PHYSICS 481 – QUANTUM MECHANICS II

Spring Semester 2019; TR 12:00–1:15; F 3:30–4:20; WAT 114
Instructor: Eric B. Szarmes (szarmes@hawaii.edu)
Office: Watanabe Hall, Room 212

Course Description: Quantum mechanics, along with the theory of relativity, is one of the cornerstones of modern physics. This course comprises the second semester of senior level quantum mechanics at the University of Hawai'i. While Physics 480 introduced the fundamental principles and concepts of quantum mechanics, Physics 481 delves more deeply into the applications of these principles in a number of systems. The fundamental system of interest is the hydrogen atom, whose analysis comprises a theoretical tour de force of quantum mechanical concepts and techniques including addition of angular momentum, degenerate and nondegenerate perturbation theory, the fine structure and hyperfine structure, and a number of techniques in higher mathematics. Other applications covered in the course include identical particles, time-dependent perturbations, periodic systems, scattering theory, and an introduction to advanced topics.

Primary textbook: David H. McIntyre, *Quantum Mechanics, A Paradigms Approach,* Pearson Higher Ed., 2012

Supplemental text: James Binney & David Skinner, *The Physics of Quantum Mechanics,* Cappella Archive, 2013, available at https://www-thphys.physics.ox.ac.uk/people/JamesBinney/qb.pdf

Course website: https://laulima.hawaii.edu/portal/site/MAN.81340.201930 → see Resources

Grade distribution:

Homework (weekly/recitation):	40%, 10%
Midterm examinations 1 and 2:	15%, 15%
Final examination:	20%

Grade assignment:

A+	90 >	B+	75–80	C+	60–65	C–	40–50
A	80–90	B	65–75	C	50–60	D/F	< 40

COURSE OUTLINE

Dates	Topics	Chapter
1/8	*Introduction and review of quantum mechanics*: fundmamentals from Phys 480	
1/10–1/24	*harmonic oscillator*: energy eigenvalues and eigenstates; ladder operators; position representation; time development; coherence.	QM 9
1/29–2/5	*time-independent perturbation theory*: non-degenerate theory; degenerate theory; harmonic oscillator; Stark effect.	QM 10
2/7–2/19	*hyperfine structure*: interaction Hamiltonian; review of angular momentum; hyperfine perturbation; addition of angular momentum; Clebsch-Gordan coefficients.	QM 11
February 12	— **MIDTERM 1 DUE FRIDAY, FEB 15** —	
2/21–3/5	*perturbation of hydrogen*: relativistic correction; spin-orbit coupling; Zeeman effect.	QM 12
3/7–3/28	*time-dependent perturbation theory*: transition probability; harmonic perturbation; dipole interaction; Einstein coefficients; selection rules; adiabatic vs. sudden	QM 14
March 12	— **MIDTERM 2 DUE FRIDAY, MAR 15** —	
4/2–4/4	*identical particles*: interacting particles in one dimension; symmetrization; helium and the periodic table.	QM 13
4/9–4/16	*periodic systems*: periodic potentials; energy bands; Bloch's theorem; density of states; Kronig-Penney; metals and semiconductors; effective mass.	QM 15
4/18–4/25	*scattering theory*: fundamentals; Born approximation; partial waves; optical theorem; low-energy scattering; resonances; S-matrix.	Suppl.^{t}
4/30	*modern applications*: quantum optics; quantum computing.	QM 16
5/2	*summary and review*	
May 6–10	— *Final Examination* —	