

PHYS 481: Quantum Mechanics II

Spring 2026 (update in progress)

Prof. Tom Browder (WAT 233, Office Hrs: after class TuTh or by appointment)

Grader: Ammar Bayyari

Quantum Mechanics Part II

The course will meet Tu-Th 12:00-1:20 pm in WAT114, and follow the textbook of David H McIntyre "Quantum Mechanics, A Paradigms Approach", Cambridge University Press (Chapters 8-14).

Recommended Reading: David J. Griffiths, An Introduction to Quantum Mechanics, 3rd edition, Cambridge University Press

After covering the basics, will try to adjust the schedule to include the EPR paradox and entangled states in the course.

- Tuesday, Jan 13: Introduction, Angular momentum operators, commutation relations (Chapter 7 & notes)
- Thursday, Jan 15; Angular momentum: raising/lowering operators, ladder of states (Chapter 7 & Notes)
- Tuesday Jan 20; Hydrogen atom I: solve radial equation (Chapter 8)
- Thursday Jan 22; Hydrogen atom II: radial equation solution, continued using power series method. Normalization in spherical coordinates (Chapter 8)
- Tuesday Jan 27; QM Harmonic Oscillator I. Raising and Lowering Operators. (Chapter 9)
- Thursday Jan 29; QM Harmonic Oscillator II. Normalization of states. Notation on Hermitian conjugation. Raising/lowering operator for expectation values. (Chapter 9)
- Tuesday Feb 3, substitute Ammar Bayari
QM Harmonic Oscillator III: Ehrenfest's Theorem Diatomic Molecules, (Chapter 9)
Start Perturbation theory (Chapter 10)
- Thursday Feb 5, substitute Ammar Bayari
Perturbation theory I: Non-degenerate (First, Second Order) and Degenerate Perturbation Theory (Chapter 10)
- Tuesday Feb 10: substitute Ammar Bayari
Perturbation Theory II: Examples and Applications (e.g. Stark Effect)

- Thursday Feb 12: Variational Principle I, Trial wavefunction (Griffiths Chapter 8)
- Tuesday Feb 17: Variational Principle II, Helium (Griffiths Chapter 8)
- Thursday Feb 19: More examples: Hydrogen Ion, Hydrogen molecule (Griffiths Chapter 8)
- Tuesday Feb 24: Review for Midterm 1 (Practice problems, review hydrogen atom and SHO)
- Thursday Feb 26, Midterm 1 (3 problems: Hydrogen Atom, SHO, Short-answer conceptual questions including angular momentum)
- Tuesday, March 3, Perturbation theory applied to the Hydrogen Atom. Overview and Hyperfine structure.
- Thursday, March 5,
- Tuesday, March 10, Review angular momentum J. Introduce Coupled and uncoupled bases.
- Thursday, March 12, Addition of angular momenta. Clebsch-Gordan coefficients. Finish Hyperfine structure
- **March 16-20, Spring Break**
- Tuesday March 24, Fine structure, $H' = L \cdot S$. How to evaluate. (In-class review).
- Thursday March 26, Kuhio Day (no class)
- Tuesday March 31, Identical particles in QM (fermions and bosons) States of Helium (ground and excited), the Periodic Table,
- Thursday April 2, Time dependent perturbation theory, part I Fermi's Golden Rule, Electric Dipole radiation. Selection Rules.
- Tuesday April 7, Practice problems for Midterm II
- Thursday April 9, midterm II (perturbation theory (time-independent), addition of angular momentum, (hyper)-fine structure of hydrogen)
- Tuesday April 14, Time dependent perturbation theory, part II) Einstein coefficients (absorption, stimulated and spontaneous emission)
- Thursday April 16, Time dependent perturbation, part III.

- Tuesday April 21, 2S->1P transition, Adiabatic approximation, Sudden approximation
- Thursday April 23, Adiabatic approximation example, Bohm-Aharanov effect, WKB approximation (Griffiths)
- Tuesday April 28, WKB approximation, SHO example, alpha decay (Griffiths)
- Thursday April 30, Scattering Theory (Born approximation) (Griffiths)
- Tuesday May 5, Scattering Theory
- Thursday May 7, Review

Final exam, Thursday May 14, 12-2 pm ,

Six problems (four involve detailed calculations, two are short-answer conceptual problems)

Major themes for the final: Time-independent perturbation theory, time-dependent perturbation theory, addition of angular momenta, identical particles

Problems on the final may involve the SHO, hydrogen atom and a particle in a box.

Knowledge of the fine and hyperfine structure of hydrogen and other splittings will be covered. A simple question on radiative transitions will be included.

Very basic knowledge of various approximations in scattering theory (sudden, adiabatic, WKB) will be covered.

There will be two midterms, and a final exam.

For the two midterms, a calculator and a notecard are allowed. For the final, bring a calculator and a sheet of notes.

Grading weights:

Homework Problems (20%)

Two Midterms (35%)

In-class exercises (15%)

Final (30%)

Midterm exam I: TBA

(Covers Chapters 8-9, bring one standard size notecard and calculator)

Midterm exam II: TBA

(Cover Chapters 10-12, bring one standard size notecard and calculator)

Final exam, (Covers Chap 8-14)

4 problems with detailed calculations and 2 short answer conceptual problems

TBA ,

Bring crib sheet (a single page of notes is allowed) and a calculator

Substitutes: Belle II General Meeting, BPAC, Jan 30-Feb 11 Australian Dark Matter Review, Feb 23-March 1 FPCP (Flavor Physics & CP Violation (Germany)), May 18-22

Last modified: Jan 26, 2026

(Check frequently for updates)

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