ASTR5780, ASEN5440 - MISSION DESIGN AND DEVELOPMENT FOR SPACE SCIENCES

HANDOUT #1

Location

Duane E126
T/Th 11am – 12:20pm

Instructors

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Overview

The goal of ASTR5780 / ASEN5440 is to expose both science and engineering students to the process by which space missions are conceived, developed, designed, and proposed. The course will bring science and engineering students into the same classroom environment to develop the multi-disciplinary skills required to design the science and instrument concepts for a NASA-funded small space mission for astrophysics, heliophysics, and planetary science and to create a successful proposal for this mission. The students enrolled in this course will have three primary goals – 1) develop the proposal science objectives based on scientific community priorities, inherent interest, and practical considerations imposed by the NASA Announcement of Opportunity, 2) learn how the mission science requirements lead to the design of the proposed instrumentation package and 3) develop an understanding of practical aspects of designing a scientific instrument, spacecraft, and mission that can accomplish these science goals. The process begins with a science question – what is it we wish to learn, and why do we care? – and flows down to measurement, instrument, spacecraft, and mission design requirements to address this question. The course focuses on the design of a specific instrument to make a specific measurement, but critical aspects of spacecraft and mission design are also covered.

These goals will be supported and augmented by the participation of NASA's Jet Propulsion Laboratory in the course design and implementation. JPL will provide hands-on engagement during the proposal development and will take part in the design review at the end of the semester. Further guest lectures will be provided by experienced scientists and engineers from LASP, SwRI, and other research centers. This course establishes a working relationship between scientists and engineers that is essential for development of a comprehensive and successful mission proposal. The course will focus on science and engineering applications for a small space mission, driven by recent NASA proposal opportunities in astronomy, heliophysics, earth science, and planetary science. By design, this course is a cross-disciplinary

effort and is therefore being cross-listed and co-taught by the Aerospace Engineering and Astrophysics and Planetary Sciences departments.

Prerequisites & Eligibility

ASTR5780 / ASEN5440 is open to senior undergraduate and graduate students in Astronomy, Engineering, Physics, Atmospheric Sciences, Applied Math, and related fields. Students are expected to have strong problem solving and organizational skills, a strong background in mathematics, as well as good oral and written communications skills. A background in basic modern physics is strongly encouraged.

Specific APS undergraduate student prerequisites include: Permission of instructor.

Specific AES student prerequisites include: Permission of instructor. Recommended background: senior undergraduate level orbital mechanics, electronics, and optics.

Suggested reading

1. NASA, Research Opportunities in Space and Earth Sciences. ROSES2015. Obtain from the website:

http://nspires.nasaprs.com/external/solicitations/summary.do?method=init&solId={9F1341A9-6D0F-F075-C993-276263B186ED}&path=future

or, http://science.nasa.gov/researchers/sara/grant-solicitations/

2. NASA, Astrophysics Small Explorer Announcement of Opportunity 2014. Obtain from the website:

http://explorers.larc.nasa.gov/APSMEX/SMEX/index.html

3. Astrophysics, Heliophysics, and Planetary Science Decadal Reviews. Obtain from the website (temporary, eventually D2L):

http://cos.colorado.edu/~kevinf/ASTR4500_F15/

4. Scientific and Instrumentation Journal Readings will be assigned based on science and instrument development concepts developed in class. Obtain through SAO/NASA ADS:

http://adsabs.harvard.edu/abstract_service.html

3. 5. (supplemental) NASA. *NASA Systems Engineering Handbook*. NASA/SP-2007-6105, Rev 1. Washington, DC: NASA, December 2007. Obtain from the website:

http://foiaelibrary.gsfc.nasa.gov/_assets/doclibBidder/tech_docs/5.%20NASA%20SP-6105%20Rev%201%20%28Sys%20Eng%20Handbook%29.pdf

Subject Outline

1. Introduction to space missions and NASA proposal opportunities
2. Community science priorities, introductory and detailed science investigations. Balancing big picture and feasibility
3. Introduction to science topics in Heliophysics, Astrophysics, Planetary Science, and other areas
4. Science Traceability Matrix
5. Requirements definition, measurements and instrumentation
6. Science instrument design and componentry
7. Space mission operation, systems engineering, and spacecraft considerations
8. Team roles; proposal layout, responsibilities, and writing
9. Spacecraft data reduction and analysis
10. Proposal review

Schedule: See Handout #2 for lecture / assignment schedule.

