COURSES OF STUDIES

FOR

THREE YEAR DEGREE COURSE

IN

SCIENCE HONOURS

DEPARTMENT OF CHEMISTRY

Choice Based Credit System(CBCS)

First & Second Semester Examination – 2018-19

Third & Fourth Semester Examination – 2019-20

Fifth & Sixth Semester Examination – 2020-21

GOVERNMENT AUTONOMOUS COLLEGE,
PHULBANI, KANDHAMAL

SYLLABI FOR CBCS COURSE

Sem	CORE COURESE (14)	Ability Enhancement Compulsory Course (AECC) (2)	Skill based Enhancement Compulsory Course (SECC) (2)	Elective: Discipline Specific DSE (4)	Elective: Generic (GE) (4)
I	CORE-I				GE-1 (Minor-1)
	CORE-II				
II	CORE-III	Environmental Studies			GE-1 (Minor-2)
	CORE -IV				
III	CORE-V				GE-2 (Minor-1)
	CORE-VI				
	CORE-VII				
IV	CORE-VIII				GE-2 (Minor-2)
	CORE-IX				
	CORE-X				
V	CORE-XI			DSE-1	
	CORE-XII			DSE-2	
VI	CORE-XIII			DSE-3	
	CORE-XIV			DSE-4 (Project)	

SECC-1 : To be offered by English Department.
SECC-2 : To be offered by Mathematics Department.
GE : Minor-1 and Minor-2 is to be decided by the college Based on Subject.

QUESTION PATTERN FOR MID SEM

Mid Semester Examination	Full Marks	No. of Short Answer type Questions (2 marks each) (Compulsory)	No. of Long Answer type Questions (8 marks each)	No. of Long Answer type Questions (12 marks each)
Practical Subject	20	6	1	*
Non-Practical Subject	20	4	*	1

QUESTION PATTERN FOR END SEM

End Semester Examination	Full Marks	GROUP – A					GROUP - B									
		No. of Short Answer type Questions (2 marks each) (Compulsory)					No. of Long Answer type Questions (8 marks each)					No. of Long Answer type Questions (12 marks each)				
Units -->		I	II	III	IV	V	I	II	III	IV	V	I	II	III	IV	V
Non-Practical Subject	80	10					*	*	*	*	*	1	1	1	1	1
Practical Subject	50	5					1	1	1	1	1	*	*	*	*	*

- There is no alternative questions (choice) in Group-A questions (Short Answer type questions). All questions are compulsory.
- There is internal alternative questions (choice) in each number in Group-B questions (Long Answer type questions). Examinee has to answer one questions out of two alternative questions from each number.
- There is little deviation in question pattern of AECC (Eng Communication) & SECC-I & II. Details regarding question pattern of concerned subject is given at appropriate place.)
- The duration of Mid Sem exam of each paper is 1 hour irrespective of Full marks.
- The duration of End Sem exam of each paper is 3 hours for 80 marks/50 marks.

YEAR & SEMESTER-WISE PAPERS & CREDITS AT A GLANCE

Three-Year (6-Semester) CBCS Programme (B.Sc. Hons.) (Chemistry Department)				
Yr.	Sl.No.	**Course Structure**	**Code**	**Credit Points**
FIRST YEAR		**SEMESTER-I**		
	1	Inorganic Chemistry-I	C-1.1	6
	2	Physical Chemistry-I	C-1.2	6
	3	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons	GE-1.3	6
		SEMESTER-II		
	4	Organic Chemistry-I	C-2.1	6
	5	Physical Chemistry-II	C-2.2	6
	6	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons	GE-2.3	6
	7	Environmental Science (For Arts/Science Stream)	AECC-2.4	6
SECOND YEAR		**SEMESTER-III**		
	8	Inorganic Chemistry-II	C-3.1	6
	9	Organic Chemistry-II	C-3.2	6
	10	Physical Chemistry-III	C-3.3	6
	11	Chemical Energetics, Equilibria & Functional Organic Chemistry-I	GE-3.4	6
		SEMESTER-IV		
	12	Inorganic Chemistry-III	C-4.1	6
	13	Organic Chemistry-III	C-4.2	6
	14	Physical Chemistry-IV	C-4.3	6
	15	Chemical Energetics, Equilibria & Functional Organic Chemistry-I	GE-4.4	6
FINAL YEAR		**SEMESTER-V**		
	16	Organic Chemistry-IV	C-5.1	6
	17	Physical Chemistry-V	C-5.2	6
	18	Polymer Chemistry	DSE-5.3	6
	19	Industrial Chemicals and Environment	DSE-5.4	6
		SEMESTER-VI		
	20	Inorganic Chemistry-IV	C-6.1	6
	21	Organic Chemistry-V	C-6.2	6
	22	Inorganic Materials of Industrial Importance	DSE-6.3	6
	23	Dissertation/Project Work	DSE-6.4	6

Notes:

- C- Core Course
- GE- Generic Elective Course
- DSE- Discipline Specific Elective Course
- AECC- Ability Enhancement Compulsory Course
- SECC- Skill based Enhancement Compulsory Course
- For a 6 credit course, the total teaching hours are: Minimum- 50 Hours, Maximum-65 Hours

SEMESTER-I

C-1.1 : INORGANIC CHEMISTRY-I

Full Marks – 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I : ATOMIC STRUCTURE: **(14 Lectures)**

Bohr's theory, its limitations and atomic spectrum of hydrogen atom. 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, Normalized and orthogonal wave functions, Sign of wave functions, Radial and angular wave functions for hydrogen atom (derivation not required), Radial and angular distribution curves, Shapes of s, p, d and f orbitals, Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau principle and its limitations

UNIT-II : **PERIODICITY OF ELEMENTS** **(16 Lectures)**

Periodicity of Elements: s, p, d, f block elements, the long form of periodic table, Detailed discussion of the following properties of the elements, with reference to s & p-block, (a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table, (b) Atomic radii (van der Waals), (c) Ionic and crystal radii, (d) Covalent radii (octahedral and tetrahedral), (e) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy, (f) Electron gain enthalpy, trends of electron gain enthalpy, (g) Electronegativity, Pauling's/Mulliken's/Allred Rachow's/and Mulliken-Jaffé's electronegativity scales, Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity, Sanderson's electron density ratio

UNIT-III : CHEMICAL BONDING-I **(16 Lectures)**

lonic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations, Packing of ions in crystals, Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy, Madelung constant, Born-Haber cycle and its application, Solvation energy, (ii) Covalent bond: Lewis structure, Valence Bond theory (Heitler-London approach), Energetics of hybridization, equivalent and non-equivalent hybrid orbitals, Bent's rule, Resonance and resonance energy,

UNIT-IV: CHEMICAL BONDING-II

Molecular orbital theory, Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions; HCl, BeF_2, CO_2, (idea of s-p mixing and orbital interaction to be given), Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding (σ and π bond approach) and bond lengths, Covalent character in ionic compounds, polarizing power and polarizability, Fajan's rules and consequences of polarization, Ionic character in covalent compounds: Bond moment and dipole moment, Percentage ionic character from dipole moment and electronegativity difference

UNIT-V : CHEMICAL BONDING:-III **(16 Lectures)**

(i) Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.

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

Reference Books:

1. Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991
2. Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970
3. Atkins, P.W. & Paula, J. Physical Chemistry, Oxford Press, 2006
4. Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962

PRACTICAL

End Sem Practical – 30/3 hrs

Expt. -15, Viva- 5 & Lab. Record- 10

(A) Titrimetric Analysis

(i) Calibration and use of apparatus

(ii) Preparation of solutions of different Molarity/Normality of titrants

(B) Acid-Base Titrations

(i) Estimation of carbonate and hydroxide present together in mixture

(ii) Estimation of carbonate and bicarbonate present together in a mixture
(iii) Estimation of free alkali present in different soaps/detergents

(C) Oxidation-Reduction Titrimetry

(i) Estimation of Fe(II) and oxalic acid using standardized $KMnO_4$ solution
(ii) Estimation of oxalic acid and sodium oxalate in a given mixture
Estimation of Fe(II) with $K_2Cr_2O_7$ using internal (diphenylamine, anthranilic acid) and external indicator

Reference text:

1. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS

C-1.2 : PHYSICAL CHEMISTRY-I

Full Marks – 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I : GASEOUS STATE-I **(18 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.

