CHEM4031: ADVANCED ORGANIC CHEMISTRY

Effective Term
Semester A 2024/25

Part I Course Overview

Course Title
Advanced Organic Chemistry

Subject Code
CHEM - Chemistry
Course Number
4031

Academic Unit
Chemistry (CHEM)

College/School
College of Science (SI)

Course Duration
One Semester

Credit Units
4

Level
B1, B2, B3, B4 - Bachelor's Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
CHEM2007/BCH2007 Principles of Organic Chemistry
CHEM3015/BCH3015 Organic Chemistry

Equivalent Courses
BCH4031 Advanced Organic Chemistry

Exclusive Courses
Nil

Part II Course Details

Abstract
This course aims to:

- introduce organic chemistry of aldol reactions and enolate anions;
- explain the structures and reactions of carbohydrates and lipids;
- introduce basic strategies of multi-step organic syntheses;
- explain conformational, steric, and stereoelectronic effects of organic molecules;
- critically evaluate organic reaction mechanisms;
- develop knowledge of nucleophilic substitution reaction.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe and explain the concepts of advanced 1H/13C NMR spectroscopies.	25	x	x	x
2	Explain the mechanistic and physical organic chemistry for organic reaction mechanisms.	20	x	x	x
3	Compare and contrast conformational, steric, and stereoelectronic effects of organic molecules; Pericyclic reactions.	20	x	x	x
4	Apply the strategies, principles, and organometallic chemistry in multi-step organic syntheses, and natural product biosynthesis.	35	x	x	x

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lectures and tutorials	Students will engage in lectures and tutorials to explain the concept of advanced 1H/13C NMR spectroscopies	1	
2	Lectures and tutorials	Students will engage in the lectures and tutorials on the basic concepts and principles of organic reaction mechanisms.	2	

3	Lectures and tutorials	Students will engage in the lectures and tutorials to analyze the basic strategies of multi-step organic syntheses, natural product biosynthesis	3	
4	Lectures and tutorials	Students will participate in the lectures and tutorials to investigate the conformational, steric, and stereo-electronic effects of organic molecules.	4	

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Short Quizzes/ Assignment	1, 2, 3, 4	30	

Continuous Assessment (%)

30

Examination (%)

70

Examination Duration (Hours)

3

Additional Information for ATs

Starting from Semester A, 2015-16, students must satisfy the following minimum passing requirement for courses offered by CHEM: "A minimum of 40% in both coursework and examination components."

Assessment Rubrics (AR)

Assessment Task

Short Quizzes/Assignment

Criterion

Student completes the activity demonstrates grasp of the important concepts to the topic concerned

Excellent (A+, A, A-)

Able to demonstrate excellent understanding of the principles of advanced organic chemistry.

Good (B+, B, B-)

Able to describe and explain the principles of advanced organic chemistry.

Fair (C+, C, C-)

Able to describe and explain some key principles of advanced organic chemistry.

Marginal (D)

Able to briefly describe isolated principles of advanced organic chemistry.

Failure (F)

Fail to accurately describe and explain relevant principles of advanced organic chemistry.

Assessment Task

Examination

Criterion

Student demonstrates grasp of the important concepts to the topic concerned, and can apply these concepts to solve problems. Strong evidence of demonstrated use of concepts for rationalization, with some originality in thought and argument.

Excellent (A+, A, A-)

Able to demonstrate excellent understanding of the principles and selected topics of advanced organic chemistry.

Good (B+, B, B-)

Able to describe and explain the principles and selected topics of advanced organic chemistry.

Fair (C+, C, C-)

Able to describe and explain some key principles and selected topics of advanced organic chemistry.

Marginal (D)

Able to briefly describe isolated principles and selected topics of advanced organic chemistry.

Failure (F)

Fail to accurately describe/ explain relevant principles and selected topics of advanced organic chemistry.

Part III Other Information

Keyword Syllabus

- Aldol reactions and enolate anions: keto and enol tautomers, crossed aldol reaction, cyclization via aldol condensation, Michael addition, Robinson annulation
- Nuclear Magnetic Resonance spectroscopy, advanced 1D and 2D $^{1}H/^{13}C$ NMR techniques
- Multi-step organic syntheses: protective group, synthetic analysis and planning, retrosynthetic analysis, control of stereochemistry, convergent and linear synthesis
- Conformational, steric, and stereoelectronic effects: steric strain, heteroatom, angle strain, conformational analysis, axial vs equatorial
- Mechanistic and Physical Organic Chemistry: organic reaction mechanisms, kinetic vs thermodynamic control, substituent effect, isotope effect, solvent effect, catalysis
- Nucleophilic substitution reaction: S_N1 vs S_N2 reaction, carbocations, nucleophilicity, leaving group effects, neighboring-group participation, rearrangement
- Frontier molecular orbital interactions and their application to: electrocyclic reactions, cycloadditions, sigmatropic rearrangements. Woodward-Hoffmann rules for pericyclic reactions.

Reading List

Compulsory Readings

	Title
1	Nil

Additional Readings

	Title
1	Organic Chemistry, T.W.G. Solomons (John Wiley and Sons, 7th or 8th edition)
2	Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg