Course # 405 ASTRONOMY

GRADE: 10 – 12
CREDITS: 5

RECOMMENDATION: Math 301 and Science 421

BASIC TEXT: Astronomy Today; Chaisson and McMillan; Prentice Hall, 4th edition

SUPPLEMENTAL READINGS: Night Watch, Dickinson ; The Great Atlas of the Sky ; The Universe and How to See It, Sparrow

REQUIRED MATERIALS (provided by student)**:** notebook, calculator, writing materials

COURSE DESCRIPTION:

Astronomy is the study of the universe and is among the most rapidly developing of the physical sciences. This course will investigate terms such as "black hole", "brown dwarf", "quasar", "pulsar", "string theory", and "quark stars" which, in recent years, have revolutionized our understanding of the universe. Goals of the course will be to stimulate scientific curiosity, create the ability to ask scientifically valid questions, strengthen scientific communication skills, interpret and use graphical information, and express an understanding of the basic principles and concepts of astronomy.

MISSION RELATED GOALS:

1) Demonstrate effective written and oral communication skills.
2) Research, focus, and apply resources to the solution of problems.
3) Demonstrate the ability to apply computational skills to the solution of problems.
4) Demonstrate the ability to apply the scientific method to the solution of problems.

STUDENT EXPECTATIONS FOR LEARNING ADDRESSED:

GENERAL PERFORMANCE OBJECTIVES:

The student should be able to:
1) Define each of the related vocabulary words.

2) Recognize the appropriate symbols used.
3) State and define the concepts introduced.
4) Distinguish between different concepts within a topic.
5) Interpret tables and graphs.
6) Collect and organize data in a systematic manner.
7) Present data by construction of charts and graphs.
8) Evaluate the relevancy of data.
9) Write a formal report.
10) Set up and solve problems using math concepts as required (instruction given as needed.).
11) Apply concepts to new situations.

12) Locate (in the sky) and identify some of the more commonly-known northern constellations
13) Locate (in the sky) and identify some of the brightest and/or nearest stars.
14) Locate (in the sky) and identify some of the more widely known Messier Objects (and other Deep-Space Objects).
15) Examine and describe evidence that explains characteristics of the universe, e.g., red and blue shifts, star clusters, types of galaxies, etc.
16) Identify and compare scientific theories of how the universe was formed, e.g., the Big Bang theory, The Steady State theory and the Inflationary universe theory.
17) Define and describe characteristics of celestial objects, e.g., galaxies, stars, planets, moons, etc.
18) Describe stellar evolution with the use of a HR diagram.

MASSACHUSETTS FRAMEWORKS STRANDS:

INQUIRY: DESIGNING AN INVESTIGATION:

- Distinguish those observations that are relevant to the question or problem at hand.
- Formulate testable questions and generate explanations using the results of predictions.
- Make decisions about the range and number of independent variables and how to control other variables in designing experiments.
- Select and use common and specialized tools to measure the dependent variable.
- Select appropriate methods of recording and interpreting data
- Accurately use scientific and technological nomenclature, symbols and conventions when representing and communication ideas, procedures and findings.
- Use mathematics to analyze and support findings and to model conclusions.
- Question interpretations or conclusions for which there is insufficient supporting evidence; recognize that any conclusion can be challenged by further evidence.
- Formulate further testable hypotheses based on the knowledge and understanding generated.

- Interpret data in the light of experimental findings, appropriate scientific and technological knowledge and understanding.

EARTH AND SPACE SCIENCE:

- Describe the components of the electromagnetic spectrum and give examples of its impact on our lives
- Describe the characteristics of waves (wavelength, frequency, velocity, amplitude).
- Describe the nature of the continuous, emission and absorption spectra that indicate the composition of stars.
- Explain how the revolution of the Earth and the inclination of the axis of the Earth cause the Earth's seasonal variations (equinoxes and solstices).
- Explain what causes the tides.
- Explain the Big Bang Theory and discuss the evidence that supports it (background radiation and the Relativistic Doppler effect—red shift)
- Define the unit of distance called a light-year.
- Use the Hertzsprung-Russell Diagram to explain the life histories of stars
- Compare and contrast the final three outcomes of stellar evolution based on mass (black hole, neutron star, white dwarf).
- Compare and contrast the motions of rotation and revolution of orbiting bodies, e.g., day, year, solar/lunar eclipses. Describe the influence of gravity and inertia on these motions.
- Explain Kepler's Laws of Motion.
- Compare and contrast the various instrumentation used to study deep space and the solar system, e.g., refracting telescope, reflecting telescope, radio telescope, spectrophotometer.
- Explain how the Sun, Earth and the solar system formed from a nebula of dust and gas in a spiral arm of the Milky Way Galaxy about 4.6 billion years ago.

CURRICULUM FRAMEWORK LEARNING STANDARDS:

Physics 1. Motion and Forces:

1.3 Distinguish between, and solve problems involving velocity, speed, and constant acceleration.

1.6 Interpret and apply Newton's first law of motion.

1.7 Interpret and apply Newton's second law of motion.

1.10 Interpret and apply Newton's third law of motion.

1.11 Understand conceptually Newton's law of universal gravitation.

2. Waves:

4.2 Recognize the measurable properties of waves.

4.3 Distinguish between mechanical and electromagnetic waves.

4.6 Recognize the effects of polarization, wave interaction, and the Doppler effect.
4.8 Explain the relationship between the speed of a wave and the medium it travels through.

3. Electromagnetic Radiation:

6.1 Describe the electromagnetic spectrum in terms of wavelength and energy, and be able to identify the specific regions such as visible light.
6.2 Explain how the various wavelengths in the electromagnetic spectrum have many useful applications such as radio, television, microwave appliances, and cellular telephones.
6.3 Calculate the frequency and energy of an electromagnetic wave from the wavelength.

