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Physics (PHYS) 2223 General Physics III (Calculus) (4 Units) CSU: UC
[Formerly Physics 4C]

Advisory: It is strongly recommended that students take the entire physics series at Taft College

Prerequisite: Successful completion of Physics 2222 with a grade of 'C' or better

Corequisites: Successful completion or concurrent enrollment in MATH 2120

Prerequisite knowledge/skills: Before entering the course the student should be able to

1. Analyze simple static charge distributions and calculate the resulting electric field and electric potential.
2. Analyze simple current distributions and calculate the resulting magnetic field.
3. Predict the trajectory of charged particles in uniform electric and magnetic fields.
4. Analyze DC and AC circuits in terms of current, potential difference, and power dissipation for each element.
5. Analyze real-world experimental data, including appropriate use of units and significant figures.
6. Relate the results of experimental data to the physical concepts discussed in the lecture portion of the class.

Hours and Unit calculations:

48 hours lecture. (96 Outside of class hours); 48 hours lab (192 Total Student Learning Hours) 4 Units

Catalog Description: This course includes demonstration lectures, problems, and laboratory work in the fundamentals of physical optics, heat, thermodynamics, atomic and nuclear physics, relativity and quantum mechanics. This is the third course in a series of three. C-ID: PHYS 215

Type of Class/Course: Degree Credit

Texts: Young H. and Freedman R. *University Physics with Modern Physics*. 15th ed. San Francisco: Addison-Wesley, 2020.

Lab Manual: Sokoloff, David R., Ronald K. Thorton, Priscilla W. Laws. *Real Time Physics Active Learning Laboratories Module 2: Heat and Thermodynamics*. 3rd ed. Hoboken: Wiley, 2011.

Additional Instructional Materials: Calculator

Course Objectives:

By the end of the course, a successful student will be able to

1. Analyze basic physical situations involving reflection and refraction, and use this analysis to predict the path of a light ray,
2. Analyze situations involving interference and diffraction of light waves, and apply these to situations including double slits, diffraction gratings, and wide slits,
3. 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,
4. Apply basic concepts of quantum mechanics to analyze basic physical setups, including a particle in a box and simple atomic models,
5. Analyze real-world experimental data, including appropriate use of units and significant figures, and
6. Relate the results of experimental data to the physical concepts discussed in the lecture portion of the class.

Course Scope and Content: Lecture

Unit I Temperature and Heat

- A. Temperature and Thermal Equilibrium
- B. Thermal expansion
- C. Mechanisms of Heat Transfer

Unit II Thermal Properties of Matter

- A. Equations of State
- B. Molecular Properties of Matter
- C. Heat Capacities

Unit III The First Law of Thermodynamics

- A. Thermodynamic Systems
- B. Paths between Thermodynamic States
- C. Kinds of Thermodynamic Processes

Unit IV The Second Law of Thermodynamics

- A. Heat Engines
- B. Refrigerators
- C. The Carnot Cycle

Unit V The Nature and Propagation of Light

- A. Reflection and Refraction
- B. Dispersion
- C. Polarization

Unit VI Geometric Optics

- A. Reflection and Refraction at a Plane Surface
- B. Thin Lenses
- C. Microscopes and Telescopes

Unit VII Wave Optics

- A. Interference and Coherent Sources
- B. Intensity in Interference Patterns

- C. The Michelson Interferometer

Unit VIII Diffraction

- A. Fresnel and Fraunhofer Diffraction
- B. Diffraction from a Single Slit
- C. The Diffraction Grating

Unit IX Light Waves Behaving as Particles

- A. The Photoelectric Effect
- B. Compton Scattering
- C. Wave-Particle Duality

Unit X Particle Physics

- A. Electron Waves
- B. Bohr Model of the Atom
- C. The Laser

Unit XI Quantum Mechanics

- A. Wave Functions and the Schrödinger Equation
- B. Particle in a Box
- C. Potential Wells

Unit XII Atomic Physics

- A. The Hydrogen Atom
- B. The Zeeman Effect
- C. Electron Spin

Unit XIII Nuclear Physics

- A. Properties of Nuclei
- B. Nuclear Binding and Nuclear Structure
- C. Nuclear Reactions

Course Scope and Content: Laboratory

Unit I Heat and Temperature

- A. Temperature Measurement
- B. Thermal Equilibrium

Unit II Energy Transfer and Temperature

- A. Mechanical Work and Temperature Change
- B. Electrical Work and Temperature Change

