General Education Course Proposal

Proposed Course: PSci (Prefix) 21 (No.) Elementary Astronomy (Title) **Units** 4

Department: Physics **School:** Natural Sciences

GE Category (Indicate one category only):

Foundation: A1 ___; A2 ___; A3___; B4 ___
Breadth: B1 X ; B2___; C1___; C2___; D___; E___
Integration: B___; C___; D___; International/Multicultural___

Existing Course X **; Revised Course**___**; New Course**___
Course Included in Current GE Program X

New courses require the Undergraduate Course Proposal form in addition to this form.
Revised courses require the Undergraduate Course Change Request in addition to this form.

Proposed catalog description: Limit course description to 40 words using succinct phrases. Include prerequisites, limitations, lecture/lab hours. Indicate former course number, e.g., (Former Biol 105)

Prerequisite: Math 4R or second-year high school algebra. Concepts, theories, important physical principles, and history of astronomy. Stellar properties, distances, and evolution. Three field trips for observing with telescopes. General Education BREADTH, Division 1. (3 lecture, 2 lab hours)

Enrollment limit per section: 125
Expected number of sections per semester – Year 1 1 **; Year 3** 1

Attachments:

1. A statement presenting the ways in which this course meets the Specifications provided in the appropriate section of the General Education Policy as well as in the Policies for Inclusion and Evaluation of General Education Courses.
2. A statement of elements common to all sections of this course, identifying content, objectives, required student activities, grading policy, representative texts, and an approximate schedule for the course. Required student activities include such things as papers, research projects, homework, laboratory and/or studio performance, recitations, participation, attendance, and exams.
3. A typical syllabus for a particular offering of the course.
4. Any special cost factors associated with this course.

Approval for Inclusion in General Education

M. J. Zuckerman 8/11/98
Department Chair — Date

See attached
School Curriculum Committee — Date

See attached
School Dean — Date

Peter Conrad 12/15/98
General Education Subcommittee — Date

Brandt Kehoe 12/22/98
Associate Provost — Date

1/14/98

Attachment 2: Elements common to all sections of Physical Science 21

Course Topics and Schedule

Physical Science 21 will chart the development of astronomy from the early civilizations to present day research problems. All sections of the course will have a common content and schedule as outlined in detail below.

Week #1

1. Scale in the universe: sizes and distances
    a) the solar system
    b) the distances to the stars
    c) galaxies and superclusters
    d) walls and voids in distribution of superclusters

2. Motions in the Sky
    a) the apparent motions of the sun: daily and annual
    b) the apparent motions of the stars
    c) the seasons
    d) the phases of the moon
    e) the motions of the planets: prograde and retrograde

Week #2

3. Astronomy and Timekeeping
    a) the solar and sidereal day
    b) the solar calendar
    c) the lunar calendar

4. Coordinate Systems
    a) altazimuth coordinate system
    b) celestial equator and celestial poles
    c) right ascension and declination

5. Eclipses
    a) solar
    b) lunar

Week #3

6. The ancient Greek astronomers
    a) Hesiod
    b) Pythagoras: the harmony of the spheres and uniform circular motion
    c) Aristotle: the geocentric universe
    d) Eratosthenes and the size of the earth
    e) Ptolemy: the geocentric universe perfected

7. Copernicus and the heliocentric universe

a) the contribution of Aristarchus
b) calculation of the distances in the solar system

Week #4 **Midterm Exam #1**

8. Tycho Brahe
    a) the stella nova of 1572
    b) Uraniborg and twenty years of observations
    c) the Tychonic system

9. Johannes Kepler
    a) the orbits of the planets and the Platonic solids
    b) Kepler's laws of planetary motion

Week #5

10. Galileo Galilei
    a) the refracting telescope
    b) observational evidence for the heliocentric system: The Sidereal Messenger
    c) Dialog Concerning the Two Chief World Systems and the trial of Galileo
    d) Galileo's contribution to mechanics
        i) the law of falling bodies
        ii) the concept of inertia

