**DEPARTMENT OF CHEMISTRY**
**GOVERNMENT GENERAL DEGREE COLLEGE, KALNA-I**
**LESSON PLAN**
**for**
**B. Sc. 1st SEMESTER (Hons.) COURSES UNDER CBCS**
**Subject: Chemistry**
**Course code: CC-1**
**Credits-4**
**Course title: Organic Chemistry-I (Theo): Basics of Organic Chemistry**

**Module-I**
Bonding and Physical Properties

**CONTENTS**

1. Valence Bond Theory: Concept of hybridisation, shapes of molecules, resonance (including hyperconjugation); calculation of formal charges and double bond equivalent (DBE); orbital pictures of bonding ($sp^3$, $sp^2$, sp: C-C, C-N & C-O systems and *s*-cis and *s*-trans geometry for suitable cases). **4 classes**
2. Electronic displacements: inductive effect, field effect, mesomeric effect, resonance energy; bond polarization and bond polarizability; electromeric effect; steric effect, steric inhibition of resonance. **4 classes**
3. MO theory: qualitative idea about molecular orbitals, bonding and antibonding interactions, idea about σ, σ*, π, π *, n – MOs; basic idea about Frontier MOs (FMO); concept of HOMO, LUMO and SOMO; interpretation of chemical reactivity in terms of FMO interactions; sketch and energy levels of π MOs of i) acyclic p orbital system (C=C, conjugated diene, triene, allyl and pentadienyl systems) ii) cyclic p orbital system (neutral systems: [4], [6]-annulenes; charged systems: 3-,4-,5-membered ring systems); Hückel's rules for aromaticity up to [10]-annulene (including mononuclear heterocyclic compounds up to 6-membered ring); concept of antiaromaticity and homoaromaticity; non-aromatic molecules; Frost diagram; elementary idea about α and β; measurement of delocalization energies in terms of β for buta-1,3-diene, cyclobutadiene, hexa-1,3,5-triene and benzene. **10 classes**
4. Physical properties: influence of hybridization on bond properties: bond dissociation energy (BDE) and bond energy; bond distances, bond angles; concept of bond angle strain (Baeyer's strain theory); melting point/boiling point and solubility of common organic compounds in terms of covalent & non-covalent intermolecular forces; polarity of molecules and dipole moments; relative stabilities of isomeric hydrocarbons in terms of heat of hydrogenation, heat of combustion and heat of formation. **6 classes**

**Module Objectives:**

This unit aims to offer basic knowledge on bonding in organic molecules and others physical parameters and stability factors. Students will also understate about aromaticity and delocalization.

| Lecture Serial | Topics of Discussion | Remarks |
|---|---|---|
| Lecture-1. | Valence Bond Theory: Concept of hybridisation, shapes of molecules | |
| Lecture-2. | resonance (including hyperconjugation) | |

| | | |
|---|---|---|
| Lecture-3. | calculation of formal charges and double bond equivalent (DBE) | |
| Lecture-4. | orbital pictures of bonding ($sp^3$, $sp^2$, sp: C-C, C-N & C-O systems and *s*-cis and *s*-trans geometry for suitable cases) | |
| Lecture-5. | Electronic displacements: inductive effect, field effect, | |
| Lecture-6. | mesomeric effect, resonance energy | |
| Lecture-7. | bond polarization and bond polarizability; electromeric effect | |
| Lecture-8. | steric effect, steric inhibition of resonance | |
| Lecture-9. | MO theory: qualitative idea about molecular orbitals, bonding and antibonding interactions, idea about σ, σ*, π, π *, n – MOs; | |
| Lecture-10. | basic idea about Frontier MOs (FMO); concept of HOMO, LUMO and SOMO; | |
| Lecture-11. | interpretation of chemical reactivity in terms of FMO interactions; sketch and energy levels of π MOs of i) acyclic p orbital system (C=C, conjugated diene, triene) | |
| Lecture-12. | sketch and energy levels of π MOs of allyl and pentadienyl systems | |
| Lecture-13. | ii) cyclic p orbital system (neutral systems: [4], [6]-annulenes; charged systems: 3-,4-,5-membered ring systems) | |
| Lecture-14. | Hückel's rules for aromaticity up to [10]-annulene (including mononuclear heterocyclic compounds up to 6-membered ring) | |
| Lecture-15. | continuation | |
| Lecture-16. | concept of antiaromaticity and homoaromaticity; non-aromatic molecules | |
| Lecture-17. | Frost diagram; elementary idea about α and β; measurement of delocalization energies in terms of β for buta-1,3-diene, cyclobutadiene, hexa-1,3,5-triene and benzene. | |
| Lecture-18. | | Solving of relevant questions |

| | | |
|---|---|---|
| Lecture-19. | Physical properties: influence of hybridization on bond properties: bond dissociation energy (BDE) and bond energy | |
| Lecture-20. | bond distances, bond angles; concept of bond angle strain (Baeyer's strain theory) | |
| Lecture-21. | melting point/boiling point and solubility of common organic compounds in terms of covalent & non-covalent intermolecular forces | |
| Lecture-22. | polarity of molecules and dipole moments | |
| Lecture-23. | relative stabilities of isomeric hydrocarbons in terms of heat of hydrogenation, heat of combustion and heat of formation | |
| Lecture-24. | | Discussion on Problems |

**Module-II**

General Treatment of Reaction Mechanism I

**CONTENTS**

1. Mechanistic classification: ionic, radical and pericyclic (definition and example); reaction type: addition, elimination and substitution reactions (definition and example); nature of bond cleavage and bond formation: homolytic and heterolytic bond fission, homogenic and heterogenic bond formation; curly arrow rules in representation of mechanistic steps; reagent type: electrophiles and nucleophiles (elementary idea); electrophilicity and nucleophilicity in terms of FMO approach. **8 classes**
2. Reactive intermediates: carbocations (carbenium and carbonium ions), carbanions, carbon radicals, carbenes: generation and stability, structure using orbital picture and electrophilic/nucleophilic behavior of reactive intermediates (elementary idea). **4 classes**

**Module Objectives:**

Concept of reaction mechanism will help students to build up knowledge about pathway of chemical conversion, types of reagents, reaction condition etc. Simultaneously study on reaction intermediates gives idea to find out a possible reaction path for an unknown reaction.

| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
|---|---|---|
| Lecture-25. | Mechanistic classification: ionic, radical and pericyclic (definition and example) | |
| Lecture-26. | continuation | |
| Lecture-27. | reaction type: addition, elimination and substitution reactions (definition and example) | |
| Lecture-28. | continuation | |
| Lecture-29. | nature of bond cleavage and bond formation: homolytic and heterolytic bond fission, | |

| | | |
|---|---|---|
| | homogenic and heterogenic bond formation, curly arrow rules in representation of mechanistic step | |
| Lecture-30. | reagent type: electrophiles and nucleophiles (elementary idea); electrophilicity and nucleophilicity in terms of FMO approach | |
| Lecture-31. | | Discussion on Problems |
| Lecture-32. | | Question-Answer |
| Lecture-33. | Reactive intermediates: carbocations (carbenium and carbonium ions), carbanions: generation and stability, structure using orbital picture and electrophilic/nucleophilic behavior of reactive intermediates (elementary idea) | |
| Lecture-34. | carbon radicals, carbenes: generation and stability, structure using orbital picture and electrophilic/nucleophilic behavior of reactive intermediates (elementary idea) | |
| Lecture-35. | | Discussion on problems |
| Lecture-36. | | Solving of questions |

**Module-III**

Stereochemistry-I

**CONTENTS**

1. Bonding geometries of carbon compounds and representation of molecules: Tetrahedral nature of carbon and concept of asymmetry; Fischer, sawhorse, flying-wedge and Newman projection formulae and their inter translations. **4 classes**

2. Concept of chirality and symmetyry; symmetry elements and point groups (Cv, Cnv, Cnh, Cn, Dh, Dnh, Dnd, Dn, Sn (Cs, Ci); molecular chirality and centre of chirality; asymmetric and dissymmetric molecules; enantiomers and diastereomers; concept of epimers; concept of stereogenicity, chirotopicity and pseudoasymmetry; chiral centres and number of stereoisomerism: systems involving 1/2/3-chiral centre(s) (AA, AB, ABA and ABC types). **10 classes**

3. Relative and absolute configuration: D/L and R/S descriptors; erythro/threo and meso nomenclature of compounds; *syn*/*anti* nomenclatures for aldols; E/Z descriptors for C=C, conjugated diene, triene, C=N and N=N systems; combination of R/S- and E/Z-isomerisms. **4 classes**

4. Optical activity of chiral compounds: optical rotation, specific rotation and molar rotation; racemic compounds, racemisation (through cationic, anionic, radical intermediates and through reversible formation of stable achiral intermediates); resolution of acids, bases and alcohols via diastereomeric salt formation; optical purity and enantiomeric excess. **6 classes**

**Module Objectives:**

This chapter is a subdiscipline of chemistry, involves the study of the relative spatial arrangement of atoms that form the structure of molecules and their manipulation. The study of stereochemistry focuses on stereoisomers, which by definition have the same molecular formula and sequence of bonded atoms (constitution), but differ in the three-dimensional orientations of their atoms in space. For this reason, it is also known as 3D chemistry—the prefix "stereo-" means "three-dimensionality".

| Lecture Serial | Topics of Discussion | Remarks |
|---|---|---|
| Lecture-37. | Bonding geometries of carbon compounds and representation of molecules: Tetrahedral nature of carbon and concept of asymmetry; | |
| Lecture-38. | Fischer, sawhorse, projection formulae | |
| Lecture-39. | flying-wedge and Newman projection formulae | |
| Lecture-40. | inter translations among different projection formulae. | |
| Lecture-41. | Concept of chirality and symmetry; symmetry elements | |
| Lecture-42. | point groups (Cv, Cnv, Cnh, Cn, Dh, Dnh, Dnd, Dn, Sn (Cs, Ci); | |
| Lecture-43. | continuation | |
| Lecture-44. | continuation | |
| Lecture-45. | molecular chirality and centre of chirality; asymmetric and dissymmetric molecules | |
| Lecture-46. | enantiomers and diastereomers; concept of epimers | |
| Lecture-47. | concept of stereogenicity, chirotopicity and pseudoasymmetry | |
| Lecture-48. | chiral centres and number of stereoisomerism: systems involving 1/2/3-chiral centre(s) (AA, AB, ABA and ABC types) | |
| Lecture-49. | | Discussion on Problems |
| Lecture-50. | | Question-Answer |
| Lecture-51. | Relative and absolute configuration: D/L and R/S descriptors; | |
| Lecture-52. | erythro/threo and meso nomenclature of compounds; *syn*/*anti* nomenclatures for aldols | |
| Lecture-53. | E/Z descriptors for C=C, conjugated diene, triene, C=N and N=N systems | |

| | | |
|---|---|---|
| Lecture-54. | combination of R/S- and E/Z-isomerisms | |
| Lecture-55. | Optical activity of chiral compounds: optical rotation, specific rotation and molar rotation; racemic compounds | |
| Lecture-56. | racemisation (through cationic, anionic, radical intermediates and through reversible formation of stable achiral intermediates) | |
| Lecture-57. | resolution of acids, bases and alcohols via diastereomeric salt formation; | |
| Lecture-58. | optical purity and enantiomeric excess | |
| Lecture-59. | | Question-answer |
| Lecture-60. | | Question-answer |

**Reference Books:**


1. Clayden, J., Greeves, N. & Warren, S. Organic Chemistry, Second edition, Oxford University Press, 2012.
2. Smith, J. G. Organic Chemistry, Tata McGraw-Hill Publishing Company Limited.
3. Nasipuri, D. Stereochemistry of Organic Compounds, Wiley Eastern Limited.
4. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
5. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd., (Pearson Education).
6. Fleming, I. Molecular Orbitals and Organic Chemical Reactions, Reference/Student Edition, Wiley, 2009.
7. James, J., Peach, J. M. Stereochemistry at a Glance, Blackwell Publishing, 2003.
8. Robinson, M. J. T., Stereochemistry, Oxford Chemistry Primer, Oxford University Press, 2005.
9. Morrison, R. T. Study guide to organic Chemistry, Pearson.

**Course code: CC-1**
**2 Credits**
**Course title: Organic Chemistry-I (Prac):**
**Basics of Organic Chemistry**

| **Module-I**<br>Separation | | |
|---|---|---|
| **CONTENTS**<br>Based upon solubility, by using common laboratory reagents like water (cold, hot), dil. HCl, dil. NaOH, dil. $NaHCO_3$, etc., of components of a binary solid mixture; purification of any one of the separated components by crystallization and determination of its melting point. The composition of the mixture may be of the following types: Benzoic acid/p-Toluidine; p-Nitrobenzoic acid/p-Aminobenzoic acid; p-Nitrotolune/p-Anisidine. **15 classes** | | |
| **Module Objectives:**<br>Students will experience hand on training regarding quantitative separation of organic compounds using several techniques. These classes may help students to develop their skills regarding laboratory experiments of various RNDs and research. | | |
| **Lecture Serial** | **Title of the Experiment** | **Remarks** |
| Lab 1 | Laboratory Instructions and guidance on Lab notebook preparation | |
| Lab 2 | Theoretical discussion about the reactions involved in this course | |
| Lab 3 | Skill development on weighing and glass instruments | |
| Lab 4 | Training to Detect MP of some common organic compounds | |
| Lab 5 | Separation of two component from the mixture of Benzoic acid/p-Toluidine | |
| Lab 6 | Continuation | |
| Lab 7 | Purification of benzoic acid through crystallization | |
| Lab 8 | Detection of MP of benzoic acid | |
| Lab 9 | Separation of two component from the mixture of p-Nitrobenzoic acid/p-Aminobenzoic acid | |
| Lab 10 | Continuation | |
| Lab 11 | Purification of p-Nitrobenzoic acid through crystallization | |
| Lab 12 | Detection of MP of p-Nitrobenzoic acid | |
| Lab 13 | Separation of two component from the mixture of p-Nitrotolune/p-Anisidine | |
| Lab 14 | Purification of p-Nitrotolune acid through crystallization | |
| Lab 15 | Detection of MP of p-Nitrotolune | |

**Module-II**

Determination of boiling point

**CONTENTS**

Determination of boiling point of common organic liquid compounds e.g., ethanol, cyclohexane, ethyl methyl ketone, cyclohexanone, acetylacetone, anisole, crotonaldehyde, mesityl oxide. [Boiling point of the chosen organic compounds should preferably be less than 160 °C]. **3 classes**

**Module Objectives:**

Students will get training on determination of boiling point with some common organic solvents. It will help to detect proper solvent for a particular reaction in their future.

| Lecture Serial | Title of the Experiment | Remarks |
|---|---|---|
| Lab 16 | Apparatus set up and showing the process | |
| Lab 17 | Determination of BP of ethanol, cyclohexane, ethyl methyl ketone, cyclohexanone | |
| Lab 18 | Determination of BP of acetylacetone, anisole, crotonaldehyde, mesityl oxide | |

**Module-III**

Identification of a Pure Organic Compound by Chemical Test(s)

**CONTENTS**

Solid compounds: oxalic acid, succinic acid, resorcinol, urea, glucose and salicylic acid.

Liquid Compounds: acetic acid, ethyl alcohol, acetone, aniline and nitrobenzene. **12 classes**

**Module Objectives:**

Students will experience hand on training regarding and skill development for identification of Organic Compounds by Chemical Tests which will help to detect the nature of compounds and their chemical behavior.

| Lecture Serial | Title of the Experiment | Remarks |
|---|---|---|
| Lab 19 | Identification of oxalic acid | |
| Lab 20 | Identification of succinic acid | |
| Lab 21 | Identification of resorcinol | |
| Lab 22 | Identification of urea | |
| Lab 23 | Identification of glucose | |
| Lab 24 | Identification of salicylic acid | |
| Lab 25 | Identification of acetic acid | |
| Lab 26 | Identification of ethyl alcohol | |
| Lab 27 | Identification of acetone | |
| Lab 28 | Identification of aniline | |
| Lab 29 | Identification of nitrobenzene | |
| Lab 30 | | Practice |

**Reference Books:**

1. Bhattacharyya, R. C, A Manual of Practical Chemistry.
2. Vogel, A. I. Elementary Practical Organic Chemistry, Part 2: Qualitative Organic Analysis, CBS Publishers and Distributors.
3. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).
4. Furniss, B.S., Hannaford, A.J., Smith, P.W.G., Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012).

**DEPARTMENT OF CHEMISTRY**
**GOVERNMENT GENERAL DEGREE COLLEGE, KALNA-I**
**LESSON PLAN**
**for**
**B. Sc. 1st SEMESTER (Hons.) COURSES UNDER CBCS**

**Subject: Chemistry**
**Course code: CC-2**
**Course title: Physical Chemistry-I (Theo)**

**Module-I**
Kinetic Theory and Gaseous state

**CONTENTS**
Kinetic Theory of gases: Concept of pressure and temperature; Collision of gas molecules; Collision diameter; Collision number and mean free path; Frequency of binary collisions (similar and different molecules); Wall collision and rate of effusion.

**Module Objectives:**
1. This unit aims to offer basic knowledge on Kinetic Theory of gases and it gives the sound knowledge about the gases in molecular level.
2.From this chapter, students have the clear concept about the gases

| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
|---|---|---|
| Lecture-1. | Concept of pressure and temperature | |
| Lecture-2. | Collision of gas molecules | |
| Lecture-3. | Collision diameter; Collision number and mean free path | |
| Lecture-4. | Frequency of binary collisions (similar and different molecules) | |
| Lecture-5. | Wall collision and rate of effusion | |
| Lecture-6. | Nature of distribution of velocities, Maxwell's distribution of speeds in one, two and three dimensions | |
| Lecture-7. | Kinetic energy distribution in one, two and three dimensions, calculations of average | |
| Lecture-8. | root mean square and most probable values in each case; Calculation of number of molecules having energy ≥ ε | |
| Lecture- 9. | Principle of equipartition of energy and its application to calculate the classical limit of molar heat capacity of gases. | |

| | | |
|---|---|---|
| Lecture-10. | Deviation of gases from ideal behavior | |
| Lecture- 11. | compressibility factor; Boyle temperature; Andrew's and Amagat's plots | |
| Lecture- 12 | van der Waals equation and its features; its derivation and application in explaining real gas behaviour, other equations of state (Berthelot, Dietrici); | |
| Lecture- 13 | Existence of critical state, Critical constants in terms of van der Waals constants; Law of corresponding states | |
| Lecture- 14 | virial equation of state; van der Waals equation expressed in virial form and significance of second virial coefficient | |
| Lecture- 15 | Intermolecular forces (Debye, Keesom and London interactions; Lennard-Jones potential - elementary idea) | |
| Lecture-16 | | Discussion on simple problems. |
| Lecture-17 | | Solutions of previous year questions |
| Lecture-18 | | Tutorial assignment |
| Lecture-19 | | Tutorial assignment |

**Module-II**

Chemical Thermodynamics-I

**CONTENTS**

Zeroth and 1st law of Thermodynamics: Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics; Concept of heat, work, internal energy 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; Joule's experiment and its consequence..

**Module Objectives:**

1. From this portion students can acquire thorough background knowledge about preliminary thermodynamics.

| | | |
|---|---|---|
| 2. It helps the students to develop the basic idea about it to motivate themselves on the further studies. | | |
| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
| Lecture-20 | Zeroth and 1st law of Thermodynamics:Intensive and extensive variables; state and path functions; isolated,closed and open systems;zeroth law of thermodynamics | |
| Lecture-21. | Concept of heat, work, internal energy and statement of first law | |
| Lecture-22. | 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 | |
| Lecture-23. | Joule's experiment and its consequence. | |
| Lecture-24. | | Discussion on simple problems. |
| Lecture-25. | | Discussion on simple problems |
| Lecture-26. | | Discussion on simple problems |
| Lecture-27. | | Solutions of previous year questions |
| Lecture-28. | | Tutorial assignment |
| Lecture-29. | | Tutorial assignment |
| Lecture-30. | | Tutorial assignment |

| |
|---|
| **Module-III**<br>Chemical Thermodynamics-II |
| **CONTENTS** |
| Thermochemistry: Standard states; Heats of reaction; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; Laws of |

| | | |
|---|---|---|
| thermochemistry; bond energy, bond dissociation energy and resonance energy from thermochemical data, Kirchhoff's equations and effect of pressure on enthalpy of reactions; Adiabatic flame temperature; explosion temperature. | | |
| **Module Objectives:**<br>Idea of Thermochemistry helps the students to understand the variation of thermal energy with the occurrence of any reaction . | | |
| Lecture Serial | Topics of Discussion | Remarks |
| Lecture-31. | Standard states; Heats of reaction; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications | |
| Lecture-32. | Laws of thermochemistry; bond energy, bond dissociation energy and resonance energy from thermochemical data | |
| Lecture-33. | Kirchhoff's equations and effect of pressure on enthalpy of reactions | |
| Lecture-34. | Adiabatic flame temperature; explosion temperature. | |
| Lecture-35. | | Discussion on simple problems. |
| Lecture-36. | | Discussion on simple problems |
| Lecture-37. | | Discussion on simple problems |
| Lecture-38. | | Solutions of previous year questions |
| Lecture-39. | | Tutorial assignment |
| Lecture-40. | | Tutorial assignment |

| |
|---|
| **Module-IV**<br>Chemical Thermodynamics-III |
| **CONTENTS** |
| Need for a Second law; statement of the second law of thermodynamics; Concept of heat reservoirs and heat engines; Carnot cycle; Physical concept of |

| | | |
|---|---|---|
| Entropy; Carnot engine and refrigerator; Kelvin – Planck and Clausius statements and equivalence of the two statements with entropic formulation; Carnot's theorem; Values of §dQ/T and Clausius inequality; Entropy change of systems and surroundings for various processes and transformations; Entropy and unavailable work; Auxiliary state functions (G and A) and their variation with T, P and V. Criteria for spontaneity and equilibrium | | |
| **Module Objectives:**<br>Learning of this chapter, students are able to determine whether the reaction is taken place or not. | | |
| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
| Lecture-42. | Need for a Second law; statement of the second law of thermodynamics; Concept of heat reservoirs and heat engines; Carnot cycle; Physical concept of Entropy; Carnot engine and refrigerator; Kelvin – Planck and Clausius statements and equivalence of the two statements with entropic formulation | |
| Lecture-43. | Carnot's theorem; Values of §dQ/T and Clausius inequality; Entropy change of systems and surroundings for various processes and transformations; Entropy and unavailable work; Auxiliary state functions (G and A) and their variation with T, P and V. Criteria for spontaneity and equilibrium | |
| Lecture-44. | Maxwell's relations; Gibbs- Helmholtz equation, Joule-Thomson experiment and its consequences | |
| Lecture-45. | inversion temperature; | |

| | | |
|---|---|---|
| | Joule-Thomson coefficient for a van der Waals gas; General heat capacity relations | |
| Lecture-46. | | Discussion on simple problems |
| Lecture-47. | | Solutions of previous year questions |
| Lecture-48 | | Tutorial assignment |
| Lecture-49. | | Tutorial assignment |

| **Module-V**<br>Chemical kinetics | | |
|---|---|---|
| **CONTENTS**<br>Rate law, order and molecularity: Introduction of rate law, Extent of reaction; rate constants,order; Forms of rates of First, second and nth order reactions; Pseudo first order reactions (example using acid catalyzed hydrolysis of methyl acetate); Determination of order of a reaction by half-life and differential method; Opposing reactions, consecutive reactions and parallel reactions (with explanation of kinetic and thermodynamic control of products; all steps first order). Role of Temperature and theories of reaction rate: Temperature dependence of rate constant; Arrhenius equation, energy of activation; Rate-determining step and steady-state approximation – explanation with suitable examples; Collision theory; Lindemann theory of unimolecular reaction; outline of Transition State theory (classical treatment) Homogeneous catalysis: Homogeneous catalysis with reference to acid-base catalysis; Primary kinetic salt effect; Enzyme catalysis; Michaelis-Menten equation, Lineweaver-Burk plot, turnovernumber.Autocatalysis; periodic reactions. | | |
| **Module Objectives:**<br>Learning of this chapter, students are able to determine how much amount of time is required to finish the reaction and the effect of temperature over the reaction path and effect catalyst etc. | | |
| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
| Lecture-50. | Rate law, order and molecularity: Introduction of rate law, Extent of reaction; rate constants,order; Forms of rates of First, second and nth order reactions | |
| Lecture-51. | Pseudo first order reactions (example using acid catalyzed hydrolysis | |

| | | |
|---|---|---|
| | of methyl acetate); Determination of order of a reaction by half-life and differential method; Opposing reactions | |
| Lecture-52. | consecutive reactions and parallel reactions (with explanation of kinetic and thermodynamic control of products; all steps first order). | |
| Lecture-53. | Role of Temperature and theories of reaction rate: Temperature dependence of rate constant; Arrhenius equation, energy of activation; Rate-determining step and steady-state approximation – explanation with suitable examples | |
| Lecture-54. | Collision theory; Lindemann theory of unimolecular reaction; outline of Transition State theory (classical treatment) | |
| Lecture-55. | Homogeneous catalysis: Homogeneous catalysis with reference to acid-base catalysis; Primary kinetic salt effect | |
| Lecture-56 | Enzyme catalysis; Michaelis-Menten equation, Lineweaver-Burk plot, turnover number. | |
| Lecture-57. | Autocatalysis; periodic reactions | |
| Lecture-58 | | Discussion on simple problems |

| | | |
|---|---|---|
| Lecture-59 | | Solutions of previous year questions |
| Lecture-60 | | Tutorial assignment |

**Course code: CC-2**

**Course title: Physica; Chemistry-I (Prac)**

| **Module-I**<br>Practicals related to Physical Chemistry | | |
|---|---|---|
| **CONTENTS**<br>Instrumnetal analysis of some physical properties | | |
| **Module Objectives:**<br>From this portion students can acquire thorough background knowledge about the instruments which have been used to study some physical properties and reaction path. | | |
| **Lecture Serial** | **Title of the Experiment** | **Remarks** |
| Lab 1 | Determination of pH of unknown solution (buffer), by color matching method | |
| Lab 2 | Determination of the reaction rate constant of | |

| | | |
|---|---|---|
| | hydrolysis of ethylacetate in the presence of an equal quantity of sodium hydroxide | |
| Lab 3 | Study of kinetics of acid-catalyzed hydrolysis of methyl acetate | |
| Lab 4 | Study of kinetics of decomposition of H2O2 by KI | |
| Lab 5 | Determination of solubility product of PbI2 by titremetric method. | |
| Lab 6 | | Repeat class I |
| Lab 7 | | Repeat class II |
| Lab 8 | | Repeat class III |
| Lab 9 | | Repeat class IV |
| Lab 10 | | Model Examination |
| Lab 11 | | Model Examination |
| Lab 12 | | Revision |
| Lab 13 | | Revision |
| Lab 14 | | Revision |
| Lab 15 | | Revision |
| Lab 16 | | Revision |
| Lab 17 | | Revision |
| Lab 18 | | Revision |
| Lab 19 | | Revision |
| Lab 20 | | Revision |

**DEPARTMENT OF CHEMISTRY**
**GOVERNMENT GENERAL DEGREE COLLEGE, KALNA-I**
**LESSON PLAN**
**for**
**B. Sc. 2nd SEMESTER (Hons.) COURSES UNDER CBCS**

**Subject: Chemistry**
**Course code: CC-3**
**Course title: Inorganic Chemistry-I (Theo)**

| **Module-I**<br>Extra nuclear Structure of atom | | |
|---|---|---|
| **CONTENTS**<br>Bohr's theory, its limitations and atomic spectrum of hydrogen atom; Sommerfeld's Theory. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and $\psi^2$. Quantum numbers and their significance. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of s, p, d and f orbitals. Pauli's Exclusion Principle, Hund's rules and multiplicity, Exchange energy, Aufbau principle and its limitations, Ground state Term symbols of atoms and ions for atomic number upto 30. | | |
| **Module Objectives:**<br>1. This unit aims to offer basic knowledge on structure of atom and fundamentals of atomic structure which provides the clear picture of the outermost electronic distribution of atom as well as the constituents of the nucleus.<br>2. From this portion students can get a clear idea about the structure of both Hydrogen like and polyelectronic atoms and ions with the use of various common existing principles guiding electronic configurations. | | |
| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
| Lecture-1. | Bohr's theory, its limitations and atomic spectrum of hydrogen atom | |
| Lecture-2. | Sommerfeld's Theory | |
| Lecture-3. | Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance | |
| Lecture-4. | Schrödinger's wave equation, significance of ψ and $\psi^2$ | |
| Lecture-5. | Quantum numbers and their significance | |
| Lecture-6. | Radial and angular wave functions for hydrogen atom | |
| Lecture-7. | Radial and angular wave | |

| | | |
|---|---|---|
| | functions for hydrogen atom | |
| Lecture-8. | Shapes of s, p, d and f orbitals | |
| Lecture- 9. | Pauli's Exclusion Principle, Hund's rules and multiplicity, Exchange energy, Aufbau principle and its limitations | |
| Lecture-10. | Pauli's Exclusion Principle, Hund's rules and multiplicity, Exchange energy, Aufbau principle and its limitations | |
| Lecture- 11. | Ground state Term symbols of atoms and ions for atomic number upto 30 | |
| Lecture-12. | | Discussion on simple problems. |
| Lecture-13. | | Solutions of previous year questions |
| Lecture-14. | | Tutorial assignment – 1 |
| Lecture-15. | | Tutorial assignment – 2 |

**Module-II**

Chemical periodicity

**CONTENTS**

Modern IUPAC Periodic table, Effective nuclear charge, screening effects and penetration, Slater's rules, atomic radii, ionic radii (Pauling's univalent), covalent radii, lanthanide contraction. Ionization potential, electron affinity and electronegativity (Pauling's, Mulliken's and Allred-Rochow's scales) and factors influencing these properties, group electronegativities. Group trends and periodic trends in these properties in respect of s-, p- and d-block elements. Secondary periodicity, Relativistic Effect, Inert pair effect.

