BSc chemistry

THEORY & PRACTICAL

Semester I (Major-1 and minor-1) Credits:Theory-03, Practicals-01

INORGANIC CHEMISTRY-I

(Atomic structure, Periodicity of Elements and Chemical bonding)

Unit-1: Atomic structure and periodicity (15 Lectures)

(i) Atomic Structure:

Bohr's theory, its limitations. 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. Shapes of *s, p, d* and *f* orbitals. Pauli's Exclusion Principle, Effective nuclear charge, shielding or screening effect, Slater rules, Hund's rule of maximum multiplicity, Aufbau's principle. eletronic configuration.

(ii) Periodic properties : Modern periodic law: division of elements into *s, p, d* and *f* block elements in the long form of periodic table. Study of the following periodic properties and their variation in the periodic table- Atomic and ionic radii, isoelectronic ions,

(Ionization enthalpy; Successive ionization enthalpies, Electron Affinity(EA)/electron gain enthalpy and electronegativity.

Unit-2: Chemical Bonding-I: (15 Lectures)

(i) ***Ionic bond:*** General characteristics of ionic bond, Lattice energy, Born-Haber cycle and its applications, Derivation of Madelung constant, Born-Lande equation with derivation and importance of Kapustinskii expression for lattice energy.

(ii) ***Weak Chemical Forces:*** van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Hydrogen bonding: Effects of melting, boiling points and solubility.

(iii**) Covalent character in ionic compounds:** polarizing power and polarizability, consequences of polarization. Fajan's rule and its applications. Ionic character in covalent compounds: Dipole moment, Calculation of dipole moment, Percentage ionic character from dipole moment and electronegativity difference.

Unit-3: Chemical Bonding-II: (15 Lectures)

Covalent bond: Lewis structure, Valence Bond theory (Heitler-London approach). Hybridisation; types of hybridization. Energetics of hybridization, equivalent and non-equivalent hybrid orbitals, Resonance and resonance energy, Resonance structures of CO_3^{-2}, NO_3^-, SO_4^{-2}, SO_2, SO_3, CO_2 Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2, O_2, F_2, CO, NO, and their ions; Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons,BeF_2, BF_3 H_3O^+, NH_3, H_2O ,H_2S, O_3, BO_3^{-3}, PCl_5,SF_4, SF_6

Reference Books:

1. B. R. Puri, L. R. Sharma, and K. C. Kalia, *Principles of Inorganic Chemistry*, Milestone.
2. W.U.Malik, G. D.Tuli, & R.D.Madan, *Selected Topics in Inorganic Chemistry*, S. Chand & Company Ltd.
3. Puri, Sharma, Kalia and Kaushal. A Text book of inorganic Chemistry - I, Vishal publications.
4. Advanced inorganic chemistry S. Chand & Company Ltd. Vol. I and II by Satya Prakash, G.D Tuli, S.K Basu, R.D Madan.
5. Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
6. Douglas, B.E. and McDaniel, D.H. *Concepts & Models of Inorganic Chemistry*Oxford, 1970
7. Atkins, P.W. & Paula, J. *Physical Chemistry*, 10th Ed., Oxford University Press, 2014.
8. Day, M.C. and Selbin, J. *Theoretical Inorganic Chemistry*, ACS Publications, 1962
9. Rodger, G.E. *Inorganic and Solid State Chemistry*, Cengage Learning India Edition,2002
10. . Madan, Tuli and Malik, selected topics of inorganic, organic & physical chemistry R.L Madan Chemistry for degree Students, S.Chand & Companny Ltd New Delhi.

CHEMISTRY LAB-MJ-1 & MN-1

Qualitative semi micro analysis of mixtures containing 2 anions and 2 cations. Emphasis should be given to the understanding of the chemistry of different reactions. The following radicals are suggested:

CO_3^{2-}, Cl-, Br-, NO_3^-, SO_4^{-2} NH_4^+, K^+,Pb^{2+} Cu^{2+}, Cd^{2+}, Bi^{3+}, Sn^{2+}, Sb^{3+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Ba^{2+},Sr^{2+}, Ca^{2+},Mg^{2+}

Oxidation-Reduction Titrimetry

(i) Estimation of Fe(II) with standard $KMnO_4$ solution.

(ii) Estimation of Fe(III) with standard $K_2Cr_2O_7$ using diphenylamine indicator.

Reference text:

1. Mendham, J., A. I. Vogel's *Quantitative Chemical Analysis 6th Ed.*, Pearson, 2009.

BSc chemistry

THEORY & PRACTICAL

Semester II (Major-2 and minor-2) Credits:Theory-03, Practicals-01

PHYSICAL CHEMISTRY-I

(States of matter & Ionic equilibria)

Unit-1:Gaseous state: **(15 Lectures)**

Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; Collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of σ from η; variation of viscosity with temperature and pressure. Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities. Vander Waals equation of state, its derivation and application in explaining real gas behaviour, Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, *Z*, and its variation with pressure for different gases and temperature. Causes of deviation from ideal behavior,Isotherms of real, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states.

Unit-2: Liquid state and Solid state: (15 Lectures)

Qualitative treatment of the structure of the liquid state; physical properties of liquids; vapour pressure, surface tension and viscosity, and their determination (Capillary rise method and the Ostwald viscometer method). Effect of addition of various solutes on surface tension and viscosity. Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, determination of crystal structure (Laue's and powder pattern method).Defects in crystals. Glasses and liquid crystals.

Unit-3:Ionic equilibria-I: (15 Lectures)

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono-, di-and tri-protic acids (exact treatment). Different types of salt; Salt hydrolysis-calculation of hydrolysis constant, Relation between K_a, K_b and K_w, degree of hydrolysis and pH for different salts; of (1) strong acid and weak base (2) weak acid and strong base. (Numerical problems on relevant topics). Qualitative treatment of acid – base titration curves. Theory of acid–base indicators; selection of indicators and their limitations. Buffer solutions; derivation of Henderson equation, calculation of pH of buffer mixtures, buffer capacity, buffer index, buffer action and its applications.

Reference Books:

1. Atkins, P. W. & Paula, J. de *Atkin's Physical Chemistry* 10th Ed., Oxford University 12 Press(2014).
2. Ball,D.W. *Physical Chemistry* Thomson Press, India (2007).
3. Castellan,G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
4. Mortimer, R.G. *Physical Chemistry* 3rd Ed. Elsevier: NOIDA, UP(2009).
5. Engel,T.& Reid,P. *Physical Chemistry* 3rd Ed. Pearson(2013).

CHEMISTRY LAB-MJ-2 & MN-2

1. Surface tension measurements.

a. Determine the surface tension by (i) drop number (ii) drop weight method.
b. Study the variation of surface tension of detergent solutions with concentration.
c.

2. Viscosity measurement using Ostwald's viscometer.

a. Determination of viscosity of aqueous solutions of (i) ethanol and (ii) sugar at room temperature.
b. Study the variation of viscosity of sucrose solution with the concentration of solute.

Any other experiment carried out in the class.

Reference Books:

1. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.:New Delhi (2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed*.; McGraw-Hill: New York(2003).
3. Halpern,A.M. & McBane,G.C. *Experimental Physical Chemistry 3rd Ed.;* W.H.Freeman & Co.: NewYork (2003).

BSc chemistry

THEORY & PRACTICAL

Semester III (Major-3 and minor-3) Credits:Theory-03, Practicals-01

ORGANIC CHEMISTRY- I

(Basic & Hydrocarbon)

Unit-1 : Basics of Organic Chemistry: (15 Lectures)

Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties.

Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Homolytic and Heterolytic fission with suitable examples; Electrophiles and Nucleophiles; Nucleophlicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes. Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

Unit-2: Chemistry of Aliphatic Hydrocarbons : (15 Lectures)

[a] Carbon-Carbon sigma bonds: Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions:

[b] Carbon-Carbon pi bonds: Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, reactions. Saytzeff and Hofmann eliminations.

Reactions of alkenes*:* Electrophilic additions their mechanisms (Markownikoff/Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroboration oxidation, ozonolysis, reduction (catalytic and chemical) 1,2-and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethylbenzene.

Unit-3: (15 Lectures)

Aromatic Hydrocarbons

Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups.

Alkynes, Cycloalkanes and Conformational Analysis

[a] Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes

[b] Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of alkanes: Relative stability: Energy diagrams of cyclohexane:

[c] Chair, Boat and Twist boat forms; Relative stability with energy diagrams.

Reference Books:

1. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. *Organic Chemistry (Volume 1)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. *Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Eliel, E. L. & Wilen, S. H. *Stereochemistry of Organic Compounds*, Wiley: London, 1994.
5. Kalsi, P. S. *Stereochemistry Conformation and Mechanism*, New Age International, 2005.
6. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.

CHEMISTRY LAB-MJ-3 & MN-3

1. Detection of extra elements.
2. Functional group test for nitro, amine and amide groups.
3. Qualitative analysis of unknown organic compounds containing simple functional groups (alcohols, carboxylic acids, phenols and carbonyl compounds)

Reference Books:

1. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education (2009)
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.,* Pearson (2012)
3. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis,* University Press (2000).
4. Ahluwalia, V.K. & Dhingra, S. *Comprehensive Practical Organic Chemistry: Qualitative Analysis,* University Press (2000).

Semester III (Major-4) Credits:Theory-03, Practicals-01

PHYSICAL CHEMISTRY-2

(Chemical thermodynamic and its application)

Unit-1: Chemical Thermodynamics-I: (15 Lectures)

Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics.

First law: Concept of heat, *q*, work, *w*, internal energy, *U*, and statement of first law; enthalpy, *H*,relation between heat capacities, calculations of *q*, *w*, *U* and *H* for reversible and irreversible under isothermal and adiabatic conditions.

Second Law: Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes.

Third Law: Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules.

Systems of Variable Composition: Partial molar quantities; Gibbs-Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases.

Unit-2: Chemical Thermodynamics-II: (15 Lectures)

Thermochemistry: Heats of reactions: standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; Hess law of constant heat summation, calculation of bond energy and bond dissociation energy from thermochemical data, effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions.

Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state.

Unit-3:Chemical Equilibrium and Colligative properties: (15 Lectures)

Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases, concept of fugacity. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration. Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants K_p,K_c and K_x. Le-Chatelier principle (quantitative treatment); 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.

Reference Books:

1. Peter,A.& Paula, J. de. *Physical Chemistry* 10th Ed.,Oxford University Press (2014).
2. Castellan, G.W. *Physical Chemistry 4th Ed.*, Narosa (2004).
3. Engel,T.& Reid, P. *Physical Chemistry 3rd Ed.*, Prentice-Hall (2012).
4. Mc Quarrie, D. A. & Simon, J. D. *Molecular Thermodynamics* Viva Books Pvt. Ltd.: NewDelhi (2004).
5. Assael, M. J.; Goodwin, A. R.H.; Stamatoudis, M.; Wakeham, W.A.& Will,S. *Commonly Asked Questionsin Thermodynamics.* CRC Press: NY(2011).
6. Levine, I.N. *Physical Chemistry* 6th Ed., Tata McGraw Hill(2010).
7. Metz,C.R.*2000 solved problems in chemistry,* Schaum Series(2006).

CHEMISTRY LAB-MJ-4

(a) Determination of the Heat of displacement.
(b) Determination of the Heat of Precipitations.
(c) Determination of enthalpy of hydration of copper sulphate.
(d) Study of the solubility of benzoic acid in water and determination of ΔH.
(e) pH metric titration of (I)strong acid vs. strong base, (ii) weak acid vs. strong base.
Any other experiment carried out in the class.

ReferenceBooks:

1. Khosla, B. D.; Garg, V. C. & Gulati, A., *Senior Practical Physical Chemistry*, R.Chand & Co.: New Delhi (2011).
2. Athawale, V.D.& Mathur, P. *Experimental Physical Chemistry* New Age International: New Delhi(2001).

BSc chemistry

THEORY & PRACTICAL
Semester IV (Major-5 and minor-4) Credits:Theory-03, Practicals-01

INORGANIC CHEMISTRY-2
(Metallurgical processes, Acids and Bases and s & p-blocks elements).

Unit-1: General Principles of Metallurgy:(15 Lectures)
Chief modes of occurrence of metals based on standard electrode potentials. Different steps of metallurgy, Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy. Methods of purification of metals: Electrolytic process, Parking process, van Arkel-de Boer process and Mond's process, Zone refining, oxidative process, Amalgamation process, Poling process. Preparation of metals (ferrous and nonferrous) and ultrapure metals for semiconductor
technology.

