ECE 607 - Fundamentals of Solid State Electronics I

Department of Electrical and Computer Engineering
University of Massachusetts at Amherst

Fall 2010

Day & Time: MWF, 11:15-12:05
Place: 327 ELAB
Instructor: Prof. Neal G. Anderson (201B Marcus, anderson@ecs.umass.edu)
Office Hours: See course web site (SPARK)

Course Goals

To understand critical distinctions between classical and quantum mechanics.

To understand the formal structure of quantum mechanics and apply it to the solution of problems.

To provide a foundation for further work and study in solid-state electronics, nanoelectronics, optical and quantum electronics, and other areas relevant to ECE that require a background in quantum mechanics (e.g. quantum computing, photovoltaics).

Preliminary Course Outline

1. Introduction
   1.1 Context: Quantum Theory and ECE
   1.2 Introductory Example
   1.3 Physical Description: What makes a theory “right”?
   1.4 Preview of Quantum Theory

2. Mathematical Preliminaries
   2.1 Hilbert Spaces
   2.2 Linear Operators

3. Quantum Theory
   3.1 Classical Backdrop
   3.2 The Quantum Postulates
   3.3 Formal Development
   3.4 Summary: Comparison Classical and Quantum Mechanics
   3.5 Wave Mechanics

4. Canonical Applications
   4.1 The Free Particle
   4.2 Potential Wells
4.3 The Harmonic Oscillator
4.4 Potential Steps and Tunnel Barriers
4.5 The Periodic Potential and Energy Bands
4.6 Angular Momentum and Spin

5. Perturbation Theory and Applications

5.1 Time-Independent Perturbation Theory (TIPT)
5.2 Time-Dependent Perturbation Theory (TDPT)
5.3 Applications of TDPT: Radiation and Scattering

6. The Density Matrix Formalism

6.1 Recasting the Postulates
6.2 Applications: (Thermal Mixtures, System-Environment Interactions)

7. Advanced Topics

Potential topics include intro to the quantum theory of semiconductors; quantum wells, wires, dots, and other nanostructures; quantum entanglement; decoherence.

Course Materials

The course is based on lecture notes, to be provided in class, parts of which draw heavily from Isham and Liboff (see below). Isham is strongly recommended but not required.

Useful Reference Texts


R.L. Liboff, Introductory Quantum Mechanics, Addison Wesley.


Grading

Homework - 20%
Exam I - 25%
Exam II - 25%
Final Exam - 30%

Updated 8•31•10