

PHYS3202 Quantum Physics II

Course Description

Atomic nucleus. Nuclear forces and models. Radioactivity and nuclear reactions. Elementary particles. Chemical bonds and molecular structure. Molecular spectra. Bonding in solids. Crystal structure. Band theory of solids. Superconductivity. Students are advised to take PHY3201 before taking this course. Prerequisite: permission of the instructor.

Course Content

	Topics	Highlights of Fundamental Concepts
1.	Molecular physics: (a) Chemical bonds and molecular structure (b) Molecular spectra	Formation of a molecule, covalent bonds and ionic bonds, H_2^+ and H_2 molecules, LCAO approximation, molecular orbitals, and C_{60} . Rotational and vibrational energy levels of molecules, rotational spectra, vibration-rotation spectra, electronic spectra.
2.	Solid state physics: (a) Crystal structure (b) Bonding in solids (c) Band theory of solids (d) Semiconductor and devices (e) Superconductivity	Crystallinity of solids, lattices and crystal structure, point defects and dislocation. Ionic and covalent crystals. Energy band, electrical conduction in metals, free electron model, forbidden bands, origin of resistivity, effective mass. Holes, electronic properties of semiconductors, pn junction and transistor. Persistent current, Meissner effect, Type I/II superconductors, flux quantum, tunneling effect, Cooper pair, and new developments.
3.	Subatomic physics (A) Introduction (B) Nuclear physics: (a) General properties and models (b) Radioactivity (C) Particle physics: (a) Elementary particles (b) Solar neutrino mystery	Reaction and scattering, Q-value, threshold energy, cross-section and differential cross-section, examples to illustrate study of subatomic structures. General properties, meson theory of nuclear forces; liquid drop model and semi-empirical formula of binding energy; nuclear energy level diagram, and deuteron. Different decay modes (alpha decay, beta decay and gamma decay,...), decay scheme; nuclear reactions, pair production and annihilation; beta-stability line, fission and fusion. Leptons and quarks, hadrons (baryons and mesons); antimatter; high energy experiments. Solar neutrino puzzle

Learning Outcomes

1.	To understand the principal ideas and concepts about molecules, solids, semiconductors, superconductors, nuclei and particles.
2.	To learn how to apply quantum mechanics to different systems.
3.	To learn how new phenomena in quantum regime were discovered and how physical models and theories were developed to understand these concepts.
4.	To understand the importance of structure-property relationship.
5.	To understand various theoretical and experimental techniques used in modern research.
6.	To appreciate how applications of modern physics affect our daily life.
7.	To appreciate the power of quantum mechanics in describing the physical world.

Learning Activities

Lecture	Tutorial		Exercise Class and Assignment		Laboratory		Project / Report		Presentation		Case study		Web teaching		Other 1 (specify)		Other 2 (specify)	
	(hr / week) in class	(hr / week) out class	(hr / week) in class	(hr / week) out class	(hr / week) in class	(hr / week) out class	(hr in total) in class	(hr in total) out class	(hr in total) in class	(hr in total) out class	(hr in total) in class	(hr in total) out class	(hr / week) in class	(hr / week) out class	(hr in total) in class	(hr in total) out class	(hr in total) in class	(hr in total) out class
3.00	5			0.75	3													
M	M	NA	NA	M	M	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.	15%
2	Mid-term examination	The schedule and venue of the mid-term examination will be announced later.	30%
3	Final Examination	The final examination will be centrally arranged by the university.	55%

Learning Resources

	Resource	Web link or ref no. in library
1.	Notes (with references)	
2.	References	(all reserved at UL)
	General	
	(a) J.R. Taylor, C.D. Zafiratos, M.A. Dubson, "Modern Physics for Scientists and Engineers", 2/e (Prentice Hall, 2004); or	(a) QC21.3.T39 2004
	(b) A. Serway, C.J. Moses and C.A. Moyer, "Modern Physics", 3rd edition, Thomson Learning, 2005	(b) QC23.2 .S45 2005
	Molecular physics:	
	(c) H. Haken, H.C. Wolf, "Molecular physics and elements of quantum chemistry : introduction to experiments and theory", Springer, 2004.	(c) QC173.3.H3513
	Solid state physics:	
	(d) B.G. Yacobi, "Semiconductor materials: an introduction to basic principles", Plenum, 2003.	(d) K7871.85.Y33 & e-book: TK7871.85.Y33 2003eb
	Nuclear physics:	
	(e) Fujia Yang & Joseph H. Hamilton, "Modern atomic and nuclear physics", McGraw-Hill, 1996, 2010.	(e) QC776.Y26 1996
	Particle physics:	
	(f) J.W. Rohlf, "Modern physics from alpha to Z", Wiley 1994.	(f) QC776.Y26 2010

Feedback for Evaluation

1.	Send an email to the teacher, give him a call (2609 6355), or come to his office, especially for issues that require immediate action;
2.	express your views in the 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 webpage.

Course Schedule

	Topics	Week No.	Activities / Readings / References
1.	Molecular physics: (a) Chemical bonds and molecular structure (b) Molecular spectra	1-3	<p>Watch video: "Race to catch a buckyball" (QD181.C1 R32 1995). It is used as an example to illustrate discovery and study of a new molecule.</p> <p>Prob. Set 1: Solve double quantum well problem by graphical method as a review of the technique learnt in PHY3201.</p> <p>Prob. Set 2</p> <p>TAs will give additional examples in exercise classes (taken from the textbooks).</p> <p>TAs will also explain in exercise classes some of the appendices. These topics will not be covered in exam.</p>
2.	Solid state physics (a) Crystal structure (b) Bonding in solids (c) Band theory of solids (d) Semiconductor and devices (e) Superconductivity	4-8	<p>Read Giaever's Nobel lecture (1974)</p> <p>Prob. Sets 3 - 6</p> <p>TAs will give additional examples in exercise classes (taken from the textbooks).</p> <p>TAs will also explain in exercise classes some of the appendices. These topics will not be covered in exam.</p>
3.	Subatomic physics (A) Introduction (B) Nuclear physics: (a) General properties and models (b) Radioactivity (C) Particle physics: (a) Elementary particles (b) Solar neutrino mystery	9-13	<p>Read C. C. Ting's Nobel lecture (1976)</p> <p>Prob. Sets 7 - 10</p> <p>TAs will give additional examples in exercise classes (taken from the textbooks).</p> <p>TAs will also explain in exercise classes some of the appendices. These topics will not be covered in exam.</p>

Teachers' or TAs' Contact Details

Teacher's Name	Contact	Additional Information
Wong Hong Kuen Teacher	Office : SC 208 Tel. no. : 2609 6355 Email : hwong@phy.cuhk.edu.hk	<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/ .
----	--

Facilities for Posting Announcements and Materials

1.	The course website (http://www.phy.cuhk.edu.hk/hkwong/index1.htm) 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 homework, latest download, and important events (e.g. examination 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.
----	---