Las Positas College
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Course Outline for ASTR 20

INTRODUCTION TO ASTRONOMY: STARS AND THE UNIVERSE

Effective: Spring 2018

I. CATALOG DESCRIPTION:
ASTR 20 — INTRODUCTION TO ASTRONOMY: STARS AND THE UNIVERSE — 3.00 units

Introduction to the study of stars, galaxies, and cosmology. Includes the nature of light and matter, telescopes, spectroscopy, stellar formation and evolution, galaxies, quasars, and cosmology. Designed for non-majors in mathematics or a physical science. A companion science lab, Astronomy 30, is also available.

3.00 Units Lecture

Grading Methods:
Letter or P/NP

Discipline:
- Physics/Astronomy

	MIN
Lecture Hours:	54.00
Total Hours:	54.00

II. NUMBER OF TIMES COURSE MAY BE TAKEN FOR CREDIT: 1

III. PREREQUISITE AND/OR ADVISORY SKILLS:

IV. MEASURABLE OBJECTIVES:

Upon completion of this course, the student should be able to:

A. review and explain the scientific method, as it applies to astronomy;
B. describe the Earth's position in the universe by comparing the scale and structure of the solar system, galaxies and universe;
C. describe the relation between the seasons, constellations, and motion of the Earth about the sun;
D. explain the nature of light as electromagnetic radiation;
E. describe the construction and uses of telescopes, spectrographs, and other astronomical tools;
F. describe the properties of our sun, including its structure, composition, and methods of energy production and transport;
G. describe and explain the relationship between energy production in the suns interior, and observable surface phenomena such as sunspots, flares, and magnetism;
H. identify the age, type, and composition of various types of stars, and summarize their evolutionary sequences
I. identify the constituents and properties of the interstellar medium;
J. identify and describe the structure, contents, and dynamics of the Milky Way galaxy;
K. describe the large scale structure and contents of the Universe;
L. describe competing cosmological models for the evolution of the universe, as well as contemporary evidence in support of each model;

V. CONTENT:
A. Astronomy and the Universe
   1. Astronomy and the Scientific Method
   2. The Solar System
   3. Stars and Stellar Evolution
   4. Galaxies and Cosmology
   5. Angles and Angular Measure
   6. Powers of Ten
   7. Astronomical Distances and scale models
   8. Measuring the Earth
B. Sky Watching and Apparent Motion of the Heavens
   1. Ancient Astronomy
   2. Constellations
   3. Motions of the Sky
   4. The Celestial Sphere
   5. The Seasons
   6. Precession
   7. Sidereal and Solar time
   8. The Calendar and Astrology
C. Eclipses and the Motion of the Moon
   1. Phases of the Moon
   2. The Moon's Rotation

3. Eclipses and the Line of Nodes
4. Lunar and Solar Eclipses

D. Gravitation, Orbital Motion, and the development of Modern Astronomy
1. Geocentric Models
2. Copernicus and the Heliocentric Models
3. Galileo and the Telescope
4. Tycho Brahe's Observations
5. Kepler and the Orbits of the Planets
6. Newton's Laws of Motion
7. Newton's Laws in Everyday Life
8. Newton and Gravity
9. Tides and the Moon
10. Einstein and relativity

E. The Nature of Light
1. The Speed of Light
2. The Wave Nature of Light
3. Blackbody Radiation
4. Wein's Law and the Stefan-Boltzmann Law
5. The Particle Nature of Light
6. Kirchoff's Laws
7. Atomic and Subatomic Structure
8. Spectral Lines and the Bohr Model
9. The Doppler Effect

F. Optics and Telescopes
1. Refracting Telescopes
2. Reflecting Telescopes
3. Angular Resolution
4. Charge-Coupled Devices (CCDs)
5. Spectrographs
6. Radio Telescopes
7. Interferometry and adaptive optics
8. Telescopes in Space
9. multi-wavelength astronomy

G. Our Star, The Sun
1. Thermonuclear Reactions
2. A Model of the Sun
3. Solar Seismology
4. Solar Neutrinos
5. The Photosphere
6. The Chromosphere
7. The Corona
8. Sunspots
9. The Sunspot Cycle
10. The Active Sun

H. The Nature of the Stars
1. Stellar Distances and Parallax
2. Apparent Brightness and Luminosity
3. The Magnitude Scale
4. Star Colors and Temperatures
5. Spectral Classes
6. The Sizes of Stars
7. The Hertzsprung-Russell Diagram
8. Spectroscopic Parallax
9. Binary Stars and Stellar Masses
10. Spectroscopy and Close Binaries
11. Eclipsing Binaries