**Module Objectives:**

1. From this portion students can acquire thorough background knowledge about the periodic trends of elements and their Compounds.
2. Periodic table and periodic properties, which helps the students to study the subject systematically. The chemistry of elements which make up the entire material world will be understood from the perspective of the periodic table.

| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
|---|---|---|
| Lecture-16. | Modern IUPAC Periodic table | |

| | | |
|---|---|---|
| Lecture-17. | Effective nuclear charge, screening effects and penetration | |
| Lecture-18. | Slater's rules | |
| Lecture-19. | Atomic radii, ionic radii (Pauling's univalent), covalent radii, lanthanide contraction | |
| Lecture-20. | Atomic radii, ionic radii (Pauling's univalent), covalent radii, lanthanide contraction | |
| Lecture-21. | Ionization potential and electron affinity | |
| Lecture-22. | Electronegativity (Pauling's, Mulliken's and Allred-Rochow's scales) and factors influencing these properties, group electronegativities | |
| Lecture-23. | Electronegativity (Pauling's, Mulliken's and Allred-Rochow's scales) and factors influencing these properties, group electronegativities | |
| Lecture-24. | Group trends and periodic trends in these properties in respect of s-, p- and d-block elements | |
| Lecture-25. | Group trends and periodic trends in these properties in respect of s-, p- and d-block elements | |
| Lecture-26. | Secondary periodicity, Relativistic Effect, Inert pair effect | |
| Lecture-27. | | Discussion on simple problems. |
| Lecture-28. | | Solutions of previous year questions |

| | | |
|---|---|---|
| Lecture-29. | | Tutorial assignment – 3 |
| Lecture-30. | | Tutorial assignment – 4 |

| **Module-III**<br>Acid-Base reactions | | |
|---|---|---|
| **CONTENTS**<br>Acid-Base concept: Arrhenius concept, theory of solvent system (in $H_2O$, $NH_3$, $SO_2$ and HF), Bronsted-Lowry's concept, relative strength of acids, Pauling's rules. Lux-Flood concept, Lewis concept, group characteristics of Lewis acids, solvent levelling and differentiating effects. Thermodynamic acidity parameters, Drago-Wayland equation. Superacids, Gas phase acidity and proton affinity; HSAB principle. Acid-base equilibria in aqueous solution (Proton transfer equilibria in water), pH, buffer. Acid-base neutralisation curves; indicator, choice of indicators. | | |
| **Module Objectives:**<br>Idea of acids and bases along with ionic equilibria help students identify various compounds in terms of acid and base and also to compare their relative strength. Concept of pH helps them quantify the acidity of a reaction medium, which is extremely important to understand various chemical phenomena. | | |
| Lecture Serial | Topics of Discussion | Remarks |
| Lecture-31. | Acid-Base concept: Arrhenius concept theory of solvent system (in $H_2O$, $NH_3$, $SO_2$ and HF) | |
| Lecture-32. | Bronsted-Lowry's concept, relative strength of acids, Pauling's rules | |
| Lecture-33. | Bronsted-Lowry's concept, relative strength of acids, Pauling's rules | |
| Lecture-34. | Lux-Flood concept, Lewis concept, group characteristics of Lewis acids, solvent levelling and differentiating effects | |
| Lecture-35. | Thermodynamic acidity parameters, Drago-Wayland equation | |
| Lecture-36. | Superacids, Gas phase acidity and proton | |

| | | |
|---|---|---|
| | affinity; HSAB principle | |
| Lecture-37. | Superacids, Gas phase acidity and proton affinity; HSAB principle | |
| Lecture-38. | Acid-base equilibria in aqueous solution (Proton transfer equilibria in water), pH, buffer | |
| Lecture-39. | Acid-base equilibria in aqueous solution (Proton transfer equilibria in water), pH, buffer | |
| Lecture-40. | Acid-base neutralisation curves; indicator, choice of indicators | |
| Lecture-41. | Acid-base neutralisation curves; indicator, choice of indicators | |
| Lecture-42. | | Discussion on simple problems. |
| Lecture-43. | | Solutions of previous year questions |
| Lecture-44. | | Tutorial assignment – 5 |
| Lecture-45. | | Tutorial assignment – 6 |

| **Module-IV**<br>Redox Reactions and precipitation reactions |
|---|
| **CONTENTS**<br>Ion-electron method of balancing equation of redox reaction. Elementary idea on standard redox potentials with sign conventions, Nernst equation (without derivation). Influence of complex formation, precipitation and change of pH on redox potentials; formal potential. Feasibility of a redox titration, redox potential at the equivalence point, redox indicators. Redox potential diagram (Latimer and Frost diagrams) of common elements and their applications. Disproportionation and comproportionation reactions (typical examples); Solubility product principle, common ion effect and their applications to the precipitation and separation of common metallic ions as hydroxides, sulfides, phosphates, carbonates, sulfates and halides. |
| **Module Objectives:**<br>Learning of Redox potential and Redox equilibria helps the learner to explain the reactions in terms of oxidation and reduction. The study of various EMF diagram and related thermodynamic considerations act as important tool to |

| explain various chemical phenomena. | | |
|---|---|---|
| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
| Lecture-46. | Ion-electron method of balancing equation of redox reaction | |
| Lecture-47. | Elementary idea on standard redox potentials with sign conventions, Nernst equation (without derivation) | |
| Lecture-48. | Influence of complex formation, precipitation and change of pH on redox potentials; formal potential | |
| Lecture-48. | Influence of complex formation, precipitation and change of pH on redox potentials; formal potential | |
| Lecture-49. | Feasibility of a redox titration, redox potential at the equivalence point, redox indicators | |
| Lecture-50. | Redox potential diagram (Latimer and Frost diagrams) of common elements and their applications. | |
| Lecture-51. | Disproportionation and comproportionation reactions | |
| Lecture-52. | Solubility product principle, common ion effect | |
| Lecture-53. | The applications of Solubility product principle, common ion effect to the precipitation and separation of common metallic ions as hydroxides, sulfides, phosphates, carbonates, sulfates and halides | |

| | | |
|---|---|---|
| Lecture-54. | The applications of Solubility product principle, common ion effect to the precipitation and separation of common metallic ions as hydroxides, sulfides, phosphates, carbonates, sulfates and halides | |
| Lecture-55. | | Discussion on simple problems. |
| Lecture-56. | | Solutions of previous year questions |
| Lecture-57. | | Tutorial assignment – 7 |
| Lecture-58. | | Tutorial assignment – 8 |

**Course code: CC-3**

**Course title: Inorganic Chemistry-I (Prac)**

| **Module-I**<br>Oxidation-Reduction Titrimetric | | |
|---|---|---|
| **CONTENTS**<br>Oxidation-Reduction Titrimetric Analysis | | |
| **Module Objectives:**<br>From this portion students can acquire thorough background knowledge about the qualitative analysis of chemical components using redox titration including iodometry and iodimetry. | | |
| **Lecture Serial** | **Title of the Experiment** | **Remarks** |
| Lab 1 | Introduction | |
| Lab 2 | Practice of preparation of standard solutions and link solutions of required normality | |
| Lab 3 | Estimation of Fe(II) using standardized $KMnO_4$ solution | |
| Lab 4 | Estimation of Fe(II) using standardized $KMnO_4$ solution | |
| Lab 5 | Estimation of oxalic acid and sodium oxalate in a given mixture | |
| Lab 6 | Estimation of oxalic acid and | |

| | | |
|---|---|---|
| | sodium oxalate in a given mixture | |
| Lab 7 | Estimation of Fe(II) and Fe(III) in a given mixture using $K_2Cr_2O_7$ solution. | |
| Lab 8 | Estimation of Fe(II) and Fe(III) in a given mixture using $K_2Cr_2O_7$ solution. | |
| Lab 9 | Estimation of Fe(II) and Fe(III) in a given mixture using $K_2Cr_2O_7$ solution. | |
| Lab 10 | Estimation of Fe(III) and Mn(II) in a mixture using standardized $KMnO_4$ solution | |
| Lab 11 | Estimation of Fe(III) and Mn(II) in a mixture using standardized $KMnO_4$ solution | |
| Lab 12 | Estimation of Fe(III) and Mn(II) in a mixture using standardized $KMnO_4$ solution | |
| Lab 13 | Estimation of Fe(III) and Cu(II) in a mixture using $K_2Cr_2O_7$. | |
| Lab 14 | Estimation of Fe(III) and Cu(II) in a mixture using $K_2Cr_2O_7$. | |
| Lab 15 | Estimation of Fe(III) and Cu(II) in a mixture using $K_2Cr_2O_7$. | |
| Lab 16 | Estimation of Fe(III) and Cr(III) in a mixture using $K_2Cr_2O_7$. | |
| Lab 17 | Estimation of Fe(III) and Cr(III) in a mixture using $K_2Cr_2O_7$. | |
| Lab 18 | Estimation of Fe(III) and Cr(III) in a mixture using $K_2Cr_2O_7$. | |
| Lab 19 | | Repeat class I |

| | | |
|---|---|---|
| Lab 20 | | Repeat class II |
| Lab 21 | | Repeat class III |
| Lab 22 | | Repeat class IV |
| Lab 23 | | Model Examination |
| Lab 24 | | Model Examination |
| Lab 25 | | Revision |
| Lab 27 | | Revision |
| Lab 28 | | Revision |

**DEPARTMENT OF CHEMISTRY**
**GOVERNMENT GENERAL DEGREE COLLEGE, KALNA-I**
**LESSON PLAN**
**for**
**B. Sc. 2nd SEMESTER (Hons.) COURSES UNDER CBCS**

**Subject: Chemistry**
**Course code: CC-4**
**Credits-4**
**Course title: Organic Chemistry-II (Theo)**

**Module-I**
Stereochemistry II

**CONTENTS**

1. Chirality arising out of stereoaxis: stereoisomerism of substituted cumulenes with even and odd number of double bonds; chiral axis in allenes, spiro compounds, alkylidene, cycloalkanes and biphenyls; related configurational descriptors (Ra/Sa and P/M); atropisomerism; racemisation of chiral biphenyls; buttressing effect.
**6 classes**
2. Concept of prostereoisomerism: prostereogenic centre; concept of (pro)n-chirality: topicity of ligands and faces (elementary idea); pro-R/pro-S, pro-E/pro-Z and Re/Si descriptors; pro-r and pro-s descriptors of ligands on propseudoasymmetric centre.
**4 classes**
3. Conformation: conformational nomenclature: eclipsed, staggered, gauche, syn and anti; dihedral angle, torsion angle; Klyne-Prelog terminology; P/M descriptors; energy barrier of rotation, concept of torsional and steric strains; relative stability of conformers on the basis of steric effect, dipole-dipole interaction and H-bonding; butane gauche interaction; conformational analysis of ethane, propane, n-butane.
**8 classes**
4. 2-methylbutane and 2,3-dimethylbutane; haloalkane, 1,2-dihaloalkanes and 1,2-diols (up to four carbons); 1,2-halohydrin; conformation of conjugated systems (s-cis and s-trans). **4 classes**

**Module Objectives:**

i) This unit aims to offer basic knowledge on stereochemistry and fundamentals of Chiral axis, atropisomers, pseudoasymmetry, conformational isomers etc.
ii) From this portion students can get a clear idea about stereogenicity of simple as well as complex molecules having axial chirality, potential energy barriers of different conformers, preferred conformation of functional molecules in their ground state.

| Lecture Serial | Topics of Discussion | Remarks |
|---|---|---|
| Lecture-1. | Chirality arising out of stereoaxis: stereoisomerism of substituted cumulenes with even and odd number of double bonds | |
| Lecture-2. | chiral axis in allenes, spiro compounds | |
| Lecture-3. | chiral axis in alkylidene, cycloalkanes and biphenyls | |

| | | |
|---|---|---|
| Lecture-4. | related configurational descriptors (Ra/Sa and P/M) | |
| Lecture-5. | atropisomerism | |
| Lecture-6. | racemisation of chiral biphenyls; buttressing effect | |
| Lecture-7. | Concept of prostereoisomerism: prostereogenic centre; | |
| Lecture-8. | concept of (pro)n-chirality: topicity of ligands of faces (elementary idea) | |
| Lecture-9. | pro-R/pro-S, pro-E/pro-Z and Re/Si descriptors; pro-r and pro-s descriptors of ligands on propseudoasymmetric centre | |
| Lecture-10. | | Discussion on problems and assignments |
| Lecture-11. | Conformation: Projection formulae due to C-C bond rotation | |
| Lecture-12. | conformational nomenclature: eclipsed, staggered, gauche, syn and anti; | |
| Lecture-13. | dihedral angle, torsion angle; Klyne-Prelog terminology; P/M descriptors | |
| Lecture-14. | energy barrier of rotation, concept of torsional and steric strains | |
| Lecture-15. | relative stability of conformers on the basis of steric effect, dipole-dipole interaction and H-bonding | |
| Lecture-16. | butane gauche interaction; conformational analysis of ethane, propane, n-butane | |
| Lecture-17. | 2-methylbutane and 2,3-dimethylbutane: stability and potential energy diagram | |
| Lecture-18. | conformational analysis: haloalkane, 1,2-dihaloalkanes | |
| Lecture-19. | conformational analysis of 1,2-diols (up to four carbons); 1,2-halohydrin | |
| Lecture-20. | conformation of conjugated systems (s-cis and s-trans) | |
| Lecture-21. | | Doubt clearance and Discussion on problems |
| Lecture-22. | | Solving of relevant questions |

**Module-II**

General Treatment of Reaction Mechanism II

**CONTENTS**

1. Reaction thermodynamics: free energy and equilibrium, enthalpy and entropy factor,calculation of enthalpy change via BDE, intermolecular & intramolecular reactions. **4 classes**

2. Concept of organic acids and bases: effect of structure, substituent and solvent on acidity and basicity; proton sponge; gas-phase acidity and basicity; comparison between nucleophlicity and basicity; HSAB principle; application of thermodynamic principles in acid-base equilibria. **4 classes**

3. Tautomerism: prototropy (keto-enol, amido-imidol, nitroso-oximino, diazo-amino and enamine-imine systems); and ring-chain tautomerism; composition of the equilibrium in different systems (simple carbonyl; 1,2- and 1,3-dicarbonyl systems, phenols and related systems), factors affecting keto-enol tautomerism; application of thermodynamic principles in tautomeric equilibria. **6 classes**

4. Reaction kinetics: rate constant and free energy of activation; concept of order and molecularity; free energy profiles for one-step, two-step and three-step reactions; catalyzed reactions: electrophilic and nucleophilic catalysis; kinetic control and thermodynamic control of reactions; isotope effect: primary and secondary kinetic isotopic effect (kH /kD); principle of microscopic reversibility. **4 classes**

**Module Objectives:**

1. From this portion students can acquire thorough background knowledge on reaction thermodynamics (How far?): free energy and equilibrium, enthalpy and entropy as well as Reaction kinetics (How fast?): rate constant and free energy of activation; concept of order and molecularity etc.
2. Concept of organic acids and bases and tautomerism will help the students to build up knowledge about different molecules and their chemical nature.

| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
|---|---|---|
| Lecture-23. | Reaction thermodynamics: free energy and equilibrium, enthalpy and entropy factor | |
| Lecture-24. | calculation of enthalpy change via BDE | |
| Lecture-25. | intermolecular reactions | |
| Lecture-26. | intramolecular reactions | |
| Lecture-27. | Concept of organic acids and bases | |
| Lecture-28. | effect of structure, substituent and solvent on acidity and basicity; proton sponge | |
| Lecture-29. | gas-phase acidity and basicity; comparison between nucleophlicity and basicity; HSAB principle | |

| | | |
|---|---|---|
| Lecture-30. | application of thermodynamic principles in acid-base equilibria | |
| Lecture-31. | Tautomerism: prototropy (keto-enol, amido-imidol, nitroso-oximino, diazo-amino and enamine-imine systems | |
| Lecture-32. | ring-chain tautomerism; composition of the equilibrium in different systems: simple carbonyl; 1,2- and 1,3-dicarbonyl systems | |
| Lecture-33. | phenols and related systems, factors affecting keto-enol tautomerism | |
| Lecture-34. | application of thermodynamic principles in tautomeric equilibria | |
| Lecture-35. | | Doubt clearance and Discussion on problems |
| Lecture-36. | | Questions-Answer solve |
| Lecture-37. | Reaction kinetics: rate constant and free energy of activation; concept of order and molecularity; free energy profiles for one-step, two-step and three-step reactions | |
| Lecture-38. | catalyzed reactions: electrophilic and nucleophilic catalysis | |
| Lecture-39. | kinetic control and thermodynamic control of reactions | |
| Lecture-40. | isotope effect: primary and secondary kinetic isotopic effect (kH /kD); principle of microscopic reversibility | |

**Module-III**

Substitution and Elimination Reactions

**CONTENTS**

1. Free-radical substitution reaction: halogentaion of alkanes, mechanism (with evidence) and stereochemical features; reactivity-selectivity principle in the light of Hammond's postulate. **4 classes**

2. Nucleophilic substitution reactions: substitution at $sp^3$ centre: mechanisms (with evidence), relative rates & stereochemical features: SN1, SN2, SN2', SN1' (allylic rearrangement) and SNi; effects of solvent, substrate structure, leaving group and nucleophiles (including ambident nucleophiles, cyanide & nitrite); substitutions involving NGP; role of crown ethers and phase transfer catalysts; [systems: alkyl halides, allyl halides, benzyl halides, alcohols, ethers, epoxides]. **10 classes**

3. Elimination reactions: E1, E2, E1cB and Ei (pyrolytic syn eliminations); formation of alkenes and alkynes; mechanisms (with evidence), reactivity, regioselectivity (Saytzeff/Hofmann) and stereoselectivity; comparison between substitution and elimination. **6 classes**

**Module Objectives:**

Idea about Substitution and Elimination Reactions may help regarding reaction of organic molecules, several aspects which affect the reaction mode, rate, products etc. This is extremely important to understand various chemical phenomena of organic molecules under different condition and reagents.

| Lecture Serial | Topics of Discussion | Remarks |
|---|---|---|
| Lecture-41. | Free-radical substitution reaction: halogentaion of alkanes | |
| Lecture-42. | mechanism (with evidence) and stereochemical features | |
| Lecture-43. | reactivity-selectivity principle in the light of Hammond's postulate | |
| Lecture-44. | Nucleophilic substitution reactions: substitution at sp3 centre: mechanisms (with evidence) | |
| Lecture-45. | relative rates & stereochemical features: SN1 reaction, SN1' (allylic rearrangement) | |
| Lecture-46. | SN2, SN2' (allylic rearrangement) | |
| Lecture-47. | SNi; effects of solvent, substrate structure, | |
| Lecture-48. | leaving group and nucleophiles (including ambident nucleophiles, cyanide & nitrite); | |

| | | |
|---|---|---|
| Lecture-49. | substitutions involving NGP | |
| Lecture-50. | role of crown ethers and phase transfer catalysts; | |
| Lecture-51. | substitution on systems like alkyl halides, allyl halides, benzyl halides | |
| Lecture-52. | substitution on systems like alcohols, ethers, epoxides | |
| Lecture-53. | | Discussion on simpleproblems. |
| Lecture-54. | Elimination reactions: E1, E2,; | |
| Lecture-55. | E1cB and Ei | |
| Lecture-56. | pyrolytic syn eliminations | |
| Lecture-57. | formation of alkenes and alkynes; mechanisms (with evidence) | |
| Lecture-58. | reactivity, regioselectivity (Saytzeff/Hofmann) and stereoselectivity | |
| Lecture-59. | comparison between substitution and elimination | |
| Lecture-60. | | Question-answer |

**Reference Books:**


1. Clayden, J., Greeves, N., Warren, S. Organic Chemistry, Second edition, Oxford University Press 2012.
2. Sykes, P. A guidebook to Mechanism in Organic Chemistry, Pearson Education, 2003.
3. Smith, J. G. Organic Chemistry, Tata McGraw-Hill Publishing Company Limited.
4. Carey, F. A. & Guiliano, R. M. Organic Chemistry, Eighth edition, McGraw Hill Education, 2012.
5. Loudon, G. M. Organic Chemistry, Fourth edition, Oxford University Press, 2008.
6. Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994.
7. Nasipuri, D. Stereochemistry of Organic Compounds, Wiley Eastern Limited.
8. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
9. Finar, I. L. Organic Chemistry (Volume 1) Pearson Education.
10. Graham Solomons, T.W., Fryhle, C. B. Organic Chemistry, John Wiley & Sons, Inc.
11. James, J., Peach, J. M. Stereochemistry at a Glance, Blackwell Publishing, 2003.
12. Robinson, M. J. T., Stereochemistry, Oxford Chemistry Primer, Oxford University Press, 2005.
13. Maskill, H., Mechanisms of Organic Reactions, Oxford Chemistry Primer, Oxford University Press.

**Course code: CC-4**
**2 Credits**
**Course title: Organic Chemistry-II (Prac)**

**Module-I**
Organic Preparations

**CONTENTS**

A. The following reactions are to be performed, noting the yield of the crude product:
1. Nitration of acetanilide
2. Condensation reactions: Synthesis of 7-hydroxy-4-methylcoumarin
3. Hydrolysis of amides/imides/esters
4. Acetylation of phenols/aromatic amines (using Zn-dust/Acetic Acid)
5. Benzoylation of phenols/aromatic amines
6. Side chain oxidation of toluene and p-nitrotoluene
7. Diazo coupling reactions of aromatic amines
8. Bromination of acetanilide using green approach (Bromate-Bromide method)
9. Green 'multi-component-coupling' reaction: Synthesis of dihydropyrimidone
10. Selective reduction of m-dinitrobenzene to m-nitroaniline

Students must also calculate percentage yield, based upon isolated yield (crude) and theoretical yield.

B. Purification of the crude product is to be made by crystallisation from water/alcohol, crystallization after charcoal treatment, or sublimation, whichever is applicable.

C. Melting point of the purified product is to be noted. **30 classes**

**Module Objectives:**

From this portion students can acquire thorough background knowledge about qualitative as well as quantitative synthesis of organic molecules. There will be a hand on experience of Yield calculation, Purification, Crystallization and MP detection which may help students to evaluate and characterize the synthesized products with rigorous literature survey.

| Lecture Serial | Title of the Experiment | Remarks |
|---|---|---|
| Lab 1 | Laboratory Instructions and guidance on Lab notebook preparation | |
| Lab 2 | Theoretical discussion about the reaction | |
| Lab 3 | Basic knowledge on reagent handling and MP detection | |
| Lab 4 | Skill development on crystallization using known sample | |
| Lab 5 | Nitration of acetanilide | |
| Lab 6 | Detection of Yield, crystallization and MP detection of the above product | |
| Lab 7 | Synthesis of 7-hydroxy-4-methylcoumarin | |
| Lab 8 | Detection of Yield, crystallization and MP detection of the above product | |
| Lab 9 | Hydrolysis of amide | |
| Lab 10 | Detection of Yield, crystallization and MP detection of the above product | |
| Lab 11 | Hydrolysis of imide | |

| | | |
|---|---|---|
| Lab 12 | Detection of Yield, crystallization and MP detection of the above product | |
| Lab 13 | Hydrolysis of ester | |
| Lab 14 | Detection of Yield, crystallization and MP detection of the above product | |
| Lab 15 | Benzoylation of phenols | |
| Lab 16 | Detection of Yield, crystallization and MP detection of the above product | |
| Lab 17 | Benzoylation of aromatic amines | |
| Lab 18 | Detection of Yield, crystallization and MP detection of the above product | |
| Lab 19 | Side chain oxidation of toluene and p-nitrotoluene | |
| Lab 20 | Detection of Yield, crystallization and MP detection of the above product | |
| Lab 21 | Diazo coupling reactions of aromatic amines | |
| Lab 22 | Detection of Yield, crystallization and MP detection of the above product | |
| Lab 23 | 8. Bromination of acetanilide using green approach (Bromate-Bromide method) | |
| Lab 24 | Detection of Yield, crystallization and MP detection of the above product | |
| Lab 25 | Green 'multi-component-coupling' reaction: Synthesis of dihydropyrimidone | |
| Lab 26 | Detection of Yield, crystallization and MP detection of the above product | |
| Lab 27 | Selective reduction of m-dinitrobenzene to m-nitroaniline | |
| Lab 28 | Detection of Yield, crystallization and MP detection of the above product | |
| Lab 29 | | Practice 1 |
| Lab 30 | | Practice 2 |

**Reference Books:**


1. Vogel, A. I. Elementary Practical Organic Chemistry, Part 1: Small scale Preparations, CBS Publishers and Distributors.
2. University Hand Book of Undergraduate Chemistry Experiments, edited by Mukherjee, G. N. University of Calcutta, 2003.
3. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).
4. Furniss, B.S., Hannaford, A.J., Smith, P.W.G. & Tatchell, A.R. Practical Organic Chemistry, 5th Ed. Pearson (2012).
5. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).
6. Practical Workbook Chemistry (Honours), UGBS, Chemistry, University of Calcutta, 2015.
7. Vishnoi, N. K., Advanced Practical Organic Chemistry.

