Johns Hopkins University
School of Professional Studies in Business and Education
Graduate Division of Education

Understanding and Teaching Stars, Galaxies and Beyond
Course number 886.633 section 1

Fall Semester, 2004
Homewood Campus, Bloomberg 462

Instructor: Dr. Helen M. Hart
410-516-4375 10 AM to 6 PM Monday thru Friday
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Credit Hours: 3

Class Time: 6:45-8:45 pm Wednesdays, Sep 01 - Dec 15
Bloomberg building room 462

Course Description:
"Understanding and Teaching Stars, Galaxies and Beyond" is an introduction to stellar, galactic and extra-galactic astronomy designed for secondary mathematics and science teachers. Astronomy topics will include: appearance of the sky; astronomical maps and time; telescopes and other tools; spectroscopy and radiative processes; the physical nature of stars; stellar formation and evolution; structures in our galaxy; nearby galaxies; distant galaxies; structure of the observable universe. Emphasis will be placed on giving participants an understanding of the stars and nebulae visible in the sky, as well as teaching methods, approaches and resources.

Course Objectives: The primary objectives of this course are
1) To give participants an understanding of the appearance of the sky and some experience in observing fundamental phenomena.
2) To give participants a basic understanding of the physical nature of stars, stellar evolution, the structure of our galaxy, the nature of other galaxies, and our current understanding of the structure of the universe.
3) To give participants an introduction to the evidence and reasoning which underlies our current view of the nature of the universe.
4) To give participants an opportunity to think about how to integrate astronomical topics into their own classroom, utilizing the education standards and benchmarks.
4) To give participants an opportunity to present ideas and experience with teaching science, particularly astronomy, in their classrooms, utilizing the education standards and benchmarks.
6) To acquaint participants with the location and content of reputable and useful sources, including internet sites, for astronomy content and pedagogy information.

Required Texts and Other Materials:
1) Freedman, R.A. and Kaufmann, W.J. III, *Universe*, 6th ed., W.H. Freeman and company, 2002.
2) Rey, H.A., *Find the Constellations, Revised Edition*, Houghton Mifflin Company, Boston, 1982.
3) Planisphere.
4) National Research Council, *National Science Education Standards*, National Acad. of Sci., 1996.
5) Project 2061, American Association for the Advancement of Science, *Benchmarks for Science Literacy*, 418 pp., Oxford University Press, New York, 1993.
6) Project 2061, American Association for the Advancement of Science, *Science for All Americans*, 272 pp., Oxford University Press, New York, 1990.
7) **CDROM:** Freedman, R.A. and Kaufmann, W.J. III, *Universe 6.0, with* Starry Night *astronomy software*, W.H. Freeman and Sumanas Multimedia Development Services, Sumanas, Inc., 2002.

Assignments
Assignments are divided among five areas: (1) in-class teaching discussions; (2) in-class exercises and quizzes; (3) homework (study of the astronomy text via reading and problems); (4) lab exercises (observing, paper, and internet); and (5) teaching essays.

1) In-class Teaching Discussion

The first 20 minutes of each class will be devoted to a critical discussion about teaching astronomy. Most weeks the topic will be ideas about teaching the previous week's content to your class. Class members will each take a turn as discussion leader.

The discussion leader will make a 10-minute oral presentation of your teaching essay for that week, emphasizing which benchmarks you were aiming at, and how you might address those benchmarks. The rest of you are expected to give useful feedback, and to bring up other points. You are graduate students and working teachers: I will expect a high level of sophistication in these discussions.

The facilitator (me) will keep the discussion on track and ensure that everyone contributes. Participation earns up to 5 points, leader earns up to 15 points. Evaluation will be based on my judgement that you made a valid effort. That is, if you participate according to your role that week, you will get full credit; if you are late, or don't actively participate, or haul the discussion off track, you will lose some points; if you miss the discussion, you will get a 0.

2) In-class exercises & quizzes

In-class exercises will consist of participation in demonstrations and activities, and an occassional quiz based on the previous few weeks reading (see especially the Key Words at the end of each chapter). Points for in-class exercises will be awarded at the end of the exercise. Quiz dates are specified in the Course Outline.

3) Homework problems

Homework will consist of reading assignments and problem sets and short writings from the text and CDROM. Homework assignments will be due by the next class.

4) Lab exercises

Lab exercises differ from homework in scope: homework should be doable in a few hours of concentrated effort; lab exercises will require independent steps which might take weeks to complete. There will be 8-10 exercises of varying difficulty, for a total of about 400 points. Some exercises require the student to observe the stars. Some exercises are web-based. Some exercises are done on paper. Some utilize *Starry Night*. Due dates and points per exercise will be specified when the assignment is handed out.

5) Teaching essays

Five teaching essays will be assigned through the semester. Length: 1-3 pages should be enough, and I will stop reading after page 3.

Essay 1: Due Sep 8. Topic: Evaluation of *Science for All Americans* and *Benchmarks*. Specifics handed out in class.

Essays 2-5: Due no later than Dec 8. Topics: Your thoughts about how to teach some aspect of the previous week's in-class topic. Do **NOT** give me a formal lesson plan! Particular attention should be paid to identifying how Benchmarks would be met. You may choose a lab exercise for your discussion, but tell me in advance.

N.B. One of these essays will coincide with your week as Discussion Leader.

Late

All assignments will be handed to me in class on the due date. A grace period may be granted with a valid excuse to me before the due date. Un-graced late assignments will be graded, and then down-graded by 25% for each week that they are overdue. No written work will be accepted after the penultimate class meeting date.

Absent

Notify me in advance, if at all possible: send an email, or leave a message on my phone. In class activities cannot be made up, except quizzes by arrangement with me.

Evaluation/Grading:

Evaluation is divided among five areas: (1) in-class teaching discussions; (2) in-class exercises and quizzes; (3) homework (study of the astronomy text via reading and problems); (4) lab exercises (observing, paper, and internet); and (5) teaching essays. Final grades will be based on cumulative points for the semester. There will be approximately 890 points, with the distribution shown below. Note that small changes in the

point total are possible. About 4/5 of the points are astronomy content, 1/5 are teaching application.

Activity	avg. points/asgn	no. asgn	semester total	percent of grade
In-class teaching discussion	5(15)	13(1)	80	9%
In-class exercises & quizzes	10	14	140	16%
Homework problems	15	13	195	22%
Lab exercises	20-50	8-10	400	45%
Teaching essays	15	5	75	8%
Total:	–	–	890	100%

Grade Scale:	GPA	grade	% of total points
	4.0	A	≥92%
	3.7	A-	≥86%
	3.3	B+	≥82%
	3.0	B	≥78%
	2.7	B-	≥74%

Course Outline: (Topic coverage may shift slightly to accomodate guest speaker schedules.)

1 - Sep 1 Introduction to the universe.
Topics: sign in and payment; class organization and requirements; the texts; brief summary of the course.
Teaching discussion: Why teach science? Astronomy topics: What do you want to learn about astronomy? Talking science: vocabulary and math.

2 - Sep 8 Sky and Stars: basics.
Teaching discussion (instructor): Why teach astronomy? The role of astronomy in K-12 education.
Astronomy topics: QUIZ (20 pts) constellation and star quiz; vocabulary; big numbers; algebra; angles.
Study: *Find the Constellations*
Standards reading: *Science for all Americans* through Chapter 4; *Benchmarks* through Chapter 4.

3 - Sep 15 Sky and Stars: how far, and how do we know.
Teaching discussion: _____
Astronomy topics: appearances, RA and Dec, parallax, proper motion, magnitude, angular measure, distances, make and use inclinometer.
Study: *Universe* Chapter 1, Chapter 19 sections 1-3
Standards reading: *Science for all Americans* and *Benchmarks* Chapter 9.

4 - Sep 22 Sky and Stars: advanced appearances.
Teaching discussion: _____
Astronomy topics: models; living orrery; planisphere.
Study: *Universe* Chapters 2-3, and Chapter 4 sections 1-2
Standards reading: *Science for all Americans* and *Benchmarks* Chapter 10.

5 - Sep 29 Stars and Light, Part 1.
Teaching discussion: _____
Astronomy topics: electromagnetic radiation; temperature; thermal emission; magnitude, color and surface temperature.
Study: *Universe* Chapter 19 sections 3-4; Chapter 5 sections 1-4.
Standards reading: *Science for all Americans* and *Benchmarks* Chapter 11.

6 - Oct 6 Stars and Light, Part 2.
Teaching discussion: _____
Astronomy topics: quantum mechanics and spectroscopy; stellar spectral classes; HR diagram; spectroscopic parallax.
Study: *Universe* Chapter 19 section 5-8; Chapter 5 sections 6-8.
Standards reading: *Science for all Americans* and *Benchmarks* Chapter 12.

7 - Oct 13 Stars and Gravity: orbits.
Teaching discussion: _____

Astronomy topics: gravity; ellipses; orbits; binary stars, eclipsing binaries; using orbital motion to measure mass.
Study: *Universe* Chapter 4 sections 3-7; Chapter 5 section 9; Chapter 19 sections 9-11.

8 - Oct 20 Telescopes and Observing.
Guest speakers: Forrest Hamilton, Space Telescope Science Institute, and Ryan Newcomer, Maryland Space Grant Observatory technician.
Teaching discussion: _____
Astronomy topics: how telescopes work, lenses and mirrors, focal length, magnification; light pollution. If it's clear, we'll go outside for observing in the last hour.
Study: *Universe* Chapter 6 sections 1-3, 7.

9 - Oct 27 Stellar evolution: star birth.
Teaching discussion: _____
Astronomy topics: QUIZ vocabulary Ch.s 1, 2, 5, 6, 19 (20 pts); nebulae; open (young) clusters; star birth, interstellar medium, stellar internal structure; the sun as a star; HR diagram and evolution.
Study: *Universe* Chapter 18 sections 1-7; Chapter 20.