11. Isaac Newton
    a) the laws of motion
    b) universal gravitation
    c) the origin of Kepler's third law
    d) escape velocity, the orbits of the comets, the discovery of Neptune

Week #6

12. Radiation and Atoms
    a) the electromagnetic spectrum
    b) the inverse square law
    c) the blackbody spectrum
    d) Wien's Law
    e) the Stefan-Boltzmann Law
    f) photon emission and absorption
    g) the spectrum of hydrogen
    h) Kirchoff's radiation laws

Week #7

13. Telescopes
    a) refraction and reflection
    b) refracting telescopes
        i) the great refractors of the nineteenth century

ii) the end of the refractors

c) reflecting telescopes
   i) the advantages of reflectors
   ii) the new generation of telescopes

d) the powers of the telescope
   i) light gathering power
   ii) resolving power
   iii) magnifying power

e) the atmosphere
   i) seeing and resolution
   ii) the atmospheric windows

f) radio astronomy
   i) Karl Jansky
   ii) Grote Reber
   iii) radio interferometry and the Very Large Array

g) telescopes in space
   i) the Hubble Space Telescope
   ii) the next generation space telescopes and the hunt for alien worlds

h) new advances
   i) adaptive optics
   ii) charge-coupled devices
   iii) multiple mirror telescopes
   iv) spin casting

Week #8 **Midterm Exam #2**

14. Stellar Spectra
   a) the origin of stellar absorption spectra
   b) Annie Jump Cannon and the spectral classification system OBAFGKM
   c) the connection between the spectral classes and surface temperature

15. The Sun
   a) the solar atmosphere
      i) photosphere
      ii) chromosphere
      iii) corona
      iv) the solar wind
   b) solar activity
      i) sunspots and the Babcock model
      ii) solar flares and prominences

Week #9

16. Measurement of the stellar properties
   a) measurement of the distances to the stars
      i) trigonometric parallax
      ii) the method of similar objects

b) the magnitude systems
    i) the apparent magnitude scale (m)
    ii) the absolute magnitude system (M)
    iii) the relation between distance, m, and M
c) the absolute magnitude of the sun
d) measuring the motions of the stars
    i) proper motion and the tangential velocity
    ii) Doppler shift and the radial velocity
    iii) Pythagorean theorem and the relative velocity

Week #10

17. The Hertzsprung-Russell Diagram
    a) the relation between luminosity and spectral class
    b) the main sequence, the super giants, red giants, and white dwarfs
    c) the relation between radius, luminosity, and surface temperature
    d) the luminosity classes
    e) spectroscopic parallax
    f) measuring stellar masses: the mass-luminosity relation
    g) variable stars
    h) stellar population counts

Week #11

18. Models of the stellar interior
    a) hydrostatic equilibrium
    b) nuclear reactions and the production of energy in the stellar core
        i) the proton-proton chain
        ii) the carbon-nitrogen-oxygen (CNO) cycle
        iii) the triple-alpha process
        iv) iron: the end of the line

19. Stellar Evolution from Birth to Main Sequence
    a) star birth in the interstellar medium
        i) the protostar
        ii) the accretion disk
    b) the main sequence
        i) stellar mass and the position on the main sequence
        ii) main sequence lifetimes

Week #12 Midterm Exam #3

20. Stellar Evolution: the late phases
    a) post-main sequence evolution
        i) the red giants
        ii) planetary nebulae and white dwarfs
        iii) recurrent novae
    b) the late evolution of high-mass stars

i) supernovae
ii) pulsars and neutron stars
iii) black holes

Week #13

21. Our place in the universe
    a) Herschel's Universe
    b) Rosse and the discovery of the spiral structure
    c) the spiral nebula in Andromeda: solar system in formation or island universe?
    d) Henrietta Leavitt, the Cepheid variables, and the period-luminosity relation
    e) Harlow Shapley, the size of the galaxy, and the location of the sun
    f) Edwin Hubble and the distance to Andromeda