**DEPARTMENT OF CHEMISTRY**
**GOVERNMENT GENERAL DEGREE COLLEGE, KALNA-I**
**LESSON PLAN**
**for**
**B. Sc. 3rd SEMESTER (Hons.) COURSES UNDER CBCS**

**Subject: Chemistry**
**Course code: CC-5**
**Course title: Physical Chemistry-II (Theo)**

| | | |
|---|---|---|
| **Module-I**<br>Transport Processes | | |
| **CONTENTS**<br>Fick's law: Flux, force, phenomenological coefficients & their inter-relationship (general form), different examples of transport properties | | |
| **Module Objectives:**<br>1. This unit aims to offer basic knowledge on Transport Processes.<br>2.From this chapter, students have the clear concept about it. | | |
| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
| Lecture-1. | Flux, force, phenomenological coefficients & their inter relationship (general form) | |
| Lecture-2. | Different examples of transport properties | |
| Lecture-3. | | Discussion on simple problems. |
| Lecture-4. | | Discussion on simple problems |
| Lecture-5. | | Solutions of previous year questions |
| Lecture-6. | | Tutorial assignment |
| Lecture-7. | | Tutorial assignment |
| **Module-II**<br>Liquid State | | |
| **CONTENTS**<br>General features of fluid flow (streamline flow and turbulent flow); Newton's equation, viscosity coefficient; Poiseuille's equation; principle of determination of viscosity coefficient of liquids by falling sphere method; Temperature variation of viscosity of liquids and comparison with that of gases | | |
| **Module Objectives:**<br>1. From this portion students can acquire thorough background knowledge | | |

about preliminary things and properties of it.
2. It helps the students to develop the basic idea about it to motivate themselves on the further studies.

| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
|---|---|---|
| Lecture-8 | General features of fluid flow (streamline flow and turbulent flow); Newton's equation, viscosity coefficient | |
| Lecture-9. | Poiseuille's equation; principle of determination of viscosity coefficient of liquids by falling sphere method | |
| Lecture-10 | Temperature variation of viscosity of liquids and comparison with that of gases | |
| Lecture-11. | | Discussion on simple problems. |
| Lecture-12. | | Discussion on simple problems |
| Lecture-13. | | Solutions of previous year questions |
| Lecture-14. | | Tutorial assignment |
| Lecture-15. | | Tutorial assignment |
| Lecture-16. | | Tutorial assignment |
| Lecture-17. | | Tutorial assignment |
| Lecture-18. | | Tutorial assignment |

**Module-III**

Electrolytic Conductance

**CONTENTS**

Conductance and transport number: Ion conductance; Conductance and measurement of conductance, cell constant, specific conductance and molar conductance; Variation of specific and equivalent conductance with dilution for strong and weak electrolytes; Kohlrausch's law of independent migration of ions; Equivalent and molar conductance at infinite dilution and their determination for strong and weak electrolytes; Debye-Hückel theory of Ion atmosphere (qualitative)-asymmetric effect, relaxation effect and electrophoretic effect; Ostwald's dilution law; Ionic mobility; Application of conductance

| | | |
|---|---|---|
| measurement (determination of solubility product and ionic product of water); Conductometric titrations. Transport number, Principles of Hittorf's and Moving-boundary method; Wien effect, Debye-Falkenhagen effect, Walden's rule. | | |
| **Module Objectives:**<br>Idea of Electrolytic Conductance helps the students to understand the various types of phenomena of conductance related topics. | | |
| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
| Lecture-19. | Ion conductance; Conductance and measurement of conductance, cell constant, specific conductance and molar conductance | |
| Lecture-20. | Variation of specific and equivalent conductance with dilution for strong and weak electrolytes | |
| Lecture-21. | Kohlrausch's law of independent migration of ions | |
| Lecture-22. | Equivalent and molar conductance at infinite dilution and their determination for strong and weak electrolytes | |
| Lecture-23. | Debye-Hückel theory of Ion atmosphere (qualitative)-asymmetric effect, relaxation effect and electrophoretic effect | |
| Lecture-24. | Ostwald's dilution law; Ionic mobility | |
| Lecture-25. | Application of conductance measurement (determination of solubility product and ionic product of water) | |
| Lecture-26. | Conductometric titrations. | |
| Lecture-27. | Transport number | |

| | | |
|---|---|---|
| Lecture-28. | Principles of Hittorf's and Moving-boundary method; | |
| Lecture-29 | Wien effect, Debye-Falkenhagen effect, Walden's rule. | |
| Lecture-30 | | Discussion on simple problems. |
| Lecture-31 | | Discussion on simple problems |
| Lecture-32 | | Solutions of previous year questions |
| Lecture-33 | | Tutorial assignment |
| Lecture-34 | | Tutorial assignment |
| Lecture-35 | | Tutorial assignment |
| Lecture-36 | | Tutorial assignment |

**Module-IV**

Application of Thermodynamics

**CONTENTS**

Partial properties and Chemical potential: Chemical potential and activity, partial molar quantities, relation between Chemical potential and Gibb's free energy and other thermodynamic state functions; variation of Chemical potential (μ) with temperature and pressure; Gibbs-Duhem equation; fugacity and fugacity coefficient; Variation of thermodynamic functions for systems with variable composition; Equations of states for these systems, Change in G, S, H and V during mixing for binary solutions

**Module Objectives:**

Learning of this chapter, students will have the clear-cut idea about the partial molar thermodynamic parameters and its variation with change of little bit amount of any reactants or products.

| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
|---|---|---|
| Lecture-38. | Chemical potential and activity, partial molar quantities, relation between Chemical potential and Gibb's free energy and other thermodynamic state functions; variation of Chemical potential (μ) with temperature and pressure | |

| | | |
|---|---|---|
| Lecture-39. | Gibbs-Duhem equation; fugacity and fugacity coefficient | |
| Lecture-40. | Variation of thermodynamic functions for systems with variable composition | |
| Lecture-41. | Equations of states for these systems, Change in G, S, H and V during mixing for binary solutions | |
| Lecture-42. | | Discussion on simple problems |
| Lecture-43. | | Solutions of previous year questions |
| Lecture-44 | | Tutorial assignment |
| Lecture-45. | | Tutorial assignment |

**Module-V**

Chemical Equilibrium

**CONTENTS**

Thermodynamic conditions for equilibrium, degree of advancement; van't Hoff's reaction isotherm (deduction from chemical potential); Variation of free energy with degree of advancement; Equilibrium constant and standard Gibbs free energy change; Definitions of KP, KC and KX; van't Hoff's reaction isobar and isochore from different standard states; Shifting of equilibrium due to change in external parameters e.g. temperature and pressure; variation of equilibrium constant with addition to inert gas; Le Chatelier's principle and its derivation. Nernst's distribution law; Application- (finding out Keq using Nernst dist law for KI+I2 KI3 and dimerization of benzene. Chemical potential and other properties of ideal substances- pure and mixtures:

a) Pure ideal gas-its Chemical potential and other thermodynamic functions and their changes during a process; Thermodynamic parameters of mixing; Chemical potential of an ideal gas in an ideal gas mixture; Concept of standard states and choice of standard states of ideal gases.

b) Condensed Phase – Chemical potential of pure solid and pure liquids, Ideal solution –Definition, Raoult's law; Mixing properties of ideal solutions, chemical potential of a component in an ideal solution; Choice of standard states of solids and liquids

**Module Objectives:**

Learning of this chapter, students are able to determine how much extent of

| | | |
|---|---|---|
| the reaction is completed and in the growing mind students have the sound knowledge of ideal and non-ideal solutions and its physical characteristics. | | |
| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
| Lecture-46. | Thermodynamic conditions for equilibrium, degree of advancement; van't Hoff's reaction isotherm (deduction from chemical potential); Variation of free energy with degree of advancement; Equilibrium constant and standard Gibbs free energy change | |
| Lecture-47. | Definitions of KP, KC and KX; van't Hoff's reaction isobar and isochore from different standard states; Shifting of equilibrium due to change in external parameters e.g. temperature and pressure | |
| Lecture-48. | variation of equilibrium constant with addition to inert gas; Le Chatelier's principle and its derivation | |
| Lecture-49. | Nernst's distribution law; Application- (finding out Keq using Nernst dist law for KI+I2 KI3 and dimerization of benzene | |
| Lecture-50. | Pure ideal gas-its Chemical potential and other thermodynamic functions and their changes during a process; Thermodynamic parameters of mixing; Chemical potential of an ideal gas in an ideal gas | |

| | | |
|---|---|---|
| | mixture; Concept of standard states and choice of standard states of ideal gases | |
| Lecture-51. | Condensed Phase – Chemical potential of pure solid and pure liquids, Ideal solution – Definition, Raoult's law | |
| Lecture-52 | Mixing properties of ideal solutions | |
| Lecture-53. | chemical potential of a component in an ideal solution; Choice of standard states of solids and liquids. | |
| Lecture-55 | | Discussion on simple problems |
| Lecture-57 | | Solutions of previous year questions |
| Lecture-58 | | Tutorial assignment |

| **Module-VI** |
|---|
| Foundation of Quantum Mechanics |
| **CONTENTS** |
| Wave-particle duality, light as particles: photoelectric and Compton effects; electrons as waves and the de Broglie hypothesis; Uncertainty relations (without proof) Schrödinger time-independent equation; nature of the equation, acceptability conditions imposed on the wave functions and probability interpretations of wave function.Concept of Operators: Elementary concepts of operators, eigenfunctions and eigenvalues; Linear operators; Commutation of operators, commutator and uncertainty relation; Expectation value; Hermitian operator; Postulates of Quantum Mechanics. Particle in a box: Setting up of Schrödinger equation for one-dimensional box and its solution; Comparison with free particle eigenfunctions and eigenvalues. Properties of PB wave functions (normalisation, orthogonality, probability distribution); Expectation values of x, x2, px and px and their significance in relation to the uncertainty principle; Extension of the problem to two and three dimensions and the concept of degenerate energy levels. Simple Harmonic Oscillator: setting up of the Schrödinger stationary equation, energy expression (without derivation), expression of wave function for n = 0 and n = 1 (without derivation) and their characteristic features. |
| **Module Objectives:** |

| Learning of this chapter, students are able to know about the properties and their nature of microscopic particles and in addition they have the clear idea about the wave-particle duality etc. | | |
|---|---|---|
| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
| Lecture-59. | Wave-particle duality, light as particles: photoelectric and Compton effects; electrons as waves and the de Broglie hypothesis; Uncertainty relations (without proof) | |
| Lecture-60. | Schrödinger time-independent equation; nature of the equation, acceptability conditions imposed on the wave functions and probability interpretations of wave function. | |
| Lecture-61. | Elementary concepts of operators, eigenfunctions and eigenvalues; Linear operators; Commutation of operators, commutator and uncertainty relation; Expectation value; Hermitian operator; Postulates of Quantum Mechanics | |
| Lecture-62. | Particle in a box: Setting up of Schrödinger equation for one-dimensional box and its solution; Comparison with free particle eigenfunctions and eigenvalues | |
| Lecture-63. | Properties of PB wave functions (normalisation, orthogonality, probability | |

| | | |
|---|---|---|
| | distribution);<br>Expectation values of x, $x^2$, $p_x$ and $p_x^2$<br>and their significance in relation to the uncertainty principle | |
| Lecture-64. | Extension of the problem to two and three dimensions and the concept of degenerate energy levels | |
| Lecture-65 | setting up of the Schrödinger stationary equation, energy expression (without derivation), expression of wave function for n = 0 and n = 1 (without derivation) and their characteristic features. | |
| Lecture-66. | | Discussion on simple problems |
| Lecture-67 | | Solutions of previous year questions |
| Lecture-68 | | Tutorial assignment |
| Lecture-69 | | Tutorial assignment |

**Course code: CC-5**

**Course title: Physical Chemistry-II (Prac)**

| | | |
|---|---|---|
| **Module-I**<br>Practicals related to Physical Chemistry | | |
| **CONTENTS**<br>Instrumnetal analysis of some physical properties | | |
| **Module Objectives:**<br>From this portion students can acquire thorough background knowledge about the instruments which have been used to study some physical properties and reaction path. | | |
| **Lecture Serial** | **Title of the Experiment** | **Remarks** |
| Lab 1 | Study of viscosity of unknown liquid (glycerol, sugar) with respect to water. | |
| Lab 2 | Determination of partition coefficient for the distribution of I2 between water and CCl4. | |
| Lab 3 | Determination of Keq for KI + I2 ⇔ KI3, using partition coefficient between water and CCl4. | |
| Lab 4 | Conductometric titration of an acid (strong, weak/ monobasic, dibasic) against strong base. | |
| Lab 5 | Study of saponification reaction conductometrically | |
| Lab 6 | Verification of Ostwald's dilution law and determination of Ka of weak acid. | |
| Lab 7 | | Repeat class I |
| Lab 8 | | Repeat class II |

| | | |
|---|---|---|
| Lab 9 | | Repeat class III |
| Lab 10 | | Model Examination |
| Lab 11 | | Model Examination |
| Lab 12 | | Revision |
| Lab 13 | | Revision |
| Lab 14 | | Revision |
| Lab 15 | | Revision |
| Lab 16 | | Revision |
| Lab 17 | | Revision |
| Lab 18 | | Revision |
| Lab 19 | | Revision |
| Lab 20 | | Revision |

**DEPARTMENT OF CHEMISTRY**
**GOVERNMENT GENERAL DEGREE COLLEGE, KALNA-I**
**LESSON PLAN**
**for**
**B. Sc. 3rd SEMESTER (Hons.) COURSES UNDER CBCS**

**Subject: Chemistry**
**Course code: CC-6**
**Course title: Inorganic Chemistry-II (Theo)**

**Module-I**
Chemical Bonding-I

**CONTENTS**

1. Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its application and 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. Solubility energetics of dissolution process.
2. Covalent bond: Polarizing power and polarizability, ionic potential, Fazan's rules. Lewis structures, formal charge. Valence Bond Theory. The hydrogen molecule (Heitler-London approach), directional character of covalent bonds, hybridizations, equivalent and non-equivalent hybrid orbitals, Bent's rule, Dipole moments, VSEPR theory, shapes of molecules and ions containing lone pairs and bond pairs (examples from main groups chemistry) and multiple bonding (σ and π bond approach).

**Module Objectives:**

Chemical bonding in covalent compounds gives the most fundamental idea of why a compound is formed. Students will acquire the knowledge of ionic bond & covalent bond formation and its features.

| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
|---|---|---|
| Lecture-1. | General characteristics of Ionic bonds, types of ions, size effects etc | |
| Lecture-2. | Radius ratio rule and its application and limitations | |
| Lecture-3. | Packing of ions in crystals | |
| Lecture-4. | Born-Landé equation with derivation | |
| Lecture-5. | Importance of Kapustinskii expression for lattice energy | |
| Lecture-6. | Madelung constant | |
| Lecture-7. | Born-Haber cycle and its application | |
| Lecture-8. | Born-Haber cycle and its application | |

| | | |
|---|---|---|
| Lecture- 9. | Solvation energy. Solubility energetics of dissolution process | |
| Lecture-10. | General characteristics of covalent bonds | |
| Lecture- 11. | Polarizing power and polarizability, ionic potential, Fazan's rules | |
| Lecture-12. | Lewis structures, formal charge | |
| Lecture-13. | Valence Bond Theory | |
| Lecture-14. | The hydrogen molecule (Heitler-London approach) and directional character of covalent bonds | |
| Lecture-15. | Hybridizations, equivalent and non-equivalent hybrid orbitals | |
| Lecture-16. | Bent's rule and Dipole moments | |
| Lecture-17. | VSEPR theory, shapes of molecules and ions containing lone pairs and bond pairs and multiple bonding | |
| Lecture-18. | VSEPR theory, shapes of molecules and ions containing lone pairs and bond pairs and multiple bonding | |
| Lecture-19. | | Discussion on simple problems. |
| Lecture-20. | | Solutions of previous year questions |
| Lecture-21. | | Tutorial assignment – 1 |
| Lecture-22. | | Tutorial assignment – 2 |

| **Module-II** |
|---|
| Chemical Bonding-II |
| **CONTENTS** |
| 1. Molecular orbital concept of bonding (The approximations of the theory, Linear combination of atomic orbitals (LCAO)) (elementary pictorial approach): sigma and pi-bonds and delta interaction, multiple bonding. Orbital designations: gerade, ungerade, HOMO, LUMO. Orbital mixing. MO diagrams of |

$H_2$, $Li_2$, $Be_2$, $B_2$, $C_2$, $N_2$, $O_2$, $F_2$, and their ions wherever possible; Heteronuclear molecular orbitals: CO, NO, NO+, CN-, HF, $BeH_2$, $CO_2$ and $H_2O$. Bond properties: bond orders, bond lengths.

2. Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids – stoichiometric and non-stoichiometric.

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

**Module Objectives:**

The knowledge Molecular orbital theory enables the students to explain the inner picture of chemical bonding. Students also learn about qualitative idea of valence bond and band theories. Concise idea on semiconductors, insulators and defects in solids are also presented.

| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
|---|---|---|
| Lecture-23. | Molecular orbital concept of bonding | |
| Lecture-24. | Linear combination of atomic orbitals | |
| Lecture-25. | Sigma and pi-bonds and delta interaction, multiple bonding | |
| Lecture-26. | Orbital designations: gerade, ungerade, HOMO, LUMO | |
| Lecture-27. | Orbital mixing | |
| Lecture-28. | MO diagrams of Homonuclear molecules | |
| Lecture-29. | MO diagrams of Heteronuclear molecules | |
| Lecture-30. | MO diagrams of Heteronuclear molecules | |
| Lecture-31. | Bond properties: bond orders, bond lengths | |
| Lecture-32. | Qualitative idea of valence bond and band theories | |
| Lecture-33. | Semiconductors and insulators | |
| Lecture-34. | Defects in solids – stoichiometric | |
| Lecture-35. | Defects in solids – non- | |

| | | |
|---|---|---|
| | stoichiometric | |
| Lecture-36. | Weak Chemical Forces | |
| Lecture-37. | Weak Chemical Forces | |
| Lecture-38. | Hydrogen bonding | |
| Lecture-39. | Receptor-guest interactions, Halogen bonds | |
| Lecture-40. | Effects of chemical force, melting and boiling points | |
| Lecture-41. | | Discussion on simple problems. |
| Lecture-42. | | |
| Lecture-43. | | Solutions of previous year questions |
| Lecture-44. | | |
| Lecture-45. | | Tutorial assignment – 3 |
| Lecture-46 | | Tutorial assignment – 4 |

| **Module-III**<br>Radioactivity | | |
|---|---|---|
| **CONTENTS**<br>1. Nuclear stability and nuclear binding energy. Nuclear forces: meson exchange theory. Nuclear models (elementary idea): Concept of nuclear quantum number, magic numbers.<br>2. Nuclear Reactions: Artificial radioactivity, transmutation of elements, fission, fusion and spallation. Nuclear energy and power generation. Separation and uses of isotopes.<br>3. Radio chemical methods: principles of determination of age of rocks and minerals, radio carbon dating, hazards of radiation and safety measures. | | |
| **Module Objectives:**<br>This unit includes the concept of radioactivity along with nuclear quantum number and magic number. Different types of Nuclear Reactions and use of Radio chemical methods have been presented. | | |
| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
| Lecture-47 | Introduction on nuclear stability and nuclear binding energy | |
| Lecture-48 | Nuclear forces: meson exchange theory | |
| Lecture-49 | Nuclear models | |
| Lecture-50 | Concept of nuclear | |

| | | |
|---|---|---|
| | quantum number, magic numbers | |
| Lecture-51 | Artificial radioactivity | |
| Lecture-52 | Transmutation of elements | |
| Lecture-53 | Fission, fusion and spallation | |
| Lecture-54 | Nuclear energy and power generation | |
| Lecture-55 | Separation and uses of isotopes | |
| Lecture-56 | Principles of determination of age of rocks and minerals | |
| Lecture-57 | Radio carbon dating | |
| Lecture-58 | Hazards of radiation and safety measures | |
| Lecture-59 | Hazards of radiation and safety measures | |
| Lecture-60 | | Discussion on simple problems. |
| Lecture-61 | | Solutions of previous year questions |
| Lecture-62 | | Tutorial assignment – 5 |
| Lecture-63 | | Tutorial assignment – 6 |

**Course code: CC-6**

**Course title: Inorganic Chemistry-II (Prac)**

| **Module-I**<br>Iodo/Iodimetric Titrations |
|---|
| **CONTENTS**<br>1. Estimation of Cu(II).<br>2. Estimation of Vitamin C.<br>3. Estimation of arsenite by iodimetric method.<br>3. Estimation of Cu in brass.<br>4. Estimation of Cr and Mn in Steel. |
| **Module Objectives:**<br>Performing practical classes, students will acquire skill of volumetric estimation of chemical components using redox titration which include iodometry and iodimetry. |

| Lecture Serial | Title of the Experiment | Remarks |
|---|---|---|
| Lab 1 | Introduction | |
| Lab 2 | Practice of preparation of standard solutions and link solutions of required normality | |
| Lab 3 | Estimation of Cu(II). | |
| Lab 4 | Estimation of Vitamin C. | |
| Lab 5 | Estimation of Vitamin C. | |
| Lab 6 | Estimation of arsenite by iodimetric method. | |
| Lab 7 | Estimation of arsenite by iodimetric method. | |
| Lab 8 | Estimation of Cu in brass | |
| Lab 9 | Estimation of Cr and Mn in Steel | |
| Lab 10 | Estimation of Cr and Mn in Steel | |
| Lab 11 | | Repeat class I |
| Lab 12 | | Repeat class II |
| Lab 13 | | Repeat class III |
| Lab 14 | | Repeat class IV |
| Lab 15 | | Model Examination |
| Lab 16 | | Model Examination |
| Lab 17 | | Revision |
| Lab 18 | | Revision |
| Lab 19 | | Revision |

**DEPARTMENT OF CHEMISTRY**
**GOVERNMENT GENERAL DEGREE COLLEGE, KALNA-I**
**LESSON PLAN**
**for**
**B. Sc. 3rd SEMESTER (Hons.) COURSES UNDER CBCS**
**Subject: Chemistry**
**Course code: CC-7**
**Credits-4**
**Course title: Organic Chemistry-III (Theo)**

**Module-I**
Chemistry of alkenes and alkynes

**CONTENTS**

1. Addition to C=C: mechanism (with evidence wherever applicable), reactivity, regioselectivity (Markownikoff and anti-Markownikoff additions) and stereoselectivity; reactions: hydrogenation, halogenations, iodolactonisation, hydrohalogenation, hydration, oxymercurationdemercuration, hydroboration-oxidation, epoxidation, syn and anti-hydroxylation, ozonolysis, addition of singlet and triplet carbenes; electrophilic addition to diene (conjugated dienes and allene); radical addition: HBr addition; mechanism of allylic and benzylic bromination in competition with brominations across C=C; use of NBS; Birch reduction of benzenoid aromatics; interconversion of E- and Z-alkenes. **10 classes**
2. Addition to C≡C (in comparison to C=C): mechanism, reactivity, regioselectivity (Markownikoff and anti-Markownikoff addition) and stereoselectivity; reactions: hydrogenation, halogenations, hydrohalogenation, hydration, oxymercuration-demercuration, hydroborationoxidation, dissolving metal reduction of alkynes (Birch); reactions of terminal alkynes by exploring its acidity. **6 classes**

**Module Objectives:**
This unit aims to offer basic knowledge on reaction chemistry of alkenes and alkynes. How reagent jugglery causes different fictionalization on simple π-bonds is the main focus of our discussion.

| Lecture Serial | Topics of Discussion | Remarks |
|---|---|---|
| Lecture-1. | Addition to C=C: mechanism (with evidence wherever applicable), reactivity, regioselectivity | |
| Lecture-2. | (Markownikoff and anti-Markownikoff additions) and stereoselectivity; | |
| Lecture-3. | reactions: hydrogenation, halogenations, | |
| Lecture-4. | iodolactonisation, hydrohalogenation, | |
| Lecture-5. | hydration, oxymercuration-demercuration, | |
| Lecture-6. | hydroboration-oxidation, | |

| | | |
|---|---|---|
| Lecture-7. | epoxidation, syn and anti-hydroxylation, ozonolysis, | |
| Lecture-8. | addition of singlet and triplet carbenes; | |
| Lecture-9. | electrophilic addition to diene (conjugated dienes and allene); | |
| Lecture-10. | radical addition: HBr addition; mechanism of allylic and benzylic bromination in competition with brominations across C=C; use of NBS | |
| Lecture-11. | Birch reduction of benzenoid aromatics; interconversion of E- and Z-alkenes. | |
| Lecture-12. | Addition to C≡C (in comparison to C=C): mechanism, reactivity, regioselectivity (Markownikoff and anti-Markownikoff addition) and stereoselectivity; | |
| Lecture-13. | reactions: hydrogenation, halogenations, hydrohalogenation, | |
| Lecture-14. | hydration, oxymercuration-demercuration, hydroborationoxidation, | |
| Lecture-15. | dissolving metal reduction of alkynes (Birch); reactions of terminal alkynes by exploring its acidity | |
| Lecture-16. | | Solving of relevant questions |

**Module-II**

Aromatic Substitution

**CONTENTS**

1. Electrophilic aromatic substitution: mechanisms and evidences in favour of it; orientation and reactivity; reactions: nitration, nitrosation, sulfonation, halogenation, Friedel-Crafts reaction; one-carbon electrophiles (reactions: chloromethylation, Gatterman-Koch, Gatterman, Houben-Hoesch, Vilsmeier-Haack, Reimer-Tiemann, Kolbe-Schmidt); Ipso substitituion. **6 classes**

2. Nucleophilic aromatic substitution: addition-elimination mechanism and evidences in favour of it; cine substitution (benzyne mechanism), structure of benzyne and unimolecular mechanism. **4 classes**

**Module Objectives:**

This chapter provides most important reactions in synthetic organic chemistry. Such reactions are used for the synthesis of important intermediates that can be used as precursors for the production of pharmaceutical, agrochemical and industrial products.

| Lecture Serial | Topics of Discussion | Remarks |
|---|---|---|
| Lecture-17. | Electrophilic aromatic substitution: mechanisms and evidences in favour of it | |
| Lecture-18. | orientation and reactivity | |
| Lecture-19. | reactions: nitration, nitrosation, sulfonation, halogenation | |
| Lecture-20. | Friedel-Crafts reaction; one-carbon electrophiles (reactions: chloromethylation) | |
| Lecture-21. | Gatterman-Koch, Gatterman, Houben-Hoesch, Vilsmeier-Haack | |
| Lecture-22. | Reimer-Tiemann, Kolbe-Schmidt); Ipso substitituion | |
| Lecture-23. | Nucleophilic aromatic substitution: addition-elimination mechanism and evidences in favour of it | |
| Lecture-24. | Examples of $S_NAr$ reaction | |
| Lecture-25. | cine substitution (benzyne mechanism), structure of benzyne and unimolecular mechanism | |
| Lecture-26. | continuation | |

**Module-III**

Carbonyl and Related Compounds

**CONTENTS**

1. Addition to C=O: structure, reactivity and preparation of carbonyl compounds; mechanism (with evidence), reactivity, equilibrium and kinetic control; Burgi-Dunitz trajectory in nucleophilic additions; formation of hydrates, cyano hydrins and bisulphite adduct; nucleophilic addition-elimination reactions with alcohols, thiols and nitrogen- based nucleophiles; reactions: benzoin condensation, Cannizzaro and Tischenko reactions, reactions with ylides: Wittig reaction; oxidations and reductions: Clemmensen, Wolff-Kishner, LiAlH4, NaBH4, MPV, Oppenauer, Bouveault-Blanc, acyloin condensation; oxidation of alcohols with PDC and PCC; periodic acid and lead tetraacetate oxidation of 1,2-diols. **10 classes**

2. Exploitation of acidity of α-H of C=O: formation of enols and enolates; kinetic and thermodynamic enolates; reactions (mechanism with evidence): halogenation of carbonyl compounds under acidic and basic conditions, Hell-Volhard-Zelinsky (H. V. Z.) reaction, nitrosation, SeO2 (Riley) oxidation; condensations (mechanism with evidence): Aldol, Tollens', Knoevenagel, Claisen-Schmidt, Claisen ester including Dieckmann, Stobbe; Mannich reaction, Perkin reaction, Favorskii rearrangement; alkylation of active methylene compounds; preparation and synthetic applications of diethyl malonate and ethyl acetoacetate; specific enol equivalents (lithium enolates, enamines) in connection with alkylation, acylation and aldol type reaction. **8 classes**

3. Aldol, Friedel-Crafts, Michael, Knoevenagel, Cannizzaro, Benzoin condensation and Dieckmann condensation by greener approach. **2 classes**

4. Nucleophilic addition to α,β-unsaturated carbonyl system: general principle and

mechanism (with evidence); direct and conjugate addition, addition of enolates (Michael reaction), Robinson annulation. **2 classes**

5. Substitution at $sp^2$ carbon (C=O system): mechanism (with evidence): $B_{AC}2$, $A_{AC}2$, $A_{AC}1$, $A_{AL}1$ (in connection to acid and ester); acid derivatives: amides, anhydrides & acyl halides (formation and hydrolysis including comparison). **6 classes**

**Module Objectives:**

1. Students will learn about Writing of mechanism for nucleophilic addition and nucleophilic addition-elimination reactions of aldehydes and ketones, and be able to predict the products of such reactions.
2. They will be able to explain the relative reactivity of carbonyl compounds toward nucleophilic addition.
3. Be able to describe the concept of employing protecting groups.
4. Predict the products of the reactions of carbonyl compounds with Grignard reagents, hydride ion donors, sulfur nucleophiles, and with phosphonium ylides (the Wittig reaction).
5. Be able to recognize Re and Si faces of carbonyl compounds, and the stereochemistry outcomes from a nucleophilic addition.
6. Predict the products of addition reactions to α,β-unsaturated carbonyl compounds.

