City University of Hong Kong
Course Syllabus

offered by Department of Chemistry
with effect from Semester B 2017/18

Part I Course Overview

Course Title:	Advanced Chemical Bonding and Molecular Spectroscopy
Course Code:	BCH8154
Course Duration:	1 semester
Credit Units:	4 credits
Level:	R8
Proposed Area: *(for GE courses only)*	☐ Arts and Humanities ☐ Study of Societies, Social and Business Organisations ☐ Science and Technology
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)*	Nil
Exclusive Courses: *(Course Code and Title)*	Nil

Part II Course Details

1. Abstract

This course is a postgraduate taught course tailored for postgraduate research students only. The aim of this course is to help students to develop an understanding of the theories of chemical bonding and applications of some important spectroscopic techniques which are essential in all branches of chemistry.

2. Course Intended Learning Outcomes (CILOs)

No.	CILOs[#]	Weighting* (if applicable)	Discovery-enriched curriculum related learning outcomes (please tick where appropriate)		
			A1	*A2*	*A3*
1.	Describe chemical bonding using quantum mechanics.	20%	✓	✓	
2.	Describe the interaction between electromagnetic radiations and atoms/molecules.	20%	✓	✓	
3.	Discover the spectra for simple organic and inorganic compounds qualitatively based on information of chemical bonding theories and spectroscopic techniques.	20%	✓	✓	✓
4.	Extract useful chemical information such as bonding and reactivity from spectroscopic data.	20%		✓	✓
5.	Design appropriate spectroscopic methods for chemical analysis.	20%		✓	✓
** If weighting is assigned to CILOs, they should add up to 100%.*		100%			

[#] Please specify the alignment of CILOs to the Gateway Education Programme Intended Learning outcomes (PILOs) in Section A of Annex.

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. Teaching and Learning Activities (TLAs)

TLA	Brief Description	CILO No.					Hours/week (if applicable)
		1	2	3	4	5	
Lectures	Students will learn the origin of quantum mechanics through literature searches; large group interactive activities will enable students to understand light–matter interactions	✓	✓				
Tutorials	Through a number of case studies the students will discover the techniques of assigning spectra			✓	✓	✓	
Presentations	Student-centered learning and student oral presentation to provide students opportunities in rationalizing the relationship between chemical bonding and spectroscopic data; problem-based learning activities to provide opportunities for students to design appropriate spectroscopic methods for chemical analysis			✓	✓	✓	

4. Assessment Tasks/Activities (ATs)

Assessment Tasks/Activities	CILO No.					Weighting*	Remarks
	1	2	3	4	5		
Continuous Assessment: 30%							
Homework	✓					5%	
Presentations				✓		5%	
Tests and Reports	✓	✓	✓			15%	
Individual Project					✓	5%	
Examination: 70% (duration: 3 hours)							
** The weightings should add up to 100%.*						100%	

Starting from Semester A, 2015-16, students must satisfy the following minimum passing requirement for BCH courses:

"A minimum of 40% in both coursework and examination components."

5. Assessment Rubrics

Grade	Grade Definitions	
A+ A A-	Excellent	Student completes all the assessment tasks/activities (quizzes, laboratory reports, group presentations, and exams) and demonstrates excellent grasp of the important concepts to various aspects of the topic covered in this course, and can apply these concepts to solve problems with clear and logical explanations. Strong evidence of superior writing and presentation skills.
B+ B B-	Good	Student completes all assessment tasks/activities and can describe and explain the important concepts to several aspects of the topic covered in this course. Shows, to some extent, the ability to use concepts for rationalization and to solve problems. Displays effective writing and presentation skills.
C+ C C-	Fair	Student completes most of the assessment tasks/activities and can describe some key elements on the topics covered in the course. Shows limited ability to apply concepts, and competent writing and presentation skills.
D	Marginal	Student has little participation and interest, and demonstrates limited ability in analysis.
F	Failure	Student has no participation, interest or original thought.

Part III Other Information (more details can be provided separately in the teaching plan)

1. Keyword Syllabus

Quantum Mechanics
Schrödinger Equation, Quantum Mechanical Postulates, Particle in a Box, Hydrogen Atom, Molecular Orbital Theory, Valence-Bond Theory, Hybridization

Symmetry, Group Theory and Quantum Mechanics
Irreducible Representations, Direct Products, Projection Operators

Nature of Radiation, Atomic and Molecular Transitions
Electromagnetic radiation–Matter Interaction, Quantized Transition in Atomic and Molecular Levels, Born-Oppenheimer Approximation, Selection Rules

Electronic Absorption Spectroscopy
Franck-Condon Principle, Spin-Orbit Coupling, Vibronic Coupling, Configuration Interaction, Oscillator Strength

Vibration and Rotation Spectroscopies
Infrared and Raman Spectroscopies, Harmonic Oscillator Approximation, Normal Mode of Vibration, Resonance Raman Spectroscopy, Microwave Spectroscopy

Nuclear Magnetic Resonance and Electron Paramagnetic Resonance Spectroscopies
Spin Quantum Number, Field Strength and Chemical Shift, Spin-Spin Splitting, Nuclear Hyperfine Splitting

Photoelectron Spectroscopy
Ultraviolet Photoelectron Spectroscopy, X-ray Photoelectron Spectroscopy

2. Reading List

2.1 Compulsory Readings

1.	
2.	
3.	
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2.2 Additional Readings

1.	Quantum Chemistry and Spectroscopy, Thomas Engel, 3rd Ed.(ISBN-13: 978-0321766199)
2.	
3.	
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