aspects of Metal Complexes: A brief outline of thermodynamic and kinetic stabilities of metal complexes and factors affecting the stability. Substitution reactions of square-planar complexes – Trans effect.

### Unit-4

Electronic Spectra of Transition Metal Complexes: Types of electronic transitions, selection rule for d-d transitions, spectroscopic ground states. Explanation of electronic spectra on the basis of Orgel energy level diagrams for  $d^1$ ,  $d^4$ ,  $d^6$  and  $d^9$  states.

### Unit-5

Chemistry of f-block Elements: Comparative study of actinide elements with respect to electronic configuration, atomic and ionic radii, oxidation states and complex formation; occurrence and principles of separation. General features and chemistry of actinides, principles of separation of Np, Pu and Am from U. Trans-Uranium elements.

#### Books References:

1. "Inorganic Chemistry", J.E. Huheey, E.A. Keiter and R.L. Keiter, O.K. Medhi, Fourth Edition, Pearson.
2. "Basic Inorganic Chemistry", F. A Cotton, G. Wilkinson, and Paul L. Gaus, 3rd Edition (1995), John Wiley & Sons, New York.
3. "Concise Inorganic Chemistry", J. D. Lee, 5th Edition (1996), Chapman & Hall, London.
4. "Inorganic Chemistry", A. G. Sharpe, 3rd International Student Edition (1999), ELBS / Longman, U.K.
5. "Inorganic Chemistry", D. F. Shriver and P. W. Atkins, 3rd Edition (1999), ELBS, London.
6. "Inorganic Chemistry" Keith F. Purcell and John C. Kotz W. B. Saunders Com. (1987), Hong Kong.
6. "Principles of Inorganic Chemistry" Puri Sharma and Kalia Vishal Publishing House.
7. "Electronic Spectra of Transition Metal Complexes", R K Ray, New Central Book Agency (P) Ltd.
8. "General and Inorganic Chemistry" (Part-I); R P Sarkar; New Central Book Agency (P) Ltd.
9. "General and Inorganic Chemistry" (Part-II); R P Sarkar; New Central Book Agency (P) Ltd.
10. "Selected Topic in Inorganic Chemistry" W. U. Malik, G. D. Tuli, R. D. Madan (1994) S. Chand and Company Ltd.
11. "Fundamental Principles of Inorganic Chemistry" D. Banerjee Sultan Chand & Sons 3rd Edition (1993).



SEMESTER V

CBT-503: ORGANIC CHEMISTRY-IV

UNIT - 1

Methods of Determining Reaction Mechanism: Mechanism of bonds breaking and formation. Inter and intra-molecular migration of groups, crossover experiments, exchange with solvents, importance reactive intermediates. Isotopic substitution in a molecule: primary and secondary kinetic isotope effects - their importance in mechanistic studies.

UNIT - 2

Molecular Rearrangements Involving Electron Deficient Atoms: Pinacol-pinacolone, Beckmann, Hofmann, Lossen, Curtius and Wolff rearrangements, Baeyer-Villiger oxidation.

UNIT - 3

Reagents and reactions in Organic Synthesis: Reducing agents: lithium aluminium hydride, sodium borohydride, Birch reduction. Oxidizing agents: Osmium tetroxide, Woodward & Prevost oxidation and m-Chloroperbenzoic acid. Hydroboration.

UNIT - 4

Photochemistry: Principles of photochemistry, photochemical reactions of carbonyl compounds and olefins.

UNIT - 5

Heterocyclic Compounds: Synthesis and chemistry of furan, pyrrole, indole and quinoline.

Books Recommended

1. "Organic Chemistry", I. L. Finar, [Vol. I, 6th Edition (1973), Reprinted in 1980 & Vol. II, 5th Edition (1975), Reprinted in 1996], ELBS and Longman Ltd., New Delhi.
2. "A Guide Book to Mechanism in Organic Chemistry", P. Sykes, 6th Edition (1997), Orient Longman Ltd., New Delhi.
3. "Organic Chemistry", R. T. Morrison and R. N. Boyd, 6th Edition (1992), Prentice-Hall of India (P) Ltd., New Delhi.
4. "Organic Chemistry", S. M. Mukherji, S. P. Singh, and R. P. Kapoor, 1<sup>st</sup> Edition (1985), 5<sup>th</sup> Reprint (1999), New Age International (P) Ltd. Publishers, New Delhi.
5. "Organic Chemistry", J. Clayden, N. Greeves, S. Warren, and E. Wothers, Oxford Univ. Press, Oxford (2001).
6. "Organic Chemistry", G. Solomon, Wiley India, Paper Back, 9<sup>th</sup> Edition.
7. "Modern Organic Chemistry", M. K. Jain and S. C. Sharma, Vishal Publishing CO. Jalandhar, India, 4<sup>th</sup> Edition (2012).



Semester – V

CBE- BIOCHEMISTRY

UNIT – 1

**Amino acids:** Amino acids – Preparative methods, physical properties, dipolar nature, chemical reactions and configuration. Concept of unnatural amino acids. Importance of amino acids.

UNIT – 2

**Peptides and Proteins:** Peptides: Peptide-linkage, peptide synthesis and structure of polypeptides. Proteins: General characteristics and primary, secondary and tertiary structure. Common deficiency diseases.

UNIT – 3

**Metalloproteins:** Enzymes: Classification, nomenclature, co-enzymes (representative examples from different classes). Enzyme kinetics and enzyme inhibition. Hemoglobin: Oxygen and carbon dioxide transport by hemoglobin.

UNIT – 4

**Vitamins and Hormones:** Chemical constitution and physiological functions of vitamins A, B2 (Riboflavin), C (Ascorbic acid); Thyroxin and estrone.

UNIT – 5

**Drugs:** Classification, preparation and Mechanism of action of the following:

- (i) Antipyretics and Analgesics : Aspirin, Paracetamol,
- (ii) Sulpha drugs: Sulphanilamide, Sulphaguanidine
- (iii) Antimalarials: Chloroquine
- (iv) Antibiotics: Chloramphenicol.

Books Recommended

1. “Organic Chemistry”, R. T. Morrison and R. N. Boyd, 6th Edition (1992), Prentice-Hall of India (P) Ltd., New Delhi.
2. “Organic Chemistry”, S. M. Mukherji, S. P. Singh, and R. P. Kapoor, 1st Edition (1985), 5<sup>th</sup> Reprint (1999), New Age International (P) Ltd. Publishers, New Delhi.
3. “Organic Chemistry”, I. L. Finar, Vol. II, 5th Edition (1975), Reprinted in 1996, ELBS and Longman Ltd., New Delhi.
4. “Biochemistry” L. Stryer, 5<sup>th</sup> edition (2002) Freeman & Co New York.
5. “Principles of Biochemistry” D. L. Nelson M.M. Cox, Lehninger, 3<sup>rd</sup> edition (2002) McMillan North Publication.



Semester-VI

CBT-601: PHYSICAL CHEMISTRY-IV

Unit-1

**Quantum Mechanics:** A review of black body radiation, the wave nature of electron, uncertainty principle, Schrödinger's wave equation. Eigen functions and Eigen values and quantum mechanical operators. Expectation value of a physical quantity. Orthogonalization and normalization of wave functions. The particle in a one dimensional box problem and its solutions. Particle in a three dimensional box.

Unit-2

**Molecular Spectroscopy:** Pure rotational spectra, selection rules, Diatomic molecules-Rigid rotor model. Vibrational-rotational spectra of diatomic molecules. Harmonic oscillator-rigid rotor approximation. Anharmonicity effect. Normal modes of vibration. Infrared spectra of linear molecules. Electronic spectra of diatomic molecules. Vibrational structure. Franck-Condon principle. Nuclear Magnetic Resonance spectroscopy. Chemical shifts. Spin-spin splitting.

Unit-3

**Thermodynamics of Solutions:** Chemical potential of ideal gases. Chemical potential of real gases and fugacity, activity and activity coefficient (concept and physical significance), Variation of fugacity with temperature and pressure. Thermodynamics of Colligative properties: Freezing point depression, Elevation of boiling point, Osmotic pressure, van't Hoff equation, Measurement of osmotic pressure.

Unit-4

**Surface chemistry:** Adsorption, Gibbs adsorption equation, Adsorption Isotherms- Langmuir, Freundlich and BET. Heterogeneous catalysis: kinetics of unimolecular reactions-inhibition and activation energy. Bimolecular surface reactions: reactions between a gas molecule and an adsorbed molecule, the reaction between two adsorbed molecules. Nature of surface. Concept of active centers, Kinetics of enzymatic reactions: Michaelis-Menten equation, effect of temperature and pH.

Unit-5

**Nuclear and Radiation Chemistry:** Nuclear reactions-Bethe's notation, types of nuclear reactions ( $n$ ,  $p$ ,  $\alpha$ ,  $d$  and  $\gamma$ ), compound nucleus theory and nuclear reactions.

