PHYS 241 - Physics for Scientists & Engineers 3 Course Outline

Approval Date: 11/08/2013
Effective Date: 08/11/2014

SECTION A

Unique ID Number	CCC000192628
Discipline(s)	
Division	Science and Engineering
Subject Area	Physics
Subject Code	PHYS
Course Number	241
Course Title	Physics for Scientists & Engineers 3
TOP Code/SAM Code	1902.00 - Physics, General / -
Rationale for adding this course to the curriculum	minor changes to language, clarifications, and additional text.
Units	4
Cross List	*N/A*
Typical Course Weeks	18

Total Instructional Hours

	Contact Hours
Lecture	54.00
Lab	72.00
Activity	0.00
Work Experience	0.00
Outside of Class Hours	108.00

Total Contact Hours	126
Total Student Hours	234
Open Entry/Open Exit	No
Maximum Enrollment	
Grading Option	Letter Grade or P/NP

Distance Education Mode of Instruction

SECTION B

General Education Information:

SECTION C

Course Description

Repeatability May be repeated 0 times

Catalog Description This is a calculus-based introduction to electromagnetic waves, physical optics, relativity, and atomic and quantum physics. Topics include Maxwell's Equations and electromagnetic waves, light, lenses, diffraction and polarization, relativity, quantum mechanics, molecules and solids, nuclear physics and radioactivity, nuclear energy, elementary particles, and astrophysics and cosmology.

Schedule Description

SECTION D

Condition on Enrollment

1a. Prerequisite(s)

- PHYS 240

1b. Corequisite(s): *None*

1c. Recommended: *None*

1d. Limitation on Enrollment: *None*

SECTION E

Course Outline Information

1. Student Learning Outcomes:

A. Communicate the principles of electromagnetism, optics, relativity and quantum mechanics theory and how they relate to the macroscopic or microscopic realm. Solve problems on these topics using qualitative reasoning.
B. Solve quantitative calculus level electromagnetic radiation and modern physics problems while demonstrating a thorough understanding of the application of Maxwell's, wave and particle theories.
C. Implement laboratory experiment techniques correctly during the investigation of electromagnetic radiation, atomic and nuclear processes and express the results clearly in written laboratory reports.

2. Course Objectives: Upon completion of this course, the student will be able to:

A. Solve problems in wave motion including sound and standing waves.
B. Find the energy and momentum of an electromagnetic wave.
C. Calculate the magnification of a microscope or a telescope.
D. Analyze situations involving interference and diffraction of light waves, and apply these to situations including double slits, diffraction gratings, and wide slits.
E. Apply concepts from special relativity to analyze physical situations, including time dilation, length contraction, and the Lorentz transformation. Solve basic problems involving relativistic momentum and energy.
F. Use the Exclusion Principle to derive the allowed quantum states of an atom.
G. Use the Band Theory of Solids to explain electrical conduction in solids.
H. Calculate the binding energy of a nucleus.
I. Explain the fission and fusion processes in a hydrogen bomb.
J. Analyze basic physical situations involving reflection and refraction, and use this analysis to predict the path of a light ray. Equations and ray diagrams may be used.
K. Apply basic concepts of quantum mechanics to analyze basic physical setups, including a particle in a box and simple atomic models.

L.

3. Course Content

A. Wave Motion:
   a. Types of waves
   b. Superposition and interference of waves
   c. Reflection and transmission of waves
   d. Energy transmitted by sinusoidal waves on strings

B. Sound Waves
   a. Speed of sound waves
   b. Periodic sound waves
   c. Intensity of periodic sound waves
   d. The Doppler effect

C. Superposition and Standing Waves
   a. Superposition and interference of sinusoidal waves
   b. Standing waves
   c. Resonance
   d. Beats: Interference in time

D. Electromagnetic Waves
   a. Maxwell's equations and Hertz's discoveries
   b. Plane electromagnetic waves
   c. Energy carried by electromagnetic waves
   d. The spectrum of electromagnetic waves

E. The Nature of Light and the Laws of Geometric Optics
   a. Measurements of the speed of light
   b. Reflection and refraction: lenses, mirrors, optical instruments.
   c. Dispersion and prisms
   d. Total internal reflection

F. Geometric Optics
   a. Young's Double-Slit experiment
   b. Phasor addition of waves
   c. Change of phase due to reflection
   d. Interference in thin films

G. Diffraction and Polarization (Wave Optics and Physical Optics)
   a. Single-Slit diffraction
   b. Resolution of Single-Slit and circular apertures
   c. The diffraction grating
   d. Polarization of light waves

H. Relativity
   a. Einstein's Principle of Relativity
   b. Special relativity: The Lorentz Transformation Equations
   c. Relativistic momentum and the relativistic form of Newton's Laws
   d. Relativistic energy

I. Introduction to Quantum Physics
   a. Blackgody radiation and Planck's hypothesis
   b. The photoelectric effect
   c. The Compton Effect
   d. Bohr's quantum model of the atom

J. Quantum Mechanics
   a. Photons and electromagnetic waves
   b. The Uncertainty Principle

c. The Schrodinger Equation
d. Tunneling through a barrier

K. Atomic Physics
a. The spin magnetic quantum number
b. The wave functions for hydrogen
c. The Exclusion Principle and the Periodic Table
d. Atomic transitions

L. Condensed matter: Molecules and Solids
a. Molecular bonds
b. Bonding in solids
c. Band theory of solids
d. Free-electron theory of metals

M. Nuclear Structure
a. Binding energy and nuclear forces
b. Nuclear reactors
c. Nuclear fusion

N. Fission and Fusion
a. Nuclear fission
b. Nuclear reactors
c. Nuclear fusion

O. Particle Physics
a. Positrons and other antiparticles
b. Classification of particles
c. Strange particles and strangeness
d. Quarks
e.

