First Year Seminar: Science From Space

Professor Marla Geha

***Description*:** This first-year seminar will explore the wide range of unique science enabled by space-based platforms. Topics will include space-based astrophysics, satellite-based imaging of Earth, and future technologies that space may enable. Readings will be a mix of in-depth popular articles, technical reports and online videos on specific topics. Students will become 'experts' in one weekly topic of their choice and help facilitate discussion during that week. The course is aimed towards students who intend to major in the physical sciences.

Pre-requisites: None. However, the course is aimed towards students who intend to major in the physical sciences.

Meeting Frequency: Twice weekly for 75 minutes

Class workload and grading:

There will be 30-50 pages of reading per week or the equivalent amount of material via online videos. In addition to discussion on weekly readings, students will be assessed via the following assignments:

1. ***25% Participation and Submitted questions:*** In addition to participation in class discussions, students will be required to generate 3 or more questions on the weekly readings to be submitted via a Canvas form in advance of class.
2. ***25% In-class presentation and discussion lead:*** At the beginning of the semester, students will sign up for one of the weekly topics below. Two students will serve as 'experts' for each week's topic, reading more deeply into the subject and helping facilitate discussion.
3. **20% Midterm paper:** The midterm assessment will be a 3-5 page paper on the 'discussion lead' topic chosen above.
4. **30% *Final Project:*** In lieu of a final exam, this course will have a final project. Students can chose to write either a 8-10 page paper expanding on a topic covered in class -or- create a 5-8 minute original video explaining the topic to a wider audience. The topic should be sufficiently different from the midterm assignment.

Tentative Course Outline

Introduction: ***Satellites 101***

Week 1-2: Overview of the Earth orbital environment and beyond:

- Low Earth Orbits, Medium Earth and Geostationary orbits

- The Rocket Equation and Satellite Payloads

Readings:

- Space Mission Design and Operations (selected modules)
- Harnessing the New Space Economy

Part 1: *Astrophysics with Space Satellites*

Week 3: Large astrophysics missions: Hubble, JWST, Roman

Week 4: Science with small astrophysics satellites

Week 5: What science actually happens on the ISS?

Readings:

- Astrophysical Decadal Survey 2020: Space Initiatives - National Academies
- Annual Highlights of Results from the ISS - NASA technical report
- https://stories.state.gov/space/

Part II: Earth Observation with Satellites

Week 6+7: Earth monitoring satellites (weather and climate monitoring)

Week 8: Science with Commercial imaging

Week 9: GPS-enabled science

Readings:

- The Future of Geography - Tim Marshall
- "GPS: An Introduction to Satellite Navigation" — Stanford open course

Part III: Emerging Technologies

Week 10: Space-based Solar energy

Week 11: Material science and manufacturing in space

Week 12: Resource extraction beyond Earth

Week 13: Astrophysics on the Moon

Readings:

- "How solar farms in space might beam electricity to Earth" -World Economic Forum
- "Asteroid mining: Helping to meet Earth's natural resource demands"
- Proposed lunar observatories such as FARSIDE and LCRT