Unit-2: Acids and Bases : (15 Lectures)
Arrhenius concept of acids and bases, Brönsted-Lowry concept of acids-bases, advantages and disadvantages of Brönsted-Lowry concept of acids-bases, Lux-Flood concept of acids –bases, Usanovich concept, applications of solvent systems concept, advantages and disadvantages of solvent systems concept, Lewis acid-base concept, classification of Lewis acid, utility and its limitations, relative strength of acids and bases, leveling and differentiating solvents, Amphoprotic substances and its applications, Pearsons classification of Lewis acids and Lewis bases, Hard and Soft Acids and Bases (HSAB) Principle and applications. Symbiosis.

Unit-3: Chemistry of *s* and *p* Block Elements (15 Lectures)
Inert pair effect, Relative stability of different oxidation states, diagonal relationship, Allotropy, catenation, isomorphism. Complex formation tendency of *s* and *p* block elements. Hydrides and their classification-ionic, covalent and interstitial.
Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses: Boric acid and borates, boron nitrides, borohydrides (diborane), Oxo acids of nitrogen and chlorine, Peroxo acids of sulphur, introduction to interhalogen compounds and pseudohalogens .
Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation, properties and structures of XeF_2, XeF_4 , XeF_6 ,XeO_3, $XeOF_4$ and $XeOF_2$; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF_2).

Reference Books:

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1. B. R. Puri, L. R. Sharma, and K. C. Kalia, *Principles of Inorganic Chemistry*, Milestone.
2. W.U.Malik, G. D.Tuli, & R.D.Madan, *Selected Topics in Inorganic Chemistry*, S. Chand & Company Ltd.
3. Puri, Sharma, Kalia and Kaushal. A Text book of inorganic Chemistry - III, Vishal publications.
4. Advanced inorganic chemistry S. Chand & Company Ltd. Vol. I and II by Satya Prakash, G.D Tuli, S.K Basu, R.D Madan.
5. Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
6. Douglas, B.E. and McDaniel, D.H. *Concepts & Models of Inorganic Chemistry* Oxford, 1970
7. Atkins, P.W. & Paula, J. *Physical Chemistry*, 10th Ed., Oxford University Press, 2014.
8. Day, M.C. and Selbin, J. *Theoretical Inorganic Chemistry*, ACS Publications, 1962
9. Rodger, G.E. *Inorganic and Solid State Chemistry*, Cengage Learning India Edition,2002
10. Madan, Tuli and Malik, selected topics of inorganic, organic & physical chemistry R.L Madan Chemistry for degree Students, S.Chand & Companny Ltd New Delhi.

CHEMISTRY LAB-MJ-5 & MN-4

(a) Inorganic compound preparations:

(i) Cuprous Chloride, Cu_2Cl_2

(ii) Preparation of potassium chromate.

(iii) Preparation of Aluminium potassium sulphate $KAl(SO_4)_2.12H_2O$ (Potash alum)

(iv) Preparation of potassium dichromate.

(b) Iodometric / Iodimetric Titrations

(i) To determine the strength of $K_2Cr_2O_7$ using N/10 sodium thiosulphate (hypo) solution.

(ii) Estimation of copper from $CuSO_4$ solution with a standard $Na_2S_2O_3$ or hypo solution.

Reference Books:

Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.,* Pearson, 2009.

Semester IV (Major-6) Credits:Theory-03, Practicals-01

ORGANIC CHEMISTRY-2
(Active methylene compounds, Petroleum and petrochemicals and Organosulphur compounds)

Unit-1 Active methylene compounds:(15 Lectures)
Acidity of α-H, preparation of ethyl malonate and its synthetic application (synthesis of mono and dicarboxylic acids and diols with their mechanism), preparation of ethyl acetoacetate (Claisen condensation, Dieck mann reaction, Keto-enol tautomerism), synthesis of mono and dicarbboxylic acids, diols and ketones with their mechanism.

Unit-2: Petroleum and petrochemicals: (15 Lectures)
Composition, petroleum refining, knocking, octane number, and cetane number, applications and drawbacks of TEL(tetra ethyl lead), factors affecting fuel efficiency cracking, synthetic fuels and synthesis, sources of petrochemicals and their applications in daily use materials.

Unit-3: Organosulphur compounds: (15 Lectures)
Structural features, nomenclature, method of preparation and reactions of thiols, thioethers, sulphonic acid, sulpha drugs (preparations and applications).

Recommended Texts:

1. I. L. Finar: *Organic Chemistry* (Vol. I & II), E. L. B. S.
2. R. T. Morrison & R. N. Boyd: *Organic Chemistry*, Pearson Education.
3. Arun Bahl and B. S. Bahl : *Advanced Organic Chemistry*, S. Chand
4. T. W. Graham Solomon's *Organic Chemistry*, John Wiley and Sons.
5. Madan, Tuli and Malik, *Selected topics of Inorganic, Organic & Physical chemistry*
6. R.L. Madan *Chemistry for Degree Students*, S.Chand & Company Ltd
7. Organic Chemistry (Vol.I, II & III) by S.M.Mukherji, S.P.Singh & R.P.Kapoor.

CHEMISTRY LAB-MJ-6

1. Detection of extra elements present in organic compound, saturation & unsaturation, Aromatic & non aromatic.
2. Functional group test for nitro, amine, amide, alcohols, carboxylic acids, phenols and carbonyl compounds

Reference Books:

1. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Pearson Education (2009)
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.*, Pearson (2012)
3. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis*, University Press (2000).
4. Ahluwalia, V.K. & Dhingra, S. *Comprehensive Practical Organic Chemistry: Qualitative Analysis*, University Press (2000).

Semester IV (Major- 7) Credits:Theory-03, Practicals-01

ORGANIC CHEMISTRY- 3

(Halogen & Oxygen containing functional groups)

Unit-1:

A. Chemistry of Halogenated Hydrocarbons: (15 Lectures)

Alkyl halides: Methods of preparation, nucleophilic substitution reactions – SN1, SN2 mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination.

Aryl halides: Preparation, including preparation from diazonium salts. nucleophilic aromatic substitution; SNAr. Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions. Organometallic compounds of Mg and Li – Use in synthesis of organic compounds**.**

B. Alcohols, Phenols: (15 Lectures)

Alcohols: preparation, properties and relative reactivity of 1°, 2°, 3° alcohols,; Preparation and properties of glycols: Oxidation by periodic acid and lead tetra-acetate, Pinacol-Pinacolone rearrangement;

Phenols: Preparation and properties; Acidity and factors effecting it, Ring substitution reactions, Reimer–Tiemann and Kolbe's–Schmidt Reactions, Fries and Claisen rearrangements with mechanism.

Unit-2: Carbonyl Compounds: (15 Lectures)

Structure, reactivity and preparation; Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel
condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, α-substitution reactions, oxidations and reductions (Clemmensen, Wolff-Kishner, LiAlH4,NaBH4, MPV.
Addition reactions of unsaturated carbonyl compounds: Michael addition.

Unit-3: (15 Lectures)

A. Carboxylic Acids and their Derivatives:

Preparation, physical properties and reactions of monocarboxylic acids: Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparative study of nucleophilic sustitution at acyl group -Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Simple reactions of dicarboxylic acids and hydroxy acids; maleic and fumaric acids.

B. Ethers , Epoxides and Sulphur containing compounds:

Ethers: Preparation and reactions with acids

Epoxides :Reactions of epoxides with alcohols, ammonia derivatives and LiAlH4
Preparation and reactions of thiols, thioethers and sulphonic acids.

Reference Books:

 Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
 Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd.(Pearson Education).
 Graham Solomons, T.W. *Organic Chemistry*, John Wiley & Sons, Inc.
 McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.

CHEMISTRY LAB-MJ-7

1. Functional group tests for alcohols, phenols, carbonyl and carboxylic acid group.
2. Organic preparations:

i. Acetylation of one of the following compounds: amines (aniline, *o*-, *m*-, *p*toluidines and *o*-, *m*-, *p*-anisidine) and phenols (β-naphthol, vanillin, salicylic acid) by any one method:
   a. Using conventional method. b. Using green approach

ii. Benzolyation of one of the following amines (aniline, *o*-, *m*-, *p*- toluidines and *o*-, *m*-, *p*-anisidine) and one of the following phenols (β-naphthol, resorcinol, pcresol) by Schotten-Baumann reaction.

Reference Books:

1. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Pearson Education (2009)
2. Furniss, B.S., Hannaford, A.J., Smith, P.W.G. & Tatchell, A.R. *Practical OrganicChemistry, 5th Ed.* Pearson (2012)
3. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry:Preparation and Quantitative Analysis*, University Press (2000).
4. Ahluwalia, V.K. & Dhingra, S. *Comprehensive Practical Organic Chemistry: Qualitative Analysis*, University Press (2000).

Semester IV (MJ-8) Credits:Theory-03, Practicals-01

PHYSICAL CHEMISTRY -3

(Phase Equilibria and Chemical Kinetics)

Unit-1:Phase Equilibria: (15 Lectures)

Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule. Clausius-Clapeyron equation and its applications to solid-liquid, liquid-vapour and solid-vapour equilibria, Reduced phase rule (definition), phase diagram for one component systems,(H_2O system) with applications. Phase diagrams for systems of solid-liquid equilibria involving eutectic, KI-H_2O system congruent Mg-Zn system and incongruent melting points: NaCl-H_2O system. Two component system of solid solution (Pb-Ag), Three component systems, water-chloroform-acetic acid system, triangular plots.

Binary solutions: Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and non-ideal), azeotropes, Lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation. Nernst distribution law: its derivation and applications.

Unit-2:Chemical Kinetics: (15 Lectures)

Order and molecularity of a reaction, factors affecting rate of reaction, determination of rate laws, Pseudomolecular reaction, derivation of integrated rate law expression up to second order reactions. Determination of order of reaction (integrated, differential and half-life period method) up to first order reactions. Kinetics of complex reactions; Opposing reactions, parallel reactions, consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms),chain reactions. Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, Activated complex Theory (Erying equation),

Unit-3:Catalysis and Surface chemistry: (15 Lectures)

Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces; effect of particle size and efficiency of nanoparticles as catalysts. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.

Surface chemistry: Physical adsorption, chemisorption, adsorption isotherms. nature of adsorbed state. Factors affecting adsorption, Freundlich adsorption isotherm derivation, Langmuir adsorption isotherm. Surface tension and surface free energy; Pressure across an interface: Laplace equation, Kelvin equation; Wetting: Young-Dupre equation; Adsorption in liquid systems: Gibbs adsorption isotherm; Adsorption on solids: BET isotherm.

ReferenceBooks:

1. Peter Atkins & Julio De Paula, *Physical Chemistry* 10th Ed., Oxford University Press(2014).
2. Castellan, G.W. *Physical Chemistry*,4th Ed., Narosa (2004).
3.McQuarrie, D. A. & Simon, J. D., *Molecular Thermodynamics*, Viva Books Pvt. Ltd. New-Delhi (2004).
4.Engel,T.& Reid,P. *Physical Chemistry 3rd Ed.*, Prentice-Hall(2012).
5.Assael,M. J.; Goodwin, A.R. H.; Stamatoudis, M.; Wakeham, W.A. & Will,S.
6. Ball,D.W. *Physical Chemistry* Cengage India(2012).
7.Mortimer,R.G. *Physical Chemistry 3rd Ed.*, Elsevier: NOIDA, UP(2009).
8.Levine,I.N. *Physical Chemistry 6th Ed.*, Tata McGraw-Hill(2011).
9.Metz,C.R. *Physical Chemistry 2nd Ed.*, Tata McGraw-Hill(2009).

CHEMISTRY LAB-MJ-8

(a) Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
(b) Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution or enthalpy of neutralization).
(c) Calculation of the enthalpy of ionization of ethanoic acid.
(d) Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts.
(e) Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.

ReferenceBooks:

1. Khosla, B. D.; Garg, V. C. &Gulati, A. *Senior Practical Physical Chemistry,* R.Chand& Co.: New Delhi (2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry8thEd.*; McGraw-Hill: New York(2003).
3. Halpern,A.M.&McBane,G.C. *Experimental Physical Chemistry3rdEd.;* W.H.Freeman& Co.: NewYork (2003).

