Quantum Mechanics I syllabus
Phys 485/685
Fall 2026
(3 credits)
Prereq: PHYS 251&251L or ME 221&222
Coreq: MATH 350, 266

Instructional team

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Course Description

Operators, one-dimensional wells and barriers, Schroedinger equation, uncertainty, duality, Born interpretation, unstable states, bosons and fermions, central force problems, angular momentum, spin.

Course goals

This course begins with the question of why quantum mechanics is necessary and how it differs from the classical physics you already know. You will see how classical ideas fail to explain phenomena at very small scales, and how quantum principles provide a new framework for understanding nature. We will begin with spin, a fundamental property of particles that has no classical analogue, to see firsthand how quantum mechanics departs from classical intuition. From this starting point, you will develop the mathematical tools of quantum theory—operators, eigenvalues, and commutators—and use them to connect abstract formalism with measurable quantities. You will solve the Schrödinger equation for one-dimensional systems such as wells and barriers, and explore the uncertainty principle, wave–particle duality, and the interpretation of the wavefunction, highlighting how these concepts challenge classical physics. Finally, you will apply quantum mechanics to central force problems and orbital angular momentum, deepening your understanding of how quantum systems behave. Throughout the course, you will build problem-solving expertise, develop intuition for quantum phenomena, and learn to interpret and evaluate quantum-mechanical results.

By the end of this course, you will be able to:

- Explain why classical physics fails at very small scales and why quantum mechanics provides a necessary new framework.
- Use spin as an example to describe how quantum systems differ fundamentally from classical systems.
- Apply the mathematical tools of quantum mechanics—operators, eigenvalues, and commutators—to connect formalism with measurable quantities.
- Solve the time-independent Schrödinger equation for one-dimensional systems such as wells and barriers, and interpret bound and scattering states.
- Articulate and apply key principles of quantum mechanics, including the uncertainty principle, wave–particle duality, and the probabilistic interpretation of the wavefunction.
- Analyze quantum phenomena such as unstable and tunneling states, comparing them with classical expectations.
- Apply quantum mechanics to central force problems, orbital angular momentum, and spin, and explain how these concepts shape the behavior of physical systems.
- Demonstrate problem-solving expertise, develop intuition for quantum phenomena, and critically evaluate quantum-mechanical results.

Prerequisites

Math 350, 266

Class Hours and attendance via Zoom
2:00 pm - 3:15 pm Tuesday, Thursday, South Engineering 221

Office Hours:
Tuesday and Thursday before class: 12:00 pm - 1:50 pm or by appointment

Course materials
1. McIntyre, D. J. (2012). Quantum Mechanics: A Paradigms Approach. Pearson Addison-Wesley.
2. Scientific calculator.

Course format
Class sessions are designed to be highly interactive, blending short instructor-led explanations with extended opportunities for discussion. You will engage with your peers and the instructor in real time to question assumptions, debate interpretations, and refine your understanding of quantum mechanics. Worksheets and guided tasks will be used as springboards for these interactions, but the central goal is not to complete problems for their own sake. Instead, the focus is on developing deep conceptual insight and sharpening your reasoning by constructing arguments, challenging ideas, and defending explanations. In this course, learning happens through dialogue—by actively questioning, responding, and collaborating to make sense of quantum principles.

Attendance
Attendance is not required, but strongly encouraged.

Homework assignments
Homework will be assigned approximately every 7–10 days in a traditional pencil-and-paper format. You will be asked to answer conceptual questions and solve quantitative problems, explaining your reasoning and showing a clear, complete solution path. Grading will emphasize clarity of reasoning as well as correctness.

You are strongly encouraged to collaborate with your classmates while working through the homework, but your final write-up must be completed independently and reflect your own understanding.

Ungraded assignments
You will complete short (~15-minute), ungraded assignments that serve as check-ins to gauge what you already understand and to highlight topics that may need deeper discussion in class. You are not expected to study beforehand—I want to see your current thinking, not just whether you can produce the correct answer—but you should explain your reasoning clearly and make a genuine effort on every question. These assignments will not be graded for correctness; instead, your participation and the effort you put into attempting all the questions will determine your credit.

Assignments will be announced in class and posted on Blackboard.

Exams.
Exams will be in class in a traditional paper-based format.

The final exam will be comprehensive (will cover all topics discussed in the course): December 16, 1 PM (SE 221).

Tentative exam dates:
Exam 1: September 24,
Exam 2: October 22,
Exam 3: November 19,
Final Exam: December 16, 1 PM (SE221).

Grading information
Your final grade will be determined on the following basis:

Homework: 45%
Exams: 50% total (the lowest exam score will be dropped, but *not* the final)
Ungraded assignments: 5%

Letter Grading:
89.5 to 100% = A
79.5 to 89.4% = B
69.5 to 79.4% = C
59.5 to 69.4% = D

Students enrolled in Phys 685 will complete modified homework assignments. For each assignment, students may substitute any one regular homework problem with a required problem specifically designed for the 685 course.

Health and Safety Expectations
Do not come to class if you are sick. Should any circumstances necessitate strictly online instruction, all course resources will remain accessible through Blackboard.

Copyright of Course Materials
According to NDSU Policy 190 on Intellectual Property, recording the lectures in this course is prohibited with your own personal devices (without prior express approval from the instructor). All recordings and course materials posted in the Blackboard cannot be used for anything other than personal use for learning.

Special Considerations
Students with disabilities or other special needs, who need special accommodations in this course, are invited to share these concerns or requests with the instructor as soon as possible. Extra time on exams must be requested by formal letter from the NDSU department of disability services and administered through that department.
Veterans and student soldiers with special circumstances or who are activated are encouraged to notify the instructor in advance.

Generative AI policy
All work submitted in this course must be your own. Generative AI tools, including ChatGPT, Copilot, Gemini, and similar systems, may not be used to generate, write, or substantially assist in preparing submitted work unless explicitly authorized by the instructor. Students are expected to perform their own analysis, calculations, interpretation of results, and written explanations. Unauthorized use of generative AI may be treated as academic misconduct under NDSU Policy 335.

You are **strongly encouraged** to attend office hours to resolve questions about course material. In some cases, however, generative AI may be used as a learning tool. Appropriate uses include asking clarifying questions about a concept, generating sample practice questions to test your understanding, and requesting hints rather than solutions. Appropriate use of generative AI does not include asking AI to solve a problem and then copying or paraphrasing the result or using AI before making a genuine attempt to solve the problem on your own.

One approach is to explain your understanding of a topic and then ask the AI to identify which aspects are correct and which are still developing. Used this way, generative AI can support, rather than replace, your own reasoning and learning.

If you are stuck on a homework problem, you may use the following prompt to guide the interaction:

"I am a student in an introductory Quantum Mechanics course. You are a friendly, knowledgeable, and patient Socratic-style physics tutor. Please ask me questions or provide a hint to help me understand the physics problem below. Do not solve the problem for me."

Although generative AI has become considerably more accurate in answering upper-division physics questions, it can still provide incorrect, incomplete, or misleading explanations. You should therefore evaluate AI-generated responses critically and verify them against course materials, established physics principles, or the instructor when needed.

If you use AI, consider submitting a brief description of its use (or an AI log).

Academic Responsibility

All work in this course must be completed in a manner consistent with NDSU University Senate Policy, section 335: Code of Academic Responsibility and Conduct.