ESE/EPS 122 Designing Satellite Missions: research methods through the lens of earth observing systems

Tuesdays/Thursdays 3:00 â€“ 4:15 PM Maxwell-Dworkin 123

Prof. Peter Zoogman (zoogman@seas.harvard.edu)

Office Hours: 1:30-2:30 PM Tuesdays MCZ 424E or by appointment

T.F.: TBD

Prerequisites: Math 1a,b and Physics 11a, or permission of the instructor

Overview:

Satellites provide a vast and powerful suite of global observations of Earth system processes. In this course, students will learn research methods and work with satellite data, including those targeted at: land use, ocean biochemistry, climate change, and air pollution. We will emphasize skills for designing and proposing projects, such as: project planning, reading scientific papers, writing research proposals, and exploratory data analysis. This course will provide the framework and understanding for the students to design future missions to address environmental, scientific, and societal challenges. By the end of the course, you will have learned to work with big data both to address existing scientific questions and to pose new ones.

Course Learning Outcomes:

- Conduct reviews and synthesize scientific literature

- Develop skills in scientific writing for literature reviews and proposals

- Perform exploratory data analyses to generate new research questions

- Utilize complementary sources of information to interpret both observations and models

- Explain and justify the policy and scientific rationale for satellite missions

- Evaluate the suitability of different types of observations for current and future science questions

- Model radiative transfer and use a process-level understanding to interpret observations

Weekly structure of topics:

1) Course overview and introduction to satellite observations

2) Surface and sub-surface remote sensing

3) Spectroscopy, vegetation, and ocean color

4) Validation and multi-generational programs

5) Weather satellites and Numerical Weather Prediction

6) Evaluation and Observing System Experiments

7) Spectroscopy of the atmosphere

8) Climate applications

9) Air pollution applications

10) Combining measurements and models

11) Observing system simulation experiments

12) Learning from future missions

13) Review and Synthesis

Classroom environment:

This course will have a flipped classroom environment, where you are tasked with accomplishing both knowledge transfer and practice applications before coming to class. In class, we will focus on providing opportunities to apply skills to novel examples to facilitate deeper understanding and retention of the course learning outcomes. This will involve frequent (low-stakes) quizzes, small group work, and student-led activities.

Assessment:

In class:

Each week will have pre-class work that draws on the required readings. Readings will be used for an introductory quiz at the beginning of each class and pre-class work will form the basis for an in-class activity. At the end of each class, there will be a discussion associated with a final written reflection quiz. Each class will have one of a quiz, pre- class work, or in-class work graded.

Assignments:

There will be three major assignments during the semester: a literature review, an analysis of satellite data, and a mission proposal. The mission proposal is the final project for the course and will incorporate the skills and knowledge from class and from the previous two assignments.

It is your responsibility to turn in assignments on their due date. However, I understand that sometimes flexibility is needed. To aid this, you have 3 1-day extensions you can use during the semester. Multiple 1-day extensions may be applied to the same assignment, but no more than 3 total. You must inform the instructor or TF when you are taking your extensions.

For each 24-hour period an assignment is late (beyond the due date or any extensions used and barring extenuating circumstances), a flat 5% will be deducted from that assignmentâ€™s final grade.

Quizzes/Pre-class/In-class work and participation: 25%

Literature review: 20% (Due: March 12)

Analysis and interpretation of satellite data: 20% (Due: April 21)

Satellite mission proposal: 35% (Due: May 6)

Attendance policy:

As this course depends on student participation, attendance is mandatory. You are allowed to be absent from 3 class sessions without extenuating circumstances (such as severe illness, injury, family emergency, or personal loss). Any such absences beyond the maximum allowed will result in at minimum failing the sessionsâ€™ pre-class/quizzes and up to withdrawal from the course. If you do experience extenuating circumstances such that you will not be able to attend class, please speak with the instructor as soon as you can to determine how to proceed.

Course credit:

ESE 122 is also offered as EPS 122. Students may not take both for credit. For SB students this course can only count as a science elective in the concentration requirements, and SB students must enroll in ESE 122. AB students may enroll in either EPS 122 or ESE 122 to meet their concentration requirements.