UNIT-II: GASEOUS STATE-II

Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, Z, and its variation with pressure for different gases. Causes of deviation from ideal behaviour. vander Waals equation of state, its derivation and application in explaining real gas behaviour, mention of other equations of state (Berthelot, Dietrici); virial equation of state; van der Waals equation expressed in virial form and calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states

UNIT-III : LIQUID STATE **(12 Lectures)**

(i) Qualitative treatment of the structure of the liquid state; Radial distribution function; physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases. Qualitative discussion of structure of water

IONIC EQUILIBRIA- I

(ii) 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 triprotic acids (exact treatment)

UNIT- IV: SOLID STATE **(16 Lectures)**

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, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Defects in crystals. Glasses and liquid crystals.

UNIT-V : IONIC EQUILIBRIA – II : **(14 Lectures)**

Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications; buffer capacity, buffer range, buffer action and applications of buffers in analytical chemistry and biochemical processes in the human body. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of acid–base indicators; selection of indicators and their limitations.

Reference Books:

1. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13 (2006)
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)

PRACTICAL

End Sem Practical – 30/3 hrs

Expt. -15, Viva- 5 & Lab. Record- 10

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.
2. **Viscosity measurement using Ostwald's viscometer.**
   a. Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room temperature.
   b. Study the variation of viscosity of sucrose solution with the concentration of solute.
3. **pH metry**
   a. Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.
   b. Preparation of buffer solutions of different pH i. Sodium acetate-acetic acid ii. Ammonium chloride-ammonium hydroxide
   c. pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base.
   d. Determination of dissociation constant of a weak acid.

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.: New York (2003)

GE- 1.3 : ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS

Full Marks – 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

SECTION A: INORGANIC CHEMISTRY-1

UNIT-I : Atomic Structure **(14 Periods)**

Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure.

What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ 2 , Schrödinger equation for hydrogen atom. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers ml and ms. Shapes of s, p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (ms).

Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

UNIT-II : Chemical Bonding and Molecular Structure-I **(16 Lectures)**

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

UNIT-III: **Chemical Bonding and Molecular Structure-II** Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements

Concept of resonance and resonating structures in various inorganic and organic compounds

MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO+ , Comparison of VB and MO approaches

SECTION B : ORGANIC CHEMISTRY-I

UNIT- IV : Fundamentals of Organic Chemistry (8 Lectures)

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis.

Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals.

Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule.

Stereochemistry (10 Lectures)

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; cis - trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

UNIT- V : Aliphatic Hydrocarbons (12 Lectures)

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

Alkanes: (Upto 5 Carbons). Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. Reactions: Free radical Substitution: Halogenation.

Alkenes: (Upto 5 Carbons) Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alk. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation.

Alkynes: (Upto 5 Carbons) Preparation: Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides.

Reactions: formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, Ozonolysis and oxidation with hot alk. $KMnO_4$.

Reference Books :

1. J. D. Lee: A new Concise Inorganic Chemistry, E L. B. S.
2. F. A. Cotton & G. Wilkinson: Basic Inorganic Chemistry, John Wiley.
3. Douglas, McDaniel and Alexader: Concepts and Models in Inorganic Chemistry, John Wiley.
4. James E. Huheey, Ellen Keiter and Richard Keiter: Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Publication.
5. T. W. Graham Solomon: Organic Chemistry, John Wiley and Sons.
6. Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
7. E. L. Eliel: Stereochemistry of Carbon Compounds, Tata McGraw Hill.• I. L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
8. R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
9. Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand

PRACTICAL

End Sem Practical – 30/3 hrs

Expt. -15, Viva- 5 & Lab. Record- 10

Section A: Inorganic Chemistry - Volumetric Analysis

1. Estimation of sodium carbonate and sodium hydroxide present in a mixture.
2. Estimation of oxalic acid by titrating it with $KMnO_4$.
3. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
4. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.
5. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.
6. Estimation of Na_2CO_3 & $NaHCO_3$ present in a mixture.

Section B: Organic Chemistry

1. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements)
2. Separation of mixtures by Chromatography: Measure the Rf value in each case (combination of two compounds to be given)
   (a) Identify and separate the components of a given mixture of 2 amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography
   (b) Identify and separate the sugars present in the given mixture by paper chromatography.

Reference Books :

1. Vogel's Qualitative Inorganic Analysis, A.I. Vogel, Prentice Hall, 7th Edition.
2. Vogel's Quantitative Chemical Analysis, A.I. Vogel, Prentice Hall, 6th Edition.
3. Textbook of Practical Organic Chemistry, A.I. Vogel , Prentice Hall, 5th edition.
4. Practical Organic Chemistry, F. G. Mann. & B. C. Saunders, Orient Longman, 1960.

SEMESTER-II

C-2.1: ORGANIC CHEMISTRY-I

Full Marks – 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT –I : BASICS OF ORGANIC CHEMISTRY: (12 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; Organic acids and bases; their relative strength.

Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; 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 – II : STEREOCHEMISTRY (18 Lectures)

Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations with C.I.P rules.

Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations.

UNIT – III : CHEMISTRY OF ALIPHATIC HYDROCARBONS (18 Lectures)

Carbon-Carbon pi bonds:

Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations.

Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroborationoxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 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, ethyl benzene. Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

UNIT – IV : AROMATIC HYDROCARBONS (12 Lectures)

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.

UNIT-V: A.CARBON-CARBON SIGMA BONDS

Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.

B. Cycloalkanes and Conformational Analysis

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

PRACTICAL

End Sem Practical – 30/3 hrs

Expt. -15, Viva- 5 & Lab. Record- 10

1. Checking the calibration of the thermometer
2. Purification of organic compounds by crystallization using the following solvents:
   a. Water
   b. Alcohol
   c. Alcohol-Water
3. Determination of the melting points of above compounds and unknown organic compounds (Kjeldahl method and electrically heated melting point apparatus)
4. Effect of impurities on the melting point – mixed melting point of two unknown organic compounds
5. Determination of boiling point of liquid compounds. (boiling point lower than and more than 100 °C by distillation and capillary method)
6. Chromatography
   a. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography
   b. Separation of a mixture of two sugars by ascending paper chromatography
   c. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC)
7. Estimation of Aniline

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)

C-2.2: PHYSICAL CHEMISTRY-II

Full Marks – 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I : CHEMICAL THERMODYNAMICS : (14 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, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions

UNIT-II : (14 Lectures)

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.

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-III : CHEMICAL EQUILIBRIUM

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. Coupling of exoergic and endoergic reactions. 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 Kp, Kc and Kx. Le Chatelier principle (quantitative treatment); equilibrium between ideal gases and a pure condensed phase.

UNIT-IV : Solutions and Colligative Properties : (14 Lectures)

Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Excess thermodynamic functions. 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.

UNIT-V: **A. Thermochemistry:**

Heats of reactions: standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions. Adiabatic flame temperature, explosion temperature

B. Systems of Variable Composition :

Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases

Reference Books :

1. Peter, A. & Paula, J. de. Physical Chemistry 9th Ed., Oxford University Press (2011).
2. Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
3. Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
4. McQuarrie, D. A. & Simon, J. D. Molecular Thermodynamics Viva Books Pvt. Ltd.: New Delhi (2004).
5. Levine, I .N. Physical Chemistry 6th Ed., Tata Mc Graw Hill (2010).
6. Metz, C.R. 2000 solved problems in chemistry, Schaum Series (2006

PRACTICAL

End Sem Practical – 30/3 hrs

Expt. -15, Viva- 5 & Lab. Record- 10

THERMOCHEMISTRY

(a) 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).
(b) Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
(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) Determination of basicity/proticity of a polyprotic acid by the thermochemical method in terms of the changes of temperatures observed in the graph of temperature versus time for different additions of a base. Also calculate the enthalpy of neutralization of the first step.
(f) Determination of enthalpy of hydration of copper sulphate.
(g) Study of the solubility of benzoic acid in water and determination of ΔH.
(h) Kinetics of pseudo-unimolecular reaction to determine the pseudo first order hydrolysis rate constant of methyl acetate/ethyl acetate at room temperature in 0.5N H_2SO_4 & 0.5 N HCl media.

***Reference Books** :*

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)

GE- 2.3 : ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS

Full Marks – 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

SECTION A: INORGANIC CHEMISTRY-1

UNIT-I : Atomic Structure **(14 Lectures)**

Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure.

