

## SEMESTER- V

### CHEMISTRY-C XI ORGANIC CHEMISTRY-IV

(Credits: Theory-04, Practicals-02)  
Theory: 60 Lectures

End Sem-60 marks  
Mid Sem- 15 marks

#### UNIT-I

##### Aminoacids, Peptides, Proteins and Nucleic Acids

Classification, structure of amino acids, acid-base behaviour, isoelectric point and electro-phoresis, Preparation and reactions of  $\alpha$ -aminoacids, structure and nomenclature of peptides & proteins, Classification of proteins, peptide structure determination, end-group analysis, selective hydrolysis of peptides, classical peptide synthesis, solid phase peptide synthesis. Structure of peptides and proteins, Levels of protein structure, Protein denaturation/ renaturation.

##### Nucleic Acid

Introduction, constituents of nucleic acids. Ribonucleosides and ribonucleotides. The double helical structure of DNA. (18 Lectures)

#### Unit – II

(a) **Molecular Rearrangement**

Pinacole – Pinacolone, Demzanov, Dienone – Phenol, Benzidine, Benzillic acid, (Mechannism and applications).

(b) **Name Reactions**

Diels-Alder, Fries, Michael, Reformatsky, Dieckmann, Mannich (Principle, mechanism and applications)

(c) **Synthetic Reagents**

Mechanism of action and uses of  $\text{OsO}_4$  ,  $\text{HIO}_4$  ,  $\text{LiAlH}_4$  ,  $\text{Pb}(\text{OAc})_4$  , PCC, DCC, & Wilkinson's catalyst. (16 Lectures)

#### UNIT-III

(a) **Fats, Oils and Detergents**

Fats & Oils, chemical properties, hydrogenation of oils, saponification; Reichert–Meissl, Iodine and Acid value ; Soaps and Detergents, alkyl & aryl sulphonates, cleansing action, Micelle formation, Critical Micellar Concentration (CMC).

(b) **Synthetic Drugs**

Synthesis and uses of Aspirin, Phenacetin, Paracetamol, Sulphaguaidine, sulphanilamide. (10 Lectures)

#### UNIT-IV Carbohydrates

Classification, nomenclature of monosaccharides, mechanism of osazone formation, interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses. Configuration of monosaccharides, conversion of glucose into mannose; formation of glycosides, ethers and esters. Determination of ring size of monosaccharides, cyclic structure of D (+) glucose, mechanism of mutarotation. Elementary idea about disaccharides (*maltose, sucrose and lactose*) and polysaccharides (*starch and cellulose*).

(10 Lectures)

#### UNIT V Synthetic Dyes

Classification, Colour and constitution; Mordant and Vat Dyes; Chemistry of dyeing. Synthesis and applications of: Azo dyes – Methyl Orange and Congo Red, mechanism of Diazo Coupling); Triphenyl Methane Dyes -Malachite Green, Rosaniline and Crystal Violet; Phthalein Dyes – Phenolphthalein and Fluorescein; Natural dyes structure elucidation and synthesis of Alizarin and Indigotin; Edible Dyes with examples.

(8 Lectures)

#### Reference Books:

1. Organic Chemistry – Morrison & Boyd (Prentice Hall)
2. Advanced Organic Chemistry – B.S. Bahl (S. Chand)
3. Organic Chemistry (Vol- I & II) I.L. Finar (ELBS)
4. Organic Chemistry, (Vol-I, II & III) Mukherjee, Singh & Kapoor (NewAge International).
5. Organic Chemistry – F.A. Carey (MC. Graw Hill Inc.)
6. Organic Chemistry – Mc. Murry
7. Organic Chemistry – Solomon
8. Reactions & Reagents - O.P. Agarwal
9. Reaction Mechanism & Reagents in Organic Chemistry- Chatwal
10. Reactions, Rearrangement and Reagents – S.N. Sanyal
11. Chemistry of Natural Products – O.P. Agarwal.

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

Time – 6 hrs

(Full Marks -25)

1. Preparations of the following compounds:
  - a. Aspirine,
  - b. Phenacetin,
  - c. Milk of magnesia,
  - d. Aluminium hydroxide gel,
  - e. Divol

2. Saponification value of oil or fat.
3. Determination of Iodine number of an oil/ fat.

#### 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).

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## CHEMISTRY-C XII INORGANIC CHEMISTRY-IV

(Credits: Theory-04, Practicals-02)  
Theory: 60 Lectures

End Sem-60 marks  
Mid Sem- 15 marks

### Unit-I

#### Metal – Ligand Bonding in Transition Metal Complexes

Limitations of valence bond theory, Crystal Field Theory; crystal field splitting in octahedral, tetrahedral and square planar complexes; Calculation of crystal field stabilization energy, factors affecting the crystal field parameters.

John Teller theorem, qualitative aspect of ligand field theory and MO theory.

(12 Lectures)

### Unit - II

#### (a) Magnetic Properties of Transition Metal Complexes

Types of magnetic behavior, methods of determining magnetic susceptibility, spin-only formula, L-S coupling, co-relation of  $\mu_s$  and  $\mu_{eff}$  values, orbital contribution to magnetic moments, application of magnetic moment data for 3d-metal complexes.

#### (b) Electronic spectra of transition metal complexes

Types of electronic transitions, selection rules for d-d transitions, spectroscopic ground states, spectrochemical series, *Orgel-energy level diagram* for  $d^1$  and  $d^9$  states, discussion of the electronic spectrum of  $[Ti(H_2O_6)]^{3+}$  complex ion.

(12 Lectures)

**Unit-III**  
**Reaction Kinetics and Mechanism**

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, Ligand field effects and reaction rates, Mechanism of substitution in octahedral complexes. **(12 Lectures)**

**Unit – IV**  
**Organometallic Chemistry**

Definition, nomenclature and classification of organometallic compounds; preparation & properties, bonding and applications of alkyls and aryls of Li & Hg. A brief account of metal-ethylenic complexes, mono-nuclear and bi-nuclear carbonyls, *Effective Atomic Number rule*, preparation and bonding in metal carbonyls -  $Ni(CO)_4$ ,  $Fe(CO)_5$ ,  $Cr(CO)_6$ ,  $Fe_2(CO)_9$  and  $Mn_2(CO)_{10}$ .

**(12 Lectures)**

**Unit - V**  
**Nuclear Chemistry**

Fundamental particles, size & stability of the nucleus, Natural & artificial radioactivity, Binding energy, mass defect, packing fraction, nuclear reactions induced by  ${}^0n^1$ ,  ${}^1H^1$ ,  ${}^1H^2$ ,  ${}^2He^4$ , nuclear fission and fusion, liquid drop model, Hydrogen bomb, Carbon dating.

**(12 Lectures)**

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**Reference Books:**

- Cotton, F.A. G.; Wilkinson & Gaus, P.L. *Basic Inorganic Chemistry 3rd Ed.*; Wiley India,
- Huheey, J. E.; Keiter, E.A. & Keiter, R.L. *Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed.*, Harper Collins 1993, Pearson, 2006.
- Sharpe, A.G. *Inorganic Chemistry*, 4th Indian Reprint (Pearson Education) 2005
- Douglas, B. E.; McDaniel, D.H. & Alexander, J.J. *Concepts and Models in Inorganic Chemistry 3rd Ed.*, John Wiley and Sons, NY, 1994.
- Greenwood, N.N. & Earnshaw, A. *Chemistry of the Elements, Elsevier 2nd Ed*, 1997 (Ziegler Natta Catalyst and Equilibria in Grignard Solution).
- Lee, J.D. *Concise Inorganic Chemistry 5th Ed.*, John Wiley and sons 2008.
- Powell, P. *Principles of Organometallic Chemistry*, Chapman and Hall, 1988.
- Shriver, D.D. & P. Atkins, *Inorganic Chemistry 2nd Ed.*, Oxford University Press, 1994.
- Basolo, F. & Person, R. *Mechanisms of Inorganic Reactions: Study of Metal Complexes in Solution 2nd Ed.*, John Wiley & Sons Inc; NY.
- Purcell, K.F. & Kotz, J.C., *Inorganic Chemistry*, W.B. Saunders Co. 1977
- Miessler, G. L. & Donald, A. Tarr, *Inorganic Chemistry 4th Ed.*, Pearson, 2010.
- Collman, James P. et al. *Principles and Applications of Organotransition Metal Chemistry*. Mill Valley, CA: University Science Books, 1987.
- Crabtree, Robert H. *The Organometallic Chemistry of the Transition Metals*. New York, NY: John Wiley, 2000.

