PHYS A285: CALCULUS-BASED PHYSICS: MODERN WITH LAB

Item	Value
Curriculum Committee Approval Date	11/03/2021
Top Code	190200 - Physics, General
Units	5 Total Units
Hours	126 Total Hours (Lecture Hours 72; Lab Hours 54)
Total Outside of Class Hours	0
Course Credit Status	Credit: Degree Applicable (D)
Material Fee	No
Basic Skills	Not Basic Skills (N)
Repeatable	No
Grading Policy	Standard Letter (S)
Associate Arts Local General Education (GE)	• OC Physical/Biological Sci - AA (OB)
Associate Science Local General Education (GE)	• OCC Physical/Biological Sci-AS (OSB)
California General Education Transfer Curriculum (Cal-GETC)	• Cal-GETC 5A Physical Science (5A) • Cal-GETC 5C Laboratory Activity (5C)
Intersegmental General Education Transfer Curriculum (IGETC)	• IGETC 5A Physical Science (5A) • IGETC 5C Laboratory Activity (5C)
California State University General Education Breadth (CSU GE-Breadth)	• CSU B1 Physical Science (B1) • CSU B3 Laboratory Activity (B3)

Course Description

Formerly: Calculus Based Physics: Modern. Part of a three-semester sequence with lab (PHYS A185/A280/A285) covering a calculus-based study of all topics in fundamental physics. Core topics for this semester include thermodynamics, optics, and modern physics. PREREQUISITE: PHYS A185 or PHYS A185. Transfer Credit: CSU; UC: Credit Limitation: PHYS A120, PHYS A125, PHYS A130, PHYS A135 and PHYS A185, PHYS A280, PHYS A285 combined: maximum credit, 1 series. C-ID: PHYS 215.**C-ID:** PHYS 215.

Course Level Student Learning Outcome(s)

1. State the basic principles of thermodyanmics, optics, and modern physics, define important scientific terms in these areas, and provides explanations of how they apply to real-world situations.
2. Use calculus, algebra, trigonometry, and conceptual reasoning towards the solution of problems involving thermodynamics, optics, and modern physics.
3. Conduct experiments using standard scientific methods, evaluate the resulting data, and construct evidence-based conclusions in a written report.

Course Objectives

- 1. State the basic principles of thermodynamics and modern physics, define important scientific terms in these areas, and give an explanation of how they apply to real-world situations.
- 2. Use calculus and conceptual reasoning to solve problems involving the laws of thermodynamics and modern physics.
- 3. Conduct simple experiments using standard scientific methods, evaluate the resulting data, and construct a scientific conclusion in a formal written report.

Lecture Content

Temperature, and thermal equilibrium, temperature scales and temperature measurements, thermal expansion of solids and gases. The atomic and molecular view of matter, statistical analysis of real and ideal gases, Maxwell-Boltzmann molecular speed and energy distributions, Intermolecular forces and the bonding potential energy functions. Heat , heat energy transfer and the first law of thermodynamics, heat capacities and specific heat , heat capacity of an ideal gas, work and the idea of internal energy of an ideal gas, a comprehensive application of the First Law of Thermodynamics. The idea of entropy, entropy change, its computation for reversible and irreversible processes, entropy and the Second Law of Thermodynamics, the correlation between entropy and various reversible and irreversible heat engines, efficiencies of real and ideal heat engines in terms of entropy changes, a statistical view of entropy and understanding of the role of entropy in order and disorder of a system. Electromagnetic spectrums, visible light, speed of light measurement, reflection and refraction of light waves, Doppler Effect for electromagnetic waves. Ray optics, reflection, refraction, dispersion, images formed by plane and spherical mirrors, optical instruments: lenses, the simple magnifier, the compound microscope, telescopes. Interference: Youngs experiment, intensity in a double–slit experiment, thin films Interference, the idea behind coherence, and Michelson's interferometer. Diffraction: Diffraction and the wave theory of light, single-slit diffraction and the intensity of a single-slit diffraction, diffraction due to circular aperture and the Rayleigh criterion, double-slit interference and diffraction combined effect. Diffraction Grating: Multiple-slits, dispersion and the resolving power of a grating, X-ray diffraction, holography, polarizatio n of electromagnetic waves by means of: polarizing sheets, reflection, double refraction, scattering, left and right circular polarizations. Special relativity: the Michelson-Morley experiment, the two postulates, relativity of simultaneity, time dilation, length contraction, relativistic Doppler effect, the twin paradox, the Lorentz transformations, addition of velocities, momentum and energy, energy – momentum correlation, introduction to space-time diagram of special relativity and its physical significance. The Nature of Light: Introducing photon and blackbody radiation problem, the photoelectric effect, the Compton effect, wave-particle duality of photons, slowing down atoms by photon bombardment. Matter Waves: de Broglie waves, electron diffraction, Schroedingers wave equation, Heisenbergs uncertainty principles, wave- particle duality. Quantum mechanical approach to solving finite and infinite potential well problems, barrier tunneling, analysis of the solution of the hydrogen atom problem. Atomic Structure: and solids: quantum numbers for the hydrogen atom, X-rays and Moseleys plot, Pauli exclusion principle and the periodic table, magnetic moments, lasers and the elementary theory of laser light.

