COURSE TITLE: GO 130 Astronomy
INSTRUCTOR: Mr. Jack L Espinal
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TERM DATES: 8 January – 2 March 2007
MEETING TIME: Tuesdays 5:00 PM - 10:00 PM
LOCATION: Thomas Jefferson Middle School

SYLLABUS FOR ASTRONOMY

I. **COURSE DESCRIPTION:** This course will study the complexities of the universe. It will examine the physical, chemical, meteorological and geological aspects of the universe, involving planets, suns, asteroids, and nebulas.

II. GOALS OF THE COURSE: This course presents basic principles of Astronomy. You will learn to use the scientific method in gathering information about the universe in which we live. Critical thinking skills will be emphasized and the evidence supporting as theories about the make-up and origins of the universe are analyzed and discussed. Although the course will mostly be descriptive in nature, students will be expected to use simple mathematics to understand and solve some problems.

III. LITERACIES: Park University continues to strive toward its goals / heritage of educating the total person so that he/she may function effectively as individuals and as members of his/her chosen profession, and in the local, national, and world community. To that end the following literacies are stressed in this course.

Science Literacy

1. Understanding of the nature and role of scientific evidence in the pursuit of knowledge.
2. Recognition of the importance of the scientific method of argument and modeling process.
3. Appreciation of the origins of scientific inquiry/method and seeing their continuing presence in the mutual interaction between society and our environment.
4. Acquisition of tools for successful involvement in scientific pursuits of the scientific community.
5. Students will learn to make observations and apply scientific disciplines to explain celestial phenomena.
6. Chemistry and Physics will be used to understand possible atmospheres around planets and the composition of planets, stars and nebula.
7. Atomic theory will be used to understand light and nuclear fusion from the perspective of Astronomy.

Critical Literacy

1. Understanding and mastery of the basic skills in communication, computing, and information management.
2. Recognition of the diversity in the processes and methods of critical thinking and problem solving, and recognition of standards of excellence.
3. Appreciation of the history and variety of approaches for examining and using information, and their technological applications in contemporary life.
4. Acquisition of tools for gathering, retrieving, evaluating, and communicating information and data for various purposes. These tools should include the basic skills in writing, speaking, listening, computing and the use of computers, and problem solving.

Values Literacy

1. Understanding of the importance of value concerns in human life, and the ability to distinguish them from factual matters.
2. Recognition of the major ways proposed for resolving value questions, and the ability to evaluate them and use them where appropriate.

Mathematical Literacy

1. Students will understand the roles that mathematics plays in astronomy.
2. Students will learn to use mathematics to solve simple astronomical problems.

IV. SESSION-BY-SESSION LEARNING OBJECTIVES:

Session One - Central Concepts:

- The motions of astronomical objects you can see by eye follow distinctive patterns and cycles in the sky over both short and long periods of time. These repeated motions suggest an underlying design to the heavens.
- Scientific models of the cosmos can explain and predict the motions of celestial bodies, especially those of the planets. Early models of the cosmos were centered on the earth.
- A heliocentric model of the cosmos was reinvented during the 16th century in Europe, but this break with the geocentric tradition required new physical laws and a revolution of the cosmological views of the time.

Session One - Learning Outcomes

1. Describe the seasonal positions of the sun—at sunrise, noon, and sunset—relative to the horizon from a mid-northern or mid-southern latitude.
2. Describe the motions of the sun and the moon, as seen from the earth, relative to the stars of the zodiac.
3. Describe the motions of the planets, as seen from the earth, relative to the sun and the stars of the zodiac, with special attention to retrograde motions.
4. Describe the astronomical conditions necessary for the occurrence of a total solar eclipse and a total lunar eclipse.
5. Argue, from naked eye observations and simple geometry, an order of the sun, moon, and planets from the earth.
6. Make use of angular measure to find positions of celestial objects relative to the horizon and relative to one another.
7. Describe and explain the essential aspects of a scientific model.
8. Evaluate the essential assets of Ptolemy's geocentric model that led to its wide, long-term acceptance; as part of this appraisal, be able to construct a simplified version of the model.
9. List the assumptions and arguments that Copernicus used to support his model and refute the Ptolemaic one.
10. Explain why Copernicus disliked Ptolemy's use of non-uniform motion and how this bias influenced the development of his heliocentric model.
11. Describe how Copernican ideas influenced the astronomical work of Kepler.
12. Describe the important geometric properties of ellipses and apply these to planetary orbits.

