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ASTR 502 : Teaching Earth and Space Science

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Fall 2015: Offered by the [Physics and Astronomy Department](#) with cooperation from the [Houston Museum of Natural Science](#) and NASA.

DESCRIPTION

This course is designed for inservice and preservice teachers (grades 5-12), but Rice undergraduates considering a teaching career are also welcome. This class is an overview of the Earth and the solar system, their structure, evolution, and dynamics. It includes fundamentals of Earth and Space Science topics as taught in 6th grade, plus solar system content of "Earth and Space Science" and "Astronomy" Texas high school courses. Includes mathematics of solar system motion at level of algebra, logarithms and simple trigonometry, including Kepler's and Newton's laws. Includes instruction in use of Earth and solar system software. Observing sessions at Rice campus observatory and George Observatory TBD.

OVERVIEW

Goal: This course develops solar system concepts and skills in a manner consistent with the Next Generation National Science Standards and Texas Essential Knowledge and Skills proficiencies. It uses solar system examples to teach mathematical skills including exponential, logarithms and powers. It covers all the solar system material in the Texas High School Astronomy course, and the "Earth in Space" concepts from the new TX "Earth and Space Science" course, but presented at a level accessible by upper elementary and middle school teachers. (The remaining stellar and galactic astronomy concepts are covered in ASTR 403). The course uses materials from the "Space Update" program, involves student inquiry using software and web-based materials, and has some hands-on solar system observing labs.

Dates: August 24 - Dec 2, 2015, Mondays, 6:00 - 9 pm (with some observing on campus and at George Observatory)

Location: Herman Brown Hall 223, Rice campus (plus planetarium in BRK 250), plus campus observatory and George Observatory as noted on schedule

LEARNING GOALS

As a result of this class, the student will be able to:

1. describe and distinguish the various types of solar system objects: planets, dwarf planets, comets, asteroids, Kuyper belt objects.
2. use Kepler's laws to calculate apogee and perigee from semimajor axis and eccentricity, or vice versa.
3. use Newton's laws as applied to planetary motion.
4. describe the principal theories of solar system formation, and explain how the planetary composition results.
5. use semi-log and log-log paper to plot planetary data, demonstrating knowledge of logarithms and exponentials.
6. calculate escape speed from solar system objects, and relate that to an object's ability to retain an atmosphere.
7. use albedo and greenhouse fraction to calculate planetarium equilibrium temperature.
8. find planet locations in the sky and be able to observe and demonstrate to others.
9. make sketches of planets using telescopic observations.
10. (Communication) research a planetary mission, a planet, or a mission to search for extrasolar planets, and make a powerpoint presentation to class.

CLASS DETAILS

Instructor

Prof. Patricia Reiff (reiff@rice.edu), with special activities by Adjunct Prof. Carolyn Sumners of the Houston Museum of Natural Science. Office Hours by appointment. Course assistant/tutor for 2015: Gigi Nevils_Noel. Observing assistant: TBD.

"Field Guide to Stars and Planets", Pasachoff, ISBN 978-0395934319

Texts	"Space Update", Rice University, ISBN 9781931-523530. Also bring your laptop to class.
University Credit Hours	3 (sorry, no stipend) To register for credit, contact Patricia Reiff (reiff@rice.edu) at 713-348-4634. You must be registered as a Visiting, undergrad, or Master of Science Teaching student. Teachers wishing to participate as a Visiting Student, please bring ID and social security number to first class. Note: up to 9 credit hours taken as a Visiting Student can be applied towards your Master of Science Teaching degree. A few slots may be available for remote participants via zoom. A few slots may be available for teachers wishing only Continuing Education Credits at a special \$150 rate.
Grading Policy	Each homework is a variable number of points (4-10); each of the two quizzes is 20-24 points; the observing lab is 6 points; and the term report is 12 points. The final grade is calculated by dividing the number of points earned by the total number available (generally 120). Calculators are encouraged both for homework and for quizzes.
Absence Policy	The lectures will be recorded for later playback through owlspace. Because of the intense hands-on nature of some of the sessions, and the fact that we will observe through the campus telescope if weather permits, students should try to attend every class but no specific penalty for absences
Tuition/fees	Thanks to a generous discount from Rice University, the tuition for teachers is only \$1200 for three hours of graduate credit, plus other University fees (roughly \$140). A few tuition scholarships are available for inservice teachers. Remote participation via Zoom is possible. Participation as an auditor only (for CEU credits) is also possible for \$150 fee. Contact Dr. Reiff.
Honor Code	Students may work together on homework but each student shall turn in their own paper. Quizzes must be pledged as individual work and are s ubject to the Rice Honor Code.
Students With Disabilities	Any student with a disability that requires accommodation should contact the instructor and the Disability Support Servies. We will attempt every reasonable accommodation.