Electrical Conduction in Solids: Introduction to the quantum theory of solids, band theory, conductors insulators and semi-conductors, pn-junction, transistors and super conductors. 15. Nuclear physics: nuclear models, binding energy and nuclear stability, radioactivity, the radioactive decay law, nuclear reactions, nuclear ionizing energy. Elementary particles and Cosmology: antimatter, exchange forces, classification of particles, symmetry and conservation laws, the eightfold way and quarks, color gauge theory, the electro weak interaction, the new quarks, quantum chromodynamics, grand unified theories, the age of the universe.

Lab Content

See Course Content.

Method(s) of Instruction

- Lecture (02)
- DE Live Online Lecture (02S)
- DE Online Lecture (02X)
- Lab (04)
- DE Live Online Lab (04S)
- DE Online Lab (04X)

Instructional Techniques

1. Lecture and some demonstrations will be used to present the basic concepts. 2. Various methods and strategies of problem solving are taught by thoroughly discussing typical sample problems in the class. 3. Students are provided with an environment that encourages participation with the instructor, i.e. during the office hours of the instructor, during lecture, as well as during the experimentation in the lab, students have the opportunity to interact with the instructor. 4. Students will perform laboratory experiments to further the understanding of applications of the theory.

Reading Assignments

2 hrs/week as assigned by instructor from texts, on-line or library research, and/or instructor handouts.

Writing Assignments

To promote critical thinking component, problem solving will be emphasized in homework and exams. For each laboratory experiment, a conclusion has to be written which contains a critical evaluation of the laboratory results.

Out-of-class Assignments

4 hrs/week of assignments and test preparation emphasizing problem solving and concept application.

Demonstration of Critical Thinking

Weekly homework assignments Short problem quizzes Problem solving exams Comprehensive final exam Laboratory experiment reports

Required Writing, Problem Solving, Skills Demonstration

To promote critical thinking component, problem solving will be emphasized in homework and exams. For each laboratory experiment, a conclusion has to be written which contains a critical evaluation of the laboratory results.

Eligible Disciplines

Physics/Astronomy: Masters degree in physics, astronomy, or astrophysics OR bachelors degree in physics or astronomy AND masters degree in engineering, mathematics, meteorology, or geophysics OR the equivalent. Masters degree required.

Textbooks Resources

1. Required Halliday, David, etal. Physics Vol I and Vol II, 5th ed. New York: J. Wiley, 2002 Rationale: - 2. Required Stanley, Paul. Student Solution Manual, for both volumes, ed. New York: J. Wiley, 2002 Rationale: - 3. Required Taylor, Edwin. Space- time physics, ed. Chicago: W. H. Freeman, 1992 Rationale: - 4. Required Moebs, William, et. al.. University Physics, ed. OpenStax College, 2017 5. Required Young, H. D. and Freedman, R. A.. University Physics, 14th ed. Pearson, 2016

Other Resources

1. Physics A285 Lab Syllabus, OCC Reprographics