13. Compare and contrast the Copernican model and the Keplerian one in terms of physics, simplicity, geometry, and prediction.
14. State Kepler's three laws of planetary motion and apply them to appropriate astronomical situations.

Session Two - Central Concepts

- Newton's laws of motion and gravitation explain, predict, and unify the motions of the bodies in the solar system. These laws are universal and apply to objects outside of the solar system.
- Matter produces light, and this light carries physical information about the sun, stars, and other celestial objects that emit it. Light comes in discrete units that are emitted and absorbed by atoms.
- Telescopes extend our perception of the cosmos by revealing faint objects and a wide range of the electromagnetic spectrum. New observations impel the development of new models and often the demise of old ones.

Session Two - Learning Outcomes

1. Describe Galileo's important telescopic discoveries and their impact on the controversy over the Copernican and Ptolemaic models.
2. Describe the difference between speed and velocity and between accelerated and unaccelerated motion, giving everyday and astronomical examples.
3. Cite Newton's three laws of motion, describe each in simple terms, provide concrete examples, and apply them to astronomical and everyday cases.
4. Contrast Newton's concept of natural motion to that of Aristotle, especially with regard to celestial motions.
5. Describe Newton's Law of Gravitation in simple physical terms, and apply this law to the concept of weight.
6. Define and describe the concept of centripetal force and acceleration, and use it in the moon - apple test to support Newton's Law of Gravitation.
7. Contrast Newton's astronomy and cosmology with those of Copernicus and Kepler.
8. Describe the differences in the appearance of continuous, absorption, and emission spectra as seen through a spectroscope.
9. Use Kirchhoff's rules to relate the three basic spectral types to the physical conditions of their production.
10. Briefly describe the electromagnetic spectrum with examples from each major region.
11. Use the energy level diagram of a hydrogen atom to explain how the Balmer series is produced, both as emission and absorption lines.
12. Describe the concept of the conservation of energy and apply it to ordinary and astrophysical situations.
13. Describe, sketch, and explain the three major types of spectra in graphical form.
14. Outline the main functions of a telescope (light gathering power, resolution, and magnifying power); relate each to specific optical properties of a telescope's design and sketch those relationships in graphical form.
15. Compare and contrast a telescope's light gathering power, resolution, and magnifying power, and discuss the limitations of ground-based telescopes.
16. Compare and contrast reflecting and refracting telescopes; include a sketch of the optical layout of each in your comparison.
17. Compare a radio telescope to an optical telescope in terms of functions, design, and use.
18. Describe what is meant by the term “invisible astronomy.”
19. Contrast an infrared telescope to an optical telescope in terms of functions, design, and use.
20. Discuss at least two important advantages a space telescope in earth orbit has over a ground-based telescope, and the even greater advantages of telescopes on the moon.

Session Three - Central Concepts

- The general theory of relativity views space and time as unified in four dimensions. The new view of gravity—radically different from that of Newton's—predicts an expanding universe that may be finite or infinite in space-time.
- The dynamic earth is a highly evolved planet, built over thousands of millions of years by geologic processes that are driven by the slow outflow of internal heat. It serves as the model for understanding other planets.

Session Three - Learning Outcomes

1. State the principle of equivalence and illustrate it with a concrete example.
2. Show how the principle of equivalence leads to the local cancellation of gravitational forces and weightlessness.
3. Compare and contrast Aristotle's, Newton's, and Einstein's concepts of natural motion for bodies falling near the earth and of the motions of heavenly bodies.
4. Describe what is meant by the term space-time and give a common example.
5. Argue that concepts of natural motion must be coupled to a notion of the geometry of space-time, both locally and for the cosmos globally.
6. Sketch the interior structure of the earth, indicating the composition of each general region, and argue that the earth's interior structure implies that it must have been molten at one time.
7. Argue from at least two observations that the earth's core probably has a metallic composition.
8. Outline a possible model for the evolution of the earth's oceans that ties in with a broader view of the earth's history.

