

**Department of Science Education  
Institute of Education & Research  
University of the Punjab, Lahore  
Course Outline**



<b>Programme</b>	BS Science Education (1-8)	<b>Course Code</b>	SE-308	<b>Credit Hours</b>	3
<b>Course Title</b>	<b>Chemistry-III (Organic Chemistry)</b>				
<b>Course Introduction</b>					
<p><b>This course provides a comprehensive foundation in organic chemistry, focusing on the structure, bonding, reactivity, and synthesis of organic compounds. It introduces fundamental concepts such as electronic effects, stereochemistry, reaction mechanisms, and functional group transformations. Students develop an understanding of aliphatic, aromatic, and heterocyclic compounds and their chemical behavior. Emphasis is placed on logical problem-solving, mechanistic interpretation and structure reactivity relationships. The course also aims to strengthen analytical thinking skills essential for advanced studies in chemistry and related disciplines.</b></p>					
<b>Learning Outcomes</b>					
<p>On the completion of the course, the students will:</p> <ol style="list-style-type: none"> <li>To learn the fundamentals of organic chemistry.</li> <li>To develop an understanding and appreciation of both structure and chemical transformations of organic molecules.</li> <li>Will acquire basic concepts of electronic structure and be able to apply them to solve problems from various areas of organic chemistry, including stereochemistry, reactivity patterns and synthesis.</li> <li>Improvements in learning strategies, critical-thinking, and problem-solving skills are an expected outcome.</li> </ol>					
<b>Course Content</b>				<b>Assignments/Readings</b>	
<b>Week 1</b>	<b>Unit-I 1. Basic Concepts in Organic Chemistry</b>			<p><b>Reading:</b> C.K. Ingold, "Structure and mechanism in organic chemistry", C.B.S.</p>	
	<p>1.1 Introduction to organic chemistry. 1.2. Hybridization of orbitals of carbon atoms in alkanes, alkenes, alkynes and arenes.</p>				
	<p>1.3. Hybridization of orbitals of nitrogen, oxygen and sulfur atoms in various functional groups,</p>			<p><b>Assignment:</b> Write importance and draw sp, sp<sup>2</sup> and sp<sup>3</sup> hybridization with examples of carbon compounds.</p>	

<b>Week 2</b>	1.4. Localized and delocalized chemical bonding; Conjugation and hyper conjugation; Resonance, rules of resonance, resonance energy, resonance hybrid, factor effecting the resonance.	<b>Reading:</b> I.L.Finar, "Organic Chemistry", Vol. I, Pearson Education, L.P.E.
	1.5. Inductive effect, applications of inductive effect and resonance on various properties of organic compounds; Steric effect and its applications, Hydrogen bonding and its effects on various properties of organic compounds, Tautomerism.	<b>Assignment: Inductive Effect (<math>\sigma</math>-Effect)</b> a) Define the inductive effect. Distinguish between +I and -I effects with suitable examples. b) Arrange the following in order of increasing acidity and justify your answer using the inductive effect: CH <sub>3</sub> COOH, ClCH <sub>2</sub> COOH, CCl <sub>3</sub> COOH c) Explain how the inductive effect influences the stability of carbocations and carbanions.
<b>Week 3</b>	<b>Unit-II Nomenclature of Organic Compounds</b> 2.1 Nomenclature of alkanes, alkenes, alkynes, cycloalkanes, bicycloalkanes, spiroalkanes,	<b>Reading:</b> I.L.Finar, "Organic Chemistry", Vol. II, 5 <sup>th</sup> Edition, L.P.E.
	2.2 Monofunctional and polyfunctional derivatives of open chain and cyclic compounds;	<b>Assignment: Structural Representation</b> a) Draw structural formulas for: i) A monofunctional open-chain compound containing an -OH group ii) A polyfunctional open-chain compound containing -OH and -COOH groups iii) A polyfunctional cyclic compound containing two different functional groups  b) Indicate the functional groups clearly in each structure.
<b>Week 4</b>	2.3 Polysubstituted benzenes; Polycyclic hydrocarbons such as naphthalene, anthracene, phenanthrene and their derivatives; Heterocyclic compounds.	<b>Reading:</b> Jerry March, "Advanced Organic Chemistry, Reaction, Mechanism and Structure", 5 <sup>th</sup> Edition, Wiley Inter Science.
	<b>Unit-III Hydrocarbons</b> 3.1 a) <b>Alkanes and Cycloalkanes</b> Preparation of alkanes from alkyl halides, coupling of alkyl halide and alkylboranes, reduction of carbonyl compounds.	<b>Assignment: Preparation from Alkyl Halides</b> a) Explain the preparation of alkanes from alkyl halides using <b>Wurtz reaction</b> . b) Write the reaction mechanism and discuss its limitations. c) Why is Wurtz reaction not

