

CHEM6118: ADVANCED CHEMICAL INSTRUMENTATION

Effective Term

Semester A 2025/26

Part I Course Overview

Course Title

Advanced Chemical Instrumentation

Subject Code

CHEM - Chemistry

Course Number

6118

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

BCH6118 Advanced Chemical Instrumentation

Exclusive Courses

CHEM8008 Advanced Chemical Instrumentation for Research

Part II Course Details

Abstract

This course enables students of postgraduate level to more in-depth understand concepts and principles of advanced chemical instrumentation (electron, vibration and NMR spectroscopies and mass spectrometry) applied for a wide variety of advanced chemistry disciplines (such as catalysis, synthetic chemistry, materials & biomaterials chemistry, analytical & bio-analytical sciences, computational chemistry, environmental chemistry and chemical biology). Through review and discussion on some recent literature, the latest instrumental developments will be introduced to students, and their advantages, limitations and challenges for chemical research and development will also be critically evaluated. Individual literature review will allow students to identify nowadays chemical problems and propose plausible usages of the advanced instrumentation to obtain chemical information to tackle the problems. On completion of this course, students should be able to design experiments with application of most appropriate instrumental tools or their combination to solve problems in chemistry and molecular sciences.

Course Intended Learning Outcomes (CILOs)

CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1 Explain and apply the fundamental concepts and working principles of advanced instrumentation, such as electron, vibration and nuclear magnetic resonance spectroscopies and mass spectrometry, for chemical analysis.	30	x	x	
2 Discuss the latest developments in the above techniques and critical evaluate their advantages, limitations and challenges for research and development in chemistry and molecular sciences, with special emphasis on molecular design and chemical methodology in synthetic and analytical chemistry.	40	x	x	
3 Propose plausible innovative and practical applications of the above advanced instrumentation for modern chemical research and development. Justify the selection of the most appropriate instrumental method or their combination to analyse and solve defined chemical problems.	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.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lectures and Tutorials	Students will engage in a combination of interactive lecture and tutorial activities to discuss and explain the fundamental concepts and working principles of the latest developments in electron, vibration and nuclear magnetic resonance spectroscopies and mass spectrometry.	1, 3	
2	Lectures and Tutorials	Students will engage in a combination of interactive lecture and tutorial activities to discuss and critical evaluate chemical information and key findings in some recent chemical literature, and discuss and evaluate the advantages, limitations and challenges of the advanced instrumentation methods for research and development in chemistry and molecular sciences.	2, 3	

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("- " for nil entry)	Allow Use of GenAI?
1	Assignment: Basic concepts, working principles of various chemical instrumental techniques	1, 2	15	-	Yes
2	Assignment: Literature reviews on latest instrumental developments and proposing potential applications	1, 2, 3	15	-	Yes

Continuous Assessment (%)

30

Examination (%)

70

Examination Duration (Hours)

3

Minimum Continuous Assessment Passing Requirement (%)

40

Minimum Examination Passing Requirement (%)

40

Additional Information for ATs

Examination

- Explain the fundamental concepts and working principles of advanced chemical instrumentation. (Achieved CILO 1, 2, weighting: 20%)
- Discuss and critical evaluate their advantages, limitations and challenges of different instruments. (Achieved CILO 1, 2, weighting: 30%)
- Propose and justify the selection of the most appropriate instrumental method or combination of methods to analyse and solve these defined chemical problems. (Achieved CILO 1, 2, 3, weighting: 20%)

Assessment Rubrics (AR)

Assessment Task

Assignment: Basic concepts, working principles of various chemical instrumental techniques (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Capacity for self-directed learning (including preview and review of teaching materials) to understand the principles of advanced chemical instrumentation

Excellent

(A+, A, A-) High - Able to discuss and explain the basic concepts and working principles, and evaluate the capabilities of commonly used advanced chemical instrumentations precisely and concisely with no errors

Good

(B+, B, B-) Significant - Able to discuss and explain the basic concepts and working principles, and evaluate the capabilities of commonly used advanced chemical instrumentations precisely and concisely with a few errors

