# Course Specification

## (Postgraduate Programs )

| | |
|---|---|
| **Course Title:** | **Physical Organic Chemistry** |
| **Course Code:** | **CHM 6122** |
| **Program:** | **Master of science in chemistry** |
| **Department:** | **Chemistry** |
| **College:** | **Science** |
| **Institution:** | : Imam Mohammad Ibn Saud Islamic University |
| **Version:** | *Course Specification Version Number* |
| **Last Revision Date:** | *Pick Revision Date.* |

## Table of Contents

# A. General information about the course:

## 1. Course Identification:

**1. Credit hours: ( ..... )**

3 (3 Lectures, 0 Lab, 0 Tutorials)

**2. Course type**

| | | | | | |
|---|---|---|---|---|---|
| A. | ☐University | ☐College | ☐Department | ☐Track | |
| B. | ☐ Required | | ☒ Elective | | |

**3. Level/year at which this course is offered: (Level 2/ Year 1)**

**4. Course General Description:**

The course covers selected special topics pertinent to current research in physical organic chemistry. Topics include molecular structure and thermodynamics, reactivity and mechanisms, stereochemistry and electronic structure.

**5. Pre-requirements for this course** (if any)**:**

Advanced Organic Chemistry – CHM 6121

**6. Pre-requirements for this course** (if any)**:**

None

**7. Course Main Objective(s):**

- **Understand the detailed structure of a molecule.**
- **Identify a molecule's hot spots with respect to reactivity (factors include sites of acidity, electronegativity, polarizability, atomic and molecular orbital character and strain).**
- **Evaluate the contribution of these factors to a molecule's energetics, noncovalent interactions and reaction mechanisms.**
- **Be familiar with molecular structure and thermodynamics, reactivity relationships.**
- **Recognize stereochemistry and electronic structures influences on the reaction mechanisms.**

## 2. Teaching Mode: (mark all that apply)

| No | Mode of Instruction | Contact Hours | Percentage |
|---|---|---|---|
| 1 | Traditional classroom | 45 | 100% |
| 2 | E-learning | | |
| 3 | Hybrid<br>• Traditional classroom | | |

| No | Mode of Instruction | Contact Hours | Percentage |
|---|---|---|---|
| | • E-learning | | |
| 4 | Distance learning | | |

### 3. Contact Hours: (based on the academic semester)

| No | Activity | Contact Hours |
|---|---|---|
| 1. | **Lectures** | 45 |
| 2. | **Laboratory/Studio** | 0 |
| 3. | **Field** | 0 |
| 4. | **Tutorial** | 0 |
| 5. | **Others (specify)……** | 0 |
| | **Total** | 45 |

## B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods:

| Code | Course Learning Outcomes | Code of PLOs aligned with the program | Teaching Strategies | Assessment Methods |
|---|---|---|---|---|
| **1.0** | **Knowledge and understanding** | | | |
| 1.1 | To recall knowledge of Molecular Structure and Thermodynamics | K1. *Org.*; K2. *Org.*; K4. *Org.* | ▪ Five hours/week lectures.<br>▪ Self-study<br>Home-exam. | ▪ Regular Exams<br>▪ Assignments<br>▪ Short Quizzes<br>▪ Oral Discussion<br>Participation. |
| 1.2 | To outline the chemical bonding and molecular structures in Organic Chemistry Reactions. | K1. *Org.*; K2. *Org.*; K4. *Org.* | ▪ Five hours/week lectures.<br>▪ Think, to justify the chemical reaction mechanism, using available references (SDL) online.<br>Open discussion. | ▪ Oral Discussion marks<br>▪ Literatures Survey<br>▪ Mini-seminar.<br>▪ Participation. |
| 1.3 | To describe Molecular Recognition and Supramolecular Chemistry. | K1. *Org.*; K2. *Org.*; K3. *Org.* | ▪ Five hours/week lectures.<br>Group Discussion using available | ▪ Midterm.<br>▪ Assignments.<br>▪ Group Discussions. |