Session Four - Central Concepts

- The evolutions of the moon, Mercury, Mars, and Venus have been driven by processes similar to those that have created the earth, but have not operated as long or as vigorously.

Session Four - Learning Outcomes

1. Compare the moon, Mercury, Mars, Venus, and the earth in terms of their general surface and physical properties (such as mass and density), with a special focus on how we know this information.
2. Describe each planet’s major surface features and indicate a possible formation process for these features.
3. Compare and contrast the surface environments (such as temperature, atmosphere, surface features, escape speed) of the terrestrial planets.
4. Sketch a model for the structure of the interior of each terrestrial planet and compare them.
5. Describe the process of cratering of planetary surfaces and tell how craters can be used to infer the relative ages of surfaces.
6. Use Newton's law of gravitation to explain the nature of tidal forces, and apply tidal forces to astrophysical situations.

Session Five - Central Concepts

- The Jovian planets, compared to the terrestrial ones, have greater masses and sizes but lower densities. Today they pretty much resemble their early states because they preserve little of the history of their evolution.

Session Five - Learning Outcomes

7. Compare and contrast the Jovian planets as a group to the terrestrial planets, emphasizing the greatest differences.
8. Contrast the Jovian planets to one another in terms of their relative sizes, relative masses, bulk densities, atmospheric compositions, internal structures, and unique features.
9. Compare the rings of Saturn with those of Uranus, Neptune, and Jupiter in terms of size, shape, and possible composition.
10. Compare and contrast the general characteristics, surface features, and evolution of the Galilean satellites of Jupiter: Io, Europa, Ganymede, and Callisto.

Session Six - Central Concepts

- The planets formed from an interstellar cloud of gas and dust as a natural outgrowth to the formation of the sun. They then evolved by common processes into the planets of today.
- The sun produces its life-giving energy by nuclear fusion reactions transforming hydrogen to helium in its hot core. The outward flow of this energy determines the sun's physical structure.

Session Six - Learning Outcomes

1. Describe and compare the general physical properties of comets, asteroids, meteoroids, and meteorites, and state what the radioactive dating of meteorites implies for the dating of the formation of the solar system.
2. Specify what clues asteroids, comets, and meteorites provide about the formation of the solar system, with special emphasis on the composition of each.
3. Describe the appearance of the sun's spectrum and state the atomic processes that produce this spectrum.
4. Briefly, in a sentence or two, explain the source of the sun's energy.
5. State the specific thermonuclear reactions that produce the sun's energy and describe the conditions needed for them to take place.

Session Seven - Central Concepts

- Astronomers determine the physical properties of stars by finding their distances and analyzing the light received from them. Their properties can be summarized in a mass luminosity diagram. Like the sun, we find that stars are naturally controlled thermonuclear reactors.
- Stars are born out of the material in the space between the stars. This material consists of gas (in a variety of forms) and dust, mostly collected in clouds.

Session Seven - Learning Outcomes

1. Outline the methods astronomers use to find the following physical properties of stars: surface temperature, chemical composition, size (radius or diameter), mass, luminosity, and density.
2. Describe the relationship between a star's color and its surface temperature.
3. Show by a simple diagram the relationship between a star's distance and its parallax, noting the limitations imposed by the earth _ sun distance.
4. Present observational evidence for the presence of gas and dust between the stars.
5. Compare and contrast the different forms in which the interstellar gas is found and tell how each form is observed.
6. Describe three observable effects of interstellar dust on starlight.
7. Argue that star birth is occurring now in our Galaxy, with a focus on infrared and radio observations.
8. Explain the observational evidence to date for the existence of extra solar planets around normal stars.

Session Eight - Central Concepts

- Stars evolve; their physical properties change as they go through their normal lives. The main agent in how and how fast a star evolves is its mass.
- Stars finally lose their struggle with gravity. Most stars die violently and leave behind strange corpses: white dwarfs, neutron stars, and black holes.