Fair

(C+, C, C-) Basic - Able to discuss and explain the basic concepts and working principles, and evaluate the capabilities of commonly used advanced chemical instrumentations precisely and concisely with some errors

Marginal

(D) Minimal - Able to discuss and explain a few basic concepts and working principles, and evaluate the capabilities of commonly used advanced chemical instrumentations precisely and concisely with some errors

Failure

(F) Not even reaching marginal levels - Unable to discuss and explain most basic concepts and working principles of commonly used advanced chemical instrumentations

Assessment Task

Assignment: Literature reviews on latest instrumental developments and proposing potential applications (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Ability to critically evaluate some selected literature on the usage of advanced instrumentation for chemical analyses in modern research; apply knowledge to propose designs with justification the selection of the most appropriate instrumental methods or their combination to perform chemical analyses for a given research task.

Excellent

(A+, A, A-) High - Able to present all required knowledge and concepts precisely and concisely with no errors; and able to propose reasonable instrumental approaches with scientific basis

Good

(B+, B, B-) Significant - Able to present most required knowledge and concepts precisely and concisely with no errors; and able to propose reasonable instrumental approaches with scientific basis

Fair

(C+, C, C-) Basic - Able to present some required knowledge and concepts precisely and concisely with no errors; and able to propose reasonable instrumental approaches with scientific basis

Marginal

(D) Minimal - Able to present a few required knowledge and concepts with some errors; and able to propose reasonable instrumental approaches with scientific basis

Failure

(F) Not even reaching marginal levels - Unable to present most required knowledge and concepts precisely and concisely; and unable to propose reasonable instrumental approaches with scientific basis

Assessment Task

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

Criterion

Ability to explain in detail and with accuracy the principles of advanced instrumentation, discuss and critically evaluate their advantages, limitations and challenges, propose and justify their applications for modern chemical researches

Excellent

(A+, A, A-) High - Able to correctly answer almost all the examination questions precisely and concisely with no errors

Good

(B+, B, B-) Significant - Able to correctly answer a substantial number of the examination questions precisely and concisely with no errors

Fair

(C+, C, C-) Basic - Able to correctly answer most of the examination questions precisely and concisely with only a few errors

Marginal

(D) Minimal - Able to correctly answer a few examination questions with some errors

Failure

(F) Not even reaching marginal levels - Unable to correctly answer most of the examination questions

Part III Other Information

Keyword Syllabus

Advanced optical spectroscopic techniques and their relationships with electronic and bonding structures, Fourier transform spectroscopy, time domain and frequency domain spectra, continuous wave laser, pulsed laser, time-resolved

spectroscopy with time window ranging from femtosecond to millisecond, time-resolved fluorescence, transient absorption, time-resolved resonance Raman, fluorescence photocounting, laser flash photolysis, in situ IR and NMR, COSY, NOESY, mass spectrometry, time-of-flight, linear quadrupole, quadrupole ion trap, orbitrap, Fourier transform ion cyclotron resonance, hybrid instruments, electron/chemical ionization, fast atom bombardment, electrospray, laser desorption, tandem mass spectrometry, collision activation, IR/UV photodissociation, electron-capture/transfer dissociation, ion-mobility spectrometry.

Reading List

Compulsory Readings

Title	
1	Nil

Additional Readings

Title	
1	Principles of Instrumental Analysis; D. A. Skoog, F. J. Holler, S. R. Crouch; (Cengage Learning, 2018, 7th Ed.)
2	Introduction to Spectroscopy; D. L. Pavia, G. M. Lampman, G. S. Kriz, J. R. Vyvyan; (Cengage Learning 2015, 5th Ed.)
3	Mass Spectrometry - A Textbook; J. H. Gross; (Springer-Verlag, 2017, 3rd Ed.)
4	Mass Spectrometry: Principles and Applications; E. de Hoffmann, V. Stroobant; (John Wiley & Sons Ltd., 3rd Ed., Reprinted 2012)