Syllabus for Periodic Systems

PH 427

Course Name: Paradigms in Physics: Periodic Systems
Course Number: PH 427
Course Credits: 3
Prerequisites: PH 424, PH 425; coreqs: PH 315

Course Catalog Description
Quantum waves in position and momentum space; Bloch waves in one-dimensional periodic systems, and the reciprocal lattice; coupled harmonic oscillators; phonons.

Student Learning Outcomes
Students shall be able to:

• Apply the principle of superposition to construct wave packets and calculate group velocity
• Move fluently between position and momentum space
• Use the uncertainty principle to estimate magnitude of quantities
• Explain how periodic symmetry relates to conservation of crystal momentum
• Solve for the normal modes and frequencies of a set of coupled harmonic oscillators
• Solve for 1D energy eigenstates of stepwise constant potentials
• Interpret band structures and dispersion relations, including finding the group and phase velocities
• Read and summarize a scientific research paper
• Give a clear oral presentation

Course Content

Physics:

• Quantum free particle
• Position and momentum space; uncertainty principle
• Wave packets and group velocity
• Coupled harmonic oscillators; normal modes
• Periodic systems and the unit cell
• Periodic coupled harmonic oscillators; phonons and dispersion relations
• Acoustic and optical phonons
• Scattering from barriers (transmission, reflection, and tunneling)
• Coupled finite square wells
• Bloch’s theorem
• Periodic finite square wells and band structures
• Journal club presentations

Math:
• Systems of equations
• Matrix representation of coupled ordinary differential equations
• Generalized eigenvalue problems
• Step functions and Dirac delta functions

Learning resources
Required textbooks:

• *Classical Mechanics*
  by J. Taylor

• *Vibrations and Waves in Physics*
  by I. G. Main

• *Quantum Mechanics: A Paradigms Approach*
  by David McIntyre

Evaluation of Student Performance
Students will be graded on weekly homework, lab reports, and midterm and final exams.
Statement Regarding Students with Disabilities

Accommodations for students with disabilities are determined and approved by Disability Access Services (DAS). If you, as a student, believe you are eligible for accommodations but have not obtained approval please contact DAS immediately at 541-737-4098 or at http://ds.oregonstate.edu. DAS notifies students and faculty members of approved academic accommodations and coordinates implementation of those accommodations. While not required, students and faculty members are encouraged to discuss details of the implementation of individual accommodations.

Link to Statement of Expectations for Student Conduct

http://oregonstate.edu/studentconduct/offenses-0