What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ 2, Schrödinger equation for hydrogen atom. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers ml and ms. Shapes of s, p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (ms).

Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

UNIT-II : Chemical Bonding and Molecular Structure-I (16 Lectures)

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

UNIT-III: **Chemical Bonding and Molecular Structure-II** Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements

Concept of resonance and resonating structures in various inorganic and organic compounds

MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO+ , Comparison of VB and MO approaches

SECTION B : ORGANIC CHEMISTRY-I

UNIT- IV : Fundamentals of Organic Chemistry (8 Lectures)

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis.

Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals.

Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule.

Stereochemistry (10 Lectures)

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; cis - trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

UNIT- V : Aliphatic Hydrocarbons (12 Lectures)

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

Alkanes: (Upto 5 Carbons). Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. Reactions: Free radical Substitution: Halogenation.

Alkenes: (Upto 5 Carbons) Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alk. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation.

Alkynes: (Upto 5 Carbons) Preparation: Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides.

Reactions: formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alk. $KMnO_4$.

Reference Books :

1. J. D. Lee: A new Concise Inorganic Chemistry, E L. B. S.
2. F. A. Cotton & G. Wilkinson: Basic Inorganic Chemistry, John Wiley.
3. Douglas, McDaniel and Alexader: Concepts and Models in Inorganic Chemistry, John Wiley.
4. James E. Huheey, Ellen Keiter and Richard Keiter: Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Publication.
5. T. W. Graham Solomon: Organic Chemistry, John Wiley and Sons.
6. Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
7. E. L. Eliel: Stereochemistry of Carbon Compounds, Tata McGraw Hill.• I. L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
8. R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
9. Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand

PRACTICAL

End Sem Practical – 30/3 hrs

Expt. -15, Viva- 5 & Lab. Record- 10

Section A: Inorganic Chemistry - Volumetric Analysis

1. Estimation of sodium carbonate and sodium hydroxide present in a mixture.
2. Estimation of oxalic acid by titrating it with $KMnO_4$.
3. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
4. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.
5. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.
6. Estimation of Na_2CO_3 & $NaHCO_3$ present in a mixture.

Section B: Organic Chemistry

1. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements)
2. Separation of mixtures by Chromatography: Measure the Rf value in each case (combination of two compounds to be given)
   (a) Identify and separate the components of a given mixture of 2 amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography
   (b) Identify and separate the sugars present in the given mixture by paper chromatography.

Reference Books :

1. Vogel's Qualitative Inorganic Analysis, A.I. Vogel, Prentice Hall, 7th Edition.
2. Vogel's Quantitative Chemical Analysis, A.I. Vogel, Prentice Hall, 6th Edition.
3. Textbook of Practical Organic Chemistry, A.I. Vogel , Prentice Hall, 5th edition.
4. Practical Organic Chemistry, F. G. Mann. & B. C. Saunders, Orient Longman, 1960.

AECC-2.4 : ENVIRONMENTAL STUDIES (FOR ARTS/SCIENCE)

Full Marks –100
Mid Sem – 20/1 hr
End Sem– 80/3hrs

UNIT-I :

Concept of environment : Ecology; Ecosystem; types and components of the ecosystem. Ecological adaptations of plants and animals

UNIT-II :

Functional aspects of ecosystem : Trophic level, food chain, food web, energy flow in the ecosystem, ecological pyramids, Biogeochemical cycles: Water cycle and Nitrogen cycle

UNIT-III :

Environmental Pollution : Source, causes and concept of air, water, noise, soil, pollution, Sewage & Sewage treatment, green house effect, Acid rain, Ozone layer depletion

UNIT-IV :

Conservation of Natural Resources : Resources, renewable & non renewable resources; soil, soil erosion and its conservation; Forest, deforestation; afforestation, conservation of Forest

UNIT-V :

Biodiversity and its Conservation : Introduction, Definition : genetic species and ecosystem diversity, value of biodiversity; consumptive use, productive use, social, ethical and aesthetic values, Biodiversity at global, national and local level, conservation of Biodiversity:- In situ and Ex-situ conservation, Bio-Geographic classification of India

Suggested Readings :

1. Shukla, R.S and Chandel, P.S : Plant Ecology and soil science, S. Chand & Company Ltd, New Delhi
2. Sharma, P.D. : Ecology and Environment, Rastogi Publication, Meerut.
3. Singh, J.S. Singh, S.P and Gupta, R.S (2006). Environmental Science, Kalyani Publishers, New Delhi

SEMESTER-III

C-3.1: INORGANIC CHEMISTRY-II

Full Marks – 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I : General Principles of Metallurgy (8 Lectures)

Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent. Electrolytic Re-duction, Hydrometallurgy. Methods of purification of metals: Electrolytic Kroll process, Parting process, van Arkel-de Boer process and Monds process, Zone refining

UNIT-II: Chemistry of s and p Block Elements-I (14 Lectures)

Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of s and p block elements. Hydrides and their classification ionic, covalent and interstitial. Basic beryllium acetate and nitrate

UNIT-III: Chemistry of s and p Block Elements-II (14 Lectures)

Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses. Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes. Oxides and oxoacids of nitrogen, Phosphorus and chlorine. Peroxo acids of sulphur, interhalogen compounds, polyhalide ions, pseudohalogens and basic properties of halogens.

UNIT-IV: Noble Gases (8 Lectures)

Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF2; XeF4 and XeF6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF2). Molecular shapes of noble gas compounds (VSEPR theory)

UNIT-V: a. Acids and Bases (8 Lectures)

Brönsted-Lowry concept of acid-base reactions, solvated proton, relative strength of acids, types of acid-base reactions, Lewis acid-base concept, Classification of Lewis acids, Hard and Soft Acids and Bases (HSAB) Application of HSAB principle

b. Inorganic Polymers: (8 Lectures)

Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes, and polysulphates.

Reference Books :

1. Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
2. Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. Concepts & Models of Inorganic Chemistry 3rd Ed., John Wiley Sons, N.Y. 1994.
3. Greenwood, N.N. & Earnshaw. Chemistry of the Elements, Butterworth-Heinemann. 1997.
4. Cotton, F.A. & Wilkinson, G. Advanced Inorganic Chemistry, Wiley, VCH, 1999.
5. Miessler, G. L. & Donald, A. Tarr. Inorganic Chemistry 4th Ed., Pearson, 2010.
6. Shriver & Atkins, Inorganic Chemistry 5th Ed.

PRACTICAL

End Sem Practical – 30/3 hrs

Expt. -15, Viva- 5 & Lab. Record- 10

(A) Iodo / Iodimetric Titrations

(i) Estimation of Cu(II) and $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodimetrically)
(ii) Estimation of available chlorine in bleaching powder iodometrically

(B) Inorganic preparations

(i) Cuprous chloride, Cu_2Cl_2:
(ii) Preparation of Manganese(III) phosphate, $MnPO_4.H_2O$
(iii) Preparation of Aluminium potassium sulphate $K_2SO_4:Al_2(SO_4)_2.24H_2O$ (Potash alum)

Reference Books :

1. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS. 1978

C-3.2: ORGANIC CHEMISTY-II

Full Marks – 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I: Chemistry of Halogenated Hydrocarbons (16 Lectures)

Alkyl halides: Methods of preparation, nucleophilic substitution reactions SN1, SN2 and SNi 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, Benzyne mechanism.

Relative reactivity of alkyl, allyl/benzyl, vinyl and arylhalides towards nucleophilic substitution reactions.

Organometallic compounds of Mg and Li- Use in synthesis of organic compounds.

UNIT-II: Alcohols, Phenols, Ethers and Epoxides (16 Lectures)

Alcohols: preparation, properties and relative reactivity of 1^0, 2^0, 3^0 alcohols, Bouvaelt-Blanc Reduction; Preparation and properties of glycols: Oxidation by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement;

Phenols: Preparation and properties; Acidity and factors effecting it, Ring substitution reactions, Reimer Tiemann and Kolbes Schmidt Reactions, Fries and Claisen rearrangements with mechanism;

UNIT-III: Carbonyl Compounds (14 Lectures)

Structure, reactivity and preparation: Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisan-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, α haloform reaction and Baeyer Villiger oxidation, substitution reactions, oxidations and reductions (Clemmensen, Wolf-Kishner, LiAlH4, $NaBH_4$, MPV, PDC and PCC).; Addition reactions of unsaturated carbonyl compounds: Michael addition.