		suitable for the preparation of unsymmetrical alkanes?
<b>Week 5</b>	3.2 Kolbe's electro synthesis, Corey-house-synthesis, hydrogenation of alkenes and alkynes.	<b>Reading:</b> Morison and Boyd, "Organic Chemistry", 6 <sup>th</sup> Edition, Prentice Hall.
	3.3. Reactions of alkanes with halogens, their mechanism and comparison of reactivities of halogens; combustion, isomerization, nitration and sulfonation.	<b>Assignment: Reactivity of Halogens</b> a) Compare the reactivity of fluorine, chlorine, bromine, and iodine towards alkanes. b) Explain why fluorination is violent while iodination is usually not feasible. c) Why is bromination more selective than chlorination?
<b>Week 6</b>	3.4 Preparations of cycloalkanes by Freund synthesis, Hydrogenation of cyclic alkenes; Structure and stability of cycloalkanes; Reaction of cycloalkanes.	<b>Reading:</b> Morison and Boyd, "Organic Chemistry", 6 <sup>th</sup> Edition, Prentice Hall.
	3.5 b) <b>Alkenes and Alkynes</b> Preparation of alkenes from elimination reaction of alkyl halides and alcohols; Mechanism and orientation of eliminations.	<b>Assignment: Elimination from Alkyl Halides</b> a) Explain the preparation of alkenes from alkyl halides by dehydrohalogenation. b) Describe the E2 mechanism with a suitable example. c) Under what conditions does the E1 mechanism occur? Explain briefly.
<b>Week 7</b>	3.6 Dehalogenation of vicinal dihalides with mechanism; Pyrolytic eliminations.	<b>Reading:</b> Seyhan N. Ege, "Organic Chemistry Structure and Reactivity", 3 <sup>rd</sup> Edition, The University of Michigan, A.I.T.B.S. Publishers & Distributors (Regd.).
	3.7 Reactions of alkene; relative stability and reactivity; Addition of halogens, additions of halogen acids and the rules governing these reactions.	<b>Assignment: Addition of Hydrogen Halides</b> a) Explain the addition of hydrogen halides (HCl, HBr, HI) to alkenes. b) State Markovnikov's rule and illustrate it with an example. c) Explain the addition of HBr in the presence of peroxide (anti-Markovnikov addition).
<b>Week 8</b>	3.8 Preparation of alkynes by carbide process, dehydrohalogenation of dihalides and alkylation of terminal alkynes	<b>Reading:</b> Thomas H. Lowry, Kathleen Schueller Richardson "Mechanism and Theory in Organic Chemistry", 3 <sup>rd</sup> Edition, Harper and Row Publishers, New York.
	3.9. Reactions of alkynes: addition reactions with mechanisms, hydration reactions, oxidation,	<b>Assignment: Addition Reactions of Alkynes</b>

