Physics 771 **Fall 2026**

QUANTUM PHYSICS I

3 credits

Bulletin Description: Kets, Bras, Operators, Observables & Uncertainty, Time Evolution, Schrodinger equation, Harmonic Oscillator, Angular Momentum, Spin, Symmetry in Quantum Mechanics, Perturbation Theory, Emission and Absorption of Radiation, Identical Particles. Prerequisite: PHYS 486 or similar course

Instructor: Andrei Kryjevski, South Engineering 318D
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Meetings: T Th 3:30-4:45
South Engineering 318D

Office Hours: W 14:00-16:00
(or by arrangement)

Goal: To master the foundations of quantum mechanics, including fundamental concepts, key experiments, theoretical methods, and practical applications to physical systems.

Student Responsibilities: Read assigned material in advance. Come prepared for discussion. Ask questions and give me feedback. Complete assignments on time.

Text: J. J. Sakurai, Jim J. Napolitano, **Modern Quantum Mechanics**, 2nd edition, Pearson, 2011
R. Shankar, **Principles of Quantum Mechanics**, 2nd edition, Plenum Press, 1994.

Major Topics:

• **Fundamental Concepts:** Kets, Bras, Operators, Base Kets, Matrix Representations, Measurements, Observables, Uncertainty Relations, Position, Momentum, Wave Functions

• **Quantum Dynamics:** Time Evolution, Schrodinger Equation, Elementary Solutions to Schrodinger's Wave Equation, Simple Harmonic Oscillator, Propagators and Feynman Path Integrals

• **Theory of Angular Momentum:** Rotations and Angular Momentum Commutation Relations, Orbital and Spin Angular Momentum, Central Potentials, Addition of Angular Momenta, Tensor Operators

• **Approximation Methods:** Time-Independent Perturbation Theory, Hydrogen-like Atoms: Fine Structure, Zeeman Effect, Variational Methods, Time-Dependent Potentials, Interaction Picture, Time-Dependent Perturbation Theory, Two Level Systems, Light-Matter Interactions, Energy Shift and Decay Width

• **Scattering Theory (if time permits):** Scattering Amplitude, Born Approximation, Phase Shifts and Partial Waves

• **Symmetry in Quantum Mechanics (if time permits):** Symmetries, Conservation Laws, Degeneracies

Course Schedule:
Weeks 1-2 - Fundamental Concepts
Weeks 3-4 - Quantum Dynamics: Time Evolution
Weeks 5-9 - Theory of Angular Momentum, **Exam 1**
Weeks 11-13 - Approximation Methods: Time-Independent Perturbation Theory
Weeks 14-16 - Scattering Theory
Weeks 17 - **Final Exam**

Evaluation: weekly homework assignments will be posted on Blackboard (50%); 3 exams (15%, 15%, 20%)

Homework and Lateness: Group discussion of homework is strongly encouraged, but written solutions must be your own. Late work will be accepted with a 20% penalty/day until next class.

Grading: A: 90-100%, B: 70-89.9%, C: 60-69.9%, D: 50-59.9%, F: $< 50\%$

The academic community is operated on the basis of honesty, integrity, and fair play. NDSU Policy 335: Code of Academic Responsibility and Conduct applies to cases in which cheating, plagiarism, or other academic misconduct have occurred in an instructional context. Students found guilty of academic misconduct are subject to penalties, up to and possibly including suspension and/or expulsion. Student academic misconduct records are maintained by the Office of Registration and Records. Informational resources about academic honesty for students and instructional staff members can be found at `www.ndsu.edu/academichonesty`.

Any students with disabilities who need accomodation in this course are encouraged to speak with the instructor as soon as possible to make appropriate arrangements.

Academic Integrity Policy:
All writing submitted for any course must be produced by the student. When appropriate, ideas, phrases, and words from other sources can be integrated into student work with attribution. In all writing, ideas and words taken from any source should be attributed to the original source.
Part of our course will focus on helping understand how and when to give credit to other sources or authors, and why it is a standard academic convention to do so. We will also discuss the role of AI in writing processes. Please pay special attention to the quotes, paraphrases, and documentation practices you use in your papers (Note: if you are referring to work previously submitted for this course, then you should cite yourself). Any writing that is not produced by a student in this course without attribution, whether it was written by a human or AI, is a violation of the university's academic regulations and will be subject to disciplinary action. AI generated composition (ChatGPT or other open-source composition software) that is used to produce any form of composition and is then submitted as the student's own writing without acknowledging the role that AI played in its production violates the writing program's academic integrity policy.
Work submitted in all courses must adhere to the Code of Academic Responsibility and Conduct as cited in the Handbook of Student Policies: "The academic community is operated on the basis of honesty, integrity, and fair play." NDSU Policy 335: Code of

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1. Students are allowed to use advanced automated tools (artificial intelligence or machine learning tools such as ChatGPT or Dall-E 2) on assignments in this course if that use is properly documented and credited. For example, text generated using ChatGPT-3 should include a citation such as: "Chat-GPT-3. (YYYY, Month DD of query). "Text of your query." Generated using OpenAI. https://chat.openai. com/" Material generated using other tools should follow a similar citation convention.

2. Instructors in the writing program try to distinguish between inadvertent and deliberate plagiarism, as well as whether and how AI has been used in the writing process. For cases of plagiarism: Initial instances of inadvertent plagiarism will be pointed out and revision will be required to receive a passing grade. Deliberate plagiarism may result in zero for the assignment, possibly an F for the course. For cases in which AI has been used to generate text for an assignment in which AI was not included as part of the assignment: Initial instances will be discussed in a meeting with the instructor, and revision will be required to receive a passing grade. Repeated instances may result in zero for the assignment, possibly an F for the course.