Course Policy

Introduction to Quantum II, Fall 2018 (PHYS 4360 / 5360)

Instructor: Jos W.Zwanikken (Olney 136b)
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Course book

"Introduction to Quantum Mechanics" by D. J. Griffiths, 2nd edition, Cambridge University Press. Other editions might work as well, but the numbers of the problems may be different.

The first chapter of "Modern Quantum Mechanics" by J. J. Sakurai will be used as well. It can be found online, e.g. http://www.fisica.net/quantica/Sakurai - Modern Quantum Mechanics.pdf.

Classes

Tuesday and Thursday, 12:30 – 13:45h (Ball Hall 314)

See Schedule

Points

Attendance	50
Homework	100
Exam 1	100
Exam 2	100
Exam 3	100
Final Exam	200
Total	650

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Attendance

There will be informal quizzes and discussions, and complementary information about the book chapters and problems. Questions during class are strongly encouraged.

Homework

Mastering the topic requires practice. Relatively simple exercises are selected to develop the necessary skills, and to internalize knowledge. Some challenging problems are also selected. Solutions to the problems can be found online (there are several websites), and can be used freely as long as it stimulates the learning process. Frequent repetition, under relaxed circumstances, is strongly encouraged (as if one were studying a musical instrument) and making more exercises than suggested will lead to more improvement. Many of the mathematical techniques are equally useful for other advanced courses.

Reading

The schedule suggests chapters from Griffith's book. Reading and rereading is suggested. Not every detail may be appreciated during a first reading, but that may improve after some exercise and a second reading. It can be helpful to make a summary of each section in the form of a short paragraph, and perhaps the one or two most important equations.

Some books, although beautifully composed, become readable after many years of practice. Griffith's book, however, is written in a casual, almost careless style, and is remarkably transparent and easy to read considering the topic (and in comparison to many other books).

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Content

The course will start with revisiting the principles of Quantum Mechanics.
Subsequently, we will learn several techniques to solve the Schrödinger equation, and use the techniques to explain many phenomena.

Using the principles of quantum mechanics, we will be able to
- calculate the size of an atom and the emission spectrum of a hydrogen atom
- calculate the emission spectrum of a hydrogen atom in a magnetic field
- estimate the emission spectrum of larger atoms and simple molecules
- study the adsorption and emission of electromagnetic waves by atoms
- understand the principle of a laser
- understand the principles of spectroscopy techniques based on scattering events
- wonder about the probabilistic and discrete aspects of nature

The mathematical framework of quantum mechanics relies heavily on concepts in linear algebra and calculus, so there will be exercises to improve proficiency in linear algebra.

Schedule

	TUESDAY	THURSDAY
SEP		06
		Overview of the course. Quantum Mechanics in 30 minutes Reading: Chapter 1 Problems: 1.3 1.5 1.7
SEP	11	13
	Linear Algebra and Probability Theory Reading: Sakurai 1.2 Problems: A.1 A.2 A.5 A.11 A.17	Vector spaces, Hilbert space, Kets and Matrix representations Reading: Sakurai 1.3, Griffiths A.5 A.6 Problems: A.18 A.19 A.21 A.25 A.28
SEP	18	20
	Statistical interpretation Reading: Sakurai 1.4, Griffiths 2.1 3.1 3.2 3.3 Problems: Sakurai 1.4, 1.10, 1.27	Change of basis Reading: Sakurai 1.5, Griffiths 3.4 3.5 3.6 Problems: 3.17 3.22 3.24 3.27 3.39
SEP	25	27
	First Exam	Time-independent Perturbation Theory Reading: Section 6.1 Problems: 6.1 6.2 6.4

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OCT	02	04
	Degenerate Perturbation Theory Reading: Section 6.2 Problems 6.9 (6.31)	Revision of the hydrogen atom Reading: Sections 4.1.1 4.1.2 4.2 Problems: 4.11 (4.13)
OCT	9	11
	Fine structure of hydrogen Reading: Section 6.3 Problems: 6.16 6.17 6.18 (6.19)	
OCT	16	18
	The Zeeman effect Reading: Sections 6.4 6.5 Problems: 6.20 6.22 6.32	The Variational Principle Reading: Section 7.1 Problems: 7.1 7.4 7.5
OCT	23	25
	Applications to the helium atom and the hydrogen molecule Reading: Sections 7.2 7.3 Problems: 7.6 7.7 (7.11) 7.13 (7.19)	Second Exam
	OCT 30	NOV 01
	The WKB Approximation, Calculating Tunneling rates Reading: Sections 8.1 8.2 Problems: 8.3 8.4	Time-Dependent Perturbation Theory Reading: Section 9.1 Problems: 9.1 9.2 (9.7)

