QUANTUM MECHANICS

Physics 880:172g, Section 1
Spring 2004

INSTRUCTOR: Dr. Michael W. Roth

OFFICE: Physics 305

OFFICE HOURS: M,W,R,F 10:00 – 11:00 A.M.; T 1:00 – 3:00 P.M.

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MEETING SPACETIME INFORMATION: M,W,R,F 1-2 PM in Physics 301.

COURSE DESCRIPTION: Quantum mechanics covers an introduction to the definition and interpretation of the wavefunction, the solution of the time-independent Schrödinger Equation for several systems, eigenvalue problems, the hydrogen atom, spin, two-particle systems, perturbation theory, the WKB Approximation and computational problems in quantum mechanics.

OBJECTIVES: The mission of Quantum Mechanics is to spark interest in the eyes of students, to have students question and analyze the world around them, to have students think, and for the class to be an experience far deeper than just a series of meetings and deadlines. At a more pragmatic level, Quantum Mechanics will help the student prepare for a career in any field(s) where physics and/or chemistry is regularly used. The successful student will be able to envision how quantum mechanics applies to situations in the everyday world as well as in technical settings and will be able to problem solve at a proficient level.

REQUIRED READING MATERIALS:

i. Textbook: David J. Griffiths, *Quantum Mechanics*, Prentice Hall (1994).

PREREQUISITE(S): Partial Differential Equations (800:149), Modern Physics Laboratory (880:137) and Classical Mechanics (880:166), or written consent of instructor.

SPECIAL NEEDS: The Americans with Disabilities Act of 1999 (ADA) provides protection from illegal discrimination for qualified individuals with disabilities. If you have any condition such as a physical or learning disability, which will prevent the fullest expression of your abilities or will require academic accommodations and would like to request instructional accommodation due to disabilities, you must arrange for such accommodation through the Office of Disability Services, 213 Student Services Center, Tel. 273-2676.

GRADING: I have tried to make every major effort for you in this class worth a "test score", or 100 points. Your grade will be calculated based on 8 homework sets, 3 exams and one comprehensive, in-class final examination with the following weights:

8 homework sets of equal weight (100 pts. possible)
3 exams of equal weight (300 pts. possible)
1 final exam (100 pts. possible)

Although any appropriate curve(s) will be announced in class, *it is assumed that the following standard scale will be utilized*. The grade cutoffs are as follows:

93% and above A,	77% C+,	60% D-,
90% A-,	73% C,	below 60% F
87% B+,	70% C-,	
83% B,	67% D+,	
80% B-,	63% D,	

ATTENDANCE: Although roll is not formally taken in class, it is expected that all participants with body temperatures above 80F will attend regularly. (If you are not in this category please see me.) If there is a reason that you must miss class please talk with me to make arrangements to cover the material.

LATE POLICY: Homework sets are due on the dates indicated on the class calendar. Your work is due on time, with the exception of reasonable **documented** excuses. *Late work will be docked 50% of face value and 100% after solutions have been posted.* **Homework solutions will be posted two class days after the due date.** If you are going to miss a test, you **must** notify me in advance (preferably one week) so alternative arrangements can be made. If you miss a test or quiz, which is not excused, a grade of zero points will have to be assessed for that particular piece of work. You must take all three-hour exams as well as the final exam in order to pass the course.

ACADEMIC DISHONESTY/PLAGIARISM: Collaboration on homework and certainly activities is welcome, but please keep in mind that your final, turned-in work should be your own and not copied. However, no form of cheating/plagiarism will be tolerated in this class. If anyone is suspected of academic dishonesty, I will privately speak with them in an attempt to reach a solution to whatever problem is manifesting itself. If anyone is without doubt determined to be cheating on a given assignment/test and no resolution can be offered, *negative credit will be given*. In extreme cases, the Department and/or College administration will become involved.

GENERAL PHILOSOPHY: In a nutshell, I believe in having fun while teaching and learning physics. I want you to do your best in a subject that is not easy. If you get behind and the class feels like a diesel tractor pulling you through mud, feel free to use me as a resource to help you. Although I love to do research, your learning and class performance is more important! Asking questions in class is strongly encouraged. If you don't wish to ask questions in class please come by my office, give me a call, make an appointment or even send me anonymous e-mail! Also, I like to talk a little about related contemporary issues in class, so if you've found an interesting newspaper clipping or watched a good documentary you'd like to share with us, please mention that. The most entertaining to me are tabloid articles that beg to be de-bunked using physics. I hope you find that physics is everywhere around you and not just in a class you had to take.

INSTRUCTOR'S STATEMENT: The instructor reserves the right to modify this syllabus in a reasonable fashion and in the best interest of the class.

