El Camino College

COURSE OUTLINE OF RECORD - Official

I. GENERAL COURSE INFORMATION

Subject and Number: **Astronomy 13**
Descriptive Title: **Astronomical Optics**

Course Disciplines: **Physics/Astronomy**

Division: **Natural Sciences**

Catalog Description: In this course, the student will be introduced to principles of astronomical optics. The student will apply those principles to the design, fabrication, and use of a telescope, which will be tested under the night sky. Primary mirrors will be ground, smoothed, polished, and figured by hand. Extensive testing will be done in the optical shop. Optics and optical testing theories will be presented. Students will design and build a custom optical tube assembly and telescope mount.
Note: Students pay a minimum cost of $375 for a completed telescope.

Conditions of Enrollment: **Recommended Preparation**

Astronomy 20
with a minimum grade of C
or

Astronomy 20H

Astronomy 25
with a minimum grade of C
or

Astronomy 25H

Mathematics 73 or

Mathematics 80

Equivalent

Course Length: [X] **Full Term** [ ] **Other (Specify number of weeks):**
Hours Lecture: **0 hours per week** [ ] **TBA**
Hours Laboratory: **3.00 hours per week** [ ] **TBA**
Course Units: **1.00**

Grading Method: **Letter**

Credit Status **Associate Degree Credit**

Transfer CSU: [X] **Effective Date: 4/26/1993**
Transfer UC: [X] **Effective Date: Proposed**

General Education:

El Camino College: _____

CSU GE: _____

IGETC: _____

II. OUTCOMES AND OBJECTIVES

A. COURSE STUDENT LEARNING OUTCOMES (The course student learning outcomes are listed below, along with a representative assessment method for each. Student learning outcomes are not subject to review, revision or approval by the College Curriculum Committee)

1. The student will understand and apply the principles of testing optical surfaces.

The above SLOs were the most recent available SLOs at the time of course review. For the most current SLO statements, visit the El Camino College SLO webpage at http://www.elcamino.edu/academics/slo/.

B. Course Student Learning Objectives (The major learning objective for students enrolled in this course are listed below, along with a representative assessment method for each)

1. Rough grind, smooth, and polish a telescope mirror.

   Other (specify)

   Optical tests

2. Measure the focal length of a mirror.

   Other (specify)

   Student will image the sun and demonstrate the correct use of a digital spherometer.

3. Determine the quality of an optical surface.

   Other (specify)

   The student will examine the optical surface microscopically and assess its appearance. The instructor will inspect.

4. Construct a pitch lap.

   Other (specify)

   Instructor will inspect.

5. Figure a telescope mirror.

   Other (specify)

   Instructor will inspect.

6. Measure the zonal foci using the Foucault test.

   Laboratory reports

7. Calculate the zonal errors and infer a mirror’s shape.

   Quizzes

8. Design and construct the optical tube assembly for a telescope.

Class Performance

9. Select the appropriate secondary mirror for a telescope.

   Laboratory reports

10. Design and construct a baffle system for an optical tube assembly.

    Class Performance

11. Collimate an optical tube assembly.

    Class Performance

12. Star-test a telescope and estimate the wave front error of an optical tube assembly.

    Objective Exams

III. OUTLINE OF SUBJECT MATTER (Topics are detailed enough to enable a qualified instructor to determine the major areas that should be covered as well as ensure consistency from instructor to instructor and semester to semester.)

Lecture or Lab	Approximate Hours	Topic Number	Major Topic
Lab	1	I	Overview of Telescopes and Their Purpose A. Magnification B. Magnitude System C. Field-of-View D. Mirror-Making Steps
Lab	3	II	Optics Terminology A. Entrance Pupil B. Exit Pupil C. Figure D. Vignetting E. Rays F. Waves G. Diffraction H. Contrast I. Airy Diffraction Pattern J. Airy Disk
Lab	1	III	Optical Aberrations A. Defocus B. Spherical Aberration C. Coma D. Astigmatism E. Optical Scattering
Lab	7	IV	Tests A. Knife-edge B. Foucault Tests C. Couder Masks
Lab	2	V	Collimation A. Star Test B. Light Baffles
Lab	40	VI	Fabrication of a Telescope A. Grind B. Smooth C. Polish Figure D. Testing a Telescope Mirror
Total Lecture Hours		0	
Total Laboratory Hours		54	

Total Hours	54

IV. PRIMARY METHOD OF EVALUATION AND SAMPLE ASSIGNMENTS

A. **PRIMARY METHOD OF EVALUATION:**

Problem solving demonstrations (computational or non-computational)

B. **TYPICAL ASSIGNMENT USING PRIMARY METHOD OF EVALUATION:**

Test the optical figure of your mirror, determine a technique to fix errors, perform the technique, and retest the optical figure to assess its new form. Submit your test results and explain how you will fix the errors. Also submit the re-evaluated test results.