| Lecture Serial | Topics of Discussion | Remarks |
|---|---|---|
| Lecture-27. | Addition to C=O: structure, reactivity and preparation of carbonyl compounds | |
| Lecture-28. | mechanism (with evidence), reactivity | |
| Lecture-29. | equilibrium and kinetic control; Burgi-Dunitz trajectory in nucleophilic additions | |
| Lecture-30. | formation of hydrates, cyano hydrins and bisulphite adduct | |
| Lecture-31. | nucleophilic addition-elimination reactions with alcohols, thiols and nitrogen- based nucleophiles; | |
| Lecture-32. | reactions: benzoin condensation, Cannizzaro and Tischenko reactions | |
| Lecture-33. | reactions with ylides: Wittig reaction; reductions: Clemmensen, Wolff-Kishner, | |
| Lecture-34. | LiAlH4, NaBH4, MPV, Bouveault-Blanc, acyloin condensation | |
| Lecture-35. | Oppenauer oxidation, oxidation of alcohols with PDC and PCC | |
| Lecture-36. | periodic acid and lead tetraacetate oxidation of 1,2-diols | |
| Lecture-37. | Exploitation of acidity of α-H of C=O: formation of enols and enolates; kinetic and thermodynamic enolates; reactions (mechanism with evidence): halogenation of carbonyl compounds under acidic and basic conditions | |

| | | |
|---|---|---|
| Lecture-38. | Hell-Volhard-Zelinsky (H. V. Z.) reaction, nitrosation, SeO2 (Riley) oxidation | |
| Lecture-39. | condensations (mechanism with evidence): Aldol, Tollens', Knoevenagel | |
| Lecture-40. | Claisen-Schmidt, Claisen ester including Dieckmann, Stobbe | |
| Lecture-41. | Mannich reaction, Perkin reaction, Favorskii rearrangement | |
| Lecture-42. | alkylation of active methylene compounds; preparation and synthetic applications of diethyl malonate and ethyl acetoacetate | |
| Lecture-43. | specific enol equivalents (lithium enolates, enamines) in connection with alkylation, acylation and aldol type reaction. | |
| Lecture-44. | | Question-Answer |
| Lecture-45. | Aldol, Friedel-Crafts, Michael, Knoevenagel condensation by greener approach | |
| Lecture-46. | Cannizzaro, Benzoin condensation and Dieckmann condensation by greener approach | |
| Lecture-47. | Nucleophilic addition to α,β-unsaturated carbonyl system: general principle and mechanism (with evidence) | |
| Lecture-48. | direct and conjugate addition, addition of enolates (Michael reaction), Robinson annulation | |
| Lecture-49. | Substitution at $sp^2$ carbon (C=O system): mechanism (with evidence): Ester hydrolysis- $B_{AC}2$, $A_{AC}2$ | |
| Lecture-50. | $A_{AC}1$, $A_{AL}1$, $B_{AL}1$ (in connection to acid and ester) | |
| Lecture-51. | acid derivatives: amides, anhydrides & acyl halides (formation and hydrolysis including comparison) | |
| Lecture-52. | | Discussion on problems |
| Lecture-53. | | Question-answer |
| Lecture-54. | | Question-answer |

**Module-IV**

Organometallics

**CONTENTS**

Grignard reagent; Organolithiums; Gilman cuprates: preparation and reactions (mechanism with evidence); addition of Grignard and organolithium to carbonyl compounds; substitution on - COX; conjugate addition by Gilman cuprates; Corey-House synthesis; abnormal behaviour of Grignard reagents; comparison of reactivity among Grignard, organolithiums and organocopper reagents; Reformatsky reaction; concept of umpolung and base-nucleophile dichotomy in case of organometallic reagents. **6 classes**

**Module Objectives:**

Organometallic compounds are widely used both stoichiometrically in research and industrial chemical reactions, as well as in the role of catalysts to increase the rates of such reactions (e.g., as in uses of homogeneous catalysis), where target molecules include polymers, pharmaceuticals, and many other types of practical products.

| Lecture Serial | Topics of Discussion | Remarks |
|---|---|---|
| Lecture-55. | Grignard reagent, abnormal behaviour of Grignard reagents | |
| Lecture-56. | Organolithiums; Gilman cuprates: preparation and reactions (mechanism with evidence) | |
| Lecture-57. | addition of Grignard and organolithium to carbonyl compounds; substitution on - COX; conjugate addition by Gilman cuprates | |
| Lecture-58. | Corey-House synthesis; comparison of reactivity among Grignard, organolithiums and organocopper reagents | |
| Lecture-59. | Reformatsky reaction; concept of umpolung and base-nucleophile dichotomy in case of organometallic reagents | |
| Lecture-60. | | Discussion on Problems |

**Reference Books:**


1. Clayden, J., Greeves, N., Warren, S. Organic Chemistry, Second edition, Oxford University Press 2012.
2. Sykes, P. A guidebook to Mechanism in Organic Chemistry, Pearson Education, 2003.
3. Smith, J. G. Organic Chemistry, Tata McGraw-Hill Publishing Company Limited.
4. Carey, F. A., Guiliano, R. M. Organic Chemistry, Eighth edition, McGraw Hill Education, 2012.
5. Loudon, G. M. Organic Chemistry, Fourth edition, Oxford University Press, 2008.
6. Norman, R.O. C., Coxon, J. M. Principles of Organic Synthesis, Third Edition, Nelson Thornes, 2003.
7. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd.

(Pearson Education).
8. Finar, I. L. Organic Chemistry (Volume 1), Pearson Education.
9. Graham Solomons, T.W., Fryhle, C. B. Organic Chemistry, John Wiley & Sons, Inc.
10. March, J. Advanced Organic Chemistry, Fourth edition, Wiley.
11. Jenkins, P. R., Organometallic Reagents in Synthesis, Oxford Chemistry Primer, Oxford University Press.
12. Ward, R. S., Bifunctional Compounds, Oxford Chemistry Primer, Oxford University Press.

## Course code: CC-7

**2 Credits**

**Course title: Organic Chemistry-III (Prac)**

**Module-I**

Qualitative Analysis of Single Solid Organic Compounds

**CONTENTS**

1. Detection of special elements (N, S, Cl, Br) by Lassaigne's test
2. Solubility and classification (solvents: $H_2O$, 5% HCl, 5% NaOH and 5% $NaHCO_3$)
3. Detection of the following functional groups by systematic chemical tests:
   Aromatic amino ($-NH_2$), aromatic nitro ($-NO_2$), amido ($-CONH_2$, including imide), phenolic –OH, carboxylic acid (-COOH), carbonyl (-CHO and >C=O); only one test for each functional group is to be reported.
4. Melting point of the given compound.
5. Preparation of one derivative of the given sample. **30 classes**

***NB:*** *Each student, during laboratory session, is required to carry out qualitative chemical tests for all the special elements and the functional groups with relevant derivatisation in known and unknown (at least six) organic compounds.*

**Module Objectives:**

Students will experience hand on training regarding quantitative separation of organic compounds using several techniques. These classes may help students to develop their skills regarding laboratory experiments of various RNDs and research.

| Lecture Serial | Title of the Experiment | Remarks |
|---|---|---|
| Lab 1 | Laboratory Instructions and guidance on Lab notebook preparation | |
| Lab 2 | Theoretical discussion about the reactions involved in this course | |
| Lab 3 | Detection of special elements (N, S, Cl, Br) by Lassaigne's test with known sample | |
| Lab 4 | Solubility and classification (solvents: $H_2O$, 5% HCl, 5% NaOH and 5% $NaHCO_3$) with some known samples | |
| Lab 5 | Detection of Nitrogeneous functional groups ($ArNH_2$, $ArNO_2$, $ArCONH_2$, -CO-NH-CO-) for known organic compounds | |
| Lab 6 | Detection of non-Nitrogeneous functional groups (ArOH, -COOH, -CHO, -CO-) with known sample | |

| | | |
|---|---|---|
| Lab 7 | Preparation of Benzoyl derivative with known sample for $ArNH_2$, ArOH functional groups | |
| Lab 8 | Preparation of Nitro derivative with known sample for $ArNO_2$ functional group | |
| Lab 9 | Hydrolysis to acid for amido (-$CONH_2$, including imide) functional groups | |
| Lab 10 | Preparation of SBT derivative with known sample for carboxylic acid (-COOH) group | |
| Lab 11 | Preparation of Semicarbazone derivative with known sample carbonyl (-CHO and >C=O) functional groups | |
| Lab 12 | Crystallization of any two derivative | |
| Lab 13 | Detection of MP of the above crystallized derivatives and their corresponding samples | |
| Lab 14 | Systematic qualitative analysis of Single Solid Organic Compounds for the detection of special elements, functional groups, MP and derivative preparation (Known sample-1) | |
| Lab 15 | do | |
| Lab 16 | Systematic qualitative analysis of Single Solid Organic Compounds for the detection of special elements, functional groups, MP and derivative preparation (Unknown sample-1) | |
| Lab 17 | do | |
| Lab 18 | do | |
| Lab 19 | (Unknown sample-2) | |
| Lab 20 | do | |
| Lab 21 | do | |
| Lab 22 | (Unknown sample-3) | |
| Lab 23 | do | |
| Lab 24 | do | |
| Lab 25 | (Unknown sample-4) | |
| Lab 26 | do | |
| Lab 27 | do | |
| Lab 28 | (Unknown sample-5) | |
| Lab 29 | do | |
| Lab 30 | do | |

**Reference Books:**

1. Vogel, A. I. Elementary Practical Organic Chemistry, Part 2: Qualitative Organic Analysis, CBS Publishers and Distributors.
2. University Hand Book of Undergraduate Chemistry Experiments, edited by Mukherjee, G. N. University of Calcutta, 2003.
3. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).
4. Furniss, B.S., Hannaford, A.J., Smith, P.W.G., Tatchell, A.R. Practical Organic Chemistry, 5th Ed.,Pearson (2012).
5. Clarke, H. T., A Handbook of Organic Analysis (Qualitative and Quantitative), Fourth Edition, CBS Publishers and Distributors (2007).
6. Practical Workbook Chemistry (Honours), UGBS, Chemistry, University of Calcutta, 2015.
7. Ghoshal, A., Mahapatra, B., Nad, A. K. An Advanced Course in Practical Chemistry, New Central Book Agency (2007).

**DEPARTMENT OF CHEMISTRY**
**GOVERNMENT GENERAL DEGREE COLLEGE, KALNA-I**
**LESSON PLAN**
**for**
**B. Sc.3RD SEMESTER (Hons.) COURSES UNDER CBCS**

**Subject: Chemistry**
**Course code: SEC-1**
**Course title: Basic Analytical Chemistry**

| | | |
|---|---|---|
| **Module-I**<br>Analysis of soil | | |
| **CONTENTS**<br>Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators.. | | |
| **Module Objectives:**<br>1. This unit aims to offer basic knowledge on the determination of various types of parameters to test the soil for the cultivation, industrialization and etc. | | |
| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
| Lecture-1. | Composition of soil | |
| Lecture-2. | Concept of pH and pH measurement | |
| Lecture-3. | Complexometric titrations | |
| Lecture-4. | Chelation | |
| Lecture-5. | Chelating agents | |
| Lecture-6. | use of indicators | |
| Lecture-7. | | Repetition of previous class |
| Lecture-8. | | Repetition of previous class |
| Lecture- 9. | | Repetition of previous class |
| Lecture-10. | | Repetition of previous class |
| Lecture- 11. | | Repetition of previous class |
| Lecture- 12 | | Repetition of previous class |
| Lecture- 13 | | Repetition of previous class |
| Lecture- 14 | | Repetition of previous class |
| Lecture- 15 | | Repetition of previous class |
| Lecture-16 | | Discussion on |

| | | |
|---|---|---|
| | | simple problems. |
| Lecture-17 | | Solutions of previous year questions |
| Lecture-18 | | Tutorial assignment |
| Lecture-19 | | Tutorial assignment |

| **Module-II**<br>Analysis of water | | |
|---|---|---|
| **CONTENTS**<br>Definition of pure water, contaminants (different type), water sampling methods, water purification methods | | |
| **Module Objectives:**<br>1. This unit aims to offer basic knowledge on the determination of various types of parameters to test the quality of water for the cultivation, industrialization and etc. | | |
| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
| Lecture-20 | Definition of pure water | |
| Lecture-21 | contaminants (different type) | |
| Lecture-22 | water sampling methods | |
| Lecture-23 | Water purification methods | |
| Lecture-24 | | Repetition of previous class |
| Lecture-25 | | Repetition of previous class |
| Lecture-26 | | Repetition of previous class |
| Lecture-27 | | Repetition of previous class |
| Lecture- 28 | | Repetition of previous class |
| Lecture-29 | | Repetition of previous class |
| Lecture-30 | | Repetition of previous class |
| Lecture- 31 | | Repetition of previous class |
| Lecture- 32 | | Repetition of previous class |
| Lecture- 33 | | Repetition of previous class |

| | | |
|---|---|---|
| Lecture- 34 | | Repetition of previous class |
| Lecture-35 | | Discussion on simple problems. |
| Lecture-36 | | Solutions of previous year questions |
| Lecture-37 | | Tutorial assignment |
| Lecture-38 | | Tutorial assignment |

**Module-III**

Analysis of food products, Chromatography, Ion-exchange and Analysis of cosmetics

**CONTENTS**

1. Nutritional value of foods, idea about food processing and food preservations and adulteration.
2. Definition, general introduction on principles of chromatography, paper chromatography, TLC etc.
3. Column, ion-exchange chromatography etc., determination of ion exchange capacity of anion & cation exchange resin.
4. Major and minor constituents and their function: Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate

**Module Objectives:**

From this total unit,we have the sound knowledge about the food and different types of estimation methods.

| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
|---|---|---|
| Lecture-39 | Nutritional value of foods, idea about food processing | |
| Lecture-40 | Food preservations and adulteration | |
| Lecture-41 | Definition, general introduction on principles of chromatography | |
| Lecture-42 | Paper chromatography, TLC etc | |
| Lecture-43 | Column, ion-exchange chromatography etc., determination of ion exchange capacity of anion / cation exchange resin | |
| Lecture-44 | Analysis of deodorants and | |

| | | |
|---|---|---|
| | antiperspirants | |
| Lecture-45 | Analysis of Al,Zn, boric acid, chloride, sulphate. | |
| Lecture-46 | | Repetition of previous class |
| Lecture- 47 | | Repetition of previous class |
| Lecture-48 | | Repetition of previous class |
| Lecture-49 | | Repetition of previous class |
| Lecture- 50 | | Repetition of previous class |
| Lecture- 51 | | Repetition of previous class |
| Lecture- 52 | | Repetition of previous class |
| Lecture- 53 | | Repetition of previous class |
| Lecture-54 | | Discussion on simple problems. |
| Lecture-55 | | Solutions of previous year questions |
| Lecture-56 | | Tutorial assignment |
| Lecture-57 | | Tutorial assignment |

**DEPARTMENT OF CHEMISTRY**
**GOVERNMENT GENERAL DEGREE COLLEGE, KALNA-I**
**LESSON PLAN**
**for**
**B. Sc. 4TH SEMESTER (Hons.) COURSES UNDER CBCS**

**Subject: Chemistry**
**Course code: CC-8**
**Course title: Physical Chemistry-III (Theo)**

**Module-I**
Application of Thermodynamics – II

**CONTENTS**

A)**Colligative properties**: Vapour pressure of solution; Ideal solutions, ideally diluted solutions and colligative properties; Raoult's law; Thermodynamic derivation using chemical potential to derive relations between the four colligative properties, i.e., (i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) Osmotic pressure.Applications in calculating molar masses of solute; Abnormal colligative properties for dissociated and associated solutes in solution.

B) **Phase rule**: Definitions of phase, component and degrees of freedom; Phase rule and its derivations; Phase diagram for water, CO2, Sulphur. First order phase transition and Clapeyron equation; Clausius-Clapeyron equation – derivation and use; Liquid vapour equilibrium for two component systems. Three component systems, water-chloroform-acetic acid system, triangular plots. Binary solutions: Ideal solution at fixed temperature and pressure; Principle of fractional distillation; Duhem-Margules equation; Henry's law; Konowaloff's rule; Positive and negative deviations from ideal behavior; Azeotropic solution; Liquid-liquid phase diagram using phenolwater system; Solid-liquid phase diagram; Eutectic mixture

**Module Objectives:**

1. The first unit aims to offer basic knowledge on Vapour pressure and its deviation with variation of nature of solution as well as this gives the idea about the colligative properties and its abnormality depending upon associative and dissociative nature of the solutions.
2. The Second unit will draw the picture of phase, component and degree of freedom on the growing mind of the student. Through it, Pupils are able to know the basic principles of distillation, phase diagram, azeotropic mixture and Eutectic mixture etc.

| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
|---|---|---|
| Lecture-1. | Vapour pressure of solution; Ideal solutions, ideally diluted solutions and colligative properties; Raoult's law | |
| Lecture-2. | Thermodynamic derivation using | |

| | | |
|---|---|---|
| | chemical potential to derive relations between the four colligative properties, i.e., (i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) Osmotic pressure | |
| Lecture-3. | Applications in calculating molar masses of solute; Abnormal colligative properties for dissociated and associated solutes in solution | |
| Lecture-4. | Definitions of phase, component and degrees of freedom; Phase rule and its derivations; Phase diagram for water, CO2, Sulphur | |
| Lecture-5. | First order phase transition and Clapeyron equation | |
| Lecture-6. | Clausius-Clapeyron equation – derivation and use; Liquid vapour equilibrium for two component systems | |
| Lecture-7. | Three component systems, water-chloroform-acetic acid system, triangular plots | |
| Lecture-8. | Ideal solution at fixed temperature and pressure; Principle of fractional distillation; Duhem-Margules equation | |
| Lecture- 9. | Henry's law; Konowaloff's rule; Positive and negative deviations from ideal behavior | |
| Lecture-10. | Azeotropic solution; Liquid-liquid phase diagram using phenolwater system; Solid-liquid phase diagram; Eutectic mixture. | |
| Lecture- 11. | | Discussion on simple problems. |
| Lecture- 12 | | Discussion on simple problems |
| Lecture- 13 | | Discussion on simple problems |
| Lecture- 14 | | Solutions of previous year |

| | | |
|---|---|---|
| | | questions |
| Lecture- 15 | | Tutorial assignment |
| Lecture-16 | | Tutorial assignment |
| Lecture-17 | | Tutorial assignment |
| Lecture-18 | | Tutorial assignment |
| Lecture-19 | | Tutorial assignment |

**Module-II**

Electrical Properties of molecules

**CONTENTS**

**A**) **Ionic equilibria:** Chemical potential of an ion in solution; Activity and activity coefficients of ions in solution; Debye-Hückel limiting law-brief qualitative description of the postulates involved, qualitative idea of the model, the equation (without derivation) for ion-ion atmosphere interaction potential. Calculation of activity coefficient for electrolytes using Debye-Hückel limiting law; Derivation of mean ionic activity coefficient from the expression of ion-atmosphere interaction potential; Applications of the equation and its limitations.

**B) Electromotive Force:** Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry; 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. Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone and glass electrodes. 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).

**Module Objectives:**

1. This first portion can give the clear idea about the electrolytic conduction and its different types of utility such as conducto-metric titration, determination of ionic product of water of specified temperature, and etc.
2. This second portion provides the general knowledge about the Overall cell potential of reaction and the judging of the concerned reaction is taken place or not and in addition to it, having various types application in biological modern research studies.

| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
|---|---|---|
| Lecture-20 | Quantitative aspects of | |

| | | |
|---|---|---|
| | Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry | |
| Lecture-21. | Chemical cells, reversible and irreversible cells with examples; Electromotive force of a cell and its measurement | |
| Lecture-22. | Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells | |
| Lecture-23. | Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone and glass electrodes. | |
| Lecture-24. | Concentration cells with and without transference | |
| Lecture-25. | liquid junction potential; determination of activity coefficients and transference numbers | |
| Lecture-26. | Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation). | |
| Lecture-27. | | Discussion on simple problems. |
| Lecture-28. | | Discussion on simple problems |
| Lecture-29. | | Tutorial assignment |
| Lecture-30. | | Tutorial assignment |

**Module-III**

Quantum Chemistry

**CONTENTS**

1. Angular momentum: Commutation rules, quantization of square of total angular momentum and z-component; Rigid rotor model of diatomic molecule; Schrödinger equation, transformation to spherical polar coordinates; Separation of variables. Spherical harmonics; Discussion of solution

2.Qualitative treatment of hydrogen atom and hydrogen-like ions: Setting up of Schrödinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression); Average and most probable distances of electron from nucleus; Setting up of Schrödinger equation for many-electron atoms (He, Li)

3. LCAO and HF-SCF: Covalent bonding, valence bond and molecular orbital approaches,

LCAO-MO treatment of $H_2^+$; Bonding and antibonding orbitals; Qualitative extension to H2; Comparison of LCAO-MO and VB treatments of H2 and their limitations.

**Module Objectives:**

Idea of Quantum chemistry helps the students to understand quantum mechanical applications.

| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
|---|---|---|
| Lecture-31. | Commutation rules | |
| Lecture-32. | quantization of square of total angular momentum and z-component | |
| Lecture-33. | Rigid rotor model of diatomic molecule | |
| Lecture-34. | Schrödinger equation | |
| Lecture-35. | transformation to spherical polar coordinates | |
| Lecture-36. | Separation of variables | |
| Lecture-37. | Spherical harmonics | |
| Lecture-38. | Discussion of solution | |
| Lecture-39. | Setting up of Schrödinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression) | |
| Lecture-40. | Average and most | |

| | | |
|---|---|---|
| | probable distances of electron from nucleus | |
| Lecture-41 | Setting up of Schrödinger equation for many-electron atoms (He, Li) | |
| Lecture-42 | Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of $H_2^+$ | |
| Lecture-43 | Bonding and antibonding orbitals | |
| Lecture-44 | Qualitative extension to $H_2$ | |
| Lecture-45 | Comparison of LCAO-MO and VB treatments of $H_2$ and their limitations | |
| Lecture-46 | | Discussion on simple problems. |
| Lecture-47 | | Discussion on simple problems |
| Lecture-48 | | Discussion on previous year problems |
| Lecture-49 | | Discussion on previous year problems |
| Lecture-50 | | Tutorial assignment |
| Lecture-51 | | Tutorial assignment |
| Lecture-52 | | Tutorial assignment |
| Lecture-53 | | Tutorial assignment |

**Course code: CC-8**

**Course title: Physical Chemistry-III (Prac)**

| |
|---|
| **Module-I**<br>Practicals related to Physical Chemistry |
| **CONTENTS**<br>Instrumnetal analysis of some physical properties |
| **Module Objectives:**<br>From this portion students can acquire thorough background knowledge about the instruments which have been used to study some physical properties and reaction path. |

| **Lecture Serial** | **Title of the Experiment** | **Remarks** |
|---|---|---|
| Lab 1 | Determination of solubility of sparingly soluble salt in water, in electrolyte with common ions and in neutral electrolyte (using common indicator) | |
| Lab 2 | Potentiometric titration of Mohr's salt solution against standard $K_2Cr_2O_7$ solution. | |
| Lab 3 | Determination of $K_{sp}$ for AgCl by potentiometric titration of $AgNO_3$ solution against standard | |
| Lab 4 | Effect of ionic strength on the rate of Persulphate – Iodide reaction | |
| Lab 5 | Study of phenol-water phase diagram. | |
| Lab 6 | | Repeat class I |
| Lab 7 | | Repeat class II |
| Lab 8 | | Repeat class III |
| Lab 9 | | Repeat class IV |
| Lab 10 | | Model Examination |
| Lab 11 | | Model Examination |
| Lab 12 | | Revision |
| Lab 13 | | Revision |
| Lab 14 | | Revision |
| Lab 15 | | Revision |
| Lab 16 | | Revision |
| Lab 17 | | Revision |
| Lab 18 | | Revision |
| Lab 19 | | Revision |
| Lab 20 | | Revision |

**DEPARTMENT OF CHEMISTRY**
**GOVERNMENT GENERAL DEGREE COLLEGE, KALNA-I**
**LESSON PLAN**
**for**
**B. Sc. 4th SEMESTER (Hons.) COURSES UNDER CBCS**

**Subject: Chemistry**
**Course code: CC-9**
**Course title: Inorganic Chemistry-III (Theo)**

| **Module-I**<br>General Principles of Metallurgy | | |
|---|---|---|
| **CONTENTS**<br>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. | | |
| **Module Objectives:**<br>Students will acquire the knowledge of Chief modes of occurrence of metals based on standard electrode potentials and extraction procedure of metals from its ore. | | |
| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
| Lecture-1. | Chief modes of occurrence of metals based on standard electrode potentials | |
| Lecture-2. | Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent | |
| Lecture-3. | Electrolytic Reduction | |
| Lecture-4. | Hydrometallurgy | |
| Lecture-5. | Electrolytic Kroll process | |
| Lecture-6. | Parting process | |
| Lecture-7. | van Arkel-de Boer process | |
| Lecture-8. | Zone refining | |
| Lecture- 9. | | Discussion on simple problems. |
| Lecture-10. | | Solutions of previous year questions |
| Lecture- 11. | | Tutorial assignment – 1 |
| Lecture-12. | | Tutorial assignment – 2 |

**Module-II**

Chemistry of s and p Block Elements

**CONTENTS**

Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses. Beryllium hydrides and halides.

Boric acid and borates, boron nitrides, borohydrides (diborane) and graphitic compounds, silanes. Oxides and oxoacids of nitrogen, phosphorus, sulphur and chlorine. Peroxo acids of sulphur. Sulphur-nitrogen compounds, Basic properties of halides and polyhalides, interhalogen compounds, polyhalides, pseudohalides, fluorocarbons and chlorofluorocarbons.

**Module Objectives:**

A study of s-block, p-block elements make students familiar with the various reactions and formation of different compounds of them.

| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
|---|---|---|
| Lecture-13. | Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group | |
| Lecture-14. | Allotropy and catenation | |
| Lecture-15. | Discussions on Group 1 elements (Alkali metals) | |
| Lecture-16. | Discussions on Group 2 elements (Alkaline earth metals) | |
| Lecture-17. | Discussions on Group 13 elements | |
| Lecture-18. | Discussions on Group 14 elements | |
| Lecture-19. | Discussions on Group 15 elements | |
| Lecture-20. | Discussions on Group 15 elements | |
| Lecture-21. | Discussions on Group 16 elements | |
| Lecture-22. | Discussions on Group 16 elements | |

| | | |
|---|---|---|
| Lecture-23. | Discussions on Group 17 elements | |
| Lecture-24. | Discussions on Group 17 elements | |
| Lecture-25. | | Discussion on simple problems. |
| Lecture-26. | | Solutions of previous year questions |
| Lecture-27. | | Tutorial assignment – 3 |
| Lecture-28. | | Tutorial assignment – 4 |

| **Module-III**<br>Noble Gases | | |
|---|---|---|
| **CONTENTS**<br>Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation, structures (VSEPR theory) and properties of $XeF_2$, $XeF_4$ and $XeF_6$; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for $XeF_2$ and $XeF_4$). Xenon-oxygen compounds. | | |
| **Module Objectives:**<br>A study of Noble gases makes students familiar with the various reactions and formation of different compounds of them. | | |
| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
| Lecture-29. | Occurrence and uses, rationalization of inertness of noble gases, Clathrates | |
| Lecture-30. | Structures (VSEPR theory) and properties of $XeF_2$, $XeF_4$ and $XeF_6$ | |
| Lecture-31. | Valence bond treatment and MO treatment for $XeF_2$ and $XeF_4$ | |
| Lecture-32. | Xenon-oxygen compounds | |
| Lecture-33. | | Discussion on simple problems & Solutions of previous year questions. |
| Lecture-34. | | Tutorial assignment – 5 |
| Lecture-35. | | Tutorial assignment – 6 |

| **Module-IV**<br>Inorganic Polymers | | |
|---|---|---|
| **CONTENTS**<br>Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes. | | |
| **Module Objectives:**<br>Students will be familiar with different types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. borazines, silicates and phosphazenes. | | |
| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
| Lecture-36. | Types of inorganic polymers, comparison with organic polymers | |
| Lecture-37. | Synthesis & structural aspects | |
| Lecture-38. | Applications of silicones and siloxanes. | |
| Lecture-39. | Applications of borazines, silicates and phosphazenes | |
| Lecture-40. | | Discussion on simple problems. |
| Lecture-41. | | Solutions of previous year questions |
| Lecture-42. | | Tutorial assignment – 7 |
| Lecture-43. | | Tutorial assignment – 8 |

| **Module-V**<br>Coordination Chemistry-I | | |
|---|---|---|
| **CONTENTS**<br>Double and complex salts. Werner's theory of coordination complexes, Classification of ligands, chelates, coordination numbers, IUPAC nomenclature of coordination complexes (up to two metal centers), Isomerism in coordination compounds, constitutional and stereo isomerism, Geometrical and optical isomerism in square planar and octahedral complexes. | | |
| **Module Objectives:**<br>The introductory idea of coordination chemistry starting with the concept of Werner's Coordination theory help the students to step into the vast realm of complex compounds, their stereochemistry and stability constant etc. | | |
| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
| Lecture-44. | Double and complex salts | |
| Lecture-45. | Werner's theory of | |

| | | |
|---|---|---|
| | coordination complexes | |
| Lecture-46. | Werner's theory of coordination complexes | |
| Lecture-47. | Classification of ligands, chelates, coordination numbers | |
| Lecture-48. | IUPAC nomenclature of coordination complexes | |
| Lecture-49. | IUPAC nomenclature of coordination complexes | |
| Lecture-50. | Isomerism in coordination compounds, constitutional and stereo isomerism | |
| Lecture-51. | Isomerism in coordination compounds, constitutional and stereo isomerism | |
| Lecture-52. | Geometrical and optical isomerism in square planar and octahedral complexes | |
| Lecture-53. | Geometrical and optical isomerism in square planar and octahedral complexes | |
| Lecture-54. | | Discussion on simple problems. |
| Lecture-55. | | Solutions of previous year questions |
| Lecture-56. | | Tutorial assignment – 9 |
| Lecture-57. | | Tutorial assignment – 10 |

**Course code: CC-9**

**Course title: Inorganic Chemistry-III (Prac)**

| **Module-I**<br>Complexometric titration & Inorganic preparations |
|---|
| **CONTENTS** |
| Complexometric titration<br>1. Zn(II) |

2. Zn(II) in a Zn(II) and Cu(II) mixture
3. Ca(II) and Mg(II) in a mixture
4. Hardness of water

Inorganic preparations

1. $[Cu(CH_3CN)_4]PF_6/ClO_4$
2. Potassium dioxalatodiaquachromate(III)
3. Tetraamminecarbonatocobalt (III) ion
4. Potassium tris(oxalate)ferrate(III)
5. Tris-(ethylenediamine) nickel(II) chloride.
6. $[Mn(acac)_3]$ and $Fe(acac)_3$ (acac = acetylacetonate).

**Module Objectives:**

The learners will acquire the skill of complexometric estimation of $CaCO_3$ and $MgCO_3$ in a mixture, and determination of $Mg^{2+}$ / $Zn^{2+}$ in a binary mixture using complexometric titration. The concept of masking and demasking agents and other aspects of analytical chemistry will be acquired by the students.

This part of the course has also been framed so that the students can acquire the skill of synthesis of various inorganic compounds. This prepares a student to grow a mentality of a future researcher. They learn to prepare various inorganic complexes like $[Cu(CH_3CN)_4]PF_6/ClO_4$, Potassium dioxalatodiaquachromate(III), Tetraamminecarbonatocobalt (III) ion, Potassium tris(oxalate)ferrate(III), Tris-(ethylenediamine) nickel(II) chloride and $[Mn(acac)_3]$ and $Fe(acac)_3$ (acac= acetylacetonate).

| **Lecture Serial** | **Title of the Experiment** | **Remarks** |
|---|---|---|
| Lab 1 | Introduction | |
| Lab 2 | Practice of preparation of standard solutions and link solutions of required normality | |
| Lab 3 | Complexometric titration of Zn(II) | |
| Lab 4 | Complexometric titration of Zn(II) in a Zn(II) and Cu(II) mixture | |
| Lab 5 | Complexometric titration of Ca(II) and Mg(II) in a mixture | |
| Lab 6 | Estimation of Hardness of water | |
| Lab 7 | Estimation of Hardness of water | |
| Lab 8 | Introduction on inorganic preparations | |
| Lab 9 | Preparation of $[Cu(CH_3CN)_4]PF_6/ClO_4$ | |
| Lab 10 | Preparation of Potassium dioxalatodiaquachromate(III) | |

| | | |
|---|---|---|
| Lab 11 | Preparation of Tetraamminecarbonatocobalt (III) ion | |
| Lab 12 | Preparation of Potassium tris(oxalate)ferrate(III) | |
| Lab 13 | Preparation of Tris-(ethylenediamine) nickel(II) chloride | |
| Lab 14 | Preparation of $[Mn(acac)_3]$ | |
| Lab 15 | Preparation of $Fe(acac)_3]$ | |
| Lab 16 | Crystallization processes | |
| Lab 17 | | Repeat class I |
| Lab 18 | | Repeat class II |
| Lab 19 | | Repeat class III |
| Lab 20 | | Repeat class IV |
| Lab 21 | | Model Examination |
| Lab 22 | | Model Examination |
| Lab 23 | | Revision |
| Lab 24 | | Revision |
| Lab 25 | | Revision |

**DEPARTMENT OF CHEMISTRY**
**GOVERNMENT GENERAL DEGREE COLLEGE, KALNA-I**
**LESSON PLAN**
**for**
**B. Sc. 4th SEMESTER (Hons.) COURSES UNDER CBCS**
**Subject: Chemistry**
**Course code: CC-10**
**Credits-4**
**Course title: Organic Chemistry-IV (Theo)**

**Module-I**
Nitrogen compounds

**CONTENTS**

1. Amines: Aliphatic & Aromatic: preparation, separation (Hinsberg's method) and identification of primary, secondary and tertiary amines; reaction (with mechanism): Eschweiler–Clarke methylation, diazo coupling reaction, Mannich reaction; formation and reactions of phenylenediamines, diazomethane and diazoacetic ester. **8 classes**
2. Nitro compounds (aliphatic and aromatic): preparation and reaction (with mechanism): reduction under different conditions; Nef carbonyl synthesis, Henry reaction and conjugate addition of nitroalkane anion. **4 classes**
3. Alkylnitrile and isonitrile: preparation and reaction (with mechanism): Thorpe nitrile condensation, von Richter reaction. **4 classes**
4. Diazonium salts and their related compounds: reactions (with mechanism) involving replacement of diazo group; reactions: Gomberg, Meerwein, Japp-Klingermann. **2 classes**

**Module Objectives:**

i) This unit aims to offer basic knowledge on organo Nitrogen chemistry and related reactions therein.
ii) From this portion students can get a clear idea about reagent chemistry and also their application in academic and industrial field.

| Lecture Serial | Topics of Discussion | Remarks |
|---|---|---|
| Lecture-1. | Amines: Aliphatic & Aromatic: preparation | |
| Lecture-2. | separation (Hinsberg's method) and identification of primary, secondary and tertiary amines | |
| Lecture-3. | Various reaction (with mechanism): Eschweiler–Clarke methylation, diazo coupling reaction, Mannich reaction etc. | |
| Lecture-4. | formation and reactions of phenylenediamines | |
| Lecture-5. | diazomethane | |
| Lecture-6. | diazoacetic ester | |
| Lecture-7. | aliphatic nitro compounds: preparation and reaction with | |

| | | |
|---|---|---|
| | mechanism | |
| Lecture-8. | aromatic nitro compounds: preparation and reaction with mechanism | |
| Lecture-9. | reduction of nitro compounds under different conditions; Nef carbonyl synthesis, | |
| Lecture-10. | Henry reaction and conjugate addition of nitroalkane anion | |
| Lecture-11. | Alkylnitrile preparation and reaction (with mechanism) | |
| Lecture-12. | isonitrile: preparation and reaction (with mechanism) | |
| Lecture-13. | Thorpe nitrile condensation, von Richter reaction | |
| Lecture-14. | Diazonium salts and their related compounds: reactions (with mechanism) involving replacement of diazo group; | |
| Lecture-15. | Diazonium salts related compounds' reactions: Gomberg, Meerwein, Japp-Klingermann | |
| Lecture-16. | | Doubt clearance and Discussion on problems |
| Lecture-17. | | Solving of relevant questions |
| Lecture-18. | | Solving of relevant questions |

**Module-II**

Rearrangements

**CONTENTS**

Mechanism with evidence and stereochemical features for the following:

1. Rearrangement to electron-deficient carbon: Wagner-Meerwein rearrangement, pinacol rearrangement, dienone-phenol; Wolff rearrangement in Arndt-Eistert synthesis, benzil-benzilic acid rearrangement, Demjanov rearrangement, Tiffeneau–Demjanov rearrangement. **4 classes**

2. Rearrangement to electron-deficient nitrogen: rearrangements: Hofmann, Curtius, Lossen, Schmidt and Beckmann. **2 classes**

3. Rearrangement to electron-deficient oxygen: Baeyer-Villiger oxidation, cumene hydroperoxide-phenol rearrangement and Dakin reaction. **2 classes**

4. Aromatic rearrangements: Migration from oxygen to ring carbon: Fries rearrangement and Claisen rearrangement. **2 classes**

5. Migration from nitrogen to ring carbon: Hofmann-Martius rearrangement, Fischer-Hepp rearrangement, N-azo to C-azo rearrangement, Bamberger rearrangement, Orton rearrangement and benzidine rearrangement. **3 classes**

6. Rearrangement reactions by green approach: Fries rearrangement, Claisen rearrangement, Beckmann rearrangement, Baeyer-Villiger oxidation. **1 classes**

| **Module Objectives:** | | |
|---|---|---|
| Concept of organic molecular rearrangement and retaliated aspects like isotope labeling, intermediate trapping, and crossover experiments will help students to build up knowledge about chemical conversion and basic approach of functionalization. | | |
| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
| Lecture-19. | Rearrangement to electron-deficient carbon: Wagner-Meerwein rearrangement | |
| Lecture-20. | pinacol rearrangement; dienone-phenol | |
| Lecture-21. | Wolff rearrangement in Arndt-Eistert synthesis; benzil-benzilic acid rearrangement | |
| Lecture-22. | Demjanov rearrangement, Tiffeneau–Demjanov rearrangement | |
| Lecture-23. | Rearrangement to electron-deficient nitrogen: rearrangements: Hofmann, Curtius, Lossen, Schmidt | |
| Lecture-24. | Beckmann Rearrangement | |
| Lecture-25. | Rearrangement to electron-deficient oxygen: Baeyer-Villiger oxidation; Cumene hydroperoxide-phenol rearrangement and Dakin reaction | |
| Lecture-26. | Aromatic rearrangements: Migration from oxygen to ring carbon: Fries rearrangement; Claisen rearrangement | |
| Lecture-27. | Migration from nitrogen to ring carbon: Hofmann-Martius rearrangement, Fischer-Hepp rearrangement | |
| Lecture-28. | N-azo to C-azo rearrangement, Bamberger rearrangement | |
| Lecture-29. | Orton rearrangement and benzidine rearrangement. | |
| Lecture-30. | Rearrangement reactions by green approach: Fries rearrangement, Claisen rearrangement, Beckmann rearrangement, Baeyer-Villiger oxidation. | |
| Lecture-31. | | Discussion on problems |
| Lecture-32. | | Solving of problems |

**Module-III**

The Logic of Organic Synthesis

**CONTENTS**

1. Retrosynthetic analysis: disconnections; synthons, donor and acceptor synthons; natural reactivity and umpolung; latent polarity in bifunctional compounds: consonant and dissonant polarity; illogical electrophiles and nucleophiles; synthetic equivalents; functional group interconversion and addition (FGI and FGA); C-C disconnections and synthesis: one-group and two-group (1,2- to 1,5-dioxygenated compounds), reconnection (1,6-dicarbonyl); protectiondeprotection strategy (alcohol, amine, carbonyl, acid). **6 classes**
2. Strategy of ring synthesis: thermodynamic and kinetic factors; synthesis of large rings, application of high dilution technique. **2 classes**
3. Asymmetric synthesis: stereoselective and stereospecific reactions; diastereoselectivity and enantioselectivity (only definition); enantioselectivity: kinetically controlled MPV reduction; diastereoselectivity: addition of nucleophiles to C=O adjacent to a stereogenic centre: Felkin-Anh model. **4 classes**

**Module Objectives:**

Idea about retro synthesis will definitely help students to understand the logic of synthesis i.e. bond formation. This is extremely important to synthesize small to large organic molecules using simpler approach. Strategy of forward synthesis along with concept of Asymmetric induction might help to generate a clear logic on total synthesis of various bilologically active and chiral moieties.

| Lecture Serial | Topics of Discussion | Remarks |
|---|---|---|
| Lecture-33. | Retrosynthetic analysis: disconnections; synthons, donor and acceptor synthons; natural reactivity and umpolung; | |
| Lecture-34. | latent polarity in bifunctional compounds: consonant and dissonant polarity; illogical electrophiles and nucleophiles; synthetic equivalents; | |
| Lecture-35. | functional group interconversion and addition (FGI and FGA): Application | |
| Lecture-36. | C-C disconnections and synthesis: one-group and two-group (1,2- to 1,5-dioxygenatedcompounds), reconnection (1,6-dicarbonyl) | |
| Lecture-37. | protectiondeprotection strategy (alcohol, amine, carbonyl, acid). | |
| Lecture-38. | Application of retro synthesis: Various functional molecules | |
| Lecture-39. | Strategy of ring synthesis: thermodynamic and kinetic factors | |
| Lecture-40. | synthesis of large rings, application of high dilution technique | |
| Lecture-41. | Asymmetric synthesis: stereoselective and stereospecific reactions; diastereoselectivity (only definition) | |

| | | |
|---|---|---|
| Lecture-42. | enantioselectivity (only definition); enantioselectivity: kinetically controlled MPV reduction | |
| Lecture-43. | diastereoselectivity: addition of nucleophiles to C=O adjacent to a stereogenic centre: Felkin-Anh model | |
| Lecture-44. | | Discussion on Problems |

**Module-IV**

Organic Spectroscopy

**CONTENTS**

1. UV Spectroscopy: introduction; types of electronic transitions, end absorption; transition dipole moment and allowed/forbidden transitions; chromophores and auxochromes; Bathochromic and Hypsochromic shifts; intensity of absorptions (Hyper-/Hypochromic effects); application of Woodward's Rules for calculation of λmax for the following systems: conjugated diene, α,β-unsaturated aldehydes and ketones (alicyclic, homoannular and heteroannular); extended conjugated systems (dienes, aldehydes and ketones); relative positions of $\lambda_{max}$ considering conjugative effect, steric effect, solvent effect, effect of pH; effective chromophore concentration: keto-enol systems; benzenoid transitions. **4 classes**

2. IR Spectroscopy: introduction; modes of molecular vibrations (fundamental and nonfundamental); IR active molecules; application of Hooke's law, force constant; fingerprint region and its significance; effect of deuteration; overtone bands; vibrational coupling in IR; characteristic and diagnostic stretching frequencies of C-H, N-H, O-H, C-O, C-N, C-X, C=C (including skeletal vibrations of aromatic compounds), C=O, C=N, N=O, C≡C, C≡N; characteristic/diagnostic bending vibrations are included; factors affecting stretching frequencies: effect of conjugation, electronic effects, mass effect, bond multiplicity, ring-size, solvent effect, H-bonding on IR absorptions; application in functional group analysis. **4 classes**

3. NMR Spectroscopy: introduction; nuclear spin; NMR active molecules; basic principles of Proton Magnetic Resonance; equivalent and non-equivalent protons; chemical shift and factors influencing it; ring current effect; significance of the terms: up-/downfield, shielded and deshielded protons; spin coupling and coupling constant (1st order spectra); relative intensities of first-order multiplets: Pascal's triangle; chemical and magnetic equivalence in NMR ; elementary idea about non-first-order splitting; anisotropic effects in alkene, alkyne, aldehydes and aromatics; NMR peak area, integration; relative peak positions with coupling patterns of common organic compounds (both aliphatic and benzenoid-aromatic); rapid proton exchange; interpretation of NMR spectra of simple compounds. **6 classes**

4. Applications of IR, UV and NMR spectroscopy for identification of simple organic molecules. **2 classes**

**Module Objectives:**

This introduction to organic spectroscopic analysis aims to provide the students with a basic understanding of how nuclear magnetic resonance (NMR), infrared (IR) and ultraviolet-visible (UV-Vis) spectroscopy give rise to spectra, and how these spectra can be used to determine the structure of organic molecules. Therefore, students will gain a comprehensive ability to use spectroscopic information in the identification of organic compounds.

| Lecture Serial | Topics of Discussion | Remarks |
|---|---|---|
| Lecture-45. | UV Spectroscopy: introduction; types of electronic transitions, end absorption; transition dipole moment and allowed/forbidden transitions | |
| Lecture-46. | chromophores and auxochromes; Bathochromic and Hypsochromic shifts; intensity of absorptions (Hyper/Hypochromic effects) | |
| Lecture-47. | application of Woodward's Rules for calculation of λmax for the following systems: conjugated diene, α,β-unsaturated aldehydes and ketones (alicyclic, homoannular and heteroannular); extended conjugated systems (dienes, aldehydes and ketones) | |
| Lecture-48. | relative positions of $\lambda_{max}$ considering conjugative effect, steric effect, solvent effect, effect of pH; effective chromophore concentration: keto-enol systems; benzenoid transitions | |
| Lecture-49. | IR Spectroscopy: introduction; modes of molecular vibrations (fundamental and nonfundamental); IR active molecules; application of Hooke's law, force constant; | |
| Lecture-50. | fingerprint region and its significance; effect of deuteration; overtone bands; vibrational coupling in IR; characteristic and diagnostic stretching frequencies of C-H, N-H, O-H, C-O, C-N, C-X, C=C (including skeletal vibrations of aromatic compounds) | |
| Lecture-51. | C=O, C=N, N=O, C≡C, C≡N; characteristic/diagnostic bending vibrations are included; factors affecting stretching frequencies: effect of conjugation, electronic effects, mass effect, bond multiplicity, ring-size, solvent effect, H-bonding on IR absorptions | |
| Lecture-52. | application of IR spectroscopy in functional group analysis | |
| Lecture-53. | NMR Spectroscopy: introduction; nuclear spin; NMR active molecules; basic principles of Proton Magnetic Resonance; equivalent and non-equivalent protons | |

| | | |
|---|---|---|
| Lecture-54. | chemical shift and factors influencing it; ring current effect; significance of the terms: up-/downfield, shielded and deshielded protons; spin coupling and coupling constant (1st order spectra) | |
| Lecture-55. | relative intensities of first-order multiplets: Pascal's triangle; chemical and magnetic equivalence in NMR; elementary idea about non-first-order splitting | |
| Lecture-56. | anisotropic effects in alkene, alkyne, aldehydes and aromatics; NMR peak area, integration | |
| Lecture-57. | relative peak positions with coupling patterns of common organic compounds (both aliphatic and benzenoid-aromatic); rapid proton exchange | |
| Lecture-58. | Interpretation of NMR spectra of simple compounds. | |
| Lecture-59. | Applications of IR, UV and NMR spectroscopy for identification of simple organic molecules | |
| Lecture-60. | | Discussion on Problems |

**Reference Books:**


1. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd.(Pearson Education).
3. Norman, R.O. C., Coxon, J. M. Principles of Organic Synthesis, Third Edition, Nelson Thornes, 2003.
4. Clayden, J., Greeves, N., Warren, S., Organic Chemistry, Second edition, Oxford University Press 2012.
5. Silverstein, R. M., Bassler, G. C., Morrill, T. C. Spectrometric Identification of Organic Compounds, John Wiley and Sons, INC, Fifth edition.
6. Kemp, W. Organic Spectroscopy, Palgrave.
7. Pavia, D. L. et al. Introduction to Spectroscopy, 5th Ed. Cengage Learning India Ed. (2015).
8. Dyer, J. Application of Absorption Spectroscopy of Organic Compounds, PHI Private Limited.
9. March, J. Advanced Organic Chemistry, Fourth edition, Wiley.
10. Harwood, L. M., Polar Rearrangements, Oxford Chemistry Primer, Oxford University Press.
11. Bailey, Morgan, Organonitrogen Chemistry, Oxford Chemistry Primer, Oxford University Press.
12. Warren, S. Organic Synthesis the Disconnection Approach, John Wiley and Sons.
13. Warren, S., Designing Organic Synthesis, Wiley India, 2009.
14. Carruthers, W. Modern methods of Organic Synthesis, Cambridge University Press.
15. Willis, C. A., Wills, M., Organic Synthesis, Oxford Chemistry Primer, Oxford University Press.

**Course code: CC-10**
**2 Credits**
**Course title: Organic Chemistry-IV (Prac)**

**Module-I**
List of Practical

**CONTENTS**

1. Estimation of glucose by titration using Fehling's solution
2. Estimation of vitamin-C (reduced)
3. Estimation of aromatic amine (aniline) by bromination (Bromate-Bromide) method
4. Estimation of phenol by bromination (Bromate-Bromide) method
5. Estimation of formaldehyde (Formalin)
6. Estimation of acetic acid in commercial vinegar
7. Estimation of urea (hypobromite method)
8. Estimation of saponification value of oil/fat/ester. **30classes**

**Module Objectives:**

Students will experience hand on training regarding quantitative analytical experiments which may help to develop their skills regarding analytical laboratory experiments of various RNDs and research.

| Lecture Serial | Title of the Experiment | Remarks |
|---|---|---|
| Lab 1 | Laboratory Instructions and guidance on Lab notebook preparation | |
| Lab 2 | Theoretical discussion about the reactions involved in this course | |
| Lab 3 | Basic knowledge on reagent handling and solution preparation | |
| Lab 4 | Skill development on weighing and glass instruments | |
| Lab 5 | Estimation of glucose by titration using Fehling's solution | |
| Lab 6 | Calculation and note book preparation | |
| Lab 7 | Estimation of vitamin-C (reduced) | |
| Lab 8 | Calculation and note book preparation | |
| Lab 9 | Estimation of aromatic amine (aniline) by bromination (Bromate-Bromide) method | |
| Lab 10 | Calculation and note book preparation | |
| Lab 11 | Estimation of phenol by bromination (Bromate-Bromide) method | |
| Lab 12 | Calculation and note book preparation | |
| Lab 13 | Estimation of formaldehyde (Formalin) | |
| Lab 14 | Calculation and note book preparation | |
| Lab 15 | Estimation of acetic acid in commercial vinegar | |
| Lab 16 | Calculation and note book preparation | |

| | | |
|---|---|---|
| Lab 17 | Estimation of urea (hypobromite method) | |
| Lab 18 | Calculation and note book preparation | |
| Lab 19 | Estimation of saponification value of oil | |
| Lab 20 | Calculation and note book preparation | |
| Lab 21 | Estimation of saponification value of fat | |
| Lab 22 | Calculation and note book preparation | |
| Lab 23 | Estimation of saponification value of ester | |
| Lab 24 | Calculation and note book preparation | |
| Lab 25 | | Practice 1 |
| Lab 26 | | Practice 2 |
| Lab 27 | | Practice 3 |
| Lab 28 | | Practice 4 |
| Lab 29 | | Practice 5 |
| Lab 30 | | Practice 6 |

**Reference Books:**

1. Vogel, A. I. Qualitative Organic Analysis, Pearson.
2. University Hand Book of Undergraduate Chemistry Experiments, edited by Mukherjee, G. N., University of Calcutta.
3. Ghoshal, A., Mahapatra, B., Nad, A. K. An Advanced Course in Practical Chemistry, New Central Book Agency (2007).
4. Ahluwalia, V. K., Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, Universities Press (India) Pvt. Ltd. (2000).

**DEPARTMENT OF CHEMISTRY**
**GOVERNMENT GENERAL DEGREE COLLEGE, KALNA-I**
**LESSON PLAN**
**for**
**B. Sc. 4th SEMESTER (Hons.) COURSES UNDER CBCS**
**Subject: Chemistry**
**Course code: SEC-2**
**Credits-2**
**Course title: Pharmaceuticals Chemistry**

**Module-I**
Drugs & Pharmaceuticals

**CONTENTS**

Drug discovery, design and development; Basic Retrosynthetic approach. Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin, paracetamol, lbuprofen); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam), Cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT- Zidovudine).

**18 classes**

**Module Objectives:**

Medicinal/Pharmaceutical chemistry deals with the discovery, design, development and both pharmacological and analytical characterization of drug substances. The chapter describes stages of drug development followed by a summary of the phases of drug activity relating to a drug's formulation. Finally, classification systems for marketed drug substances are presented, with an emphasis on their structure, synthesis and use.

| Lecture Serial | Topics of Discussion | Remarks |
|---|---|---|
| Lecture-1. | Drug discovery, design and development (part 1) | |
| Lecture-2. | Drug discovery, design and development (part 2) | |
| Lecture-3. | Drug discovery, design and development (part 3) | |
| Lecture-4. | Drug Targets, Mechanism of drug action (part 1) | |
| Lecture-5. | Drug Targets, Mechanism of drug action (part 2) | |
| Lecture-6. | Definition and classification of analgesics agents, antipyretic agents, anti-inflammatory agents | |
| Lecture-7. | Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin, paracetamol, ibuprofen) | |
| Lecture-8. | Comparative discussion on activity and use of Aspirin, paracetamol, ibuprofen | |

| | | |
|---|---|---|
| Lecture-9. | antibiotics (Chloramphenicol) | |
| Lecture-10. | antibacterial and antifungal agents: Sulphonamides; Sulphanethoxazol | |
| Lecture-11. | antibacterial and antifungal agents: Sulphacetamide, Trimethoprim | |
| Lecture-12. | antiviral agents (Acyclovir) | |
| Lecture-13. | Central Nervous System agents (Phenobarbital, Diazepam) | |
| Lecture-14. | Cardiovascular (Glyceryl trinitrate) | |
| Lecture-15. | antilaprosy (Dapsone) | |
| Lecture-16. | HIV-AIDS related drugs (AZT- Zidovudine) | |
| Lecture-17. | | Discussion on Problems |
| Lecture-18. | | Question-Answer |

**Module-II**

Fermentation

**CONTENTS**

Aerobic and anaerobic fermentation. Production of
(i) Ethyl alcohol and citric acid,
(ii) Antibiotics; Penicillin, Cephalosporin, Chloromycetin and Streptomycin,
(iii) Lysine, Glutamic acid, Vitamin B2, Vitamin B12 and Vitamin C. **12 classes**

**Module Objectives:**

By the end of this lesson, students will be able to know:

- the process of fermentation in making beer, wine, and liquors
- distinguish similarities and differences in yeast fermentation
- explain how distillation is used to create a higher alcohol content in liquors.
- Commercial preparations of some common antibiotics, amino acids and vitamins

| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
|---|---|---|
| Lecture-19. | Aerobic fermentation | |
| Lecture-20. | anaerobic fermentation; difference between them | |
| Lecture-21. | Production of Ethyl alcohol | |
| Lecture-22. | Production of citric acid | |
| Lecture-23. | Antibiotics: Definition, use, example | |
| Lecture-24. | Penicillin, Cephalosporin | |
| Lecture-25. | Chloromycetin and Streptomycin | |
| Lecture-26. | Lysine, Glutamic acid | |
| Lecture-27. | Vitamin B2, Vitamin B12 | |
| Lecture-28. | Vitamin C | |

| | | |
|---|---|---|
| Lecture-29. | | Discussion on problems |
| Lecture-30. | | Solving of problems |

**Reference Books:**

1. Patrick, G. L. Introduction to Medicinal Chemistry, Oxford University Press, UK, 2013.
2. Singh, H. & Kapoor, V.K. Medicinal and Pharmaceutical Chemistry, Vallabh Prakashan, Pitampura, New Delhi, 2012.
3. Foye, W.O., Lemke, T.L. & William, D.A.: Principles of Medicinal Chemistry, 4th ed., B.I. Waverly Pvt. Ltd. New Delhi.
4. El-Mansi, E.M.T., Bryce, C.F.A., Ddemain, A.L., Allman, A.R., Fermentatias Microbiology and Biotechnology, 2nd Ed. Taylor & Francis.
5. Prescott & Dunn's Industrial Microbilogy, 2004, CBS Publisher.

