SEMESTER-II

Program: B.Sc. (Sem-II)	**Type:** Theory
Subject: DSC-3-Organic Chemistry-I: Fundamentals Of Organic Chemistry	
Credit: 04 (T) + 02 (P)	**Total learning hours:** 60
Course description: This course provides a systematic study of the theories, principles, and techniques of basic organic chemistry. Topics include structure and structural theories of organic compounds, organic reactions and their mechanisms, study of aliphatic and aromatic hydrocarbons and stereochemistry.	
Student learning outcome: **Students will be able:** • To describe structure of organic compounds. • To explain organic reactions and their mechanisms. • To use organic nomenclature. • To identify functional groups. • To describe alkanes, alkenes, and alkynes. • To describe isomerism in alkenes and cyclic compounds • To explain the properties of organohalogen compounds and benzene and its derivatives	

Unit-1 Structure and Structural Theories of Organic Compounds (07Hrs)

1.1 Introduction
1.2 Structures and properties of molecules
1.3 Isomerism
1.4 Shapes of atomic orbital
1.5 Molecular orbital
1.6 The covalent bond
1.7 Types of MOs
1.8 Hybridization
1.9 Hydrogen bond
1.10 Polarity of bonds and molecules and dipole moment

Unit-2 Organic Reactions and their Mechanisms (07Hrs)

2.1 Introduction
2.2 Types of organic reactions
2.3 Types of reaction intermediates
2.4 Electron delocalization
2.5 Types of reagents and organic reactions
2.6 Organic acids and bases & their strength
2.7 Thermodynamics of organic reactions
2.8 Kinetics of organic reactions
2.9 Effect of catalyst on the kinetics of a reaction
2.10 IUPAC Nomenclature of organic compounds

Unit-3 Alkanes and Alkyl Halides (08Hrs)

Alkanes:

3.1 Introduction
3.2 Nomenclature

3.3 Substitution reactions of methane
3.4 Structural isomerism in alkane
3.5 Homologous series
3.6 General Method of preparation of the alkanes
3.7 General Physical properties of the alkanes
3.8 General Chemical properties of the alkanes
3.9 Some Individual alkanes: Methane, Ethane, Propane

Alkyl halides

3.10 Introduction
3.11 Nomenclature
3.12 Method of Preparation
3.13 Physical Properties
3.14 Chemical Properties-Substitution Reaction (SN1&SN2), Elimination Reaction (E1&E2)
3.15 Monohalogen, Dihalogen, Trihalogen and Polyhalogen Derivatives

Unit- 4 Alkenes, Dienes and Alkynes (08Hrs)

Alkenes

4.1 Introduction
4.2. Nomenclature
4.3 Method of Preparation-Saytzeff Rule
4.4 Physical Properties
4.5 Chemical Properties-Markoynikov Rule
4.6 Some alkenes: Ethylene, Propylene

Dienes

4.7 Classification of Dienes
4.8 1, 3-butadiene: Preparation and Properties

Alkynes

4.9 Acidity of Alkynes
4.10 Nomenclature
4.11 Method of preparation
4.12 Physical and Chemical Properties
4.13 Acetylene

Unit- 5 Aryl halides & Aromatic Compounds (08Hrs)

Aryl halides

5.1 Introduction
5.2 Method of Preparation
5.3 Physical Properties
5.4 Chemical Properties- 1) Reactions involving Halogen Atom
2) Reactions involving Aromatic Ring
5.5 Chlorobenzene, Chlorotouene
5.6 Arylalkyl Halides, Arylmagnesium Halides

Aromatic Compounds

5.7 Introduction
5.8 Sources of aromatic compounds: Coal, Petroleum
5.9 Nomenclature

Unit- 6 Cycloalkanes and Benzene & its Homologous (08Hrs)

Cycloalkanes:

6.1 Introduction

6.2 Nomenclature
6.3 Physical Properties
6.4 Method of Preparation
6.5 Chemical Reactions
6.6 Cyclopropane aaand Cyclobutane preparation
6.7 Bayer's Strain Theory and its limitations
6.8 Theory of Strainless ring
6.9 Conformations of Cycloalkanes

Benzene & its Homologous

6.10 Nomenclature
6.11 Structure of Benzene
6.12 Resonance Energy of Benzene
6.13 Aromaticity
6.14 Benzene, Toluene, Xylene, Cumene, Styrene
6.15 Futuristic Material Fullerenes (Bucky Balls), Carbon Nanotubes (Bucky tubes)

