

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 11:00-12:15 **Office Hours:** W 14:00-16:00
South Engineering 318D (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: According to NDSU health regulations, a proper face covering must be worn for all face-to-face class activities.

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

HyFlex Options: Students have an option of taking the course remotely. You can view and participate in the class meetings, use office hours remotely, access and submit the assignments and exams via your NDSU email account. See <https://kb.ndsu.edu/learn> web resource for students on HyFlex.

Note that you will need reliable internet access for this option.

Text: J. J. Sakurai, Jim J. Napolitano, **Modern Quantum Mechanics**, 2nd edition (Pearson, 2011).

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
- **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

• **Approximation Methods (if time permits):** 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

• **Identical Particles (if time permits):** Permutation Symmetry, Symmetrization Postulate, The Helium Atom, Multi-Particle States, Quantization of the Electromagnetic Field

Evaluation: weekly homework assignments will be posted on Blackboard (50%); 3 take-home 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%

Health and Safety Expectations, Attendance:

See www.ndsu.edu/admission/fall_2020_prelim_plan for information on COVID-19 and NDSU's response.

- Students must follow NDSU guidance on face coverings, physical distancing, and sanitation.
- Do not come to class if you are sick. You can view the lectures and ask any questions you have remotely.
- I will be flexible regarding deadlines for students who are experiencing illness or other challenges related to COVID-19. Please contact me as early as possible if you think you may not be able to complete an assignment or participate in the course due to illness.
- NDSU requires students to wear face coverings in classrooms. Wearing face coverings helps reduce the risk to others in case you are infected but do not have symptoms.
- You must properly wear a face covering (covering both the mouth and nose) for the entirety of the class.
- If you fail to properly wear a face covering, you will not be admitted to the classroom. However, you may choose to participate in the class remotely. The following will be used as needed: referral to Dean of Students Office or administrative removal from class.
- Students who cannot wear a face covering due to a medical condition or disability may seek accommodation through Disability Services (701-231-8463; <https://www.ndsu.edu/disabilityservices/>).
- Disinfecting supplies are provided for you to disinfect your learning space. You may also use your own disinfecting supplies.
- Students should observe social distancing guidelines whenever possible. Students should avoid congregating around instructional space entrances before or after class. Students should exit the instructional space immediately after the end of class to ensure social distancing and allow for the persons attending the next scheduled class to enter the classroom.
- In accordance with NDSU Policy 601, failure to comply with instructions, including this syllabus, may be handled according to the Code of Student Conduct resolution process and may result in disciplinary sanctions.

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.