Unit III Heat Energy Transfer

- A. Controlling the Transfer of Heat Energy
- B. Heat Transfer by Radiation

Unit IV The First Law of Thermodynamics

- A. Heat of Fusion

B. Change of Phase

Unit V The Ideal Gas Law
A. Measuring Pressure
B. Pressure vs. Volume

Unit VI Heat Engines
A. Adiabatic Compression of Gases
B. Work Done by the Heat Engine

Unit VII Introduction to Light
A. Light Intensity Around a Point Source
B. Light from Extended and Small Objects

Unit VIII Reflection and Refraction of Light
A. Laws of Reflection and Refraction
B. Dispersion

Unit IX Lenses
A. Converging Lenses
B. Diverging Lenses

Unit X Mirrors
A. Concave Mirrors
B. Convex Mirrors

Unit XI Polarized Light
A. Polaroid Filters
B. Brewster's Angle

Unit XII Light and Waves
A. Single Slit Diffraction
B. Two-Slit Interference

Unit XIII Michelson Interferometer
A. Interferometry
B. Index of Refraction of Air

Unit XIV Spectrometry
A. Photospectrometry of Known Gases
B. Photospectrometry of the Sun

Unit XV Global Positioning System
A. General Relativity
B. Schwarzschild Metric

Learning Activities Required Outside of Class:

The students in this class will spend a minimum of 6 hours per week outside of the regular class time doing the following:

1. Studying
2. Completing required reading
3. Problem solving activity or exercise
4. Written work

Methods of Instruction:

1. Lectures, demonstrations, class discussions, and sample problems solved by the instructor with student involvement to illustrate the application of physical principles
2. Laboratory experiments. The principal objectives of the laboratory work are the demonstration of fundamental physical phenomena and the development of physical intuition based on hands-on experience with equipment in exploring these physical phenomena. High accuracy of measurements and development of sophisticated laboratory techniques are not emphasized, but the crucial role of experimental inquiry in the development of physical theory and in the refinement of our knowledge of physical constants and the behavior and properties of matter necessary as a foundation for technological progress are stressed.
3. Problem solving sessions under the direction of the instructor using whatever portion of laboratory time remains after performance of the experiments.
4. In both lecture and laboratory, emphasis will be placed on the development of an understanding of physical principles, and on the development of the thinking skills necessary to analyze increasingly complex problems and select an appropriate set and sequence of physical principles to solve them. Rote memorization of "format" approaches to solve typical exam problems will be avoided.
5. Maximum use will be made, where appropriate, of the student's developing mathematical capabilities to increase the generality and transparency of the physical presentations.

Methods of Evaluation:

1. Substantial writing assignments, including:
 - a. laboratory reports
 - b. brief expositions as part of exams
2. Computational or non-computational problem-solving demonstrations, including:
 - a. exams
 - b. homework problems
 - c. laboratory reports
 - d. class discussions

Laboratory Category: Extensive Laboratory

Pre delivery criteria: All of the following criteria are met by this lab:

1. curriculum development for each lab,
2. published schedule of individual laboratory activities,
3. published laboratory activity objectives,
4. published methods of evaluation, and
5. supervision of equipment maintenance, laboratory setup, and acquisition of lab materials and supplies.

During laboratory activity of the laboratory: All of the following criteria are met by this lab:

1. Instructor is physically present in lab when students are performing lab activities.
2. Instructor is responsible for active facilitation of laboratory learning.
3. Instructor is responsible for active delivery of curriculum.
4. Instructor is required for safety and mentoring of lab activities.
5. Instructor is responsible for presentation of significant evaluation.

Post laboratory activity of the laboratory: All of the following criteria are met by this lab:

1. Instructor is responsible for personal evaluation of significant student outcomes (lab exercises, exams, practicals, notebooks, portfolios, etc.) that become a component of the student grade that cover the majority of lab exercises performed during the course.
2. Instructor is responsible for supervision of laboratory clean up of equipment and materials.

Supplemental Data:

TOP Code:	190200 Physics, General
SAM Priority Code:	E: Non-Occupational
Funding Agency:	Y: Not Applicable
Program Status:	I: Program Applicable
Noncredit Category:	Y: Not Applicable
Special Class Status:	N: Course is not a special class
Basic Skills Status:	N: Not Applicable
Prior to College Level:	Y: Not Applicable
Cooperative Work Experience:	N: Course is not a part of a cooperative education program
Eligible for Credit by Exam:	No
Eligible for Pass/No Pass:	Yes
Discipline:	Physics/Astronomy