UNIT-IV: Carboxylic Acids and their Derivatives (10 Lectures)

Preparation, physical properties and reactions of monocarboxylic acids: Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic/phthalic, lactic, malic, tartaric, citric, maleic and fumaric 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, Hofmann-bromamide degradation and Curtius rearrangement.

UNIT-V: ***Ethers and Epoxides:*** Preparation and reactions with acids. Reactions of epoxides with alcohols, ammonia derivatives and $LiAlH_4$

Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

Sulphur containing compounds : (4 Lectures)

Preparation and reactions of thiols, thioethers and sulphonic acids.

Reference Books :

1. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.

PRACTICAL

End Sem Practical – 30/3 hrs

Expt. -15, Viva- 5 & Lab. Record- 10

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 (-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 (-naphthol, resorcinol, p-cresol) by Schotten-Baumann reaction.
   (iii) Bromination of any one of the following:
      (a) Acetanilide by conventional methods.
      (b) Acetanilide using green approach (Bromate-bromide method).
   (iv) Nitration of any one of the following:
      (a) Acetanilide/nitrobenzene by conventional method.
      (b) Salicylic acid by green approach (using ceric ammonium nitrate).

(v) Preparation of Idoform

The above derivatives should be prepared using 0.5-1gm. of the organic compound. The solid samples must be collected and may be used for recrystallization, melting point and TLC.

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).

C-3.3 : PHYSICAL CHEMISTRY-III

Full Marks – 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I : Phase Equilibria-I **(14 Lectures)**

Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems; Clausius-Clapeyron equation and its applications to solid-liquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems, with applications.

UNIT-II : Phase Equilibria-II **(14 Lectures)**

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.

UNIT-III : Chemical Kinetics-I **(18 Lectures)**

Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods of the determination of rate laws (orders of reaction), kinetics of complex reactions (integrated rate expressions up to first order only): (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions. .

UNIT-IV : Catalysis **(8 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 **(6 Lectures)**

Physical adsorption, chemisorption, adsorption isotherms, nature of adsorbed state.

UNIT-V: Phase Equilibria-III

Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points, solid solutions.

Nernst distribution law: its derivation and applications.

Chemical Kinetics-II

Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, qualitative treatment of the theory of absolute reaction rates

Reference Books :

1. Peter Atkins & Julio De Paula, Physical Chemistry 9th Ed., Oxford University Press (2010).
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. Commonly Asked Questions in Thermodynamics. CRC Press: NY (2011).
6. Zundhal, S.S. Chemistry concepts and applications Cengage India (2011).
7. Ball, D. W. Physical Chemistry Cengage India (2012).
8. Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: NOIDA, UP (2009).
9. Levine, I. N. Physical Chemistry 6th Ed., Tata McGraw-Hill (2011).
10. Metz, C. R. Physical Chemistry 2nd Ed., Tata McGraw-Hill (2009).

PRACTICAL

End Sem Practical – 30/3 hrs

Expt. -15, Viva- 5 & Lab. Record- 10

I. Distribution of acetic/ benzoic acid between water and cyclohexane.
II. Study the equilibrium of at least one of the following reactions by the distribution method:
   $I_2(aq) + I^- \rightarrow I_3^-(aq)^{2+}$
   $Cu^{2+}(aq) + nNH_3 \rightarrow Cu(NH_3)n$
III. Study the kinetics of the following reactions.
   (1) Integrated rate method:
      a. Acid hydrolysis of ethyl acetate with hydrochloric acid.
      b. Saponi_cation of ethyl acetate.
   (2) Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methyl acetate.

Adsorption

1. Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.

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.: New York (2003).

GE- 3.4 : CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL ORGANIC CHEMISTRY-I

Full Marks – 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

SECTION A: PHYSICAL CHEMISTRY-1

UNIT-I : Chemical Energetics **(10 Lectures)**

Review of thermodynamics and the Laws of Thermodynamics.

Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation.

Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

Chemical Equilibrium: **(8 Lectures)**

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG^o , Le Chatelier's principle. Relationships between Kp, Kc and Kx for reactions involving ideal gases.

UNIT- II : Ionic Equilibria: **(12 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. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

SECTION B: ORGANIC CHEMISTRY-2

UNIT- III : **(8 Lectures)**

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

Aromatic hydrocarbons

Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid.

Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (upto 4 carbons on benzene). Side chain oxidation of alkyl benzenes (upto 4 carbons on benzene).

Alkyl and Aryl Halides **(8 Lectures)**

Alkyl Halides (Upto 5 Carbons) Types of Nucleophilic Substitution (SN1, SN2 and SNi) reactions.

Preparation: from alkenes and alcohols.

Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.

UNIT- IV : (14 Lectures)

Alcohols, Phenols and Ethers (Upto 5 Carbons)

Alcohols: Preparation: Preparation of 1^0 , 2^0 and 3^0 alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.

Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. $KMnO_4$, acidic dichromate, conc. HNO_3). Oppeneauer oxidation Diols: (Upto 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

Phenols: (Phenol case) Preparation: Cumene hydroperoxide method, from diazonium salts. Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. ReimerTiemann Reaction, Gattermann-Koch Reaction, Houben–Hoesch Condensation, Schotten – Baumann Reaction.

Ethers (aliphatic and aromatic): Cleavage of ethers with HI.

UNIT-V: Aryl Halides Preparation: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions.

Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituent. Benzyne Mechanism: KNH2/NH3 (or NaNH2/NH3).

Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides

Aldehydes and ketones (aliphatic and aromatic): (Formaldehye, acetaldehyde, acetone and benzaldehyde)

Preparation: from acid chlorides and from nitriles.

Reactions – Reaction with HCN, ROH, $NaHSO_3$, NH2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-Pondorff Verley reduction.

Reference Books :

1. T. W. Graham Solomons: Organic Chemistry, John Wiley and Sons.
2. Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
3. I.L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
4. R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
5. Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand.
6. G. M. Barrow: Physical Chemistry Tata McGraw-Hill (2007).
7. G. W. Castellan: Physical Chemistry 4th Edn. Narosa (2004).
8. J.C. Kotz, P.M. Treichel & J.R. Townsend: General Chemistry Cengage Lening India Pvt. Ltd., New Delhi (2009).
9. B. H. Mahan: University Chemistry 3rd Ed. Narosa (1998).
10. R. H. Petrucci: General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).

PRACTICAL

End Sem Practical – 30/3 hrs

Expt. -15, Viva- 5 & Lab. Record- 10

Section A: Physical Chemistry : Thermochemistry

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of ionization of acetic acid.
4. Determination of integral enthalpy of solution of salts (KNO_3, NH_4Cl).
5. Determination of enthalpy of hydration of copper sulphate.
6. Study of the solubility of benzoic acid in water and determination of ΔH.

Ionic equilibria

pH measurements

a) Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.
b) Preparation of buffer solutions:
   (i) Sodium acetate-acetic acid
   (ii) Ammonium chloride-ammonium hydroxide Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

Section B: Organic Chemistry

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Preparations: Mechanism of various reactions involved to be discussed. Recrystallisation, determination of melting point and calculation of quantitative yields to be done.

(a) Bromination of Phenol/Aniline
(b) Benzoylation of amines/phenols
(c) Oxime and 2,4 dinitrophenylhydrazone of aldehyde/ketone

4. Identification of simple organic compounds containing C, H, O & C, H, N & their confirmation using melting & boiling point only.

Reference Books :

1. A.I. Vogel: Textbook of Practical Organic Chemistry, 5th edition, Prentice-Hall
2. F. G. Mann & B. C. Saunders, Practical Organic Chemistry, Orient Longman (1960)
3. B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co

SEMESTER-IV

C-4.1: INORGANIC CHEMISTRY-III

Full Marks – 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I : Coordination Chemistry **(20 Lectures)**

Werners theory, valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. Crystal field theory, measurements of CFSE weak and strong fields, pairing energies, factors affecting the magnitude of 10 Dq in octahedral vs. tetrahedral coordination, square planar geometry. IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers. Chelate effect

UNIT-II: Transition Elements-I **(12 Lectures)**

General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer & Bsworth diagrams). Difference between the first, second and third transition series.

UNIT-III: Transition Elements-II **(12 Lectures)**

Chemistry of Ti, V, Cr Mn, Fe and Co in various oxidation states (excluding their metallurgy).

