PHYS 0210 - PRINCIPLES OF PHYSICS: ELECTRICITY AND MAGNETISM

Catalog Description

Formerly known as PHYS 4B (PHYS 210 and 210L, combined)
Prerequisite: Completion of PHYS 205, PHYS 205L, and MATH 31 with grades of "C" or better
Corequisite: Concurrent enrollment in PHYS 210L
Hours: 54 lecture
Description: Electrostatics, AC and DC circuits, magnetism, Maxwell's Equations, electromagnetic waves, and the electric and magnetic properties of matter. The 205-210-215 sequence presents general principles and analytical methods used in physics for physical science and engineering majors. (combined with PHYS 210L, C-ID PHYS 210) (CSU, UC-with unit limitation)

Course Student Learning Outcomes

- CSLO #1: Solve problems associated with electricity and magnetism using calculus, trigonometry, and algebra.
- CSLO #2: Identify which physical concepts associated with electricity and magnetism explain physical phenomena.
- CSLO #3: Develop an overlying and rigorous process to aid in evaluating the behavior of physical systems obeying Maxwell's Equations.

Effective Term

Fall 2022

Course Type

Credit - Degree-applicable

Contact Hours

54

Outside of Class Hours

108

Total Student Learning Hours

162

Course Objectives

It should be noted that a thorough understanding of physics requires the student to evaluate data and synthesize ideas to solve conceptual and numerical problems. The list of objectives below is intended to help the student in this endeavor. Thus students in Physics 210 are expected to:
1. Describe the properties of charge and explain how they affect the electrical properties of a material.
2. Apply Coulomb's law to solve conceptual and numerical problems. The latter are limited to calculations involving discrete charge distributions.
3. Apply kinematic principles to describe (conceptually and numerically) the motion of charged particles in an electric field.
4. Apply the relationship between the electric force and electric field to solve conceptual and numerical problems.
5. Explain the relationship between the electric field, electric field lines, and electric flux.
6. Apply the proper mathematical technique to calculate the electric field due to:
A. discrete charge distributions
B. continuous charge distributions at a specific location in space at a mathematical level appropriate for the course.
7. Apply the proper mathematical technique to calculate electric flux at a mathematical level appropriate to the course.
8. Identify the limitations of the applicability of Gauss's Law to determine the electric field of a charge distribution.
9. Apply Gauss's law for highly symmetric geometries to calculate the electric field due to uniform charge distributions.
10. Apply Gauss's law for highly symmetric geometries to calculate the electric field due to non-uniform charge distributions at a mathematical level appropriate for the course.
11. Explain the nature of the charge distribution and electric field for conductors in electrostatic equilibrium.
12. Apply Gauss's Law for highly symmetry geometries to calculate electric fields due to charged conductors or conductors and insulators.
13. Apply the relationship between the electric potential and the electric field to solve conceptual and numerical problems.
14. Apply the concepts of equipotential lines and surfaces and potential difference to solve conceptual and numerical problems.
15. Apply the relationship between the electric potential and the electric potential energy to solve conceptual and numerical problems.
16. Apply the proper mathematical technique to calculate the electric potential due to:
A. discrete charge distributions
B. continuous charge distributions
at a specific location in space at a mathematical level appropriate for the course.
17. Calculate the electric potential of discrete charge distributions.
18. Apply the concepts of electric potential and charge conservation to conceptual and numerical problems involving charge sharing between conductors.
19. Apply the concept of dipole moment and the dynamics of an electric dipole in a uniform electric field to solve conceptual and numerical problems.
20. Apply the definition of capacitance and the proper mathematical tools to calculate the capacitance of simple geometric arrangements of conductors.
21. Apply the principles governing series and parallel capacitors to calculate quantities such as the charge on capacitor(s), the voltage across capacitor(s), and the energy stored in capacitor(s).
22. Explain electrical properties of dielectrics in terms of a simple molecular model.
23. Apply the concepts of capacitance, dielectrics, energy storage, charge, electrical potential, and electric fields to analyze and solve conceptual problems involving capacitors.
24. Explain the simple model of charge flow (Drude model) and how it relates to Ohm's law, electric current, resistance, resistivity, and electrical potential difference.
25. Describe the basic components of an electrical circuit.
26. Explain the concepts of direct current (DC), electromotive force, and terminal voltage.
27. Apply the rules of series and parallel circuits, and/or Kirchhoff's rules to conceptual and numerical circuit problems consisting of resistors and DC voltage sources.