Session Eight - Learning Outcomes

1. Describe the physical basis of a theoretical model of a star, that is, the physical concepts that go into building a star model.
2. Trace the evolution of a 1-solar_mass star on an H -R diagram, describing the physical changes of the star that result from changes in the star's core.
3. Compare the evolutionary tracks of a 1-solar-mass star and a 5-solar--mass star on an H - R diagram.
4. Indicate how mass and chemical composition affects stellar evolution.
5. Describe how fusion reactions in stars during their normal lives result in the manufacture of some heavy elements, and indicate how these processed materials may be recycled to the interstellar medium.
6. Compare the physical natures of white dwarfs and neutron stars; describe the place of each in stellar evolution and observational evidence for them.
7. Outline possible models for supernova explosions and describe the effects of the aftermath of such an explosion on the interstellar medium.
8. Cite observational evidence that the Crab Nebula is a supernova remnant and describe the effect of the pulsar on the nebula now.
9. Describe how synchrotron radiation is emitted, identify its observed properties, and apply this concept to appropriate astrophysical situations.
10. Describe how nucleosynthesis can occur in a supernova and identify possible products of such nuclear reactions.

Session Nine - Central Concepts

- Field Trip to the Air and Space Museum

Session Nine - Learning Outcomes

- Review and application of all previous outcomes

Session Ten - Central Concepts

- The evolution of the Milky Way, a spiral galaxy, is driven primarily by the evolution of the parts that make up its disk.
- Galaxies make up the visible universe; how are they distributed throughout space and time gives us clues about the origin of the cosmos.

Session Ten - Learning Outcomes

1. Explain at least one astronomical difficulty in trying to figure out the structure of the Galaxy from our location in it.
2. Name the important spiral arm tracers and state generally how they are used to map spiral structure.
3. Present the observational evidence for the Galaxy's having a spiral structure; that is, describe what specific methods astronomers use to work out the positions of spiral arms.
4. Sketch the rotation curve of the Galaxy, describe how to find from it the approximate mass of the Galaxy, and argue that a significant amount of the Galaxy's mass must exist in the halo in an unseen form.
5. Outline a model for the evolution of the disk of the Galaxy.
6. Speculate on the future of the Galaxy from current information and models.

V. COURSE ARRANGEMENTS: Lectures, class/group assignments; problem solving, discussions of readings, oral reports/presentations; field trips; films, videos, and other media that may be deemed appropriate and available will be used throughout the course. Collaborative learning techniques will be used to analyze and solve problems in small groups.

VI. COURSE REQUIREMENTS: Students are required to read all assigned material prior to class and be prepared to discuss them and apply them to problem solving situations presented in class. Assigned problems and chapter questions will be completed before the beginning of class. Discussion of chapter questions and assigned problems will be the basis of the class participation grade. Students will research an instructor-approved astronomer and make an oral presentation on that individual to the class. Students will make an oral group presentation to the class after the Smithsonian Field Trip

VII. TEXTBOOK: Zeilik, Michael. (2001). Astronomy: The Evolving Universe Ninth Edition. Cambridge University Press.

VIII. SUPPLEMENTAL RESOURCE MATERIALS LIST:
The course web page: http://www.jespinal.com
Moche, Dinah L. Astronomy: A Self Teaching Guide. John Wiley and Sons.
Sagan, Carl. Billions and Billions. Random House

Sagan, Carl. Carl Sagan's Cosmic Connection. Cambridge University Press.
Consolmagno, Guy and Davis, Dan M. Turn Left at Orion. Cambridge University Press
Davis, Kenneth C. Don't Know Much about the Universe. Harper Collins.
The Planetary Society http://planetary.org/
The Hubble Heritage Project http://heritage.stsci.edu/
The Heavens Above http://www.heavens_above.com/