THEORY & PRACTICAL
Semester V (MJ-9) Credits:Theory-03, Practicals-01
INORGANIC CHEMISTRY-3
(Co-ordination chemistry, d & f blocks elements and Bioinorganic chemistry)

Unit-1: Coordination Chemistry-: (15 Lectures)
Introduction: IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers. Chelate effect, Labile and inert complexes. Werner's theory, valence bond theory (inner and outer orbital complexes) and its limitations, Crystal field theory, crystal field splitting of d-orbitals in octahedral and tetrahedral complexes, factors affecting the magnitude of 10 Dq , CFSE in weak and strong fields.

Unit-2: Transition and inner transition elements: (15 Lectures)
Transition Elements: General group trends with special reference to electronic configuration: atomic and ionic radii, colouration, variable valency, magnetic properties, catalytic properties, ability to form alloys, interstitial compounds and ability to form complexes. Differences between the first, second and third transition series.
Lanthanoids and Actinoids:
Introduction, Electronic configuration, oxidation states, ionic radii, colour, complex formation tendency, spectral and magnetic properties, lanthanide contraction: Causes and consequences, actinoid contraction, separation of lanthanoides (ion-exchange method and from monazite sand). Comparison of lanthanoides and actinoides, chemistry of separation of Np, Pu and Am from U.

Unit-3: Bioinorganic Chemistry: (15 Lectures)
Essential and trace elements in biological system. Sodium/Potassium pump, carbonic anhydrase and carboxypeptidase. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine. Iron and its application in bio-systems; Metalloporphyrins (chlorophyll), heme-proteins (Haemoglobin, Myoglobin) , vitamin B_{12},and crown-ethers. Biological role of alkaline earth metal ions with reference to Ca^{+2}.

Reference Books:

1. B. R. Puri, L. R. Sharma, and K. C. Kalia, *Principles of Inorganic Chemistry*, Milestone.
2. W.U.Malik, G. D.Tuli, & R.D.Madan, *Selected Topics in Inorganic Chemistry*, S. Chand & Company Ltd.
3. Puri, Sharma, Kalia and Kaushal. A Text book of inorganic Chemistry - IV, Vishal publications.
4. Advanced inorganic chemistry S. Chand & Company Ltd. Vol. I and II by Satya Prakash, G.D Tuli, S.K Basu, R.D Madan.
5. Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
6. Douglas, B.E. and McDaniel, D.H. *Concepts & Models of Inorganic Chemistry*Oxford, 1970
7. Atkins, P.W. & Paula, J. *Physical Chemistry*, 10th Ed., Oxford University Press, 2014.
8. Day, M.C. and Selbin, J. *Theoretical Inorganic Chemistry*, ACS Publications, 1962
9. Rodger, G.E. *Inorganic and Solid State Chemistry*, Cengage Learning India Edition,2002
10. . Madan, Tuli and Malik, selected topics of inorganic, organic & physical chemistry
R.L Madan Chemistry for degree Students, S.Chand & Companny Ltd New Delhi.

CHEMISTRY LAB-MJ-9

Gravimetric Analysis:

i. Estimation of nickel (II) using Dimethylglyoxime (DMG).
ii. Estimation of copper as CuSCN
iii. Estimation of iron as Fe_2O_3 by precipitating iron as $Fe(OH)_3$.

Inorganic Preparations:

(i) Tetraamminecopper (II) sulphate, $[Cu(NH_3)_4]SO_4.H_2O$
(ii) Tetraamminecarbonatocobalt (III) ion
(iii) Potassium tris (oxalate)ferrate(III)
(iv) Sodium ferrioxalate or sodium trioxalato Ferrate.

Reference Book:

Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.,* Pearson, 2009.

Semester V (MJ-10) Credits:Theory-03, Practicals-01
ORGANIC CHEMISTRY-4
(Heterocyclic compound & Nitrogen containing functional groups)

Unit-1: Nitrogen Containing Functional Groups: (15 Lectures)
Preparation and important reactions of nitro and compounds, nitriles and isonitriles Amines: Effect of substituent and solvent on basicity; Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction; Distinction between 1°, 2°and 3°amines with Hinsberg reagent and nitrous acid. Diazonium Salts: Preparation and their synthetic applications.

Unit-2: (15 Lectures)

a. **Heterocyclic Compounds :**

Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom; Synthesis, reactions and mechanism of substitution reactions of: Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis),Thiophene, Pyridine (Hantzsch synthesis), Pyrimidine, Structure elucidation of indole, Fischer indole synthesis and Madelung synthesis), Structure elucidation of quinoline and isoquinoline, Skraup synthesis, Knorr quinoline synthesis, Bischler-Napieralski reaction.

b. **Polynuclear Hydrocarbons:**

Reactions of naphthalene phenanthrene and anthracene Structure, Preparation and structure elucidation and important derivatives of naphthalene and anthracene;

Unit-3: (15 Lectures)

a. **Alkaloids :**

Natural occurrence, General structural features, Isolation and their physiological action Hoffmann's exhaustive methylation, Emde's modification, Structure elucidation and synthesis of Hygrine, Morphine, reserpine and Nicotine. Medicinal importance of Nicotine, Hygrine, Quinine,Morphine, Cocaine, and Reserpine.

b. **Terpenes:**

Occurrence, classification, isoprene rule; Elucidation of stucture and synthesis of Citral, Neral,Limonene, beta-Pinene and α-terpineol.

Reference Books:

1. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd.(Pearson Education).
3. Finar, I. L. *Organic Chemistry* (*Volume 2: Stereochemistry and the Chemistry of Natural Products*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Acheson, R.M. *Introduction to the Chemistry of Heterocyclic compounds*, JohnWelly & Sons (1976).
5. Graham Solomons, T.W. *Organic Chemistry*, John Wiley & Sons, Inc.
6. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
7. Kalsi, P. S. *Textbook of Organic Chemistry 1st Ed.*, New Age International (P)Ltd. Pub.
8. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; *Organic Chemistry*, Oxford
9. Singh, J.; Ali, S.M. & Singh, J. *Natural Product Chemistry*, Prajati Parakashan

CHEMISTRY LAB-MJ-10

1 Purification of organic compounds by crystallization using the following solvents:
   a. Water b. Alcohol c. Alcohol-Water
2. Determination of the melting points of above compounds and unknown organic compounds (Kjeldahl method and electrically heated melting point apparatus)
3. Determination of boiling point of liquid compounds. (boiling point lower than and more than 100 °C by distillation and capillary method)

Reference Books:

1. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Pearson Education (2009)
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.*, Pearson (2012)

Semester V (MJ-11 & MN-5) Credits:Theory-03, Practicals-01

PHYSICAL CHEMISTRY-4

(Electrochemistry, Electro-Chemistry& Spectroscopy)

Unit-1:Conductance: (15 Lectures)

Arrhenius theory of electrolytic dissociation and its limitations. Conductivity: equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law, migration of ions. Ostwald`s dilution law, its uses and limitations, Debye-Hückel-Onsager equation. Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transport numbers using Hittorf and Moving Boundary methods.

Theory of strong electrolytes, Relaxation effect, Electrophoretic effect,Wien effect,Debye-Falkenhagen effect, Walden's rules. Activity coefficients of electrolytes, Mean Ionic activity coefficients, Ionic strength, Concentration cells with and without transference, liquid junction potential; Applications of conductance measurement: (i)degree of dissociation of weak electrolytes, ionic product of water (iii) solubility and solubility product of sparingly soluble salts, (iv) conductometric titrations, and (v) hydrolysis constants of salts.

Unit-2:Electrochemistry: (15 Lectures)

Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry. Electrolytic and Galvanic cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells. Polarization, decomposition potential, overvoltage, polarography, corrosion.

Types of electrodes: Metal-metal ion electrodes, metal-metal insoluble salt electrodes, metal-amalgam electrodes, redox electrodes, calomel-electrode. Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii)equilibrium constants, and pH values, using hydrogen and quinhydrone electrode, Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation). Structures of electrified interfaces: The Helmholtz-Perrin model, Electro catalysis.

Unit-3:Molecular Spectroscopy: (15 Lectures)

Interaction of electromagnetic radiation with molecules and various types of spectra; Born-Oppenheimer approximation.

Rotational spectroscopy: Spectra of diatomic molecule, Selection rules, intensities of spectral lines, determination of bond lengths in polyatomic molecules

Vibrational spectroscopy: Classical equation of vibration, computation of force constant, Amplitude of diatomic molecular vibrations, an harmonicity, Morse potential, fundamental frequencies, overtones, hot bands, modes of vibration, concept of group frequencies.

Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Stokes and anti-Stokes lines; rule of mutual exclusion.

Electronic spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and pre-dissociation.

ReferenceBooks:

1. Atkins,P.W&Paula,J.D. *Physical Chemistry*,10th Ed.,Oxford University Press(2014).
2. Castellan,G.W. *Physical Chemistry 4th Ed.*,Narosa(2004).
3. Mortimer,R.G. *Physical Chemistry 3rd Ed.*, Elsevier: NOIDA, UP(2009).
4. Barrow,G.M., *Physical Chemistry 5th Ed.*,Tata McGrawHill: NewDelhi(2006).
5. Engel,T.&Reid,P.*Physical Chemistry 3rd Ed.*, Prentice-Hall(2012).
6. Rogers,D.W. *Concise Physical Chemistry* Wiley(2010).
7. Silbey,R.J.;Alberty,R.A.&Bawendi,M.G. *Physical Chemistry4th Ed.*,John Wiley & Sons,Inc.(2005).
8. Banwell,C.N.&McCash,E.M. *Fundamentals of Molecular Spectroscopy* 4th Ed.Tata McGraw-Hill:New Delhi (2006).
9. Kakkar,R.*Atomic & Molecular Spectroscopy*: *Concepts & Applications*, Cambridge University Press(2015).

CHEMISTRY LAB -MJ-11 & MN-5

1. Distribution of acetic/benzoic acid between water and cyclohexane
2. Study the kinetics of the following reactions.
   a. Acid hydrolysis of methylacetate with hydrochloric acid.
   b. Saponification of ethyl acetate.
   c. Compare the strengths of HCl and H_2SO_4 by studying
3. Kinetics of hydrolysis of methyl acetate.
4. Determination of critical solution temperature and composition of the phenol-water system and to study the effect of impurities on it.
5. Phase equilibria: Construction of the phase diagram using cooling curves or ignition tube method:
   a .simple eutectic and b. congruently melting systems.

ReferenceBooks:

1. Khosla, B. D.; Garg, V. C. &Gulati, A. *Senior Practical Physical Chemistry*, R.Chand& Co.: New Delhi (2011).
2. Garland,C.W.;Nibler,J.W.& Shoemaker,D.P. *Experiments in Physical Chemistry 8th Ed.;* Mc Graw-Hill: New York (2003).

BSc chemistry

THEORY & PRACTICAL
Semester VI (MJ-12) Credits:Theory-03, Practicals-01

INORGANIC CHEMISTRY-4
(Organo metallic compounds, Kinetics and reaction mechanism)

Unit-1: Organometallic Compounds-I: (15 Lectures)
Definition and classification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands. Metal carbonyls: 18 electron rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series. Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT. pi-acceptor behaviour of CO (MO diagram of CO to be discussed).

Unit-2: Organometallic Compounds-II: (15 Lectures)
***Zeise's salt*:** Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls.
***Metal Alkyls*:** Important structural features of methyl lithium (tetramer) and trialkylaluminium (dimer), concept of multicentre bonding in these compounds. Role of triethylaluminium in polymerisation of ethene (Ziegler – Natta Catalyst).
Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation). Structure and aromaticity. Comparison of aromaticity and reactivity with that of benzene.
Study of the following industrial processes and their mechanism:
1. Alkene hydrogenation (Wilkinsons Catalyst).
2. Hydroformylation (Co salts).
3. Wacker Process.
4. Synthetic gasoline (Fischer Tropsch reaction).

Unit-3: Kinetics and reaction mechanisms - I (15 Lectures)
Introduction to inorganic reaction mechanisms. Thermodynamic and Kinetic stability; Factors affecting the stability of complexes in solutions. Mechanism of substitution in octahedral complexes; Unimolecular nucleophilic substitution (S_N^1) and bimolecular nucleophilic substitution(S_N^2) mechanism. Types of intermediates formed during S_N^1 and S_N^2 reactions; Lability of non-transition metal complexes. Kinetics of octahedral substitution, Ligand field effects and reaction rates.
Square planar complexes: Mechanism and rate law of nucleophilic substitution in square planar complexes. Trans- effect, application of trans effect. Theories to explain trans effect by Electrostatic polarization and pi – bonding theory.

