City University of Hong Kong
Course Syllabus

offered by Department of Physics
with effect from Semester A 2020/21

Part I Course Overview

Course Title:	Advanced Quantum Mechanics
Course Code:	PHY6251
Course Duration:	1 semester
Credit Units:	3 credits
Level:	P6
Medium of Instruction:	English
Medium of Assessment:	English
Prerequisites: *(Course Code and Title)*	Nil
Precursors: *(Course Code and Title)*	AP1203/PHY1203 General Physics III or equivalent AP3251/PHY3251 Quantum Physics or equivalent
Equivalent Courses: *(Course Code and Title)*	Nil
Exclusive Courses: *(Course Code and Title)*	PHY8251 Advanced Quantum Mechanics

Part II Course Details

1. Abstract

This course aims to equip graduate students with advanced knowledges of quantum mechanics that are necessary to conduct research and understand literature. The course will start with the Schrödinger, Heisenberg and the interaction picture, then covers the perturbation theory and scattering theory, the fundamental theories dealing with interacting problems. After that students will learn about identical particles, spins and second quantization. At last, there will be an introduction on applications of quantum mechanics to modern many-body physics.

2. Course Intended Learning Outcomes (CILOs)

(CILOs state what the student is expected to be able to do at the end of the course according to a given standard of performance.)

No.	CILOs	Weighting (if applicable)	Discovery-enriched curriculum related learning outcomes (please tick where appropriate)		
			A1	*A2*	*A3*
1.	Recognize and use appropriately important technical terms and definitions		✓		
2.	Use appropriate mathematical notations and apply in concise form the laws of quantum mechanics to the study of modern physics problems		✓	✓	
3.	Apply the laws of quantum mechanics to the study of modern physics problems		✓	✓	✓
4.	Solve real and hypothetical problems in quantum physics by identifying the underlying physics and analysing the problem		✓	✓	✓
		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. Teaching and Learning Activities (TLAs)

(TLAs designed to facilitate students' achievement of the CILOs.)

TLA	Brief Description	CILO No.				Hours/week (if applicable)
		1	2	3	4	
Lecture	Explain key concepts and theory of topics of the course	✓	✓	✓		2 hrs/wk
Tutorial	Explain how some problems are solved and the techniques used explain some concepts	✓	✓	✓	✓	1 hr/wk

4. Assessment Tasks/Activities (ATs)

(ATs are designed to assess how well the students achieve the CILOs.)

Assessment Tasks/Activities	CILO No.				Weighting	Remarks
	1	2	3	4		
Continuous Assessment: 60%						
Homework, Quizzes etc.	✓	✓	✓	✓	60%	
Examination: 40% (duration: 2 hours)	✓	✓	✓	✓	40%	
					100%	

5. Assessment Rubrics

(Grading of student achievements is based on student performance in assessment tasks/activities with the following rubrics.)

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Assignment	1. Capacity for using physics knowledge and theory to solve problems 2. Demonstrate correct understanding of key concepts.	Will exhibit a high level of competence in understanding, explaining, and integrating the knowledge in written format	Will exhibit a good level of competence in understanding, explaining, and integrating the knowledge in written format	Will exhibit a basic level of competence in understanding, explaining, and integrating the knowledge in written format	Will exhibit some deficiencies in understanding, explaining, and integrating the knowledge in written format	Will exhibit lack of competence in understanding, explaining, and integrating the knowledge in written format
2. Examination	1. Capacity for using physics knowledge and theory to solve problems 2. Demonstrate correct understanding of key concepts and physics theory.	Will exhibit a high level of competence in understanding, explaining, and integrating the knowledge in written format	Will exhibit a good level of competence in understanding, explaining, and integrating the knowledge in written format	Will exhibit a basic level of competence in understanding, explaining, and integrating the knowledge in written format	Will exhibit some deficiencies in understanding about experimental methods and the interpretation of results	Will exhibit lack of competence in understanding, explaining, and integrating the knowledge in written format

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

1. Keyword Syllabus

(An indication of the key topics of the course.)

Theory of Angular Momentum
Symmetry in Quantum Mechanics
Basic Group Theory
Schrödinger, Heisenberg and the interaction picture
Perturbation theory

Identical particles and spins
Second quantization
Introduction to modern many-body physics

2. Reading List

2.1 Compulsory Readings

(Compulsory readings can include books, book chapters, or journal/magazine articles. There are also collections of e-books, e-journals available from the CityU Library.)

None.

2.2 Additional Readings

(Additional references for students to learn to expand their knowledge about the subject.)

1.	J. J. Sakurai, Modern Quantum Mechanics (Second Edition) (Cambridge University Press, 2017)
2.	R. Shankar, Principles of Quantum Mechanics (Plenum Press, 2011)
3.	David J. Griffiths, Introduction to Quantum Mechanics, (Cambridge University Press, 2018)
4.	Gerald D. Mahan, Many-Particle Physics (Physics of Solids and Liquids) 3rd ed. (Springer, 2000)
5.	Franz Schwabl (translated by R. Hilton and Angela Lahee), Advanced Quantum Mechanics 4th ed. (Springer, 2008)