**Physics 771** **Fall 2023**

# 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
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

• **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 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: $< 50\%$

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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.