**Radiation chemistry:** Elementary ideas of radiation chemistry, radiolysis of water and aqueous solutions, units of radiation chemical yield (G value), radiation dosimetry (Fricke's dosimeter).



#### Unit-4

Inorganic Polymers: Classification, Types of Inorganic Polymerization, Comparison with organic polymers, Boron-oxygen and boron-nitrogen polymers, silicones, coordination polymers, sulfur-nitrogen, sulfur-nitrogen-fluorine compounds.

#### Unit -5

Bioinorganic Chemistry: Essential and trace element in biological process, metalloporphyrins, Haemoglobin structure and biological functions, Myoglobin, synthetic models of O<sub>2</sub> carriers, Biological role of alkali metals ions. Electron transfer reaction in biological system.

#### Books Recommended:

1. "Inorganic Chemistry", J.E. Huheey, E.A. Keiter and R.L. Keiter, O.K. Medhi, Fourth Edition, Pearson.
2. "Basic Inorganic Chemistry", F. A Cotton, G. Wilkinson, and Paul L. Gaus, 3rd Edition (1995), John Wiley & Sons, New York.
3. "Concise Inorganic Chemistry", J. D. Lee, 5th Edition (1996), Chapman & Hall, London.
4. "Inorganic Chemistry", A. G. Sharpe, 3rd International Student Edition (1999), ELBS / Longman, U.K.
5. "Inorganic Chemistry", D. F. Shriver and P. W. Atkins, 3rd Edition (1999), ELBS, London.
6. "Inorganic Chemistry" Keith F. Purcell and John C. Kotz W. B. Saunders Com. (1987), Hong Kong.
6. "Principles of Inorganic Chemistry" Puri Sharma and Kalia Vishal Publishing House.
7. "Electronic Spectra of Transition Metal Complexes", R K Ray, New Central Book Agency (P) Ltd;
8. "General and Inorganic Chemistry" (Part-I); R P Sarkar; New Central Book Agency (P) Ltd.
9. "General and Inorganic Chemistry" (Part-II); R P Sarkar; New Central Book Agency (P) Ltd.
10. "Selected Topic in Inorganic Chemistry" W. U. Malik, G. D. Tuli, R. D. Madan (1994) S. Chand and Company Ltd.
11. "Fundamental Principles of Inorganic Chemistry" D. Banerjee Sultan Chand & Sons 3<sup>rd</sup> Edition (1993).

### SEMESTER- VI CBT-603: SPECIAL TOPICS IN CHEMISTRY

#### Unit-1

Symmetry and Group Theory in Chemistry

Symmetry elements and symmetry operation, definition of a group, subgroup, relation between orders of a finite group and its subgroup. Point symmetry group. Character table and their use.

#### UNIT - 2

Green Chemistry: Introduction and importance of green chemistry? Principles of green chemistry. Green alternative solvents and reagents in organic synthesis. Recent advances in green synthetic methodologies.

#### UNIT - 3

Chemical Toxicology:

Toxic chemicals in the environment, biochemical effects of arsenic, cadmium, lead, mercury, carbon dioxide, chloro-fluorocarbons, pesticides. Chemical and bio-warfare agents. Environmental and public health.



#### UNIT - 4

##### Separation Techniques:

Liquid-liquid solvent extraction, super critical fluid extraction. Theory of chromatography, terminology used in chromatography, high performance liquid chromatography, gas chromatography and size exclusion chromatography.

#### UNIT - 5

##### Chemistry of some Typical Natural Products:

A study of the following compounds involving their isolation, structure elucidation and synthesis: Alkaloids- Hofmann exhaustive methylation, nicotine; Terpenes- Isoprene rule, citral, flavonoids- quercetin.

