Physics 4022: Introduction to Quantum Mechanics II
Spring 2005

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Class webpage: http://www.phys.columbia.edu/~millis/4022/4022.html

Class meeting time and place: Tuesdays and Thursdays, 9:35- 10:50 AM , 420 Pupin

Recitation: Optional recitation session, time and place TBA

Credits for course: 3

Description: Part II of two-semester introduction to quantum mechanics. Continuation of Physics 4021. Time independent and time-dependent perturbation theory as well as scattering theory are introduced and illustrated by means of physically relevant examples, mainly drawn from radiation physics and related topics. Concepts relevant to quantum computing including entanglement, coherence and decoherence are briefly introduced. If time permimts, an introduction to relativistic quantum mechanics will be given.

Prerequisites: Physics 4021 or equivalent; calculus and differential equations. Basic linear algebra is very helpful but not required .

Textbook: David J. Griffiths, *Introduction to Quantum Mechanics* (Prentice Hall, Upper Saddle River, NJ, 1995) , supplemented by additional readings as needed.

Homework: Weekly assignments.

Examinations:

Midterm: Tuesday, March 8, 2005 in class. **Final:** TBA

Grading: (Numbers are appoximate): *Final:* 40% *Midterm: 25*% *Homework: 35*%.

Tentative Schedule of Lectures, Assignments and Exams

Week of	#	Topics	Assigned	To be turned in
1/17	1	Variational Method and Density Functional Theory	HW #1	
		Griffiths Ch 7 and Notes		
1/24	2	Time Independent Perturbation Theory I	HW #2	HW #1
		Griffiths Ch 6		
1/31	3	Time Independent Perturbation Theory 2	HW #3	HW #2
		Griffiths Ch. 6		
2/7	4	WKB	HW #4	HW #3
		Griffiths Ch. 8		
2/14	5	Scattering Theory I: Phase Shifts	HW #5	HW #4
		Griffiths Ch 11 and notes; see also Merzbacher and Schiff.		
2/21	6	Scattering Theory II: Born Approximation	HW #6	HW #5
		Griffiths Ch 11 and notes; see also Merzbacher and Schiff		
2/28	7	Formalism: H, S and I pictures; time evolution	HW #7	HW#6
		Shankar; Notes		
3/7 HW#7	8	Adiabatic Approximation ***Midterm: 3/8 in class***	HW #8	
		Griffiths 10 and Shankar		
3/14	9	Spring Break: No classes		
3/21	10	Time Dependent Perturbation Theory I	HW #9	HW #8
		Griffiths 9 and notes		
3/28	11	Time Dependent Perturbation Theory II,	HW #10	HW#9
		Griffiths 9 and notes; Shankar		
4/4	12	Density Matrices	HW #11	HW #10
		Notes		
4/11	13	Quantum Computing I	HW #12	HW #11
		Notes; Chuang and Nielsen		
4/18	14	Quantum computing II	HW#13	HW#12
		Notes; Chuang and Nielsen		
4/25 #13	15	Relativistic Quantum Mechanics (shankar)		HW

Additional References:

Introductory (below level of course)

R. M. Eisberg and R. Resnick, *Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles*, 2nd Ed. (Wiley, New York, 1985).

A. P. French and E. F. Taylor, *An Introduction to Quantum Physics* (Norton, NY, 1978).

R. P.Feynman, R. B. Leighton and M. Sands, *The Feynman Lectures on Physics, vol III (Quantum Mechanics)*(Addison-Wesley: Reading: 1966) (*Very* physical and intuitive presentation; highly recommended for insight, not useful for learning to calculate).

At approximate level of course:

C. Cohen-Tannoudji, B. Diu, and L. Franck, Q*uantum Mechanics* (Wiley, New York, 1977). [Very well written; comprehensive; advanced undergraduate level]

Stephen Gasiorowicz, *Quantum Physics, 2nd Ed.* (Wiley, New York, 1996).

R. L. Liboff, *Introductory Quantum Mechanics, 3rd Ed.* (Addison-Wesley, Reading, 1998).

J. D. McGervey, *Quantum Mechanics: Concepts and Applications* (Academic Press, New York, 1995) [Includes program for numerical simulations of solution to Schrödinger equation]

David Park, *Introduction to Quantum Theory, 3rd Ed.* (McGraw-Hill, New York, 1992).

R. W. Robinett, *Quantum Mechanics: Classical Results, Modern Systems, and Visualized Examples* (Oxford University Press, New York, 1997).

J. S. Townsend, *A Modern Approach to Quantum Mechanics*. (University Science Books, Sausalito, CA, 2000).

E. Merzbacher, *Quantum Mechanics, 3rd Ed.* (Wiley, New York, 1998). (Almost a graduate text; extremely clearly written).

Graduate level:

G. Baym, *Lectures on Quantum Mechanics* (W. A. Benjamin, New York, 1969).

A. Messiah, *Quantum Mechanics* (Interscience Pub., New York, 1962).

Kurt Gottfried, *Quantum Mechanics* (Addison-Wesley, Redwood City, CA, 1989).

L. D. Landau and E. M. Lifshitz, *Quantum Mechanics (Nonrelativsitic Theory), 2nd Ed*. (Addison-Wesley, Reading, MA 1965).

J. J. Sakurai and S. F. Tuan, *Modern Quantum Mechanics* (Addison-Wesley, Reading, 1994).

R.. Shankar, *Principles of Quantum Mechanics, 2nd Ed.* (Plenum, New York, 1994). (Outstanding for the formal structure of the theory).

Mathematical Background:

G. Strang, *Introduction to Linear Algebra 2nd Ed.* (Wellesley, MA : Wellesley-Cambridge Press, 1998). (Excellent standard text).

P. Bamberg and S. Sternberg *A Course in Mathematics for Students of Physics vol I* (Cambridge University Press, 1991) (Non-standard; very geometrical and intuitive view of linear algebra).

T. Korner, *Fourier Analysis*, (Cambridge University Press: 1988). (Outstanding introduction to mathematics of Fourier analysis; also delightful historical asides and many applications).

D. Williams, *Weighing the Odds,* (Cambridge University Press: 2001) (Intuitive and interesting introduction to probability and statistics, written for undergraduate mathematics majors).

Quantum Computing

- I Chuang and D. Neilsen, *Quantum Computing,* Cambridge University Press 2001.

Historical Background

A. Pais, *Subtle is the Lord: the Science and Life of Albert Einstein* (Oxford University Press: New York, 1982). (Biography written by and for physicists--with equations and explanantions so

you can see what Einstein and others were thinking and why. Most relevant to this course is Section VI, pps 397-464)

S. Schweber, *QED and the men who made it : Dyson, Feynman, Schwinger, and Tomonaga* Princeton, N.J. : Princeton University Press, c1994.

W. J. Moore*, A Life of Erwin Schroedinger*Cambridge ; New York : Cambridge University Press, (1994)