28. Apply the concepts of energy and electric power to conceptual and numerical DC circuit problems.
29. Apply the principles governing the transient RC circuits to solve conceptual and numerical problems.
30. Explain the physical properties of the magnetic field and the differences between it and the electric field.
31. Explain the relationship between the magnetic field, magnetic field lines, and magnetic flux.
32. Apply the proper mathematical technique to calculate electric flux at a mathematical level appropriate to the course.
33. Apply the kinematics and dynamics of charged particles in a magnetic field to solve conceptual and numerical problems.
34. Apply the proper mathematical tool to calculate the force on a wire in a magnetic field at a mathematical level appropriate to the course.
35. Describe and explain the force and torque acting on a loop of wire in uniform or non-uniform magnetic fields.
36. Explain the concept of magnetic dipole moment.
37. Explain the principles governing the DC motor and the Hall effect.
38. Apply the Biot-Savart law to calculate the magnetic field due to a current in a filamentary wire at a mathematical level appropriate to the course.
39. Apply the forces between current carrying filamentary wires to solve conceptual and numerical problems.
40. Identify the limitations of the applicability of Ampere's Law to determine the magnetic field due to a current.
41. Apply Ampere's law for highly symmetric geometries to calculate the magnetic field due to uniform current densities.
42. Apply Ampere's law for highly symmetric geometries to calculate the magnetic field due to non-uniform current densities at a mathematical level appropriate for the course.
43. Explain the magnetic properties of matter- paramagnetism, diamagnetism, and ferromagnetism.
44. Apply the Faraday's law and Lenz's law to conceptual and numerical problems. The numerical problems must be at a mathematical level appropriate to the course.
45. Explain the similarities and differences between induced EMFs due to moving circuits and changing flux.
46. Apply Faraday's law to calculate the induced electric field from for simple systems.
47. Explain the origin of eddy currents and their implications on physical systems.
48. Explain the concept of displacement current and its implication to Ampere's law.
49. Apply the concepts of self-inductance and mutual inductance to conceptual problems.
50. Apply the proper mathematical technique to calculate self-inductance and mutual inductance at a mathematical level appropriate to the course.
51. Apply the relationship between the magnetic field and the energy stored in a magnetic field to solve conceptual and numerical problems.
52. Apply the principles governing the transient RL circuits to solve conceptual and numerical problems.
53. Apply the principles governing the LC circuits to solve conceptual and numerical problems.
54. Describe and explain AC sources, reactance, and impedance.
55. Apply phasors to solve simple AC circuits.
56. Describe and explain the resonance in a series RLC circuit.
57. Properly apply the rules of series or parallel circuits to conceptual and numerical circuit problems consisting of resistors, capacitors and inductors with AC voltage sources.
58. Apply the concepts of energy and electric power to conceptual and numerical AC circuit problems.
59. Apply the basic principles governing transformers to solve conceptual and numerical problems.
60. Describe Maxwell's equations and their significance.
61. Describe the electromagnetic spectrum and the relationship between wavelength, frequency, and the speed of light. Students need to apply these ideas to simple numerical and conceptual problems.
62. Explain the nature of plane and spherical electromagnetic waves at a mathematical level appropriate to the course.
63. Explain how electromagnetic waves carry energy, linear momentum, and angular momentum. Furthermore, use these concepts to solve conceptual and numerical problems.
64. Explain how electromagnetic waves exert forces and pressure. Furthermore, use these concepts to solve conceptual and numerical problems.
65. Apply the basic principles of special relativity to solve numerical and conceptual problems involving relativistic kinematics and dynamics.

General Education Information

- Approved College Associate Degree GE Applicability
  - AA/AS - Physical Sciences
- CSU GE Applicability (Recommended-requires CSU approval)
  - CSUGE - B1 Physical Science
- Cal-GETC Applicability (Recommended - Requires External Approval)
- IGETC Applicability (Recommended-requires CSU/UC approval)
  - IGETC - 5A Physical Science

Articulation Information

Methods of Evaluation

- Classroom Discussions
  - Example: Example for Classroom Discussion Assessment or Objective Exam: Two current carrying coils of wire are close to each other. We can change the mutual inductance of the pair by A. changing the relative positions of the coils. B. changing the currents in the coils. C. increasing the number of turns in one of the coils. D. Both A and B are correct. E. Both A and C are correct. F. A, B, and C are correct. Individual students will be graded based on the following two criteria: 1. Is the student participating in the discussion? 2. Did the student get the correct response? Based on how well the class responds to the question, the instructor will ask additional questions on this topic, review this topic, or move on to the next topic.
- Objective Examinations
  - Example: Example for Classroom Discussion Assessment or Objective Exam: Two current carrying coils of wire are close to each other. We can change the mutual inductance of the pair by A. changing the relative positions of the coils. B. changing the currents in the coils. C. increasing the number of turns in one of the coils. D. Both A and B are correct. E. Both A and C are correct. F. A, B, and C are correct. Individual students will be graded based on the following two criteria: 1. Is the student participating in the discussion? 2. Did the student get the correct response? Based on how well the class responds to the question, the instructor will ask additional questions on this topic, review this topic, or move on to the next topic.
- Problem Solving Examinations
  - Example: 1. Exam problem (problem solving with rubric grading): A non-conducting sphere of radius R=5.00cm has a uniform charge density p=C/r where C=4.0x10^(-6)C/m^(2). Use Gauss's Law to determine the magnitude of the electric field a distance

2.00cm from the axis of the sphere. (13pts). 2. Quiz problem (problem solving with rubric grading): Two capacitors one of 2 microfarads and the other of 7microfarads are connected in series to a 180V power supply. The capacitors are then disconnected from each other without discharging them. Next the positive terminals of the two capacitors are connected together. And their negative terminals are also connected together. What is the charge on each capacitor? (15 points).

Repeatable

No

Methods of Instruction

- Lecture/Discussion
- Distance Learning

Lecture:

1. (In Class or Distance Learning)
2. A multimedia presentation is used to discuss electric fields. The presentation includes graphics and video clips for emphasis and clarity. The instructor presents example problems that are solved in great detail at appropriate times throughout presentation. Students are always encouraged to ask questions in class or in the LMS discussion board throughout the presentation. (In Class or Distance Learning)
3. Demonstrations illustrating electric fields are used at appropriate times to elucidate this topic. Students are always encouraged to ask questions in class or in the LMS discussion board throughout the presentation.

Distance Learning

1. An audience response system is used to ask questions on electric fields in order to assess the level of student understanding during lecture. Based on how well students respond to the questions, the instructor will ask additional questions on this topic, review this topic, or move on to the next topic.

Typical Out of Class Assignments

Reading Assignments

1. Read textbook chapter on Gauss's law in preparation for class discussion. 2.Read the lecture slide notes on Electromagnetic Induction in preparation for class discussion.

Writing, Problem Solving or Performance

1. Complete online homework assignment. This is an assignment created by the instructor using an online homework service that accompanies the course textbook. Sample Problem: A slab of insulating material has thickness 2d and is oriented so that its faces are parallel to the yz-plane and given by the planes x=d and x=-d. The y- and z-dimensions of the slab are very large compared to d and may be treated as essentially infinite. The slab has a uniform positive charge density r. a. Using Gauss's law, find the magnitude of the electric field due to the slab at the points 0≤x≤d. b. What is the direction of the electric field due to the slab at the points 0≤x≤d? c. Using Gauss's law, find the magnitude of the electric field due to the slab at the points x≥d. d. What is the direction of the electric field due to the slab at the points x≥d? 2. Complete the "Distributed Charges" Worksheet. Problem Solving. Example: A charge, q, is distributed non-uniformly over a disk of radius R. The charge distribution is described by the expression σ=br2. Write the expression, dq, that represents the infinitesimal charge on a ring of radius r and infinitesimal thickness dr. Don't forget to determine the expression for b in terms of L and q.

Other (Term projects, research papers, portfolios, etc.)

Required Materials

- University Physics
  - Author: Young and Freedman
  - Publisher: Pearson
  - Publication Date: 2020
  - Text Edition: 15th
  - Classic Textbook?:
  - OER Link:
  - OER:
- Physics for Scientists and Engineers - Technology Update
  - Author: Serway and Jewitt
  - Publisher: Cengage
  - Publication Date: 2019
  - Text Edition: 10th
  - Classic Textbook?:
  - OER Link:
  - OER:

Other materials and-or supplies required of students that contribute to the cost of the course.