| Code | Course Learning Outcomes | Code of PLOs aligned with the program | Teaching Strategies | Assessment Methods |
|---|---|---|---|---|
| | | | references (SDL) online. | ▪ Literatures Survey<br>▪ Mini-seminar.<br>Participation. |
| 1.4 | To state a molecule's hot spots with respect to reactivity. | K2. *Org.*; K3. *Org.* | ▪ Five hours/week lectures.<br>Group Discussion using available references (SDL) online | ▪ Assignments<br>▪ Open Discussions.<br>▪ Literatures Survey<br>▪ Mini-seminar.<br>Participation. |
| **2.0** | **Skills** | | | |
| 2.1 | To evaluate knowledge and understanding of concepts and principles of Physical Organic Chemistry. | S1. *Org.*; S2. *Org.*; S3. *Org.* | ▪ Lectures activity.<br>▪ Self-study<br>Deep discussion on Physical Organic Chemistry concepts. | ▪ Questions in Lectures.<br>▪ Short Quizzes and Exams.<br>▪ Open Discussions.<br>▪ Participation<br>Mini -seminar. |
| 2.2 | To analyze problems and explore strategies for their solution, with justify the optimum approaches to appropriate reaction mechanism. | S2. *Org.*; S4. *Org.* | ▪ Practice some reaction examples by proposing the Reaction Mechanism achieving.<br>▪ Brainstorming.<br>Self-study | ▪ Questions in Lectures.<br>▪ Participation<br>▪ Oral Discussion<br>Short Quizzes. |
| 2.3 | To justify Organic chemical information interpreting to predict and postulate the Organic Reaction Mechanism support a reasonable arguments. | S2. *Org.*; S3. *Org.* | ▪ Lectures<br>▪ Oral Discussions.<br>▪ Brainstorming.<br>Self-study | ▪ Questions in Lectures.<br>▪ Short Quizzes and Exams.<br>▪ Oral Discussion.<br>Participation. |
| 2.4 | To demonstrate Oral Communication for reactivity and mechanisms of organic molecules and its applications, accompanying writing of mini- Reports, operating electronic | S1. *Org.*; S3. *Org.*; S4. *Org.* | ▪ Group Discussion and Assignments<br>▪ Suggest several examples for reactivity and mechanisms of organic molecules, which will require reading, writing, | ▪ Oral Discussion.<br>▪ Quizzes, and Exams.<br>▪ Giving marks for Oral Discussion in Lectures.<br>Marks given for Assignments |

| Code | Course Learning Outcomes | Code of PLOs aligned with the program | Teaching Strategies | Assessment Methods |
|---|---|---|---|---|
| | mail, and Network in communicating with others. | | and oral presentation. Encourage students to use electronic mail to submit Home Exams and Assignments. | |
| **3.0** | **Values, autonomy, and responsibility** | | | |
| 3.1 | To perform a scientific presentation, research, and work independently and integrate with a collaborated group, Using IT to acquire, analyze, and communicate information. | V1. *Org.* | ▪ Brainstorming.<br>▪ Exercises<br>▪ Group Discussion.<br>▪ Team work. | ▪ Oral Discussion.<br>▪ Group Discussion<br>▪ Assignments. |
| 3.2 | To appraise effectively the collaboration and inter-professionalism in class discussions or team works, as well as independently. | V1. *Org.*; V2. *Org.* | ▪ Small Group tasks<br>▪ Open discussion at classroom.<br>▪ Office hour guiding.<br>Group Presentation of mini-projects | ▪ Participation<br>▪ Homework's Mini-project(s). |
| ... | | | | |

## C. Course Content:

| No | List of Topics | Contact Hours |
|---|---|---|
| **1.** | ***Molecular Structure and Thermodynamics*** | |
| 1.1 | ***Introduction to Structure and Models of Bonding***: Review on Basic bonding concept, Modern theory of organic bonding, Bonding and structures of reactive intermediates | **8** |
| 1.2 | ***Strain and Stability:*** Thermochemistry of stable molecules and reactive intermediates, Relationships between structure and energetic-Basic conformational analysis, Electronic effects, highly strained molecules, Molecular mechanics. | **5** |
| 1.3 | ***Solutions and Non-Covalent Binding Forces:*** Solvent and solution properties (Dielectric constant, solubility, Solute mobility, The thermodynamics of solutions), Binding forces. | **3** |

| | | |
|---|---|---|
| 1.4 | ***Molecular Recognition and Supramolecular Chemistry:*** Thermodynamic Analyses of Binding phenomena. | 3 |
| 1.5 | ***Stereochemistry:*** Symmetry and Stereochemistry, Topicity relationships (Homotopic, Enantiotropic and Diastereotropic), Stereoselectivity and Sterospecificity. | 3 |
| | ***Reactivity, Kinetics, and Mechanisms*** | |
| 2.1 | ***Energy Surfaces and Kinetic Analyses:*** Energy surfaces and related concepts, Postulates and principles related to kinetic analysis (The Hammond Postulate, The reactivity vs Selectivity principle, Kinetic vs Thermodynamic control). | 3 |
| 2.2 | ***Catalysis:*** General Principles of catalysis, Bronsted Acide-Base catalysis, Enzymatic catalysis. | 3 |
| 2.3 | ***Organic Reaction Mechanisms:*** Part 1. Reactions Involving Additions and/or Eliminations, Part 2. Substitutions and Thermal Isomerizations/Rearrangements. | 3 |
| 2.4 | ***Organo-transition Metal Reaction (Mechanisms and Catalysis):*** Common Organometallic Reactions**.** | 3 |
| | **Electronic Structure: Theory and Applications** | |
| 3.1 | ***Advanced Concepts in Electronic Structure Theory:*** Introductory Quantum Mechanics, Solving the Schrodinger equation for complex systems, Organometallic complexes. | 5 |
| 3.2 | ***Thermal Pericyclic Reactions:*** Cycloaddition, Analysis of two simple cycloadditions, Electrocyclic reactions, Sigmatropic rearrangements**.** | 3 |
| 3.3 | ***Photochemistry:*** Photo-physical processes, Photochemical Reactions | 3 |
| **Total** | | **45** |