Reference Books:

1. B. R. Puri, L. R. Sharma, and K. C. Kalia, *Principles of Inorganic Chemistry*, Milestone.
2. W.U.Malik, G.D. Tuli, & R. D. Madan, *Selected Topics in Inorganic Chemistry*, S. Chand & Company Ltd.
3. Puri, Sharma, Kalia and Kaushal . A text book of inorganic chemistry – VI. Vishal publications.
4. Svehla, G. *Vogel's Qualitative Inorganic Analysis*, 7th Edition, Prentice Hall,1996.
5. Cotton, F.A.G.; Wilkinson & Gaus, P.L. *Basic Inorganic Chemistry 3rd Ed.;* Wiley India,
6. Huheey, J. E.; Keiter, E.A. & Keiter, R.L. *Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed.*, Harper Collins 1993, Pearson,2006.
7. Sharpe, A.G. *Inorganic Chemistry*, 4th Indian Reprint (Pearson Education) 2005
8. Douglas, B. E.; McDaniel, D.H. & Alexander, J.J. *Concepts and Models in Inorganic Chemistry 3rd Ed.*, John Wiley and Sons, NY, 1994.
9. Greenwood, N.N. & Earnshaw, A. *Chemistry of the Elements, Elsevier 2nd Ed*,1997 (Ziegler Natta Catalyst and Equilibria in Grignard Solution).
10 . Lee, J.D. *Concise Inorganic Chemistry 5th Ed.*, John Wiley and sons 2008.
11. Powell, P. *Principles of Organometallic Chemistry*, Chapman and Hall, 1988.
12. Shriver, D.D. & P. Atkins, *Inorganic Chemistry 2nd Ed.*, Oxford University Press,1994.
13. Basolo, F. & Pearson, R. *Mechanisms of Inorganic Reactions: Study of Metal Complexes in Solution 2nd Ed.*, John Wiley & Sons Inc; NY.
14. Purcell, K.F. & Kotz, J.C., *Inorganic Chemistry*, W.B. Saunders Co. 1977
15. Miessler, G. L. & Tarr, D.A. *Inorganic Chemistry 4th Ed.*, Pearson, 2010.
16. Collman, J. P. *et al. Principles and Applications of Organo Chemistry*. Mill Valley, CA: University Science Books, 1987.

CHEMISTRY LAB-MJ-12

1. Estimation of Mg^{2+} by complexometric titrations using EDTA.
2. Estimation of total hardness of a given sample of water by complexometric titration.

Preparation of inorganic compounds:

i. Preparation of acetylacetanato complexes of Cu^{2+}/Fe^{3+}.
ii. Preparation of ammine complexes of Ni(II).

Reference Books

1. Vogel's *Qualitative Inorganic Analysis*, Revised by G. Svehla. Pearson Education, 2002.
2. Marr & Rockett *Practical Inorganic Chemistry.* John Wiley & Sons 1972.

Semester VI (MJ-13) Credits:Theory-03, Practicals-01
INORGANIC CHEMISTRY-5

(Analytical Methods in Chemistry)

Unit-1:(15 Lectures)
(a) Qualitative and quantitative aspects of analysis:
Evaluation of analytical data, significance figures, rounding off numerical expression, errors, types of errors, accuracy and precision, difference between accuracy and precision, methods of their expression, normal law of distribution of indeterminate errors, statistical test of data; F, Q and t test, rejection of a result of Q-test, tests of significance: F and t-tests.
(b) Electroanalytical methods:
Electroanalytical methods: Basic principle of Electrogravimetric analysis, Coulometry, potentiometry and voltammetry; basic principle of pH metric, potentiometric and conductometric titrations.

Unit-2:(15 Lectures)
(a) Optical methods of analysis-I:
Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.
UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument;
(b) Optical methods of analysis-II:
Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques.
Structural illustration through interpretation of data
Flame Atomic Absorption and Emission Spectrometry: Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization.,

Unit-3: (15 Lectures)
(a) Separation techniques:
Solvent extraction: Classification, principle.
Mechanism of extraction: extraction by solvation and chelation.
Technique of extraction: batch, continuous and counter current extractions.
extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non-aqueous media.
(b) Chromatography: Classification, principle and efficiency of the technique.
Mechanism of separation: adsorption, partition & ion exchange.
Development of chromatograms: frontal, elution and displacement methods.
chromatographic methods of analysis: IC, GLC, GPC,TLC and HPLC.
Stereoisomeric separation and analysis: Measurement of optical rotation, calculation of Enantiomeric excess (ee)/ diastereomeric excess (de) ratios and determination of enantiomeric composition using NMR.

Reference Books:

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.,* Pearson, 2009.
2. Willard, H.H. *et al.*: *Instrumental Methods of Analysis*, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Christian, G.D. *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, D.C.: *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
5. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009.
6. Skoog, D.A. Holler F.J. &Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
7. Mikes, O. *Laboratory Hand Book of Chromatographic & Allied Methods*, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.
8. Ditts, R.V. Analytical Chemistry; Methods of separation, van Nostrand, 1974.

CHEMISTRY LAB-MJ-13

1. **Separation Techniques**
   Chromatography:
   (a)Separation and identification of the monosaccharides present in the given mixture (glucose& fructose) by paper chromatography. Reporting the Rf values.
   (b) Chromatographic separation of the active ingredients of plants, flowers and juices by TLC
2. Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.

Reference Books:

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.,* Pearson, 2009.
2. Willard, H.H. *et al.*: *Instrumental Methods of Analysis*, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Christian, G.D. *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, D.C. *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
5. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009.
6. Skoog, D.A. Holler F.J. and Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Edition.
7. Mikes, O. &Chalmes, R.A. *Laboratory Handbook of Chromatographic & Allied Methods*, Elles Harwood Ltd. London.
8. Ditts, R.V. *Analytical Chemistry: Methods of separation.* Van Nostrand, New York, 1974.

Semester VI (MJ-14 & MN-6) Credits:Theory-03, Practicals-01
ORGANIC CHEMISTRY-5

(Biomolecules)

Unit-1: (15 Lectures)

Nucleic Acids :

Components of nucleic acids, Nucleosides and nucleotides, nucleosides, DNA, RNA replication, Transcription and translation, Structure, synthesis : Adenine, Guanine, Cytosine, Uracil and Thymine;Structure of polynucleotides.

Lipids:

Introduction to oils and fats; common fatty acids present in oils and fats, Hydrogenation of fats and oils, Saponification value, acid value, iodine number. Rancidity. Drying and non drying oils,phospholipids, glycolipids. Trans and omega fats.

Unit-2: (15 Lectures)

a. Amino Acids, Peptides and Proteins:

Amino acids, Peptides and their classification.

α-Amino Acids - Synthesis, ionic properties and reactions. Zwitterions, p*K*a values, isoelectric point and electrophoresis; Study of peptides: determination of their primary structures-end group analysis, methods of peptide synthesis. Synthesis of peptides using N-protecting, C-protecting and C-activating groups -Solid-phase synthesis

b. Pharmaceutical Compounds: Structure and Importance:

Classification, structure and therapeutic uses of antipyretics: Paracetamol (with synthesis), Analgesics: Ibuprofen (with synthesis), Antimalarials: Chloroquine (with synthesis). An elementary treatment of Antibiotics and detailed study of chloramphenicol, Medicinal values of vitamin C and antacid (ranitidine).

Unit-3: Enzymes: (15 Lectures)

Introduction, classification and characteristics of enzymes. Salient features of active site of enzymes.

Mechanism of enzyme action (taking chemotrypsin as example), factors affecting enzyme action,coenzymes and cofactors and their role in biological reactions, specificity of enzyme action (including stereo specificity), structure and functions of FAD ATP and ADP. Enzyme inhibitors and their importance, phenomenon of inhibition (competitive, uncompetitive and non-competitive inhibition including allosteric inhibition).

Reference Books:

1. Berg, J.M., Tymoczko, J.L. & Stryer, L. (2006) *Biochemistr*y. 6th Ed. W.H. Freeman and Co.
2. Nelson, D.L., Cox, M.M. & Lehninger, A.L. (2009) *Principles of Biochemistry. IV Edition.* W.H. Freeman and Co.
3. Murray, R.K., Granner, D.K., Mayes, P.A. & Rodwell, V.W. (2009) *Harper's Illustrated Biochemistry.* XXVIII edition. Lange Medical Books/ McGraw-Hill.

CHEMISTRY LAB-MJ-14 & MN-6

1. Estimation of glycine by Sorenson's formalin method.
2. Study of the titration curve of glycine.
3. Study of the action of salivary amylase on starch at optimum conditions.
4. Effect of temperature on the action of salivary amylase.
5. Saponification value of an oil or a fat.
6. Determination of Iodine number of an oil/ fat.

Reference Books:

1. Manual of Biochemistry Workshop, 2012, Department of Chemistry, University of Delhi.
2. Arthur, I. V. *Quantitative Organic Analysis*, Pearson.

Semester VI (MJ-15) Credits:Theory-03, Practicals-01

PHYSICAL CHEMISTRY-5

(Quantum-Chemistry, Physical properties and Chemical constitution & Reaction Dynamics)

Unit-1:Quantum Chemistry: (15 Lectures)

Postulates of quantum mechanics, quantum mechanical operators, Schrödinger equation and its application to free particle and "particle-in-1D-box" quantization of energy levels, zero-point energy and Heisenberg Uncertainty principle; wave functions, probability distribution functions, Qualitative treatment of hydrogen atom and hydrogen-like ions: setting up of Schrödinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression). Average and most probable distances of electron from nucleus. Setting up of Schrödinger equation for many-electron atoms (He, Li). Need for approximation methods. Statement of variation theorem and application to simple systems; Chemical bonding: Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of H_2^+. Bonding and antibonding orbitals. Qualitative extension to H_2.Comparison of LCAO-MO and VB treatments of H_2.

Unit-2:Physical properties and Chemical constitution: (15 Lectures)

Influence of temperature and pressure on physical properties, molar volumes, Parachor, refractive index, Optical exaltation, refraction, optical activity and chemical constitution, Basic ideas of electrostatics, Clausius - Mosotti equation, Lorentz-Laurentz equation, Debye equation, bond moments Dipole moment and molecular polarizabilities. Dielectric polarization and dielectric constant, determination of dielectric constant, Magnetic permeability, Diamagnetism, paramagnetism, magnetic susceptibility, its measurement and application, molecular interpretation.

Unit-3:Reaction Dynamics: (15 Lectures)

Methods of determining rate laws: Arrhenius law, Collision theory, conventional transition state theory (CTST) - equilibrium hypothesis, statistical mechanics and chemical equilibrium, derivations of the rate equations, applications of CTST - reaction between atoms, thermodynamic formulation of conventional transition state theory. Factors determining reaction rates in solution, collision in solution, encounter, Franck - Rabinowitch effect, reaction between ions, single-sphere and double-sphere model for activated complex, influence of ionic strength (primary salt effects),

ReferenceBooks:

1. Castellan,G.W. *Physical Chemistry 4th Ed.*,Narosa(2004).
2. Mortimer,R.G. *Physical Chemistry 3rd Ed.*, Elsevier: NOIDA, UP(2009).
3. Barrow,G.M., *Physical Chemistry 5th Ed.*,Tata Mc GrawHill: New Delhi(2006).
4. Chandra,A.K. *Introductory Quantum Chemistry*Tata Mc Graw-Hill(2001).
5. House,J. E. *Fundamentals of Quantum Chemistry*2nd Ed.Elsevier: USA(2004).
6. Kakkar, R. *Atomic & Molecular Spectroscopy*: *Concepts & Applications*, Cambridge University Press (2015).
7. Lowe,J.P. & Peterson,K. *Quantum Chemistry*
8. *Chemical Kinetics*, K. J. Laidler, (4th Edn.), Pearson Eductions (2007).
9. *Chemical kinetics and Reaction Mechanism* by James H. Espenson, 2nd Ed., McGraw-Hill, (1995).
10. *Chemical Kinetics and Reaction Dynamics* by Santosh K. Upadhyay, Anamaya Publishers, New Delhi, (2006).