Alignment with Texas Standards and High School Course requirements

SCIENCE TEKS

Grade Levels: 6-8 (general science) and 9-12 (IPC, Astronomy)

Strands: Components of the Solar System, Changes and Cycles (seasons, tilt; phases of Moon), Conceptual Models, Major Earth processes and systems, Forces and Energy; Newton's and Kepler's Laws, Waves, The Sun

MATH TEKS

Grade Levels: 6-8 and 9-12

Strands: Numbers, Operations, and Quantitative Reasoning, Patterns, proportions, algebraic reasoning, Geometric shapes, volumes, densities, Measurement; units, formulas, Linear and logarithmic functions, Graphing, Relationship between algebra and geometry

HIGH SCHOOL ASTRONOMY (TEXAS COURSE 112.48)

Knowledge and Skills: Scientific Processes, scientific methods, field and laboratory investigations, use of data to make inferences, communicate conclusions

- Science Concepts:
1. Observe and record data about lunar phases and use that information to model the earth, moon and sun system; observe and record the apparent movement of the Sun and Moon during the day and the Moon, planets and stars in the nighttime sky
 2. Units of measurement such as Light Year and Astronomical Unit; History of astronomy;

planetary motion; Equation of gravitation; compare and contrast the scale, size, and distance of the Sun, Earth and Moon system, and the sizes and distances of the planets

3. The Sun: its energy sources; the Sun's effect on earth; the effect of rotation, revolution and tilt on the environment; the effect of the Moon on tides; the solar system (the remaining stellar and galactic astronomy concepts are covered in [ASTR 503](#)).

HIGH SCHOOL EARTH AND SPACE SCIENCE (TEXAS COURSE 112.36)

Knowledge and Skills: Scientific Processes, scientific methods, field and laboratory investigations, use of data to make inferences, communicate conclusions

Science Concepts: 1. The student knows that Earth's place in the solar system is explained by the star, planets, and minor bodies of a stellar system that accrete from a stellar nebula as explained by the nebular-planetesimal-protoplanet model.

2. The student can explain how the Sun and other stars transform matter into energy through nuclear fusion.

3. The student will explore the historical and current hypotheses for the origin of the Moon, including the collision of Earth with a Mars-sized planetesimal.

4. contrast the characteristics of solar system planetesimals such as comets, asteroids, meteoroids, and their positions within the Oort Cloud, the Kuiper Belt, and the asteroid belt

5. compare the terrestrial planets to the gas giant planets, including internal structure, atmosphere, size, density, solar orbit, presence of water, surface features, tectonic activity, temperature, and suitability for life; explore the historical and current hypotheses for the origin of the moon, including the collision of Earth with a Mars-sized planetesimal; compare recently-discovered extra-solar planets with planets in our solar system, and describe how such planets are detected. The student can describe the formation and structure of Earth's magnetic field, including its interaction with charged solar particles to form the Van Allen belts and auroras.

SCHEDULE : FALL 2015 (Tentative)

DATE	MATERIAL
Mon Aug 24 6:00-9:00 pm, HBH 223	Class overview; filling out of forms and pretest; installation of Space Update DVD; Install Stellarium; Overview of the Solar System. Start on Homework 1 . (BRING A LAPTOP)
Mon August 31 6:00-9:00 pm, HBH 223	Celestial coordinates; Seasons; Ecliptic, orbits. Activity: Stellarium. Start on homework: Homework 2)
Mon Sept 7 No Class - LABOR DAY	Enjoy the holiday! (Will be rescheduled TBD)
Mon Sept 14 BRK 230 (6-9 pm)	More on Celestial coordinates; sidereal and solar rotation and revolutions, galactic coordinates. Turn in homework 1 and 2. Start Homework 3 .
Sat, Sept 19) 8 - 10 pm, Brockman 4th floor	Public Observing, campus observatory; Observe the Moon Night
Mon Sept 21 HBH 223 (6-9 pm)	Kepler's Laws 1&2: ellipses (semimajor axis, eccentricity, periapsis, apoapsis), speeds of planets (Homework: ellipse activity)
Tues Sept 29 HMNS (TBD)	Planetarium show: Celestial coordinates; the solar system
Mon Oct 5 HBH 223 (6-9 pm)	Kepler's Laws 3: periods and semimajor axes; logarithms; plotting orbits. (Activity: orbits; Homework: plotting periods versus distance for Saturn's moons)

