PHYS 0210L - PRINCIPLES OF PHYSICS LABORATORY: 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 210
Hours: 54 laboratory
Description: Laboratory portion of PHYS 210. 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 210, C-ID PHYS 210) (CSU, UC-with unit limitation)

Course Student Learning Outcomes

- CSLO #1: Use appropriate lab equipment to achieve successful measurements associated with the motion of electric charges.
- CSLO #2: Use appropriate software and numerical calculations to perform data analysis on measurements associated with the motion of electric charges.
- CSLO #3: Communicate experimental results in written and oral form.
- CSLO #4: Integrate theoretical constructs of electricity and magnetism from Physics 210 into concrete applications via experimental methodology.

Effective Term

Fall 2022

Course Type

Credit - Degree-applicable

Contact Hours

54

Outside of Class Hours

108

Total Student Learning Hours

162

Course Objectives

The objectives listed below are aligned with the recommendations for introductory laboratories developed by the American Association of Physics Committee on Laboratories in 2014 (https://www.aapt.org/Resources/upload/LabGuidlinesDocument_EBendorsed_nov10.pdf) and are based the current state of physics education research and the following six focus areas: constructing knowledge, modeling, designing of experiments, developing technical and practical laboratory skills analyzing and visualizing data, and communicating physics. These objectives are intended for both major and non-major introductory courses as such they are evaluated at a level commensurate with the curriculum of the lecture course.
Thus, students are expected to:
1. Explain the importance of experimental evidence as one of the main byways of physics knowledge.
2. Devise falsifiable models or hypotheses to explain observable features of nature as a means to construct knowledge without relying on outside authority (constructing knowledge).
3. Apply the appropriate framework for the physical situation being modeled in an experiment (modeling).
4. Integrate abstract concepts from Physics 210 into their concrete applications through experimentation (modeling and developing technical and practical laboratory skills).
5. Apply multiple model representations to a given investigation (e.g mathematical, conceptual or diagrammatical modeling).
6. Explain the limitations, assumptions and approximations inherent in the models used in an experimental investigation (modeling).
7. Design a procedure to test a model or hypothesis or to make a measurement of something unknown while accounting for the types, amount, range, and accuracy of data needed to give reproducible results (designing experiments).
8. Explain the difference between precision and accuracy (designing experiments and developing technical and practical laboratory skills).
9. Apply basic troubleshooting as needed in an experimental investigation (designing experiments).
10. Explain the limitations of experimental equipment or an experiment design including sources of error and experimental uncertainties (designing experiments and developing technical and practical laboratory skills).
11. Measure the voltage across circuit elements, resistance of circuit elements and the current in any section of a circuit with a multimeter (developing technical and practical laboratory skills).
12. Measure voltage signals with an oscilloscope (developing technical and practical laboratory skills).
13. Apply other standard instruments used in measuring and observing phenomena involving concepts covered in Physics 210 (developing technical and practical laboratory skills).
14. Apply basic practical, hands-on laboratory skills such as safe practices, experimental construction and setup, the alignment and leveling of laboratory apparatus, the wiring of basic AC and DC Circuits and the taring and calibration of sensors (developing technical and practical laboratory skills).
15. Identify environmental factors that affect the integrity of experimental data or observations (analyzing and visualizing data).
16. Use computers for the collection, analysis, and graphical display of data (developing technical and practical laboratory skills and analyzing and visualizing data)
17. Manipulate data and apply standard quantitative techniques involving data visualization and statistical analysis (analyzing and visualizing data).
18. Evaluate the validity of experimental data (analyzing and visualizing data).
19. Express, characterize, and communicate the effect of experimental error on measured values (analyzing and visualizing data and communication).
20. Develop clearly stated scientific arguments that proceed from a clearly stated question or hypothesis to the presentation of data-driven evidence-based conclusions (communication).
21. Develop and present scientific arguments using a number of standard elements of technical communication (e.g. graphs, sketches and

diagrams, proper technical vocabulary, evaluation of experimental uncertainty etc.).
22. Communicate results ethically and effectively in variety of formats ranging from informal discussion and oral presentations to formal laboratory papers and reports that adhere to accepted guidelines for formal presentation (communication).
23. Critique the student's own presentations for both the quality of the scientific arguments and the scientific style (communication).
24. Exhibit cooperative skills in the collection and analysis data (communication, designing of experiments, developing technical and practical laboratory skills).

General Education Information

- Approved College Associate Degree GE Applicability
  - AA/AS - Physical Sciences
  - AS - Physical Science Lab
- CSU GE Applicability (Recommended-requires CSU approval)
  - CSUGE - B3 Lab Activity
- Cal-GETC Applicability (Recommended - Requires External Approval)
- IGETC Applicability (Recommended-requires CSU/UC approval)
  - IGETC - 5C Laboratory Science

Articulation Information
Methods of Evaluation

- Reports
  - Example: Write a formal laboratory report on Experiment 6: "The Current Balance," using a word processor and the report guidelines. Formal laboratory reports are graded using a rubric based on proper format, proper data analysis techniques, proper use of instrumentation, correct interpretation of results, identification, prevention, and assessment of sources of experimental error, and the ability to evaluate the integrity of laboratory data.
- Skill Demonstrations
  - Example: 1. Complete the "Uses of the Multimeter" skill demonstration quiz by the next class meeting. 2. Complete the "Oscilloscope" skill demonstration quiz by the next class meeting. Skill demonstrations for Physics 210L are graded using a rubric based on proper use of instrumentation, correct interpretation of results, identification, prevention, and assessment of sources of experimental error.

Repeatable

No

Methods of Instruction

- Laboratory
- Distance Learning

Lab:

1. (In Class or Distance Learning) The faculty member introduces the laboratory experiment "Properties of Charge" using a multimedia presentation. Detailed guidelines for the experiment are provided by the instructor with some information omitted to encourage critical thinking. The faculty member then oversees students perform laboratory experiments based on oral and written guidelines. This is a qualitative experiment that requires the student to observe and explain physical phenomena in a written report. In the online modality, the faculty member introduces the experiment and provides guidelines through a recorded synchronous lecture. The students then carry out experiments with lab kits that are either purchased through the bookstore of provided by the department. In lieu of a written lab report, students are required to create and post a video report that requires students to demonstrate and explain their observations. While the in-class version of this experiment utilizes a van de Graaff generator, an electrophorus, and a Kelvin generator, the distance learning version is scaled down with inexpensive equipment and material that is readily available at home, at the supermarket, or at the hardware store. (Lab Objectives 2-4,9-10,13-15,18-22).
2. (In Class only) The faculty member introduces the laboratory experiment "The Current Balance" using a multimedia presentation. Detailed guidelines for the experiment are provided by the instructor with some information omitted to encourage critical thinking. The faculty member then oversees students perform laboratory experiments based on oral and written guidelines. An important part of the laboratory experience is the proper analysis of data which includes error analysis and the identification of random and systematic errors and an estimation of their sizes. Students are then required to write a formal laboratory report. Formal reports are written using a word processor. Students are required to use graphing software to plot and analyze data. On occasion, students are required to use spreadsheet software to organize and analyze their data. Finally, students are evaluated for proficiency on important laboratory equipment such as multi-meters, oscilloscopes and circuit wiring. (Lab Objectives 1-22). The experiments are chosen to provide students with 1) "Hands-on" experience with difficult concepts. 2) Experience with scientific equipment. 3) Exposure to the scientific method of investigation. 4) Problem solving skills necessary to troubleshoot experiments or experimental apparatus. 5) Experience with the communication of technical information."

Distance Learning

1. (In Class or Distance Learning) The faculty member introduces the laboratory experiment "RLC Circuits" using a multimedia presentation. Detailed guidelines for the experiment are provided by the instructor with some information omitted to encourage critical thinking. The faculty member then oversees students perform laboratory experiments based on oral and written guidelines. An important part of the laboratory experience is the proper analysis of data which includes error analysis and the identification of random and systematic errors and an estimation of their sizes. Students are then required to write a formal laboratory report. In the online modality, the faculty member introduces the experiment and provides guidelines through a recorded synchronous lecture. The students then carry out the experiment with lab kits that are either purchased through the bookstore of provided by the department. Formal lab reports are submitted the college's LMS. While the in-class version of this experiment utilizes signal generators, multimeters and oscilloscopes that are typically used by scientists and engineers, the distance learning version utilizes signal generators, multimeters and oscilloscopes that are typically used by hobbyists. (Lab Objectives 1-6, 8-22).

Typical Out of Class Assignments
Reading Assignments

1. Read Laboratory 12: RLC circuits in preparation for lab. 2. Read the handout "The Fatal Current" in preparation for the DC Circuit lab.

Writing, Problem Solving or Performance

1. Write a formal laboratory report on Experiment 6: "The Current Balance," using a word processor and the report guidelines. 2. Complete the Pre-lab assignment for Experiment 6: "The Current Balance. Example question: Why must the movable and fixed wires be aligned with the tangential component of the Earth's magnetic field?

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

Required Materials

- University Physics - Technology Update
  - 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 Learning
  - Publication Date: 2019
  - Text Edition: 10th
  - Classic Textbook?:
  - OER Link:
  - OER:
- Physics Lab Manual
  - Author: David Loyd
  - Publisher: Cengage Learning
  - Publication Date: 2014
  - Text Edition: 4th
  - Classic Textbook?:
  - OER Link:
  - OER:
- PHYS 210L Lab Manual
  - Author: Shackell
  - Publisher: Sierra
  - Publication Date: 2019
  - Text Edition:
  - Classic Textbook?:
  - OER Link:
  - OER:

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