CHEMISTRY LAB-MJ-15

1. Determination of the heat of solution of solid calcium chloride by the Born-Haber cycle.
2. Determination of the molecular weight by Rast's method.
3. Verification of Hardy-Schulze law: Preparation and coagulation of arsenic sulphide (As_2S_3) sol using NaCl, $BaCl_2$ and $AlCl_3$ solutions.
4. To study the kinetics of iodination of acetone.
5. Study the equilibrium of at least one of the following reactions by the distribution method:

   (i) $I_2(aq)+I^- \rightarrow I_3^-(aq)^{2+}$

   (ii) $Cu^{2+}(aq)+nNH_3 \rightarrow Cu(NH_3)n$

ReferenceBooks:

1. Khosla, B. D.; Garg, V. C. &Gulati, A., *Senior Practical Physical Chemistry,* R.Chand & Co.: New Delhi (2011).
2. Garland,C.W.;Nibler,J.W.& Shoemaker,D.P. *Experimentsin Physical Chemistry 8th Ed.;* McGraw-Hill: New York (2003).
3. Halpern,A.M .& McBane,G.C. *Experimental Physical Chemistry 3rd Ed.;* W.H.Freeman & Co.: New York (2003).

BSc chemistry

THEORY & PRACTICAL
Semester VII (MJ-16) Credits:Theory-03, Practicals-01
INORGANIC CHEMISTRY-6
(Symmetry and Structure, Magnetic Properties and Electronic Structure of Transition Metal Complexes)

Unit 1(15 Lectures)
Symmetry and Structure:
Symmetry elements and operations; equivalent symmetry elements and equivalent atoms; symmetry point groups with examples from inorganic compounds; groups of very high symmetry; molecular dissymmetry and optical activity; systematic procedure for symmetry classification of molecules and illustrative examples; molecular symmetry for compounds having co-ordination numbers 2 to 9.

Unit - 2 (15 Lectures)
Magnetic Properties:
Brief review of different types of magnetic behavior, spin-orbit coupling, quenching of orbital angular momenta, temperature-independent paramagnetism, measurement of magnetic susceptibility using Gouy and Faraday methods, Term symbols for metal ions; Crystal field theory and its application to explain magnetic properties of coordination compounds, spin crossover; Structural effects: ionic radii and Jahn-Teller effect; octahedral vs. tetrahedral coordination, magnetic properties of Lanthanides and Actinides and splitting of f-orbitals in octahedral field.

Unit – 3 (15 Lectures)
Electronic Structure of Transition Metal Complexes:
Electronic absorption spectra of octahedral and tetrahedral complexes, Orgel diagrams, Tanabe-Sugano diagrams, calculation of Dq, B and ß values, selection rules, band intensities and band widths, spectra of high-spin octahedral and tetrahedral complexes of d^1 to d^9 systems, Spectrochemical series; Adjusted crystal field theory, Nephelauxetic series, molecular orbital theory of complexes (qualitative principles involved in complexes with and without π-bonding), MO diagrams for octahedral and tetrahedral complexes and charge-transfer spectra, optical properties of Lanthanides and Actinides.

Recommended Books and References:

1. J. E. Huheey, E. A. Keiter, R. L. Keiter & O. K. Medhi. *Principles of Structure and Reactivity* (1st impression), Pearson Education (2006).
2. F. A. Cotton. *Chemical Applications of Group Theory*, (3rd edn.), John Wiley & Sons (1999).
3. F. A. Cotton and G. Wilkinson, *Advanced Inorganic Chemistry* (5th edition), John Wiley (1988).
4. P. Atkins, T. Overton, J. Rourke, M. Weller & F. Armstrong. *Shriver and Atkins Inorganic Chemistry*, Oxford University Press (2006).
5. N. N. Greenwood & A. Earnshaw. *Chemistry of the Elements*, Pergamon Press (1984).
6. F. Basolo & R. G. Pearson, *Mechanism of Inorganic Reactions*, Wiley Eastern (1967).
7. F. A. Cotton, G. Wilkinson, C. A. Murillo & M. Bochmann. *Advanced Inorganic Chemistry* (6th edition), John Wiley (1999).
8. S. F. A. Kettle, *Physical Inorganic Chemistry*, Spectrum (1996).

CHEMISTRY LAB-MJ-16

1. Estimation of calcium by complexometric titrations using EDTA.
2. Estimation of Zn^{2+} by complexometric titrations using EDTA.
3. Estimation of available chlorine in bleaching powder iodometrically.
4. To determine the percentage of oxalic acid and sodium oxalate in a given mixture.

Inorganic compound Preparations:
(i) Sodium cobaltinitrite.
(ii) Potassium trisoxalatoaluminate.
(iii) Barium thiocarbonate.

Reference text:

Practical chemistry by O.P Pandey, D.N.Bajpai and S.Guri.

Semester VII (MJ-17 & MN-7) Credits:Theory-03, Practicals-01
ORGANIC CHEMISTRY-6
(Organic spectroscopy)

Unit-1: (15 Lectures)
Organic Spectroscopy-I:
a. UV Spectroscopy: Types of electronic transitions, λmax, Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; Application of Woodward Rules for calculation of λmax for the following systems: α,β unsaturated aldehydes, ketones, carboxylic acids and esters; Conjugated dienes: alicyclic, homoannular and heteroannular; Extended conjugated systems (aldehydes, ketones and dienes)
b. IR Spectroscopy: Fundamental and non-fundamental molecular vibrations; IR absorption positions of O, N and S containing functional groups; Effect of H-bonding, conjugation, resonance and IR absorptions; Fingerprint region and its significance; application in functional group analysis.
Organic Spectroscopy-II:
NMR Spectroscopy: Basic principles of Proton Magnetic Resonance, chemical shift and factors influencing it; Spin – Spin coupling and coupling constant; Anisotropic effects in alkene, alkyne, aldehydes and aromatics, Interpretation of NMR spectra of simple compounds.

Unit-2: (15 Lectures)
a. Mass spectroscopy:
Mass spectral fragmentation of organic compounds, common function groups: molecular peak, McLafferty rearrangement, examples of mass spectral fragmentation of organic compounds with respect to their structure determination.
b. Carbohydrates:
Occurrence, classification and their biological importance. Monosaccharides: Constitution of glucose and fructose, epimers and anomers, mutarotation, determination of ring size of glucose, Haworth projections and conformational structures; Interconversions of aldoses and ketoses; Killiani-Fischer synthesis and Ruff degradation; Disaccharides – Structure elucidation of maltose and sucrose. Polysaccharides – Elementary treatment of starch, cellulose.

Unit-3: (15 Lectures)
a. Dyes:
Classification, Colour and constitution; Mordant and Vat Dyes; Synthesis and applications of: Azo dyes – Methyl Orange and Congo Red (mechanism of Diazo Coupling); Triphenyl Methane Dyes -Malachite Green, Rosaniline and Crystal Violet; Phthalein Dyes – Phenolphthalein and Fluorescein; Natural dyes –structure elucidation and synthesis of Alizarin and Indigotin;.
b. Polymers:
Number average molecular weight, Weight average molecular weight, Polydispersity Index. Polymerisation reactions -Addition and condensation -Mechanism of cationic, anionic and free radical addition polymerization; Metallocene-based Ziegler-Natta polymerisation of alkenes; Preparation and applications of plastics – thermosetting (phenol-formaldehyde, Polyurethanes) and thermo softening (PVC, polythene); Fabrics – natural and synthetic (acrylic, polyamido, polyester); Rubbers – natural and synthetic: Buna-S, Chloroprene and Neoprene; Vulcanization; Polymer additives; Biodegradable with examples.

Reference Books:

1. Kalsi, P. S. *Textbook of Organic Chemistry 1st Ed.*, New Age International (P)Ltd. Pub.
2. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India)Pvt. Ltd. (Pearson Education).
3. Billmeyer, F. W. *Textbook of Polymer Science*, John Wiley & Sons, Inc.
4. Gowariker, V. R.; Viswanathan, N. V. & Sreedhar, J. *Polymer Science*, New Age International (P) Ltd. Pub.
5. Finar, I. L. *Organic Chemistry* (*Volume 2: Stereochemistry and the Chemistry of Natural Products*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6. Graham Solomons, T.W. *Organic Chemistry*, John Wiley & Sons, Inc.
7. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
8. Singh, J.; Ali, S.M. & Singh, J. *Natural Product Chemistry*, Prajati Prakashan (2010).
9. Kemp, W. *Organic Spectroscopy*, Palgrave.
10. Pavia, D. L. *et al. Introduction to Spectroscopy* 5th Ed. Cengage Learning India Ed. (2015).

CHEMISTRY LAB-MJ-17& MN-7

1. Extraction of caffeine from tea leaves.
3. Preparation of urea formaldehyde.
3. Qualitative analysis of unknown organic compounds containing mono-functional groups (carbohydrates, aryl halides, aromatic hydrocarbons, nitro compounds, amines and amides) and simple bi-functional groups, for e.g. salicylic acid, cinnamic acid, nitrophenols, etc.

Reference Books:

1. Vogel, A.I. *Quantitative Organic Analysis*, Part 3, Pearson (2012).
2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Pearson Education(2009)
3. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.*, Pearson (2012)
4. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry:Preparation and Quantitative Analysis*, University Press (2000).
5. Ahluwalia, V.K. & Dhingra, S. *Comprehensive Practical Organic Chemistry: Qualitative Analysis*, University Press (2000).

Semester VII (MJ-18) Credits:Theory-03, Practicals-01
PHYSICAL CHEMISTRY-6
(Nuclear Chemistry)

Unit-1: Introduction& Nuclear reaction I: (15 Lectures)
Natural radioactivity, half life, mean life. Units of radioactivity, the natural radioactive series, secular and transient equilibrium. The nuclear atom, neutron-proton model of the atom, isotopes and their separation, neutron decay, β-spectrum, the neutrino, electron capture and internal conversion; nuclear stability, stability lines, exotic nuclei. Standard α, β, γ and neutron laboratory sources. Nuclear sizes, binding energy per nucleon, nuclear saturation, liquid drop model leading to Weizsacker formula. Regions of fission and fusion. Magic numbers, shell model, ground state nuclear spins. Qualitative idea of collective models. Nuclear scattering and reactions, cross-sections, units, phase shifts, Resonance, Breit-Wigner formula. Qualitative idea of Bohr's picture of a nuclear reaction. Qualitative idea of the nucleon-nucleon and the complex nucleon-nucleon potential (the optical model). Different types of reactions, notation.

Unit-2 : Nuclear reaction II: (15 Lectures)
Nuclear reaction cycles in stars, the p-p chain and the C-N cycle. Artificial radioactivity, radioactive isotopes of the elements. The Szilard-Chalmers process. Preparation of suitable compounds containing ^{35}S and ^{131}I.Slow neutron absorption in nuclei. Discovery of induced fission its important features. Discovery of spontaneous fission. Broad ideas of research reactors, power reactors. Recovery of unused fuel and waste disposal. Broad idea of Breeder reactors. Broad sketch of a fusion reactor. Metallurgy of U and Th. Enrichment of Uranium, separation of heavy water from ordinary water. Production of the Trans-Uranic elements. A somewhat detailed study of Pu. Energy loss suffered by charged particles in traversing matter-excitation, ionisation, Bremsshtrahlung and Cerenkov radiation. Attenuation of γ-rays in traversing matter-photoelectric effect, Compton effect and pair production.

Unit-3: Instrumentation in Nuclear Chemistry & Application to Chemistry: (15 Lectures)
Instruments for detection and measurement of charged particles and neutrons-G.M. counter, solid state detectors and neutron counters. Cloud chamber. Instruments for γ-rays-scintillation counters. A broad idea of counting and scaling circuits. Shielding of charged particles, γ-rays and neutrons. Van de Graaff and heavy ion beam accelerators. Cyclotron. Very broad idea of Synchrotron principle leading to the era of super-energy machines. Electron Synchrotron and Synchrotron radiation. Radio-dating of wood and Pb-containing minerals.
.Radiometric titration including radiometric indicators. Brief introduction to radio-chromatography. Direct isotope dilution analysis and inverse isotope dilution analysis. Selection rules for γ-emission (or absorption), Nuclear isomerism, PIXE, Pair production chemistry, Muon chemistry, Mössbauer effect, Cow and Milk system. Applications of nuclear chemistry to biology, medicine, agriculture, industry etc.

