

**ACTIVE COURSE FILE**B. \*Curricular Area: Physics Course Number: PHY2115Course Title: Physics for Science and Engineering IIISemester Credit Hours: 4 Lecture Hours: 3 Lab Hours: 2.5 Clinical Hours: 0

\*Changes from the present course must be accompanied by a yellow Course Revision or Deletion Form.

Course description to appear in catalog:

Calculus-based study of fluids, thermodynamics, special relativity, introductory quantum mechanics, nuclear physics, and particle physics

Prerequisite: PHY2112 with a C or better and completion of or concurrent enrollment in MATH2270

## A. General Course Objectives

Upon successful completion of this course the student should be able to do the following:

1. Calculate the static fluid pressure on an object at any depth for any fluid
2. Formulate the buoyant force from a static fluid on objects of any size and density
3. Explain the difference between heat and thermal energy
4. Explain the concept of the ideal gas model and its predictions
5. Predict the amount of energy transferred during different types of phase transitions
6. Interpret and explain the concept of entropy and the 2<sup>nd</sup> Law of Thermodynamics
7. Calculate work completed and energy transferred during a thermodynamic cycle
8. Interpret pressure-volume (P-V) diagrams
9. Recognize the constancy of speed of light as the basis for special relativity
10. Calculate time dilations and length contractions for frames in relative motion
11. Calculate the relativistic energy and momentum of particles using the invariance of total energy
12. Explain the importance of photo-electric effect in the basis of quantum theory
13. Recognize the meaning of quantum mechanical wave function in terms of probability
14. Solve the time independent Schrodinger wave equation for simple cases (such as the infinite square well) and use this solution to determine basis attributes of the particle (such as average position)
15. Explain the concept of quantum tunneling using the Schrodinger wave equation
16. Calculate the positions of spectral line frequencies of a hydrogen atom using quantized energy states of Bohr atomic model
17. Explain the importance of the Pauli exclusion principle and how periodic table is built from it

18. Explain the fundamental concept of statistical mechanics including Fermi-energy and occupancy probabilities
19. Differentiate between conductors, insulators and semi-conductors using band-theory and apply this theory to simple solid state devices such as p-n junctions
20. Differentiate between the different methods for measuring radioactivity and radiation dosage and explain their appropriate use
21. Use the activity law to calculate the half life of a material and to determine its age
22. Differentiate between the major types of radiation (gamma, alpha, beta) and explain the effects of each on different materials including the human body
23. Explain the concepts of nuclear binding energy and how it is transformed into useful thermal energy in both fission and fusion
24. Explain the fundamental mechanisms involved in nuclear power including electrical power generation, different reactor types, the nuclear fuel cycle, and spent fuel disposal
25. Describe the concepts involved in the creation of nuclear weapons and the effects of their use
26. Organize all elements of matter and force according to the Standard Model
27. Determine allowable and forbidden decays according to conservation laws of the Standard Model
28. Explain how the requirements of the Standard Model effect current cosmological theories

## B. Topical Outline

1. Fluids
  - a. Definition of density and pressure
  - b. Relationship between depth and pressure for a static fluid
  - c. Buoyant force and Archimedes' principle
  - d. Bernoulli's equation and the relationship between depth, pressure and velocity for a fluid in motion
2. Temperature/Heat
  - a. Definition of temperature and different temperature scales
  - b. Definition and units of heat
  - c. Distinction between temperature and heat
  - d. Mass and molar specific heats
  - e. Thermal expansion
  - f. Solids and liquids

3. Kinetic Theory of Gases
  - a. The first law of thermodynamics
  - b. The ideal gas law
  - c. Work done by a gas when it expands
  - d. The equipartition of energy
  - e. Calorimetry
  - f. Heat transfer-conduction, convection and radiation
  
4. Entropy and the 2<sup>nd</sup> Law of Thermodynamics
  - a. Cycles, heat engines and refrigerators
  - b. Efficiency of a heat engine
  - c. The Carnot heat engine and Carnot cycle efficiency
  - d. The second law of thermodynamics
  - e. P-V diagrams
  - f. The definition of entropy-order and disorder in the universe
  
5. Relativity
  - a. Basis of special relativity
  - b. Length contraction and time dilation
  - c. Relativity of simultaneity
  - d. Lorentz equations
  - e. Relativistic Doppler effect
  - f. Relativistic velocity addition
  - g. Invariance of space-time and space-time 4-vectors
  - h. Invariance of momentum-energy and momentum-energy 4-vectors
  
6. Wave-particle duality
  - a. Experimental foundations for quantum mechanics including photoelectric effect and Bragg scattering of electrons
  - b. Momentum and energy from wave properties of matters
  - c. Schrodinger wave equation
  - d. Heisenberg uncertainty principle
  - e. Quantum mechanical tunneling
  
7. Applications of the Schrodinger wave equation
  - a. One-dimensional infinite square well
  - b. Quantized energy levels of trapped particle
  - c. One-dimensional finite square well
  - d. Two- and three-dimensional infinite square well
  
8. Quantized atomic structure
  - a. Bohr model of the atom
  - b. Quantized electromagnetic spectrum of hydrogen
  - c. Electron spin
  - d. Total angular momentum
  - e. Magnetic resonance
  - f. Pauli Exclusion Principle and the periodic table
  - g. Lasers