UNIT-IV: Lanthanoids and Actinoids **(6 Lectures)**

Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only)

UNIT-V: Bioinorganic Chemistry **(10 Lectures)**

Metal ions present in biological systems, classification of elements according to their action in biological system. Na/K-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. 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, Haemoglobin; Storage and transfer of iron.

Reference Books :

1. Purcell, K.F & Kotz, J.C. Inorganic Chemistry W.B. Saunders Co, 1977
2. Huheey, J.E., Inorganic Chemistry, Prentice Hall, 1993
3. Lippard, S.J. & Berg, J.M. Principles of Bioinorganic Chemistry Panima Publishing Company 1994
4. Cotton, F.A. & Wilkinson, G, Advanced Inorganic Chemistry. Wiley-VCH, 1999
5. Basolo, F, and Pearson, R.C., Mechanisms of Inorganic Chemistry, John Wiley & Sons, NY, 1967
6. Greenwood, N.N. & Earnshaw A., Chemistry of the Elements, Butterworth-Heinemann, 1997

PRACTICAL

End Sem Practical – 30/3 hrs

Expt. -15, Viva- 5 & Lab. Record- 10

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 $Fe(OH)_3$:
iv. Estimation of Al(III) by precipitating with oxine and weighing as $Al(oxine)_3$ (aluminium oxinate).

Chromatography of metal ions

1. Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions:
   i. Ni(II) and Co(II)
   ii. Fe(III) and Al(III)

2. Estimation of Mn in pyrolusite
3. Estimate the amount of Fe^{2+} & Fe^{3+} in a mixture using standard $K_2Cr_2O_7$.

Reference Book :

1. Vogel, A.I. A text book of Quantitative Analysis, ELBS 1986

C-4.2 : ORGANIC CHEMISTRY-III

Full Marks – 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I : Nitrogen Containing Functional Groups **(12 Lectures)**

Preparation and important reactions of nitro and compounds, nitriles & isonitriles

Amines: Effect of substituent and solvent on basicity; Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmanns exhaustive methylation, Hofmann-elimination reaction; Distinction between 1, 2 and 3 amines with Hinsberg reagent and nitrous acid.

UNIT-II: Diazonium Salts **(8 Lectures)**

Preparation and their synthetic applications.

Polynuclear Hydrocarbons :

Reactions of naphthalene phenanthrene and anthracene structure, Preparation and structure elucidation and important derivatives of naphthalene and anthracene, Polynuclear hydrocarbons.

UNIT-III: Heterocyclic Compounds-I **(20 Lectures)**

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,

UNIT-IV: Alkaloids **(8 Lectures)**

Natural occurrence, General structural features, Isolation and their physiological action Hoffmanns exhaustive methylation, Emdes modification, Structure elucidation and synthesis of Hygrine and Nicotine. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine. .

UNIT-V: Heterocyclic Compounds-II

Structure of quinoline and isoquinoline.

Derivatives of furan: Furfural and furoic acid (preparation only).

Terpenes : **(6 Lectures)**

Occurrence, classification, isoprene rule; Elucidation of stucture and synthesis of Citral, Neral 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, John Welly & Sons(1976)
5. Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc
6. Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd. Pub
7. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press
8. Singh, J.; Ali, S.M. & Singh, J. Natural Product Chemistry, Prajati Parakashan (2010)

PRACTICAL

End Sem Practical – 30/3 hrs

Expt. -15, Viva- 5 & Lab. Record- 10

1. Detection of extra elements (N, X, S)
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)
4. Identification of organic compounds containing C,H,O & C,H,N, halogens and sulphur (confirmation through preparation of derivative is included.

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)

C-4.3 : PHYSICAL CHEMISTRY-IV

Full Marks – 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I: Conductance-I **(12 Lectures)**

Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution.Kohlrausch law of independent migration of ions. Debye-Hckel-Onsager equation, Wien effect, Walden's rules

UNIT-II: Conductance-II **(16 Lectures)**

Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods. Applications of conductance measurement: (i) degree of dissociation of weak electrolytes, (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts, (iv) conductometric titrations, and (v) hydrolysis constants of salts

UNIT-III: Electrochemistry-I **(18 Lectures)**

Quantitative aspects of Faradays laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry. Chemical 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.

UNIT-IV: Electrochemistry-II **(14 Lectures)**

Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation

UNIT-V: Electrochemistry-III

Application of EMF measurements in determining free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone, glass electrodes.

Dipole moment and molecular polarizabilities and their measurements. Diamagnetism, papamagnetism, magnetic susceptibility and its measurement, molecular interpretation.

Reference Books :

1. Atkins, P.W & Paula, J.D. Physical Chemistry, 9th Ed., Oxford University Press (2011)
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 McGraw Hill: New Delhi (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 Chemistry 4th Ed., John Wiley & Sons, Inc. (2005)

PRACTICAL

End Sem Practical – 30/3 hrs

Expt. -15, Viva- 5 & Lab. Record- 10

Conductometry

I. Determination of cell constant.
II. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
III. Perform the following conductometric titrations:
    i. Strong acid vs. strong base
    ii. Weak acid vs. strong base
    iii. Strong acid vs. weak base

Potentiometry

I. Perform the following potentiometric titrations:
    i. Strong acid vs. strong base
    ii. Weak acid vs. strong base
    iii. Dibasic acid vs. strong base
II. Determination of partition coefficient of I_2 between H_2O & CCl_4.

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.: New York (2003).

GE- 4.4 : CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL ORGANIC CHEMISTRY-I

Full Marks – 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

SECTION A: PHYSICAL CHEMISTRY-1

UNIT-I : Chemical Energetics **(10 Lectures)**

Review of thermodynamics and the Laws of Thermodynamics.

Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation.

Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

Chemical Equilibrium: **(8 Lectures)**

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG^o , Le Chatelier's principle. Relationships between Kp, Kc and Kx for reactions involving ideal gases.

UNIT- II : Ionic Equilibria: **(12 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. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

SECTION B: ORGANIC CHEMISTRY-2

UNIT- III : **(8 Lectures)**

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

Aromatic hydrocarbons

Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid.

Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (upto 4 carbons on benzene). Side chain oxidation of alkyl benzenes (upto 4 carbons on benzene).

Alkyl and Aryl Halides **(8 Lectures)**

Alkyl Halides (Upto 5 Carbons) Types of Nucleophilic Substitution (SN1, SN2 and SNi) reactions.

Preparation: from alkenes and alcohols.

Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.

UNIT- IV : **(14 Lectures)**

Alcohols, Phenols and Ethers (Upto 5 Carbons)

Alcohols: Preparation: Preparation of 1^0 , 2^0 and 3^0 alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.

Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. $KMnO_4$, acidic dichromate, conc. HNO_3). Oppeneauer oxidation Diols: (Upto 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

Phenols: (Phenol case) Preparation: Cumene hydroperoxide method, from diazonium salts. Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. ReimerTiemann Reaction, Gattermann-Koch Reaction, Houben–Hoesch Condensation, Schotten – Baumann Reaction.

Ethers (aliphatic and aromatic): Cleavage of ethers with HI.

UNIT-V: Aryl Halides Preparation: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions.

Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituent. Benzyne Mechanism: KNH_2/NH_3 (or $NaNH_2/NH_3$).

Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides

Aldehydes and ketones (aliphatic and aromatic): (Formaldehye, acetaldehyde, acetone and benzaldehyde)

Preparation: from acid chlorides and from nitriles.

Reactions – Reaction with HCN, ROH, $NaHSO_3$, NH_2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-Pondorff Verley reduction.

Reference Books :

1. T. W. Graham Solomons: Organic Chemistry, John Wiley and Sons.
2. Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
3. I.L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
4. R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
5. Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand.
6. G. M. Barrow: Physical Chemistry Tata McGraw-Hill (2007).
7. G. W. Castellan: Physical Chemistry 4th Edn. Narosa (2004).
8. J. C. Kotz, P. M. Treichel & J. R. Townsend: General Chemistry Cengage Lening India Pvt. Ltd., New Delhi (2009).
9. B. H. Mahan: University Chemistry 3rd Ed. Narosa (1998).
10. R. H. Petrucci: General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).