Unit- 7 Polynuclear Hydrocarbons (07Hrs)

7.1 Introduction
7.2 Classification
7.3 Nomenclature
7.4 Synthesis, Chemical Reactions and Uses: Naphthalene, Anthracene, Phenanthrene
7.5 Derivatives of Naphthalene, Anthracene, Phenanthrene

Unit- 8 Stereo Chemistry (07Hrs)

8.1 Introduction
8.2 Isomerism and its classification
8.3 Geometrical isomerism: cis-trans and syn-anti isomerism E/Z notations with C.I.P rules.
8.4 Conformational isomerism in alkanes (Ethane, Propane and n-butane) with energy profile diagrams
8.5 Optical Isomerism: Optical activity, specific rotation, chirality/asymmetry, enantiomers, molecules with two or more chiral centers, distereo isomers, meso structures, racemic mixtures and resolution, relative and absolute configuration, D/L, R/S and E/Z designations.
8.6 Fischer, Newmann and Sawhorse Projection formulae and their inter conversions

Reference Books:

1. Organic Chemistry, Volume-1,2, I.L.Finar, 6 th Edn., 2002, , Pearson
2. Organic Chemistry, Seventh Edition, By R.T.Morrison, R.N.Boyd, S.K. Bhattacharjee 2010, Pearson
3. Advance Organic Chemistry, Arun Bahl and B S Bahl, 2012, S.Chand
4. Organic Chemistry, W.H. Perkin and F. S. Kipping, 2012, Nabu Press

Program: B.Sc. (Sem-II)	**Type:** Theory
Subject: DSC-4-Physical Chemistry-I-Chemical Equilibrium and Electrochemistry	
Credit: 04 (T) + 02(P)	**Total learning hours:** 60
Course description: This Course Paper proposes to teach about: The chemical equilibrium, solubility, phase equilibria, hydrolysis, pH metric titrations, electrolytes and electrolysis, behaviour of ions in aqueous solutions, conductance and conductometric titrations, characteristics of above all and their applications.	
Student learning outcome: After completing this course, the students will be able to learn: Concepts and characteristics, various laws, principles, rules, derivations, measurements, determinations, and calculations related to chemical equilibrium, solubility, phase equilibria, hydrolysis, pH metric titrations, electrolytes and electrolysis, behaviour of ions in aqueous solutions, conductance and conductometric titrations.	

Unit 1: Chemical Equilibrium **(04 Hrs)**

- **1.1** Concepts and characteristics
- **1.2** The law of chemical equilibrium
- **1.3** The Le Chatelier's principle
  - **1.3.1** Effects of change of temperature, pressure and concentration
- **1.4** Applications of the law of chemical equilibrium
  - **1.4.1** Chemical equilibria in homogeneous systems
  - **1.4.2** Chemical equilibria in heterogeneous systems
- **1.5** Numerical

Unit 2:Solubility **(04 Hrs)**

- **2.1** Solubility and solubility product
- **2.2** Common ion effect
- **2.3** Applications of solubility product
  - **2.3.1** Determination of solubility of sparingly soluble salt
  - **2.3.2** Fractional precipitation
  - **2.3.3** Qualitative analysis
  - **2.3.4** Salting out of soap
- **2.4** Numerical

Unit 3: Phase Equilibria **(08 Hrs)**

- **3.1** Phase and components, Degree of freedom (F)
- **3.2** Gibb's phase rule: derivation, reduced phase rule and phase diagram
- **3.3** One component system: phase diagram of Water, Carbon Dioxide and Sulfur
- **3.4** Two component system: eutectic behaviour
  Phase diagram of Lead-Silver, Zinc-Magnesium, Ferric Chloride-Water, Sodium-Potassium, Sodium Sulfate-Water
- **3.5** Method of construction of a phase diagram: cooling curve, heating curve, lever rule
- **3.6** Phase diagram of liquid-liquid systems: Phenol-Water and Sodium Chloride-Wate

Unit 4: Hydrolysis **(06 Hrs)**

- **4.1** Hydrolysis, salt hydrolysis, hydrolysis constants
- **4.2** Relation between degree of hydrolysis

4.3 Hydrolysis constant and pH of solutions of
(a) Salts of weak acid and strong base
(b) Salts of strong acid and weak base
(c) Salts of weak acid and weak base
4.4 Significance of the Henderson-Hasselback equation
4.5 Numerical

