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Course Outline for ASTR 20

STARS AND THE UNIVERSE

Effective: Fall 2004

I. CATALOG DESCRIPTION:
ASTR 20 — 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:

Discipline:

	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. understand the relation between the seasons, constellations, and motion of the Earth about the sun;
D. demonstrate a basic knowledge of the nature of light as electromagnetic radiation;
E. demonstrate a basic knowledge 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. demonstrate a basic knowledge of the age, type, composition, and evolution of stars;
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. demonstrate an overall understanding and appreciation of the large scale structure and contents of the Universe;
L. describe and demonstrate understanding of competing cosmological models for the evolution of the universe, as well as contemporary evidence in support of each model;
M. demonstrate basic knowledge about the search for life beyond the Earth, and recent developments in the search for extra solar planets.

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

G. 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
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

S. The Search for Extraterrestrial Life
1. Building Blocks of Life
2. Life in the Solar System
3. Meteorites from Mars
4. The Drake Equation
5. Radio Searches
6. Infrared Searches
7. Search and discovery of Extra-Solar Planets

VI. METHODS OF INSTRUCTION:
A. **Lecture** -
B. Directed dark sky observations
C. **Audio-visual Activity** - Laser disk and CD ROM Images Images, film and animation from astronomical Internet sites Videos
D. **Field Trips** -

VII. TYPICAL ASSIGNMENTS:
A. Weekly homework assignments from the textbook 1. Read chapter 1. Write out the definitions of each of the listed key ideas for yourself. Try to do this without referring back to the book. Once you have finished, use the book to check your answers, and to study the key ideas you missed the first time through. On separate sheets of paper answer all the Review Questions on pages 15 and 16. Answer Advanced Question 24 on page 16. Finally, do Observing Project 43. 2. Read all of Chapter 4 in Fraknoi. Starting at the Voyages Student Resources page, http://www.harcourtcollege.com/astro/fraknoi/students.html, choose Chapter 4: Radiation and Spectra from the Voyages to the Stars and Galaxies pull-down menu. Using whatever source you like (the website, your book), define all of the New Terms and Concepts. Follow the link to Web Pages with More Information and visit and document your findings on at least two of those pages. Take the practice/tutorial quiz for this chapter. 2. Research Project: submit a one page proposal via email or hard copy to your instructor and/or classmates as directed in the course syllabus. Based on feedback from your instructor and/or classmates, submit a six page 12 point typed and doubled spaced paper on an area of current astronomical research not already covered in detail in the required course reading material. In Lieu of a formal paper, you may create a web site, or power point presentation of equivalent length and content.

VIII. EVALUATION:
A. **Methods**

1. Exams/Tests

2. Quizzes
3. Papers
4. Home Work
5. Final Performance

B. **Frequency**

1. Quizzes will be given weekly, bi-weekly, or at discretion of instructor.
2. Unit exams will be given once or twice per semester.
3. A research paper will be turned in prior to the final examination, at the discretion of the instructor.
4. A final examination will be given at the end of the semester.

IX. TYPICAL TEXTS:

1. Roger A. Freedman and William Kaufmann III *Universe: Stars and Galaxies.*. 1st Ed ed., W. H. Freeman and Company, 2002.
2. Andrew Fraknoi, David Morrison, and Sidney Wolff. *Voyages To The Stars and Galaxies.*., Harcourt, Inc, 2002.
3. . Jeffrey Bennett *1. Stars, Galaxies, and Cosmology, The Cosmic Perspective.* 3rd Ed., ed., Pearson/Addison Wesley, 2004.
4. Computer access, through purchase of a Computer Use Card at LPC, or access to a personal computer at home or work with an Internet connection.

X. OTHER MATERIALS REQUIRED OF STUDENTS: