Quantum Mechanics I

Marietta College Physics 362, Fall 2010

Dr. Cavendish Q. McKay

Syllabus

Course details: MWF 1:00 – 1:50 PM; Bartlett 362

Texts: Introduction to Quantum Mechanics, Griffiths, Pearson/Prentice Hall 2005.

Contact information: RSC/AHP 143, 376-4871, cavendish.mckay@marietta.edu

Office hours: MWF 11:00–12:00; M 3:00–4:00, or any other time my office door is ajar.

What this course is all about:

In Modern Physics, you were exposed to some of the basics of quantum mechanics. In this course, we will revisit many of those ideas with more depth and a greater degree of mathematical sophistication. We will begin the semester by covering some of the basics about probability which we will need to make sense of the standard interpretation of quantum mechanics. Then we will consider what Schrödinger's equation says about a single particle in a variety of one dimensional potentials. Most of the potentials we will look at can be solved (with some effort) analytically, but we will also discuss some techniques for numerical solutions when the analytic approach fails.

Once we have looked at these specific cases in one dimension, we will prepare to move into the three dimensional world by building a more formal, abstract framework within which we can understand quantum mechanical principles. (Yay! Formalism! Abstraction!) Finally, we will study the hydrogen atom in three dimensions. The spherical symmetry of the hydrogen atom will lead us naturally into a discussion of angular momentum.

Throughout the semester, we will make use of computational tools in solving problems. The focus is not intended to be on programming as a discipline; you should instead think of the computer as a sophisticated calculator with a big keyboard. Part of the goal of this approach is to help you distinguish between the cases where the the use of a computer can be very helpful, marginally helpful, not particularly helpful, or actively harmful.

Outcomes: By the end of this course, students should be able to

- Prepare a useful and correct solution to any of the quantum mechanical problems we have covered over the course of the semester.
- Lead a discussion about a homework problem at the board.
- Use Maxima or a similar computer algebra system in solving physics problems.
- Be able to judge when it is appropriate to use a computer in solving a physics problem.

Evaluation: Homework, exams, and class discussion will contribute to your grade. Each student will have the opportunity several times during the semester to lead the class in discussing a problem. Your performance in leading these discussions will be graded according to a rubric explained in detail in a separate handout, and will account for 15% of your final grade. There will be two midterm exams (each worth 15% of your final grade) and a final exam, worth 20%. Homework problems will be due at the beginning of each class period. When these problems are returned to you, you will assemble them in a homework portfolio (explained in detail in a separate handout) which will be graded at the end of the semester. The homework problems count for 20% of your final grade; the portfolio is an additional 15%. You will be able to use your portfolio (and only your portfolio) as a reference during exams.

Some of the assigned problems are marked as "computational" problems. You are expected to use Maxima (a freely available, cross platform tool for doing algebra and calculus on a computer) to write your solutions to these problems. I will spend some class time on teaching you to use Maxima, and will also point you toward some online resources you can use to learn more. I will distribute to you all of my solutions to the computational problems (after you have turned them in, of course).

Summarizing:	Leading discussion of board problems	15%	
	Homework problems	20%	
	Homework Portfolio	15%	
	Midterm 1	15%	
	Midterm 2	15%	
	Final Exam	20%	Friday, May 1, 8:30 AM

Policies:

- I will endeavor to return homework to you the class period after you turn it in to me. Therefore, no late homework will be accepted.
- Exams must be taken at the scheduled time unless a documented excuse is presented. If possible, arrangements for a make-up exam should be made prior to the scheduled exam time.
- Students who believe that they may need accommodations due to a documented disability should contact the Academic Resource Center (Andrews Hall, Third floor, 376-4700) and the instructor as soon as possible to ensure that such accommodations are implemented in a timely manner. You must meet with the ARC staff to verify your eligibility for any accommodation and for academic assistance.
- The following statement is an excerpt from the **Marietta College Undergraduate Programs, 2010-2011 Catalog**, page 121:

  > Dishonesty within the academic community is a very seriouss matter, because dishonesty destroys the basic trust necessary for a healthy educational environment. Academic dishonesty is any treatment or representation of work as if one were fully responsible for it, when it is in fact the work of another person. Academic dishonesty includes cheating, plagiarism, theft, or improper manipulation of laboratory or research data or theft of services. A substantiated case of academic dishonesty may result in disciplinary action, including a failing grade on the project, a failing grade in the course, or expulsion from the College.

- I reserve the right to adjust this syllabus should it become necessary.

Approximate schedule

Date	Topic	Assigned problems (underlined problems are computational)
M 23 Aug	Introduction, Probability	
W 25 Aug	Normalization	1.1, 1.3, 1.11
F 27 Aug	Uncertainty	1.4, 1.5, 1.6
M 30 Aug	Computational issues	1.7, 1.9, 1.12
W 1 Sep	Schrödinger equation	1.15, 1.16, 1.17
F 3 Sep	Infinite Square Well	2.1, 2.2, 2.3
M 6 Sep		2.4, 2.5, 2.7
W 8 Sep	Harmonic Oscillator	2.8, 2.38, 2.39
F 10 Sep		2.10, 2.11, 2.12
M 13 Sep	Free particle	2.13, 2.15, 2.17
W 15 Sep	Delta function potential	1.14, 2.19, 2.21
F 17 Sep		2.23, 2.24, 2.27
M 20 Sep		2.20, 2.26
W 22 Sep	Finite square well	2.29, 2.30, 2.31
F 24 Sep	Shooting in Maxima	2.34, 2.35
M 27 Sep		2.54, 2.55, 2.56
W 29 Sep	Review	
F 1 Oct	Midterm Exam I	Portfolio check
M 4 Oct	Hilbert Space	
W 6 Oct	Observables	3.1, 3.2
F 8 Oct	OSAPS	3.3, 3.4, 3.5
M 11 Oct	Fall Break	
W 13 Oct	Eigenfunctions of Hermitian operators	3.6, 3.7, 3.8
F 15 Oct		3.9, 3.10, 3.11
M 18 Oct	Uncertainty	3.13, 3.14, 3.15
W 20 Oct	Dirac notation	3.17, 3.31, 3.27
F 22 Oct		3.21, 3.22, 3.23, 3.24
M 25 Oct		3.33, 3.34
W 27 Oct	Review	
F 29 Oct	Midterm Exam II	Portfolio check
M 1 Nov	Separation of Variables!	
W 3 Nov		4.1, 4.2
F 5 Nov		4.3, 4.4, 4.5
M 8 Nov	Hydrogen	4.6, 4.9
W 10 Nov		4.10, 4.11, 4.12
F 12 Nov		4.13, 4.14, 4.15
M 15 Nov	Angular momentum	4.16, 4.17
W 17 Nov		4.18, 4.19
F 19 Nov	Spin	4.21, 4.22, 4.23
M 22 Nov		4.27, 4.28, 4.29, 4.31
W 24 Nov	Thanksgiving	
F 26 Nov	Thanksgiving	
M 29 Nov		4.34, 4.35
W 1 Dec		
F 3 Dec	Review	Portfolios due
F 10 Dec	Final Exam	12:00–2:30