Week #14

22. A Universe of Galaxies
    a) types of galaxies
        i) spirals
        ii) ellipticals
        iii) irregular
    b) measuring the distances the galaxies
        i) the Cepheid variable method
        ii) supernovae
        iii) the Fisher-Tully relation
    c) the distribution of galaxies in space
        i) the local group
        ii) superclusters and voids
        iii) the Great Wall and the Great Attractor

Week #15

23. The Search for the Hubble Constant and the Age of the Universe
    a) the galactic redshift
    b) the velocity-distance relation and the Hubble constant
    c) the age of the universe

24. The Microwave Background and the Origin of the Universe
    a) discovery of the 3 K background
    b) the COBE data

Comprehensive Two-Hour Final Examination

Physical Science 21 Examinations

All sections will require three midterm exams and a comprehensive final. The exams will include multiple choice questions drawn from the lectures, the required reading, and the homework. The first and third midterm exams will consist of fifty multiple choice questions. The second midterm exam will consist of twenty-five multiple choice questions and a star map. The star map requires that students start with a blank map of the sky for the current season and then fill-in the constellation patterns and names for every constellation on the map. Students are also required to locate and name all of the bright stars on the map. The star map is worth fifty per cent of the second midterm. The final exam will be comprehensive and will consist of fifty multiple choice questions (50%), an essay (25%), and a star map (25%). The essay will explore themes brought up repeatedly throughout the course over several lectures. Satisfactory performance on the essay question and will require that the students demonstrate a mastery of the material. Essays will be graded for content (50%), organization (25%), and mechanics (25%). The star map will be chosen to match the early evening sky at the time of the final exam.

Physical Science 21 Required Texts

All sections of Physical Science 21 will utilize the following required texts:

Discovering the Cosmos, R.C. Bless
The Stars, A New Way to See Them, H.A. Rey
PS21 Laboratory Manual, S.J. White

Physical Science 21 Lecture Sections

All sections of this course will meet twice weekly for one hour and fifteen minutes for lectures and examinations. Attendance will not be recorded for the lecture sections, however, regular attendance will be expected.

Physical Science 21 Activity Sections

All students will be required to attend a two-hour activity section each week. Attendance will be recorded for all activity sections. Three or more absences from the activity sessions, without serious and compelling reasons, will result in an "F" in the course. Students will observe the motions of the sun, moon, planets, and stars in terms of the geocentric and heliocentric models. All students will travel to the CSUF Experimental Range at least three times during the semester for supervised evening telescope observing sessions. It is expected that all students will learn to easily recognize the constellations, asterisms, and bright stars visible during the semester. All students will learn how to assemble and align a reflecting telescope, determine the magnification of the instrument, and develop a proficiency for locating faint deep-sky objects using detailed maps. All students will be required to use the Internet to gather information on current discoveries in astronomy.

Physical Science 21 Course Writing Requirement

All students in all sections will submit a two-thousand word research paper according to the following guidelines and schedule. All papers will be submitted on floppy disk and will require five references. Papers may include graphs, diagrams, and images. Only the final version of your paper will be graded, however each student will receive significant feedback from a peer reviewer and the instructor.

Schedule for Writing Requirement
Week 2: Choose a topic from the list of suggested topics or submit your own idea for a topic
Week 3: Submit a list of 3 possible sources for your paper
Week 5: Submit an outline of your paper and a five source bibliography
Week 8: Submit a first version of your paper for peer review
Week 9: Return your peer review
Week 12: Submit a revised version to the instructor for comments
Week 14: Submit final version to the instructor for grading

Homework and Reading Assignments

Weekly homework assignments will be made which will consist of required reading from the texts, questions, and computational problems. One or more homework projects will also be assigned in which students must devise, carry out, and report on an astronomical measurement. Possible projects include the measurement of the diameter of the sun, the motion of the moon, the length of the sidereal day, the diameter of the moon, and the current positions of the planets as seen from a point above the plane of the solar system.

Physical Science 21 Course Grading Policy

All sections of this course will use the following weight system for determination of final course grades. Exam scores will not be "curved" and no extra credit work will be allowed. No exam scores will be dropped.