• Spessard, Gary O., & Gary L. Miessler. *Organometallic Chemistry*. Upper Saddle River, NJ: Prentice-Hall, 1996.

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

**Time – 6hrs**

**(Full Marks -25)**

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:  $\text{CO}_3^{2-}$ ,  $\text{NO}_2^-$ ,  $\text{S}^{2-}$ ,  $\text{SO}_3^{2-}$ ,  $\text{S}_2\text{O}_3^{2-}$ ,  $\text{CH}_3\text{COO}^-$ ,  $\text{F}^-$ ,  $\text{Cl}^-$ ,  $\text{Br}^-$ ,  $\text{I}^-$ ,  $\text{NO}_3^-$ ,  $\text{BO}_3^{3-}$ ,  $\text{C}_2\text{O}_4^{2-}$ ,  $\text{PO}_4^{3-}$ ,  $\text{NH}_4^+$ ,  $\text{K}^+$ ,  $\text{Pb}^{2+}$ ,  $\text{Cu}^{2+}$ ,  $\text{Cd}^{2+}$ ,  $\text{Bi}^{3+}$ ,  $\text{Sn}^{2+}$ ,  $\text{Sb}^{3+}$ ,  $\text{Fe}^{3+}$ ,  $\text{Al}^{3+}$ ,  $\text{Cr}^{3+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Mn}^{2+}$ ,  $\text{Co}^{2+}$ ,  $\text{Ni}^{2+}$ ,  $\text{Ba}^{2+}$ ,  $\text{Sr}^{2+}$ ,  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ . Mixtures should preferably contain one interfering anion, **or** insoluble component ( $\text{BaSO}_4$ ,  $\text{SrSO}_4$ ,  $\text{PbSO}_4$ ,  $\text{CaF}_2$  or  $\text{Al}_2\text{O}_3$ ) **or** combination of anions e.g.  $\text{CO}_3^{2-}$  and  $\text{SO}_3^{2-}$ ,  $\text{Cl}^-$  and  $\text{Br}^-$ ,  $\text{Cl}^-$  and  $\text{I}^-$ ,  $\text{Br}^-$  and  $\text{I}^-$ ,  $\text{NO}_3^-$  and  $\text{Br}^-$ ,  $\text{NO}_3^-$  and  $\text{I}^-$  and  $\text{NO}_2^-$ .

**Reference Books**

• Vogel's *Qualitative Inorganic Analysis*, Revised by G. Svehla.

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**DSE- 1**  
**POLYMER CHEMISTRY**

**(Credits: Theory-06, Practicals-02)**

**End Sem- 60 Marks**

**Mid Sem- 15 Marks**

**Unit I**

**Introduction and history of polymeric materials**

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

**(4 Lectures)**

**Functionality and its importance:**

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

**(8 Lectures)**

**Unit II**

**Kinetics of Polymerization:**

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.

**(8 Lectures)**

### **Crystallization and crystallinity:**

Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point. **(8 Lectures)**

### **Unit III**

#### **Determination of molecular weight of polymers**

( $M_n$ ,  $M_w$ , etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index.

**(8 Lectures)**

### **Unit IV**

#### **Glass transition temperature (T<sub>g</sub>) and determination of T<sub>g</sub>,**

Free volume theory, WLF equation, Factors affecting glass transition temperature (T<sub>g</sub>).

**(8 Lectures)**

#### **Polymer Solution**

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.

**(8 Lectures)**

### **Unit V**

#### **Properties of Polymers**

(Physical, thermal, Flow & Mechanical Properties)

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)].

**(8 Lectures)**

#### **Reference Books:**

- R.B. Seymour & C.E. Carraher: *Polymer Chemistry: An Introduction*, Marcel Dekker, Inc. New York, 1981.
- G. Odian: *Principles of Polymerization*, 4<sup>th</sup> Ed. Wiley, 2004.
- F.W. Billmeyer: *Textbook of Polymer Science*, 2<sup>nd</sup> Ed. Wiley Interscience, 1971.
- P. Ghosh: *Polymer Science & Technology*, Tata McGraw-Hill Education, 1991.
- R.W. Lenz: *Organic Chemistry of Synthetic High Polymers*. Interscience Publishers, New York, 1967.

