DETAILED COURSE DESCRIPTION

Course Number PHYS 252

Course Title Fundamentals of Physics: Quantum Physics and Applications

Target audience Sophomore level physics majors and minors, and majors in some engineering programs. (As of 2021 this is expected to be only Nuclear Engineering.)

Prerequisites PHYS 232M or PHYS 231; and MATH 142 (with C or above) or MATH 148 (with C or above).

Catalog description Explores the fundamentals of quantum physics and applications to solid state physics, nuclear physics, particle physics, and cosmology. Topics covered include: The nature of photons; Wave particle duality; Application of the Schrödinger Equation to simple steps and barriers; and Models of single- and multi-electron atoms. This course includes a laboratory component that may be incorporated into the class time in a studio physics modality. Basic scientific computing will be integrated into the course.

Expected previous knowledge

> ***Concepts*** Electricity and magnetism. Wave behavior including resonance, sound. Derivatives and integrals. Students coming through PHYS 231 may not have been exposed to special relativity and may have been exposed to less material about waves.
>
> ***Skills*** Able to calculate derivatives and integrals in 1-D, manipulate trigonometric functions, solve equations with logs and exponents.

Course Objectives

After successfully completing this course, students should be able to: 1) Describe the main concepts and experiments in quantum physics; 2) Calculate observables using simple models of quantum systems; 3) Connect the design and outcome of experiments with physical concepts; 4) Estimate uncertainties in experiments; 5) Use simple integrals and differentials in derivations and calculations; 6) Write clear and concise laboratory reports and responses to short-answer questions; 7) Describe basic concepts in solid state physics, nuclear physics, particle physics, and cosmology; 8) Write computer codes to solve problems in quantum physics and applications,

Sample Text

"Modern Physics", Kenneth Krane, Wiley.

Or "University Physics with modern physics", Young and Freedman, Pearson (for engineering students who have already purchased this book for other classes).

Minimum Material Covered

Photons – Photoelectric effect, Compton effect, pair production and annihilation.

Wave-like properties of particles – de Broglie's hypothesis, Heisenberg uncertainty principle.

The Schrödinger Equation – Simple Harmonic Oscillator, steps and barriers.

Models of the Atom – The Bohr model.

The hydrogen atom – Energy levels, spectroscopic notation, Zeeman effect.

Many-electron atom – Pauli exclusion principle, build-up of periodic table.

Solid state – Metals, semiconductors, superconductors, and magnetic materials.

Nuclear physics – Radioactive decay, α, β, and γ decay, fission and fusion.

Elementary particle physics – Conservation laws, the Standard Model.

Cosmology – Black holes, the big bang.