

PELLISSIPPI STATE TECHNICAL COMMUNITY COLLEGE
MASTER SYLLABUS

WAVE MOTION, OPTICS & MODERN PHYSICS W/LAB
PHY 2320

Class Hours: 3.0

Credit Hours: 4.0

Laboratory Hours: 3.0

**Date Revised: Spring
01**

Catalog Course Description:

For students majoring in engineering, mathematics, and physics. This is a calculus-based approach to topics in wave motion, optics, and modern physics. Course includes 3 hours of lecture and 3 hours of laboratory applications.

Entry Level Standards:

Students taking this course must have completed Physics 2310.

Prerequisite:

PHY 2310

Textbook(s) and Other Reference Materials Basic to the Course:

University Physics, Revised Edition by Harris Benson, Wiley
Wilson, Jerry D., *Physics Laboratory Experiments*, D.C. Heath and Company, Fifth Edition

I. Week/Unit/Topic Basis:

Week	Topic
1	Lecture: Chapter 15: Oscillations 15.1 Simple Harmonic Oscillation(SHM) 15.2 The Block-Spring System 15.3 Energy in SHM 15.4 Pendulums 15.5,6 Damped and Forced Oscillations Lab: Group Problems Session
2	Lecture: Chapter 16: Mechanical Waves 16.1 Wave Characteristics 16.2 Superposition of Waves 16.3 Speed of a Pulse on a String 16.4 Reflection and Transmission Lab: Group Experiment #1: Hooke's Law and SHM
3	Lecture: Chapter 16: Continued... 16.5-7 Traveling and Standing Waves 16.9 The Wave Equation 16.10 Energy Transport on a String

- 16.11 Velocity of Waves on a String
 TEST 1
 Lab: Group Experiment #2: Standing Waves on a String
- 4 Lecture: Chapter 17: Sound
 17.1 The Nature of Sound Waves
 17.2 Resonant Standing Sound Waves
 17.3 The Doppler Effect
 17.4 Interference in Time; Beats
 17.5 Velocity of Longitudinal Waves in a Fluid
 17.6 Sound Intensity
 17.7 Fourier Series(Optional)
 Lab: Group Experiment #3: Air-Column Resonance: The Speed of Sound
- 5 Lecture: Chapter 35: Reflection & Refraction
 35.1 Ray Optics
 35.2,3 Reflection and Refraction
 35.4 Total Internal Reflection
 35.5 The Prism and Dispersion
 35.6 Images Formed by Plane Mirrors
 35.7 Spherical Mirrors
 35.8 The Speed of Light
 Lab: Group Experiment # 4: Reflection & Refraction
- 6 Lecture: Chapter 36: Lenses & Optical Instruments
 36.1 Lenses
 36.2 The Simple Magnifier
 36.3 The Compound Microscope
 36.4 Telescopes
 36.5 The Eye
 36.7 Lens Maker's Formula
 TEST 2
 Lab: Group Experiment # 5: Spherical Mirrors & Lenses
- 7 Lecture: Chapter 37: Wave Optics (I)
 37.1 Interference
 37.2 Diffraction
 37.3 Young's Experiment
 37.4 Intensity of Double-Slit Patterns
 37.5 Thin Films
 37.6 Michelson Interferometer
 37.7 Coherence
 Lab: Group Experiment # 6: Diffraction Grating: Wavelength Measurement
 Group Experiment # 7: Dispersion and the Index of Refraction
- 8 Lecture: Chapter 38: Wave Optics (II)
 38.1 Fraunhofer & Fresnel Diffraction
 38.2 Single-Slit Diffraction
 38.3 The Rayleigh Criterion
 38.4 Gratings
 38.5 Multiple Slits
 38.6 Single-Slit Diffraction Intensity
 TEST 3
 Lab: Group Experiment # 8: Polarized Light