Earth and Space Science

1. Matter and Energy in the Earth System

1.2 Describe the components of the electromagnetic spectrum and give examples of its impact on our lives.
1.4 Describe the nature of the continuous emission and absorption spectrum that indicates the composition of stars.
1.8 Explain how the revolution of the Earth and the inclination of the axis of the Earth causes the seasonal variations.
1.9 Describe how the inclination of the incoming solar radiation can impact the amount of energy received by a given surface area.
1.14 Explain how scientists the Earth system through the use of a combination of ground-based observations, satellite observations, and computer models of the Earth system, and why it is necessary to use all these tools together.

2. Origin and Evolution of the Universe:

4.1 Explain the Big Bang Theory and discuss the evidence that supports it.
4.2 Define the unit of distance called a light year.
4.3 Use the Hertzsprung-Russell diagram to explain the life histories of stars.
4.4 Compare and contrast the final three outcomes of stellar evolution based on mass.
4.5 Compare and contrast the motions of rotation and revolution of orbiting.
4.6 Explain Kepler' laws of Motion.
4.7 Compare and contrast the various instrumentation used to study deep space and the solar system.
4.8 Explain how the Sun, Earth, and Solar System formed from a nebula of dust and gas in a spiral arm of the Milky Way Galaxy about 4.6 billion years ago.

UNITS AND THEMES STANDARD NUMBER COVERED:

I. The Formation of Planetary Systems 4.1, 4.2, 4.3, 4.5, 4.6, 4.8
II. The Solar System 4.1, 4.2, 4.4, 4.5, 4.6, 4.7, 4.8

III. Star Formation 4.1, 4.3, 4.4,

IV. Stellar Explosions
V. Neutron Stars and Black Holes1.2, 1.4, 1.14, 4.6, 4.8,
A. The Milky Way Galaxy 6.1, 6.2, 6.3
VI. Active Galaxies and Quasars 1.3, 1.6, 1.7, 1.10, 1.11
A. Cosmology 1.3, 4.2, 4.3, 4.6

VII. The Early Universe 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7

COURSE OUTLINE:

The Formation of Planetary Systems
The Condensation Theory
A. The Differentiation of the Solar System
B. The Role of Catastrophes
C. Planets Beyond the Solar System

VIII. The Solar System
A. Planetary Properties and Kepler's Laws
B. The Overall Layout of the Solar System
C. Terrestrial and Jovian Planets
D. Interplanetary Debris
E. Exploration/Investigation of the Solar System

IX. Star Formation
A. Star-Forming Regions
B. The Formation of Stars Like the Sun
C. Stars of Other Masses
D. Observations of Cloud Fragments and Protostars
E. Star Clusters

X. Stellar Explosions
A. Life after Death for White Dwarfs
B. The End of a High-Mass Star
C. Supernova Explosions
D. The Formation of the Elements
E. The Cycle of Stellar Evolution

XI. Neutron Stars and Black Holes
A. Neutron Stars
B. Pulsars
C. Black Holes
D. Black Holes and Curved Space
E. Space Travel Near Black Holes

XII. The Milky Way Galaxy

B. The Large-Scale Structure of our Galaxy
C. The Formation of the Milky Way
D. Galactic Spiral Arms
E. The Galactic Center

XIII. Active Galaxies and Quasars
A. Beyond the Local Realm
B. Properties of Active Galaxies
C. Quasi-Stellar Objects
D. The Central Engine of an Active Galaxy
E. Quasars as Cosmic Probes

XIV. Cosmology
B. The Universe on the Largest Scales
C. The Expanding Universe
D. The Fate of the Universe
E. The Geometry of Space
F. The Cosmic Microwave Background

XV. The Early Universe
A. Back to the Big Bang
B. The Evolution of the Universe
C. The Formation of Nuclei and Atoms
F. The Inflationary Universe

SUGGESTED Instructional Strategies:

- Count the number of stars visible in the night sky using a random sampling method.
- Identify well-known constellations in the northern night sky.
- Observe stars of different magnitudes and colors; graph the magnitudes vs. temperatures to create a Hertzsprung-Russell diagram.
- Use spectroscopes to observe emission and continuous spectra.
- Construct a Cross-Staff and Quadrant to measure angular separation and size of celestial objects.
- Construct pinhole protractor to measure distance to objects of known size.
- Observing Exercises: the Moon, the Planets, the Sun, Stars, Clusters, and Nebulae; NOTE: minimum of 1 nighttime astronomical observation exercise is required.
- Investigate of Kirchhoff's Laws and Spectroscopy.
- Investigate of Galactic Clusters by means of HR Diagrams.
- Determine the Absolute Magnitude of a Quasar.
- Construct a Star Finder.

SUGGESTED INTEGRATED ACTIVITIES:

Combining astronomy class with photography class on developing some astrophotography units

Combining astronomy class with physics class on electromagnetism and Kepler's Laws of Motion.

USE OF TOOLS/TECHNOLOGY:

- Use classroom computer(s) and integrated software package.
- Use of Smart Board
- Use of Smart Response responders
- Use scientific calculator.
- Use overhead projector.
- Use TV and VCR for viewing video selections.
- Use library computer laboratory.
- Use Starlab Planetarium.

ASSESSMENT TECHNIQUES:

- Objective quizzes and tests.
- Essay questions (including open-ended questions).
- Quizzes on comprehension of videotapes shown.
- Integration projects.
- Cooperative team poster projects.
- Oral reports
- Midterm and Final exams.