ECE/PHYS 3740: Introduction to Quantum Theory and Relativity

Credits and Contact Hours: 3.0 Credit Hours
15 weeks: Two 80-minute lectures + one 50-minute problem solving session per week

Instructor’s Name: Douglas Bergman

Text Book(s) and/or Required Material:
• R. Harris, Modern Physics, Second Edition, Pearson Addison-Wesley 2007
• Selected on-line readings

Catalog Description: Introduction to Special Relativity: time dilation, length contraction, Lorentz transforms. Introduction to classical and quantum statistics. Maxwell-Boltzmann, Fermi-Dirac, Bose-Einstein, Pauli principle with emphasis on relativistic energy and momentum. The quantization of light: Planck black body radiation, the photoelectric effect and x-rays, and Bragg diffraction. Basic quantum ideas: wave-particle duality, uncertainty relations, and wave packets. Introduction to quantum mechanics: Schrodinger equation in one, two, and three dimensions. Square wells, barriers, harmonic oscillator, and hydrogen atom. Quantum properties of spin and angular momentum: Zeeman effect, Stern-Gerlach experiment, atomic and molecular structure, and covalent bonding. Multi-electron atoms and the Periodic Table. Applications to solid-state physics, particle physics, and nuclear physics per instructor and time permitting.

Prerequisites: C- or better in:
• PHYS 2220: Physics for Scientists & Engineers I; and
• MATH 2250: Diff. Equations and Linear Algebra; and
• Full major status in Computer Engineering

Designation: Elective

Contribution of Course to Meeting the Requirements of ABET Criterion 5: This course teaches engineering science (college-level physics).

Specific Outcomes of Instruction: The objectives of this course are to:
1. Help students understand and solve problems in a broad range of scientific and engineering fields;
2. Teach students the fundamental principles of physics;
3. Teach students how to describe real world phenomena quantitatively; and
4. Teach problem-solving skills that can be applied to other areas of science, engineering, and life.

Relationship of the Course to the Program Outcomes:
(a) An ability to apply knowledge of mathematics, science, and engineering. Assessed through homework problems and in exams.
(b) An ability to design and conduct experiments, to analyze and interpret data, and to debug and analyze software. Assessed through exams where the students must understand the operation and results of historical experiments.

(g) An ability to communicate effectively in written and oral form. The students must demonstrate their mastery of the material in a written exam.

(h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context. The material in this class relates to engineering and societal issues such as nuclear arms testing, semiconductor technology and GPS location services (among others).

(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice. Students must use Linear Algebra and know the methods of solving Differential Equations to do well in this class.

Topics Covered in the Course:
- Special Relativity
- Wave/Particle Duality
- Schrödinger’s Equation
- Quantum Mechanics in 3D/Atomic Physics
- Quantum Statistical Mechanics
- Cosmic Rays