I. The Birth of Stars
1. Modeling Stellar Evolution
2. The Interstellar Medium
3. Protostars and Dark Nebulae
4. Reaching the Main Sequence
5. Mass Ejection and Accretion
6. Young Stars and H II Regions
7. Giant Molecular Clouds
8. Supernovae and Star Birth

J. Stellar Evolution: After the Main Sequence
1. Red Giants
2. Helium Burning
3. Star Clusters and Stellar Evolution
4. Population I and II Stars
5. Pulsating Stars
6. Mass Transfer in Close Binaries

K. Stellar Evolution: The Deaths of Stars
1. A Second Red-Giant Phase
2. Planetary Nebulae
3. White Dwarfs
4. The Creation of Heavy Elements
5. Supernovae
6. Recent Supernova observations including SN1987A
7. Detecting Supernova Neutrinos
8. White Dwarfs and Supernovae
9. Supernova Remnants

L. Neutron Stars
1. Neutrons and Neutron Stars
2. Pulsars
3. Modeling Pulsars
4. The Crab Nebula
5. Pulsar Slowing and Energy Loss
6. Inside a Neutron Star
7. Millisecond Pulsars

8. Pulsating X-Ray Sources
9. Novae and X-Ray Bursters
10. Beyond Neutron Stars

M. Black Holes
1. Applications of Special and General Relativity
2. Black Holes in Binary Systems
3. Supermassive Black Holes
4. The Event Horizon
5. Mass, Charge, and Spin
6. Falling into a Black Hole
7. Evaporating Black Holes

N. Our Galaxy - The Milky Way
1. The Size, Shape, and Structure of the Galaxy
2. Spiral Arms
3. The Sun's Orbit and Dark Matter
4. Density Waves
5. At the Center of the Galaxy

O. Galaxies
1. Island Universes
2. Classifying Galaxies
3. The Distance Ladder
4. The Hubble Law
5. Clusters and Superclusters
6. Colliding Galaxies
7. Dark Matter in the Universe
8. The Evolution of Galaxies

P. Quasars, Active Galaxies, and Gamma-Ray Bursts
1. The Discovery of Quasars
2. Ultraluminous Galactic Nuclei
3. Seyfert and Radio Galaxies
4. Active Galaxies
5. Black Holes as "Central Engines"
6. A Unified Model
7. Gamma-Ray Bursters

Q. Cosmology: The Creation of the Universe
1. The Dark Night Sky
2. The Expanding Universe
3. The Big Bang
4. The Cosmic Microwave Background
5. The Universe Before Recombination
6. The Shape of the Universe
7. Dark Energy
8. The Accelerating Universe
9. The Future of the Universe

R. Exploring the Early Universe
1. Inflation
2. Matter, Antimatter, and the Uncertainty Principle
3. Annihilation and Symmetry Breaking
4. Relics of the Primordial Fireball
5. The Origin of Galaxies
6. Unified Theories
7. Cosmic Strings
8. The Dimensions of Space-time

VI. METHODS OF INSTRUCTION:

A. **Field Trips** -
B. **Lecture** -
C. **Classroom Activity** -
D. **Projects** -
E. **Discussion** -
F. Directed dark sky observations

VII. TYPICAL ASSIGNMENTS:

Typical assignments may include:

A. weekly or bi-weekly textbook readings
B. weekly or bi-weekly take-home video quizzes
C. weekly or bi-weekly homework problems
D. special topic projects a few times per semester (Special topic projects may range from performing night-sky observations, attending star-parties or planetarium shows, and/or writing a research paper on a topic of astronomical interest.)

VIII. EVALUATION:

A. **Methods**

1. Exams/Tests
2. Quizzes
3. Papers
4. Class Participation
5. Class Work
6. Home Work

B. **Frequency**

1. Quizzes may be given weekly, bi-weekly, or at discretion of instructor.
2. Exams may be given 2-4 times per semester.
3. A research paper may be turned in once per semester, at the discretion of the instructor.
4. Class participation and classwork may be evaluated during every class, or at the discretion of the instructor.
5. Homework may be assigned weekly, bi-weekly, or at the discretion of the instructor.

IX. TYPICAL TEXTS:

1. Bennett, Jeffrey, Megan Donahue, Nicholas Schneider, and Mark Voit. *The Cosmic Perspective.* 8th ed., Pearson, 2017.
2. Kay, Laura, Stacy Palen, and George Blumenthal. *21st Century Astronomy.* 5th ed., W. W. Norton & Company, 2017.
3. Chaisson, Eric, and Steve McMillan. *Astronomy Today.* 9th ed., Pearson, 2018.

X. OTHER MATERIALS REQUIRED OF STUDENTS: