

# CHEM4031: ADVANCED ORGANIC CHEMISTRY

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## Effective Term

Semester A 2023/24

## 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;
- explain how nature synthesizes organic molecules and compare biosynthetic reactions and synthetic organic reactions.

### Course Intended Learning Outcomes (CILOs)

CILOs		Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Understand the principles of advanced <sup>1</sup> H/ <sup>13</sup> C NMR spectroscopies for molecular structural analysis.	25	x	x	x
2	Develop general problem-solving strategy with a good understanding of the fundamentals of organic reaction mechanisms.	25	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 organic chemistry in natural products chemistry, bioorganic chemistry, and biosynthesis.	30	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.

### Teaching and Learning Activities (TLAs)

TLAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lectures and tutorials	Teaching and learning will be primarily based on lectures and tutorials explaining the concept of advanced <sup>1</sup> H/ <sup>13</sup> C NMR spectroscopies	1

2	Lectures and tutorials	Teaching and learning will be primarily based on lectures explaining basic concepts and principles of modern techniques used in studying organic reaction mechanisms.	2	
3	Lectures and tutorials	Teaching and learning will be primarily based on lectures and tutorials explaining basic strategies of multi-step organic syntheses, natural product biosynthesis	3	
4	Lectures and tutorials	Teaching and learning will be primarily based on lectures and tutorials examining conformational, steric, and stereoelectronic 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-)**

High

**Good (B+, B, B-)**

Significant

**Fair (C+, C, C-)**

Moderate

**Marginal (D)**

Basic

**Failure (F)**

Not even reaching marginal levels

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### 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-)**

High

**Good (B+, B, B-)**

Significant

**Fair (C+, C, C-)**

Moderate

**Marginal (D)**

Basic

**Failure (F)**

Not even reaching marginal levels

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## 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  $^1\text{H}/^{13}\text{C}$  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:  $\text{S}_{\text{N}}1$  vs  $\text{S}_{\text{N}}2$  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
- Acetate pathway, mevalonate and methylerythritol phosphate (MEP) pathways, peptide biosynthesis

### 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
3	Medicinal Natural Products: A Biosynthetic Approach; Paul M. Dewick (John Wiley & Sons, Ltd, 3rd Edition). The electronic version of the textbook is available from the CityU Library: <a href="https://onlinelibrary.wiley.com/doi/book/10.1002/9780470742761">https://onlinelibrary.wiley.com/doi/book/10.1002/9780470742761</a>