**DEPARTMENT OF CHEMISTRY**
**GOVERNMENT GENERAL DEGREE COLLEGE, KALNA-I**
**LESSON PLAN**
**for**
**B. Sc. 5th SEMESTER (Hons.) COURSES UNDER CBCS**

**Subject: Chemistry**
**Course code: CC-11**
**Course title: Inorganic Chemistry-IV (Theo)**

| **Module-I**<br>Coordination Chemistry-II | | |
|---|---|---|
| **CONTENTS**<br>VB description and its limitations. Elementary Crystal Field Theory: splitting of $d^n$ configurations in octahedral, square planar and tetrahedral fields, crystal field stabilization energy (CFSE) in weak and strong fields; pairing energy. Spectrochemical series. Jahn-Teller distortion. Octahedral site stabilization energy (OSSE). Metal-ligand bonding (MO concept, elementary idea), sigma- and pi-bonding in octahedral complexes (qualitative pictorial approach) and their effects on the oxidation states of transitional metals (examples). Magnetism and Colour: Orbital and spin magnetic moments, spin only moments of $d^n$ ions and their correlation with effective magnetic moments, including orbital contribution; quenching of magnetic moment: super exchange and antiferromagnetic interactions (elementary idea with examples only); d-d transitions; L-S coupling; qualitative Orgel diagrams for $3d^1$ to $3d^9$ ions. Racah parameter. Selection rules for electronic spectral transitions; spectrochemical series of ligands; charge transfer spectra (elementary idea). | | |
| **Module Objectives:**<br>The students will have an extensive knowledge of Crystal Field Theory, Magnetochemistry, and origin of colour in transition metal chemistry. | | |
| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
| Lecture-1. | VB description and its limitations | |
| Lecture-2. | VB description and its limitations | |
| Lecture-3. | Elementary idea on Crystal Field Theory | |
| Lecture-4. | Splitting of $d^n$ configurations in octahedral, square planar and tetrahedral fields | |
| Lecture-5. | Crystal field stabilization energy (CFSE) in weak and strong fields; pairing energy | |
| Lecture-6. | Spectrochemical series | |
| Lecture-7. | Jahn-Teller distortion | |

| | | |
|---|---|---|
| Lecture-8. | Octahedral site stabilization energy (OSSE) | |
| Lecture- 9. | MO concept on Metal-ligand bonding | |
| Lecture-10. | MO concept on Metal-ligand bonding | |
| Lecture- 11. | Sigma- and pi-bonding in octahedral complexes and their effects on the oxidation states of transitional metals | |
| Lecture-12. | Orbital and spin magnetic moments | |
| Lecture-13. | Spin only moments of $d^n$ ions and their correlation with effective magnetic moments, including orbital contribution | |
| Lecture-14. | Super exchange and anti-ferromagnetic interactions | |
| Lecture-15. | d-d transitions | |
| Lecture-16. | L-S coupling | |
| Lecture-17. | Orgel diagrams for $3d^1$ to $3d^9$ ions | |
| Lecture-18. | Orgel diagrams for $3d^1$ to $3d^9$ ions | |
| Lecture-19. | Racah parameter | |
| Lecture-20. | Selection rules for electronic spectral transitions | |
| Lecture-21. | Charge transfer spectra | |
| Lecture-22. | | Discussion on simple problems. |
| Lecture-23. | | Discussion on simple problems. |
| Lecture-24. | | Solutions of previous year questions |
| Lecture-25. | | Tutorial assignment – 1 |
| Lecture-26. | | Tutorial assignment – 2 |

**Module-II**

Chemistry of d- and f- block elements

**CONTENTS**

Transition Elements:

General comparison of 3d, 4d and 5d elements in term of electronic configuration, oxidation states, redox properties, coordination chemistry.

Lanthanoids and Actinoids:

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

**Module Objectives:**

1. The students will have a strong foundation on chemistry of d- elements after the completion of the course and better understanding of their reactivity and compounds formed by them.
2. Students will get information on electronic configuration, oxidation states, colour, spectral & magnetic properties of lanthanide and separation techniques of lanthanides from this chapter.

| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
|---|---|---|
| Lecture-27. | General survey of the Transition Elements | |
| Lecture-28. | General features of the d-block Transition Elements | |
| Lecture-29. | Some important aspects of Transition Elements: Colour, Paramagnetism & Catalytic activity | |
| Lecture-30. | Comparison of 3d, 4d and 5d elements in term of electronic configuration & oxidation states | |
| Lecture-31. | Comparison of 3d, 4d and 5d elements in term of coordination chemistry | |
| Lecture-32. | Discussion on Group 3 elements | |
| Lecture-33. | Discussion on Group 4 elements | |
| Lecture-34. | Discussion on Group 5 elements | |
| Lecture-35. | Discussion on Group 6 elements | |
| Lecture-36. | Discussion on Group 7 | |

| | | |
|---|---|---|
| | elements | |
| Lecture-37. | | |
| Lecture-38. | Discussion on Group 7 elements | |
| Lecture-39. | Discussion on Group 8, 9 & 10 elements | |
| Lecture-40. | Discussion on Group 11 elements | |
| Lecture-41. | Discussion on Group 12 elements | |
| Lecture-42. | General introduction on inner transition series elements | |
| Lecture-43. | Comparison on electronic configuration, oxidation states and colours of Lanthanoids and Actinoids | |
| Lecture-44. | Comparison on electronic configuration, oxidation states, colours of Lanthanoids and Actinoids | |
| Lecture-45. | Comparison on spectral and magnetic properties of Lanthanoids and Actinoids lanthanide contraction | |
| Lecture-46. | Isolation of the lanthanides by solvent extraction technique & ion exchange technique | |
| Lecture-47. | Isolation of the lanthanides by solvent extraction technique & ion exchange technique | |
| Lecture-48. | | Discussion on simple problems. |
| Lecture-48. | | Discussion on simple problems. |
| Lecture-49. | | Solutions of previous year questions |
| Lecture-50. | | Tutorial assignment – 3 |
| Lecture-51. | | Tutorial assignment – 4 |

**Course code: CC-11**

**Course title: Inorganic Chemistry-IV (Prac)**

| **Module-I**<br>Chromatography of metal ions | | |
|---|---|---|
| **CONTENTS**<br>Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions:<br>1. Ni(II) and Co(II)<br>2. Fe(III) and Al(III) | | |
| **Module Objectives:**<br>Performing practical classes, students will acquire skill of principles involved in chromatographic separations. | | |
| **Lecture Serial** | **Title of the Experiment** | **Remarks** |
| Lab 1 | Introduction | |
| Lab 2 | Practice of preparation of standard solutions and link solutions of required normality | |
| Lab 3 | Paper chromatographic separation of following metal ions: Ni(II) and Co(II) | |
| Lab 4 | Paper chromatographic separation of following metal ions: Ni(II) and Co(II) | |
| Lab 5 | Paper chromatographic separation of following metal ions: Fe(III) and Al(III) | |
| Lab 6 | Paper chromatographic separation of following metal ions: Fe(III) and Al(III) | |
| Lab 7 | | Repeat class I |
| Lab 8 | | Repeat class II |
| Lab 9 | | Repeat class III |
| Lab 10 | | Repeat class IV |
| Lab 11 | | Model Examination |
| Lab 12 | | Model Examination |
| Lab 13 | | Revision |
| Lab 14 | | Revision |
| Lab 15 | | Revision |

**Module-II**

Gravimetry

**CONTENTS**

1. Estimation of nickel(II) using Dimethylglyoxime (DMG).
2. Estimation of copper as CuSCN
3. Estimation of Al(III) by precipitating with oxine and weighing as $Al(oxine)_3$ (aluminium oxinate)
4. Estimation of chloride

**Module Objectives:**

Students learn the skill of Gravimetrically analysis through this practical paper such as Ni2+ using DMG, estimation of Cu as CuSCN, and Al after precipitation as $Al(oxin)_3$.

| **Lecture Serial** | **Title of the Experiment** | **Remarks** |
|---|---|---|
| Lab 16 | Introduction | |
| Lab 17 | Practice of preparation of standard solutions and link solutions of required normality | |
| Lab 18 | Estimation of nickel(II) using Dimethylglyoxime (DMG) | |
| Lab 19 | Estimation of nickel(II) using Dimethylglyoxime (DMG) | |
| Lab 20 | Estimation of copper as CuSCN | |
| Lab 21 | Estimation of Al(III) by precipitating with oxine and weighing as $Al(oxine)_3$ | |
| Lab 22 | Estimation of Al(III) by precipitating with oxine and weighing as $Al(oxine)_3$ | |
| Lab 23 | Estimation of chloride | |
| Lab 24 | Estimation of chloride | |
| Lab 25 | | Repeat class I |
| Lab 27 | | Repeat class II |
| Lab 28 | | Repeat class III |
| Lab 29 | | Repeat class IV |
| Lab 30 | | Model Examination |
| Lab 31 | | Model Examination |
| Lab 32 | | Revision |
| Lab 33 | | Revision |
| Lab 34 | | Revision |

**Module-III**

Spectrophotometry

**CONTENTS**

Spectrophotometry

1. Measurement of 10Dq of 3d metal complexes by spectrophotometric method.
2. Determination of $\lambda_{max}$ of $KMnO_4$ and $K_2Cr_2O_7$.

**Module Objectives:**

Performing practical classes, students will acquire skill of spectrophotometric measurement of 10Dq of 3d metal complexes and determination of $\lambda_{max}$ values

| **Lecture Serial** | **Title of the Experiment** | **Remarks** |
|---|---|---|
| Lab 35 | Introduction | |
| Lab 36 | Practice of preparation of standard solutions and link solutions of required normality | |
| Lab 37 | Measurement of 10Dq of 3d metal complexes by spectrophotometric method | |
| Lab 38 | Measurement of 10Dq of 3d metal complexes by spectrophotometric method | |
| Lab 39 | Determination of $\lambda_{max}$ of $KMnO_4$ and $K_2Cr_2O_7$ | |
| Lab 40 | Determination of $\lambda_{max}$ of $KMnO_4$ and $K_2Cr_2O_7$ | |
| Lab 41 | | Repeat class I |
| Lab 42 | | Repeat class II |
| Lab 43 | | Repeat class III |
| Lab 44 | | Repeat class IV |
| Lab 45 | | Model Examination |
| Lab 46 | | Model Examination |
| Lab 47 | | Revision |
| Lab 48 | | Revision |
| Lab 49 | | Revision |

**DEPARTMENT OF CHEMISTRY**
**GOVERNMENT GENERAL DEGREE COLLEGE, KALNA-I**
**LESSON PLAN**
**for**
**B. Sc. 5th SEMESTER (Hons.) COURSES UNDER CBCS**
**Subject: Chemistry**
**Course code: CC-12**
**Credits-4**
**Course title: Organic Chemistry-V (Theo)**

**Module-I**
Carbocycles and Heterocycles

**CONTENTS**

1. Polynuclear hydrocarbons and their derivatives: synthetic methods include Haworth, Bardhan-Sengupta and other useful syntheses (with mechanistic details); fixation of double bonds and Fries rule; reactions (with mechanism) of naphthalene, anthracene, phenanthrene and their derivatives. **4 classes**
2. Heterocyclic compounds: 5- and 6-membered rings with one heteroatom; reactivity, orientation and important reactions (with mechanism) of furan, pyrrole, thiophene and pyridine; synthesis (including retrosynthetic approach and mechanistic details): pyrrole: Knorr synthesis, Paal-Knorr synthesis, Hantzsch; furan: Paal-Knorr synthesis, Feist-Benary synthesis and its variation; thiophenes: Paal-Knorr synthesis, Hinsberg synthesis; pyridine: Hantzsch synthesis; benzo-fused 5- and 6-membered rings with one heteroatom: reactivity, orientation and important reactions (with mechanistic details) of indole, quinoline and isoquinoline; synthesis (including retrosynthetic approach and mechanistic details): indole: Fischer, Madelung and Reissert; quinoline: Skraup, Doebner- Miller, Friedlander; isoquinoline: Bischler-Napieralski synthesis. **12 classes**

**Module Objectives:**

1. Polycyclic aromatic hydrocarbons (PAHs) are ubiquitous environmental pollutants. The aim of this portion is to discuss PAHs impact on the environmental and the majority of the chapter includes synthesis and common reactions of PAHs.
2. This course aims at providing theoretical understanding of heterocyclic chemistry which includes various methods for ring synthesis and application of those methods for the preparation of specific groups of heterocyclic systems. The students will be made familiar with particular properties, reactions, and applications of the most important as well as less common heterocycles.

| Lecture Serial | Topics of Discussion | Remarks |
|---|---|---|
| Lecture-1. | Polynuclear hydrocarbons and their derivatives: synthetic methods include Haworth, Bardhan-Sengupta and other useful syntheses (with mechanistic details) | |
| Lecture-2. | fixation of double bonds and Fries rule; reactions (with mechanism) of naphthalene | |

| | | |
|---|---|---|
| Lecture-3. | reactions (with mechanism) of anthracene, phenanthrene and their derivatives. | |
| Lecture-4. | | Discussion on Problems |
| Lecture-5. | Heterocyclic compounds: 5- and 6-membered rings with one heteroatom; reactivity, orientation and important reactions (with mechanism) of furan, pyrrole | |
| Lecture-6. | continuation | |
| Lecture-7. | Thiophene: important reactions (with mechanism) | |
| | Pyridine: important reactions (with mechanism) | |
| Lecture-8. | synthesis (including retrosynthetic approach and mechanistic details): pyrrole: Knorr synthesis, Paal-Knorr synthesis, Hantzsch; | |
| Lecture-9. | furan: Paal-Knorr synthesis, Feist-Benary synthesis and its variation | |
| Lecture-10. | thiophenes: Paal-Knorr synthesis, Hinsberg synthesis; pyridine: Hantzsch synthesis | |
| Lecture-11. | benzo-fused 5- and 6-membered rings with one heteroatom: reactivity, orientation | |
| Lecture-12. | important reactions (with mechanistic details) of indole, | |
| Lecture-13. | important reactions (with mechanistic details) of quinoline and isoquinoline | |
| Lecture-14. | synthesis (including retrosynthetic approach and mechanistic details): indole: Fischer, Madelung and Reissert; | |
| Lecture-15. | quinoline: Skraup, Doebner-Miller, Friedlander; isoquinoline: Bischler-Napieralski synthesis | |
| Lecture-16. | | Solving of relevant questions |

**Module-II**

Cyclic Stereochemistry

**CONTENTS**

Alicyclic compounds: concept of I-strain; conformational analysis: cyclohexane, mono and disubstituted cyclohexane; symmetry properties and optical activity; ring-size and ease of cyclisation; conformation & reactivity in cyclohexane system: consideration of steric and stereoelectronic requirements; elimination (E2, E1), nucleophilic substitution (SN1, SN2, SNi, NGP), merged substitution-elimination; rearrangements; oxidation of cyclohexanol, esterification, saponification, lactonisation, epoxidation, pyrolytic syn elimination and fragmentation reactions. **10 classes**

**Module Objectives:**

This chapter provides most important reactions in synthetic organic chemistry. Such reactions are used for the synthesis of important intermediates that can be used as precursors for the production of pharmaceutical, agrochemical and industrial products.

| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
|---|---|---|
| Lecture-17. | Alicyclic compounds: concept of I-strain | |
| Lecture-18. | conformational analysis: cyclohexane with symmetry properties and optical activity | |
| Lecture-19. | conformational analysis: mono and disubstituted cyclohexane with symmetry properties and optical activity | |
| Lecture-20. | ring-size and ease of cyclisation | |
| Lecture-21. | conformation & reactivity in cyclohexane system: consideration of steric and stereoelectronic requirements | |
| Lecture-22. | elimination (E2, E1) | |
| Lecture-23. | nucleophilic substitution (SN1, SN2, SNi, NGP) | |
| Lecture-24. | merged substitution-elimination; rearrangements | |
| Lecture-25. | oxidation of cyclohexanol, esterification, saponification, lactonisation | |
| Lecture-26. | pyrolytic syn elimination and fragmentation reactions | |

**Module-III**

Pericyclic reactions

**CONTENTS**

Mechanism, stereochemistry, regioselectivity in case of

1. Electrocyclic reactions: FMO approach involving 4π- and 6π-electrons (thermal and photochemical) and corresponding cycloreversion reactions.
2. Cycloaddition reactions: FMO approach, Diels-Alder reaction, photochemical [2+2] cycloadditions.
3. Sigmatropic reactions: FMO approach, sigmatropic shifts and their order; [1,3]- and [1,5]-H shifts and [3,3]-shifts with reference to Claisen and Cope rearrangements.

**10 classes**

**Module Objectives:**

*By the end of this chapter students should be familiar with*

- Types and principles of pericyclic reactions.
- What determines whether these pericyclic reactions go forwards or backwards.
- Conservation of orbital symmetry and what conrotatory and disrotatory mean.
- Electrocyclic reactions and rules governing them.
- Cycloaddition reactions and rules governing them.
- Sigmatropic reactions and rules governing them.
- Applications of pericyclic reactions.

| Lecture Serial | Topics of Discussion | Remarks |
|---|---|---|
| Lecture-27. | Electrocyclic reactions: FMO approach involving 4π- and 6π-electrons (thermal and photochemical) and corresponding cycloreversion reactions | |
| Lecture-28. | continuation | |
| Lecture-29. | continuation | |
| Lecture-30. | Cycloaddition reactions: FMO approach, Diels-Alder reaction, photochemical [2+2] cycloadditions. | |
| Lecture-31. | continuation | |
| Lecture-32. | continuation | |
| Lecture-33. | Sigmatropic reactions: FMO approach, sigmatropic shifts and their order; [1,3]- and [1,5]-H shifts | |
| Lecture-34. | continuation | |
| Lecture-35. | [3,3]-shifts with reference to Claisen and Cope rearrangements | |
| Lecture-36. | | Question-Answer |

**Module-IV**

Carbohydrates

**CONTENTS**

Monosaccharides: Aldoses up to 6 carbons; structure of D-glucose & D-fructose (configuration & conformation); ring structure of monosaccharides (furanose and pyranose forms): Haworth representations and non-planar conformations; anomeric effect (including stereoelectronic explanation); mutarotation; epimerization; reactions (mechanisms in relevant cases): Fischer glycosidation, osazone formation, bromine-water oxidation, $HNO_3$ oxidation, selective oxidation of terminal $-CH_2OH$ of aldoses, reduction to alditols, Lobry de Bruyn-van Ekenstein rearrangement; stepping–up (Kiliani-Fischer method) and stepping–down (Ruff's & Wohl's methods) of aldoses; acetonide (isopropylidene) and benzylidene protections; ring-size determination; Fischer's proof of configuration of (+)-glucose. **8 classes**

**Module Objectives:**

1. Know the glycosidic bonds for the acetal and ketal bonds. Know the different positions for the alpha and beta linkage conformations. Be able to recognize the structures of the modifications of sugars: glycosides, sugar alcohols, sugar acids, phosphate esters, deoxy sugars and amino sugars.
2. Carbohydrates are, in fact, an essential part of our diet; grains, fruits, and vegetables are all natural sources of carbohydrates. Carbohydrates provide energy to the body, particularly through glucose, a simple sugar that is a component of starch and an ingredient in many staple foods.

| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
|---|---|---|
| Lecture-37. | Monosaccharides: Aldoses up to 6 carbons | |
| Lecture-38. | structure of D-glucose & D-fructose (configuration & conformation); ring structure of monosaccharides (furanose and pyranose forms): Haworth representations and non-planar conformations | |
| Lecture-39. | anomeric effect (including stereoelectronic explanation); mutarotation; epimerization; | |
| Lecture-40. | reactions (mechanisms in relevant cases): Fischer glycosidation, osazone formation, bromine-water oxidation, $HNO_3$ oxidation, selective oxidation of terminal $-CH_2OH$ of aldoses | |
| Lecture-41. | reduction to alditols, Lobry de Bruyn-van Ekenstein rearrangement; stepping–up (Kiliani-Fischer method) and stepping–down (Ruff's & Wohl's methods) of aldoses | |
| Lecture-42. | acetonide (isopropylidene) and benzylidene protections; ring-size determination; Fischer's proof of configuration of (+)-glucose | |
| Lecture-43. | | Discussion on Problems |
| Lecture-44. | | Question-Answer |

**Module-V**

Biomolecules

**CONTENTS**

1. Amino acids: synthesis with mechanistic details: Strecker, Gabriel, acetamido malonic ester, azlactone, Bücherer hydantoin synthesis, synthesis involving diketopiperazine; isoelectric point, zwitterions; electrophoresis, reaction (with mechanism): ninhydrin reaction; resolution of racemic amino acids. **4 classes**
2. Peptides: peptide linkage and its geometry; syntheses (with mechanistic details) of peptides using N-protection & C-protection, solid-phase (Merrifield) synthesis; peptide sequence: Cterminal and N-terminal unit determination (Edman, Sanger & 'dansyl' methods); partial hydrolysis; specific cleavage of peptides: use of CNBr. **4 classes**
3. Nucleic acids: pyrimidine and purine bases (only structure & nomenclature); nucleosides and nucleotides corresponding to DNA and RNA; elementary idea of double helical structure of DNA (Watson-Crick model); complimentary base–pairing in DNA. **4 classes**

**Module Objectives:**

1. To teach students about important biomolecules essential to life processes.
2. To discuss aspects of the principles of organic chemistry in connection with structure and function of important biomolecules such as amino acids, peptides, proteins.
3. Understand the structure and function of important biological molecules such as DNA, RNA and some enzymes.

| Lecture Serial | Topics of Discussion | Remarks |
|---|---|---|
| Lecture-45. | Amino acids: synthesis with mechanistic details: Strecker, Gabriel, acetamido malonic ester, | |
| Lecture-46. | azlactone, Bücherer hydantoin synthesis, synthesis involving diketopiperazine; | |
| Lecture-47. | isoelectric point, zwitterions; electrophoresis | |
| Lecture-48. | reaction (with mechanism): ninhydrin reaction; resolution of racemic amino acids | |
| Lecture-49. | Peptides: peptide linkage and its geometry | |
| Lecture-50. | syntheses (with mechanistic details) of peptides using N-protection & C-protection, solid-phase (Merrifield) synthesis | |
| Lecture-51. | peptide sequence: Cterminal and N-terminal unit determination (Edman, Sanger & 'dansyl' methods) | |
| Lecture-52. | partial hydrolysis; specific cleavage of peptides: use of CNBr | |
| Lecture-53. | Nucleic acids: pyrimidine and purine bases (only structure & nomenclature); nucleosides and nucleotides corresponding to DNA and RNA | |
| Lecture-54. | elementary idea of double helical structure of DNA (Watson-Crick | |

| | | |
|---|---|---|
| | model); complimentary base–pairing in DNA | |
| Lecture-55. | | Question-Answer |
| Lecture-56. | | Question-Answer |

| **Module-VI**<br>Alkaloids and Terpenoids | | |
|---|---|---|
| **CONTENTS**<br>General studies on terpenoids and alkaloids; determination of structure of α-Terpenol and ephedrine. **4 classes** | | |
| **Module Objectives:**<br>A natural product such as terpenoids and alkaloids is a chemical compound or substance produced by a living organism - that is found in nature. In board sense, natural products can also be prepared by chemical synthesis (both) semi synthesis. Natural products has also been important to study as they extended for commercial/purposes to refer to cosmetics, dietary supplements and food produced from natural sources without added artificial ingredients. | | |
| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
| Lecture-57. | General studies on terpenoids | |
| Lecture-58. | General studies on alkaloids | |
| Lecture-59. | determination of structure of α-Terpenol and ephedrine | |
| Lecture-60. | | Question-Answer |

**Reference Books:**


1. Clayden, J., Greeves, N., Warren, S. Organic Chemistry, Second edition, Oxford University Press 2012.
2. Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London.
3. Nasipuri, D. Stereochemistry of Organic Compounds, Wiley Eastern Limited.
4. Sen Gupta, Subrata. Basic Stereochemistry of Organic molecules.
5. Kalsi, P. S. Stereochemistry Conformation and Mechanism, Eighth edition, New Age International, 2014.
6. Fleming, I. Molecular Orbitals and Organic Chemical reactions, Reference/Student Edition, Wiley, 2009.
7. Fleming, I. Pericyclic Reactions, Oxford Chemistry Primer, Oxford University Press.
8. Gilchrist, T. L. & Storr, R. C. Organic Reactions and Orbital symmetry, Cambridge University Press.
9. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd.(Pearson Education).
10. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
11. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
12. Loudon, G. M. Organic Chemistry, Fourth edition, Oxford University Press.
13. James, J., Peach, J. M. Stereochemistry at a Glance, Blackwell Publishing, 2003.

14. Robinson, M. J. T., Stereochemistry, Oxford Chemistry Primer, Oxford University Press, 2005.
15. Davis, B. G., Fairbanks, A. J., Carbohydrate Chemistry, Oxford Chemistry Primer, Oxford University Press.
16. Joule, J. A. Mills, K. Heterocyclic Chemistry, Blackwell Science.
17. Acheson, R.M. Introduction to the Chemistry of Heterocyclic compounds, John Wiely & Sons (1976).
18. Gilchrist, T. L. Heterocyclic Chemistry, 3rd edition, Pearson.
19. Bansal, R. K. Heterocyclic Chemistry, New Age International Publishers.
20. Davies, D. T., Heterocyclic Chemistry, Oxford Chemistry Primer, Oxford University Press.

## Course code: CC-12

**2 Credits**

**Course title: Organic Chemistry-V (Prac)**

**Module-I**

Chromatographic Separations

**CONTENTS**

1. TLC separation of a mixture containing 2/3 amino acids
2. TLC separation of a mixture of dyes (fluorescein and methylene blue)
3. Column chromatographic separation of mixture of dyes
4. Paper chromatographic separation of a mixture containing 2/3 amino acids. **10 classes**

**Module Objectives:**

Students will experience a practical study regarding quantitative separation of organic compounds from their mixture using several The mixture is dissolved in a fluid (gas, solvent, water, ...) called the mobile phase, which carries it through a system (a column, a capillary tube, a plate, or a sheet) on which is fixed a material called the stationary phase. This part includes hands on training on Column chromatography, Thin Layer chromatography and Paper chromatography.

| Lecture Serial | Title of the Experiment | Remarks |
|---|---|---|
| Lab 1 | Laboratory Instructions and guidance on Lab notebook preparation | |
| Lab 2 | Theoretical discussion about the reactions involved in this course | |
| Lab 3 | TLC separation of a mixture containing 2 amino acids | |
| Lab 4 | do | |
| Lab 5 | TLC separation of a mixture of dyes (fluorescein and methylene blue) | |
| Lab 6 | Column chromatographic separation of mixture of dyes | |
| Lab 7 | do | |
| Lab 8 | do | |
| Lab 9 | Paper chromatographic separation of a mixture containing 2/3 amino acids | |

| | | |
|---|---|---|
| Lab 10 | do | |

**Module-II**

Spectroscopic Analysis of Organic Compounds

**CONTENTS**

1. Assignment of labelled peaks in the $^{1}$H-NMR spectra of the known organic compounds explaining the relative δ-values and splitting pattern.
2. Assignment of labelled peaks in the IR spectrum of the same compound explaining the relative frequencies of the absorptions (C-H, O-H, N-H, C-O, C-N, C-X, C=C, C=O, N=O, C≡C, C≡N stretching frequencies; characteristic bending vibrations are included).
3. The students must record full spectral analysis of at least 15 (fifteen) compounds from the following list:

a. 4-Bromoacetanilide
b. 2/-Bromo-4/-methylacetophenone
c. Vanillin
d. 2/-Methoxyacetophenone
e. 4-Aminobenzoic acid
f. Salicylamide
g. 2/-Hydroxyacetophenone
h. 1,3-Dinitrobenzene
i. Benzylacetate
j. trans-4-Nitrocinnamaldehyde
k. Diethyl fumarate
l. 4-Nitrobenzaldehyde
m. 4-Methylacetanilide
n. Mesityl oxide
o. 2-Hydroxybenzaldehyde
p. 4-Nitroaniline
q. 2-Hydroxy-3-nitrobenzaldehyde
r. 2,3-Dimethylbenzonitrile
s. Pent-1-yn-3-ol
t. 3-Nitrobenzaldehyde
u. 3-Ethoxy-4-hydroxybenzaldehyde
v. 2-Methoxybenzaldehyde
w. Methyl 4-hydroxybenzoate
x. Methyl 3-hydroxybenzoate
y. 3-Aminobenzoic acid
z. Ethyl 3-aminobenzoate
aa. Ethyl 4-aminobenzoate
bb. 3-nitroanisole
cc. 5-Methyl-2-nitroanisole
dd. 3-Methylacetanilide **20 classes**

**Module Objectives:**

Knowledge of the most important organic spectroscopic analysis aims structural identification and characterization of simple and complex organic compounds. It offers the students a basic understanding of how nuclear magnetic resonance (NMR), infrared (IR) and ultraviolet-visible (UV-Vis) spectroscopy, and mass spectrometry (MS) give rise to spectra, and how these spectra can be used to determine the structure of organic molecules. The processing of the data thus obtained allows them to intervene in the synthesis, development, production and analysis of the organic substances considered.

| Lecture Serial | Title of the Experiment | Remarks |
|---|---|---|
| Lab 11 | Assignment of labelled peaks in the $^{1}$H-NMR spectra of the known organic compounds explaining the relative δ-values and splitting pattern. | |
| Lab 12 | do | |
| Lab 13 | do | |
| Lab 14 | Assignment of labelled peaks in the IR spectrum of the same compound explaining the relative frequencies of the absorptions (C-H, O-H, N-H, C-O, C-N, C-X, C=C, C=O, N=O, C≡C, C≡N stretching frequencies; characteristic bending vibrations are included). | |
| Lab 15 | do | |
| Lab 16 | do | |
| Lab 17 | full spectral analysis of 4-Bromoacetanilide | |
| Lab 18 | 2/-Bromo-4/-methylacetophenone | |
| Lab 19 | Vanillin, 2/-Methoxyacetophenone | |
| Lab 20 | 4-Aminobenzoic acid, Salicylamide | |
| Lab 21 | 2/-Hydroxyacetophenone, 1,3-Dinitrobenzene | |
| Lab 22 | Benzylacetate, *trans*-4-Nitrocinnamaldehyde | |
| Lab 23 | Diethyl fumarate, 4-Nitrobenzaldehyde | |
| Lab 24 | 4-Methylacetanilide, Mesityl oxide | |
| Lab 25 | 2-Hydroxybenzaldehyde, 4-Nitroaniline | |
| Lab 26 | 2-Hydroxy-3-nitrobenzaldehyde, 2,3-Dimethylbenzonitrile | |
| Lab 27 | Pent-1-yn-3-ol, 3-Nitrobenzaldehyde, 3-Ethoxy-4-hydroxybenzaldehyde | |
| Lab 28 | 2-Methoxybenzaldehyde, Methyl 4-hydroxy benzoate, Methyl 3-hydroxybenzoate | Practice |
| Lab 29 | 3-Aminobenzoic acid, Ethyl 3-aminobenzoate, Ethyl 4-aminobenzoate | Practice |
| Lab 30 | 3-nitroanisole, 5-Methyl-2-nitroanisole, 3-Methylacetanilide | Practice |

**Reference Books:**

1. University Hand Book of Undergraduate Chemistry Experiments, edited by Mukherjee, G. N. University of Calcutta, 2003.
2. Practical Workbook Chemistry (Honours), UGBS, Chemistry, University of Calcutta, 2015.
3. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012).
4. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education.

