ASTR 0013 - LABORATORY ASTRONOMY

Catalog Description

Prerequisite: Completion with grade of "C" or better or concurrent enrollment in ASTR 2, ASTR 5 or ASTR 10
Hours: 54 laboratory
Description: Understanding of analysis of scientific data, including graphing, data-fitting, data management, and predictive science, within the environment of astronomy. Extensive use of graphing techniques, understanding of precision and accuracy, and image scales. (CSU, UC)

Course Student Learning Outcomes

- CSLO #1: Learn how to recognize the various attributes of scientific data--the value itself, aspects of uncertainty such as error bars or significant figures, and units; also how to apply unit conversions.\\n
- CSLO #2: Apply graphing techniques within an astronomical context, such as how to graph data; how to graph multiple data sets on a single graph; fitting data with lines and curves; how to read data off fitted graphs for further analysis.
- CSLO #3: Develop skill in analyzing scientific data to determine the strength of scientific claims--understanding discrepancies and how to assess if they are significant.
- CSLO #4: Increase competency in working with resources such as astronomical databases or programs, such as planetarium programs.

Effective Term

Fall 2026

Course Type

Credit - Degree-applicable

Contact Hours

54

Outside of Class Hours

0

Total Student Learning Hours

54

Course Objectives

1. Explain constellation designations and boundaries, and stellar naming systems
2. Explain stellar magnitudes, absolute magnitudes
3. Navigating by horizon and celestial coordinate systems, conventional star charts and all-sky star charts
4. Use the small angle formula to calculate distances and angular sizes
5. Manage precision and significant figures in calculations
6. Manage accuracy and discrepancy in calculations
7. Describe the creation and use of image scales, map scales, and model scales
8. Create and complete unit conversions
9. Plot data and create best fit lines, and fit data with nonlinear curves
10. Read data off lines
11. Compute optical resolution, light gathering power, magnification, focal ratio, exit pupil, magnitude gain, limiting magnitude
12. From Jovian satellite orbit simulators, calculate orbital periods, orbital resonances, orbital distances, periods
13. From Kepler's 3rd law, using orbital distances and periods, calculating system masses
14. From orbital/transit data, determine masses, sizes, densities, and likely composition of solid-surface planetary bodies
15. Using sunspot data, determine rotational period for the sun, and explore the sunspot cycle
16. Using photometric data, create a cluster diagram and determine the distance to a cluster
17. Given a cluster diagram, identify different classes of stars
18. Create HR diagrams to conduct spectroscopic parallaxes and distance moduli
19. Create Cepheid Type I, Type II period-luminosity relationships; determine distances to Cepheid variables
20. Create Hubble diagrams using standard ruler and Type Ia supernovae data
21. Use Hubble's Law to determine distances of galaxies
22. Analyze sky scenarios to hypothesize astronomical puzzles

General Education Information

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

Articulation Information

- CSU Transferable
- UC Transferable

Methods of Evaluation

- Objective Examinations
  - Example: Laboratory assignments, quizzes, mid-term, and final exams consisting of a variety of tasks and question formats, evaluating all levels of performance according to Bloom's taxonomy (knowledge, understanding, application, analysis, synthesis, and evaluation)(Example question: The distance to a galaxy is 357 Mpc. Convert this distance to km, and show all your conversion factors; supply your answer with appropriate units and significant figures.
- Problem Solving Examinations
  - Example: Using observations during classtime, the students will observe the sun using filters, eyepiece projection, and campus telescopes. Then the students will analyze a series of images of the sun, measure the changing coordinates of a sunspot group, and from this, determine the apparent rotation rate of the sun. Correcting for the Earth's orbital motion, the rotational period of the sun will be obtained.
- Projects
  - Example: Students will propose a hypothetical observing project for a certain night of the year, indicating which objects would be in the sky for observing, noting on star charts where the objects will be found, and indicate the key characteristics of each astronomical object.

- Reports
  - Example: Each person will build or co-build a working sundial. Students submit a report and tell the class about how they constructed it.
- Skill Demonstrations
  - Example: Students will calibrate their fist at arm's length, to be able to measure degrees on the sky. The student will then measure the distances between stars in the night sky, to develop proficiency. The student will then measure the drift rate of stars across the night sky, to calculate the rotational period of the Earth.

Repeatable

No

Methods of Instruction

- Activity
- Laboratory
- Distance Learning

Activity:

1. The instructor will explain how the students can measure the positions of stars in the sky, and how to calibrate their fists as measuring tools. Students will go out at night and observe the stars in the sky, comparing them to their star charts, and measure the distances between three pairs of stars. In class they will analyze how close their values are to actual stellar separations. The students will learn about precision and accuracy in their work.

Lab:

1. The instructor will review how the students are to plot stellar data for Cepheid variables, and how to interpret their graphs. The students will then complete the plotting of their data, fit the data, and then use their calibrated graphs and the distance modulus equation to determine the distances of a number of Cepheid variables. The students will learn how astronomical data can be leveraged to deduce information such as stellar luminosities and distances.

Distance Learning

1. Students will watch instructional videos on how to complete a laboratory activity that is based upon measuring the dimensions of an object that is provided to them in a gear pack at the beginning of the semester. At the end of the laboratory exercise, there are three particularly challenging analysis questions. Students will then interact with each other in a discussion board, where they are given a prompt to discuss one of the three challenging analysis questions in the lab. This discussion board is shaped with hints from the instructor, as to how to solve the problems. Answers to the problems are submitted individually by the students.

Typical Out of Class Assignments

Reading Assignments

1. Reading from assigned text on a weekly basis. Example: Read the Chapter on "Jovian planetary systems." Be prepared to discuss in class. 2. Read fully the laboratory assignment that will be conducted, before coming to lab. Read any supplementary material accompanying the lab. Be prepared to apply readings in lab.

Writing, Problem Solving or Performance

1. Prelabs--a summary of the work to be completed during labtime--must be completed and printed out for class. 2. Weekly laboratory assignments. Example question: Based upon the density you have calculated for the moon Dysnomia, and the table of solar system data provided, what is the composition of Dysnomia likely to be? Supply supporting logic for your diagnosis. 3. Quizzes, Midterm, and final exam to demonstrate acquisition of critical thinking skills and astronomical knowledge. Example exam question: Given Figure 1 (a graph showing poorly plotted and fitted data), comment on the strengths and weaknesses of the graph--identify all characteristics that would be considered flawed. Then, correct these errors as needed.

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

Watch the prelab preparatory video before coming to class. This video will include instructions on how to annotate the student's Hertzsprung-Russell diagram, which they will do as they watch the video. The annotated diagram will be graded at the beginning of lab class.

Required Materials

- NightWatch
  - Author: Terence Dickenson and Ken Hewitt-White
  - Publisher: DK Books
  - Publication Date: 2023
  - Text Edition: 5th
  - Classic Textbook?: No
  - OER Link:
  - OER:

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

1. Laboratory exercise packet prepared by instructors and updated every semester, printed and packaged on campus and distributed through the campus bookstore.* 2. Two pencils--one colored. * Lab exercises and handbook are written with relevance to existing facilities, equipment, and current course content.