COMPUTATIONAL HOMWORK SUBSTITUTION: You may replace one entire homework set with a computational project, with the provision that you have a good understanding of the problems contained in the particular assignment you wish to substitute.

EXAMS: There will be three hour exams and a final exam. They are take-home and on the honor system and due by 9 A.M. on the chronological morning after the dates indicated on the syllabus.

QUANTUM MECHANICS CLASS SCHEDULE – SPRING 2004

Week	Day	Date	Topic(s)	Text Chapter.Section	Item(s) Due
1	M	Jan. 12	Introduction / Schrödinger's Equation	1.1	
	W	14	Interpretation of Ψ / Probability	1.2; 1.3	
	R	15	Homework Day		
	F	16	Normalization, position and momentum	1 .4; 1.5	
2	M	19	**No Class – Dr. Martin Luther King, Jr. Day**		
	W	21	Stationary states / T.I.S.E.	2.1	
	R	22	Homework Day		
	F	23	Square well	2.2	**Homework 1**
3	M	26	Harmonic oscillator	2.3	
	W	28	Free particle	2.4	
	R	29	Homework Day		
	F	30	δ potential	2.5	
4	M	Feb. 2	Finite square well	2.6	
	W	4	More examples	2	
	R	5	Homework Day		
	F	6	2D problems	(2)	**Homework 2**
5	M	9	Vectors / vector spaces	3.1	
	W	11	Inner product / orthonormality	3.1	**First Exam Distributed**
	R	12	Homework Day		
	F	13	Matrices (Det; Tr; special matrices, etc.)	3.1	**First Exam Due**

Week	Day	Date	Topic(s)	Text Chapter	Item(s) Due

6	M	16	Eigenvalue problems	3.1	
	W	18	Eigenvalue problems	3.1	
	R	19	Homework Day		
	F	20	Hilbert space	3.2	
7	M	23	Uncertainty principle	3.4	**Homework 3**
	W	25	Computational QM		
	R	26	Homework Day		
	F	27	Computational QM		
8	M	Mar. 1	Computational QM		
	W	3	Particle in a sphere	(4)	
	R	4	Homework Day		
	F	5	Rigid rotor / hydrogen atom	4.2	**Homework 4**
9	M	8	Hydrogen atom	4.2	
	W	10	Angular momentum	4.3	**Second Exam Distributed**
	R	11	Homework Day		
	F	12	Spin	4	**Second Exam Due**
10	M	15	**Spring Break**		
	W	17	**Spring Break**		
	R	18	**Spring Break**		
	F	19	**Spring Break**		
11	M	22	Magnetic fields / Stern-Gerlach Expt.	4	
	W	24	Angular momentum addition	4	
	R	25	Homework Day		
	F	26	Examples	4	**Homework 5**

Week	**Day**	**Date**	**Topic(s)**	**Text Chapter**	**Item(s) Due**
12	M	29	Two-particle systems	5.1	

	W	31	Bosons and Fermions	5.1	
	R	Apr. 1	Homework Day		
	F	2	A bit about helium / DFT	5.2	
13	M	5	Non-degenerate perturbation theory	6.1	
	W	7	Degenerate perturbation theory	6.2	
	R	8	Homework Day		
	F	9	Hydrogen fine structure	6.3	**Homework 6**
14	M	12	Spin-orbit coupling	6.4	
	W	14	Zeeman Effect	6.5	**Third Exam Distributed**
	R	15	Homework Day		
	F	16	Hyperfine splitting	6	**Third Exam Due**
15	M	19	WKB Approximation	8	
	W	21	Tunneling	8	
	R	22	Homework Day		
	F	23	Examples	8	**Homework 7**
16	M	26	Class Choice		**Final Exam Distributed**
	W	28	Class Choice		
	R	29	Homework Day		
	F	30	Class Choice		**Homework 8**
17	**T**	**4**	**Final Examination (Formal Time 1 – 2:50 PM)**		**Final Exam Due**

Homework Set	Problems
1	1.1, 1.6, 1.10, 1.14, 2.2, 2.5, 2.6, 2.7,2.8
2	2.9, 2.10, 2.11, 2.12, 2.13, 2.14, 2.15
3	2.17, 2.22, 2.26, 2.28, 2.32, 2.33, 2.44
4	2.46, 3.22, 3.23, 3.36, 3.41, 3.47, 3.58
5	4.13, 4.16, 4.20, 4.28, 4.29, 4.35, 4.46
6	4.48, 5.1, 5.4, 5.5, 6.1, 6.2
7	6.3, 6.8, 6.4
8	8.1,CC,CC