Fall 2015 Physics 321 Quantum Mechanics

Professor
Dr. Jared Workman

Class Location
WS 366

Class Hours
Tue Thu 11:00-12:15

Text Book
Introduction to Quantum Mechanics (2nd Edition) , David Griffiths

Course Website
http://org.coloradomesa.edu/~jworkman/teaching/fall15/321/index321.php. If you ever forget the link to this site go to www.jaredworkman.com and scroll down to the "My Colorado Mesa University Webpage" link.

Welcome to Physics 321, Quantum Mechanics 1

This syllabus is your guide to class policies and procedures as well as a tool for planning. Each student is encouraged to work with the instructor and their peers.

This course is going to be hard. This course is going to require a great deal of work. It will be moving quickly and you will get a lot of new math thrown at you. Quantum mechanics completely deviates from the framework of physics you have been used to up until now and incorporates a highly abstract methodology to studying the world of the tiny. I strongly encourage you not to miss any homework or classes. Feel free to drop by my office at any time for help or to express general concerns.

Course objectives

Learn (Topical Course Outline)

- The Fundamentals of Quantum Mechanics
  - The Wave Equation
  - Probability Theory
  - Linear Algebra
  - Time dependent versus time independent solutions
  - Rudiments of the Matrix formulation
  - Operators
  - 1, 2, & 3 dimensional problems
  - The simple harmonic oscillator
  - The hydrogen atom

Goal

1. Be able to apply the formalism of quantum mechanics to 1, 2, and three dimensional problems and solve for the system's wave function.
2. Use the solutions to determine physical/spatial/temporal quantities associated with the system.
3. Understand the probabilistic/non-deterministic nature of the solution and its physical relevance to a given system.
4. Learn new mathematical techniques and demonstrate a mastery of them in problem sets and on exams.

CMU Catalog Description

"Quantum physics foundation. Includes quantum states, measurements, and time evolution using Dirac formalism for discrete and continuous systems. Connection between Dirac formalism and wave mechanics established and Schrodinger equation solved in various context. Includes particles in piecewise square potentials, tunneling, the harmonic oscillator, angular momentum, and the hydrogen atom. Introduces linear algebra for describing quantum physics and uses techniques for solving differential equations.

Prerequisite: PHYS 231. "

What to look for in this syllabus

- How to contact me
- Evaluation (grades)
- Homework
- Exams
- Project
- Topical Course Outline
- Attendance
- Resources for student assistance
- Student Conduct
- Important Dates
- Course Learning Objectives
- Student Learning Objectives
- Work Load

How to Contact Your Instructor

Visit my office: WS 230C
Office Hours: TUE: 10:00-11:00, WED: 2:00-3:00, THU: 10:00-11:00 & 1:30-2:30, FRI: 12:00 – 1:00
Leave me a message at: (970)-248-1327 (email is much better)
Email me at: mailto:jworkman@coloradomesa.edu

Evaluation

Homework 40%
Exams 35%
Project 25%
Attendance – see below

Grading

Grades will be assigned as follows:

Excellent	A	> 90%
Good	B	80%-90%

Average	C	70%-80%
Deficient	D	60%-70%
Failing	F	< 60%

A curve may be used at the end of the semester. I can be contacted at any time to give you an update of your current grade.

