

SYLLABUS

Department: Physics and Engineering Physics
Course Number: PHY 580

Credit Hours: 3 hours

I. Title: Modern Physics I

II. Catalog Description: Fundamentals of special relativity, atomic structure of matter, wave-particle dualism. The Bohr-Sommerfeld atom, atomic spectra, atomic and molecular structure.

III. Purpose: The purpose of the course is to:

- A. Investigate the physical phenomena which have become understood since about 1990, within a historical context.
- B. Develop the mathematical tools necessary for the quantitative analysis of microscopic phenomena; an introduction to Quantum Mechanics.
- C. Interpretation of predictions given by Quantum Mechanics.
- D. Contrast the phenomena, mechanics and understanding in the quantum picture with the classical.
- E. Develop working knowledge of the quantum aspects as applied to blackbody radiation, wave-particle dualism, and atomic and molecular structure.

IV. Course Objectives: Students will

- A. become familiar with blackbody radiation and understand the failure of classical physics in explaining the spectra.
- B. investigate the implications of Planck's hypothesis used in solving the blackbody problem.
- C. study other particle-like properties of radiation.
- D. understand the logic for the complementary hypothesis of wave-like properties of particles.
- E. investigate how wave aspects of matter limits our knowledge of measurable quantities.
- F. study the motivation for progressively better models of the atom, including the Bohr atom.
- G. arrive at a logical approach to the Schrodinger's Wave Equation.
- H. apply the Schrodinger's Wave Equation to systems, investigate interpretations and predict physical phenomena.
- I. investigate limitations.

V. Content Outline:

- A. Thermal Radiation and Planck's Postulate
 1. Thermal Radiation – Phenomena and Classical Theory
 2. Planck's Theory of Cavity Radiation
 3. Implications of Planck's Postulate
 4. Applications of Blackbody Radiation
- B. Photon – Particle-like Properties of Radiation
 1. Photoelectric Effect – Einstein's Explanation
 2. Compton Scattering
 3. Pair Production and Pair Annihilation
 4. Cross Sections and Detection Probability
- C. Wave Aspects of Particles
 1. Matter Waves – DeBroglie Hypothesis
 2. Wave – Particle Duality
 3. Uncertainty Principle, Consequences
- D. Atoms
 1. Thompson and Rutherford Models – Experiments
 2. Atomic Spectra
 3. Bohr Postulates, Bohr Atom, Successes, Failures
 4. Sommerfeld Model
 5. "Old" Quantum Theory, Correspondence Principle

- E. Schroedinger's Theory of Quantum Mechanics
 - 1. Physically Sound Arguments from Old Theory
 - 2. The Equation
 - 3. Properties Required for Functions
 - 4. Interpretation
 - 5. Quantization
- F. Solutions to Schroedinger's Equation
 - 1. Step Potential, Variations
 - 2. Infinite and Finite Square Wells
 - 3. Simple Harmonic Oscillation
- G. One Electron Atoms
 - 1. Solution Techniques
 - 2. Quantization of Constants of Motion
 - 3. Introduction to Angular Momentum Quantization
 - 4. Probability Densities

For education certification students, this course addresses content topics found in Praxis exams 0261 (Physics Content) and/or 0432 (General Science), and addresses Kentucky Core Content sections SC-H-1.1.1-1.1.3, 1.2.1-1.2.6, 1.4.1-1.4.4, 1.5.1-1.5.4, and 1.6.1-1.6.2.

VI. Instructional Activities: Computer simulations, problems for solution.

VII. Field, Clinical, and Laboratory Experiences: None

VIII. Resources:

Classroom: Blackburn 170

Instructor: H.R. Kobraei, BL 114

Class times: 8:30-9:20 MWF

Office Hours: As posted on office door or as requested.

IX. Grading Procedures: Hourly exams (60%) and a comprehensive final exam (20%) account for 80% of the course grade.

Homework is assigned on a daily basis. Homework accounts for 20% of the grade. Grade distributions nominally follow the 10% buckets of 90-100 for A, 80-90 for B, etc.

X. Attendance Policy: Attendance at scheduled exam times is mandatory. Any deviation must be excused by the instructor and rescheduled before exam time. Homework is due when scheduled. You are responsible for material covered during unexcused absences. Help can be scheduled for periods of excused absence.

XI. Academic Honesty Policy: Complete academic integrity is expected of all students. Graded individual assignments and examinations should consist solely of the work of that individual whose name is on the document. Cheating on examinations will not be tolerated. Cheating is defined to be the use of any unauthorized source of information for the purpose of deceiving the instructor in evaluating the student's performance or to gain an unfair advantage over fellow students. Students who are caught cheating will receive a failing grade in the course.

XII. Text: Modern Physics for Scientists and Engineers, 2nd Ed., Thornton and Rex

XIII. Prerequisites: PHY 530, 560