

Course Information

- Course Number: PHYS 412
- Course Title: Quantum Mechanics I
- Section: 200 and 500
- Time: MWF 10:20-11:10
- Location: 213 MPHY

Instructor Details

- Instructor: Joseph Ross
- Office: 448 MPHY (office in physics building) and B03 Cain (office in research lab)
- Phone: lab phone 979-845-7823
- E-Mail: jhross@tamu.edu
- Office Hours: **M 12:30-1:30 & W 12:40-1:30** in **448 MPHY**; **T 2-3** in **B03 Cain**; **Zoom meetings** also encouraged. As noted I will plan to be in my research lab on Tuesdays & will be available to meet there on that day. I am also typically available at other times than listed but it is best to **email** me first.
- Web pages: Copies of slides, homework solutions, the syllabus, and all other posted course information will be made available on **Canvas** as the semester proceeds. For convenience, in my tamu webspace at <http://rossgroup.tamu.edu/412page.html> I will also post a few pieces of basic information, especially this syllabus so that it readily accessible without logging into Canvas.

Course Description

This is the first of a sequence of two courses providing a survey of non-relativistic quantum mechanics, covering the fundamental physics as well as selected applications and approximation methods that can be used to analyze numerous physical problems. This course will focus on fundamental theoretical tools and concepts, including the wave-equation and matrix formalisms, quantum behavior in the free-particle regime as well as in situations such as harmonic-oscillator and central potentials, and will include Hilbert spaces, conservation laws and symmetry, angular momentum and hydrogenic atoms.

Course Prerequisites

PHYS 302, 309, and 332 or equivalent with instructor approval

Honors Course Section

The honors section of this course (section 200) has the same meeting times and exams/homework. In addition, to take this course under honors credit requires an extra research paper. This involves investigating a topic related to this course beyond what is covered in the textbook and regular lectures, preparing a paper on this subject summarizing the results. The paper should include a description of some of the relevant physics, showing how the results connect to what is covered in class. Also you should include at least four references to recent research papers showing one or more current research directions related to your topic. I will provide suggestions for topics as the course proceeds.

Course Learning Outcomes

Students in this course will:

- Understand the Schrödinger equation and its application in wave mechanics.
- Become familiar with the properties of the wave function in quantum mechanics, including its connection to the probability of real-world events and the theory of quantum measurement.
- Gain an understanding of wave mechanics in 3D systems, including a development of the theory of orbital and spin angular momentum.
- Learn to apply these tools to other systems such as those corresponding to harmonic oscillator potentials or quantum wells and step functions.
- Develop an understanding of the role of symmetry in determining conservation laws as well as uncertainty principles and quantum tunneling.
- Understand the matrix formalism of quantum mechanics and its connection to wave mechanics, and the role of Hilbert spaces and unitary transformations.
- Become familiar with the physics of hydrogenic atoms and its connection to the properties of atoms and molecules.

Textbook

Griffiths & Schroeter, *Introduction to Quantum Mechanics (3rd ed)*; Zettili, *Quantum Mechanics (2nd ed)*.

Grading Policy

- *Overall course grade will be based on the following scheme:*
 - **Homework 25%**
 - **Exam I 25%**
 - **Exam II 25%**
 - **Final Exam 25%.**
- *Assignment of final grades according to point totals calculated using the percentages above is expected to follow the scale, 80-100 A, 70-80 B, 60-70 C, 50-60 D, <50 F.*
- *For Honors students the final paper will be accorded 10%, with other items adjusted accordingly.*

Late Work Policy

- *Late homework turned in before the solutions are given out will be awarded ½ credit. This does not apply in the case of homework that is late due to an excused absence (approved by me).*
- *After solutions are posted, it will still be possible to get 1/3 credit for homework turned in if I am convinced that the work was not copied from the solutions.*

Course Schedule

There will be three course *exams*, as follows:

- **Exam I, Tuesday Feb. 22, 7 PM**
- **Exam II, Tuesday Apr. 12, 7 PM**
- **Final Exam, Monday May 9, 8 AM**

Note that the two evening exams follow the schedule established at the time of registration, and the final exam will be in the standard 2-hour slot corresponding to our lecture time.

The general *schedule* for the semester is as given below. The order of topics will follow that of the Griffiths and Schroeter text for the most part, with additional readings from Zettili (particularly chapter 1 and 6 for this semester, with additional specific readings to be specified as the course proceeds). The times spent on individual topics might also be adjusted as the course proceeds, but even so note that exams I and II will remain as scheduled, with the topics covered on the exams possibly rearranged.

1. Wave-functions and Schrödinger equation; background and foundations for quantum mechanics (approx. 1.5 weeks).
2. Stationary states. Free particles and wave mechanics in unbounded space. Other specific cases including square well, harmonic oscillator. Tunneling. (approx. 3 weeks).
Exam I, Feb. 22. Topics from units 1 and 2 above.
3. Hilbert spaces; matrix formalism for quantum mechanics and Dirac notation. Uncertainty principle. (approx. 2 weeks).
4. 3D quantum mechanics; separation of variables. Angular momentum states and central potentials; other 3D applications. (approx. 3 weeks).
Exam II, Apr. 12. Topics from units 3 and 4 above.
5. Hydrogen atom; other hydrogenic systems. Identical particles. (approx. 1.5 weeks).
6. Conservation laws; symmetry. (approx. 2 weeks).

