City University of Hong Kong
Course Syllabus

offered by Department of Chemistry
with effect from Semester A 2024/25

Part I Course Overview

Course Title:	Advanced Chemical Instrumentation for Research
Course Code:	CHEM8008
Course Duration:	1 semester
Credit Units:	3 credits
Level:	R8
Medium of Instruction:	English
Medium of Assessment:	English
Prerequisites: *(Course Code and Title)*	Nil
Precursors: *(Course Code and Title)*	Nil
Equivalent Courses: *(Course Code and Title)*	BCH8008 Advanced Chemical Instrumentation for Research
Exclusive Courses: *(Course Code and Title)*	CHEM6118 Advanced Chemical Instrumentation

Part II Course Details

1. Abstract

The course aims to provide the student with concepts and principles of some advanced and widely used research techniques and instrumental methods in chemistry. The course will introduce to the students the basic concepts, working principles and specific capabilities of different chemical instrumentations.

2. Course Intended Learning Outcomes (CILOs)

No.	CILOs[#]	Weighting (if applicable)	Discovery-enriched curriculum related learning outcomes		
			A1	*A2*	*A3*
1.	Explain and apply the basic concepts and working principles of electronic spectroscopy (UV-VIS absorption and fluorescence) and vibrational spectroscopy (Raman and IR), review the latest developments in laser based time-resolved electronic and vibrational spectroscopies, and evaluate their capabilities for chemical analyses in modern research.		√	√	
2.	Explain and apply the basic concepts and working principles of mass spectrometry, characterize the capabilities of commonly used ion sources and mass analyzers for chemical analyses, review their latest instrumental developments in hyphened and tandem mass spectrometric techniques, and evaluate their capabilities for chemical analyses in modern research.		√	√	
3.	Explain and apply the basic concepts and working principles of *in situ* IR and NMR spectroscopies, review their latest instrumental developments in 2D NMR techniques, and evaluate their capabilities for chemical analyses in modern research.		√	√	
4.	Demonstrate critical thinking skills in proposing possible applications of UV-VIS, fluorescence, IR, Raman, NMR spectroscopies, and mass spectrometry for modern chemical researches; design and justify the selection of the most appropriate instrumental methods or their combination to perform chemical analyses for given research tasks.		√	√	√
		100%			

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 self-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.

3. Learning and Teaching Activities (LTAs)

LTA	Brief Description	CILO No.				Hours/week (if applicable)
		1	2	3	4	
Lectures and tutorials	Students will engage in a combination of interactive lecture and tutorial activities to discuss and explain the basic concepts, working principles; to review and evaluate latest instrumental developments in time-resolved electronic and vibrational spectroscopies with some recent applications in literature.	✓			✓	
Lectures and tutorials	Students will engage in a combination of interactive lecture and tutorial activities to discuss and explain the basic concepts, working principles, and the capabilities of commonly used ion sources and mass analyzers in mass spectrometry; to review and evaluate latest instrumental developments in hyphened and tandem mass spectrometric techniques with some recent applications in literature.		✓		✓	
Lectures and tutorials	Students will engage in a combination of interactive lecture and tutorial activities to discuss and explain the basic concepts and working principles of *in situ* IR and NMR; to review and evaluate latest instrumental developments in 2D NMR techniques with some recent applications in literature.			✓	✓	

4. Assessment Tasks/Activities (ATs)

Assessment Tasks/Activities	CILO No.				Weighting	Remarks
	1	2	3	4		
Continuous Assessment: 30%						
Assignment: Basic concepts, working principles of various chemical instrumental techniques	✓	✓	✓		15%	
Assignment: Literature reviews on latest instrumental developments and proposing potential applications	✓	✓	✓	✓	15%	
Examination: 70% (duration: 3 hours)						
Explain the fundamental concepts and working principles of advanced chemical instrumentation.	✓	✓	✓		20%	
Discuss and critical evaluate their advantages, limitations and challenges of different instruments.	✓	✓	✓		30%	
Propose and justify the selection of the most appropriate instrumental method or combination of methods to analyse and solve these defined chemical problems.	✓	✓	✓	✓	20%	
					100%	

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."

5. Assessment Rubrics

Applicable to students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Literature reviews, group discussions and oral presentation	Capacity for self-directed learning to understand the principles of advanced chemical instrumentation	High	Significant	Moderate	Basic	Not even reaching marginal levels
	Ability to critically evaluate some selected literature on the usage of advanced instrumentation for modern chemical researches	High	Significant	Moderate	Basic	Not even reaching marginal levels
	Ability to propose with detail explanation possible applications of advanced instrumentation for modern chemical researches	High	Significant	Moderate	Basic	Not even reaching marginal levels
2. Examination	Ability to explain in detail and with accuracy the principles of advanced chemical instrumentation and their applications for modern chemical researches	High	Significant	Moderate	Basic	Not even reaching marginal levels

Applicable to students admitted from Semester A 2022/23 to Summer Term 2024

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B)	Marginal (B-, C+, C)	Failure (F)
Assignment: Basic concepts, working principles of various chemical instrumental techniques	Capacity for self-directed learning (including preview and review of teaching materials) to understand the principles of advanced chemical instrumentation	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	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	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	Not even reaching marginal levels Unable to discuss and explain most basic concepts and working principles of commonly used advanced chemical instrumentations
Assignment: Literature reviews on latest	Ability to critically evaluate some selected literature on the usage of advanced instrumentation for chemical analyses in modern	High Able to present all required knowledge and concepts precisely and	Significant Able to present most required knowledge and concepts precisely and	Basic Able to present some required knowledge and concepts precisely and	Not even reaching marginal levels Unable to present most required knowledge

instrumental developments and proposing potential applications	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.	concisely with no errors; and able to propose reasonable instrumental approaches with scientific basis	concisely with no errors; and able to propose reasonable instrumental approaches with scientific basis	concisely with no errors; and able to propose reasonable instrumental approaches with scientific basis	and concepts precisely and concisely; and unable to propose reasonable instrumental approaches with scientific basis
Examination	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	High Able to correctly answer almost all the examination questions precisely and concisely with no errors	Significant Able to correctly answer a substantial number of the examination questions precisely and concisely with no errors	Basic Able to correctly answer most of the examination questions precisely and concisely with only a few errors	Not even reaching marginal levels Unable to correctly answer most of the examination questions

Part III Other Information

1. Keyword Syllabus

UV-Vis absorption, fluorescence spectroscopy, Raman spectroscopy, Infrared (IR) spectroscopy, Fourier Transfer IR 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, mass spectrometry, electron ionization, fast atom bombardment, chemical ionization, electrospray, laser desorption, quadrupole mass analyzer, quadrupole ion trap, time-of-flight, Fourier transform ion cyclotron resonance, hybrid instruments, tandem mass spectrometry, *in situ* IR and NMR.

2. Reading List

2.1 Compulsory Readings

1.	
2.	
3.	
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2.2 Additional Readings

1.	Principles of Instrumental Analysis; D. A. Skoog, F. J. Holler, S. R. Crouch; (Cengage Learning, 2018, 7th Ed.)
2.	Mass Spectrometry - A Textbook; J. H. Gross; (Springer-Verlag, 2017, 3rd Ed.)
3.	Mass Spectrometry: Principles and Applications; E. de Hoffmann, V. Stroobant; (John Wiley & Sons Ltd., 3rd Ed., Reprinted 2012)