- 9 Lecture: Chapter 39: Special Relativity
39.1 Introduction
39.2 The Michelson-Morley Experiment
39.3 Covariance
39.4 The Two Postulates
39.5 Some Preliminaries
39.6 Relativity of Simultaneity
39.7 Time Dilation
39.8 Length Contraction
39.9 The Relativistic Doppler Effect
39.10 The Twin Paradox
39.11 The Lorentz Transformation
Lab: Group Problems Session
- 10 Lecture: Chapter 40: Early Quantum Theory
40.1 Blackbody Radiation
40.2 The Photoelectric Effect
40.3 The Compton Effect
40.4 Line Spectra
40.5 Atomic Models
40.6 The Bohr Model
40.7 Wave-Particle Duality of Light
40.8 Bohr's Correspondence Principle
Lab: Group Experiment # 9: Line Spectra and Rydberg Constant
- 11 Lecture: Chapter 41: Wave Mechanics
41.1 De Broglie Waves
41.2 Electron Diffraction
41.6 Heisenberg Uncertainty Principle
41.7 Wave-Particle Duality
TEST 4
Lab: Group Problems Session
- 12 Lecture: Chapter 42: Atoms and Solids
42.1 Quantum Numbers of Hydrogen
42.2 Spin
42.5 Pauli Exclusion Principle
Lab: Group Problems Session
- 13 Lecture: Chapter 43: Nuclear Physics
43.1 The Structure of Nucleus
43.2 Binding Energy, Nucl. Stability
43.3 Radioactivity
43.4 The Radioactive Decay Law
43.5 Nuclear Reactions
43.6,7 Fission and Fusion
Lab: Group Experiment # 10: Radiation Detection: The Geiger Counter
- 14 Lecture: Chapter 44: Elementary Particles
44.1 Antimatter
44.2 Exchange Forces
44.3 Classification of Particles
44.4 Symmetry and Conservation Laws
44.5 The Eightfold Way and Quarks
44.6 Color

44.7 Gauge Theory
44.8 The Electroweak Interaction
44.9 The New Quarks
44.10 Quantum Chromodynamics
44.11 Grand Unified Theory
TEST 5
Lab: Group Problems Session

15 Lecture: Review
 Lab: Group Problems Session

16 Final Exam

II. Course Objectives*:

- A. Explain metric and American units and systems and perform various conversions between the two, (The gauges at work sites often use both types of units). I.5, VI.2
- B. Describe oscillatory motion, simple harmonic motion, mass-spring system, simple pendulum, and damped and forced oscillation and calculate the parameters involved in motions classified as being oscillatory. I.5
- C. Define wave, explain wave characteristics, superposition of waves, waves on strings, and wave reflection and transmission. I.5
- D. Explain the traveling and standing waves, wave velocity, energy, and related equations. I.5
- E. Explain types of waves, sound waves, resonance, the Doppler effect applied to mechanical waves, interference, and beats. I.5
- F. Describe the straight-line-motion behavior of light through ray optics using the reflection and refraction phenomena in mirrors and lenses. I.5
- G. Explain how speed of light may be measured by use of ray optics. I.5
- H. Realize the use of mirrors and lenses in optical instruments such as microscopes, telescopes, cameras, human eye, etc. I.5
- I. Calculate simple problems involving flat and spherical mirrors as well as ray-optics instruments. III.2, I.5
- J. Explain the wave-like behavior of light through the interference, diffraction, single-slit diffraction, and multi-source interference. I.5
- K. Study the special relativity, the Lorentz transformation, time dilation and length contraction as an introduction to modern physics. I.5
- L. Describe black-body radiation, the photoelectric effect, the Compton effect, and line spectra of atoms as verifications of particle-like behavior of light. I.5
- M. Explain the Bohr model of the atomic configuration and related formulas. I.5
- N. Explain De Broglie waves, electron diffraction, and the Heisenberg uncertainty principle as well as wave-particle duality. I.5
- O. Explain the quantum numbers in atomic structure. I.5

- P. Describe the structure of the nucleus, binding energy, radioactivity, nuclear fission and fusion. I.5
- Q. Have an understanding of the most recent developments in atomic structure and subatomic particles. I.5
- R. Search for the solutions to the assigned projects by examining the available software(s) and resources. VII

*Roman numerals after course objectives reference goals of the university parallel program.