Grading Weights	
Midterm Exams (3 @11.66% each)	35%
Laboratory	15%
Homework	10%
2000-Word Paper	15%
Final Exam	25%
Total	100%

Course letter grades for Physical Science 21 will be assigned on the following basis in all sections:

Grades	
100-85.0	A
84.9-75.0	B
74.9-60.0	C
59.9-50.0	D
below 49.9	F

Attachment 3: A typical syllabus for Physical Science 21

PHYSICAL SCIENCE 21 SYLLABUS
ELEMENTARY ASTRONOMY

INSTRUCTOR: Dr. Steven J. White
LECTURE: 3:45-5:00 p.m. M & W, 101 Industrial Technology
OFFICE: 208 MCL, 278-2040
OFFICE HOURS: M, T, W, Th 5:10-6:00 P.M., F 1:00-3:00 P.M.
TEXTS: *Discovering the Cosmos*, R.C. Bless
The Stars, A New Way to See Them, H.A. Rey
PSci 21 Laboratory Manual
REQUIRED EQUIPMENT: Scientific Calculator, Flashlight, Ruler
WEBSITE: http://maxwell.phys.csufresno.edu:8001/~white/PS21.html

Overview: Through our study of astronomy we will gain a better appreciation of our place in nature within an incredibly vast but comprehensible universe. We will follow in the footsteps of great astronomers like Copernicus and Galileo and learn of their struggle to gain an understanding of the solar system. Next, we will study the Sun in order to learn how it provides the Earth with life sustaining energy. We will find that all stars go through a series of life cycle changes, from birth to eventual death. Although great distances lie between the stars, astronomers are able to measure the distances using a variety of simple but clever techniques. The distances between the stars are truly vast and our solar system is but a speck in an enormous spiral galaxy of over one hundred billion stars. Our nearest neighbor is another spiral galaxy in the constellation Andromeda, located over two million light-years away! Looking further into the universe, we see the galaxies scattered like dust and rushing away from us in all directions. Our curiosity drives us to ask how the universe began and we wonder if it will all come to an end someday. We are about to embark upon a very exciting voyage of discovery.

PSci 21 Homepage: Materials for this course are available via the Internet at the class website listed above. At the website you will find an online syllabus, class announcements, and homework assignments. In addition, you will find many images, movies, and information dealing with the latest exciting discoveries in astronomy. New material will be added on a regular basis, so check the site often. Some of the reading assignments will be found on the homepage.

Preparation: This course will require the use of intermediate algebra and basic geometry. The prerequisites are Math 4R or a second year high school algebra course. We will also utilize scientific notation and unit conversion factors.

Attendance: Please make an effort to attend every lecture. Many of the exam questions will come from the lecture so it will be to your advantage to attend class regularly. If you miss a lecture then get the notes from a friend. Attendance to the laboratory is mandatory.

Homework: Weekly problem sets will be assigned. Homework will be collected at the beginning of class. Late papers will not be accepted. Regular reading assignments will also be made. It is strongly suggested that you complete the reading assignment before attempting the problem sets. Homework solutions will be available, after the due date, in the Reserved Reading Room at the Madden Library. Be sure to check the solutions even if you receive full credit on your homework. If you have any difficulty with the material please come to my office hours or make an appointment.

Activity Section: All PSci 21 students must sign-up for an activity section . A flashlight will be required for map reading at observing sessions. A scientific calculator and a clear plastic ruler will be required as well. In addition to the activities in the lab manual, we will become familiar with the constellations and bright stars. By the end of this course you will be able to easily point out and name the constellations, asterisms, and bright stars. We will also learn how to use a telescope in order to view the moon, the planets, star clusters, gaseous nebulae, and galaxies. I expect that, by the end of the course, you will be able to locate even dim, hard-to-find objects, using the telescopes while working from your maps. If you miss a lab, then you will receive a zero for that lab. There will be no make-up labs without an excused absence for a compelling reason. If you have three or more unexcused absences from the lab then you will receive an F in the course.

Research Paper: All students will submit a 2000 word research paper according to the following guidelines and schedule. All papers will be submitted on floppy disk and will require five references. Papers may include graphs, diagrams, and images. Only the final version of your paper will be graded, however you will receive significant feedback from your peer reviewer and instructor.