10 - Nov 3 Stellar evolution: aging and death
Teaching Discussion: _____
Astronomy Topics: star mass, nuclear fusion, main sequence lifetime; variable stars, stellar clusters, low mass stars: planetary nebulae, white dwarfs; high mass stars, giant and supergiant stars, supernovae, the creation of elements, seeding the interstellar medium; the distance ladder.
Study: *Universe* Chapter 21, 22.

11 - Nov 10 Neutron stars and black holes.
Teaching Discussion: _____
Astronomy topics: neutron stars, pulsars, novae, bursters; gravity and relativity, space-time, event horizon.
Study: *Universe* Chapters 23, 24.

12 - Nov 17 Introduction to the Milky Way.
Teaching discussion: _____
Astronomy topics: kinds and distribution of nebulae, the size and shape of the galaxy, rotation and dark matter, variables, globular clusters.
Study: *Universe* Chapter 25.

Nov 24 *Thanksgiving break - no class*

13 - Dec 1 Other galaxies.
Teaching discussion: _____
Astronomy topics: the nebulae, morphology, finding the distances: type and surface brightness, variable stars, supernovae, red shift and distance, the age of the universe.
Study: *Universe* Chapter 26.

14 - Dec 8 Cosmology: the Creation and Fate of the Universe.
Teaching discussion: _____
Astronomy topics: expansion; big bang; dark energy; universe through time.
Study: *Universe* Chapter 28.

15 - Dec 15 Extrasolar planets and SETI.
Teaching discussion: the role of astronomy in K-12 education.
Astronomy topics: QUIZ vocabulary Ch 20-22, 25-27 (20 pts); probability of other planetary systems, the Drake equation, discovery of extrasolar planets, the search for extraterrestrial intelligence.
Study: *Universe* Chapter 30

Classroom Accommodations for Students with Disabilities:
If you are a student with a documented disability who requires an academic adjustment, auxiliary aid, or similar accommodation, please contact Ann Harrell in the Office of Student Affairs at 410-872-1210 or via email at harrell@jhu.edu

In case of bad weather, alien invasions, etc...
The JHU WEATHER EMERGENCY LINE can be reached at 410-516-7781 or 1-800-548-9004. Weather Emergency Line provides information on class and campus closing, due to inclement weather. The university may also use the same phone lines occasionally to distribute other urgent information.

Other Opportunities:

Public observing around Maryland. (Observing is ALWAYS contingent on the weather!)

JHU Maryland Space Grant telescope Fridays dusk-10 pm	call 410-516-6525
Soldier's Delight Park, Owings Mills MD	call 410-922-3044
Maryland Science Center, Baltimore MD Thursdays dusk-10 pm, Sundays 11 am - 4 pm	http://www.mdsci.org/obs.htm
Astronomy for Everyone at Sky Meadows Park Delaplane VA dusk-11 pm at the Visitor Center	http://www.howardastro.org/skymeadow.htm

Open Night at the Space Telescope Science Institute
Free public lectures, 8 pm the first Tuesday of every month, in the STScI auditorium (across the street from Bloomberg). Call 410-338-4700 or check the web site http://hubblesite.org/about_us/open-night.shtml

Additional Reference Materials: Some of these materials are available on loan from the instructor. Most of the rest can be found in the JHU library.

Teaching astronomy

The Universe at Your Fingertips and *More Universe at Your Fingertips*, Project ASTRO, Astronomical Society of the Pacific, edited by A. Fraknoi and D. Schatz. Hands-on exercises for teaching astronomy; lessons developed to support the Benchmarks.

Math review

Introductory Mathematics for Industry, Science, and Technology, by Keith Roberts and Leo Michels, Brooks/Cole Publishing Company.

General astronomy

The Stars: a New Way to See Them, by H.A. Rey (yes, the Curious George author!) For ages 12+. A simple, but not simplistic, introduction to the night sky, the planets, and the motions of the sun and moon.

365 Starry Nights, by Chet Raymo. Short essays on introductory astronomical topics, one for each night of the year. The diagrams are great!

The Sky: a User's Guide, by David H. Levy. An excellent guide to observing the moon, the sun, comets, planets, the stars, and the nebulae, written by a noted amateur astronomer with several comet discoveries to his credit. This is an excellent book for someone who wants to go beyond the introductory level.

The Physical Universe: an Introduction to Astronomy, by Frank H. Shu. Excellent presentation of the physical processes underlying astronomical phenomena. I strongly recommend this book for anyone planning to teach at the college, high school or advanced middle school level.

Topical astronomy

Looking for Earths: The Race to Find New Solar Systems by Alan Boss. An excellent discussion of the search for planets around other stars, by a leading theoretician in the field of planetary formation.

Cosmic Clouds : Birth, Death, and Recycling in the Galaxy by James B. Kaler. An in-depth discussion of the processes of stellar formation, stellar death, and the interstellar medium.

The Accelerating Universe : Infinite Expansion, the Cosmological Constant, and the Beauty of the Cosmos, by Mario Livio and Allan Sandage. This new book discusses some of the most profound aspects of cosmology and physics.