Homework

- There will be roughly one assignment per 1-2 weeks consisting of approximately 4-10 homework problems per assignment. Assignments are to be turned in during class on the date due. An assignment not done by the beginning of class is considered late for the day and will be penalized 25% for that day. Each following day the assignment is not handed in by 11:00 AM it will accrue a further 25% late penalty.
- You are encouraged to discuss homework problems with your classmates. Working problems with your peers is an excellent learning method, however, anything turned in **must** be your own work. If you have worked with other students at the blackboard and I see identical solutions the credit will be split amongst the participants. Ex – 100 percent correct with 2 identical solutions = 50% per student, with 3 participants = 33% per student.
- Homework is worth 35% of your grade.
- There is a great deal of freely available solutions to everything in almost any book on the internet. Speaking from experience, you won't pass the tests if you copy solutions. The homework IS the place you'll really learn quantum mechanics. If you hand in obviously copied solutions the penalty for the first offense will be a zero grade and a report to the office of academic affairs, the penalty for the second offense will be failing the course. If the copying is egregious on the first offense a grade of zero may be assigned for the entire class at my discretion. If you use solutions as a guide you should come to me beforehand and have me look over the homework before handing it in.
    - Note – a very easy way for me to tell who is copying is if you skip steps that you obviously can not.
- Do not use online integrators or canned table solutions to integrals, work them out entirely, this is to help not punish you.
- Write only on one side of each sheet of paper, keep your work neat and understandable
- I will not grade all problems assigned however I will hand out solutions, the problems I grade will be random so skipping problems is a bad choice

Exams

- There will be three exams. Exams will be worth 35% of your grade
- Each exam will cover approximately one and a half chapters
- The Final Period is Tuesday, December 8th 10:00-11:50

Project

You will be required to complete a project that will include a written report and a presentation to the class during the final exam period. This project will entail the numerical study of some aspect of quantum mechanics covered in the first 4 chapters.

You may pick any topic you find interesting.

Suggestions include but are not limited to:

- The creation of a wavepacket from plane waves
- The study of the hydrogen atom wavefunction
- The study of the harmonic oscillator wavefunction
- Numerical solutions of bound, scattering, or tunneling states, If you are really ambitious we can do the case of alpha particle tunneling numerically
- The evolution of expectation values for wavefunctions comprised of linear superposition of basis functions

Essentially I want you to: either pick something you need to plot using a computer to truly see and/or solve some equations numerically and plot their results. I will require you to come and sit down with me for guidance after your topic has been chosen as I will explicitly outline what I want you to do.

You may use Excel, C, Matlab, Maple, python, existing software, etc. to generate your results.

Dates

- You must pick a topic to explore by September 8th
- You must have results and a rough draft of a paper by November 10th. I will return a copy to you by the following week
- You must schedule a time during the last week of regular classes to have me watch a trial run of your presentation, this scheduling must occur by December 1st
- You must have you final paper and presentation ready to present during the final exam period
- You will be penalized 5% of your project's grade every day after each deadline date posted above passes

The paper should be ***at least*** 5 pages long and include

- A description of the physics you are modeling/solving, include any and all relevant derivations, include why you chose this topic
- A description of the methods you used to generate your results
- Your results plotted in a readable and understandable format
- A discussion of how the numerical exploration and visualization extended your knowledge on this topic beyond the pencil and paper methods used in class
- Essentially – INTRODUCTION, METHODS, RESULTS, CONCLUSION/DISCUSSION

You will need to also present your project to the class during the final period. I expect the presentation to last 10:00-15:00 minutes and require you to have me watch your presentation beforehand.

The final paper and project will be worth 20% of your grade and the presentation will be worth 5%. Your grade will be based on your writing, the quality of the description of the physics, and the sophistication of your project, methods, and results.

You may, after checking with me, work in pairs of two but then all lengths of submitted work are doubled – 10 page paper, 20-30 minute presentation. If you work in pairs I expect twice the result of individual efforts.

I will be happy to provide continuous feedback throughout the course of the semester. This is ¼ of your grade, DO NOT wait until the last minute. Please take this project seriously, you will be using your knowledge of physics and computers in any job you take outside of school unless you leave the scientific/engineering fields.

Attendance

This is up to you. I highly encourage you to come as this is not generally good self study material. Like the homework, attendance is a key factor in passing a course of this difficulty but you are far enough along in your studies that I don't penalize you for attendance.

Reading Schedule

We will cover the first four chapters of the book as well as the appendix on linear algebra. It would seem self evident to me that you need to read the book but as it is not so to all students – READ THE BOOK

Resources for Students

Your instructor: I am here to help you learn; please let me know if you are having trouble with anything! My contact information is at the top of the syllabus, or you can talk to me after class or during my office hours.