Covid Protection

To help protect Aggieland and stop the spread of COVID-19, Texas A&M University urges students to be vaccinated and to wear masks in classrooms and all other academic facilities on campus, including labs. Doing so exemplifies the Aggie Core Values of respect, leadership, integrity, and selfless service by putting community concerns above individual preferences. COVID-19 vaccines and masking — regardless of vaccination status — have been shown to be safe and effective at reducing spread to others, infection, hospitalization, and death.

Students should follow CDC recommendations for self-monitoring. Students who have a fever or exhibit any symptoms of COVID-19 should participate in class remotely, and should not participate in face-to-face instruction. **Please ask me for a link if you need to participate remotely**; in addition I plan to make lecture recordings generally available for later viewing as needed.

University Policies

These are the standard policies for all Texas A&M Courses:

Attendance Policy

The university views class attendance and participation as an individual student responsibility. Students are expected to attend class and to complete all assignments.

Please refer to [Student Rule 7](#) in its entirety for information about excused absences, including definitions, and related documentation and timelines.

Makeup Work Policy

Students will be excused from attending class on the day of a graded activity or when attendance contributes to a student's grade, for the reasons stated in Student Rule 7, or other reason deemed appropriate by the instructor.

Please refer to [Student Rule 7](#) in its entirety for information about makeup work, including definitions, and related documentation and timelines.

Absences related to Title IX of the Education Amendments of 1972 may necessitate a period of more than 30 days for make-up work, and the timeframe for make-up work should be agreed upon by the student and instructor" ([Student Rule 7, Section 7.4.1](#)).

"The instructor is under no obligation to provide an opportunity for the student to make up work missed because of an unexcused absence" ([Student Rule 7, Section 7.4.2](#)).

Students who request an excused absence are expected to uphold the Aggie Honor Code and Student Conduct Code. (See [Student Rule 24](#).)

Academic Integrity Statement and Policy

"An Aggie does not lie, cheat or steal, or tolerate those who do."

"Texas A&M University students are responsible for authenticating all work submitted to an instructor. If asked, students must be able to produce proof that the item submitted is indeed the work of that student. Students must keep appropriate records at all times. The inability to authenticate one's work, should the instructor request it, may be sufficient grounds to initiate an academic misconduct case" ([Section 20.1.2.3, Student Rule 20](#)).

You can learn more about the Aggie Honor System Office Rules and Procedures, academic integrity, and your rights and responsibilities at aggiehonor.tamu.edu.

Americans with Disabilities Act (ADA) Policy

Texas A&M University is committed to providing equitable access to learning opportunities for all students. If you experience barriers to your education due to a disability or think you may have a disability, please contact the Disability Resources office on your campus (resources listed below)

Disabilities may include, but are not limited to attentional, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to discuss their disability related needs with Disability Resources and their instructors as soon as possible.

Disability Resources is located in the Student Services Building or at (979) 845-1637 or visit disability.tamu.edu.

Title IX and Statement on Limits to Confidentiality

Texas A&M University is committed to fostering a learning environment that is safe and productive for all. University policies and federal and state laws prohibit gender-based discrimination and sexual harassment, including sexual assault, sexual exploitation, domestic violence, dating violence, and stalking.

With the exception of some medical and mental health providers, all university employees (including full and part-time faculty, staff, paid graduate assistants, student workers, etc.) are Mandatory Reporters and must report to the Title IX Office if the employee experiences, observes, or becomes aware of an incident that meets the following conditions (see [University Rule 08.01.01.M1](#)):

- The incident is reasonably believed to be discrimination or harassment.
- The incident is alleged to have been committed by or against a person who, at the time of the incident, was (1) a student enrolled at the University or (2) an employee of the University.

Mandatory Reporters must file a report regardless of how the information comes to their attention – including but not limited to face-to-face conversations, a written class assignment or paper, class discussion, email, text, or social media post. Although Mandatory Reporters must file a report, in most instances, a person who is subjected to the alleged conduct will be able to control how the report is handled, including whether or not to pursue a formal investigation. The University's goal is to make sure you are aware of the range of options available to you and to ensure access to the resources you need.

Students wishing to discuss concerns in a confidential setting are encouraged to make an appointment with [Counseling and Psychological Services \(CAPS\)](#).

Students can learn more about filing a report, accessing supportive resources, and navigating the Title IX investigation and resolution process on the University's [Title IX webpage](#).

Statement on Mental Health and Wellness

Texas A&M University recognizes that mental health and wellness are critical factors that influence a student's academic success and overall wellbeing. Students are encouraged to engage in healthy self-care by utilizing available resources and services on your campus

Students who need someone to talk to can contact Counseling & Psychological Services (CAPS) or call the TAMU Helpline (979-845-2700) from 4:00 p.m. to 8:00 a.m. weekdays and 24 hours on weekends. 24-hour emergency help is also available through the National Suicide Prevention Hotline (800-273-8255) or at suicidepreventionlifeline.org.