## D. Students Assessment Activities:

| No | Assessment Activities * | Assessment timing (in week no) | Percentage of Total Assessment Score |
|---|---|---|---|
| 1. | **Class Activities ( Open Discussion, Mini-reports, Oral Presentation, solving questions)** | **weekly** | **30 %** |
| 2. | **Midterm Exam** | **9 th week** | **30 %** |
| 3. | **Final Exam** | **Around 17th week** | **40 %** |
| ... | **Total** | | **100%** |

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.)

## E. Learning Resources and Facilities:

### 1. References and Learning Resources:

| | |
|---|---|
| **Essential References** | ***Advanced Organic Chemistry, Part A: Structure and Mechanisms,*** F. A. Carey; R. J. Sundberg (2007), Fifth edition, Springer US. ISBN 13: 9780387448978.<br><br>***Modern physical organic chemistry,*** E.V. Anslyn, D. A. Dougherty (2005). ISBN: 978- 1891389313.<br><br>***Organic chemistry: Theory, reactivity, and mechanisms in modern synthesis***, P. Vogel, K.N. Houk (2019). ISBN: 978-3527345328. |
| **Supportive References** | ***MARCH'S Advanced Organic Chemistry, Reactions, Mechanisms, and Structure,*** Michael B. Smith, Jerry March, John Wiley & Sons, Inc., 7th Ed., 2007. ISBN: 978-0-470-46259-1 |
| **Electronic Materials** | • Journal of Organic Chemistry, ACS<br>• Organic Letters, ACS<br>• Tetrahedron<br>• Tetrahedron Letters<br>• Organic and Biomolecules Chemistry, RSC<br>• European Journal Of Organic Chemistry<br>Saudi Digital Library |
| **Other Learning Materials** | • Blackboard.<br>Multimedia associated with the text book and the relevant websites. |

## 2. Educational and Research Facilities and Equipment Required:

| Items | Resources |
|---|---|
| **facilities**<br>(Classrooms, laboratories, exhibition rooms, simulation rooms, etc.) | **Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.** |
| **Technology equipment**<br>(Projector, smart board, software) | **The rooms are equipped with data show, Smart Board,<br>WI-FI access.** |
| **Other equipment**<br>(Depending on the nature of the specialty) | **None** |

## F. Assessment of Course Quality:

| Assessment Areas/Issues | Assessor | Assessment Methods |
|---|---|---|
| **Effectiveness of teaching** | Students | **Direct:** Questionnaire. |
| | Course Responsible | **Direct:** Course e-Portfolio.<br>**Indirect:** Second examiner checklist-Course report. |
| | Peer Reviewer | **Direct:** Questionnaire.<br>**Indirect:** External assessor report. |
| **Effectiveness of students' assessment** | Program Leaders | **Direct:** Course e-Portfolio.<br>**Indirect:** Course report. |

| Assessment Areas/Issues | Assessor | Assessment Methods |
|---|---|---|
| **Quality of learning resources** | Students | **Indirect:** Second examiner checklist-Course report. |
| | Faculty ( Academic Advisory-GCC) | **Direct:** course Entrance/Exit. **Indirect:** Observations - Accreditation review. |
| | Program Leaders | **Direct:** Course e-Portfolio. **Indirect:** Course evaluation survey- Observations- Syllabus review- Accreditation review. |
| | Course Responsible | |
| **The extent to which CLOs have been achieved** | Course Responsible | **Direct:** Exams - Course e-Portfolio. **Indirect:** Second examiner checklist-Course report. |
| | Program Leaders | **Indirect:** Exams. |
| **Other** | | |

**Assessor** (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)

**Assessment Methods** (Direct, Indirect)

## G. Specification Approval Data:

| | |
|---|---|
| **COUNCIL /COMMITTEE** | **Council of Chemistry Department** |
| **REFERENCE NO.** | **10 (No. 2/10)** |
| **DATE** | **21/04/1444- 15/11/2022** |