**CHEMISTRY PRACTICAL - DSE LAB-1**  
**(Expt. -15, Viva Voce- 6 & Lab. Record- 4)**

**Time – 6 hrs**

**(Full Marks -25)**

**1. 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-isobutyronitrile (AIBN)
2. Preparation of nylon 66/6
  1. Interfacial polymerization, preparation of polyester from isophthaloyl chloride (IPC) and phenolphthalein
    - a. Preparation of IPC
    - b. Purification of IPC
    - c. Interfacial polymerization
  3. Redox polymerization of acrylamide
  4. Precipitation polymerization of acrylonitrile
  5. Preparation of urea-formaldehyde resin
  6. Preparations of novalac resin/ resold resin.
  7. Microscale Emulsion Polymerization of Poly(methylacrylate).

**Polymer characterization**

1. Determination of molecular weight by viscometry:
  - (a) Polyacrylamide-aq.NaNO<sub>2</sub> solution
  - (b) (Poly vinyl propylidene (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.
5. 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

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**Reference Books:**

- M.P. Stevens, *Polymer Chemistry: An Introduction*, 3<sup>rd</sup> Ed., Oxford University Press, 1999.
- H.R. Allcock, F.W. Lampe & J.E. Mark, *Contemporary Polymer Chemistry*, 3<sup>rd</sup> ed. Prentice-Hall (2003)
- F.W. Billmeyer, *Textbook of Polymer Science*, 3<sup>rd</sup> ed. Wiley-Interscience (1984)
- J.R. Fried, *Polymer Science and Technology*, 2<sup>nd</sup> ed. Prentice-Hall (2003)
- P. Munk & T.M. Aminabhavi, *Introduction to Macromolecular Science*, 2<sup>nd</sup> ed. John Wiley & Sons (2002)
- L. H. Sperling, *Introduction to Physical Polymer Science*, 4<sup>th</sup> ed. John Wiley & Sons (2005)
- M.P. Stevens, *Polymer Chemistry: An Introduction* 3<sup>rd</sup> ed. Oxford University Press (2005).
- Seymour/ Carraher's *Polymer Chemistry*, 9<sup>th</sup> ed. by Charles E. Carraher, Jr. (2013).

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**DSE-2****INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE****(Credits: Theory-06, Practicals-02)****End Sem- 60 Marks****60 Lectures****Mid Sem- 15 Marks****Unit I****Silicate Industries**

**Glass:** 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: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive 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.

**(12 Lectures)****Unit II****Fertilizers:**

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 sulphate.

**(8 Lectures)****Cements**

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

**(4 Lectures)****Unit III****Surface Coatings**

Objectives of coatings surfaces, preliminary treatment of surface, classification of surface



coatings. Paints and pigments-formulation, composition and related properties. Oil paint, Vehicle, modified oils, Pigments, toners and lakes pigments, Fillers, Thinners, Enamels, emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco-friendly paint, Plastic paint), Dyes, Wax polishing, Water and Oil paints, additives. **(10 Lectures)**

#### **Unit IV**

##### **Batteries**

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.

**(6 Lectures)**

##### **Chemical explosives:**

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

**(4 Lectures)**

#### **Unit V**

##### **Alloys**

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.

**(10 Lectures)**

##### **Catalysis:**

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.

**(6 Lectures)**

##### **Reference Books:**

- E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
  - R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
  - W. D. Kingery, H. K. Bowen, D. R. Uhlmann: *Introduction to Ceramics*, Wiley Publishers, New Delhi.
  - J. A. Kent: *Riegel's Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
  - P. C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
  - R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry*, Vikas Publications, New Delhi.
  - Sharma, B.K. & Gaur, H. *Industrial Chemistry*, Goel Publishing House, Meerut (1996).
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**CHEMISTRY PRACTICAL - DSE LAB-2:**  
**(Expt. -15, Viva Voce- 6 & Lab. Record- 4)**

**Time – 3 hrs**

**(F.M=25)**

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:**

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