	reduction, hydroboration, formation of metal acetylides, polymerization (linear and closed chain).	<p>a) Explain the addition of halogens to alkynes with a suitable example.</p> <p>b) Describe the mechanism of addition of one mole of bromine to ethyne.</p> <p>c) How does the addition of hydrogen halides to alkynes differ from alkenes?</p>
<b>Week 9</b>	3.8 c) <b>Aromatic Hydrocarbons</b> Structure of benzene, Resonance energy of benzene, Aromaticity, criteria for aromaticity, Evidences of aromaticity; Natural sources of aromatic hydrocarbons; Preparation of aromatic hydrocarbons by different methods.	<b>Reading:</b> Alder, Baker, Brown, "Mechanism in Organic Chemistry", Wiley Publishers.
	3.9. Reaction of aromatic hydrocarbons: electrophilic aromatic substitution reactions i.e. nitration, halogenation, Friedel-Crafts reaction and its limitations, sulfonation; Orientation and reactivity of substituted benzenes.	<b>Assignment: Nitration of Benzene</b> <p>a) Explain the nitration of benzene, including reagents and conditions.</p> <p>b) Describe the mechanism of nitration, showing the formation of the <math>\sigma</math>-complex.</p> <p>c) Why is concentrated sulfuric acid used along with nitric acid in this reaction?</p>
<b>Week 10</b>	3.10. Nucleophilic aromatic substitution reactions; reaction such as addition, hydrogenation, Birch reduction, and oxidation reactions of side chains.	<b>Reading:</b> Atkins Carey, "Organic Chemistry", A Brief Course, 2 <sup>nd</sup> Edition.
	3.11. Polycyclic aromatic hydrocarbons like naphthalene, anthracene and phenanthrene, their resonance structures and relative stabilities; Synthesis of naphthalene.	<b>Assignment: Structure and Resonance</b> <p>a) Draw all possible resonance structures of <b>naphthalene</b>.</p> <p>b) Explain how resonance contributes to the stability of naphthalene.</p> <p>c) Compare the resonance stabilization of naphthalene with that of benzene.</p>
<b>Week 11</b>	3.12 Electrophilic substitution reactions of naphthalene; Oxidation and reduction reactions; Brief description of orientation and reactivity of naphthalene.	<b>Reading:</b> Peter Sykes, "A guide book to mechanism in organic chemistry", 6 <sup>th</sup> Edition, Pearson Education, Singapore
	<p><b>Unit 4 Isomerism</b></p> <p><b>4.1. Conformational isomerism:</b> conformational analysis of ethane, n-butane, cyclohexane, mono- and di-substituted cyclohexanes.</p> <p><b>4.2. Optical isomerism:</b> optical activity; chirality and optical activity; enantiomers, diastereomers; racemates and their resolution; D, L and R, S</p>	<b>Assignment::</b> Conformational Analysis of Ethane and n-Butane <p>a) Draw Newman projections of ethane showing staggered and eclipsed conformations.</p> <p>b) Explain the energy difference between these conformations.</p>

