SCIENCE ENGINEERING SENIOR PROJECT
ASTRONOMY

I. INSTRUCTIONAL OBJECTIVES

Upon completion of this project area the following objectives will be achieved:

The student is expected to

1. demonstrate an understanding of the design of different types ot telescopes, their advantages and their disadvantages.

2. demonstrate an understanding of the various characteristics ot telescopes and how these factors affect the uses of same.

3.demonstrate an understanding of the various types of telescope eyepieces (oculars) , their applications, similarities, advantages and their disadvantages.

4. demonstrate a knowledge of the alternative types of telescope mounts, their applications, advantages and disadvantages.

5. understand how the heavens are laid out and be able to use this information to locate the position of a designated celestial object.

6. be able to use star charts, catalogs and handbooks to designate and determine the location of selected celestial objects.

7. properly use a telescope in the observation of the heavens.

8. understand the different types of celestial objects and be able to categorize these objects into their appropriate classes based on their special characteristics.

9. understand what characteristics interfere and/or affect telescope viewing and have an understanding of the measures which can be taken to compensate for these characteristics.

10. be able use a camera either with or without a telescope to take satisfactory and appropriate photographs of celestial objects.

II. PROJECT OUTLINE

1. Telescopes
   - A. What are the primary functions of a telescope?
     1. collecting light
     2. resolving celestial objects
     3. magnification of celestial objects
     4. controlling field size
   - B. What are the different types of telescopes?
     1. reflectors
     2. refractors
     3. hybrids (catadioptrics)

C. What are the advantages/disadvantages of each type of telescope?
   1. portability
   2. cost
   3. performance

D. What characteristics affect a telescope's usability?
   1. aperture
   2. focal length
   3. magnification
   4. type of mount
   5. size and portability
   6. electrical needs
   7. clock drive
   8. setting circles

E. What are the different types of eyepieces (oculars)?
   1. orthoscopic
   2. plossl
   3. erfle
   4. kellner
   5. nagler
   6. other

F. How are each of the eyepieces designed?

G. What characteristics affect eyepiece performance?
   1. field of view
   2. focal length
   3. coatings
   4. coma
   5. cost
   6. eye relief
   7. exit pupil

H. How are the eyepiece and telescope related?
   1. image magnification
   2. image brightness

2. Celestial objects

A. How is the theoretical position of a celestial object defined?
   1 . universal time
   2. right ascension and declination
   3. altitude and azimuth

B. How can the theoretical position of a celestial object be found?
   1. New General Catalog (NGC)
   2. Messier Catalog
   3. star charts
   4. magazines 'Astronomy' and 'Sky and Telescope''
   5. Burnham's Celestial Handbook
   6.Amateur Astronomer's Handbook
   7. others

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C. How do you locate the position of a celestial object?
1. star charts
2. setting circles
3. star hopping

D. What factors affect your ability to observe a celestial object? 1. turbulence -- "seeing"
1. turbulence - “seeing”
2. sky glow
3. night vision
4. averted vision
5. telescope aperture
6. magnification
7. location

E. What different types of celestial objects can be observed:
1. with the naked eye?
   a. bright stars magnitude greater than 6
   b. a few bright star clusters
   c. the Milky Way galaxy
   d. planets Venus, Mars, Jupiter, Saturn
   e. a couple very bright nebulae
2. with a pair of decent binoculars
   a. all of above
   b. a couple of relatively bright star clusters
   c. a couple of bright nebulae
   d. many moderately dim stars
   e. a couple multiple star systems
   f. the Andromeda galaxy
3. with a very small telescope less than 4" clear aperture?
   a. all of the above
   b. dim stars magnitude greater than 13
   c. some moderately bright globular star clusters
   d. some moderately bright open star clusters
   e. A few relatively bright galaxies i.e. Andromeda
   f. a few relatively bright planetary nebulae
   g. a few relatively bright nebulae
   h. some detail on the planets mentioned above
   i. the moons of Jupiter and Saturn
   j. considerable detail of the Earth's moon
   k. widely spaced multiple star systems 2" of arc and up
   1. variable stars
4. with a moderate telescope between 4" and 10" clear aperture?
   a. all of the above
   b. dim stars down to magnitude 15
   c. many dim globular clusters can resolve individual stars
   d. many dim open star clusters
   e. many relatively dim galaxies
   f. many relatively dim plantary and bright nebulae
   g. a number of dark nebulae
   h. other planets including; Uranus, Neptune, Pluto

i. some individual asteroids
j. additional planetary detail
1. ice caps on Mars
2. cloud bands on Jupiter and Saturn
3. "big red spot" on Jupiter
k. multiple star systems down to .6" of arc
1. comets

5. with a large telescope greater than 12' clear aperture?
a. all of above
b. quasars
c. many dim galaxies
d. many dim star clusters
e. dim stars down to magnitude 16 or 17
f. multiple star systems down to .3" of arc
g. considerable planetary detail
h. many dim planetary and bright nebulae

3. Astrophotography
A. Why use photography to observe the heavens?
1. light gathering ability
2. improved resolution
B. What are the different ways that astrophotographs can be taken?
1. camera only
2. "piggy back"
3. prime focus
4. eyepiece projection
C. What problems are encountered in taking astrophotographs?
1. type of film
2. speed of film
3. hypering
4. cold treatment
5. filters
a. skyglow
b. nebular
c. polarizing
d. colored
6. tracking
D. What specialized equipment may be required for astrophotography?
1. illuminated reticle eyepiece
2. off axis guider
3. camera adapter
4. T ring for specific camera
5. very high speed film
6. piggyback mount
7. counterweight set
E. How can the film be prepared and printed?
1. commercial preparation
2. home darkroom developing and printing

F. What are the advantages/disadvantages of each choice above?
   1. costs
   2. convenience
   3. specialized results
   4. flexibility & time

G. How is an actual photograph taken?
   1. selecting a photographic subject
   2. deciding on the type of camera to use
   3. selecting the film
   4. aligning the telescope and finding the subject
   5. exposing the film
   6. developing and printing the photograph

III. RELATED STUDENT ACTIVITIES

The students will spend the project time developing the techniques necessary to use a telescope to locate, observe and photograph appropriate celestial objects.

The project activities will include:

A. researching the different types of telescopes and selecting the type of telescope to be used in the project.

B. learning how to use star charts to locate the position of celestial objects.

C. learning how to use a telescope to locate the position of celestial objects including setting circles.

D. researching the various types of celestial objects with emphasis on the special techniques needed for viewing each type of object.

E. using a telescope to locate and observe celestial objects.

F. using a camera to take photographs of selected celestial objects.

G. evaluating the various types of specialized hardware available for celestial viewing.

H. constructing a telescope (optional)

I. constructing a telescope mount (optional)

J. hand grinding a telescope mirror (optional)

K. developing and printing astrophotographs (optional)

L. observing celestial objects using binoculars (optional)

N. other specific topic to be pursued upon consultation with the instructor.

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IV. STUDENT EVALUATION PROCEDURES

The students will be evaluated on this project according to the following criteria:

1. Topical content (20%) Each student will be evaluated on his/her ability to demonstrate a knowledge and understanding of the content enumerated in the proficiencies through ongoing written and/or verbal reports. Each project member is expected to keep an ongoing diary.

2. Creativity and originality (20%) This property of the project may include some or all of the following:
   a. Does the choice of the final proj ect demonstrat.e original/creative thought?
   b. Does the approach to the project demonstrate original/creative thought?
   c. Does the use of materials and/or equipment demonstrate original/ creative thought?
   d. Does the project involve the development of new equipment or the use of old equipment in a new or inovative way?

3. Final product (20%) The final product of the project will be evaluated on some or all of the following criteria:
   a. A specific construct which clearly and thoroughly demonstrates the concepts behind the final project. Particular attention will be paid to how well the project helps to meet the goals as stated in the proficiencies.
   b. Charts and/or graphs which explain, compare, contrast or illustrate the concepts behind the project.
   c. The QUALITY of the workmanship of the final project. It is expected that the project's quality will be indicative of the time spent.

4. Oral report (20%) The oral report is expected to be given by the individual project group to the entire Science/Engineering class if possible and if not possible to as many S/E students as can be arranged. The oral report must include participation by ALL members of the individual project group, must be sufficient in length to clearly present the project and will be evaluated on the following criteria:
   a. Is the oral report well organized and does it demonstrate sufficient preparation?
   b. Does the report include a clear statement of the goal of the project?
   c. Does the oral report include a clear explanation of the thecrv behind the project?
   d. Does the report include a carefully planned demonstration/explanation of the final product?
   e. Does the report include an evaluation of the success/failure of the prc'ject to reach the stated goal.
   f. What future lines ot research regarding this project are possible and desirable?
5. Written report (20%) Each member of the project group is expected to submit a written report on the entire project including each of t.he following:
   a. A clear statement of the goal of the project including the motivation behind the selection of the specific topic.
   b. A thorough analysis of the theory behind the project demonstrating significant research into the background of the topic including a DIALOG search of the concepts incorporated into the final product
   c. A clear description of the procedures used in the development of the project.
   d. A thorough analysis of the final product and its relationship to the stated goals.
   e. A concluding statement regarding the success/failure of the project to reach t.he stated goals with relevant recommendations regarding future projects of a similar nature.

V. MATERIALS REQUIRED

The required materials for this project may include each of the following:
star charts, binoculars, telescope, eyepieces, telescope mount. camera, camera adapter, photographic film, portable red light, warm clothes, development chemicals and equipment.

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VI. REQUIRED PROFICIENCIES

Students enrolled in this project will demonstrate mastery of the following proficiency requirements as outlined in the curriculum guide and receive a passing grade in accordance with Board of Education policies on grading and attendance:

Each student is expected to:

1. Demonstrate an understanding of the different types of telescopes their designs, uses and adjustments.

2. Demonstrate the ability to use a telescope to locate and observe designated celestial objects including: planets, stars, star clusters, bright and dark nebulae, galaxies and planetary nebulae.

3. Demonstrate an understanding of the various celestial objects as listed above, their relationships, and their distances.

4. Demonstrate a basic understanding of the underlying principles of cosmology.