CALCULUS-BASED PHYSICS II
Physics 222-21 & Physics 222-61
Syllabus

Course Description: 4 credits (3 class hours and 3 laboratory hours per week)

This is the second course in the Engineering Physics sequence. Subject areas include applied problems in electricity, magnetism, waves, optics, sound, light and as time permits, introduction to modern physics in the area of nuclear and atomic physics, special and general relativity. The use of computers, analysis software, computer interfaces and sensors are an integral part of this course.

Prerequisite: PHY 222 – PHY* 221 and MAT* 254 with a grade of "C" or better.

Goals:

The goals of this course are to develop the students' abilities to understand, utilize, and apply a significant portion of the physics discipline. This course will provide students with an opportunity to demonstrate an understanding of the fundamental principles, concepts, and knowledge of electricity, magnetism, waves, optics, sound, light and modern physics, assist students in applying these principles to the student's area of interest, and to develop analytical problem-solving skills important to scientists and engineers. We will utilize the derivative and integral in both conceptual definitions and problem solving.

Outcomes:

Upon successful completion of this course, each student must have demonstrated understanding and competency in each of the following topics and techniques (through in-class testing of each individual student independently and collaborative lab-work):

1. Describe electricity
    a. Explain charges and apply the charge model.
    b. Explain and apply Charge polarization.
    c. Relate charges to atoms and molecules.
    d. Explain and Apply Coulombs law.
    e. Explain electric fields and apply the field model.
        i. Including non-uniform electric fields.
        ii. Describe electric flux
    f. Describe and apply Gauss's Law
    g. Understand the applications of electric fields.
    h. Describe and apply forces and torques in electric fields.
    i. Describe electric potential.
        i. Find electric potential from electric fields
    j. Calculate electric potential.
    k. Describe capacitance and capacitors.
    l. Describe current
    m. Describe resistance
    n. Describe and apply Ohm's law.
    o. Understand and draw circuit diagrams
        i. Understand series vs parallel circuits
    p. Describe and apply Kirchoff's Laws

2. Describe magnetism
    a. Describe magnetic fields
    b. Explain how magnetic fields and electric currents relate
    c. Describe magnets and magnetic materials
    d. Describe magnetic flux
        i Including non-uniform magnetic fields
    e. Describe and apply Ampère's Law
    f. Describe and apply Lenz's law.
    g. Describe and apply Faraday's law.
    h. Describe electromagnetic waves.
    i. Describe and apply the photon model of electromagnetic waves.
    j. Describe the electromagnetic spectrum.
    k. Apply Maxwell's equations
    l. Describe and Apply Ampère-Maxwell law
3. Describe Alternating current
    a. Understand AC circuits
    b. Understand household electricity
4. Understand waves
    a. Understand and apply the wave model
    b. Understand traveling waves
        i Including sound and electromagnetic waves.
    c. Describe and apply superposition and standing waves
5. Describe Wave optics
    a. Describe index of refraction
    b. Understand diffraction gradient
    c. Describe and apply the ray model of light
    d. Draw ray diagrams
    e. Describe lenses and mirrors.
    f. Describe optical instruments
6. Describe topics in modern physics
    a. Describe and apply relativity
        i Describe time dilation
        ii Describe length contraction
    b. Describe topics in quantum physics
        i Apply the photoelectric effect
        ii Describe photons
        iii Describe matter waves
        iv Understand energy quantization
        v Apply the uncertainty principle

Competencies:

Scientific Reasoning: Upon the completion of this course, students should be able to:

- Explain the methods of scientific inquiry that lead to the acquisition of knowledge. Such methods include observations, testable hypotheses, logical inferences, experimental design, data acquisition, interpretation, and reproducible outcomes.

- Apply scientific methods to investigate real-world phenomena, and routine and novel problems. This includes data acquisition and evaluation, and prediction.
- Represent scientific data symbolically, graphically, numerically, and verbally.
- Interpret scientific information and draw logical references from representations such as formulas, equations, graphs, tables, and schematics.
- Evaluate the results obtained from scientific methods for accuracy and/or reasonableness

Scientific Knowledge: Upon the completion of this course, students should be able to:

- Communicate using appropriate scientific terminology.
- Use representations and models to communicate scientific knowledge and solve scientific problems.
- Plan and implement data collection strategies appropriate to a particular scientific question.
- Articulate the reasons that scientific explanations and theories are refined or replaced.
- Evaluate the quality of scientific information on the basis of its source and the methods used to generate it.