Week 2: Choose a topic from the list of suggested topics or submit your own idea for a topic
Week 3: Submit a list of 3 possible sources for your paper
Week 5: Submit an outline of your paper and a five source bibliography
Week 8: Submit a first version of your paper for peer review
Week 9: Return your peer review
Week 12: Submit a revised version to the instructor for comments
Week 14: Submit final version to the instructor for grading

Examinations: There will be three midterm exams during the semester and a comprehensive final exam. The material for these exams will come from the lectures, assigned reading, and the homework. The exams will include multiple choice questions and identification of constellations and stars from maps. The final exam will be comprehensive and include a map and an essay question. All of the examinations will be closed book and as such you may not use any notes or books during the exam. Calculators will be needed for the exams. Make-up exams will not be given without an excused absence. If you are absolutely unable to take an exam you must notify me before the exam. An excused absence will be granted only in cases of illness or family emergency. You must provide written evidence to obtain an excused absence.

Note on disabilities: If you have a disability of any kind, please inform me so that accommodation may be made.

Note on cheating and plagiarism: Please refer to the catalog or the schedule of courses for the university policy this important issue. I will not tolerate cheating and plagiarism in this course and I am determined to enforce the university policy.

Note on incomplete grades: The "I" grade is given only when a student fails to a portion of the required course work and only when the student has completed at least 2/3 of the required course work at a passing level. When making up an incomplete, the student does only the work that was left unfinished. The student may not repeat all of the course work as if he/she were starting at the beginning of the semester.

Grading:

Course grades will be based on these weights:

Midterm Exams (3 @10% each)	30%
Laboratory	20%
Homework	10%
2000-Word Paper	15%
Final Exam	25%
Total	100%

Course Grades:

100-85.0	A
84.9-75.0	B
74.9-60.0	C
59.9-50.0	D
below 49.9	F

Physical Science 21
Course Topics and Schedule

Week #1

1. Scale in the universe: sizes and distances
    a) the solar system
    b) the distances to the stars
    c) galaxies and superclusters
    d) walls and voids in distribution of superclusters

2. Motions in the Sky
    a) the apparent motions of the sun: daily and annual
    b) the apparent motions of the stars
    c) the seasons
    d) the phases of the moon
    e) the motions of the planets: prograde and retrograde

Week #2

3. Astronomy and Timekeeping
    a) the solar and sidereal day
    b) the solar calendar
    c) the lunar calendar

4. Eclipses
    a) solar
    b) lunar

Week #3

5. The ancient Greek astronomers
    a) Hesiod
    b) Pythagoras: the harmony of the spheres and uniform circular motion
    c) Aristotle: the geocentric universe
    d) Eratosthenes and the size of the earth
    e) Ptolemy: the geocentric universe perfected

6. Copernicus and the heliocentric universe
    a) the contribution of Aristarchus
    b) calculation of the distances in the solar system

Week #4 **Midterm Exam #1**

7. Tycho Brahe
    a) the stella nova of 1572
    b) Uraniborg and twenty years of observations
    c) the Tychonic system

8. Johannes Kepler
    a) the orbits of the planets and the Platonic solids
    b) Kepler's laws of planetary motion

Week #5

9. Galileo Galilei
    a) the refracting telescope
    b) observational evidence for the heliocentric system: The Sidereal Messenger
    c) Dialog Concerning the Two Chief World Systems and the trial of Galileo
    d) Galileo's contribution to mechanics
        i) the law of falling bodies
        ii) the concept of inertia

10. Isaac Newton
    a) the laws of motion
    b) universal gravitation
    c) the origin of Kepler's third law
    d) escape velocity, the orbits of the comets, the discovery of Neptune

Week #6

11. Radiation and Atoms
    a) the electromagnetic spectrum
    b) the inverse square law
    c) the blackbody spectrum
    d) Wien's Law
    e) the Stefan-Boltzmann Law
    f) photon emission and absorption
    g) the spectrum of hydrogen
    h) Kirchoff's radiation laws