4. Methods of Instruction:

Discussion: class room discussion of example problems
Experiments: Laboratory Experiments
Lab: Problem Solving Lab in Computer Laboratory
Lecture: Presentation of course material
Observation and Demonstration:

5. Methods of Evaluation: Describe the general types of evaluations for this course and provide at least two, specific examples.

Typical classroom assessment techniques

Exams/Tests -- Multiple Choice Questions, Conceptual Questions, and Symbolic and Numerical Problems
Projects -- Lab Experiment
Home Work -- Textbook problems
Lab Activities -- Complete Lab Experiments
Final Exam -- Multiple Choice Questions, Conceptual Questions, and Symbolic and Numerical Problems
Mid Term -- Multiple Choice Questions, Conceptual Questions, and Symbolic and Numerical Problems

Letter Grade or P/NP

6. Assignments: State the general types of assignments for this course under the following categories and provide at least two specific examples for each section.

A. Reading Assignments

Textbook chapters
Laboratory Manual experiments

Sample Reading Assignment 1:
Read Chapter 33 - Lenses and Optical Instruments

Sample Reading Assignment 2:
Read Experiment 17 - Polarized Light Malus's Law

B. Writing Assignments
Complete Laboratory Reports

Lab Report Requirements:

1) Cover Page (Typed): Include Your Name, Lab Exp. #, Lab Title, Date, and list of Lab Partners.

2) Procedure (Typed): In your own words describe the general procedure(s) for this experiment. The procedure can be in an outline format, paragraphs, or any other way that can best convey the procedure used to carry out the experiment, make measurements, and obtain the required results. Please: Do Not Just Copy the Procedure from the Lab Manual.

3) Data Sheet(s) Section: Include your Lab data sheets here that came out of your Wilson Lab Manual or were provided on handouts. This sheet MUST have my initials from the lab. Do Not Forget to include units, correct number of significant figures, and make sure your entries are legible.

4) Graph Section: Any graphs assigned are to be done on the computer with software that includes Regression Analysis by the method of least squares. The regression equation must be printed on the top of the graph. Each graph must be labeled with a Title and Axes description with units. In Lab Graphs MUST have my initials from the lab.

5) Calculations Section: Hand calculations, which includes providing units for each factor, term and results. Any conversions or geometric calculations are to be included. Intermediate calculations are to be provided. Your goal should be to write up your calculations so someone else can understand them. Always start by stating the equation being used and then restate it with all variables replaced with their values and dimensions filled in. Leave pie as a symbol. If the same identical calculations are repeated, you only need to show each result once. Calculation details of average values can be omitted. You will lose points if data and results do not include units. Use a separate piece of paper when needed and label the calculations. Do not try to cram the calculations into the margins or put them in the wrong order.

6) Question Answer Section (Typed): Answers to assigned lab questions must be typed and spell checked. Be sure to include the question number and any reference page number. The question must be restated (typed) followed by your answer.

7) Analysis and Conclusion (Typed): In this section, you must critically analyze your results, experiment procedure, measurement techniques, and include a conclusion that explains if the experiment objectives were met or not. Explain why or why not. You are expected to show clear logic and understanding of the final results and their physical

meaning.

The laboratory is a large portion of your PHYS 240 grade. In fact, the lab accounts for 30% of the total grade. Hence, it is important to make sure that you meet the entire requirement on every lab. Please ask for assistance and/or any clarification.

The lab work is done by teams and it is acceptable for students to do analysis together but the laboratory report is to be your own work. Laboratory reports from group members that are identical or essentially identical will be treated as a single report and the points awarded to each member will be graded as one report and the points will be split among the students violating this rule. The very best grade you can get if you do not do your own work is 50%.

You are expected to obtain a copy of the laboratory instructions for each week and study them before coming to the laboratory class. This preparation will enhance your learning experience. In order to encourage you to do your preparation, there will be occasional quizzes covering the procedure for the current lab experiment. It is your responsibility to obtain a copy of the laboratory instructions before you come to the lab. Copies will not be available at the laboratory during the lab session.

C. Other Assignments
Homework Problems

Sample Problem 1:
One of the beams of an interferometer passes through a small evacuated glass container 1.155 cm deep. When a gas is allowed to slowly fill the container, a total of 187 dark fringes are counted to move past a reference line. The light used has a wavelength of 631.8 nm. Calculate the index of refraction of the gas at its final density, assuming that the interferometer is in vacuum.

Sample Problem 2:
How long must you wait (in half-lives) for a radioactive sample to drop to 1.00% of its original activity?

7. Required Materials

A. EXAMPLES of typical college-level textbooks (for degree-applicable courses) or other print materials.

Book #1:

Author:	Giancoli, D.C.
Title:	Physics for Scientists and Engineers with Modern Physics
Publisher:	Pearson Education
Date of Publication:	2008
Edition:	4th

Book #2:

Author:	Knight, Randall
Title:	Physics for Scientists and Engineers: A Strategic Approach
Publisher:	Addison-Wesley
Date of Publication:	2012
Edition:	3rd

Manual #1:

Author:	Wilson, D.P., Hernandez, C.A.
Title:	Physics Laboratory Experiments 8th edition
Publisher:	Cengage Learning
Date of Publication:	01-03-2014

B. Other required materials/supplies.