PRACTICAL

End Sem Practical – 30/3 hrs

Expt. -15, Viva- 5 & Lab. Record- 10

Section A: Physical Chemistry : Thermochemistry

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of ionization of acetic acid.
4. Determination of integral enthalpy of solution of salts (KNO_3, NH_4Cl).
5. Determination of enthalpy of hydration of copper sulphate.
6. Study of the solubility of benzoic acid in water and determination of ΔH.

Ionic equilibria

pH measurements

a) Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.
b) Preparation of buffer solutions:
   (i) Sodium acetate-acetic acid
   (ii) Ammonium chloride-ammonium hydroxide Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

Section B: Organic Chemistry

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Preparations: Mechanism of various reactions involved to be discussed. Recrystallisation, determination of melting point and calculation of quantitative yields to be done.
   (a) Bromination of Phenol/Aniline
   (b) Benzoylation of amines/phenols
   (c) Oxime and 2,4 dinitrophenylhydrazone of aldehyde/ketone
4. Identification of simple organic compounds containing C, H, O & C, H, N & their confirmation using melting & boiling point only.

Reference Books :

1. A.I. Vogel: Textbook of Practical Organic Chemistry, 5th edition, Prentice-Hall
2. F. G. Mann & B. C. Saunders, Practical Organic Chemistry, Orient Longman (1960)
3. B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co

SEMESTER-V

C-5.1: ORGANIC CHEMISTRY-IV

Full Marks – 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I : Nucleic Acids **(8 Lectures)**

Components of nucleic acids, Nucleosides and nucleotides;
Structure, synthesis and reactions of: Adenine, Guanine, Cytosine, Uracil and Thymine

UNIT-II: Enzymes **(8 Lectures)**

Introduction, classification and characteristics of enzymes. Salient features of active site of enzymes.
Mechanism of enzyme action (taking trypsin as example), factors affecting enzyme action, coenzymes and cofactors and their role in biological reactions, specificity of enzyme action (including stereospecificity), enzyme inhibitors and their importance, phenomenon of inhibition (competitive, uncompetitive and non-competitive inhibition including allosteric inhibition).

UNIT-III : Amino Acids, Peptides and Proteins **(16 Lectures)**

Amino acids, peptides and their classification.
α-Amino acids - Synthesis, ionic properties and reactions. Zwitterions, pKa 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

UNIT-IV: Name Reactions **(12 Lectures)**

Principle, mechanism & applications : Michael Condensation, Reformatsky reaction, Benzidine rearrangement, Wagner-Meerwien rearrangement, Houben-Hoesch reaction, Lossen rearrangement, Demjanov rearrangement, Favorskii rearrangment

Synthetic Reagents : **(4 Lectures)**

Synthesis & aplication : Aluminium t-butoides, DCC, OSO_4, HIO_4, PCC, Diborane

UNIT-V : Pharmaceutical Compounds: Structure and Importance **(12 Lectures)**

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 curcumin (haldi), azadirachtin (neem), vitamin C and antacid (ranitidine)

Reference Books :

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

PRACTICAL

End Sem Practical – 30/3 hrs

Expt. -15, Viva- 5 & Lab. Record- 10

1. Preparations of the following compounds:
   i. Aspirine, ii. Phenacetin, iii. Milk of magnesia, iv. Aluminium hydroxide gel,
   v. Divol, vi. Picric acid, vii. Benzophenone (from Benzene), viii. Phenyl Benzoate
2. Saponification value of an oil or a fat.
3. 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. Vogel, Quantitative Organic Analysis, Pearson.

C-5.2: PHYSICAL CHEMISTRY-V

Full Marks – 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I : Elementary Quantum Mechanics-I **(20 Lectures)**

Black body radiation, Planck's radiation law, photoelectric effect, heat capacity of solids, Bohr's model of hydrogen atom (derivation not required) and its limitations, Compton effect, de-Broglie equation, Heisenberg's uncertainty principle,

UNIT-II: Elementary Quantum Mechanics-II

Hamiltonian operator, Schrodinger wave equation and its derivation, physical interpretation of the wave function, Postulates of quantum mechanics (Problems based on algebra of operators excluded), particle in an one dimensional box, electron in a ring

UNIT-III : Photochemistry **(14 Lectures)**

Difference between thermal and photochemical reaction; laws of photochemistry; Grotthus Draper law; Start-Einstein law; Beer-Lambert's law; Quantum yield and its determination-actinometry, mechanism and kinetics of decomposition of HI; Photochemical combination of hydrogen and bromine & hydrogen and chlorine reactions; Jablonski diagram; Radiative and non-radiative processes; Fluorescence, phosphorescence, resonance fluorescence, chemiluminescence, bioluminescence, photosensitization and photosynthesis (elementary idea)

UNIT-IV : Molecular Spectroscopy **(14 Lectures)**

Scope; Molecular spectra; Born-Oppenheimer approximation; Brief idea about various types of molecular spectra; Rotational (Micro wave) spectra of diatomic molecules, energy levels of a rigid rotator, selection rules, spectral intensities, vibrational spectra (IR) of diatomic molecules, energy levels of a simple harmonic oscillator, Anharmonicity, Electronic spectra of diatomic molecules, Franck-Condon principle

UNIT-V :

Kinetics of Fast Reactions **(4 Lectures)**

General features of fast reactions, Study of fast reactions by flow and relaxation method

Macromolecules **(4 Lectures)**

Types of polymers, mechanism of polymerization, kinetics of addition polymerization

Micelles **(4 Lectures)**

Surface active agents, classification of surface active agents, micellization, critical micellar concentration (CMC), factors affecting the CMC of surfactants

Reference Books :

1. Puri, Sharma & Pathania, Principles of Physical Chemistry Revised Ed.
2. Banwell, C. N. & McCash, E. M. Fundamentals of Molecular Spectroscopy 4th Ed. Tata McGraw-Hill: New Delhi (2006).
3. Chandra, A. K. Introductory Quantum Chemistry Tata McGraw-Hill (2001).
4. House, J. E. Fundamentals of Quantum Chemistry 2nd Ed. Elsevier: USA (2004).
5. Lowe, J. P. & Peterson, K. Quantum Chemistry, Academic Press (2005).
6. Kakkar, R. Atomic & Molecular Spectroscopy, Cambridge University Press (2015).
7. Acharya & Sharma, Modern College Chemistry, Physical
8. Physical Chemistry, Atkins

PRACTICAL

End Sem Practical – 30/3 hrs

Expt. -15, Viva- 5 & Lab. Record- 10

Colourimetry

1. Determine the concentration of HCl against 0.1 N NaOH spectrophotometrically.
2. To find the strength of given ferric ammonium sulfate solution of (0.05 M) by using EDTA spectrophotometrically.
3. To find out the strength of CuSO4 solution by titrating with EDTA spectrophotometrically.
4. To determine the concentration of Cu(II) and Fe(III) solution photometrically by titrating with EDTA.
5. Estimation of Ca & Mg in a mixture by EDTA Titration.

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.: New York (2003).

4. Experimental Physical Chemistry by J. N. Gurtu, R. Kapoor.

DSE-5.3: POLYMER CHEMISTRY

Full Marks – 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I: Introduction and history of polymeric materials: (4 Lectures)

Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers.

Functionality and its importance: (8 Lectures)

Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bi-functional systems, Polyfunctional systems.

UNIT-II: Kinetics of Polymerization: (8 lectures)

Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques.

Crystallization and crystallinity: (4 Lectures)

Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point.

UNIT-III:

Nature and structure of polymers-Structure property relationships. **(10 Lectures)**

Determination of molecular weight of polymers (Mn, Mw, etc.) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index.

Glass transition temperature (Tg) and determination of Tg (8 Lectures)

Free volume theory, WLF equation, Factors affecting glass transition temperature (Tg).

UNIT-IV: Polymer Solution (8 Lectures)

Criteria for polymer solubility, Solubility parameter, Thermodynamics of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions. Flory-Huggins theory, Lower and Upper critical solution temperatures.

UNIT-V:

Properties of Polymers (Physical, thermal & mechanical properties) **(10 Lectures)**

Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride) and related polymers, poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers, phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes, Polycarbonates, Conducting Polymers [polyacetylene, polyaniline, poly(p-phenylene sulphide polypyrrole, polythiophene)].

Reference Books :

1. Seymours Polymer Chemistry, Marcel Dekker, Inc.
2. G. Odian: Principles of Polymerization, John Wiley.
3. F.W. Billmeyer: Text Book of Polymer Science, John Wiley.
4. P. Ghosh: Polymer Science & Technology, Tata Mcgraw-Hill.
5. R.W. Lenz: Organic Chemistry of Synthetic High Polymers.