Unit 5: Electrochemistry (04 Hrs)

5.1 Principle: Faraday's law
5.2 Electrochemical cell
5.3 Electrode Potential: Nernst's equation
5.4 Potentiometric titrations
5.5 Numerical

Unit 6:pH metric Titrations (06 Hrs)

6.1 Principle of pH measurements
6.2 Acid-base titration curves
6.2.1 pH curve for a strong acid –strong base titrations
6.2.2 pH curve for a weak acid –strong base titrations
6.3.3 pH curve for a strong acid –weak base titrations
6.4 Numerical

Unit 7: Electrolytes (12 Hrs)

7.1 Ions in solutions
7.2 Metalic conductance
7.3 Electrolytic conductance
7.4 Classification of electrolytes
7.5 Electrolysis: Product formation of electrolysis
7.6 Migration of ions: Hittorf's rule
7.7 Transport number of ions and its determination by moving boundry method.
7.8 Factors affecting transport numbers
7.9 Kohlraush law of ionic conductance
7.10 Application of Kohlraush law to
(a) Determination of degree of dissociation of weak electrolyte.
(b) Determination of equivalent conductivity of weak electrolyte at infinite dilution.
(c) Determination of solubility and solubility product of sparingly soluble salts.
(d) Determination of ionic product of water
7.11 Numerical

Unit 8:Electrolytic Conductance (12 Hrs)

1.1 Electrical conductance, specific conductance, equivalent conductance, molar conductance
8.2 Cell constant, Determination of Cell constant
8.3 Effect of dilution on concentration- Ostwald's dilution law and its limitations
8.4 Factors affecting conductance of electrolytic solutions
8.5 Conductometric titrations: advantages, procedures and precautions
8.6 Principle and types of conductometric titrations:
(a) strong acid v/s strong base (b) strong acid v/s weak base
(c) weak acid v/s strong base (d) weak acid v/s weak base

(e) weak acid and strong base mixture v/s strong base
(f) Precipitation titrations

8.7 Numerical

Reference Books:

1. Essentials of Physical Chemistry, Arun Bahl, B.S. Bahi, G.D. Tuli, 1st Revised Edition 2008, Reprint 2016, S. Chand and Company Limited.
2. An Introduction to Physical Chemistry, Ishwar Das, Archana Sharma, Namita Rani Agrawal, 3rd Revised Edition, 2012, New Age International Publishers.
3. Text book of Engineering Chemistry by Shashi Chawla, Dhanpat Rai and Company, 3rd Edition, 2003, Dhanpat rai and co. pvt. ltd.
4. Textbook of Physical Chemistry, M.V. Sangaranarayanan, V. Mahadevan, 1st Edition, 2011, University Press (India) Pvt. Ltd.
5. Physical Chemistry for S.Y.B.Sc. Sem-4, Dr. Hemangi Desai, 2017, New Popular Prakashan,
6. Elements of Physical Chemistry; 2nd Edition, Samuel Glasstone, David Lewis, 1960, The MacMillan Company of India Ltd.
7. A Text Book of Physical Chemistry A. S. Negi & S.C. Anand, 1st Edition, 1999, New Age International.
8. Text Book of Physical Chemistry, P. L. Soni and O. P. Dharmraj, 19th Edition, 1992, S. Chand and Company.
9. Text book of Physical Chemistry, S.C.Khetarpal and Yogeshwar Sharma, 1st Edition, 2001, S. Chand and Company.

Program: B.Sc. (Sem-II)	**Type:** Theory
Subject: DSE-2- Polymer Chemistry	
Credit: 02 (T)	**Total learning hours:** 30

Course description:

The course gives a general introduction to polymers. Focus is placed on the classification and systematics of polymers. It also deals with the polymerization techniques, kinetics of polymerization, molecular weight and size, polymer structures and physical properties, polymer reaction, polymer solutions and individual polymers**.**

Student learning outcome:

Students will be able:

- To understand the Chemistry of polymers.
- To recognize the types of polymers, the significance and determination of their molecular mass and understand the relationships between polymer molecular weight, molecular weight distribution, and the properties of polymeric materials.
- To acknowledge in detail the mechanisms of the reactions that lead to the formation
- To understand different levels of polymer structure.
- To apprehend an overview of polymer reactions and reactivity of polymers.
- To understand factors that influences the degradation of polymers.
- To learn about the properties of polymers in solution and biopolymers.

Unit-1 The Genesis of Polymers (04 Hrs)

1.1 A Brief History
1.2 Monomer: Basic concept, Types, Functionality, Purification
1.3 Polymer: Basic concept, Types of Polymer structure, Effect of functionality, IUPAC nomenclature of polymer
1.4 Classification of Polymers
1.5 Chemistry of Polymerization

Unit-2 Molecular Weight and Size (04Hrs)

2.1 "Average" molecular weight
2.2 Number-Average and Weight-average molecular weights
2.3 Molecular weight and Degree of Polymerization
2.4 The Practical significance of Polymer molecular weight

Unit-3 Kinetics of Polymerization (03Hrs)

3.1 Introduction
3.2 Free-radical Chain Polymerization
3.3 Cationic Polymerization
3.4 Anionic Polymerization

Unit-4 Copolymerization (03Hrs)

4.1 Introduction
4.2 Kinetics of Copolymerization
4.3 Free-radical Copolymerization
4.4 Ionic Copolymerization

Unit-5 Polymer Structure and Physical Properties (04Hrs)

5.1 Polymer Microstructure
5.2 Glass Transition Temperature
5.3 Crystallinity in Polymer
5.4 Viscoelasticity

Unit-6 Polymer Reactions (04Hrs)

6.1 Introduction
6.2 Hydrolysis, Acidolysis, Aminolysis, Hydrogenation
6.3 Addition and Substitution Reactions
6.4 Cyclization Reactions

Unit-7 Polymer Solutions (04Hrs)

7.1 Polymer Dissolution
7.2 Thermodynamics of Polymer Dissolution
7.3 The Flory-Huggins Theory of Polymer Solution
7.4 Nature of Polymer Molecules in Solution

Unit-8 Individual Polymers (04Hrs)

8.1 Hydrocarbon Plastics and Elastomers:Polyethylene, Polypropylene, Polyisoprene, Polybutadiene
8.2 Carbon-Chain Polymers:Polystyrene,Polyacrylonitrile, Polyesters, PVC, PFC
8.3 Hetero Chain Thermoplastics: Polyamide, Polypeptides, Cellulosic Polymers
8.4 Inorganic Polymers and Biopolymers

Reference books:

1. Polymer Science, V R Gowarikar, N V Vishwanathan, Jaydev Sreedhar, 1987, Wiley–Blackwell
2. Text Book of Polymers Vol I to III, M S Bhatnagar, 2004, S. Chand Publication
3. Text Book of Polymer Science, F W Billmeyer, 2007, Wiley
4. Principles of Polymerization, George Odian, 2004, Wiley-Interscience
5. Introductory Polymer Chemistry, S Misra, 1994, Wiley–Blackwell
6. Text Book of Polymer Science, P L Nayak and S Lenka, 2001, Kalyani Publishers
7. Polymer Science and Technology, A Ghosh, 2001, Tata McGraw Hill Education
8. Polymer Chemistry, M G Arora and M Singh, 2003, Anmol Publisher

Program: B.Sc. (Sem-II)	**Type:** Theory
Subject: : DSE-2- Chemistry of New Material	
Credit: 02 (T)	**Total learning hours:** 30

Course description:

This course provides an overview of novel material like composites, solid electrolytes, liquid crystal, self-healing materials, and nanomaterial.

This course emphasises on the introduction and application of modern material.

Student learning outcome:

Upon completion of this course, students will:

- Have understanding of importance and types of inorganic solids like electrolytes, , molecular compounds
- Get information regarding types, properties and classification of nanoparticles, preparation of metallic nanoparticles
- Know about carbon nanotubes as well as bio-nano material
- Get insight of characteristics of alloys, their classification and some application
- Find information regarding the various types of composites as engineering materials and environmental effects on composites
- Be able to discuss the synthesis and properties of speciality polymers
- Get knowledge about liquid crystal and some of the properties of liquid crystals
- Be familiar with new idea of self-healing materials and mechanism

Unit-1 Solid Electrolyte **(04Hrs)**

1.1 Introduction
1.2 Characteristics and advantage
1.3 Types of solid electrolyte
1.4 Application of solid electrolyte

Unit-2 Molecular Material **(04Hrs)**

2.1 Molecular material and fullerides
2.2 One-dimensional metals
2.3 Molecular magnets

Unit-3 Composites **(04Hrs)**

3.1 Definition, General characteristics and classification
3.2 Role of matrix in composites
3.3 Fibre-reinforced composites
3.4 Applications of composites