Recommended Books & References:

1. *Nuclear and Radiochemistry* G. Friedlander, J. W. Kennedy and J. M. Miller, , John Wiley (1981).
2. *Radiochemistry and nuclear chemistry* G. Choppin, J. O. Liljenzin and J. Rydberg, ,Butterworth (1996).
3. *Essentials of Nuclear Chemistry*,H. J. Arnikar, Wiley Eastern Ltd. (1995).
4. Indian Association of Nuclear Chemistry & Allied Scientists (2004).
5. Nuclear and radiation Chemistry B.K.Sharma , Krishna Publication (2011).

CHEMISTRY LAB-MJ-18

1. Molecular weight of a polymer by viscometric method.
2. Solubility product of potassium hydrogen tartrate and the common ion effect.
3. Conductometric titration : silver nitrate with potassium chloride.
4. Conductometric titration : hydrochloric acid with sodium hydroxide.
5 .Determine the Heat of Formation of Magnesium Oxide.

ReferenceBooks

1. Khosla, B. D.; Garg, V. C. &Gulati, A. *Senior Practical Physical Chemistry* R.Chand& Co.:NewDelhi (2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed*.; McGraw-Hill: New York(2003).
3. Halpern,A.M. & McBane,G.C. *Experimental Physical Chemistry 3rd Ed.;* W.H.Freeman & Co.: New York (2003).

Semester VII (MJ-19) Credits:Theory-03, Practicals-01

PHYSICAL CHEMISTRY-7

(Polymer Chemistry)

UNIT-1: Introduction to Polymers & Polymer Characterization I: (15 Lectures)

Polymer Molecules, Conformation and Molecular Dimensions of Polymer Molecules, Properties of Isolated Polymer Molecules, Elasticity and Swelling of Polymer Gels, Molecular Motion of Polymers in Dilute Solutions, Amorphous Polymers, Structure of Amorphous Phase in Bulk Polymers, Mobility in Polymers, Glass Transition- Measurement of T_g , Effect of Various Parameters on T_g, Theoretical Interpretations, Crystallinity in Polymers. Thermodynamics of Polymer Solutions, Flory-Huggins and Lattice Theory of Polymer Solution, Entropy and Enthalpy of Mixing, Theta Temperature, Molecular Weight and Molecular Dimensions by Osmometry, Light Scattering, Viscometry and Gel Permeation Chromatography.

UNIT-2: Polymer Characterization II &Biopolymers and Special Polymers: (15 Lectures)

Thermal Analysis of Polymers: Differential Scanning Calorimetry (DSC), Thermogravimetric Analysis (TGA) and Differential Thermal Analysis (DTA), Polymer Degradation and Stabilization. Structure, Functions and Properties of Naturally Occurring Polymers such as Proteins, Polysaccharides and DNA, Polymer Chemistry of Biological Processes, Synthetic Biopolymers, their Fabrication and Applications Conductive Polymers: Theory of Conduction, Synthesis and Applications of Conductive Polymers, Biodegradable Polymers, Biomaterials, Polymers in Medicine, Drug Delivery Systems, Recycling of Polymers.

UNIT-3: Polymer Technology & Polymer Rheology: (15 Lectures)

Polymers of Commercial Importance, Mass Polymerization: Solution, Emulsion and Suspension Polymerizations, Ziegler Natta Coordination Polymerization, Methathesis Polymerization. Additives for Plastics: Fillers, Plasticizers, Stabilizers, Lubricants, Flame Retardants, Foaming Agents, Cross linking Agents, Manufacture, Properties and Applications of Major Thermoplastics and Thermosetting Polymers: PE, PP, PVC, PS, Polyamides, Polyesters, Phenolic Resins, Amino Resins and Epoxy Resins, Polymeric Coatings.

Definition of Rheology, Geometry of Deformation, Newtonian and Non-Newtonian Behaviors, Measurement of Rheological Properties, Power Law, Free Volume Theory of Polymer Fluidity, Dynamic Flow Behavior, Time-Dependent Fluid Responses, Viscoelastic Properties, Mechanical Models of a Viscoelastic Material, Stress Relaxation, Creep and Relaxation behavior of Plastics.

Recommended Books & References:

1. Text Book of Polymer Science By F. W. Billmeyer, Wiley-Blackwell; 3rd edition (1984)
2. Introduction to Polymers by R. J. Young and P. A. Lovell,Springer-science,BuisnessMedia,B.V(1991)
3. Polymer Chemistry by G. Challa, Ellis Horwood Ltd ,(1993)
4. "Nanomaterials Chemistry: Recent Developments and New Directions", ed. by C.N.R. Rao, A. Muller & A.K. Cheetham (Eds.), Wiley-VCH, (2007).
5. Solid State Chemistry and its applications, Anthony R. West, John Wiley &Sons.(2017).
6. Polymers: Chemistry and Physics of Modern Materials by JMG Cowie,CRC press Taylor & Francis group,(2007)
7. Principles of Polymerization by George Odian, Wiley-Interscience; 4^{th} edition (February 9, 2004)

CHEMISTRY LAB-MJ-19

1. Determination of transition temperature of $MnCI_2$. $4H_2O$.
2. Determination of the Phase Diagram for three component system (ethyl acetate-ethyl alcohol-water).
3. Determination of the Phase Diagram for three component system (acetic acid-chloroform-water).
4. Determination of coordination number of Cu^{2+} in copper-ammonia complex by partition method.
5. To determine the partial molar volumes of sodium chloride solution.

ReferenceBooks:

1. Khosla, B. D.; Garg, V. C. & Gulati, A., *Senior Practical Physical Chemistry*, R.Chand& Co.: New Delhi (2011).
2. Garland,C.W.;Nibler,J.W.& Shoemaker,D.P. *Experiments in Physical Chemistry 8th Ed.;* McGraw-Hill: New York (2003).

3. Halpern,A.M.& McBane,G.C. *Experimental Physical Chemistry 3rd Ed.;* W.H.Freeman & Co.: NewYork (2003).

BSc chemistry

THEORY & PRACTICAL
Semester VIII (MJ-20 & MN-8) Credits:Theory-03, Practicals-01
INORGANIC CHEMISTRY-7
(Transition Metal π-acid Complexes, Supramolecular Chemistry, Non-aqueous Solvents and Inorganic Polymers)

Unit 1 (15 Lectures)
Transition Metal π-acid Complexes and Supramolecular Chemistry
Bonding, synthesis and reactivity of transition metal complexes with CO, NO, O_2, N_2 and tertiary phosphine and arsine ligands; metal carbonyl hydrides and metal carbonyl clusters: LNCC and HNCC, Wade's rule and the capping rule.
Supramolecular chemistry: Definition, supramolecular host-guest compounds, macrocyclic effect, nature of supramolecular interaction.

Unit 2. Non-aqueous Solvents
Classification of solvents; general properties of ionizing solvents; chemical reactions, liquid ammonia as solvent, advantages and disadvantages of liquid ammonia as solvent, liquid sulfur dioxide as solvent; solubility of inorganic materials in liquid sulphur dioxide, liquid dinitrogen tetra-oxide; liquid hydrogen fluoride; liquid hydrogen sulfide; liquid hydrogen cyanide , acetic acid; liquid bromine trifluoride; oxyhalides: formation of adduct and its mechanism.

Unit 3 (15 Lectures)
(a)Inorganic Polymers: Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes- phosphonitrylic compounds: polyphosphazenes, polyphosphonitrilic chloride$(PNCl_2)_n$ n=3 to 7. Uses of phosphazenes. Structure of $(NPCl_2)_3$ molecule, formation of different types of bonds in $(NPCl_2)_3$. Formation of island type pi- bond in $(NPCl_2)_3$. Comparison between the structures of benzene and$(NPCl_2)_3$.
(b) Study of some selected topics
Synthesis, properties and structures of boranes, carboranes, non-stoichiometric oxides: zeolites and clay; polymorphism of carbon, phosphorus and sulphur.

Text Books:

1. R.C. Mehrotra & A. Singh.*Organometallic Chemistry: A Unified Approach* (2nd edn.), New Age International (2000).
2. F.A. Cotton & G.Wilkinson. *Advanced Inorganic Chemistry* (5thedn.), JohnWiley (1988)
3. D.M.Round hill. *Photochemistry and Photophysics of Metal Complexes*, Plenum Press(1990).
James E. Mark, Harry R. Allcock, Robert West, Inorganic Polymers, Second Edition, Oxford University Press (2005)
4. P.B. Saxena, Inorganic Polymers, Discovery Publishing House, 2007
5. Roger De Jaeger, Mario Gleria , Inorganic Polymers, Nova Science Publishers, 2007
6. Ronald D. Archer, Inorganic and Organometallic Polymers, John Wiley & Sons, 2001
7. S. J. Lippard& J. M. Berg. *Principles of Bio-Inorganic Chemistry*, Panima Publ. Corpn. (2005).

Reference Books:

1. C. Cutal & A.W. Adamson,.*Comprehensive Coordination Chemistry*, Vol. 1, Editor-in-Chief G.
Wilkinson (1985).
2. A.W. Adamson &P.D. Fleischauer.*Concepts of Inorganic Photochemistry*, John Wiley & Sons (1975).
3. M. Ratner & D. Ratner.*Nanotechnology: A Gentle Introduction to the Next Big Idea*, Pearson Education (2003).
4. P. Atkins, T. Overton, J. Rourke, M. Weller & F. Armstrong.*Shriver and Atkins Inorganic Chemistry*, Oxford University Press (2006).

CHEMISTRY LAB-MJ-20 & MN-8

Gravimetric analysis :

1. Estimation of barium as barium sulphate.
2. Estimation of zinc as zinc oxide.
3. Estimation of aluminium as Al_2O_3.
4. Estimation of chromium as Cr_2O_3.

Inorganic compound Preparations:

(i) Sodium thiosulphate.
(ii) Potassium trisoxalatochromate.
(iii) Chrome red.

Reference text:

Practical chemistry by O.P Pandey, D.N.Bajpai and S.Guri.

Semester VIII (MJ-21) Credits:Theory-03, Practicals-01
INORGANIC CHEMISTRY-8
(Kinetics and Mechanism of Inorganic Reactions- II, Transition Metal–Carbon Bond, Syntheses of Cyclopentadienyl and Arene Metal Analogues)

Unit 1 *Kinetics and Mechanism of Inorganic Reactions- II* (15 Lectures)
Labile and inert complexes; mechanisms of ligand-replacement reactions; ligand displacement reactions octahedral complexes; Mechanisms of acid and base hydrolysis of octahedral complexes, isomerisation and racemisation of tris-chelate complexes; Mechanisms of electron transfer reactions in solution phase; outer sphere and inner sphere mechanism, stereochemical non-rigidity and fluxional molecules.

Unit 2 *Transition Metal–Carbon Bond*(15 Lectures)
Transition Metal–Carbon σ-Bond: Brief review of metal alkyl compounds; transition metal carbene and transition metal-carbyne compounds; transition metal vinylidene and transition metalallenylidene compounds.
Transition Metal-Carbon π-Bond: Cyclopropenyl cation (C_3R^{3+}) as a ligand; C_4R_4 as a ligand (R = H, Me, Ph)

Unit 3 *Syntheses of Cyclopentadienyl and Arene Metal Analogues* (15 Lectures)
Synthesis and reactions of cyclopentadienyl metal carbonyls, cyclopentadienyl metal hydrides,cyclopentadienyl metal halides, arene metal group complexes, η6-arene-chromium tricarbonyl inorganic synthesis.
In Organic Synthesis: Hydrozirconation of alkenes and alkynes; Carbonylation of Colman'sreagent; η4-diene iron-tricarbonyls in organic synthesis.

Recommended Books and References:

1. M. Bochmann. Organometallics-I Complexes with Transition Metal-Carbon σ-Bonds, Oxford Chemistry Primers (1994).
2. M. Bochmann. Organometallics-2 Complexes with Transition Metal–Carbon π-bonds, Oxford
3. J. E. Huheey, E. A. Keiter, R. L. Keiter& O. K. Medhi, *Principles, Structure and Reactivity* (1st impression), Pearson Education (2006).
4. F. A. Cotton, G. Wilkinson, C.A. Murillo & M. Bochmann, *Advanced Inorganic Chemistry* (6^{th}edn.), John Wiley (1999).
5. J. W. Steed & J. L. Atwood.*Supramolecular Chemistry*, John Wiley (2002
6. B. R. Puri, L. R. Sharma, and K. C. Kalia, *Principles of Inorganic Chemistry*, Milestone.
7. P. Atkins, T. Overton, J. Rourke, M. Weller & F. Armstrong.*Shriver and Atkins Inorganic Chemistry*, Oxford University Press (2006).
8. T. Moeller. *Inorganic Chemistry: A Modern Approach*, John Wiley (1982).
9. J. W. Steed & J. L. Atwood.*Supramolecular Chemistry*, John Wiley (2002)

CHEMISTRY LAB-MJ-21

1. Gravimetric estimation of two constituents when present together:

(i) Copper and Zinc.
(ii) Copper and Magnessium.
(iii) Iron and Nickel.
(iv) Iron and Magnessium.

