SEMESTER- III

CHEMISTRY - C V
INORGANIC CHEMISTRY-II

(Credits: Theory-04, Practicals-02) **End Sem-60 marks**
Theory: 60 Lectures **Mid Sem- 15 marks**

UNIT-I

General Principles of Metallurgy

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 Reduction, Hydrometallurgy. Methods of purification of metals: Electrolytic Kroll process, Parting process, van Arkel-de Boer process and Mond's process, Zone refining.

(8 Lectures)

UNIT-II

Chemistry of *s* and *p* Block Elements:-I

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. **(14 Lectures)**

UNIT-III

Chemistry of *s* and *p* Block Elements-II

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.

(14 Lectures)

UNIT-IV

Acids and Bases

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

(8 Lectures)

Noble Gases

Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF_2, XeF_4 and XeF_6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF_2). Molecular shapes of noble gas compounds (VSEPR theory).

(8 Lectures)

Unit-V

Inorganic Polymers:

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

(8 Lectures)

Reference Books:

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

CHEMISTRY LAB-C V LAB

(Expt. -15, Viva Voce- 6 & Lab. Record- 4)

Time – 3hrs **(Full Marks 25)**

(A) Iodo / Iodimetric Titrations
(i) Estimation of Cu(II) using sodium thiosulphate solution (Iodimetrically).
(ii) Estimation of Ba using K_2CrO_4
(B) Inorganic preparations
(i) Cuprous Chloride, Cu_2Cl_2
(ii) Mohr's Salt.
(iii) Preparation of Manganese(III) phosphate, $MnPO_4.H_2O$
(iv) Preparation of Aluminium potassium sulphate $K_2SO_4\,Al_2(SO_4)_3.24H_2O$ (Potash alum).

Reference Books:

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

CHEMISTRY-C VI:
ORGANIC CHEMISTRY-II

(Credits: Theory-04, Practicals-02) **End Sem-60 marks**
Theory: 60 Lectures **Mid Sem- 15 marks**

UNIT-I

Chemistry of Halogenated Hydrocarbons

Alkyl halides: Methods of preparation, nucleophilic substitution reactions – S_N1, S_N2 and S_Ni 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 aryl halides towards nucleophilic substitution reactions.
(16 Lectures)

UNIT-II

Alcohols, Phenols, Ethers and Epoxides

Alcohols: preparation, properties and relative reactivity of 1°, 2°, 3° 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 Kolbe's–Schmidt Reactions, Fries and Claisen rearrangements with mechanism;

Ethers and Epoxides: Preparation and reactions with acids. Reactions of epoxides with alcohols, ammonia derivatives and $LiAlH_4$ (**16 Lectures)**

UNIT-III

Carbonyl Compounds

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 rearrangements, α haloform reaction and Baeyer Villiger oxidation, - substitution reactions, oxidations and reductions (Clemmensen, Wolff-Kishner, LiAlH4, $NaBH_4$.

Addition reactions of unsaturated carbonyl compounds: Michael addition.

(**14 Lectures)**

UNIT-IV

Carboxylic Acids and their Derivatives

Preparation, physical properties and reactions of monocarboxylic acids: Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic, lactic, tartaric, 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. **(10 Lectures)**

Sulphur containing compounds

Preparation and reactions of thiols, thioethers and sulphonic acids. **(4 Lectures)**

UNIT-V

(I) Organometallic compounds of Mg and Li – Use in synthesis of organic compounds.

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

(**8 Lectures)**

Reference Books:

• Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
• Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
• Graham Solomons, T.W. *Organic Chemistry*, John Wiley & Sons, Inc.

CHEMISTRY LAB- C VI LAB

(Expt. -15, Viva Voce- 6 & Lab. Record- 4)

Time – 3hrs **(Full Mark-25)**

1. **Organic preparations:**

i. Acetylation of one of the following compounds: amines (aniline, *o*-,*m*-, *p*-toluidines and *o*-, *m*-, *p*-anisidine)β 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) andβ 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 Picric acid.
vi. Preparation of benzoic acid from toluene.
vii. Preparation of Iodoform.

Reference Books

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

CHEMISTRY-C VII
PHYSICAL CHEMISTRY-III

(Credits: Theory-04, Practicals-02) **End Sem-60 marks**
Theory: 60 Lectures **Mid Sem- 15 marks**

UNIT-I
Phase Equilibria-I

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.
Phase diagrams for two component systems: Lead-Silver. **(14 Lectures)**

UNIT-II
Non-Aqueous Solvent

Classification and Characteristic properties of solvents. Liquid ammonia: chemical reaction in liquid ammonia, solution of alkali metals, liquid hydrogen fluoride: chemical reaction liq. HF, Liquid sulphur dioxide: reaction in liquid SO_2.
. **(8 Lectures)**

UNIT-III
Chemical Kinetics

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. Half life periods. Experimental methods of the determination of order of reactions.
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).
Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, **(18 Lectures)**

UNIT-IV
Catalysis

Types of catalyst, Homogeneous and heterogeneous catalysis. Promoters, catalytic poising, auto catalysis, negative catalysis. Activation energy and catalysis. Theories of catalysis- intermediate compound formation theory, adsorption theory. Specificity and selectivity, effect of particle size and efficiency of nanoparticles as catalysts. Enzyme catalysis and mechanism, acid-base catalysis.

(8 Lectures)

Surface chemistry

Physical adsorption, chemisorption, adsorption isotherms of Freundlich and of langmuir. Electrokinetic potential.

(6 Lectures)

Reference Books:

• Peter Atkins & Julio De Paula, *Physical Chemistry 9th Ed.,* Oxford University Press (2010).
• Castellan, G. W. *Physical Chemistry*, 4th Ed., Narosa (2004).
• McQuarrie, D. A. & Simon, J. D., *Molecular Thermodynamics*, Viva Books Pvt. Ltd.: New Delhi (2004).
• Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.,* Prentice-Hall (2012).
• Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. *Commonly Asked Questions in Thermodynamics.* CRC Press: NY (2011).
• Zundhal, S.S. *Chemistry concepts and applications* Cengage India (2011).
• Ball, D. W. *Physical Chemistry* Cengage India (2012).
• Mortimer, R. G. *Physical Chemistry 3rd Ed.,* Elsevier: NOIDA, UP (2009).
• Levine, I. N. *Physical Chemistry 6th Ed.,* Tata McGraw-Hill (2011).
• Metz, C. R. *Physical Chemistry 2nd Ed.,* Tata McGraw-Hill (2009).

CHEMISTRY PRACTICAL-C VII LAB
(Expt. -15, Viva Voce- 6 & Lab. Record- 4)

Time – 3hrs **(Full Marks-25)**

I. Distribution of acetic/ benzoic acid between water and benzene/cyclohexane.
II. Determination of the equilibrium constant of the reaction
$KI + I_2 \rightleftharpoons KI_3$ by partition method. (water/benzene)
III. Study the kinetics of the following reactions.
1) Integrated rate method:
a. Acid hydrolysis of methyl acetate with hydrochloric acid.
b. Saponification of ethyl acetate.
2) Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methyl acetate.

Adsorption

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

Reference Books:

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