**DEPARTMENT OF CHEMISTRY**
**GOVERNMENT GENERAL DEGREE COLLEGE, KALNA-I**
**LESSON PLAN**
**for**
**B. Sc. 5TH SEMESTER (Hons.) COURSES UNDER CBCS**

**Subject: Chemistry**
**Course code: DSE-1**
**Course title: Advanced Physical Chemistry (Theo)**

**Module-I**
Crystal Structure

**CONTENTS**

1. Bravais Lattice and Laws of Crystallography: Types of solid, Bragg's law of diffraction; Laws of crystallography (Haüy's law and Steno's law); Permissible symmetry axes in crystals; Lattice, space lattice, unit cell, crystal planes, Bravais lattice. Packing of uniform hard sphere, close packed arrangements (fcc and hcp); Tetrahedral and octahedral voids.
2. Crystal planes: Distance between consecutive planes [cubic, tetragonal and orthorhombic lattices]; Indexing of planes, Miller indices; calculation of dhkl; Relation between molar mass and unit cell dimension for cubic system; Bragg's law (derivation).
3. Determination of crystal structure: Powder method; Structure of NaCl and KCl crystals.

**Module Objectives:**

1. This unit aims to offer basic knowledge on Bravais Lattice and its different types of forms as well as percentage of packing,distance between two successive planes, Bragg's equation and determination of crystal structure with the help of various methods.

| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
|---|---|---|
| Lecture-1. | Types of solid, Bragg's law of diffraction | |
| Lecture-2. | Laws of crystallography (Haüy's law and Steno's law) | |
| Lecture-3. | Permissible symmetry axes in crystals | |
| Lecture-4. | Lattice, space lattice, unit cell, crystal planes, Bravais lattice. | |
| Lecture-5. | Packing of uniform hard sphere | |
| Lecture-6. | Close packed arrangements (fcc and hcp); Tetrahedral and octahedral voids. | |
| Lecture-7. | Distance between consecutive planes [cubic, tetragonal and orthorhombic lattices]; Indexing of planes, Miller indices; | |

| | | |
|---|---|---|
| | calculation of dhkl | |
| Lecture-8. | Relation between molar mass and unit cell dimension for cubic system; Bragg's law (derivation) | |
| Lecture- 9. | Determination of crystal structure by Powder method; Structure of NaCl and KCl crystals | |
| Lecture-10. | | Discussion on simple problems. |
| Lecture- 11. | | Discussion on simple problems |
| Lecture- 12 | | Discussion on simple problems |
| Lecture- 13 | | Solutions of previous year questions |
| Lecture- 14 | | Tutorial assignment |
| Lecture- 15 | | Tutorial assignment |
| Lecture-16 | | Tutorial assignment |
| Lecture-17 | | Tutorial assignment |
| Lecture-18 | | Tutorial assignment |
| Lecture-19 | | Tutorial assignment |

**Module-II**

Statistical Thermodynamics

**CONTENTS**

Macrostates, microstates and configuration; calculation with harmonic oscillator; variation of W with E; equilibrium configuration. Thermodynamic probability, entropy and probability, Boltzmann distribution formula (with derivation); Applications to barometric distribution; Partition function, concept of ensemble-canonical ensemble. molecular partition function and thermodynamic properties, Maxwell's speed distribution; Gibbs' paradox

**Module Objectives:**

1.From this portion students can acquire thorough background knowledge about preliminaries of statistical thermodynamics.

2. It helps the students to develop the basic idea about it to motivate themselves on the further studies.

| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
|---|---|---|

| | | |
|---|---|---|
| Lecture-20 | Macrostates, microstates and configuration | |
| Lecture-21. | Calculation with harmonic oscillator; variation of W with E; equilibrium configuration | |
| Lecture-22. | Thermodynamic probability, entropy and probability, Boltzmann distribution formula (with derivation) | |
| Lecture-23. | Applications to barometric distribution; Partition function, concept of ensemble - canonical ensemble. | |
| Lecture-24. | molecular partition function and thermodynamic properties, Maxwell's speed distribution; Gibbs' paradox. | |
| Lecture-25. | | Discussion on simple problems. |
| Lecture-26. | | Discussion on simple problems |
| Lecture-27. | | Solutions of previous year questions |
| Lecture-28. | | Tutorial assignment |
| Lecture-29. | | Tutorial assignment |
| Lecture-30. | | Tutorial assignment |

| **Module-III** |
|---|
| Special selected topics |
| **CONTENTS** |
| 1.Specific heat of solid: Coefficient of thermal expansion, thermal compressibility of solids; Dulong –Petit's law; Perfect Crystal model, Einstein's theory – derivation from partition function, limitations; Debye's $T^3$ law – analysis at the two extremes (without derivation of T3 law).<br>2. 3rd law: Absolute entropy, Planck's law, Calculation of entropy, Nernst heat |

theorem.
3. Polymers: Classification of polymers, nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers; Criteria for synthetic polymer formation; Relationships between functionality, extent of reaction and degree of polymerization; Mechanism and kinetics of step growth and copolymerization; Conducting polymers.
4. Dipole moment and polarizability: Polarizability of atoms and molecules, dielectric constant and polarisation, molar polarisation for polar and non-polar molecules; Clausius-Mosotti equation and Debye equation (both without derivation) and their application; Determination of dipole moments.

**Module Objectives:**

Idea of the above topic helps the students to understand the different types of applications of physical chemistry in various fields.

| Lecture Serial | Topics of Discussion | Remarks |
|---|---|---|
| Lecture-31. | Coefficient of thermal expansion, thermal compressibility of solids | |
| Lecture-32. | Dulong –Petit's law; Perfect Crystal model | |
| Lecture-33. | Einstein's theory – derivation from partition function, limitations | |
| Lecture-34. | Debye's T3 law–analysis at the two extremes (without derivation of T3 law). | |
| Lecture-35. | Absolute entropy, Planck's law, Calculation of entropy | |
| Lecture-36. | Nernst heat theorem | |
| Lecture-37. | Classification of polymers, nomenclature, Molecular forces and chemical bonding in polymers | |
| Lecture-38. | Texture of Polymers; Criteria for synthetic polymer formation; Relationships between functionality | |
| Lecture-39. | extent of reaction and degree of polymerization; Mechanism and kinetics of step growth and copolymerization; | |

| | | |
|---|---|---|
| | Conducting polymers. | |
| Lecture-40. | Polarizability of atoms and molecules, dielectric constant and polarisation | |
| Lecture-41 | molar polarisation for polar and non-polar molecules | |
| Lecture-42 | Clausius-Mosotti equation and Debye equation (both without derivation) and their application | |
| Lecture-43 | Determination of dipole moments. | |
| Lecture-44 | | Discussion on simple problems. |
| Lecture-45 | | Discussion on simple problems |
| Lecture-46 | | Discussion on simple problems |
| Lecture-47 | | Discussion on simple problems. |
| Lecture-48 | | Discussion on simple problems |
| Lecture-49 | | Discussion on simple problems |
| Lecture-50 | | Discussion on simple problems. |
| Lecture-51 | | Discussion on simple problems |
| Lecture-52 | | Discussion on simple problems |
| Lecture-53 | | Discussion on simple problems. |
| Lecture-54 | | Solutions of previous year questions |
| Lecture-55 | | Solutions of previous year questions |
| Lecture-56 | | Solutions of previous year questions |
| Lecture-57 | | Tutorial assignment |
| Lecture-58 | | Tutorial assignment |
| Lecture-60 | | Tutorial assignment |

| | | |
|---|---|---|
| Lecture-61 | | Tutorial assignment |
| Lecture-62 | | Tutorial assignment |
| Lecture-63 | | Tutorial assignment |

**Course code: DSE-1**

**Course title: Advanced Physical Chemistry (Prac)**

| **Module-I**<br>Practicals related to Physical Chemistry | | |
|---|---|---|
| **CONTENTS**<br>Numerical analysis of some physical properties | | |
| **Module Objectives:**<br>From this portion students can acquire background knowledge about the numerical processes which have been used to study some physical properties easily with the help of computational method. | | |
| **Lecture Serial** | **Title of the Experiment** | **Remarks** |
| Lab 1 | Roots of equations: (e.g. volume of van der Waals gas and comparison with ideal gas, pH of a weak acid) | |
| Lab 2 | Numerical differentiation (e.g., change in pressure for small change in volume of a van der Waals gas, potentiometric titrations) | |
| Lab 3 | Numerical integration (e.g. entropy/ enthalpy change from heat capacity data), probability distributions (gas kinetic theory) and mean values | |
| Lab 4 | Matrix operations (Application of Gauss-Siedel method in colourimetry) | |
| Lab 5 | . | Repeat class I |
| Lab 6 | | Repeat class II |
| Lab 7 | | Repeat class III |
| Lab 8 | | Repeat class IV |

| | | |
|---|---|---|
| Lab 9 | | Repeat class V |
| Lab 10 | | Model Examination |
| Lab 11 | | Model Examination |
| Lab 12 | | Revision |
| Lab 13 | | Revision |
| Lab 14 | | Revision |
| Lab 15 | | Revision |
| Lab 16 | | Revision |
| Lab 17 | | Revision |
| Lab 18 | | Revision |
| Lab 19 | | Revision |
| Lab 20 | | Revision |

**DEPARTMENT OF CHEMISTRY**
**GOVERNMENT GENERAL DEGREE COLLEGE, KALNA-I**
**LESSON PLAN**
**for**
**B. Sc. 5TH SEMESTER (Hons.) COURSES UNDER CBCS**

**Subject: Chemistry**
**Course code: DSE-2**
**Course title: Analytical methods in chemistry (Theo)**

| **Module-I**<br>Qualitative and quantitative aspects of analysis | | |
|---|---|---|
| **CONTENTS**<br>Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution, indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals. | | |
| **Module Objectives:**<br>1. This unit aims to offer basic knowledge on the handling of different types data coming from various analysis with proper error limit and reproducibility. | | |
| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
| Lecture-1. | Sampling, evaluation of analytical data, errors, accuracy and precision | |
| Lecture-2. | Methods of their expression, normal law of distribution, indeterminate errors | |
| Lecture-3. | Statistical test of data; F, Q and t test, rejection of data, and confidence intervals | |
| Lecture-4. | | Revison of previous class |
| Lecture-5. | | Revison of previous class |
| Lecture-6. | | Revison of previous class |
| Lecture-7. | | Revison of previous class |
| Lecture-8. | | Revison of previous class |
| Lecture- 9. | | Revison of previous class |
| Lecture-10. | | Discussion on simple problems. |

| | | |
|---|---|---|
| Lecture- 11. | | Discussion on simple problems |
| Lecture- 12 | | Discussion on simple problems |
| Lecture- 13 | | Solutions of previous year questions |
| Lecture- 14 | | Tutorial assignment |
| Lecture- 15 | | Tutorial assignment |
| Lecture-16 | | Tutorial assignment |
| Lecture-17 | | Tutorial assignment |
| Lecture-18 | | Tutorial assignment |
| Lecture-19 | | Tutorial assignment |

**Module-II**

Optical methods of analysis

**CONTENTS**

1. Origin of spectra, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.
2. UV-Visible Spectrophotometry: Basic principles of instrumentation (choice of source,monochromator and detector) for single and double beam instrument;
3. Basic principles of quantitative analysis: estimation of metal ions from aqueous solution,geometrical isomers, keto-enol tautomers. Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method.
4. Infrared Spectroscopy: Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques.Structural illustration through interpretation of data, Effect and importance of isotope substitution.
5. Flame Atomic Absorption and Emission Spectroscopy: Basic principles of instrumentation (choice of source, monochromator, and detector, choice of flame and Burner designs. Techniques of atomization and sample introduction; background correction, sources of chemical interferences and their removal. Techniques for the quantitative estimation of trace level of metal ions from environmental samples.

**Module Objectives:**

From this portion students can acquire thorough knowledge about different optical tools to measure the unknown species and it motivates themselves on the further studies for their self progression.

| Lecture Serial | Topics of Discussion | Remarks |
|---|---|---|
| Lecture-20 | Origin of spectra, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law. | |
| Lecture-21. | UV-Visible Spectrophotometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument | |
| Lecture-22. | Basic principles of quantitative analysis: estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers. Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method. | |
| Lecture-23. | Infrared Spectroscopy: Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques. Structural illustration through interpretation of data, Effect and importance of isotope substitution. | |
| Lecture-24. | Flame Atomic Absorption and Emission Spectroscopy: Basic principles of instrumentation (choice of source, monochromator, and detector, choice of | |

| | | |
|---|---|---|
| | flame and Burner designs. Techniques of atomization and sample introduction; background correction, sources of chemical interferences and their removal. Techniques for the quantitative estimation of trace level of metal ions from environmental samples. | |
| Lecture-25. | | Discussion on simple problems |
| Lecture-26. | | Discussion on simple problems |
| Lecture-27. | | Solutions of previous year questions |
| Lecture-28. | | Tutorial assignment |
| Lecture-29. | | Tutorial assignment |
| Lecture-30. | | Tutorial assignment |

**Module-III**

Thermal methods of analysis & Electroanalytical methods

**CONTENTS**

1. Theory of thermogravimetry (TG), basic principle of instrumentation. Techniques for quantitative estimation of Ca and Mg from their mixture.
2. Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pKa values.

**Module Objectives:**

Idea of the above topic helps the students to understand thermal analysis and electroanalytical aanlysis of the substances

| Lecture Serial | Topics of Discussion | Remarks |
|---|---|---|
| Lecture-31. | Theory of thermogravimetry (TG), basic principle of instrumentation | |
| Lecture-32. | Techniques for quantitative estimation of Ca and Mg from their | |

| | | |
|---|---|---|
| | mixture. | |
| Lecture-33. | Classification of electroanalytical methods, basic principle of pH metric | |
| Lecture-34. | potentiometric and conductometric titrations | |
| Lecture-35. | Techniques used for the determination of equivalence points. Techniques used for the determination of pKa values. | |
| Lecture-36. | | Revison of previous class |
| Lecture-37. | | Revison of previous class |
| Lecture-38. | | Discussion on simple problems. |
| Lecture-39. | | Discussion on simple problems |
| Lecture-40. | | Tutorial assignment |
| Lecture-41 | | Tutorial assignment |

| **Module-IV**<br>Separation techniques |
|---|
| CONTENTS<br>1. Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation.<br>2. Technique of extraction: batch, continuous and counter current extractions.<br>3. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media.<br>4. Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange.<br>5. Development of chromatograms: frontal, elution and displacement methods.<br>6. Qualitative and quantitative aspects of chromatographic methods of analysis: TLC, LC, GLC, and HPLC.<br>7. Stereoisomeric separation and analysis: Measurement of optical rotation, calculation of Enantiomeric excess (ee)/ diastereomeric excess (de) ratios and determination of enantiomeric composition using NMR, Chiral solvents and chiral shift reagents. Chiral chromatographic techniques using chiral columns (GC and HPLC).<br>8. Role of computers in instrumental methods of analysis. |
| **Module Objectives**:<br>Idea of the above topic helps the students to understand solvent techniques for |

| | | |
|---|---|---|
| the estimation of the substances | | |
| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
| Lecture-42. | Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. | |
| Lecture-43. | Technique of extraction: batch, continuous and counter current extractions. | |
| Lecture-44. | Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media. | |
| Lecture-45. | Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. | |
| Lecture-46. | Development of chromatograms: frontal, elution and displacement methods. | |
| Lecture-47. | Qualitative and quantitative aspects of chromatographic methods of analysis: TLC, LC, GLC, and HPLC. | |
| Lecture-48. | Stereoisomeric separation and analysis: Measurement of optical rotation, calculation of Enantiomeric excess (ee)/ diastereomeric excess (de) ratios and determination of enantiomeric | |

| | | |
|---|---|---|
| | composition using NMR, Chiral solvents and chiral shift reagents. Chiral chromatographic techniques using chiral columns (GC and HPLC). | |
| Lecture-49. | Role of computers in instrumental methods of analysis | |
| Lecture-50. | | Revison of previous class |
| Lecture-51. | | Revison of previous class |
| Lecture-52 | | Revison of previous class |
| Lecture-53 | | Revison of previous class |
| Lecture-54 | | Revison of previous class |
| Lecture-55 | | Discussion on simple problems. |
| Lecture-56 | | Discussion on simple problems |
| Lecture-57 | | Discussion on simple problems. |
| Lecture-58 | | Discussion on simple problems |
| Lecture-59 | | Tutorial assignment |
| Lecture-60 | | Tutorial assignment |
| Lecture-61 | | Tutorial assignment |
| Lecture-62 | | Tutorial assignment |

**Course code: DSE-2**

**Course title: Analytical methods in chemistry (Prac)**

| **Module-I**<br>Practicals related to Physical Chemistry | | |
|---|---|---|
| **CONTENTS**<br>Numerical analysis of some physical properties | | |
| **Module Objectives:**<br>From this portion students can acquire background knowledge about the numerical processes which have been used to study some physical properties easily with the help of computational method. | | |
| **Lecture Serial** | **Title of the Experiment** | **Remarks** |
| Lab 1 | Separation and identification of the monosaccharides in a mixture (glucose & fructose) by paper chromatography. Reporting the Rf values. | |
| Lab 2 | Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their Rf values. | |
| Lab 3 | Separation of the active ingredients of plants, flowers and juices by TLC | |
| Lab 4 | To separate a mixture of $Ni^{2+}$ & $Fe^{2+}$ by complexation with DMG and extracting the $Ni^{2+}$- DMG complex in chloroform, and determine its concentration by spectrophotometry | |
| Lab 5 | Determination of pH of soil | |
| Lab 6 | Determination of total soluble salt | |
| Lab 7 | Estimation of calcium, magnesium, phosphate, nitrate | |
| Lab 8 | Determination of exchange capacity of cation exchange resins and anion exchange resins. | |
| Lab 9 | Determination of pKa values of indicator using spectrophotometry | |

| | | |
|---|---|---|
| Lab 10 | Determination of chemical oxygen demand (COD) | |
| Lab 11 | Determination of Biological oxygen demand (BOD) | |
| Lab 12 | | Model Examination |
| Lab 13 | | Model Examination |
| Lab 14 | | Revision |
| Lab 15 | | Revision |
| Lab 16 | | Revision |
| Lab 17 | | Revision |
| Lab 18 | | Revision |
| Lab 19 | | Revision |
| Lab 20 | | Revision |

**DEPARTMENT OF CHEMISTRY**
**GOVERNMENT GENERAL DEGREE COLLEGE, KALNA-I**
**LESSON PLAN**
**for**
**B. Sc. 6th SEMESTER (Hons.) COURSES UNDER CBCS**

**Subject: Chemistry**
**Course code: CC-13**
**Course title: Inorganic Chemistry-V (Theo)**

| **Module-I**<br>Bioinorganic Chemistry | | |
|---|---|---|
| **CONTENTS**<br>Elements of life: essential and beneficial elements, major, trace and ultratrace elements. Role of metal ions (specially $Na^+$, $K^+$, $Mg^{2+}$, $Ca^{2+}$, $Fe^{3+/2+}$, $Cu^{2+/+}$, and $Zn^{2+}$)in biological systems. Metal ion transport across biological membrane $Na^+/K^+$-ion pump. Oxygen transport in biological systems: Haemoglobin, Myoglobin, Hemocyanine and Hemerythrin. Electron transfer proteins: Cytochromes and Ferredoxins. Hydrolytic enzymes: carbonate bicarbonate buffering system, carbonic anhydrase and carboxyanhydrase A. Biological nitrogen fixation, Photosynthesis: Photosystem-I and Photosystem-II. Toxic metal ions and their effects, chelation therapy (examples only), Pt and Au complexes as drugs (examples only), metal dependent diseases (examples only). | | |
| **Module Objectives:**<br>The study bioinorganic chemistry helps student understand the role of various metal ions in biological systems and provide them a clear picture of two important aspects of life process like photosynthesis and respiration.<br>Important applications of chelation therapy and uses of complexes make student interested for the further study of medicinal chemistry. | | |
| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
| Lecture-1. | Essential and beneficial elements, major, trace and ultratrace elements. | |
| Lecture-2. | Role of metal ions in biological systems. | |
| Lecture-3. | Role of metal ions in different biological systems. | |
| Lecture-4. | Metal ion transport across biological membrane | |
| Lecture-5. | $Na^+/K^+$-ion pump | |
| Lecture-6. | Oxygen transport in biological systems: Haemoglobin | |
| Lecture-7. | Myoglobin, Hemocyanine and Hemerythrin | |
| Lecture-8. | Electron transfer proteins: | |

| | | |
|---|---|---|
| | Cytochromes and Ferredoxins | |
| Lecture- 9. | Hydrolytic enzymes: carbonate bicarbonate buffering system | |
| Lecture-10. | carbonic anhydrase and carboxyanhydrase A | |
| Lecture- 11. | Biological nitrogen fixation | |
| Lecture-12. | Photosynthesis: Photosystem-I | |
| Lecture-13. | Photosystem-II | |
| Lecture-14. | Toxic metal ions and their effects | |
| Lecture-15. | Chelation therapy | |
| Lecture-16. | Pt and Au complexes as drugs, metal dependent diseases | |
| Lecture-17. | | Discussion on simple problems. |
| Lecture-18. | | Solutions of previous year questions |
| Lecture-19. | | Tutorial assignment – 1 |
| Lecture-20. | | Tutorial assignment – 2 |

**Module-II**

Organometallic Chemistry

**CONTENTS**

Definition and classification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands. 18-electron and 16-electron rules (pictorial MO approach). Applications of 18-electron rule to metal carbonyls, nitrosyls, cyanides. General methods of preparation of mono and binuclear carbonyls of 3d series. Structures of mononuclear and binuclear carbonyls. Π-acceptor properties of CO, synergic effect and use of IR data to explain extent of back bonding. Zeise's salt: Preparation, structure, evidences of synergic effect. Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation). Reactions of organometallic complexes: substitution, oxidative addition, reductive elimination and insertion reactions.

**Module Objectives:**

After the completion of the study of organometallic chemistry learners now begin a journey to a new world of chemistry which is indeed an interdisciplinary study of organic and inorganic chemistry. This study pays the students a huge dividend in their future course of research work.

| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
|---|---|---|

| | | |
|---|---|---|
| Lecture-21. | Definition and classification of organometallic compounds on the basis of bond type | |
| Lecture-22. | Concept of hapticity of organic ligands. 18-electron and 16-electron rules | |
| Lecture-23. | Applications of 18-electron rule to metal carbonyls, nitrosyls, cyanides | |
| Lecture-24. | General methods of preparation of mono and binuclear carbonyls of 3d series | |
| Lecture-25. | Structures of mononuclear and binuclear carbonyls | |
| Lecture-26. | Π-acceptor properties of CO, synergic effect | |
| Lecture-27. | Use of IR data to explain extent of back bonding | |
| Lecture-28. | Zeise's salt: Preparation, structure, evidences of synergic effect | |
| Lecture-29. | Ferrocene: Preparation and reactions | |
| Lecture-30. | Reactions of organometallic complexes: substitution, oxidative addition, reductive elimination and insertion reactions | |
| Lecture-31. | Reactions of organometallic complexes: substitution, oxidative addition, reductive elimination and insertion reactions | |
| Lecture-32. | | Discussion on simple problems. |
| Lecture-33. | | Solutions of previous year questions |

| | | |
|---|---|---|
| Lecture-34. | | Tutorial assignment – 3 |
| Lecture-35. | | Tutorial assignment – 4 |

| **Module-III**<br>Catalysis by Organometallic Compounds | | |
|---|---|---|
| **CONTENTS**<br>Study of the following industrial processes<br>1. Alkene hydrogenation (Wilkinson's Catalyst)<br>2. Hydroformylation<br>3. Wacker Process<br>4. Synthetic gasoline (Fischer Tropsch reaction)<br>5. Ziegler-Natta catalysis for olefin polymerization. | | |
| **Module Objectives:**<br>Students learn the industrial applications of different Organometallic Compounds through this unit. | | |
| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
| Lecture-36. | Alkene hydrogenation | |
| Lecture-37. | Hydroformylation | |
| Lecture-38. | Wacker Process | |
| Lecture-39. | Synthetic gasoline | |
| Lecture-40. | Ziegler-Natta catalysis for olefin polymerization | |
| Lecture-41. | Industrial applications of different Organometallic Compounds | |
| Lecture-42. | | Discussion on simple problems. |
| Lecture-43. | | Solutions of previous year questions |
| Lecture-44. | | Tutorial assignment – 5 |
| Lecture-45. | | Tutorial assignment – 6 |

| **Module-IV**<br>Reaction Kinetics and Mechanism |
|---|
| **CONTENTS**<br>Introduction to inorganic reaction mechanisms. Substitution reactions in square planar complexes, Trans- effect and its application in complex synthesis, theories of trans effect, Mechanism of nucleophilic substitution in square planar complexes, Thermodynamic and Kinetic stability, Kinetics of |

| | | |
|---|---|---|
| octahedral substitution reactions, Ligand field effects and reaction rates, Mechanism of substitution in octahedral complexes. | | |
| **Module Objectives:**<br>The students will have an introductory concept of inorganic reaction kinetics & mechanism and thermodynamic and kinetic stability. | | |
| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
| Lecture-46. | Classifications of inorganic reactions | |
| Lecture-47. | Substitution reactions in square planar complexes | |
| Lecture-48. | Trans- effect and its application in complex synthesis | |
| Lecture-48. | Theories of trans effect | |
| Lecture-49. | Mechanism of nucleophilic substitution in square planar complexes | |
| Lecture-50. | Thermodynamic and Kinetic stability (Lability & Inertness) | |
| Lecture-51. | Kinetics of octahedral substitution reactions | |
| Lecture-52. | Ligand field effects and reaction rates | |
| Lecture-53. | Mechanism of substitution in octahedral complexes | |
| Lecture-54. | Different factors that affecting rate of substitutions reactions | |
| Lecture-55. | | Discussion on simple problems. |
| Lecture-56. | | Solutions of previous year questions |
| Lecture-57. | | Tutorial assignment – 7 |
| Lecture-58. | | Tutorial assignment – 8 |

**Course code: CC-13**

**Course title: Inorganic Chemistry-V (Prac)**

| **Module-I** |
|---|
| Qualitative semimicro analysis |

**CONTENTS**

Qualitative semimicro analysis of mixtures containing four radicals. Emphasis should be given to the understanding of the chemistry of different reactions and to assign the most probable composition.

