PHYS 0215L - PRINCIPLES OF PHYSICS LABORATORY: HEAT, WAVES AND MODERN PHYSICS

Catalog Description

Formerly known as PHYS 4C (PHYS 215 and 215L, combined)
Prerequisite: Completion of PHYS 205, PHYS 205L, and MATH 31 with grades of "C" or better
Corequisite: Concurrent enrollment in PHYS 215
Hours: 54 laboratory
Description: Laboratory portion of PHYS 215. Covers topics of thermodynamics, kinetic theory of gases, waves, geometrical and physical optics, sound, and modern physics. (combined with PHYS 215, C-ID PHYS 215) (CSU, UC-with unit limitation)

Course Student Learning Outcomes

- CSLO #1: Use the necessary lab equipment to achieve successful measurements associated with the motion of waves and heat.
- CSLO #2: Use the necessary software and numerical calculations to perform data analysis on measurements associated with the motion of waves and heat.
- CSLO #3: Communicate comprehension of measurements of moving waves and heat energy in written reports using software, communication skills, and clear presentation of data.
- CSLO #4: Integrate theoretical constructs of waves and thermodynamics from Physics 215 into concrete applications via experimental methodology.

Effective Term

Fall 2022

Course Type

Credit - Degree-applicable

Contact Hours

54

Outside of Class Hours

0

Total Student Learning Hours

54

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 on 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 215 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. Apply standard instruments used in measuring and observing phenomena involving concepts covered in Physics 215 (developing technical and practical laboratory skills).
12. Apply basic practical, hands-on laboratory skills such as safe practices, experimental construction and setup, the alignment and leveling of laboratory apparatus, the focusing of optical elements, and the taring and calibration of sensors (developing technical and practical laboratory skills).
13. Identify environmental factors that affect the integrity of experimental data or observations (analyzing and visualizing data).
14. Use computers for the collection, analysis, and graphical display of data (developing technical and practical laboratory skills and analyzing and visualizing data)
15. Manipulate data and apply standard quantitative techniques involving data visualization and statistical analysis (analyzing and visualizing data).
16. Evaluate the validity of experimental data (analyzing and visualizing data).
17. Express, characterize, and communicate the effect of experimental error on measured values (analyzing and visualizing data and communication).
18. Develop clearly stated scientific arguments that proceed from a clearly stated question or hypothesis to the presentation of data-driven evidence-based conclusions (communication).
19. 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.).
20. 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).
21. Critique the student's own presentations for both the quality of the scientific arguments and the scientific style (communication).
22. 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

- CSU Transferable
- UC Transferable

Methods of Evaluation

- Reports
  - Example: Write a formal report for the Driven Damped Harmonic Oscillator Lab. 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: Complete the "Spectroscope Calibration" skill demonstration before performing with the Line Spectra Laboratory. Skill demonstrations are graded using a rubric based on 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.

Repeatable

No

Methods of Instruction

- Laboratory
- Distance Learning

Lab:

1. (In Class only) The faculty member introduces the laboratory experiment "The Hydrogen Spectrum and Atomic Spectroscopy" 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 barometers, electronic sensors, and spectrometers (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 "The Physical Pendulum" 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 experiments 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 sensors and a data acquisition system for accurate timing, the distance learning version utilizes clocks or stopwatches for timing (Lab Objectives 1-6, 8-22).

Typical Out of Class Assignments
Reading Assignments

1. Read Laboratory 2: Heat Transfer. Be prepared for a pre-lab quiz. 2. Read the Data Analysis handout. Be prepared for class discussion.

Writing, Problem Solving or Performance

1. Write a formal laboratory report on Experiment 2: Heat Transfer using a word processor and the report guidelines. 2. Complete the pre-lab for Experiment 1. Vibratory Motion. Example: Derive the equation for the amplitude of oscillation of the driven damped harmonic oscillator.

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

- University of 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:
- Physics Laboratory Manual
    - Author: David Loyd
    - Publisher: Cengage
    - Publication Date: 2014
    - Text Edition: 4th
    - Classic Textbook?:
    - OER Link:
    - OER:
- PHYS 215L Lab Manual
    - Author: Calabrese
    - Publisher: Sierra College
    - 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.