Dr. James Franson
Physics 314
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Location: Physics 107
Time: Tuesday and Thursday 1:00 – 2:15
Office hours: Any afternoon 2:00 to 4:30 (except as noted)

Course description:

This course is intended to cover most of the basic topics in quantum mechanics, including postulates, one-dimensional and three-dimensional systems, Kronig-Penny model, angular momentum, operator methods, harmonic oscillators, perturbation theory, interaction of charged particles with a classical electromagnetic field, hydrogen and helium atoms, Zeeman effect, and fine and hyper-fine structure. A more complete list of topics is given in the schedule below. Applications to solid-state theory, lasers, and quantum optics will be included as examples of the theory.

Additional topics and more advanced techniques are covered in a second course (Quantum Mechanics II).

Course learning goals:

This course is intended to provide an enhanced, graduate level understanding of quantum mechanics. The specific topics to be included are outlined in the schedule provided below.

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

1. Utilize the postulates of quantum mechanics to describe quantum systems and determine their properties, including the results of measurements.
2. Use operator techniques to solve relevant problems.
3. Analyze the time dependence of quantum systems using the Heisenberg picture.
4. Use the properties of angular momentum and spin to describe quantum systems such as the hydrogen atom and an electron in a magnetic field.

5. Understand the interaction of the electromagnetic field with charged quantum-mechanical particles and solve related problems such as the rate of absorption and emission of light.
6. Use perturbation theory to find approximate solutions to more complex quantum-mechanical systems.

Textbooks:

The texts will be *Quantum Physics* by Stephen Gasiorowicz and *Lectures on Quantum Mechanics* by Gordon Baym. The more basic topics will be covered in the text by Gasiorowicz, while some of the more advanced topics will be taken from Baym's text, which is also used in Quantum Mechanics II.

Class structure:

Students are encouraged to read the corresponding textbook chapters before each lecture. Homework solutions will be discussed in class and will also be posted on the Blackboard website.

There will be an in-class midterm and final exam. Pop quizzes may also be given periodically.

Grading procedure:

The grade will be determined as follows:

Homework and pop quizzes	15%
Midterm	40%
Final exam	45%

The exams, homework, and quizzes are intended to cover all of the topics described in the course schedule with equal weighting for each. Given the amount of material to be covered, it is expected that the exams and quizzes will have to be based on a representative sampling of the material.

Learning outcome assessment:

The results of the exams and quizzes for the class as a whole will be used as part of the Physics Department's student learning outcome assessment plan. These statistical results will be provided to the faculty, graduate program committee, and department chairman for use in assessing the department's success in achieving its overall goals and in determining the need for any possible improvements to the curriculum or teaching methods. The test results for individual students will not be used for this purpose.

Course requirements:

The students are expected to make their best effort at solving the homework problems on their own, which will give them feedback on their knowledge of the topic as well as develop problem-solving skills. If questions arise, the homework problems can be discussed with other students or with Dr. Franson. The exams will allow the use of text books or a laptop computer for Mathematica or similar software.

Academic integrity:

Academic integrity is an important part of scientific research. The UMBC academic integrity statement is as follows:

"By enrolling in this course, each student assumes the responsibilities of an active participant in UMBC's scholarly community in which everyone's academic work and behavior are held to the highest standards of honesty. Cheating, fabrication, plagiarism, and helping others to commit these acts are all forms of academic dishonesty, and they are wrong. Academic misconduct could result in disciplinary action that may include, but is not limited to, suspension or dismissal. To read the full Student Academic Conduct Policy, consult the UMBC Student Handbook, the Faculty Handbook, or the UMBC Policies section of the UMBC Directory [or for graduate courses, the Graduate School website]."

COVID-19:

- Please see the following link for UMBC Policies and Resources during COVID-19.

    https://docs.google.com/document/d/1xWWGAR8qEzKYr7qaVHoEhvO6lyXIyn6M3M7EFZPJQgA/edit

Class schedule:

Lecture 1	Syllabus and introduction; experimental basis
Lecture 2	Photon polarization: example of a state vector
Lecture 3	Postulates of quantum mechanics
Lecture 4	Schrodinger's equation and wave functions
Lecture 5	Operators, eigenfunctions, and eigenvalues
Lecture 6	One-dimensional potentials
Lecture 7	One-dimensional potentials
Lecture 8	Harmonic oscillator (based on wave functions)