PRACTICAL

End Sem Practical – 30/3 hrs

Expt. -15, Viva- 5 & Lab. Record- 10 (*at least 7 experiments to be carried out.)

Polymer synthesis

1. Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA) / Methyl Acrylate (MA) / Acrylic acid (AA).
   (a) Purification of monomer.
   (b) Polymerization using benzoyl peroxide (BPO) / 2,2-azo-bis-isobutylonitrile (AIBN).
2. Preparation of nylon 66/6.
3. Interfacial polymerization, preparation of polyester from isophthaloyl chloride (IPC) and phenolphthalein.
   (a) Preparation of IPC.
   (b) Purification of IPC.
   (c) Interfacial polymerization.
4. Redox polymerization of acrylamide.

5. Precipitation polymerization of acrylonitrile.
6. Preparation of urea-formaldehyde resin.
7. Preparations of novalac resin/resold resin.
8. Microscale Emulsion Polymerization of poly(methylacrylate).

Polymer characterization

1. Determination of molecular weight by viscometry:
   (a) Polyacrylamide-aq. $NaNO_2$ solution
   (b) (Poly vinyl proplylidine (PVP) in water
2. Determination of the viscosity-average molecular weight of poly(vinyl alcohol) (PVOH) and the fraction of head-to-head monomer linkages in the polymer.
3. Determination of molecular weight by end group analysis : Polyethylene glycol (PEG) (OH group)
4. Testing of mechanical properties of polymers.
4. Determination of hydroxyl number of a polymer using colorimetric method.

Polymer analysis

1. Estimation of the amount of HCHO in the given solution by sodium sulphite method
2. Instrumental Techniques
3. IR studies of polymers
4. DSC analysis of polymers
5. Preparation of polyacrylamide and its electrophoresis

Reference Books :

1. Malcohm P. Stevens, Polymer Chemistry: An Introduction, 3rd Ed.
2. Harry R. Allcock, Frederick W. Lampe and James E. Mark, Contemporary Polymer Chemistry, 3rd ed. Prentice-Hall (2003).
3. Fred W. Billmeyer, Textbook of Polymer Science, 3rd ed. Wiley-Interscience (1984).
4. Joel R. Fried, Polymer Science and Technology, 2nd ed. Prentice-Hall (2003).
5. Petr Munk and Tejraj M. Aminabhavi, Introduction to Macromolecular Science, 2nd ed. John Wiley & Sons (2002).
6. L.H. Sperling, Introduction to Physical Polymer Science, 4th ed. John Wiley & Sons (2005).
7. Malcolm P. Stevens, Polymer Chemistry: An Introduction, 3rd ed. Oxford University Press (2005).
8. Seymour/ Carrahers Polymer Chemistry, 9th ed. by Charles E. Carraher, Jr. (2013).

DSE-5.4: INDUSTRIAL CHEMICALS AND ENVIRONMENT

Full Marks – 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I : Industrial Gases and Inorganic Chemicals (10 Lectures)

Industrial Gases: Large scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene.

Inorganic Chemicals: Manufacture, application analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.

UNIT-II : Environment and its segments-I (17 Lectures)

Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur. Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone. Major sources of air pollution. Pollution by SO_2;CO_2;CO;NO_x; and H_2S and other foul smelling gasses.

UNIT-III : Water Pollution: (17 Lectures)

Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems. Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluents from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, fertilizer.

UNIT-IV : Energy & Environment (10 Lectures)

Sources of energy: Coal, petrol and natural gas. Nuclear fusion/fission, solar energy, hydrogen, geothermal, tidal and hydel. Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management.

Biocatalysis: Introduction to biocatalysis: Importance in green chemistry and chemical industry.

UNIT-V: Environment and its segments-II **(6 Lectures)**

a. Methods of estimation of CO, NO_X , SO_X and control procedures. Effects of air pollution on living organisms and vegetation. Greenhouse effect and global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and halogens, removal of sulphur from coal, Control of particulates.

b. Sludge disposal. Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, ion exchange). Water quality parameters for waste water, industrial water and domestic water.

Reference Books :

1. E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
2. R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
3. J.A. Kent: Riegels Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
4. S. S. Dara: A Textbook of Engineering Chemistry, S. Chand & Company Ltd. New Delhi.
5. K. De, Environmental Chemistry: New Age International Pvt., Ltd, New Delhi.
6. S. M. Khopkar, Environmental Pollution Analysis: Wiley Eastern Ltd, New Delhi.
7. S.E. Manahan, Environmental Chemistry, CRC Press (2005).
8. G.T. Miller, Environmental Science 11th edition. Brooks/ Cole (2006).
9. A. Mishra, Environmental Studies. Selective and Scientific Books, New Delhi (2005).

PRACTICAL

End Sem Practical – 30/3 hrs

Expt. -15, Viva- 5 & Lab. Record- 10

1. Determination of dissolved oxygen in water.
2. Determination of Chemical Oxygen Demand (COD).
3. Determination of Biological Oxygen Demand (BOD).
4. Percentage of available chlorine in bleaching powder.
5. Measurement of chloride, sulphate and salinity of water samples by simple titration method ($AgNO_3$ and potassium chromate).
6. Estimation of total alkalinity of water samples (CO_3^{2-}, HCO_3^-) using double titration method.
7. Measurement of dissolved CO_2
8. Study of some of the common bio-indicators of pollution.
9. Estimation of SPM in air samples.
10. Preparation of borax/ boric acid.

Reference Books :

1. E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
2. R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
3. J.A. Kent: Riegels Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
4. S. S. Dara: A Textbook of Engineering Chemistry, S. Chand & Company Ltd. New Delhi.
5. K. De, Environmental Chemistry: New Age International Pvt., Ltd, New Delhi.
6. S. M. Khopkar, Environmental Pollution Analysis: Wiley Eastern Ltd, New Delhi.

SEMESTER-VI

C-6.1: INORGANIC CHEMISTRY-IV

Full Marks – 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I : Non-Aqueous Solvents : **(10 Lectures)**

Properties of non-aqueous solvent, classification of solvents, liquid NH_3, solutions of metal in liquid NH_3, Reactions in liquid NH_3.

Metal carbides : Classification, some important carbides, Preparations, properties, Calcium carbide, Aluminium carbide, Silicon carbide

UNIT-II: Organometallic Compounds-I **(14 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. π-acceptor behaviour of CO (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding.

UNIT-III: Group Theory **(12 Lectures)**

Basic idea about group & classes, symmetry elements, symmetry operations present in a molecule, point groups

Ferrocene : Preparation and reactions (acetylation, alkylation, metallation, Mannich condensation), Structure and aromaticity, Comparison of aromaticity and reactivity with that of benzene

UNIT-IV: Reaction Kinetics and Mechanism **(14 Lectures)**

Introduction to inorganic reaction mechanisms. Substitution reactions in square planar complexes, Trans-effect, theories of trans effect, Mechanism of nucleophilic substitution in square planar complexes. Thermodynamic and kinetic stability, Kinetics of octahedral substitution, General mechanism of substitution in octahedral complexes, Ligand field effects & Reaction rates

UNIT-V: Catalysis by Organometallic Compounds

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) 5. Synthesis gas by metal carbonyl complexes.
2. Zeise's salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls

Reference Books :

1. Vogel, A.I. Qualitative Inorganic Analysis, Longman, 1972.
2. Svehla, G. Vogel's Qualitative Inorganic Analysis, 7th Edition, Prentice Hall, 1996-03-07.
3. Huheey, J. E.; Keiter, E.A. & Keiter, R.L. Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed., Harper Collins 1993, Pearson,2006.
4. Sharpe, A.G. Inorganic Chemistry, 4th Indian Reprint (Pearson Education) 2005.
5. Douglas, B. E.; McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic Chemistry, 3rd Ed., John Wiley and Sons, NY, 1994.
6. Greenwood, N.N. & Earnshaw, A. Chemistry of the Elements, Elsevier 2nd Ed, 1997 (Ziegler Natta Catalyst and Equilibria in Grignard Solution).
7. Lee, J.D. Concise Inorganic Chemistry 5th Ed., John Wiley and sons 2008.
8. Powell, P. Principles of Organometallic Chemistry, Chapman and Hall, 1988.
9. Shriver, D.D. & P. Atkins, Inorganic Chemistry 2nd Ed., Oxford University Press, 1994.
10. Basolo, F. & Person, R. Mechanisms of Inorganic Reactions: Study of Metal Complexes in Solution 2nd Ed., John Wiley & Sons Inc; NY.
11. Purcell, K.F. & Kotz, J.C., Inorganic Chemistry, W.B. Saunders Co. 1977.
12. Miessler, G. L. & Donald, A. Tarr, Inorganic Chemistry 4th Ed., Pearson, 2010.
13. Collman, James P. et al. Principles and Applications of Organotransition Metal Chemistry. Mill Valley, CA: University Science Books, 1987.
14. Crabtree, Robert H. The Organometallic Chemistry of the Transition Metals, New York, NY: John Wiley, 2000.
15. Spessard, Gary O., & Gary L. Miessler. Organometallic Chemistry. Upper Saddle River, NJ: Prentice-Hall, 1996.
16. Mehrotra R.C. and Singh, A. Organometallic Chemistry, New Age International Publishers, 2nd Edn, 2000.