NOV	06	08
	Stimulated Emission and Adsorption of EM waves Reading: Section 9.2 Problems: 9.15 9.16 (9.17)	Spontaneous Emission Reading: Section 9.3 Problems: 9.8 9.9 9.10
NOV	13	15
	Scattering Reading: Sections 11.1 11.2 Problems: 11.2 11.3 11.4	Third Exam
NOV	20	22
	Born Approximation Reading: Section 11.4 Problems: 11.8 11.10 11.11 11.13 (11.14) (11.18)	Thanksgiving Day
NOV	27	29
	Phase shifts Reading: Section 11.3 Problems: 11.5 (11.6) (11.7)	Introducing more uncertainty: large numbers of particles (Stat. Mech.) Reading: Sections 5.1 5.3 5.4.1 5.4.2 Problems: 5.5 5.22 5.23 5.24
DEC	04	06
	Ensemble Averages and the Density Operator Reading: Section 5.4.3 Problems: 5.26 5.27 5.28 5.29	Energy Distributions and Black Body Radiation Reading: Section 5.4.4 Problems: 5.30 5.31 5.34

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DEC	11	13
	What is the meaning of it all? Reading: Chapter 12 Problem: Form your opinion about the chapter	
DEC	18 final exam week	20 final exam week

	Themes
	Principles of Quantum Mechanics, and Linear Algebra
	Techniques to solve the Schrödinger Equation, applications to atoms
	Light – Matter interactions (lasers, fluorescence, scattering)
	Large numbers of particles, Quantum Statistical Mechanics (big atoms, metals)
	Exams

Exams

There will be three exams during the class hours:

Exam 1: Principles of Quantum Mechanics Tue Sept 25th

Exam 2: Techniques to solve the Schödinger Equation Tue Oct 25th

Exam 3: Light – Matter interactions Th Nov 15th

Final Exam: Mon Dec 17th

Each of these exams will count for 100 points.

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Questions

Questions of any form are always welcome, whether in class, via written correspondence, or in Olney 136b. The office hours are shown on the web. Working together, if desired, is encouraged.

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Course Policy

If too obvious, the following can be skipped:

Academic Integrity

You are responsible for proper academic conduct. The basic rule-of-thumb is simple: you should not try to receive credit for work you have not performed.

Please refer to the university's academic integrity policy at the following URL:

http://www.uml.edu/Catalog/Undergraduate/Policies/Academic-Integrity.aspx

The introduction to the academic integrity policy is reproduced below:

"The university has a responsibility to promote academic honesty and integrity and to develop procedures to deal effectively with instances of academic dishonesty. Students are responsible for the honest completion and representation of their work, for the appropriate citation of sources, and for respect of others' academic endeavors. Academic dishonesty is prohibited in all programs of the university."

Academic Misconduct Subject to Disciplinary Action

(1) Academic misconduct is an act in which a student:

(a) Seeks to claim credit for the work or efforts of another without authorization or citation;

(b) Uses unauthorized materials or fabricated data in any academic exercise;

(c) Forges or falsifies academic documents or records;

(d) Intentionally impedes or damages the academic work of others;

(e) Engages in conduct aimed at making false representation of a student's academic performance; or

(f) Assists other students in any of these acts.

(2) Examples of academic misconduct include, but are not limited to: cheating on an examination; collaborating with others in work to be presented, contrary to the stated rules of the course; submitting a paper or assignment as one's own work when a part or all of the paper or assignment is the work of another; submitting a paper or assignment that contains ideas or research of others without appropriately identifying the sources of those ideas; getting unauthorized access to examinations or course materials; submitting, without the permission of the current instructor, work previously presented in another course; tampering with the laboratory experiment or computer program of another student; knowingly and intentionally assisting another student in any of the above, including assistance in an arrangement whereby any work, classroom performance, examination or other activity is submitted or performed by a person other than the student under whose name the work is submitted or performed."