The Course Website: Contains all class information and several helpful (and some just fun) links.

Tutorial Learning Center: HH113 http://www.coloradomesa.edu/tutoring/index.html

Students With Disabilities: Students with disabilities have certain privileges extended to them including but not limited to extended exam time. It is your responsibility to contact the EAS (Educational Access Services) At Houston Hall, Room 108, 1-970.248.1856 http://www.coloradomesa.edu/eas/links.html and bring me the necessary forms for any special dispensations received.

Class Policies

All students expected to follow the Student Code of Conduct. Violations of the Student Code of Conduct may result in disciplinary action. The code of conduct is here here http://www.coloradomesa.edu/academics/policies/academic_integrity.html. Some specific items that are important in this class are:

1. Don't call me mister, it's Dr. Workman.
2. Create and sustain a respectful and quiet learning environment. Allow your fellow students to learn and the instructor to teach. Disrespectful, disruptive or abusive behavior toward an individual or group is unacceptable. If you disrupt your classmates I will dis-enroll you from the course.
3. Due to the rapid pace of this course, late work is generally not accepted. In the event of illness, family emergency or other special circumstances, you must contact me BEFORE the deadline to make arrangements for late work or early tests. At the instructor's discretion, you may then turn in the work within 1 week of the deadline.
4. I encourage participation, ask questions, email me, ask for reading material for your own edification after the course is over, provide me with feedback. I am not directly grading you on participation but it will play a factor in the end of the semester grade. This is an interesting topic and I want you to be involved in learning it.
5. Turn off your cell phone.
6. No smart phones, ipads, earphones, etc. during class time, no texting or web browsing. You all get one freebie phone ring then I may ask you to leave. I reserve the right to temporarily or permanently remove a student for the continued disruptive use of electronic equipment.
7. Laptops are fine for note taking but please do not web surf during class. If I find you surfing the web you forfeit your laptop privileges. Students using laptops are required to sit at the front of the class.
8. I will turn any students I find cheating, copying each other's work, or plagiarizing material over to the department chair, no exceptions. If you are unsure if something is prohibited, ask me. You are encouraged to work together but please do not hand in identical assignments, they will not be accepted.
9. Please arrive to class on time and wait until class is over to leave. I will remove students who regularly arrive late from the course.
10. It is your responsibility to learn of any missed work.
11. Don't talk during class, raise your hand whenever you want to but don't talk. I reserve the right to require you to leave the class for the day or completely dis-enroll you from the course for talking during lecture.

Important dates:

http://www.coloradomesa.edu/registrar/dates.html

Course Learning Objectives

1. Demonstrate an understanding of the foundations of quantum mechanics including the probabilistic formulation, wave mechanics, operators, normalization, spin, angular momentum, and algebraic methods.
2. Solve Schroedingers equation in one, two and three dimensional regimes.
3. Apply formula to generate special functions and temporal evolution of expectation values.
4. Utilize the methods of linear algebra in the solution and examination of solutions to problems in quantum mechanics.
5. Apply both the wave mechanics and algebraic formulations of quantum mechanics to physical systems.

Student Learning Outcomes

The physics program has several learning outcomes that will be attained by graduates of the program; this course contributes to the attainment of these two objectives

1) Articulate the knowledge base and show fluency with the ideas and techniques of the major fields of physics (classical mechanics, electromagnetism, statistical physics and quantum theory).
2) Translate physical problems into mathematical problems, solve these using appropriate mathematics and extract physically meaningful statements from the solutions.

Work Load:

An undergraduate student should expect to spend on this course a **minimum** of two hours outside the classroom for every hour in the classroom. The outside hours may vary depending on the number of credit hours or type of course. More details are available from the faculty member or department office and in CMU's Curriculum Policies and Procedures Manual. In reality you should expect to spend a great deal more than this minimum outside of class. In this class 10-20 hours of work a week may be reasonable.

Disclaimer:

The instructor reserves the right to modify the schedule. It is tentative based on class progress.