#### Books Recommended

1. "Chemical Applications of Group Theory" F. Albert Cotton, 3<sup>rd</sup> Edition 1993, Wiley-India .
2. "Environmental Chemistry", A. K. De, 3<sup>rd</sup> Edition (1994), Wiley Eastern, New Delhi.
3. "Analytical Chemistry", G. D. Christian, 4<sup>th</sup> Edition (1986), John Wiley & Sons, New York.
4. "Principles of Instrumental Analysis", D.A. Skoog, 5<sup>th</sup> Edition (1998), Saunders College Publishing, Philadelphia, London, New York.
5. "Basic Concepts of Analytical Chemistry", S. M. Khopkar, 2<sup>nd</sup> Edition (1998), New Age International Publications, New Delhi.
6. "Instrumental Methods of Analysis", H. H. Willard, L. L. Merritt, and J. A. Dean, 6<sup>th</sup> Edition (1986), CBS Publishers & Distributors, Shahdara, Delhi.
7. "Organic Chemistry", I. L. Finar, [Vol. 2, 6<sup>th</sup> Edition (1973), Reprinted in 1980 & Vol. II, 5<sup>th</sup> Edition (1975), Reprinted in 1996], ELBS and Longman Ltd., New Delhi.
8. "New Trends in Green Chemistry", V. K. Ahluwalia and M. Kidwai (2004) Kluwer Academic Publishers, Netherland.
9. "Green Chemical Syntheses and Processes" Paul T. Anastas, Lauren G. Heine and Tracy C. Williamson (2000) American Chemical Society- Science.

#### Semester-VI

#### CBE-POLYMER CHEMISTRY

##### Unit-1

Introduction: Classification of polymers, various structures of copolymers such as linear, branched and cross-linked copolymers and their types, Configuration and conformation of polymers, Types of inorganic polymers, Nature of molecular interaction in Polymers, Tacticity of polymers.

##### Unit-2

Polymerization reactions: Addition and condensation - Mechanism of cationic, anionic and free radical addition polymerization; Metallocene-based Ziegler-Natta polymerisation of alkenes, basic methods of polymerization: mass (bulk), suspension & emulsion.

##### Unit-3

Molecular Weight of polymer: Degree of polymerization, Polydispersity Index. Polydispersity and molecular weight distribution, Number average molecular weight, weight average molecular weight,





and Z average molecular weight, determination of molecular weight by end group analysis, colligative property measurement, viscosity, osmotic pressure, light scattering.

#### Unit-4

Structure and Properties of polymers- Morphology of crystalline polymer, Crystallization and melting point, tensile strength, mechanical properties of crystalline polymers, Glass transition temperature (T<sub>g</sub>) and measurement of T<sub>g</sub>. importance of glass transition temperature.

#### Unit-5

Preparation and applications of commercial polymers

Fabrics – natural and synthetic (acrylic, polyamides, polyester)

Rubbers– natural and synthetic: Buna-S, Chloroprene and Neoprene; Vulcanization;

Polymer additives; Introduction to liquid crystal polymers, conducting polymers

Fire Resistance Polymers.

#### Books Recommended

1. “Textbook of Polymer Science”, Billmeyer, F. W. John Wiley & Sons, Inc.
2. Gowariker, V. R., Viswanathan, N. V. & Sreedhar, J. *Polymer Science*, New Age International (P) Ltd. Pub.
3. *Molecular Weight Distribution in Polymer* by L.H. Peebles, Wiley Interscience N.Y. (1971).
4. *Polymer Chemistry*, by Seymour R.B. and Carraher, Marcel Dekker (2000).
5. *Introduction to Polymer Chemistry*, C.E Carraher Jr. ,Taylor and Francis 1<sup>st</sup> edition (2007), Boca Raton, FL.
6. *Principle of Polymerization* G. Odian, 3<sup>rd</sup> edition (1991) John Wiley, Singapore.







B. Sc. I SEM

**CBL 103**

**Credits : 2**

1. *Qualitative Inorganic Mixture Analysis*: Detection of two Acidic and two Basic Radicals in the given inorganic mixture.
2. Determination of the surface tension and viscosity of various solvent/ mixture by Stalagmometer and Ostwald's Viscometer.

**Note:** Experiments may be added/deleted subject to availability of time and facilities.



**B. Sc. II SEM**

**CBL 203**

**Credits : 2**

**Compound identification and Physical Experiments**

1. Systematic identification of organic compounds with respect to following points
  - Physical Characteristic e.g. burning, litmus paper test, permanganate, bromine-water, soda-lime test
  - Functional group detection such as -COOH, PhOH, >C=O, Carbohydrate, hydrocarbons, amino, nitro, amide.
2. Determination of Critical Solution Temperature.
3. To determine the enthalpy of neutralization of strong acid and strong base.
5. Viscosity-composition curve for a binary liquid mixture.
6. Surface tension-composition curve for a binary liquid mixture.
4. Determination of pH of a given buffer.