Cation Radicals: Na+, K+, $Ca^{2+}$, $Sr^{2+}$, $Ba^{2+}$, $Al^{3+}$, $Cr^{2+}$, $Mn^{2+}/Mn^{4+}$, $Fe^{3+}$, $Co^{2+}/Co^{3+}$, $Ni^{2+}$, $Cu^{2+}$, $Zn_{2+}$, $Pb^{2+}$, $Cd^{2+}$, $Bi^{3+}$, $Sn^{2+}/Sn^{4+}$, $As^{3+}/As^{5+}$, $Sb^{3+/5+}$, $NH_4^+$, $Mg^{2+}$.

Anion Radicals: $F^-$, $Cl^-$, $Br^-$, $BrO_3^-$, $I^-$, $IO_3^-$, $SCN^-$, $S^{2-}$, $SO_4^{2-}$, $NO_3^-$, $NO_2^-$, $PO_4^{3-}$, $AsO_4^{3-}$, $BO_3^{3-}$, $CrO_4^{2-}/Cr_2O_7^{2-}$, $Fe(CN)_6^{4-}$, $Fe(CN)_6^{3-}$.

Insoluble Materials: $Al_2O_3$(ig), $Fe_2O_3$(ig), $Cr_2O_3$(ig), $SnO_2$, $SrSO_4$, $BaSO_4$, $CaF_2$, $PbSO_4$.

**Module Objectives:**

After completion this course the students will be acquainted with the practical qualitative analysis of various acid radicals as well as basic radicals including the treatment of insoluble materials.

| **Lecture Serial** | **Title of the Experiment** | **Remarks** |
|---|---|---|
| Lab 1 | Introduction | |
| Lab 2 | Dry test for basic radicals<br>Heating in a dry test tube<br>Soda lime test | |
| Lab 3 | Dry test for basic radicals<br>Charcoal block test<br>Cobalt nitrate test<br>Flame test | |
| Lab 4 | Borax bead test<br>Oxidative fusion test for Cr and Mn<br>Fluorescence test for Sn | |
| Lab 5 | Special test for Fe, Cu, Cd, Co, Ni, Sb, Bi, K, Zn, Al, Zn, Pb, Ag, As, Sb and $NH_4^+$ salts | |
| Lab 6 | Special test for interfering acid radicals | |
| Lab 7 | Dry test for acidic radicals | |
| Lab 8 | Wet test for basic radicals | |
| Lab 9 | General group separation | |
| Lab 10 | General group separation | |
| Lab 11 | Interfering acid radicals removal | |
| Lab 12 | Analysis of group precipitates | |
| Lab 13 | Analysis of group | |

| | | |
|---|---|---|
| | precipitates | |
| Lab 14 | Analysis of group precipitates | |
| Lab 15 | Analysis of group precipitates | |
| Lab 16 | Analysis of group precipitates | |
| Lab 17 | Analysis of some insoluble compounds | |
| Lab 18 | Analysis of some insoluble compounds | |
| Lab 19 | Analysis of an unknown inorganic mixture | |
| Lab 20 | Analysis of an unknown inorganic mixture | |
| Lab 21 | Analysis of an unknown inorganic mixture | |
| Lab 22 | | Repeat class I |
| Lab 23 | | Repeat class II |
| Lab 24 | | Repeat class III |
| Lab 25 | | Repeat class IV |
| Lab 26 | | Model Examination |
| Lab 27 | | Model Examination |
| Lab 28 | | Revision |
| Lab 29 | | Revision |
| Lab 30 | | Revision |

**DEPARTMENT OF CHEMISTRY**
**GOVERNMENT GENERAL DEGREE COLLEGE, KALNA-I**
**LESSON PLAN**
**for**
**B. Sc. 6th SEMESTER (Hons.) COURSES UNDER CBCS**

**Subject: Chemistry**
**Course code: CC-14**
**Course title: Physical Chemistry-IV (Theo)**

**Module-I**
Molecular Spectroscopy

**CONTENTS**

1. Interaction of electromagnetic radiation with molecules and various types of spectra; Born-Oppenheimer approximation
2. Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution
3. Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration.
4. Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion
5. Nuclear Magnetic Resonance (NMR) spectroscopy: Principles of NMR spectroscopy, Larmor precession, chemical shift and low resolution spectra, different scales, spin-spin coupling and high resolution spectra.

**Module Objectives:**

This unit aims to offer basic knowledge on Molecular Spectroscopy which gives the idea about the electronic transistion whatever it will be taken place or not. And in addition to it, From this student will have to know about the molecular structure and its salient features.

| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
|---|---|---|
| Lecture-1. | Interaction of electromagnetic radiation with molecules and various types of spectra; Born-Oppenheimer approximation | |
| Lecture-2. | Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution | |
| Lecture-3. | Classical equation of vibration, | |

| | | |
|---|---|---|
| | computation of force constant, amplitude of diatomic molecular vibrations | |
| Lecture-4. | Anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration. | |
| Lecture-5. | Qualitative treatment of Rotational Raman effect | |
| Lecture-6. | Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines | |
| Lecture-7. | Intensity difference, rule of mutual exclusion | |
| Lecture-8. | Principles of NMR spectroscopy, Larmor precession, chemical shift | |
| Lecture- 9. | Low resolution spectra, different scales, spin-spin coupling and high resolution spectra | |
| Lecture-10. | | Discussion on simple problems. |
| Lecture- 11. | | Discussion on simple problems |
| Lecture- 12 | | Discussion on simple problems |
| Lecture- 13 | | Solutions of previous year questions |
| Lecture- 14 | | Tutorial assignment |
| Lecture- 15 | | Tutorial assignment |
| Lecture-16 | | Tutorial assignment |
| Lecture-17 | | Tutorial assignment |
| Lecture-18 | | Tutorial assignment |
| Lecture-19 | | Tutorial |

| | | |
|---|---|---|
| | | assignment |

**Module-II**

Photochemistry

**CONTENTS**

1. Lambert-Beer's law: Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients; Laws of photochemistry, Stark-Einstein law of photochemical equivalence quantum yield, actinometry, examples of low and high quantum yields
2. Photochemical Processes: Potential energy curves (diatomic molecules), Frank-Condon principle and vibrational structure of electronic spectra; Bond dissociation and principle of determination of dissociation energy (ground state); Decay of excited states by radiative and non-radiative paths; Pre-dissociation; Fluorescence and phosphorescence, Jablonski diagram;
3. Rate of Photochemical processes: Photochemical equilibrium and the differential rate of photochemical reactions, Photostationary state; HI decomposition, H2-Br2 reaction, dimerisation of anthracene; photosensitised reactions, quenching; Role of photochemical reactions in biochemical processes,photostationary states, chemiluminescence.

**Module Objectives:**

1. From this portion students can acquire sound knowledge about preliminaries of Photochemistry.
2. It helps the students to develop the basic idea about it to motivate themselves on the further studies.

| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
|---|---|---|
| Lecture-20 | Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients | |
| Lecture-21. | Laws of photochemistry, Stark-Einstein law of photochemical equivalence quantum yield | |
| Lecture-22. | Examples of low and high quantum yields | |
| Lecture-23. | Joule's experiment and its consequence. | |
| Lecture-24. | Potential energy curves (diatomic molecules), Frank-Condon principle and vibrational structure of electronic spectra | |

| | | |
|---|---|---|
| Lecture-25. | Bond dissociation and principle of determination of dissociation energy (ground state); Decay of excited states by radiative and non-radiative paths; Pre-dissociation; Fluorescence and phosphorescence, Jablonski diagram; | |
| Lecture-26. | Photochemical equilibrium and the differential rate of photochemical reactions, Photostationary state; HI decomposition, H2-Br2 reaction, dimerisation of anthracene; photosensitised reactions, quenching | |
| Lecture-27. | Role of photochemical reactions in biochemical processes, photostationary states,chemiluminescence. | |
| Lecture-28. | | Discussion on simple problems |
| Lecture-29. | | Solutions of previous year questions |
| Lecture-30. | | Tutorial assignment |

| **Module-III** |
|---|
| Surface phenomenon |
| **CONTENTS** |
| 1. Surface tension and energy: Surface tension, surface energy, excess pressure, capillary rise and surface tension; Work of cohesion and adhesion, spreading of liquid over other surfaces; Vapour pressure over curved surface; Temperature dependence of surface tension<br>2. Adsorption: Physical and chemical adsorption; Freundlich and Langmuir adsorption isotherms; multilayer adsorption and BET isotherm (no derivation required); Gibbs adsorption isotherm and surface excess; Heterogenous catalysis (single reactant); Zero order and fractional order reactions;<br>3. Colloids: Lyophobic and lyophilic sols, Origin of charge and stability of lyophobic colloids,Coagulation and Schultz-Hardy rule, Zeta potential and |

| | | |
|---|---|---|
| Stern double layer (qualitative idea),Tyndall effect; Electrokinetic phenomena (qualitative idea only); Determination of Avogadro number by Perrin's method; Stability of colloids and zeta potential; Micelle formation. | | |
| **Module Objectives:**<br>Idea of Surface phenomenon helps the students to understand the various types surface related activity of different substances and which will lead the students into further research oriented studies. | | |
| Lecture Serial | Topics of Discussion | Remarks |
| Lecture-31. | Surface tension, surface energy | |
| Lecture-32. | Excess pressure, capillary rise and surface tension | |
| Lecture-33. | Work of cohesion and adhesion, spreading of liquid over other surfaces | |
| Lecture-34. | Vapour pressure over curved surface; Temperature dependence of surface tension | |
| Lecture-35. | Physical and chemical adsorption; Freundlich and Langmuir adsorption isotherms | |
| Lecture-36. | Multilayer adsorption and BET isotherm (no derivation required) | |
| Lecture-37. | Gibbs adsorption isotherm and surface excess | |
| Lecture-38. | Heterogenous catalysis (single reactant) | |
| Lecture-39. | Zero order and fractional order reactions | |
| Lecture-40. | Lyophobic and lyophilic sols | |
| Lecture-41 | Origin of charge and stability of lyophobic colloids | |
| Lecture-42 | Coagulation and Schultz-Hardy rule | |
| Lecture-43 | Zeta potential and Stern double layer (qualitative idea),Tyndall effect | |

| | | |
|---|---|---|
| Lecture-44 | Electrokinetic phenomena (qualitative idea only) | |
| Lecture-45 | Determination of Avogadro number by Perrin's method | |
| Lecture-46 | Stability of colloids and zeta potential | |
| Lecture-47 | Micelle formation | |
| Lecture-48 | | Discussion on simple problems. |
| Lecture-50 | | Discussion on simple problems |
| Lecture-51 | | Discussion on simple problems |
| Lecture-52 | | Solutions of previous year questions |
| Lecture-53 | | Tutorial assignment |
| Lecture-54 | | Tutorial assignment |
| Lecture-55 | | Tutorial assignment |
| Lecture-56 | | Tutorial assignment |
| Lecture-57 | | Tutorial assignment |

**Course code: CC-14**

**Course title: Physical Chemistry-IV (Prac)**

| **Module-I**<br>Practicals related to Physical Chemistry | | |
|---|---|---|
| **CONTENTS**<br>Instrumnetal analysis of some physical properties | | |
| **Module Objectives:**<br>From this portion students can acquire sound knowledge about the instruments which have been used to study some physical properties and reaction path. | | |
| **Lecture Serial** | **Title of the Experiment** | **Remarks** |
| Lab 1 | Determination of surface tension of a liquid using Stalagmometer. | |
| Lab 2 | Determination of CMC from surface tension measurements | |
| Lab 3 | Verification of Beer and Lambert's Law for $KMnO_4$ and $K_2Cr_2O_7$ solution | |
| Lab 4 | Determination of pH of unknown buffer, spectrophotometrically | |
| Lab 5 | | Repeat class I |
| Lab 6 | | Repeat class II |
| Lab 7 | | Repeat class III |
| Lab 8 | | Repeat class IV |
| Lab 9 | | Repeat class V |
| Lab 10 | | Model Examination |
| Lab 11 | | Model Examination |
| Lab 12 | | Revision |
| Lab 13 | | Revision |
| Lab 14 | | Revision |
| Lab 15 | | Revision |
| Lab 16 | | Revision |
| Lab 17 | | Revision |

| | | |
|---|---|---|
| Lab 18 | | Revision |
| Lab 19 | | Revision |
| Lab 20 | | Revision |

**DEPARTMENT OF CHEMISTRY**
**GOVERNMENT GENERAL DEGREE COLLEGE, KALNA-I**
**LESSON PLAN**
**for**
**B. Sc. 6th SEMESTER (Hons.) COURSES UNDER CBCS**

**Subject: Chemistry**
**Course code: DSE-3**
**Credits-4**
**Course title: Polymer Chemistry (Theo)**

| **Module-I**<br>Introduction and history of polymeric materials | | |
|---|---|---|
| **CONTENTS**<br>Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers. **4 classes** | | |
| **Module Objectives**<br>This unit aims to offer basic knowledge on polymeric materials and their classifications. It includes several examples of our daily use. | | |
| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
| Lecture-1. | Different schemes of classification of polymers | |
| Lecture-2. | Polymer nomenclature | |
| Lecture-3. | Molecular forces and chemical bonding in polymers; Texture of Polymers | |
| Lecture-4. | | Discussion on doubts and problems |

| **Module-II**<br>Functionality and its importance | | |
|---|---|---|
| **CONTENTS**<br>Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bifunctional systems, Poly-functional systems. **4 classes** | | |
| **Module Objectives**<br>This unit will provide knowledge on criteria and classification of polymerization processes. It will also help students to know about extent and degree of polymerization. | | |
| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
| Lecture-5. | Criteria for synthetic polymer formation, classification of polymerization processes | |
| Lecture-6. | Relationships between functionality, extent of reaction and degree of polymerization | |

| | | |
|---|---|---|
| Lecture-7. | Bifunctional systems, Poly-functional systems | |
| Lecture-8. | | Discussion on doubts and problems |

| **Module-III**<br>Kinetics of Polymerization | | |
|---|---|---|
| **CONTENTS**<br>Mechanism and kinetics of step growth, radical chain growth, kinetics of copolymerization, polymerization techniques. **4 classes** | | |
| **Module Objectives**<br>This part will help students to raise knowledge about<br>• mechanism and kinetics of polymerization and copolymerization<br>• Techniques of polymerization | | |
| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
| Lecture-9. | Mechanism and kinetics of step growth | |
| Lecture-10. | Mechanism and kinetics of radical chain growth | |
| Lecture-11. | kinetics of copolymerization | |
| Lecture-12. | polymerization techniques | |

| **Module-IV**<br>Determination of molecular weight of polymers | | |
|---|---|---|
| **CONTENTS**<br>Mn, Mw, etc. (by end group analysis), viscometry, osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index. **4 classes** | | |
| **Module Objectives**<br>Determination of molecular weight is not easy for polymeric materials. There are two types of Molecular weight namely weight average Molecular weight (Mw) and Number average Molecular weight (Mn). This portion will engage about the methods and calculations of molecular weight of polymers.<br>The concept of Polydispersity index (PDI) is used as a measure of broadness of molecular weight distribution. The larger the PDI, the broader the molecular weight. | | |
| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
| Lecture-13. | Mn, Mw, etc. (by end group analysis) | |
| Lecture-14. | viscometry, osmotic pressure methods | |
| Lecture-15. | Molecular weight distribution and its significance | |
| Lecture-16. | Polydispersity Index (PDI) | |

**Module-V**

Glass transition temperature (Tg) and determination of Tg

**CONTENTS**

Free volume theory, WLF equation, Factors affecting glass transition temperature (Tg). **4 classes**

**Module Objectives**

Tg of polymers describes the conversion of glassy state into rubbery state whereas the Tm of polymers describes the conversion of crystalline state into an amorphous state. Students also learn about the importance of Tg over Tm and its determenation.

| Lecture Serial | Topics of Discussion | Remarks |
|---|---|---|
| Lecture-17. | Definition of Tg and Tm; differences; importance of Tg | |
| Lecture-18. | Free volume theory, WLF equation | |
| Lecture-19. | Factors affecting glass transition temperature (Tg) | |
| Lecture-20. | | Question-Answer |

**Module-VI**

Polymer Solution

**CONTENTS**

Criteria for polymer solubility, Solubility parameter, Thermodynamics of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions. **2 classes**

**Module Objectives**

In this part students will accrue knowledge about solubility of polymers in different solvents: Kinetic and Thermodynamic aspects

| Lecture Serial | Topics of Discussion | Remarks |
|---|---|---|
| Lecture-21. | Criteria for polymer solubility, Solubility parameter | |
| Lecture-22. | Thermodynamics of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions | |

**Module-VII**

Polymer Solution

**CONTENTS**

Brief introduction to preparation, structure, properties and application of the following polymers:

1. polyolefins, polystyrene and styrene copolymers
2. poly(vinyl chloride) and related polymers
3. Polyamides and related polymers
4. Phenol formaldehyde resins (Bakelite, Novalac)
5. Polycarbonates
6. Conducting Polymers, [polyacetylene, polyaniline, poly(p-phenylene sulphide)

polypyrrole, polythiophene)] **38 classes**

**Module Objectives**

In this portion students will actually learn about the preparation, structure, properties and application of the commonly used synthetic polymers such as polythene, polypropylene, PVC, Bakelite etc. They will also study about world wide application of polymers from our house hold to various fields i.e. polymer industry.

| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
|---|---|---|
| Lecture-23. | polyolefins | |
| Lecture-24. | Polythene (PE) | |
| Lecture-25. | Polypropylene (PP) | |
| Lecture-26. | polystyrene | |
| Lecture-27. | styrene copolymers | |
| Lecture-28. | poly(vinyl chloride) -PVC | |
| Lecture-29. | PVC related polymers | |
| Lecture-30. | Polyamides and related polymers-Part I | |
| Lecture-31. | Polyamides and related polymers-Part II | |
| Lecture-32. | Phenol formaldehyde resins (Bakelite) | |
| Lecture-33. | Phenol formaldehyde resins (Novalac) | |
| Lecture-34. | Polycarbonates | |
| Lecture-35. | Conducting Polymers | |
| Lecture-36. | polyacetylene | |
| Lecture-37. | polyaniline | |
| Lecture-38. | poly(p-phenylene sulphide) | |
| Lecture-39. | polypyrrole | |
| Lecture-40. | polythiophene | |
| Lecture-41. | Preparation of flow chart of different polymers | |
| Lecture-42. | do | |
| Lecture-43. | do | |
| Lecture-44. | do | |
| Lecture-45. | do | |
| Lecture-46. | do | |
| Lecture-47. | do | |
| Lecture-48. | do | |
| Lecture-49. | do | |
| Lecture-50. | Video graphic representation of application of polymers | |

| | | |
|---|---|---|
| Lecture-51. | do | |
| Lecture-52. | do | |
| Lecture-53. | do | |
| Lecture-54. | | Discussion on doubts and problems |
| Lecture-55. | | Discussion on doubts and problems |
| Lecture-56. | | Question-Answer |
| Lecture-57. | | Question-Answer |
| Lecture-58. | | Question-Answer |
| Lecture-59. | | Question-Answer |
| Lecture-60. | | Question-Answer |

**Reference Books:**


1. R.B. Seymour & C.E. Carraher: Polymer Chemistry: An Introduction, Marcel Dekker, Inc. New York, 1981.
2. G. Odian: Principles of Polymerization, 4th Ed. Wiley, 2004.
3. F.W. Billmeyer: Textbook of Polymer Science, 2nd Ed. Wiley Interscience, 1971.
4. P. Ghosh: Polymer Science & Technology, Tata McGraw-Hill Education, 1991.
5. R.W. Lenz: Organic Chemistry of Synthetic High Polymers. Interscience Publishers, New York, 1967.
6. Tanford, C., Physical chemistry of macromolecules, John Wiley & Sons, Inc., 440 Park Ave. South, New York 16, N. Y., 1961.


## Course code: DSE-3

**2 Credits**

## Course title: Polymer Chemistry (Prac)

| **Module-I**<br>Polymer Synthesis | | |
|---|---|---|
| **CONTENTS**<br>1. Preparation of nylon 66/6<br>2. Preparations of novalac resin/ resold resin. **12 classes** | | |
| **Module Objectives:**<br>There will be a scope to the students for practical experience of polymer synthesis which may be fruitful during their future research or in allied job markets. | | |
| **Lecture Serial** | **Title of the Experiment** | **Remarks** |
| Lab 1 | Laboratory Instructions and guidance on Lab notebook preparation | |
| Lab 2 | Theoretical discussion about the reaction | |
| Lab 3 | Basic design for the synthesis protocol and collection of apparatus | |
| Lab 4 | Preparation of nylon 66 | |

| | | |
|---|---|---|
| Lab 5 | continuation | |
| Lab 6 | continuation | |
| Lab 7 | Isolation and purification of nylon 66 | |
| Lab 8 | Preparations of novalac resin | |
| Lab 9 | continuation | |
| Lab 10 | continuation | |
| Lab 11 | continuation | |
| Lab 12 | Isolation and purification of novalac resin | |

| **Module-II**<br>Polymer Characterization | | |
|---|---|---|
| **CONTENTS**<br>1. Determination of molecular weight by viscometry:<br>a. Polyacrylamide-aq.$NaNO_2$ solution<br>b. (Poly vinyl proplylidine (PVP) in water<br>2. Determination of hydroxyl number of a polymer using colorimetric method. **12 classes** | | |
| **Module Objectives:**<br>There will be a scope to the students for practical experience of polymer synthesis which may be fruitful during their future research or in allied job markets. | | |
| **Lecture Serial** | **Title of the Experiment** | **Remarks** |
| Lab 13 | Determination of molecular weight by viscometry: Polyacrylamide-aq.$NaNO_2$ solution | |
| Lab 14 | continuation | |
| Lab 15 | continuation | |
| Lab 16 | calculation and lab note book preparation | |
| Lab 17 | Determination of molecular weight by viscometry: (Poly vinyl proplylidine (PVP) in water | |
| Lab 18 | continuation | |
| Lab 19 | continuation | |
| Lab 20 | calculation and lab note book preparation | |
| Lab 21 | Determination of hydroxyl number of a polymer using colorimetric method | |
| Lab 22 | continuation | |
| Lab 23 | continuation | |
| Lab 24 | calculation and lab note book preparation | |

| Module-III<br>Polymer Analysis | | |
|---|---|---|
| **CONTENTS**<br>1. Estimation of the amount of HCHO in the given solution by sodium sulphite method.<br>**6 classes** | | |
| **Module Objectives:**<br>This part will help student to quantitative analysis of known and unknown polymers through laboratory experiments. | | |
| **Lecture Serial** | **Title of the Experiment** | **Remarks** |
| Lab 25 | Estimation of the amount of HCHO in the given solution by sodium sulphite method | |
| Lab 26 | continuation | |
| Lab 27 | continuation | |
| Lab 28 | calculation and lab note book preparation | |
| Lab 29 | | Practice 1 |
| Lab 30 | | Practice 2 |

**Reference Books:**


1. M.P. Stevens, Polymer Chemistry: An Introduction, 3rd Ed., Oxford University Press, 1999.
2. H.R. Allcock, F.W. Lampe & J.E. Mark, Contemporary Polymer Chemistry, 3rd ed. Prentice-Hall (2003).
3. F.W. Billmeyer, Textbook of Polymer Science, 3rd ed. Wiley-Interscience (1984).
4. J.R. Fried, Polymer Science and Technology, 2nd ed. Prentice-Hall (2003).
5. P. Munk & T.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. M.P. Stevens, Polymer Chemistry: An Introduction 3rd ed. Oxford University Press (2005).
8. Seymour/ Carraher's Polymer Chemistry, 9th ed. by Charles E. Carraher, Jr. (2013).

**DEPARTMENT OF CHEMISTRY**
**GOVERNMENT GENERAL DEGREE COLLEGE, KALNA-I**
**LESSON PLAN**
**for**
**B. Sc. 6th SEMESTER (Hons.) COURSES UNDER CBCS**
**Subject: Chemistry**
**Course code: DSE-4**
**Credits-4+2**
**Course title: Dissertation followed by power point presentation**

| **Module-I**<br>Dissertation | | |
|---|---|---|
| **CONTENTS**<br>Dissertation writing. **60 classes** | | |
| **Module Objectives:**<br>Students will learn the best way to prepare Dissertation for review of their work carefully. They will take notes of the key decisions that have been made throughout their review works and the scholarly literature that supports these choices. Once the content has been written, they should write a short excerpt. This short thesis should be informative and well designed to be presented. More particularly it should reflect a vivid idea and knowledge on the topic which is chosen for Dissertation. | | |
| **Lecture Serial** | **Topics of Discussion** | **Remarks** |
| Lecture-1. | Brief discussion on Dissertation: How to write? | |
| Lecture-2. | Sample of common dissertation | |
| Lecture-3. | Selection of Topic | |
| Lecture-4. | Literature review: How, what and where? | |
| Lecture-5. | Collection of materials | |
| Lecture-6. | do | |
| Lecture-7. | do | |
| Lecture-8. | do | |
| Lecture-9. | do | |
| Lecture-10. | do | |
| Lecture-11. | do | |
| Lecture-12. | do | |
| Lecture-13. | do | |
| Lecture-14. | do | |
| Lecture-15. | do | |
| Lecture-16. | do | |
| Lecture-17. | Journal club: discussion on several article, journals etc. | |
| Lecture-18. | do | |
| Lecture-19. | do | |
| Lecture-20. | do | |

| | | |
|---|---|---|
| Lecture-21. | do | |
| Lecture-22. | do | |
| Lecture-23. | do | |
| Lecture-24. | do | |
| Lecture-25. | do | |
| Lecture-26. | do | |
| Lecture-27. | do | |
| Lecture-28. | do | |
| Lecture-29. | do | |
| Lecture-30. | do | |
| Lecture-31. | do | |
| Lecture-32. | do | |
| Lecture-33. | do | |
| Lecture-34. | do | |
| Lecture-35. | do | |
| Lecture-36. | do | |
| Lecture-37. | do | |
| Lecture-38. | do | |
| Lecture-39. | do | |
| Lecture-40. | do | |
| Lecture-41. | do | |
| Lecture-42. | do | |
| Lecture-43. | do | |
| Lecture-44. | do | |
| Lecture-45. | do | |
| Lecture-46. | do | |
| Lecture-47. | do | |
| Lecture-48. | do | |
| Lecture-49. | Writing of dissertation | |
| Lecture-50. | do | |
| Lecture-51. | do | |
| Lecture-52. | do | |
| Lecture-53. | do | |
| Lecture-54. | do | |
| Lecture-55. | do | |
| Lecture-56. | do | |
| Lecture-57. | do | |
| Lecture-58. | do | |
| Lecture-59. | do | |
| Lecture-60. | do | |

**Module-II**

Power point presentation

**CONTENTS**

Power point presentation: preparation of slides. **30 classes**

**Module Objectives:**

1. Once the content has been written, they should create a PowerPoint presentation to deliver a talk within specified time. The slides should be informative but not wordy – bullet points concise and use pictures sparingly will look smart. They should make sure that they have rehearsed their presentation several times.
2. During an Assessment Dissertation Presentation, the student is required to present a summary of their research and results. They will then be asked questions by the examiners in a somewhat lengthy oral examination. The purpose of this Dissertation Presentation is to assess the student's original project and test its scholarly validity.

| Lecture Serial | Topics of Discussion | Remarks |
|---|---|---|
| Lecture-1. | Brief Discussion on power point presentation: How to prepare? | |
| Lecture-2. | Sample of common presentation slides | |
| Lecture-3. | Art of presentation | |
| Lecture-4. | Technical guidance on slide preparation | |
| Lecture-5. | do | |
| Lecture-6. | do | |
| Lecture-7. | Preparation of slides | |
| Lecture-8. | do | |
| Lecture-9. | do | |
| Lecture-10. | do | |
| Lecture-11. | do | |
| Lecture-12. | do | |
| Lecture-13. | do | |
| Lecture-14. | do | |
| Lecture-15. | do | |
| Lecture-16. | do | |
| Lecture-17. | do | |
| Lecture-18. | do | |
| Lecture-19. | do | |
| Lecture-20. | do | |
| Lecture-21. | Rehearsal of the presentation | |
| Lecture-22. | do | |
| Lecture-23. | do | |
| Lecture-24. | do | |
| Lecture-25. | do | |
| Lecture-26. | do | |
| Lecture-27. | do | |
| Lecture-28. | Final Practice using projector and screen | |
| Lecture-29. | do | |
| Lecture-30. | do | |