PRACTICAL

End Sem Practical – 30/3 hrs

Expt. -15, Viva- 5 & Lab. Record- 10

Qualitative semimicro analysis of mixtures containing 3 anions and 3 cations. Emphasis should be given to the understanding of the chemistry of different reactions. The following radicals are suggested:

CO_3^{2-}, NO_2^-, S^{2-}, SO_3^{2-}, CH_3COO^-, F^-, Cl^-, Br^-, I^-, NO_3^-, BO_3^{3-}, $C_2O_4^{2-}$, PO_4^{3-}, 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+}

Mixtures should preferably contain one interfering anion, or insoluble component ($BaSO_4$, $SrSO_4$, $PbSO_4$, CaF_2 or Al_2O_3) or combination of anions e.g. CO_3^{2-} and SO_3^{2-}, NO_2^- and NO_3^-, Cl^- and Br^-, Cl^- and I^-, Br^- and I^-, NO_3^- and Br^-, NO_3^- and Br^- and NO_3^- and I^-.

Spot tests should be done whenever possible.

Reference Books :

1. Vogels Qualitative Inorganic Analysis, Revised by G. Svehla.
2. Marr & Rockett Inorganic Preparations.

C-6.2 : ORGANIC CHEMISTRY-V

Full Marks – 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I : Organic Spectroscopy-I **(20 Lectures)**

General principles, Introduction to absorption and emission spectroscopy.

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

UNIT-II:

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 ring size on IR absorptions; Fingerprint region and its significance; application in functional group analysis.

UNIT-III: Organic Spectroscopy-II **(12 Lectures)**

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. Ethanol, Propanol, Ethyl bromide, 1,3-dichloropropane, Acetal dehyde, Toluene, Acetone, Applications of IR, UV and NMR for identification of simple organic molecules.

UNIT-IV: Carbohydrates **(18 Lectures)**

Occurrence, classification and their biological importance. Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, determination of ring size of glucose and fructose, Haworth projections and conformational structures; Interconversions of aldoses and ketoses; Killiani-Fischer synthesis and Ruff degradation;

Disaccharides Structure elucidation of maltose, lactose and sucrose

Polysaccharides Elementary treatment of starch, cellulose & glycogen

UNIT-V : Dyes **(8 Lectures)**

Classification, colour and constitution; Mordant and Vat dyes; Chemistry of dyeing. Synthesis and applications of: Azo dyes Methyl orange, Triphenyl methane dyes - Malachite Green, and Rosaniline; Phthalein dyes – Phenolphthalein, Natural dyes – Structure elucidation and synthesis of Alizarin and Indigotin; Edible dyes 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. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.
8. Singh, J.; Ali, S.M. & Singh, J. Natural Product Chemistry, Pragati Prakashan (2010).
9. Kemp, W. Organic Spectroscopy, Palgrave.

PRACTICAL

End Sem Practical – 30/3 hrs

Expt. -15, Viva- 5 & Lab. Record- 10

1. Extraction of caffeine from tea leaves.
2. Preparation of urea formaldehyde resin.
3. Qualitative analysis of unknown organic compounds containing mono-functional groups (carbohydrates, aryl halides, aromatic hydrocarbons, nitro compounds, amines and amides) and simple bifunctional groups, for e.g. salicylic acid, cinnamic acid, nitrophenols etc.
4. Identification of simple organic compounds by IR spectroscopy and NMR spectroscopy (Spectra to be provided).
5. Preparation of methyl orange.

6. Estimation of Glucose.

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).

DSE-6.3 : INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE

Full Marks – 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I : Silicate Industries **(14 Lectures)**

Glasses : Glassy state and its properties, classification (silicate and non-silicate glasses),Manufacture and processing of glass, Composition and properties of the following types of glasses -fluorosilicate, coloured glass, photosensitive glass, sodalime glass, lead glass, armoured glass, safety glass, borosilicate glass.

Ceramics : Important clays and feldspar, ceramic, their types and manufacture, High technology ceramics and their applications, superconducting and semiconducting oxides, fullerenes carbon nanotubes and carbon fibre.

UNIT-II : Fertilizers **(10 Lectures)**

Different types of fertilizers, Manufacture of the following fertilizers : Urea, Ammonium nitrate, Calcium ammonium nitrate, Ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium suphate.

UNIT-III : Alloys **(12 Lectures)**

Classification of alloys, ferrous and non-ferrous alloys, Specific properties of elements in alloys, Manufacture of Steel (removal of silicon decarbonization, demanganization, desulphurization dephosphorisation) and surface treatment (argon treatment, heat treatment, nitriding, carburizing), composition and properties of different types of steels.

UNIT-IV : Batteries **(7 Lectures)**

Primary and secondary batteries, battery components and their role, characteristics of battery, working of following batteries : Pb acid, Li-battery, solid state electrolyte battery, fuel cells, solar cell and polymer cell

Chemical explosives : **(5 Lectures)**

Origin of explosive properties in organic compounds, preparation and explosive properties of lead azide, PETN cyclonite (RDX), Introduction to rocket propellants

UNIT-V: a. Cements : **(5 Lectures)**

Classification of cement, ingredients and their role, Manufacture of cement and the setting process, quick setting cements.

b. Catalysis : **(7 Lectures)**

General principles and properties of catalysts, homogenous catalysis (catalytic steps and examples) and heterogenous catalysis (catalytic steps and examples) and their industrial applications, Deactivation or regeneration of catalysts, Phase transfer catalysts, application of zeolites as catalysts.

Reference Books :

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. W.D. Kingery, H.K. Bowen, R.R. Uhlmann : *Introduction to Ceramics*, Wiley Publishers, New Delhi.
4. J.A. Kent: Riegels *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
5. P.C. Jain, M. Jain : *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi
6. R. Gopalan, D. Venkappayya, S. Nagarajan : *Engineering Chemistry*, Vikas Publications, New Delhi
7. Sharma, B.K. & Gaur, H. *Industrial Chemistry*, Goel Publishing House, Meerut (1996)

PRACTICAL

End Sem Practical – 30/3 hrs

Expt. -15, Viva- 5 & Lab. Record- 10

1. Determination of free acidity in ammonium sulphate fertilizer
2. Estimation of Calcium in Calcium ammonium nitrate fertilizer

3. Estimation of phosphoric acid in superphosphate fertilizer
4. Electroless metallic coatings on ceramic and plastic material
5. Determination of composition of dolomite (by complexometric titration)
6. Analysis of (Cu, Ni); (Cu, Zn) in alloy or synthetic samples
7. Analysis of Cement
8. Preparation of pigment (zinc oxide)

Reference Books :

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. W.D. Kingery, H.K. Bowen, R.R. Uhlmann : *Introduction to Ceramics*, Wiley Publishers, New Delhi.
4. J.A. Kent: Riegels *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
5. P.C. Jain, M. Jain : *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi
6. R. Gopalan, D. Venkappayya, S. Nagarajan : *Engineering Chemistry*, Vikas Publications, New Delhi
7. Sharma, B.K. & Gaur, H. *Industrial Chemistry*, Goel Publishing House, Meerut (1996)

DSE-4 : DISSERTATION/PROJECT WORK

Full Marks – 100
End Sem Project– 100

To be announced by HOD.

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