2. Inorganic compound Preparations:

(i) Reinecke's salt
(ii) Prussian Blue
(iii) Tri(acetylacetonato)manganese(III)

Reference text:

Advanced Practical Inorganic Chemistry by Gurdeep Raj.

Semester VIII (MJ-22) Credits:Theory-03, Practicals-01
ORGANIC CHEMISTRY-7

(Organic reactions, Reactive intermediates, Retro-synthesis in Organic chemistry)

Unit 1 (15 Lectures)

Photochemistry

Photochemistry of alkenes and carbonyl compounds; Photooxygenation; Photochemistry of aromatic compounds; Photochemical isomerisation, addition and substitution;Photo-Fries rearrangement of ethers and anilides; Barton reaction, Hoffmann-Loeflller-Freytag reaction, di-π-methane rearrangement; Photo-cleavages.

Pericyclic Reaction

Main features of pericyclic reactions; Woodward-Hoffman rules, FMO approaches; Electrocyclic reactions – conrotatory and disrotatory motions for *4n*and *4n+2* systems;. Cycloadditions – antarafacial and suprafacial additions, [2+2] and [4+2]reactions (*hν*and *Δ*), chelotropic reactions; Sigmatropic*[i,j]* shiftsof C-H and C-C bonds; Sommelet-Hauser, Claisen, thio-Claisen, Cope and aza-Coperearrangements.

Unit 2 (15 Lectures)

Reactive Intermediates-I

(a) ***Carbenes:*** Stability, structure and spin states of carbenes; Cyclopropanation – spin dependence and stereochemistry; Carbene insertion to C-H bonds; Rearrangement to alkenes; Wolff rearrangement of acylcarbenes and its synthetic applications; Carbenoids.

(b) ***Nitrenes*****:** Stability, structure and spin states of nitrenes; C-H bond insertions and aziridine formation; Rearrangement of acylnitrenes (Hoffmann, Curtius and Schmidt reactions with applications in organic synthesis).

Reactive Intermediates-II

Free Radicals**:** Stability and fate of organic free radicals; Radical cyclisation and coupling reactions; Addition to multiple bonds; Aromatic substitution by radicals; Allylic bromination by NBS and decarboxylative bromination.

Unit-3(15 Lectures)

Synthons and synthetic equivalents, disconnection approach, functional group inter-conversions, importance of order of events in organic synthesis, one group and two group C-X disconnections, chemoselectivity, reversal of polarity, cyclisation reactions, amine synthesis.

One group C-C disconnections – alcohols and carbonyl compounds, region selectiviity, alkene synthesis, use of acetylenes and aliphatic nitro compounds in organic synthesis. Two group C-C disconnections – Diels-Alder reaction, α, β-unsaturated carbonyl compounds and Michael addition.

Recommended Books and References:

1 .D. Nasipuri, *Stereochemistry of Organic Compounds*, 2nd Edn, New Age International (1994).

2. J. March. *Advanced Organic Chemistry: Reactions, Mechanisms and Structure* (4th edn.), Wiley Student Edition, John Wiley & Sons Asia Pte. Ltd. (2005).

3. P. S. Kalsi. *Stereochemistry, Conformation and Mechanism* (7th edn.), New Age (2008).

4. C. Depuy& O. L. Chapman. *Molecular Reactions and Photochemistry,* Prentice-Hall of India (1975).

5. Basic Stereochemistry of organic molecules, SubrataSen Gupta Oxford university press

6. F. A. Carey & R. J. Sanburg. *Advanced Organic Chemistry*, Part A and B, 3rd edn. (1990).

7. Wamser& Harris, *Fundamentals of Organic Reaction Mechanisms*, John Wiley (1990).

8. R. B Woodward & R. Hoffman, *Conservation of Orbital Symmetry*; Verlag-Chemie Academic Press (1970).

9. I. Fleming. *Frontier Orbital Theory and Organic Reactions*, John Wiley & Sons (1976).A. P.Marchand& R. E. Lehr, *Pericyclic Reactions*, Academic Press (1977).

10. P.S. Kalsi, Stereochemistry conformation and mechanism (7th Edn), New Age International (2008).

CHEMISTRY LAB-MJ-22

1. Purification Techniques of organic compounds and their spectroscopic identifications.
   a) Separation/ purification of binary mixtures by Thin Layer Chromatography (TLC) and Column chromatography (CC).
   b) Purification of tertiary mixtures of amino acids by Paper Chromatography.
2. Organic Preparations: At least eight preparations (involving two or more than two steps) involving the following representative reactions-
   a. Esterification and saponification
   b. Nucleophilic substitution
   c. Condensation reaction
   d. Preparation of dyes
   e. Aromatic electrophilic substitution

Recommended Books and References:

1.K. Bansal. *Laboratory Manual of Organic Chemistry* (3rd edn.), Wiley-Eastern (1994).

2. R. G. Brewster & W.E. Mcwedn. *Unitized Experimental Organic Chemistry* (4th edn.), East-West Press (1977).

3. A. I. Vogel. *Practical Organic Chemistry* (3rd edn.), Longman Group Ltd. (1973).

4. A. O. Fitton& R. K. Smallery.*Practical Heterocyclic Chemistry* Academic Press (1968)

5. R.L. Shriner & R. C. Fuson. *Systematic Identification of Organic Compounds* (5th edn.), John Wiley & Sons (1964).

Semester VIII (MJ-23) Credits:Theory-03, Practicals-01
PHYSICAL CHEMISTRY-7

(Nano Chemistry)

UNIT-1: Fundamentals of Nanoscience & Synthesis of Nanomaterials I: (15 Lectures)
Solid materials and their strength, Perspective of length, Nanomaterials, Nanoscience and Nanotechnology, Nanostructures in nature, Prime materials, Carbon nanostructures viz. Carbon-nanotube (Single-walled and multi-walled), Fullerenes, Surface effects of Nanomaterials, Surface plasmon resonance, Quantum size effects, Quantum structures, Quantum confinement, Bright future of nanotechnology. Nanomaterial metal oxides:Zinc oxide, Magnesium oxide, Aluminum oxide. Nanomaterials synthesis, Top-Down and Bottom-Up Approaches, Solvothermal synthesis, Hydrothermal synthesis, Reverse micellar/Micro-emulsion method, Reverse micelles works as nano reactor, Mechanism for nanoparticle synthesis inside the reverse micelles.

UNIT-2: Synthesis of Nanomaterials II & Characterization of Nanomaterials I: (15 Lectures)
Co-precipitation, Sol-Gel Method, Polymeric Precursor Method and Sono-chemical Methods. Theory, Experimental conditions, Kinetics of solid state reactions and molten–salt routes. X-Ray Diffraction Technique: Structure of nano materials, X-ray diffraction (XRD), The Laue method, The Rotating crystal method, The Powder method, Determination of grain size/crystallite size using X-ray line broadening studies (Scherrer's formula), Determination of crystallite size distribution using X-ray line shape analysis. Dynamic Light Scattering (DLS) Studies: Principle, Theory and methodology. Electron Microscopic Techniques: Principles of electron microscopy, Scanning Electron Microscopy (SEM), Strengths and limitations of Scanning electron microscopy.

UNIT-3: Characterization of Nanomaterials II &Applications of Nanomaterials: (15 Lectures)
Energy dispersive X-ray analysis (EDX), Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM) and Scanning Tunneling microscopy (STM). BET Surface Area Studies: Principle, Theory and Methodology. Importance of Nano materials (Gold, Silver, Dielectric and Magnetic Oxide Nanoparticles), Some selected applications like, Nanomaterials in medicine, Nanomaterials for energy sector, Kinetic energy (KE) penetrators with enhanced lethality, High energy density batteries, Nanomaterials in Next-Generation Computer, Nanomaterials in catalysis and sensors, Nanomaterials for water purification, Nanomaterials in communication sector, Nanomaterials in food, Nanomaterials for the environment, Nanomaterials in automobiles, Nanomaterials in ceramics industry.

Recommended Books and References:

1. Principals of Nanoscience and Nanotechnology, M. A. Shah and Tokeer Ahmad, Narosa Publications, (2010).
2. Nano Materials, B. Viswanathan, Narosa Publications, (2009).
3. Nano: The Essentials, T. Pradeep, Tata Mcgraw Hill, (2009).
4. Introduction to Atomic Force Microscopy, Paul E. West, Pacific Nanotechnology, USA.(2010)
5. Scanning Probe Microscopy and Spectroscopy, Ronald Weisendanger, Cambridge University Press. (1994).

CHEMISTRY LAB-MJ-23

1. Determination of CMC of Ionic surfactant.
2. To find the critical point for colloidal mixtures composed of different types of starches.
3. Determination of the acidic and basic dissociation constants of an amino acid and hence its isoelectric point.
4. Partition Coefficient of benzoic acid between water and Toulene.
5. To determine the concentration of H_2SO_4, CH_3COOH & $CuSO_4$. $5H_2O$ in a mixture by conductometric titration with NaOH.

ReferenceBooks

1. Khosla, B. D.; Garg, V. C. &Gulati, A., *Senior Practical Physical Chemistry,* R.Chand& Co.: New Delhi (2011).
2. Garland,C.W.;Nibler,J.W.& Shoemaker,D.P. *Experiments in Physical Chemistry 8th Ed.;* McGraw-Hill: New York (2003).
3. Halpern,A.M. & McBane,G.C. *Experimental Physical Chemistry 3rd Ed.;* W.H.Freeman & Co.: New York (2003).

Skill Enhancement Course (SEC-1)

(Credit: 03)

PHARMACUETICAL CHEMISTRY
(THEORY- 1 CREDIT)

Unit-1:

Drug discovery, design and development; Basic Retrosynthetic approach.

Fermentation: Preparation of Ethyl alcohol. Central Nervous System agents (Phenobarbital and Diazepam),Cardiovascular (Glyceryltrinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT- Zidovudine).Antibiotics; Penicillin, Cephalosporin, Chloromycetin and Streptomycin . Vitamin B_2, Vitamin B_{12} and Vitamin C.

Synthesis of the representative drugs of the following classes: antibiotics (Chloramphenicol); antibacterial agent (Sulphonamides and Sulphacetamide); antiviral agents (Acyclovir).

Reference Books:

1. Patrick, G. L. Introduction to Medicinal Chemistry, Oxford University Press, UK, 2013.
2. Singh, H. & Kapoor, V.K. Medicinal and Pharmaceutical Chemistry, Vallabh Prakashan, Pitampura, New Delhi, 2012.
3. Foye, W.O., Lemke, T.L. & William, D.A.: Principles of Medicinal Chemistry, 4th ed., B.I. Waverly Pvt. Ltd. New Delhi.

(PRACTICAL- 2 CREDITS)

1. Synthesis of Paracetamol.
2. Synthesis of Aspirin.
3. Synthesis of Ibuprofen.
4. Synthesis of Sulphanilamide
5. Synthesis of Metronidazole.
6. Synthesis of 7- Hydroxy -4- Methyl Coumarin.
7. Synthesis of Chlorbutanol.
8. Synthesis of Hexamine.

Reference Book :

1. Dr. Sumanta Mondal and Dr. Prasenjit Mondal, Handbook of Practical Pharmaceutical organic, Inorganic and Medicinal chemistry Handbook of practical Pharmaceutical Chemistry. Publisher: EDUCREATION PUBLISHING, RZ 94, Sector - 6, Dwarka, New Delhi - 110075 Shubham Vihar, Mangla, Bilaspur, Chhattisgarh - 495001, ISBN: 978-93-88719-71-1.