Week #7

12. Telescopes
    a) refraction and reflection
    b) refracting telescopes
        i) the great refractors of the nineteenth century
        ii) the end of the refractors
    c) reflecting telescopes
        i) the advantages of reflectors
        ii) the new generation of telescopes
    d) the powers of the telescope
        i) light gathering power
        ii) resolving power
        iii) magnifying power
    e) the atmosphere

i) seeing and resolution
ii) the atmospheric windows

f) radio astronomy
i) Karl Jansky
ii) Grote Reber
iii) radio interferometry and the Very Large Array

g) telescopes in space
i) the Hubble Space Telescope
ii) the next generation space telescopes and the hunt for alien worlds

h) new advances
i) adaptive optics
ii) charge-coupled devices
iii) multiple mirror telescopes
iv) spin casting

Week #8 **Midterm Exam #2**

13. Stellar Spectra
a) the origin of stellar absorption spectra
b) Annie Jump Cannon and the spectral classification system OBAFGKM
c) the connection between the spectral classes and surface temperature

14. The Sun
a) the solar atmosphere
i) photosphere
ii) chromosphere
iii) corona
iv) the solar wind

b) solar activity
i) sunspots and the Babcock model
ii) solar flares and prominences

Week #9

15. Measurement of the stellar properties
a) measurement of the distances to the stars
i) trigonometric parallax
ii) the method of similar objects

b) the magnitude systems
i) the apparent magnitude scale (m)
ii) the absolute magnitude system (M)
iii) the relation between distance, m, and M

c) the absolute magnitude of the sun
d) measuring the motions of the stars
i) proper motion and the tangential velocity
ii) Doppler shift and the radial velocity
iii) Pythagorean theorem and the relative velocity

Week #10

16. The Hertzsprung-Russell Diagram
    a) the relation between luminosity and spectral class
    b) the main sequence, the super giants, red giants, and white dwarfs
    c) the relation between radius, luminosity, and surface temperature
    d) the luminosity classes
    e) spectroscopic parallax
    f) measuring stellar masses: the mass-luminosity relation
    g) variable stars
    h) stellar population counts

Week #11

17. Models of the stellar interior
    a) hydrostatic equilibrium
    b) nuclear reactions and the production of energy in the stellar core
        i) the proton-proton chain
        ii) the carbon-nitrogen-oxygen (CNO) cycle
        iii) the triple-alpha process
        iv) iron: the end of the line

18. Stellar Evolution from Birth to Main Sequence
    a) star birth in the interstellar medium
        i) the protostar
        ii) the accretion disk
    b) the main sequence
        i) stellar mass and the position on the main sequence
        ii) main sequence lifetimes

Week #12 Midterm Exam #3

19. Stellar Evolution: the late phases
    a) post-main sequence evolution
        i) the red giants
        ii) planetary nebulae and white dwarfs
        iii) recurrent novae
    b) the late evolution of high-mass stars
        i) supernovae
        ii) pulsars and neutron stars
        iii) black holes

Week #13

20. Our place in the universe
    a) Herschel's Universe
    b) Rosse and the discovery of the spiral structure
    c) the spiral nebula in Andromeda: solar system in formation or island universe?

d) Henrietta Leavitt, the Cepheid variables, and the period-luminosity relation
e) Harlow Shapley, the size of the galaxy, and the location of the sun
f) Edwin Hubble and the distance to Andromeda

Week #14

21. A Universe of Galaxies
    a) types of galaxies
        i) spirals
        ii) ellipticals
        iii) irregular
    b) measuring the distances the galaxies
        i) the Cepheid variable method
        ii) supernovae
        iii) the Fisher-Tully relation
    c) the distribution of galaxies in space
        i) the local group
        ii) superclusters and voids
        iii) the Great Wall and the Great Attractor

Week #15

22. The Search for the Hubble Constant and the Age of the Universe
    a) the galactic redshift
    b) the velocity-distance relation and the Hubble constant
    c) the age of the universe

23. The Microwave Background and the Origin of the Universe
    a) discovery of the 3 K background
    b) the COBE data