

PHY 4221 Quantum Mechanics I

Course Description

This course provides an exposition of the central concepts and the theoretical framework of non-relativistic quantum mechanics. Topics covered include: experimental basis, wave mechanics, Schrödinger's equation, one-dimensional potentials, orbital angular momentum, central force problems, matrix representation, spin, and approximation methods. Students are advised to take PHY3201 or its equivalent before taking this course. Prerequisite: permission of the instructor.

Course Content

	Topics	Highlights of Fundamental Concepts
1.	Review of wave mechanics	Wave function, probabilistic interpretation, wave packets, Schrödinger's equation, probability current density, expectation values, Ehrenfest theorem, momentum representation, 1D potential problems
2.	Formalism of quantum mechanics	Hypothesis, Dirac notation, state vectors, operators and their matrix representations, eigenvalues, eigenvectors, operator algebra, uncertainty relations, unitary transformation, time evolution problems, quantum measurement
3.	Spin and two-level systems	Spin 1/2 particle, two-level atom, Pauli matrices, spin precession in magnetic field.
4.	Simple harmonic oscillator	Creation and annihilation operators, coherent states, quantum dynamics
5.	Central force	Orbital angular momentum, spherical harmonics, parity, hydrogen-like atoms.
6.	Approximation methods	Non-degenerate time independent perturbation theory (1st and 2nd order corrections for energy), variational method.
7.	Quantum correlation in two two-level systems	Structure of joint state vectors, quantum entanglement and applications.

Learning Outcomes

1.	To learn the formalism of quantum mechanics in terms of Dirac notations and matrix representation
2.	To learn basic operator algebra in quantum mechanics, and to apply them to harmonic oscillator systems and central force systems.
3.	To learn how to solve energy spectrum and quantum dynamics in interacting two-level systems such as an electron spin in magnetic fields.
4.	To learn time-independent non-degenerate perturbation theory
5.	To learn the meaning of state vectors and measurement operators in two-particle systems. In particular, the concept and applications of quantum entanglement in two two-level systems.

Learning Activities

Lecture		Tutorial		Exercise Class and Assignment		Laboratory		Project / Report		Presentation		Case study		Web teaching		Other 1 (specify)		Other 2 (specify)	
(hr / week)		(hr / week)		(hr / week)		(hr / week)		(hr in total)		(hr in total)		(hr in total)		(hr / week)		(hr in total)		(hr in total)	
in class	out class	in class	out class	in class	out class	in class	out class	in class	out class	in class	out class	in class	out class	in class	out class	in class	out class	in class	out class
2.25	2	0.75	1	0.75	4														
M	M	M	M	M	M	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

M: Mandatory activity in the course O: Optional activity NA: Not applicable

Assessment Scheme

	Component	Description	Weight
1.	Homework	The homework will be graded by the TAs and the graded homework will be returned to you. If you have enquiries concerning the grading, please feel free to contact me or the TAs.	20%
2.	Mid-term Test	The schedule and venue of the mid-term test will be announced later.	30%
3.	Final Exam	The final examination will be centrally arranged by the university.	50%

Learning Resources

	Resource	Web link or ref no. in library
1.	B H Bransden & C J Joachain, "Introduction to Quantum Mechanics", Pearson 2000	
2.	D. J. Griffiths, "Introduction of Quantum Mechanics", Pearson 2005	QC174.12 .G74 2005

Feedback for Evaluation

1.	Send email to the teacher, give him a call, or come to his office, especially for issues that require immediate action;
2.	express your views in the mid-term and term-end course evaluation;
3.	express your views (or ask a student representative to help you convey the messages) in the staff-student consultation meeting held every year;
4.	post a message on the forum of the course website.

Teachers' or TAs' Contact Details

Teacher's Name	Contact	Additional Information
LAW Chi Kwong Teacher	Office : SC 307 Tel. no. : 3163 4334 Email : cklaw@phy.cuhk.edu.hk Office hr : F7	<ul style="list-style-type: none">••••
TA's Name	Contact	Additional Information
<ul style="list-style-type: none">• To be arranged		

Academic Honesty and Plagiarism

Attention is drawn to University policy and regulations on honesty in academic work, and to the disciplinary guidelines and procedures applicable to breaches of such policy and regulations. Details can be found at <http://www.cuhk.edu.hk/policy/academichonesty/>.

1.	After the course registration, you are required to submit "Declaration of Honesty in Academic Work" declaring that you are aware of these policies, regulations and procedures. The form can be found at http://www.phy.cuhk.edu.hk/ .
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Facilities for Posting Announcements and Materials

1.	The course website (http://www.phy.cuhk.edu.hk/course/2009-2010/1/phy4221) contains the following useful information and resources: (a) All course materials, including lecture notes, homework and solution. The password for download will be given to you in the first lecture. (b) A notice board for announcements of assignments, latest download, and important events (e.g. exam. schedule). (c) A web forum for you to ask questions, discuss problems with teachers and classmates. You are also welcome to express your comments on the course in the forum.
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