PHYS 4C: GENERAL PHYSICS (CALCULUS)

Foothill College Course Outline of Record

Heading	Value
Units:	6
Hours:	5 lecture, 3 laboratory per week (96 total per quarter)
Prerequisite:	MATH 1C and PHYS 4B.
Degree & Credit Status:	Degree-Applicable Credit Course
Foothill GE:	Non-GE
Transferable:	CSU/UC
Grade Type:	Letter Grade (Request for Pass/No Pass)
Repeatability:	Not Repeatable

Student Learning Outcomes

- Students should understand the following concepts about optics:
- Students should understand the following concepts about waves:
- Students should understand the following concepts Thermal physics:

Description

Thermodynamics; mechanical, acoustical, and electromagnetic waves; optics.

Course Objectives

The student will be able to:
A. Explain the zeroth, first and second laws of thermodynamics and solve related problems and calculate results from statistical mechanics, such as the kinetic theory of gases.
B. Analyze the properties of waves and apply mathematical formulas to physical problems.
C. Analyze and solve problems in optics.
D. Assess the limitations of physical laws and make mathematical approximations in appropriate situations.
E. Understand how physical laws are established and the role of scientific evidence as support.

Course Content

A. Explain the zeroth, first and second laws of thermodynamics and solve related problems and calculate results from statistical mechanics, such as the kinetic theory of gases.
1. Temperature
a. Thermometers
b. Zeroth law of thermodynamics
2. Thermal expansion
3. Heat
a. Definition of heat
b. Calorimetry and phase changes
1) Specific heat
2) Heat of vaporization
3) Heat of fusion
4. First law of thermodynamics
a. Definition of work
b. Relationship between work and heat
c. Definition of internal energy
d. Adiabats
e. Isotherms
5. Heat transfer processes
a. Conduction
b. Convection
c. Radiation
6. The kinetic theory of gases and the Maxwell-Boltzmann distribution functions
a. Molecular model of a gas
1) Temperature
2) Molar specific heat of an ideal gas
3) Ideal gas treatment of adiabatic process
b. Equipartition of energy
c. Maxwell-Boltzmann distribution
1) Derivation of Maxwell-Boltzmann distribution
2) Velocities
a) Vmp
b) Vave
c) Vrms
7. Entropy, heat engines, and the second law of thermodynamics
a. Definition of a heat engine
1) Work done
2) Efficiency
3) Kelvin-Planck formulation of the second law
b. Definition of a refrigerator
1) Coefficient of performance
2) Clausius formulation of the second law
c. Reversible and irreversible processes
d. The Carnot cycle
1) Efficiency
2) Applications to the second law
e. Other engines
1) Gasoline
2) Diesel
f. Entropy
1) Macroscopic definition
2) Entropy and irreversibility
3) Microscopic/probabilistic definition
B. Analyze the properties of waves and apply mathematical formulas to physical problems.
1. The wave function and the propagation speed of a wave
a. Traveling waves
b. Speed of a wave on a string
c. Transverse vs. longitudinal waves
d. Energy transfer
2. Reflection, transmission, and superposition of waves
3. Sound waves, intensity, and the Doppler effect
a. Sounds as a pressure wave
b. Speed of sound
c. Periodic sound waves
1) Definition
2) Intensity
a) Decibels
b) Loudness and frequency
d. Doppler effect
1) Source moving
2) Detector moving
3) Both moving
4) Sonic booms
4. Standing waves, interference, and resonance
a. Superposition and interference

1) Destructive interference
2) Constructive interference
3) Superposition of sinusoidal waves
b. Standing waves
1) Nodes and antinodes
2) Standing waves as a function of time
3) Standing waves on a string
4) Standing waves in air columns
a) Open both ends
b) Closed one end
c. Resonance
d. Beats
C. Analyze and solve problems in optics.
1. Reflection and refraction of light
a. Ray approximation
b. Reflection
c. Refraction
1) Index of refraction
2) Snell's law
a) Huygen's principle
b) Total internal reflection
2. Geometrical optics, mirrors, lenses, and optical instruments
a. Images formed by mirrors
1) Image distance
2) Object distance
3) Magnification
4) Real vs. virtual
5) Upright vs. inverted
6) Concave vs. convex
7) Ray diagrams for mirrors
b. Images formed by lenses
1) Image distance
2) Object distance
3) Magnification
4) Real vs. virtual
5) Upright vs. inverted
6) Concave vs. convex
7) Ray diagrams for lenses
c. Optical instruments
1) The eye
2) Microscopes
3) Telescopes
3. Optical interference, diffraction, and polarization
a. Young's double slit
1) Constructive and destructive interference
2) Intensity distribution
b. Thin film interference
1) Change of phase on reflection
2) Coatings
3) Newton's rings
c. Michelson interferometer
D. Assess the limitations of physical laws and make mathematical approximations in appropriate situations.
1. Physical laws as ideal models
2. Methods of approximation
E. Discuss how physical laws are established and the role of scientific evidence as support.
1. Historical development of a sampling of physical laws
2. Use of student-collected data in labs to confirm physical laws

Lab Content

A. Suggested laboratory experiments (some experiments may use computer-generated data and/or data from audio-visual media):
1. Absolute zero and Boyle's law
2. The thermal coefficient of linear expansion
3. The specific heat capacity of metal and latent heats of water
4. The ratio of the molar heat capacities of air and heat engines
5. Standing waves on a stretched string
6. The propagation speed of sound waves through air
7. Resonance and tubes
8. Light intensity and Snell's law
9. Focal length and law of Malus
10. Image formation by mirrors and lenses
11. Michelson's interferometer
12. Interference and diffraction by small apertures
13. The relative intensity of polarized light

Special Facilities and/or Equipment

A. Physics laboratory with equipment for teaching introductory thermodynamics, wave behavior, and optics.

Method(s) of Evaluation

A. Weekly problem sets
B. Periodic midterm tests
C. Laboratory performance
D. Final examination

Method(s) of Instruction

A. Lecture
B. Discussion
C. Cooperative learning exercises
D. Electronic discussions/chat
E. Laboratory
F. Demonstration

Representative Text(s) and Other Materials

Moebs, Ling, and Sanny. University Physics. OpenStax, 2017.

Types and/or Examples of Required Reading, Writing, and Outside of Class Assignments

A. Homework problems: Homework problems covering subject matter from text and related material ranging from 10-40 problems per week. Students will need to employ critical thinking in order to complete assignments.

B. Lecture: Five hours per week of lecture covering subject matter from text and related material. Reading and study of the textbook, related materials and notes.

C. Labs: Students will perform experiments and discuss their results in either the form of a written lab report or via oral examination. Reading and understanding the lab manual prior to class is essential to success.

Discipline(s)

Physics/Astronomy