**Note:** Experiments may be added/deleted subject to availability of time and facilities.

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B. Sc. III SEM

Credits : 2

**CBL 303**

**Quantitative analysis (Compound identification and Volumetric analysis)**

1. Systematic identification of organic compounds with respect to following points
  - Functional group test
  - Specific test
  - M.P. determination
2. Volumetric inorganic analysis
  - Preparation of Standard solutions
  - Redox titrations

**Note:** Experiments may be added/deleted subject to availability of time and facilities.



B. Sc. IV SEM

Credits : 2

**CBL 403**

1. Derivative preparation of carboxylic acid, alcohol, phenolic-OH, carbonyl compounds, hydrocarbons, carbohydrates and identification of the derivative by melting point determination.
2. Determination of indicator constant - colorimetry.
3. Determination of pH of a given solution using glass electrode.
4. Beer's Law - Determination of concentration of solution by colorimetry
5. Order of reaction of  $I_2$  / Acetone /  $H^+$ .
6. Equilibrium constant of methyl acetate hydrolysis reaction

**Note:** Experiments may be added/deleted subject to availability of time and facilities.

*Signature*

**B. Sc. V SEM**

**CBL 504**

**Laboratory I: Analytical Chemistry Practical**

Credits :

1. Estimation of total hardness of water sample.
2. Determination of available chlorine in bleaching powder
3. Determination of strength of  $H_2O_2$  sample.
4. Estimation of formalin.
5. Estimation of dissolved oxygen in water samples.
6. Estimation of Ca in milk.

**Note:** Experiments may be added/deleted subject to availability of time and facilities.

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B. Sc. V SEM

**CBL 505**

Credits : 2

**Laboratory II: Inorganic Chemistry Practical**

1. Redox titrimetric estimation using standard potassium dichromate solution
  - A)  $\text{Fe}^{\text{III}}$  -  $\text{Cr}_2\text{O}_7^{2-}$  in mixture
  - B) Fe and Cu in mixture
2. Redox titrimetric estimation based on permanganometry.
  - A) Estimation of  $\text{Fe}^{\text{II}}$  and  $\text{Fe}^{\text{III}}$  in a mixture
  - B) Estimation of  $\text{CaCO}_3$  dolomite in a mixture

**Note:** Experiments may be added/deleted subject to availability of time and facilities.

**CBL 506**

Credits : 2

**Laboratory III: Organic Chemistry Practical**

Organic preparation and characterization by UV-VIS spectroscopy and IR spectroscopy .

- Hydrolysis of ester: Preparation of benzoic acid from ethyl or methyl benzoate
- Hydrolysis of amide/imide : preparation of phthalic from phthalimide
- Preparation of the following compounds: nitrobenzene, p-nitroaniline from acetanilide, p-bromoaniline, o-chlorobenzoic acid, aspirin

**Note:** Experiments may be added/deleted subject to availability of time and facilities.



**B. SC VI SEM**

**CBL 604**

**Laboratory I: Inorganic Chemistry Practical**

**Credits : 2**

1. Complexometric titration

- Determination of Zinc against EDTA using Eriochrome Black T as indicator.
- Determination of Zinc against EDTA using Xylenol orange as indicator.
- Determination of  $\text{Ca}^{2+}$  &  $\text{Mg}^{2+}$  ions in a given solution using EDTA.
- Determination of Cu using pyrocatechol violet as indicator
- Determination of Ni using murexide as indicator.

**Note:** Experiments may be added/deleted subject to availability of time and facilities.

**B. SC VI SEM**

**CBL 605**

**Laboratory II: Organic Chemistry Practical**

**Credits : 2**

1. Quantification of Organic acids Acid/Base and Iodometric Titration
2. Quantification of protein from milk (casein) and egg (albumin)
3. Analysis of dye formation (methyl orange, methylene blue, fluorescein) by UV-Vis spectroscopy and colorimetric titration.
4. Synthesis of aspirin.
5. Distillation of common organic solvents (ether, methanol, ethanol) and measurement of boiling point using kjedals apparatus.
6. Study of metal binding capacity of organic acids and phenolic compounds by UV-Vis spectroscopy/ Colorimetrically.



B. Sc. VI SEM

CBL 606

Laboratory III: Physical Chemistry Practical

Credits :

1. Conductometric titration: acid-base.
2. Potentiometric titration: acid-base.
3. To determine the molecular weight of given substance by Rast's camphor method.
4. To determine the solubility of Benzoic acid at different temperatures and to determine  $\Delta$  of the dissolution process.
5. Kinetics of acid-catalysed hydrolysis of sugar (chemical method/polarimeter).
6. To study the kinetics of Iodine Clock reaction.