CHEM6131: FRONTIERS IN MODERN SYNTHETIC CHEMISTRY

Effective Term
Semester A 2025/26

Part I Course Overview

Course Title
Frontiers in Modern Synthetic Chemistry

Subject Code
CHEM - Chemistry
Course Number
6131

Academic Unit
Chemistry (CHEM)

College/School
College of Science (SI)

Course Duration
One Semester

Credit Units
3

Level
P5, P6 - Postgraduate Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
Nil

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

Abstract

This course aims to explore the cutting edge of synthetic technologies and methodologies for the synthesis of functional molecules, advanced materials, and pharmaceuticals. Synthetic chemistry is of vital significance in multiple disciplines, such as medicinal chemistry, material science, chemical biology, and many other areas. In this course, different areas of synthetic chemistry, including asymmetric catalysis, electrochemical synthesis, photoredox catalysis, flow chemistry, main group element chemistry, and other relevant technologies will be introduced. Upon completion of this course, students will attain a comprehensive view of advanced synthetic chemistry, which will endow them with the ability to enter different research areas in their future careers.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Introduce the asymmetric synthesis based on organic and organometallic catalytic methods, the catalytic system design, mechanism studies as well as their applications in pharmaceutical synthesis. Demonstrate the utilization and advantages of advanced approaches of molecule synthesis, including photo- and electro-chemical techniques.	20	x	x	x
2	Describe the basic concepts of continuous flow chemistry and its application in modern organic synthesis. Describe the equipment and technique used in modern synthetic chemistry.	20	x	x	x
3	Introduce the synthesis and structure of reactive main-group compounds. Describe the application of main-group compounds in small-molecule activation, catalysis, and organic synthesis.	20	x	x	x
4	Show the ability to search references, identify scientific problems, propose solutions, and give presentations in class.	40	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	Students will be introduced to the importance of chirality, the designing principle of asymmetric catalysis, advanced photo-/ electrochemical synthetic technologies, mechanistic understanding, and practical applications in industrial production.	1	
2	Lectures	Students will be introduced to the fundamental principles of continuous flow chemistry, working principles of flow equipment, recent examples of continuous flow synthesis, and the development of continuous flow systems.	2	
3	Lectures	Students will be introduced to the synthesis, structure, and reactivity of main-group compounds.	3	
4	Quizzes	Students will be engaged in short quizzes in each lecture class to reinforce the understanding of learning contents and set it as one of the assessments of students' competence.	1, 2, 3	
5	Assignments	Students will complete assignments to consolidate the classroom learning and in-depth understanding of related knowledge, including asymmetric organic catalysts, organometallic catalysts, mechanism of chiral induction, mechanism of photo- and electrochemical processes, principles of continuous flow chemistry, the main group chemistry.	1, 2, 3	

6	Presentation	Students will be involved in presentations of relevant synthetic topics to enhance students' self-learning ability, expression skills, literature-searching ability, and teamwork spirit.	4	

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("-" for nil entry)	Allow Use of GenAI?
1	In-class tutorials and quizzes Tutorials and quizzes will be arranged in each lecture class to test the learning quality.	1, 2, 3	30	-	Yes
2	Out-class assignments One assignment on asymmetric catalysis, photochemistry, and electrochemical synthesis; one assignment on continuous flow technology; one assignment on main group chemistry.	1, 2, 3	30	-	Yes
3	Presentation A selected topic, either given by teachers or chosen by students themselves, related to advanced synthetic technology will be assigned to individuals or groups for presentation.	4	40	2 assessors will be arranged to give an objective and comprehensive evaluation.	No

Continuous Assessment (%)

100

Minimum Continuous Assessment Passing Requirement (%)

40

Assessment Rubrics (AR)

Assessment Task

1. Quizzes (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

The extent of mastery of class learning outcome, ability to solve practice problems, including the design of synthetic routes for target molecules, reaction mechanisms, flow system design, structure, and reactivity of main group chemistry.

Excellent

(A+, A, A-) Very proficient and high ability to analyze and solve practice problems.

Good

(B+, B, B-) Significant ability to analyze and solve problems.

Fair

(C+, C, C-) Moderate ability to analyze and solve problems.

Marginal

(D) Basic ability to analyze and solve problems.

Failure

(F) Not even reaching marginal levels.

Assessment Task

2. Assignments (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Ability to periodically summarize and recall the in-class learning knowledge; the depth and width of understanding and memory of various synthetic methods and technologies; ability to apply in-class learning concepts for rationalization and to solve chemical problems.

Excellent

(A+, A, A-) High ability and excellent performance in solving practice problems.

Good

(B+, B, B-) Significant ability to solve practice problems.

Fair

(C+, C, C-) Moderate ability to solve practice problems.

Marginal

(D) Basic ability to solve practice problems.

Failure

(F) Not even reaching marginal levels.

Assessment Task

3. Presentation (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Ability to search reference, extract, and summarize scientific ideas; capability of self-learning and analysis of critical problems; skills of expression and convincing others.

Excellent

(A+, A, A-) Very fluent expression and articulate, audience been well convinced.

Good

(B+, B, B-) Good expression, critical problems and ideas are well-received by the audience.

Fair

(C+, C, C-) Moderate expression, the presented content is well-organized.

Marginal

(D) Basic complement.

Failure

(F) Not even reaching marginal levels.

Part III Other Information

Keyword Syllabus

Synthetic Chemistry
Material science. Physical science. Medicinal chemistry.
Asymmetric Synthesis
Chirality. Asymmetric catalysis. Organic catalyst. Organometallic catalyst. Chiral pharmaceuticals.
Photo-/Electrochemical Synthesis
Sustainable chemistry. Photoredox reaction. Electrochemical oxidation. Electrochemical reduction.
Continuous Flow Chemistry
Working principles of flow equipment. Establishment of continuous flow system. Advantages of continuous flow chemistry.

Main Group Chemistry
Small molecular activation. Metal-free catalysis. Main-group compounds.

Reading List

Compulsory Readings

	Title
1	Mukherjee, S.; Yang, J. W.; Hoffmann, S.; List, B., Asymmetric Enamine Catalysis. Chem. Rev. 2007, 107, 5471-5569.
2	Yan, M.; Kawamata, Y.; Baran, P. S., Synthetic Organic Electrochemical Methods Since 2000: On the Verge of a Renaissance. Chem. Rev. 2017, 117, 13230-13319.
3	Chan, A. Y.; MacMillan, D. W. C., et.al. Metallaphotoredox: The Merger of Photoredox and Transition Metal Catalysis. Chem. Rev. 2022, 122, 1485-1542.
4	Plutschack, M. B.; Pieber, B.; Gilmore, K.; Seeberger, P. H., The Hitchhiker’ s Guide to Flow Chemistry. Chem. Rev. 2017, 117, 11796-11893.
5	Stephan, D. W.; Erker, G., Frustrated Lewis Pair Chemistry: Development and Perspectives. Angew. Chem. Int. Ed. 2015, 54, 6400-6441.

Additional Readings

	Title
1	Nil