Syllabus – PTYS/GEOS 551 – Fall 2024

Remote Sensing of Planetary Surfaces

Instructor: Shane Byrne. Pronouns: he/him/his
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Times and locations:

- Two 75-minute lectures each week: T/Th 11am-12.15pm
- A 2-hour lab session each week: Fri. 11am-1.50pm
- Room 330 in the Kuiper Space Science Building

I'll be available for questions and discussion, after lectures. If you need help and cannot make these times, then please email me to make arrangements. I have a general open-door policy, but I'm more likely to be available if we set up a time in advance.

Michael Phillips will be teaching for one week (September 23rd) due to my travel commitments. Lectures will be canceled in the week of October 14th due to the department fieldtrip.

Course Website: Lectures, homework assignments, lab information, and general information on the course will be posted on D2L at:

https://d2l.arizona.edu/d2l/home/1495647

A GitHub repository with code for in-class demos and lab sessions is here:

https://github.com/shanebyrneonmars/PTYS551_2024/

Course Description: This graduate course will focus on the use of remote sensing in the study of rocky and icy planetary surfaces. It is not a science course, but rather intended to provide technical knowledge of how instruments work and practical techniques to deal with their datasets. In this course, we will cover how different types of remote-sensing instruments work in theory and practice along with case studies (student-led) of specific planetary science instruments. We will discuss what datasets are generated by these instruments, their limitations and where they can be located. Lab sessions will provide experience in how these data are processed, visualized and intercompared. The class consists of two lectures and a 2-hour lab session each week.

Course Objectives: During this course students will:

- Learn the background physics of scattering and emission of electromagnetic radiation and nuclear particles from planetary surfaces.
- Learn how different remote sensing instruments work and the common tradeoffs that distinguish one specific instance of an instrument from another.
- Learn what datasets are available, where they are stored on the Planetary Data System and how to select and obtain these data.
- Learn how spacecraft navigation and pointing is recorded and some of the uses of the SPICE toolkit.
- Gain practical experience of data processing for selected datasets, including using the ISIS, Socet Set, and Ames Stereo Pipeline software.
- Gain practical experience with Geographic Information System (GIS) software to visualize, manipulate and inter-compare different datasets.
- Learn the tradeoffs in displaying data in different map projections.

Expected Learning Outcomes: Upon completion of this course students will be able to:

- Be able to select a region of interest on any planetary surface and identify and locate all the relevant data available to address some scientific problem.
- Select an appropriate map projection and produce gridded data products.

- Produce higher-order products such as stereo Digital Terrain Models.
- Produce representations of data such as maps, perspective views etc.… using a variety of tools such as QGIS, GMT etc.…

Course credit: There will be no final or mid-term exam in this course, students get credit for homework, class presentations, and weekly labs. You are encouraged to discuss approaches to solving any assignments with each other; however, all work submitted must be your own. You cannot share computer code or the end result of any data processing exercises.

- Homeworks that recap the theory covered in lectures will be assigned throughout the semester. Late homework receives half credit and homework submitted a week or more after the due date receives no credit. If you are unable to complete a homework assignment on time (and have a good reason) you must come *talk to me before the due date* to avoid losing credit.
- Class presentations for each student will occur at least twice during the semester (exact frequency depends on enrollment). In these presentations, you will describe case studies of planetary instruments relevant to the previous week's lectures. Capabilities and limitations of the instrument will be described along with what data it produced and its major findings.
- Lab sessions on data processing and visualization will occur weekly and lead to the completion of several discrete assignments over the course of the semester. The labs are a time for us to demo software capabilities and resolve difficulties – the lab projects themselves will take longer than 2hrs/week to complete.

Course components are weighted by:	Class Presentations Homeworks and Lab Assignments Class engagement	20% 75% 5%
Grades are assigned according to the following scale. I don't rescale grades to ensure that any particular statistical distribution is met.		90-100% A 75-89% B 60-74% C 50-59% D 0-49% E

Prerequisites: Instrument characterization often uses mathematical analyses so background that includes basic calculus is required. Introductory experience with coding and GIS would be helpful, but is not required. Students may complete assignments with any programming language or GIS software that they find efficient to use. Examples in this class will typically utilize Python and QGIS respectively. UA offers many introductory programming and GIS classes that can be located in the course catalog. Undergraduate enrollment is limited to seniors with a GPA $\geq$3.0 and approval by instructor, major advisor, and Registrar.

Accessibility and Accommodations:
At the University of Arizona, we strive to make learning experiences as accessible as possible. If you anticipate or experience barriers based on disability or pregnancy, please contact the Disability Resource Center (520-621-3268, https://drc.arizona.edu/) to establish reasonable accommodations.

Subject to Change Statement:
Information contained in the course syllabus (including this statement), other than the grade and absence policy, may be subject to change with advance notice, as deemed appropriate by the instructor.

University Policies: Other University policies are listed at:
https://academicaffairs.arizona.edu/syllabus-policies

Draft Schedule

- Changes often occur.
- Blue slots are instrument descriptions and student presentations
- Orange slots are undecided and will be pulled from a list of topics that includes the options below.
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Week	Tuesday 11am-12.15pm	Thursday 11am-12.15pm	Friday 11am-1pm	Special Notes
26-Aug	Introduction	SPICE	Lab 1: Using SPICE	
2-Sep	Illumination of Planetary Surfaces	Data Sources and Software		
9-Sep	Photometry	Cameras	Lab 2: Radiometric processing of rasters	
16-Sep	Spectrometers and Hyperspectral Imagers	Cameras - Case Studies		
23-Sep	Hyperspectral Imagers - Case Studies	Spectral modeling	Lab 3: Spectral Modeling	**Shane on Travel. Michael teaching.**
30-Sep	Planetary Shapes and Maps	Laser Altimeters		
7-Oct	Dealing with Vector Datasets	Laser Altimeters - Case Studies	Lab 4: Dealing with global datasets	
14-Oct				**Scablands Field Trip no class**
21-Oct	Geometric processing of datasets	Thermal Bolometers and Spectrometers	Lab 5: Geometric Processing of Rasters	
28-Oct		Thermal Bolometers and Spectrometers - Case Studies		
4-Nov	Topography from Images	Topographic Products & Statistics	Lab 6: Stereogrammetry	
11-Nov		Gamma-Ray and Neutron Spectrometers		
18-Nov	RADAR - Sounders by Jack Holt	Gamma-Ray and Neutron Spectrometers - Case Studies	Lab 7: Photoclinometry	
25-Nov	RADAR Sounders - Case Studies	**No Class: Thanksgiving**	**No Class: Thanksgiving**	
2-Dec	RADAR - SAR by Lynn Carter			
9-Dec	RADAR SAR - Case Studies	**No Class: Reading Day**	**No Class**	**AGU week**
16-Dec	**Finals Week**			

Signal Processing	X-ray Spectrometers
Machine Learning	X-Ray Spectrometers - Case Studies
Crater Counting Tools and Approaches	