Syllabus – PTYS/GEOS 551 – Fall 2026

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 lead a lecture and lab on spectral modeling (Sep. 10th and 18th) and AI/ML techniques (Nov. 12th and 13th). I'll be travelling on the week of Nov. 16th so no classes then.

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/1782521

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

https://github.com/shanebyrneonmars/PTYS551_2026

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 uses of the SPICE toolkit.
- Gain practical experience of data processing for selected datasets, including using the ISIS 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 biweekly 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.

- Four class presentations from each student will occur during the semester. 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 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 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

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 (https://drc.arizona.edu/) to establish reasonable accommodations.

Use of generative AI
Generative AI like Claude and ChatGPT (as opposed to the image classifiers that we'll study in Lab 8) can write code and solve problems for you. In many ways, it will be an important tool for future research in planetary science and so practice with it is important. However, these tools also styme learning and so reduce the value of the class exercises to you. Thus, to try and strike a balance we will have the following policy.

- AI tools should not be used at a high-level to solve problems that relate to methodology i.e. you should figure out and understand how to solve all the homework problems.
- AI tools can be used to solve or speed up the resolution of low-level technical problems in coding e.g. implementing an approach you describe, debugging lines of code, reading/writing data files, setting up loops/condition tests etc…

In this second case, be aware that many AI companies collect information; do not enter confidential information as part of a prompt. LLMs may generate false information and tools may reflect misconceptions and biases of the data they were trained on and the human-written prompts used to steer them. You are responsible for checking facts, finding reliable sources for, and making a careful, critical examination of any work that you submit.

Subject to Change Statement:
Information contained in the course syllabus, 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.
- Orange slots are instrument descriptions
- Blue are student presentations
- Green are practical lab sessions
- No class in horizontal lined cells

Week	Tuesday 11am-12.15pm	Thursday 11am-12.15pm	Friday 11am-1pm	Special Notes
24-Aug	Introduction	SPICE	Data Sources and Software	MRO PSG Travel the following week. Use the Friday slot for lecture.
31-Aug	Illumination of Planetary Surfaces		Lab 1: Using SPICE	
7-Sep	Photometry	Spectral modeling	Lab 2: Short intro to ISIS (no assignment for this lab)	
14-Sep	Spectrometers and Hyperspectral Imagers	Cameras	Lab 3: Spectral Modeling	
21-Sep	Hyperspectral Imagers - Case Studies	Cameras - Case Studies	Lab 4: Short intro to QGIS (no assignment for this lab)	
28-Sep	Planetary Shapes and Maps	Laser Altimeters	Lab 5: Dealing with global datasets	
5-Oct	Dealing with Vector Datasets	Thermal Bolometers and Spectrometers		
12-Oct	Geometric processing of datasets	Laser Altimeters - Case Studies	Lab 6: Geometric Processing of Rasters	
19-Oct	X-Ray Spectrometers	Thermal Bolometers and Spectrometers - Case Studies		HiRISE Team meeting Travel On Friday
26-Oct		Topography from Images	Lab 7: Stereogrammetry & Photoclinometry	HiRISE Team meeting Travel On Mon-Wed
2-Nov	RADAR - Sounders by Stefano Nerozzi	Gamma-Ray and Neutron Spectrometers	Topographic Products & Statistics	Use Friday Slot for Lecture
9-Nov	X-Ray Spectrometers - case studies	AI/ML in Planetary Images	Lab 8: AI/ML	
16-Nov				CaSSIS Team Meeting. Shane on travel all week.
23-Nov	RADAR Sounders - Case Studies	**No Class: Thanksgiving**	**No Class: Thanksgiving**	
30-Nov	RADAR - SAR by Lynn Carter	Gamma-Ray and Neutron Spectrometers - Case Studies		
7-Dec	RADAR SAR - Case Studies	**No Class: Reading Day**	**No Class**	**AGU Week**
14-Dec	**Finals Week**			