	conventions; Optical Isomerism in cyclohexanes, biphenyls and allenes.	c) Draw and compare all important conformations of n-butane and identify the most stable one with justification.
<b>Week 12</b>	4.3. <b>Geometrical Isomerism:</b> cis and trans isomers; E-Z convention; Determination of configuration of the isomers; Inter-conversion of geometrical isomers; Geometrical isomerism in cyclic compounds.	<b>Reading:</b> Carruthers, "Modern Methods of Organic Synthesis", Cambridge low Priced Edition, Cambridge.
	<b>Unit 5 Alkyl halides</b> 5.1. Preparation of alkyl halides from alcohols and carboxylic acids; Chemical reactions: Aliphatic nucleophilic substitution reactions, SN <sub>1</sub> and SN <sub>2</sub> mechanism.	<b>Reading:</b> Carruthers, "Modern Methods of Organic Synthesis", Cambridge low Priced Edition, Cambridge.
<b>Week 13</b>	5.2. Effects of the nature of substrate, attacking nucleophile, leaving group and the nature of solvent. Elimination reactions, E <sub>1</sub> and E <sub>2</sub> , mechanisms, orientation of elimination ( Hoffmann and Sytzeff rules).	<b>Reading:</b> Harris, Wamser, "Fundamentals of Organic Reaction Mechanism", Wiley Publishers.
	5.3. Grignard Reagents; synthesis, structure, and reactions with active hydrogen compounds, carbonyl compounds such as aldehydes,	<b>Assignment: Synthesis of Grignard Reagents</b> a) Describe the preparation of Grignard reagents from alkyl halides. b) Write the reaction for the preparation of ethyl magnesium bromide. c) Why must the reaction be carried out in absolutely dry ether?
<b>Week 14</b>	5.4. ketones, esters, acid halides and CO <sub>2</sub> ; Reactions with nitriles, ethylene oxide, sulphur and oxygen.	<b>Reading:</b> : Harris, Wamser, "Fundamentals of Organic Reaction Mechanism", Wiley Publishers.
	<b>Unit 6 Chemistry of Hydroxyl Group containing Compounds and Ethers</b> 6.1. <b>Alcohols:</b> Physical properties; Preparation of alcohols by the reduction of carbonyl compound,; Reactions of alcohol with metals, organic and inorganic acids.	<b>Reading:</b> R. Panico, W.H.Powell, Jean-Claude Richer, "A guide to IUPAC Nomenclature of Organic Compounds", Blackwell Sci. Publication, 1993

<b>Week 15</b>	<b>6.2.</b> Oxidation of alcohols; Distinction between primary, secondary and tertiary alcohols; Preparation of diols, triols and their important reactions and uses.	<b>Reading:</b> G. Malcolm, Dyson, "A Manual of Organic Chemistry", Vol. I
	<b>6.3. Phenols:</b> Physical properties; Synthesis of phenols; Reactions of phenols such as acylation, Friedel-Crafts reaction, nitration, sulfonation, carbonation, formylation and diazo coupling.	<b>Assignment:</b> Acylation and Friedel–Crafts Reactions a) Explain the <b>acylation of phenol</b> with suitable reagents and conditions. b) Why does phenol not undergo Friedel–Crafts alkylation under normal conditions? c) How can Friedel–Crafts acylation be carried out in phenols indirectly?
<b>Week 16</b>	<b>6.4. Ethers:</b> Physical properties; Preparation of ethers from alcohols, alkyl halides and alkenes; Reactions of ethers; Brief introduction of crown ethers and polyethers.	<b>Reading</b> Canant Blat, "The Chemistry of Organic Compound", 5 <sup>th</sup> Edition.
	<b>6.5. Revision and QiuZ</b>	<b>Revision and QiuZ</b>

#### Textbooks and Reading Material

#### Recommended Books:

1. C.K. Ingold, "Structure and mechanism in organic chemistry", C.B.S.
2. I.L.Finar, "Organic Chemistry", Vol. I, Pearson Education, L.P.E.
3. I.L.Finar, "Organic Chemistry", Vol. II, 5<sup>th</sup> Edition, L.P.E.
4. Jerry March, "Advanced Organic Chemistry, Reaction, Mechanism and Structure", 5<sup>th</sup> Edition, Wiley Inter Science.
5. Morison and Boyd, "Organic Chemistry", 6<sup>th</sup> Edition, Prentice Hall.
6. Seyhan N. Ege, "Organic Chemistry Structure and Reactivity", 3<sup>rd</sup> Edition, The University of Michigan, A.I.T.B.S. Publishers & Distributors (Regd.).
7. Thomas H. Lowry, Kathleen Schueller Richardson "Mechanism and Theory in Organic Chemistry", 3<sup>rd</sup> Edition, Harper and Row Publishers, New York.
8. Alder, Baker, Brown, "Mechanism in Organic Chemistry", Wiley Publishers.
9. Atkins Carey, "Organic Chemistry", A Brief Course, 2<sup>nd</sup> Edition.
10. Peter Sykes, "A guide book to mechanism in organic chemistry", 6<sup>th</sup> Edition, Pearson Education, Singapore.
11. Carruthers, "Modern Methods of Organic Synthesis", Cambridge low Priced Edition, Cambridge.
12. Harris, Wamser, "Fundamentals of Organic Reaction Mechanism", Wiley Publishers.
13. G. Malcolm, Dyson, "A Manual of Organic Chemistry", Vol. I.

