University of Arkansas – Fort Smith
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General Syllabus:

PHYS 31063 Modern Physics

Credit Hours: 3 Lecture Hours: 3 Laboratory Hours: 0

Prerequisite: PHYS 20403 University Physics II

Effective: 2018~2019

I. Course Information

A. Catalog Description

Emphasizes the physics of this century. The topics include relativistic collisions, elementary particle physics, particle-wave duality, philosophical interpretations of quantum theory, and solutions to the Schroedinger equation for simple bound-state and scattering problems.

B. Additional Information

Sometimes called non-classical physics, this is an exploration of the world on its smallest, largest, and sometimes most mind-bending scales: relativity, quantum mechanics, particle and nuclear physics, to name a few. These new theories, developed primarily in the 20th century, are conceptually more difficult to grasp than those of classical physics since they are not in accord with our everyday physical intuition. It builds on material from previous courses in University and mathematical physics.

II. Student Learning Outcomes

A. Subject Matter

Upon completion of this course, the student will be able to:

1. Develop a strong conceptual understanding of the special theory of relativity and elementary quantum mechanics, and to apply that understanding to a variety of basic problems in both fields.
2. Develop an elementary understanding of the analytical and computational techniques used in modern physics research.
3. Demonstrate qualitative understanding of the experimental evidence that supports modern physical theories.
4. Apply and identify “proper” times and lengths, and dilated/contracted times and lengths.
5. Apply conservation of relativistic momentum and energy to one- or two-body

problems.

6. Apply the deBroglie relationship to determine the wavelength of a particle.
7. Apply the uncertainty relationships to determine such quantities as:
   a. Minimum possible uncertainty in (time, energy, position, momentum) and related quantities;
   b. An estimate of the energy of a confined particle;
   c. The lifetime of a particle, or of an atom's excited state
8. Apply and sketch wavefunctions:
   a. First, second, third, etc., energy levels
   b. Boundary conditions;
   c. Qualitative wavelength dependence on energy
9. Evaluate the 1-D, time-independent Schrödinger equation for any potential and identify relevant boundary conditions.
10. Apply the rules for the allowed quantum numbers for electrons in an atom
11. Analyze the angular momentum, and its orientation, of an electron
12. Determine the energy of an electron in an atom;
    a. This may or may not require an estimate of electron shielding
13. Compute the probability that the electron in hydrogen is in a given radial range, given its quantum state.
14. Analyze the "screening" of electrons in an atom, and explain the different screening effects for electrons in different shells and subshells.
    a. Calculate the energy of a K-alpha or L-alpha X-ray for a given nucleus.
    b. Determine the energy that an incident electron must have to create the "hole" in the atom's electron distribution that is needed for this process.

B. University Learning Outcomes

This course enhances student abilities in the following areas:

Analytical Skills

Critical Thinking Skills: Students will identify a problem or issue and will research, evaluate, and compare information from varying sources in order to evaluate authority, accuracy, recency, and bias relevant to the problems/issues. The student will generate solutions/analysis of problems/issues evaluated and will assess and justify the solutions and/or analysis.

Communication Skills (written and oral)

Students will communicate proficiently. The student will compose coherent documents appropriate to the intended audience and effectively communicate orally in a public setting.

Ethical Decision Making

Students will model ethical decision-making processes. The students will identify ethical dilemmas and affected parties and will apply ethical frameworks to resolve a variety of ethical dilemmas.

Global & Cultural Perspectives

Students will reflect upon cultural differences and their implications for interacting with people from cultures other than their own. The students will demonstrate understanding or application of their discipline in a global environment and will demonstrate how their discipline impacts or is impacted by different cultures.

III. Major Course Topics

A. Perspective
B. Special theory of relativity
C. Experimental basis of Quantum Theory
D. Atomic Structure
E. Wave properties of Matter
F. Quantum Theory
G. Hydrogen Atom
H. Many-Electron Atoms
I. Statistical Physics
J. Molecules and Solids
K. Semiconductor Theory
L. Atomic Nucleus
M. Quarks