2. Anees Ahmad Siddiqui, Organic Medicinal Chemistry Practical Manual, CBS Publishers & Distributors Pvt. Ltd 4819/XI Prahlad Street,24 Ansari Road, Daryaganj, New Delhi 110 002,India., ISBN: 978-93-87085-14-5

Skill Enhancement Course (SEC-2)

(Credit: 03)

FUEL CHEMISTRY

(THEORY- 1 CREDIT)

UNIT-1:

Classification of fuels and their calorific value. Coal: Uses of coal (fuel and non-fuel) in various industries, its composition, carbonization of coal. Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke, Coal gasification (Hydro gasification and Catalytic gasification), Coal liquefaction. Lubricants: Classification of lubricants, lubricating oils (conducting and non-conducting) Solid and semisolid lubricants, synthetic lubricants. Petroleum and Petrochemical Industry: Composition of crude petroleum, Refining and different types of petroleum products. Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass).

Reference Books:

1. Stocchi, E. Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK (1990).
2. Jain, P.C. & Jain, M. Engineering Chemistry Dhanpat Rai & Sons, Delhi.
3. Sharma, B.K. & Gaur, H. Industrial Chemistry, Goel Publishing House, Meerut(1996).

(PRACTICAL- 2 CREDITS)

1. Determination of Surface tension of lubricants.
2. Determination of percentage of copper in brass.
3. Determination of acid value of coconut oil.
4. Determination of Percentage of Iron in a rust solution.
5. Determination of Moisture content and Ash content in Coal.
6. Determination of calorific value of solid fuel.
7. Determination of Sulphur content in coal.

Reference Books:

1. Applied Chemistry: Theory and practice, O.P. Vermani, A.K.Narula, New age International Publication New Delhi, 2005, ISBN:8122408141.
2. Practical book on Engineering Chemistry by Dr. P.K. Khatua, Platinum publishers Kolkata, ISBN : 0788189872438.
3. Experiments and calculations in Engineering Chemistry by Dr. Dara S.S.S Chand. Publication, New Delhi, 2011, ISBN:8121908647.

Skill Enhancement Course (SEC-3)

(Credit: 03)

CHEMISTRY OF COSMETICS AND PERFUMES

(THEORY-1 CREDIT)

UNIT-1:

A general study including preparation and uses of the following: Hair dye, hair spray, shampoo, suntan lotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishing and shaving creams), 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.

Reference Book:

1. John W. Hill, Terry W. McCreary & Doris K. Kolb, Chemistry for changing times 13th Ed, Prentice-Hall (2012).
2. Dinesh Fuel Chemistry & Chemistry of Cosmetics & Perfumes, ISBN-10 :9389255295.
3. Stocchi, E. Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK (1990).
4. Jain, P.C. & Jain, M. Engineering Chemistry Dhanpat Rai & Sons, Delhi.
5. Sharma, B.K. & Gaur, H. Industrial Chemistry, Goel Publishing House, Meerut (1996).

(PRACTICAL- 2 CREDITS)

1. Analysis of Face Powder or Talcum Powder
   i. Determination of Al, Mg, Zn and Boric Acid
2. Analysis of Hair dyes (Non-Volatile, Ash content, Lead and Sulphur)
3. Preparation of shampoo.
4. Preparation of talcum powder.
5. Preparation of Hair dyes.
6. Isolation of casein and Lactose from Milk.
7. Isolation of Lycopene from Tomato.
8. Isolation of Nicotine from tobacco.

Reference Books:

1. Anees Ahmad Siddiqui, Organic Medicinal Chemistry Practical Manual, CBS Publishers & Distributors Pvt. Ltd 4819/XI Prahlad Street,24 Ansari Road, Daryaganj, New Delhi 110 002,India., ISBN: 978-93-87085-14-5
2. Poucher's Perfumes, Cosmetics and Soaps , Volume 3: Cosmetics , Volume 3, ISBN: 9789401114820, 940111482X, Publisher: Springer, Netherlands.

Inter disciplinary Course-I
Chemistry in Daily Life
(Credit:03)

Unit-1: Dairy Products & Food Additives:

Composition of milk and milk product. Principles of dairy safety; Milk processing. Qualitative analysis of fat content, minerals in milk and butter. Qualitative analysis of caffeine in coffee and tea, detection of chicory in coffee, chloral hydrate in toddy

Food additives: Food preservatives like benzoates, propionates, sorbates, disulphites. Artificial sweeteners: Aspartame, saccharin, dulcin, sucralose, and sodium cyclamate.

Unit-2: Flavors & Food Adulterants:

Vanillin, alkyl esters (fruit flavors),Chlorophyll, carotenoids, Melanins, Betalaines and monosodium glutamate. Food adulterants, and contaminants: Food processing and packaging; Food adulteration: definition and its importance, adulterants present in coffee, tea, milk, spices, grains and food colour; Difference between food adulteration and contamination.

Unit-3:Artificial food colorants:

Natural and synthetic colors, fake colors, inorganic pigments, application of colors in food industry, flavoring agents, Coal tar dyes and non-permitted colors and metallic salts. Utility of coal tar dyes in food and cosmetics and its harmful effect. Sensory perception of flavour, flavour retention during food processing,

Reference Books:

1. Food Science & Quality Control by SMT. B. Poornima - Centrum Press First edition 2014.
2. Post-Harvest Management of Horticultural crops - S. Saraswathy, T.L. Preethi AGROBIOS (India) 2013.
3. A Handbook of Agn. Food processing and marketing by S.C. Gaur, Agro Bios (India) 2012.
4. Quality Control for value edition in Food processing – by Dev Raj, Rakesh Sharma & V.K. Joshi New India Publishing Agency, 2011.
5. Food processing and preservation – Subbulakshmi, G. Shobha, A. Udipi, New Age International (P) Ltd., 2006.
6. Food processing and preservation – B. Sivasankar, Meenakshi printers, New Delhi, 2009.

Inter disciplinary Course-II
Inorganic Materials of Industrial Importance
(Credit:03)

Unit-1: Fertilizers and Batteries:
Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate.
Primary and secondary batteries, battery components and their role, Characteristics of Battery. Working of following batteries: Pb acid, Li-Battery. Fuel cells, Solar cell and polymer cell.

Unit-2: Alloys and Cements:
Classification of alloys, ferrous and non-ferrous alloys, Specific properties of elements inalloys. Manufacture of Steel (removal of silicon decarbonization, demanganization, Desulphurization, Dephosphorisation) and surface treatment (heat treatment, nitriding, carburizing).*Cements:* Classification of cement, ingredients and their role, Manufacture of cement and the setting process, quick setting cements.

Unit-3: Surface Coatings:
Objectives of coatings surfaces, classification of surface coatings. Paints and pigments-formulation, composition and related properties. Oil paint, modified oils, Pigments, toners and lakes pigments, Fillers, Thinners, Enamels, emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco- friendly paint, Plastic-paint), Dyes, Wax polishing, Water and Oil paints, additives, Metallic coatings(electrolytic and electroless), metal spraying and anodizing.

Reference Books:

1. J. A. Kent: Riegel's*Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
2. P. C. Jain, M. Jain: *Engineering Chemistry*, DhanpatRai& Sons, Delhi.
3. R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry,* VikasPublications, New Delhi.
4. Sharma, B.K. & Gaur, H. *Industrial Chemistry,* Goel Publishing House, Meerut(1996).

Inter disciplinary Course-III
Inorganic Materials of Industrial Importance
(Credit:03)

Unit-1: Introduction to Green Chemistry & Green Solvents I:

What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry. Twelve principles of Green Chemistry with their explanations and examples and specialemphasis on the following: Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts;maximum incorporation of the materials used in the process into the final products, Atom Economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions. Green solvents– supercritical fluids, water as a solvent for organic reactions, ionic liquids, solventless processes, immobilized solvents and how to compare greenness of solvents. Energy requirements for reactions – alternative sources of energy: use of microwavesand ultrasonic energy. Selection of starting materials; avoidance of unnecessary derivatization – careful use of blocking/protecting groups.

Unit-2: Green solvents II & Designing Greener Processes:

Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; catalysis and green chemistry, comparison of heterogeneous and homogeneous catalysis, biocatalysis, asymmetric catalysis and photocatalysis. Prevention/ minimization of hazardous/ toxic products reducing toxicity.risk = (function) hazard ×exposure; waste or pollution prevention hierarchy. Prevention of chemical accidents designing greener processes, inherent safer design,principle of ISD "What you don't have cannot harm you", greener alternative to Bhopal Gas Tragedy (safer route to carcarbaryl) and Flixiborough accident (safer route to cyclohexanol), minimization, simplification, substitution, moderation and limitation. Strengthening/ development of analytical techniques to prevent and minimize thegeneration of hazardous substances in chemical processes.

Unit-3: Some Compounds of Green synthesis/reactions & Future trends in Green Chemistry:

Green Synthesis of the following compounds: adipic acid, catechol (alternative to Strecker synthesis) Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoicacid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents Diels-Alder reaction and Decarboxylation reaction. Surfactants for carbon dioxide – replacing smog producing and ozone depletingsolvents with CO_2 for precision cleaning and dry cleaning of garments. Designing of Environmentally safe marine antifoulant. An efficient, green synthesis of a compostable and widely applicable plastic (poly lactic acid) made from corn. Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; co crystal controlled solid state synthesis (C2S3); Green chemistry in sustainable development, Green Chemistry versus Environment.

Reference Books:

1. Ahluwalia, V.K. & Kidwai, M.R.*New Trends in Green Chemistry*, AnamalayaPublishers (2005).
2. Anastas, P.T. & Warner, J.K.: *Green Chemistry - Theory and Practical*, Oxford University Press (1998).
3. Matlack, A.S. *Introduction to Green Chemistry*, Marcel Dekker (2001).
4. Cann, M.C. & Connely, M.E. *Real-World cases in Green Chemistry*, AmericanChemical Society, Washington (2000).
5. Ryan, M.A. &Tinnesand, M. *Introduction to Green Chemistry*, American Chemical Society, Washington (2002).
6. Lancaster, M. *Green Chemistry: An Introductory Text* RSC Publishing, 2nd Edition,2010.

VALUE ADDED COURSE

INDIAN TEXTILES

(Total credits : 3)

Unit-1 :- Traditional textiles of India

Introduction, History of textiles in India, Textile technology - Material Base of Indian Textiles, Weavers' Loom; Textile patterns – Ikat, Brocaded Textile; Traditional embroideries of india; Dyes – Resist-dye, bandhani, Azarak, Block printing; Embroidered Textiles- Kantha,Cikan, Applique work, Phulkari (flower work), Ari Bharat, Naqshabandhas, Silk technology, Wool weaving technology.

UNIT-2 :- Overview of textile industries and textile fibres

The major Textile Production Segments in India. Sources of Fabrics. Properties of Cotton, Flax, Hemp, Jute. Objectives Classification of Textile Fibers according to origin and chemical composition; Essential Properties and Performances of Textile Materials like Aesthetic, Durability, Comfort, Safety and Care and Maintenance Properties. Properties of Silk, Wool, Mohair and Other Natural Fibers. Properties of Viscose Rayon, Lyocell, Acetate. Properties of Polyester, Nylon, Acrylic, Spandex.

Unit-3:- Other Forms of Textiles

Differences between woven and knitted fabrics. General knitting terms types of knitting machines; circular and flat machines. Types of Knitting Stitches. Properties of Weft Knitted Fabrics; Jersey, Rib, Purl and Interlock. Comparison and properties of Warp Knitted Fabrics; Non-Woven Fabrics; Methods and Materials to Manufacture Non-Woven Fabrics; Felt; Embroidery; Tufted Fabrics, braids and other narrow fabrics.

Recommended Books and References

1. Indian textiles past and present: G. K. Ghosh, Shukla Ghosh, APH Publishing Corporation (1 January 2011), SBN-13 : 978-8170247067
2. Embroidered Histories, Indian Textiles for the Portuguese Market during the Sixteenth and Seventeenth Centuries, Barbara Karl, 2016, ISBN 978-3-205-20209-7.
3. India in Situ: Textile History and Practice, a Team Approach, Annin Barrett, Carol Bier, Anna Jolly, Louise W. Mackie, Barbara Setsu Pickett,2020. Textile Society of America Symposium Proceedings. 1191.
4. Indian Textile Patterns and Techniques: A sourcebook, Avalon Fotheringham, Thames and Hudson (16 April 2019),ISBN:9780500480427.
5. Traditional Indian Textiles – Class XII, Students Handbook + Practical Manual, First edition: 2014
6. Textile Science- Class XI, Textbook and Practical Manual, CBSE in collaboration with NIFT, First Edition 2013.
7. http://egyankosh.ac.in//handle/123456789/16910.
8. Textiles in British India, Bakhtawar, Ms & Hameed, Umer,2022, 10.13140/RG.2.2.12309.40160.