IX. CLASS MEETING AND EXAMINATION SCHEDULE:

Date	Reading	Prepare for Class Session Topic	Evaluations
Thursday January 11, 2007	Astronomy, Chapters 1, 2 & 3	**Ch1** 2, 3, 6, 8 **Ch2** 10-12 **Ch3** 1, 6, 9, 10 Historical Astronomy Naked Eye Observation	Stick In Ground Ex Quiz
Thursday January 18, 2007	Astronomy, Chapters 4 & 5	**Ch4** 1, 5, 10, 15 **Ch5** 3, 5, 10, 12, 14 Clockwork Universe Astrophysics and Telescopes	Moon Observation Ex Quiz
Thursday January 25, 2007	Astronomy, Chapter 6 & 7	**Ch6** 3, 5 ,8, 9 **Ch7** 1, 2, 6 Telescopes & the Cosmos, Einstein's Relativity	Quiz
Thursday February 1, 2007	Astronomy, Chapter 8 & 9	**Ch8** 2, 4, 9 **Ch9** 1-4, 6 Terrestrial Planets	Quiz
Thursday February 8, 2007	Astronomy, Chapter 10 & 11	**Ch10** 1, 2, 4 **Ch11** 1-2 Jovian Planets and Evolution of the Solar System	Mid Term
Thursday February 15, 2007	Astronomy, Chapter 12 & 13	**Ch12** 3, 4, 9 **Ch13** 1, 3, 10 The Sun and the Stars	
Thursday February 22, 2007	Astronomy, Chapter 14 & 15	**Ch14** 2, 10, 14 **Ch15** 1, 4, 6, 8 The lives of the Stars	Quiz
Saturday February 24, 2007		**Smithsonian Field Trip** (No class on Thursday 8 March 2007)	
Thursday March 1, 2007	Astronomy, Chapter 16 & 17	**Ch16** 1, 4-6 **Ch17** 1, 7, 12, 14 Star Death and Galaxies	Final Examination

X. CLASS POLICIES: Class attendance is important. Class participation is expected and will form a part of the final grade. Students are expected to come to all classes and be on time. Roll will be checked each class meeting. Classes missed for legitimate reasons, such as illness, temporary duty, are excusable; however, the student must make up the missed work by completing class exercise sheets and attending alternate activities. See the course web page for details. (a partial failing grade for class participation will be assessed for late chapter assignments or un-excused absences). Quizzes, announced or unannounced cannot be made-up. Videotapes shown in class and associated written class work cannot be made up. The course web page - http://www.jespinal.com - contains electronic copies of many of the exercises and practice sets used in class. Browse the page to see what is there.

Academic honesty is required of all members of a learning community; hence, the College will not tolerate cheating or plagiarism on tests, examinations, papers, and other course assignments. Students who engage in such dishonesty may be given failing grades or expelled from the College.

Plagiarism, the appropriation or imitation of the language or ideas of another person and presenting them as one's original work, sometimes occurs through carelessness or ignorance. This does not make it less serious, however. Students who are uncertain about proper documentation of sources should consult their course faculty member.

XI. GRADING POLICY: Grades will be based upon the following items:

Item	Approximate Weight	**Notes**: Quizzes and Video Viewing Guides are given only during class. There are no make-ups

<table>
<tr><td>Class Participation</td><td>10%</td><td rowspan="8">permitted if you miss them in class.

Students must have at least a passing grade for each of the above areas to receive a passing grade for the course.

Research Project Presentations must be made on the date scheduled to receive full credit</td></tr>
<tr><td>Reading & Problem Sets</td><td>10%</td></tr>
<tr><td>In Class Labs / Quizzes</td><td>15%</td></tr>
<tr><td>Video Viewing Guides (Collaborative)</td><td>15%</td></tr>
<tr><td>Research Project / Presentation</td><td>10%</td></tr>
<tr><td>Smithsonian Field Trip & Presentation</td><td>10%</td></tr>
<tr><td>Midterm Examination</td><td>15%</td></tr>
<tr><td>Final Examination</td><td>25%</td></tr>
</table>

Letter Grades for the course will be calculated as follows:

Percentage	Grade
90-100	A
80-92	B
70-79	C
60-69	D
Below 60 or 3 un-excused absences	F

XII. MAKING UP A MISSED FINAL EXAM: Only extraordinary circumstances warrant a student's being allowed to make up a missed final examination. It is the student's responsibility to contact the instructor before the scheduled exam or by the end of the first working day after the day of the missed exam to request permission to take a make-up exam. In the process of determining whether a make-up exam should be allowed, the burden of proof is on the student. The instructor has the right to request verification of any excuse offered by the student.

The student who is denied permission to take a make-up exam may appeal immediately to the Academic Director or Resident Center Administrator. The appeal must be made by the end of the first working day after the day of the denial. The appeal will be forwarded immediately to the Assistant Vice President for Extended Learning whose decision will be final.