C. **COLLEGE-LEVEL CRITICAL THINKING ASSIGNMENTS:**

1. Construct a Foucault test diagram for your mirror, measure the zonal foci of the mirror and determine if your mirror meets the optical tolerances of the test. Submit the test diagram and zonal foci on the report sheet provided. In a few sentences, explain if your mirror meets the optical tolerances.
2. Calculate the field-of-view, magnification, and the exit pupil for each eyepiece from the list provided. Determine which eyepieces provide the full illumination of your primary mirror and which ones are “wasting” light. Submit your calculations and a list of suitable mirrors to your instructor. In a short paragraph, give a reason for your selection of mirrors.

D. **OTHER TYPICAL ASSESSMENT AND EVALUATION METHODS:**

Written homework
Laboratory reports
Field work
Other (specify):
1. Evaluation of errors in optical figure, determination of a technique to fix them, execution of the technique, and assessment of the results. 2. Fabrication and testing (using multiple techniques) of a telescope by hand.

V. INSTRUCTIONAL METHODS

Demonstration
Group Activities
Laboratory
Other (please specify)

Alternate class sites

Note: In compliance with Board Policies 1600 and 3410, Title 5 California Code of Regulations, the Rehabilitation Act of 1973, and Sections 504 and 508 of the Americans with Disabilities Act, instruction delivery shall provide access, full inclusion, and effective communication for students with disabilities.

VI. WORK OUTSIDE OF CLASS

Course is lab only - minimum required hours satisfied by scheduled lab time and estimated student hours outside of class per week is zero.
Other (specify)
It is not required for the student to work outside of class. However, it is highly recommended if the student wants a finished product by the end of the semester to put in about 3 extra hours outside of class per week.

Estimated Independent Study Hours per Week: 3

VII. TEXTS AND MATERIALS

A. **UP-TO-DATE REPRESENTATIVE TEXTBOOKS**
Jean Texereau. HOW TO MAKE A TELESCOPE. 2nd ed. Willmann-Bell, 1984.
Qualifier Text: Discipline Standard,

B. **ALTERNATIVE TEXTBOOKS**

C. **REQUIRED SUPPLEMENTARY READINGS**

D. **OTHER REQUIRED MATERIALS**
$375 for materials. (Mirror supplies only would require $60)

Mirror-making supplies

Mirror blank

Tool

Abrasives (#120, #220, #320, SiC; 25µm, 15µm, 9µm, 5µm, A1203)

Polish (CeO or Rouge)

Polishing pitch (medium burgundy or medium swedish)

Miscellaneous cleaning supplies

Mirror cell

Secondary mirror

Secondary mirror holder

Spider

Focusser

Tube

Mount

Paint and finish

VIII. CONDITIONS OF ENROLLMENT

A. Requisites (Course and Non-Course Prerequisites and Corequisites)

Requisites	Category and Justification

B. Requisite Skills

Requisite Skills

C. Recommended Preparations (Course and Non-Course)

Recommended Preparation	Category and Justification
Course Recommended Preparation or Astronomy-20	
Course Recommended Preparation Astronomy-20H	
Course Recommended Preparation or Astronomy-25	
Course Recommended Preparation Astronomy-25H	
Course Recommended Preparation or Mathematics-73	
Course Recommended Preparation Mathematics-80	
Non-Course Recommended Preparation Equivalent	A knowledge of optics or experience with astronomical equipment will provide the necessary technical background for success in the course.

D. Recommended Skills

Recommended Skills
Students should be able to do intermediate level algebraic calculations for measurements and calculations in the telescope construction and assembly.
Students should be familiar with objects in the night sky that may be observed with the telescopes.

E. Enrollment Limitations

Enrollment Limitations and Category	Enrollment Limitations Impact

Course created by Perry Hacking on 10/07/2016.

BOARD APPROVAL DATE: 04/26/1993

LAST BOARD APPROVAL DATE: 05/21/2018

Last Reviewed and/or Revised by Shimonee Kadakia on 10/07/2016

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