14. Canant Blat, "The Chemistry of Organic Compound", 5<sup>th</sup> Edition.
15. R. Panico, W.H.Powell, Jean-Claude Richer, "A guide to IUPAC Nomenclature of Organic Compounds", Blackwell Sci. Publication, 1993.
- 15.1. Journal Articles/ Reports

**Note:**

16. It is preferable to use latest available editions of books. Mention the publisher & year of publication.
17. The References/ bibliography may be in accordance with the typing manual of the concerned faculty/subject. Preferably follow APA 7<sup>th</sup> Edition publication manual.

**Teaching Learning Strategies**

1. Lectures with Visual Aids
2. Problem-Solving Sessions
3. Group Discussions and Peer Learning
4. Hands-On Computational Exercises
5. Case Studies and Real-World Applications

**Assignments: Types and Number with Calendar**

1. **Types of Assignments:**
  - 1.1. **Numerical Problem-Solving:** Application-based problems.
  - 1.2. **Short Reports:** Writing brief explanations or summaries.
  - 1.3. **Derivations and Mathematical Proofs:** Step-by-step understanding of the concepts with models.
  - 1.4. **Real-World Applications:** Researching and reporting on practical uses of chemistry principles
  - 1.5. **Comparative Analysis:** Comparing theoretical and experimental results,
2. **Number of Assignments:**
  - 2.1. **Before Midterm:** 2 Major assignments.
  - 2.2. **After Midterm:** 2 Major assignments.

This approach ensures a balance of theoretical understanding and applied learning throughout the course.

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<b>Programme</b>	BS Science Education (1-8)	<b>Course Code</b>	SE-308A	<b>Credit Hours</b>	3
<b>Course Title</b>	<b>Physics-III: Thermal Physics</b>				
<b>Course Introduction</b>					
This course is designed to explore the microscopic and macroscopic principles governing heat, temperature, and energy transfer through kinetic theory and the laws of thermodynamics.					
<b>Learning Outcomes</b>					
Upon completion of this course, students will be able to:					
<ol style="list-style-type: none"> <li>1. Explain the kinetic theory of gases and fundamental laws of thermodynamics.</li> <li>2. Apply thermodynamic principles to analyze physical systems and processes.</li> <li>3. Evaluate entropy, thermodynamic cycles, and efficiency of heat engines.</li> <li>4. Understand basic concepts of statistical mechanics and thermoelectric effects.</li> </ol>					
<b>Course Content</b>				<b>Assignments/Readings</b>	
<b>Week 1</b>	<b>Unit-I: Kinetic Theory of Gases</b>			Resnick & Halliday, Ch. 17	
	1.1 Kinetic theory of the ideal gas				
<b>Week 2</b>	1.2 Postulates and assumptions			Resnick & Halliday, Ch. 18	
	1.3 Work done on an ideal gas			Resnick & Halliday, Ch. 18	
<b>Week 3</b>	1.4 Internal energy of an ideal gas.			Resnick & Halliday, Ch. 18	
	1.5 Intermolecular forces			Resnick & Halliday, Ch. 18	
<b>Week 4</b>	1.6 Limitations of ideal gas model			Resnick & Halliday, Ch. 18	
	<b>Unit-II: Statistical Mechanics</b>			Resnick & Halliday, Ch. 18	
<b>Week 5</b>	2.1 Fundamentals of statistical mechanics			Resnick & Halliday, Ch. 18	
	2.2 Macrostates and microstates.			Resnick & Halliday, Ch. 18	
<b>Week 6</b>	2.3 Statistical distribution and mean values			Resnick & Halliday, Ch. 18	
	2.4 Maxwell distribution of molecular speeds			Resnick & Halliday, Ch. 18	
<b>Week 7</b>	2.5 Distribution of molecular energies			Resnick & Halliday, Ch. 18	
	2.6 Brownian motion.				
<b>Week 8</b>	<b>Unit-III: Heat and Laws of Thermodynamics</b>			Resnick & Halliday, Ch. 19	
	3.1 Heat and different theories of heat			Resnick & Halliday, Ch. 19	
<b>Week 9</b>	3.2 Specific heat and gram molecular specific heat			Resnick & Halliday, Ch. 19	
	3.3 Zeroth Law and First Law of Thermodynamics; Applications.			Resnick & Halliday, Ch. 19	
	3.4 Second Law of Thermodynamics			Blundell, Ch. 3	

	3.5 Reversible and irreversible processes.	Blundell, Ch. 3
<b>Week 10</b>	3.6 Indicator diagram	Blundell, Ch. 3
	3.7 Practical thermodynamic processes	Blundell, Ch. 3
<b>Week 11</b>	<b>Unit-IV: Entropy and Thermodynamic Relations</b> 4.1 Entropy 4.2 Law of increase of entropy	Resnick & Halliday, Ch. 20
	4.3 Entropy and second law of thermodynamics	Resnick & Halliday, Ch. 20
<b>Week 12</b>	4.4 Temperature–Entropy (T–S) diagram	Roy, Ch. 4
	4.5 Maxwell’s thermodynamic relations.	Resnick & Halliday, Ch. 20
<b>Week 13</b>	4.6 TDS equations	Roy, Ch. 4
	4.7 Clapeyron’s equation	Resnick & Halliday, Ch. 20
<b>Week 14</b>	<b>Unit-V: Thermodynamic Cycles and Applications</b> 5.1 Carnot cycle and Carnot engine	Young & Freedman, Ch. 19
	5.2 Thermodynamic temperature scale	Resnick & Halliday, Ch. 20
<b>Week 15</b>	5.3 Third Law of Thermodynamics	Blundell, Ch. 5
	5.4 Low temperature physics	Resnick & Halliday, Ch. 20
<b>Week 16</b>	5.5 Thermoelectricity (Seebeck effect, Peltier effect, Thermocouple)	Resnick & Halliday, Ch. 20
	Course review	

### Textbooks and Reading Material

#### Textbooks.

1. *Physics (Volume 1 & 2)* by R. Resnick, D. Halliday and K. S. Krane (5th Edition), Wiley (2002).
2. *Concepts in Thermal Physics*, by S. J. Blundell and K. M. Blundell, Oxford, (2009).
3. *University Physics with Modern Physics* by H. D. Young, R. A. Freedman (14th Edition), Addison-Wesley (2015).
4. *Principle of Modern Thermodynamics* by B. N. Roy, Institute of Physics, London (1995).

#### Suggested Readings

1. *Concepts in Thermal Physics*, by S. J. Blundell and K. M. Blundell, Oxford, Journal Articles/ Reports

### Teaching Learning Strategies

1. Interactive lectures with multimedia presentations
2. Problem-solving sessions and numerical practice
3. Classroom discussions and conceptual questioning
4. Tutorial assignments and quizzes
5. Use of simulations and graphical analysis
6. Student presentations and group activities
7. Continuous formative assessment and feedback

### Assignments: Types and Number with Calendar

#### Total Assignments: 4

1. **Assignment-1:** Written (Numerical + Short Questions) – *Unit-I: Kinetic Theory of Gases* – **Week 4**
2. **Assignment-2:** Written (Problems + Conceptual Questions) – *Unit-II: Statistical Mechanics* – **Week 7**
3. **Assignment-3:** Written (Numerical + Descriptive Questions) – *Unit-III: Laws of Thermodynamics* – **Week 10**
4. **Assignment-4:** Written / Presentation – *Unit-IV & V: Entropy, Thermodynamic Relations & Applications* – **Week 14**

Submission deadline: One week after issuance of each assignment.