III. Instructional Processes*:

Students will:

1. Learn in a cooperative mode by working in small groups with other students and exchanging ideas within each group (or sometimes collectively) while being coached by the instructor who provides assistance when needed. *Communication Outcome, Problem Solving and Decision Making Outcome, Active Learning Strategy*
2. Learn by being a problem solver rather than being lectured. *Problem Solving and Decision Making Outcome, Active Learning Strategy*
3. Explore and (enthusiastically) seek the solutions to the given problems which measures his/her level of accomplishment. *Problem Solving and Decision Making Outcome, Active Learning Strategy*
4. Visit industry sites or will be visited by a person from industry who applies the concepts being learned at his/her work site. *Transitional Strategy*
5. Gradually be given higher- and higher-level problems to promote his/her critical thinking ability. *Problem Solving and Decision Making Outcome, Personal Development Outcome*
6. Be tested more frequently for progress assessment while working independently on test problems. *Problem Solving and Decision Making Outcome*
7. Get engaged in learning processes such as projects, mentoring, apprenticeships, and/or research activities as time allows. *Communication Outcome, Transitional Strategy*
8. Use computers with appropriate software during class or lab as a boost to the learning process. *Information Literacy Outcome, Technological Literacy Outcome*

*Strategies and outcomes listed after instructional processes reference Mississippi State's goals for strengthening general education knowledge and skills, connecting coursework to experiences beyond the classroom, and encouraging students to take active and responsible roles in the educational process.

IV. Expectations for Student Performance*:

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

1. Apply the physics concepts to theoretical and practical situations. A-U
2. Estimate an unknown parameter in a given practical situation by using the physics principles involved. B, D, E, F, G, H, I, J, L, M, N, P
3. Perform necessary conversions between metric and non-metric units and systems. A

4. Calculate the variables in simple harmonic motion and analyze the period of oscillations with regard to mass and spring stiffness in mass-spring systems. B
5. Analyze and solve problems on wave motion and calculate the necessary parameters involved such as wavelength, frequency, amplitude, phase, etc. B, C, D, E
6. Solve problems involving ray optics in mirrors and lenses and calculate the image size, position, and magnification. F
7. Analyze and solve problems explained by the refraction phenomenon and calculate the parameters involved. F
8. Know how to calculate the speed of light by at least one method. F, G
9. Apply mirror, lens, and refraction formula to solve telescope, camera, and the human-eye problems. F, G, H
10. Apply the Young's double-slit formula to measure an unknown wavelength by measuring other simple parameters. J
11. Use a diffraction grating to measure the wavelength of an unknown source. J
12. Learn Einstein's relativity postulates to apply the necessary formulas where relativistic considerations become important. K
13. Apply the photoelectric and Compton effects where particle energy is vital to initiate electron release or movement. L
14. Explain the Bohr model of atomic structure and calculate the radius of the hydrogen atom. M
15. Use the De Broglie wavelength for different masses moving at different speeds. N
16. Write the atomic structure of different atoms. O
17. Explain nuclear structure, binding energy, short-range forces, radioactivity, fission, fusion, and calculate the mass loss in nuclear reactions. P
18. Briefly explain new development in atomic structure and subatomic particles. R

*Letters after performance expectations reference the course objectives listed above.

V. Evaluation:

A. Testing Procedures:

Students are primarily evaluated on the basis of test/quiz type assessments and homework as outlined on the syllabus supplement distributed by the instructor. The following formula is used to evaluate the course grade:

$$\text{Course Grade} = (0.75) \times (\text{Theory Grade}) + (0.25) \times (\text{Lab Grade})$$

$$\text{Theory Grade} = 0.80 (\text{Tests} + \text{Quizzes} + \text{H.W.}) + 0.20 (\text{Comprehensive Final})$$

(80%) (10%) (10%)

The number of tests vary from 5 to 7 at the discretion of instructor.

The quizzes and homework percentages depends on the instructor.

B. Laboratory Expectations:

Ten experiments are designed for the course. Each experiment requires a word-processed report which must be at least spell-checked. Other procedures for a standard lab report will be given by your instructor. No late lab report will be accepted and there are NO lab make-ups.

Lab Grade = (the sum of report grades) / (the number of the reports)

C. Field Work:

Site Visits: The necessary site visits will be announced as the arrangements are made. Evaluation will be based on of attendance as well as the visit report.

D. Other Evaluation Methods:

N/A

E. Grading Scale:

91-100 : A	77-81 : C+
87- 91 : B+	70-77 : C
81- 87 : B	60-70 : D

VI. Policies:

Attendance Policy:

Pellissippi State Technical Community College expects students to attend all scheduled instructional activities. As a minimum, students in all courses must be present for at least 75 percent of their scheduled class and laboratory meetings in order to receive credit for the course.