Logistics

1. Office Hours – We have them, you should attend them.

2. Assignments – There are two types of take-home assignments in this course –*homework and projects*. Collaboration is permitted on these assignments. This means you may discuss the means and methods for solving problems and even compare answers, but you are not free to copy solutions from classmates or from internet resources. The work that you turn in must be your own--copying is not allowed for any assignments. Students who are caught copying any portion of an assignment will be reported for violation of honor code and may incur both academic and non-academic sanctions.
This course is based on the development of a scientific mission proposal concept that will be developed in the first month of the course. As part of this science goal definition, the instructors will provide introductory lectures, but *students will be expected to read and report on refereed journal articles in the relevant fields*. This will constitute both a *homework and a component of the class project*. Students will be expected to *demonstrate basic understanding of space instrumentation relevant to their proposal concept, basic understanding and quantitative analysis of data products, and practical issues relating to spacecraft and communications issues. These also constitute homework*.
The primary course project is the *development of a final proposal document for the mission concept*. The students will work in teams that are responsible for various components of the scientific and engineering requirements for the mission. These components will be reviewed by an “internal Blue Team Review” made up of the course students and instructors and an “external Red Team Review” that will be the final mission proposal review. Following the Red Team review, the students will be expected to revise and finalize their sections prior to final mission proposal submission to the instructors. *All of these proposal activities are considered proposal/presentations*.

3. Deadlines – Each assignment will have a marked deadline. Late assignments are not accepted except under extenuating circumstances; 24-hour notice is required for work to be considered after the due date. If such an event occurs, you are expected to contact the instructors immediately by phone or email or carrier pigeon. If you know in advance that you will not be on campus for a due date, you may submit your assignment to the instructors any time prior to the due date.

4. Grading – Grades on individual assignments and for the overall course are set based on the following criteria:

A, A-	Superior understanding of the material beyond the course requirements; excellent technical work
B+, B	Comprehensive understanding of the material; strong technical work
B-	Adequate understanding of the material; complete technical work
C	Barely adequate understanding of the material and minimally sufficient technical work
D	Poor technical work
F	Unsatisfactory performance

GRADING

Activities	%
Homework	**20%**
Proposal/Presentations	**70%**
--concept paper--	10%
--concept slides--	5%
--concept oral--	10%
--final proposal document--	30%
--final proposal slides--	5%
--final proposal oral--	10%
Active class participation	**10%**

University Policies

CHEATING

Cheating will not be tolerated and the CU Honor Code will be upheld.

SPECIAL ACCOMMODATIONS

If you qualify for accommodations because of a disability, please submit to your professor a letter from Disability Services in a timely manner (for exam accommodations provide your letter at least one week prior to the exam) so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities. Contact Disability Services at 303-492-8671 or by e-mail at dsinfo@colorado.edu.
If you have a temporary medical condition or injury, see Temporary Injuries under Quick Links at Disability Services website (http://disabilityservices.colorado.edu/) and discuss your needs with your professor.

RELIGIOUS OBSERVANCES

Campus policy regarding religious observances requires that faculty make every effort to reasonably and fairly deal with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class notify the instructors PRIOR to any potential conflicts to properly accommodate your schedule. See full details at http://www.colorado.edu/policies/fac_relig.html and http://www.interfaithcalendar.org/

CLASSROOM EXPECTATIONS

Students and faculty each have responsibility for maintaining an appropriate learning environment. Students who fail to adhere to such behavioral standards may be subject to discipline. Faculty have the professional responsibility to treat all students with understanding, dignity and respect, to guide classroom discussion and to set reasonable limits on the manner in which they and their students express opinions. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with differences of race, culture, religion, politics, sexual orientation, gender, gender variance, and nationalities. Class rosters are provided to the instructor with the student's legal name. The professors will gladly honor your request to address you by an alternate name or gender pronoun. Please advise us of this preference early in the semester so that we may make appropriate changes to our records. See polices at http://www.colorado.edu/policies/classbehavior.html and at http://www.colorado.edu/studentaffairs/judicialaffairs/code.html#student_code

DISCRIMINATION/HARASSMENT

The University of Colorado at Boulder policy on Discrimination and Harassment, the University of Colorado policy on Sexual Harassment and the University of Colorado policy on Amorous Relationships apply to all students, staff and faculty. Any student, staff or faculty member who believes s/he has been the subject of discrimination or harassment based upon race, color, national origin, sex, age, disability, religion, sexual orientation, or veteran status should contact the Office of Discrimination and Harassment (ODH) at 303-492-2127 or the Office of Judicial Affairs at 303-492-5550. Information about the ODH, the above referenced policies and the campus resources available to assist individuals regarding discrimination or harassment can be obtained at http://www.colorado.edu/odh

HONOR CODE VIOLATIONS

All students of the University of Colorado at Boulder are responsible for knowing and adhering to the academic integrity policy of this institution. Violations of this policy may include: cheating, plagiarism, aid of academic dishonesty, fabrication, lying, bribery, and threatening behavior. All incidents of academic misconduct shall be reported to the Honor Code Council (honor@colorado.edu; 303-725-2273). Students who are found to be in violation of the academic integrity policy will be subject to both academic sanctions from the faculty member and non-academic sanctions (including but not limited to university probation, suspension, or expulsion). Other information on the Honor Code can be found at http://www.colorado.edu/policies/honor.html and at http://www.colorado.edu/academics/honorcode/