PHYS 202: PHYSICS B: THERMODYNAMICS AND ELECTROMAGNETISM

Citrus College Course Outline of Record

Heading	Value
Effective Term:	Fall 2023
Credits:	5
Total Contact Hours:	126
Lecture Hours :	72
Lab Hours:	54
Hours Arranged:	0
Outside of Class Hours:	144
Total Student Learning Hours:	270
Prerequisite:	PHYS 201 or PHYS 201H; MATH 191.
Strongly Recommended:	MATH 210 as a pre- or co-requisite.
District General Education:	B2. Natural Sciences - Physical Sciences, B3. Natural Sciences - Laboratory
Transferable to CSU:	Yes
Transferable to UC:	Yes - Approved
Grading Method:	Standard Letter

Catalog Course Description

Core topics include electrostatics, magnetism, DC and AC circuits, laws of thermodynamics, and the kinetic theory of gases. This course is part of a three-semester sequence and is required of all majors in engineering, physics, chemistry, and some geology and mathematics majors. 72 lecture hours, 54 lab hours.

Course Objectives

- THERMODYNAMICS
- Describe atomic-level models of solids, liquids, and gases; and recognize and use the state variables that characterize macroscopic phenomena.
- Understand and use energy conservation as expressed in the first law of thermodynamics.
- Identify heat transfer mechanisms and apply heat transfer ideas to practical situations of calorimetry.
- Distinguish between and use the concepts of specific heat, molar specific heat and latent heat.
- Understand the fundamental ideas of the kinetic theory of gases including: the equipartition theorem, mean free path, the distribution of molecular speeds, the molecular basis for pressure, the transfer of heat via molecular collisions and how thermally interacting systems reach equilibrium, the relationship between temperature, thermal energy, and the average translational kinetic energy of the molecules in the system.
- Obtain a qualitative understanding of entropy, the second law of thermodynamics, and some of the implications of the second law on the reversibility/irreversibility of processes.
- Understand and use the ideal-gas law.
- Distinguish between the four basic ideal gas processes (isobaric, isochoric, isothermal and adiabatic) and understand the thermodynamics of these processes.
- Understand and use pV diagrams for ideal-gas processes.
- Understand the physics of simple heat engines and refrigerators and the limits on the efficiency of a heat engine
- Calculate the efficiency and Carnot efficiency of a heat engine and the coefficient of performance and Carnot coefficient of performance for a refrigerator.
- ELECTRICITY
- Understand the charge model and to apply it to situations involving conductors and insulators.
- Understand polarization and the attraction between neutral and charged objects.
- Understand and use Coulomb's law for point charges and charge distributions.
- Understand and use the electric field model for point charges and charge distributions.
- Understand the properties of conductors in electrostatic equilibrium.
- Predict and/or explain the motion of charged particles and dipoles in simple electric fields.
- Understand the electric field of a parallel-plate capacitor and some of its applications.
- Calculate electric flux and use Gauss's law to derive several electric fields of interest.
- Understand and calculate the electric potential of point charges, charged spheres, parallel plate capacitors, and of a continuous distribution of charge; use it in conservation of energy problems.
- Understand and use electric potential graphs and maps of equipotential surfaces.
- Understand the relationship between the electric field and the electric potential both graphically and analytically; be able to determine the electric field from a given electric potential both graphically and by calculating the gradient of the potential.
- CURRENT, RESISTANCE AND DC CIRCUITS
- Use the charge and field models to understand a model of current in a conductor.
- Distinguish between important parameters describing the electrical properties of materials including conductivity, resistivity, resistance and capacitance.
- Understand and use Ohm's Law and Kirchoff's Laws for the analysis of simple DC circuits including series, parallel, combination and RC circuits.
- Understand energy transfer and power dissipation in DC circuits.
- MAGNETISM AND INDUCTION
- Understand a dipole model of magnetism that allows students to understand and reason about basic magnetic phenomena; understand a simple atomic-level model of ferromagnetism and be able to connect the theory of electromagnetism to the phenomena of permanent magnets.
- Understand and use the Biot-Savart Law to calculate magnetic fields.
- Understand and use Ampere's Law to calculate magnetic fields.
- Calculate the magnetic force on a charged particle and understand the motion of charged particles in magnetic fields.
- Calculate the magnetic forces and torques on wires and current loops.
- Understand and calculate the magnetic flux.

- Understand and use Lenz's Law and Faraday's Law of Induction.
- Understand the relationship between inductance, magnetic flux, current, induced emf; understand how these quantities are related to the energy in inductors and magnetic fields.
- Analyze circuits with inductors.
- Understand and use the Galilean field transformation equations for magnetic and electric fields.
- Understand and calculate the displacement current.
- ELECTROMAGNETIC FIELDS AND WAVES
- Understand how Maxwell's Equations and the Lorentz force law form a complete theory of electromagnetism.
- Understand that electromagnetic fields can exist without source charges or currents in the form of a self-sustaining electromagnetic wave as described by Maxwell's equations.
- Understand and calculate the energy and intensity of electromagnetic waves; understand the relationship between radiation pressure and intensity.
- Understand that charges and currents are needed as sources of electromagnetic waves; understand how an antenna is a source of an electromagnetic wave.
- Understand the polarization of light and use Malus' Law.
- AC CIRCUITS
- Use a phasor analysis to analyze AC circuits.
- Describe the purpose of and design RC filter circuits.
- Understand the series RLC circuit and resonance in the RLC circuit; understand use the relationship between resonance frequency, inductance and capacitance.
- Distinguish between the instantaneous, peak and rms values for voltage and current.
- Understand and use the relationships between various parameters used in the analysis of AC circuits such as (current, voltage, emf, capacitive reactance, crossover frequency, inductive reactance, impedance).
- Calculate power loss in an AC circuit using the power factor.

Major Course Content

1. Thermodyamics
   a. Heat, Temperature & Phase Changes
   b. Temperature Scales
   c. Thermal Equilibrium
   d. Thermal Expansion
2. Ideal Gas Processes
   a. Work and Heat in Isobaric, Isochoric, Isothermal and Adiabatic Processes
   b. PV Diagrams
3. Kinetic Theory of Gases
   a. Ideal gas: a macroscopic description
   b. Ideal gas: a microscopic description
   c. Equipartition of energy
   d. Distribution of molecular speeds
   e. Mean free path
4. Calorimetry
   a. Specific Heat
   b. Specific Heat of Gases
   c. Latent Heat
   d. Heat Transfer Mechanisms
   e. First Law of Thermodynamics
5. Entropy & the 2nd Law of Thermodynamics
   a. Entropy
   b. Second Law of Thermodynamics
   c. Reversible and Irreversible Processes
6. Heat Engines and Refrigerators
   a. Efficiency
   b. The Carnot Cycle
7. Charge and Matter
   a. Charge Model; Electrostatics
   b. Conductors and Insulators
   c. Coulomb's Law
8. The Electric Field
   a. Electric Field Model
   b. Calculating Electric Fields
9. Gauss' Law
   a. The Concept of Electric Flux
   b. Calculating Electric Flux
   c. Using Gauss' Law
10. Electric Potential & Energy
   a. Electric Potential Energy
   b. The Electric Potential
   c. Point Charges
   d. Parallel Plate Capacitor
   e. Relationship between Electric Potential and Electric Field
   f. Capacitors & Dielectrics
   g. Capacitance
   h. Energy Stored in a Capacitor
11. Circuit Fundamentals
   a. Circuit Elements & Diagrams
   b. Kirchoff's Laws
   c. Energy & Power
   d. RC Circuits
12. Magnetism
   a. Magnetic Field
   b. Biot-Savart Law
   c. Ampere's Law
   d. Magnetic Force
   e. Forces & Torques on Current Loops
   f. Magnetic Properties of Matter
13. EM Induction
   a. Induced Currents
   b. Motional emf
   c. Magnetic Flux
   d. Lenz's Law
   e. Faraday's Law
   f. Induced Fields
   g. Inductors
   h. LC Circuits
   i. LR Circuits
14. EM Fields & Waves
   a. Displacement Current
   b. Maxwell' s Equations

   c. Properties of EM Waves
   d. Polarization
15. AC Circuits
   a. AC Sources & Phasors
   b. Capacitor Circuits
   c. RC Filter Circuits
   d. Inductor Circuits
   e. Series RLC Circuit
   f. Power in AC Circuits

Lab Content

At least twelve of the following experiments:

1. PV Diagrams
2. Transfer of Thermal Energy (specific heat, latent heat, thermal conductivity)
3. Heat Engines
4. Electrostatics
5. Coulomb's Law
6. Gauss's Law
7. Parallel Plate Capacitor
8. Electric Potential and Electric Field Mapping
9. DC Circuits I: Ohm's Law/ Wheatstone Bridge
10. DC Circuits II: RC Circuits
11. DC Circuits III: Diodes
12. Helmholtz Coils
13. Earth's Magnetic Field
14. Faraday's Law
15. AC Circuits
16. The Oscilloscope

Examples of Required Writing Assignments

3-4 page informal lab summaries following guidelines given in lab manual.

Examples of Outside Assignments

Conceptual and quantitative problems such as: You and your roommates need a new refrigerator. At the appliance store, the salesman shows you the DreamFridge. According to its sticker, the DreamFridge uses a mere 100W of power to remove 100kJ of heat per minute from the 2degree Celsius interior. According to the fine print on the sticker, this claim is true in a 22degree Celsius kitchen. Should you buy it? Explain.

Instruction Type(s)

Lab, Lecture, Online Education Lab, Online Education Lecture

IGETC Area 5: Physical and Biological Sciences

5A. Physical Science, 5C. Science Laboratory