Mon Oct 12 HBH 223 (6-9 pm)	More on Kepler's Laws; The Sun; Formation of the Solar System
Mon Oct 19 HBH 223 (6-9 pm)	The Moon (Activity: lunar size and distance); Review for Quiz; Observing, observatory
Sat Oct 24 3pm - 10 pm, George Observatory, Brazos Bend State Park	"Astronomy Day" (lectures and observing after dusk)
Mon Oct 26 HBH 223 (6-9 pm)	Review and quiz 1. Use the topics and terms sheet to review. You may use a double-sided handwritten cheat sheet.
Mon Nov 2 HBH 223 (6-9 pm)	Inner planets: Mercury, Venus, Earth
SATURDAY November 7 (tentative) starting 8 pm if clear, George Observatory, Brazos Bend State Park	OVERNIGHT at the George! (bring sleeping bags and floor pads)
Mon Nov 9 HBH 223 (6-9 pm)	Earth as a planet: Albedo, temperature and greenhouse effect; ice ages
Mon Nov 16 HBH 223 (6-9 pm)	Mars and Asteroid Belts, comets
Mon Nov 23 HBH 223 (6-9 pm)	Outer planets. SPECIAL: Lecture by Fran Bagenal on New Horizons
Mon Nov 30 HBH 223 (6-9 pm)	Dwarf planets (Pluto, Eris, etc...); Extrasolar planets; Class presentations.
Thursday, Dec 4 HBH 223 (6-9 pm)	(Optional) Class presentations (if needed); Review for Quiz 2 (will be takehome)

HOMEWORK (Fall 2015 (tentative))

- **Homework 1** (due Sept 14): Using "the Sky Tonight" portion of Space Update, which planets will be visible in the evening skies this semester? Which in the morning skies? Which day(s) will be the best for early morning observing of planets passing each other? Which planet(s), if any, will be near opposition this semester (visible in the EAST in the evening and in the WEST in the morning? Read the "[Astronomy Activities for Elementary Students](#)". Look in [Naval Observatory Moon page](#): when will the next new moon be? (note: subtract 5 hours from UT to get CDT). The day of the next new moon, start watching for the Moon in the west, just after sunset (but before fully dark). (Generally is not visible until 24 hours after new). Start making daily observations of the Moon's altitude, azimuth, and shape, all at the same time of the evening (will be turned in as Homework 2).
- **Homework 2** (due Sept 14): Download Stellarium from stellarium.org, for your personal computer. Do the [Stellarium activity](#). Use the [Stellarium key codes](#) for shorthand
- **Homework 3**: (Due Nov 9) [Plotting the Moon: Sky Tonight activities number 4 and number 5](#) from Space Update (use your own data from HW1 and also separately do that from Sky Tonight)
- **Homework 4**: (Due Oct 5) Solar system algebra (Solar System Activity 3) "[Planet Math](#)" and Activity 5 "[Exploring Ellipses](#)" (include at least two ellipses, one fat and one skinny, from the "advanced activity")
- **Homework 5**: (Due Oct 19) [Plotting the moons of Jupiter or Saturn](#): logarithm plots
- **Homework 6**: (Due Nov 16) Solar system - view from the top
- **Homework 7**: Observing Project
- **Homework 8**: (Due Nov 30) Public Education Project (Write up a paragraph on what you participated in, e.g. Astronomy Day or Public Observing night)
- **Homework 9**: (Due Nov 23) Albedo and Temperature, Greenhouse effect
- **Homework 10**: (Due Nov 30) Solar System Mission Report (counts as 12 points, including presentation)

OBSERVING PROJECT (Fall 2015 (tentative))

Observe at least 6 solar system objects. Draw a sketch using the [JPG](#) or [PDF](#) observing form, being sure to note the location, telescope used, etc. Put a sketch of what you see in the eyepiece in the circular field. Try to make it accurate as to the relative size

of the object compared to the field of view. Use a different page for each session. One of your objects can be the Sun (use safe techniques!)

You may do your viewing at "**Astronomy Day**", George Observatory (Oct 24 this year), 3 - 10 pm. Excellent time to knock them all out! Doors open 3pm for talks but observing doesn't start till dark, obviously.

Limiting magnitude: The "limiting magnitude" is the magnitude of the dimmest star you can see with your naked eye. Use a finder chart or a sky program on your phone or iPad to check the sky. Note it can change during the evening.

Field of View: If the Moon is visible, it makes a great way to estimate the field of view, since it is a half-degree (30 arc minutes) across. But if the Moon isn't out, you can use Jupiter or Mars. Given Jupiter's or Mars' size in your field of view, you can estimate the field of view of the eyepiece by seeing how many Jupiters or Marses fit across the field of view.

Find out how far away Jupiter or Mars was the day you observed (use Stellarium). Use its physical size to get its angular diameter; from that you should be able to calculate the field of view. NOTE: once you calculate the field of view using one eyepiece/telescope combination, it stays the same for other objects using that eyepiece and telescope.

Magnification: Equals the focal length of the objective divided by the focal length of the eyepiece. The Focal Length of the observatory 16 inch telescope is 4 m; of the 11-inch Celestron is 2m; of the 8 inch Celestron, 1 m. Most of the time we will use the 31mm eyepiece for wide views and 12mm for higher magnification. The field of view is inversely proportional to the magnification.

There will be at least four evening sessions, but we get clouded out a lot, so be sure to come to the first possible session you can! Or, you can go the "George Observatory" (in Brazos Bend State Park) any clear Saturday evening.

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