Physics 424 Quantum Mechanics
Preliminary Syllabus

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Class Meeting: Monday - Wednesday - Friday 9:00 – 9:50 Via Webex

Course Overview: This course is the undergraduate, upper-level quantum mechanics course. You should start the course with an understanding of basic ideas in quantum physics from your modern physics class. In this course, we will look at the formalism of quantum mechanics and be able to apply quantum mechanics to a larger array of problems and situations. In particular, we will examine in detail some of the applications from modern physics and recent applications in the fields of quantum optics and materials. By the end of the semester, I expect you to be able to

- Understand the origins and use of the wave function
- Detemine expectation values of operators
- Find values and probabilities of these values for measurements on systems
- Apply raising and lowering operators to appropriate situations
- Apply perturbation theory
- Recognize specific standard situations and their solutions

What the course will cover:

- Historical Origins (see Taylor, or Eisberg & Resnick)
  - Black-body radiation (Stefan-Boltzmann, Rayleigh-Jeans, Planck Laws)
  - Bohr theory of the atom
  - Other wave-particle duality systems
- Basic Concepts
  - Wave properties of matter
  - States of quantum systems
  - Uncertainty principle
- Wave Mechanics
  - Schrödinger equation
  - One-dimensional systems
  - Motion of free particles
  - Statistical interpretation
  - Orthogonality of wave functions
  - Operators
  - Parity
  - State vectors and their representations
  - Commuting operators
  - Raising and lowering operators
  - Three-dimensional systems
- Multi-Particle Systems and the Pauli Principle
- Angular Momentum in Quantum Mechanics
- Approximation Methods, Perturbation Theory

- Specific Applications
  - Harmonic oscillator
  - Central potentials
  - Hydrogen atom
  - Entangled systems
  - Quantum layered materials

Since this class is relatively small, it will be a relaxed lecture setting. In other words, although it will be a lecture course, there is opportunity for you to ask questions during the lecture. In addition, there are many opportunities for me to ask you questions during the lecture. I expect you to have your webcams active during the lecture and interact mainly through audio and webcam. We will examine some of the homework problems in detail during class, and you will lead the discussion in these instances.

Pre-requisite: Phys321, Phys324, Math221, Math225, Math251

Textbook: Introduction to Quantum Mechanics by David Griffiths

Other useful textbooks:

Modern Physics by Taylor (your 324 textbook for the intro to quantum mechanics)
Thermal Physics by Schroeder (your 303 textbook for blackbody radiation)
Quantum Mechanics of Atoms, Molecules, Solids, Nuclei and Particles by Eisberg and Resnick
(introductory book with lots of verbiage on the quantum mechanics we will be doing)
Understanding Quantum Physics by Morrison (detailed book)
Introductory Quantum Mechanics by Liboff (lots more mathematical details)

Grading: There will be three exams during the semester each of these will be worth 20% of your final grade. The final exam will be comprehensive and worth 20% of your final grade. As with all physics courses, homework assignments are an integral part of learning the material, and will be worth 20% of your grade for this class.

Lectures: As I mentioned earlier, we will have a participatory lecture format. You need to re-read the textbook material before each lecture to be prepared; the list of lecture topics is in the schedule on Blackboard. The lectures are in Webex, and I want you to be present with your webcams running during the lectures. You will be able to ask questions and make comments using both the chat window of Webex and using your microphone. Questions that I ask specific students during the lecture should be answered using your microphone.

Homework: This is one of the most important aspects of this class. Although you will learn a lot from my enlightening lectures and from reading the textbook, the only way to learn this material is by working through the important derivations and applying the material to problems. The homework will at times be challenging; remember that it is the only time I can ensure that you examine a complicated problem. There is not enough time for this on exams. Homework will be assigned each week and it will be found on the course Blackboard website under the *Assignments* tab. The dates these assignments are due will be found on the assignment. These homework assignments are to be emailed as an attachment to the following Box folder: Phys424.jevsrsls0zigcujc@u.box.com

Homework that is late will be accepted for one additional day with a 20% penalty. Assignments will not be accepted past the one-day-late period.

I expect a bit more from you than other instructors may have expected in the past as this is a senior –level course. In particular, I expect there to be a bit of explanation (you know those things called words and diagrams) within your homework solutions. I highly recommend writing out the solution and then copying it in a neat orderly fashion with your ideas incorporated. This is an effective way to do an immediate review of the material you have just covered; and this is a well-documented method of learning material. *A point that I want to emphasis is the need to reference any assistance you get with a problem. In particular, if you come across the solution or part of the solution in another book, and you use that to formulate your own solution, please reference it. You will not be penalized for learning how to do something from another source; however, you will be penalized for using another source without noting it.* Please do not just copy things down from other sources or your friends. This is a method that ensures you do not learn from the homework and will result in very poor exam grades. Another important issue I want to address is neatness. The solutions must be reasonably clean, neat, and complete. Also, please begin each problem on a new page.

I know that many of you will get together on a regular basis in groups. This is a good tool if used properly and a disaster if used incorrectly. I assume that you will spend around 8 hours per week studying on your own for this class. Once you have done your own studying and worked out the problems, it is good to discuss the ideas with others. However, please do not do this without working on the problems on your own. Beware, that I will ask you to demonstrate solutions to the class. If you cannot show a solution, you will not receive credit for it in the homework.

Office Hours: I will set up a Blackboard Collaborate session that will be for office ours to ensure that you have an adequate opportunity to see me. My office hours for this class are Monday, Wednesday, and Thursday 1-2. I will be in the Collaborate session during these hours. Please take advantage of these hours if you have any problems with the material.

Academic Integrity: I feel obligated to ensure that students know the repercussions of cheating. If you are found cheating, you will receive a zero for that work. The university has a website that addresses the concept of academic integrity: http://www.umbc.edu/provost/integrity/faculty.html

Sexual Misconduct: As a faculty member, I am considered a Responsible Employee, per UMBC's Policy on Prohibited Sexual Misconduct, Interpersonal Violence, and Other Related Misconduct. I want you to recognize that as a Responsible Employee I am required to report disclosures of sexual assault, domestic violence, relationship violence, stalking, and gender-based harassment to the University's Title IX Coordinator.

The purpose of these reporting requirements is for the University to inform you of options, supports and resources. Note that you will not be forced to file a report with the police. Further, you are able to receive supports and resources, even if you choose to not want any action taken. Please note that in certain situations, based on the nature of the disclosure, the University may need to take action.

Schedule:

Week	Date	Topic
Week 1	Th Aug 27	
	F Aug 28	CMech's failure and the QMech wave equation
Week 2		Wave functions and their statistics
Week 3	M Sept 7	**Labor Day**
		Time-independent Schrodinger equation
Week 4		States and Measurements
Week 5		Harmonic Oscillators
Week 6	M Sept 28	**Exam 1**
Week 6/7		Steps, Wells, and Barriers
Week 8		Quant Mechanics Formalism & Dirac Notation
Week 9		Central Potentials
	F Oct 23	**Exam 2**
Week 10		Angular Momentum
Week 11		Hydrogen Atom
Week 12		Spin and **L·S**
Week 13	W Nov 18	**Exam 3**
Week 13/14		Identical Particles
Week 14	F Nov 27	**Thanksgiving Break**
Week 15		Perturbation Theory
Week 16	F Dec 11	**Final Exam** Friday Dec 11th 8:00-10:00 am