Unit-4 Nanomaterial **(04Hrs)**

4.1 Definition and types of nano-materials
4.2 Size dependent properties
4.3 Carbon nanotubes
4.4 Bio-inorganic nanomaterials and composites

Unit-5 Organic Conductors **(03Hrs)**

- **5.1** Conducting polymers - Introduction, conduction mechanism
- **5.2** Electrically conducting organic solids
- **5.3** Polyacetylene, polyparaphenylene and polypyrole
- **5.4** Applications

Unit-6 Liquid Crystal **(04Hrs)**

- **6.1** Mesomorphic behaviour
- **6.2** Thermotropic liquid crystal
- **6.3** Optical properties of liquid crystals
- **6.4** Optical storage memory switches and sensors

Unit-7 Alloys for Mechanical Construction **(04Hrs)**

- **7.1** Classification of alloys
- **7.2** Copper, aluminum and their alloys like duralumin, brasses and bronzes
- **7.3** High speed tool steel
- **7.4** Super alloys

Unit-8 Self-healing Material **(03Hrs)**

- **8.1** History
- **8.2** Self-healing cementitious material
- **8.3** Autonomic, autogenic and bio-based healing
- **8.4** Various Self-healing materials (Introduction only)

Reference Books:

1. Solid electrolytes and their applications, Subbarao, E. (Ed.). 2012, Springer Science & Business Media
2. Self-healing materials, Advanced Materials, 22(47), 5424-5430, Hager, M. D., Greil, P., Leyens, C., van der Zwaag, S., & Schubert, U. S. (2010).
3. Self-healing materials: fundamentals, design strategies, and applications (pp. 138-217), Ghosh, S. K. (Ed.), 2009, Weinheim: Wiley-vch
4. Inorganic solids: an introduction to concepts in solid-state structural chemistry, Adams, D. M. (1974), John Wiley & Sons
5. Introduction to Nanotechnology, Charles P. Poole Jr., Frank J. Owens, 2003, John Wiley & Sons
6. Shriver and Atkins' inorganic chemistry, Atkins, P., & Overton, T., 2010, Oxford University Press, USA.
7. Descriptive inorganic, coordination, and solid state chemistry, Rodgers, G. E., 2011, Cengage Learning.
8. Principles of the solid state, Keer, H. V., 1993, New Age International
9. Introduction to Solids, Azároff, L. V., 1961, American Journal of Physics, 29(9), 647-647
10. Materials Science and Engineering, V. Raghavan, 6th edition, 2015, PHI publication
11. A textbook of engineering chemistry, DARA, S. S., 2008, S. Chand Publishing
12. Liquid Crystal-Applications And Uses (Volume 1) (Vol. 1), Bahadur, B. (Ed.),1990, World scientific

Chemistry Lab-Semester-II

1. Determination of cell constant and calibration of conductivity meter and determination of the normality and amount of the strong acid solution by conductometric titration against strong base solution.
2. Determination of the solubility and solubility product of sparingly soluble salt $PbSO_4$ by conductivity measurements.
3. Standardization of pH meter and determination of the normality and amount of the acids (mixture of strong and weak acid) solution by pH metric titration against strong base solution.
4. Determination of formal reduction potential of ferrous-ferric system and concentration of Fe^{++} potentiometrically
5. Qualitative analysis of unknown organic compounds containing monofunctional groups (carbohydrates, aryl halides, aromatic hydrocarbons, nitro compounds, amines and amides) and simple bifunctional groups, for e.g. salicylic acid, cinnamic acid, nitrophenols etc. **(Minimum seven)**

Reference Books:

1. Advanced Physical Chemistry; J.B. Yadav, 14th Edition, 1995, Goel Publishing House.
2. Laboratory Manual on Engineering Chemistry;3rd Edition, S.K.Bhasin, Sudha Rani, 2011, Dhanpatrai Publishing Company.
3. Experiments in Physical Chemistry 8th Ed.; Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. McGraw-Hill: New York (2003).
4. A Text Book on Chemistry Practical; 1st Edition, Bidhan Chandra Ray, Satyanarayan Das, Reprint 2017, NCBA.
5. Vogel, A.I. Quantitative Organic Analysis, Part 3, ,2012, Pearson
6. Practical Organic Chemistry, Mann, F.G. & Saunders, B.C., 2009, Pearson Education