OSE6349: Applied Quantum Mechanics for Optics and Engineering (Fall 2025)

Grading

50% homework

25% midterm

25% final

Suggested textbooks

H. Kroemer, “Applied quantum mechanics for engineering, materials science, and applied physics,” (Prentice Hall, New Jersey, 1994).

R. Gilmore, “Quantum mechanics in one dimension,” (The Johns Hopkins University Press, 2004).

D. A. B. Miller, “Quantum mechanics for scientists and engineers,” (Cambridge University Press, 2008).

Bibliography:

There are of course a very large number of introductory textbooks on quantum mechanics. There is no single agreed upon textbook for applied quantum mechanics geared towards the student of optics. Here are some suggestions (other suggestions will be provided as we go along):

Chris Isham, “Lectures on quantum theory: Mathematical and structural foundations”; A. Messiah, “Quantum mechanics”; Paul M. A. Dirac, “The Principles of Quantum Mechanics”; The Feynman Lectures on Physics, Volume III; J. J. Sakurai, “Modern Quantum Mechanics”; David Bohm, “Quantum theory”; Peter Atkins, “Physical Chemistry” and “Molecular Quantum Mechanics”.

The students will also be provided with course notes prepared by the instructor.

<u>Week 1:</u>

08/18 Lecture 1: Introduction

08/20 Lecture 2: 2D linear vector spaces

<u>Week 2:</u>

08/25 Lecture 3: Quantum mechanics using 2×2 matrices I

08/27 Lecture 4: Quantum mechanics using 2×2 matrices II

<u>Week 3:</u>

09/01 Labor day

09/03 Lecture 5: General linear vector spaces I

<u>Week 4:</u>

09/08 Lecture 6: General linear vector spaces II; Axioms of quantum mechanics I

09/10 Lecture 7: Axioms of quantum mechanics II

<u>Week 5:</u>

09/15 Lecture 8: Infinite quantum wells I

09/17 Lecture 9: Infinite quantum wells II: density of states, degenerate perturbation theory

<u>Week 6:</u>

09/22 Lecture 10: The quantum harmonic oscillator I

09/24 Lecture 11: The quantum harmonic oscillator II

<u>Week 7:</u>

09/29 Lecture 12: Quantum mechanics in 1D I: General formalism, scattering states from a barrier, and bound states in a finite quantum well

10/01 Lecture 13: Quantum mechanics in 1D II: Multiple barriers, coupled quantum wells, and degenerate perturbation theory

<u>Week 8:</u>

10/06 Lecture 14: Quantum Mechanics in 1D III: Bound states, non-degenerate perturbation theory

10/08 Lecture 15: Quantum Mechanics in 1D IV: Linearly varying potentials, Variational principle

<u>Week 9:</u>

10/13 Lecture 16: Quantum Mechanics in 1D V: Periodic potentials

10/15 Lecture 17: Quantum Mechanics in 1D VI: Periodic potentials, perturbation theory

<u>Week 10:</u>

10/20 Lecture 18: Rotational motion and angular momentum I

10/22 Lecture 19: Rotational motion and angular momentum II

<u>Week 11:</u>

10/27 Lecture 20: Hydrogen and hydrogen-like atoms, the periodic table

10/29 Lecture 21: Hydrogen molecule

<u>Week 12:</u>

11/03 Lecture 22: Time-dependent perturbation theory I

11/05 Lecture 23: Time-dependent perturbation theory II

<u>Week 13:</u>

11/10 Lecture 24: Mixed states, the density operator

11/12 Lecture 25: Bipartite states I: definition, partial trace

<u>Week 14:</u>

11/17 Lecture 26: Bipartite states II: separability and quantum entanglement

11/19 Lecture 27: Applications

<u>Week 15:</u>

11/24 Lecture 28: Applications

11/26 End of class