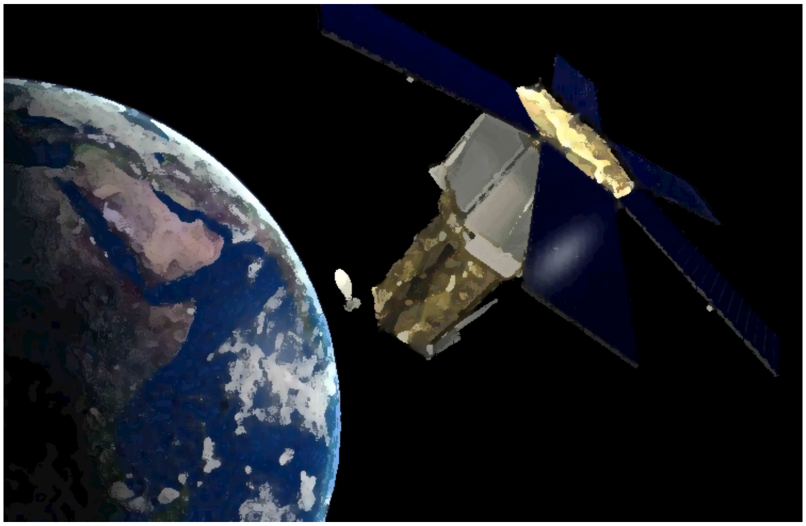
Course Outline – Remote Sensing for Earth and Planetary Sciences
01:460:427 – 01:460:527
Spring 2021
Thursday: 3:20 PM – 6:20 PM

Instructor: Dr. Lujendra Ojha
Email: Luju.ojha@rutgers.edu
Office Hours: Tuesday (2:00 to 3:00 PM) and Thursday: (12:00 to 1:00 PM)
WebEx/Zoom Link: To Be Updated



Course overview:
This is an advanced remote sensing course designed for students interested in learning how to use and interpret remote sensing data acquired for Earth and other rocky bodies in the Solar System. The first half of the course will cover the broad spectrum of techniques for making remote measurements of the composition, morphology, and thermophysical properties of solid surfaces on Earth and other planetary bodies. Topics include a) overview of the electromagnetic (EM) spectrum; b) interaction of the EM radiation with solid, liquid, and gas; c) principles of remote sensing techniques; d) analysis of remote sensing data; e) imaging spectroscopy and photometry; and f) science objectives and instrumentation of several ongoing and planned planetary missions. The second half of the course will cover a broad spectrum of techniques for understanding planetary interiors. Topics include a) gravity measurement and modeling; b) crustal magnetic field and modeling techniques; c) application of RADAR/LIDAR data; d) X-ray, γ-ray spectroscopy of planetary subsurface. The course is designed to provide students with both the physics underlying the remote sensing techniques and their application to a range of planetary topics. As such, the class will have a heavy math component. Students will learn how to access, process, and interpret remote sensing data and (hopefully) understand which techniques are most useful for answering a range of scientific questions. The class will be held synchronously on Thursdays, but the lectures will be recorded, so students can access lectures even if they miss a class. We will use Zoom and/or WebEx.

Prerequisites:
The course is taught at an advanced undergraduate or entry graduate level. Prerequisites include:
1) A basic understanding of mineralogy/petrology, chemistry, introductory physics, and Geophysics.

2) **Math courses** that cover the topics of Calculus I and Calculus II. Some understanding of differential equations and linear algebra. There will be math in class.
3) A personal computer since we will use various remote sensing software like ESRI ArcGIS, IDL/ENVI, QGIS, and MATLAB.

Course Expectation: *Basic Class Etiquette:* Respect yourself, your peers, and your teacher. Pay attention, participate, and ask questions. Come to class with a positive learning attitude. Student actions that interfere with teaching or learning in the classroom will NOT be tolerated.

Assignments: There will be ~5-7 graded homework and ~5 computer lab exercises throughout the term. Graduate students will have extra questions in homework that may require additional research. Homework sets will be due at the beginning of class. Please do your best work and turn it in time. We all have bad days (or even weeks), so please communicate with the instructor if you cannot meet a deadline. There will be one midterm and one final exam (equally weighted), and a final project consisting of a research term paper and an oral presentation. The course grading breakdown is as follows:

Homework: ~5 – 7 in-class activity worth 20% of your grade.
Computer Lab: There will be ~5 computer lab exercises worth 20% of your grade.
Exams: Midterm = 20% of your grade. Final = 20% of your grade. Total = 40%.
Class Project: 20% of your grade. Total = 20%.

Grades:
A = 89.5 – 100
B+ = 84.5 – 89.49
B = 79.5 – 84.49
C+ = 74.5 – 79.49
D = 59.5 – 69.49
F = 0 – 59.49

Final Project: The culmination of this course will be a final project that integrates all that students have learned over the course of the semester in terms of data processing and analysis. This will be an independent research project defined by the student. Students are welcome to discuss the projects with each other and to help troubleshoot issues that arise, but each student is responsible for completing the work his/herself/themself. The bar will be set higher for graduate student's final projects and graded accordingly.

Exams: No unexcused make-up exams will be given without WRITTEN documentation from a Rutgers University official. Those with valid excuses will be allowed to take exams at a different time. Graduate students will have an extra set of questions in the midterm and final.

Textbook:
There is no textbook required for this course, but there will be various papers, handouts, and articles that students are responsible for reading. There are also some excellent books available through Rutgers library that will be helpful in class:

1. Remote Compositional Analysis Techniques for Understanding Spectroscopy, Mineralogy, and Geochemistry of Planetary Surfaces. (https://doi.org/10.1017/9781316888872)
2. Geodynamics. (https://doi.org/10.1017/CBO9780511843877)
3. Matlab Recipes for Earth Sciences (https://www.springer.com/gp/book/9783662462430)

Learning Goals: Students will

- Learn the basic theory behind various remote sensing techniques.
- Learn how to apply remote sensing techniques to understand various geological processes on terrestrial planets.
- Learn about the history of remote sensing techniques in solar system exploration.
- Learn how to access a variety of remote sensing data for Earth, Mars, Venus and other rocky bodies of the solar system.
- Learn how to process and interpret remote sensing data for answering a range of scientific questions.
- Learn basic numerical modeling in MATLAB to help interpret their results.
- Learn how to design basic algorithms to auto process large volumes of remote sensing data.

Attendance: Students are expected to attend class. We will engage in numerous in-class group activities, and if you are not here, you may have a hard time completing the activities on your own.

Tardiness and Leaving Class Early: Habitually arriving in class late and departing early is disruptive and rude. We ask that once you make every effort possible to get to class on time, and once there, STAY.

Academic Integrity: Academic integrity includes commitment in your part to not partake in or tolerate acts of falsification, misrepresentation or deception. Such acts of dishonesty include cheating or copying, plagiarizing, submitting another persons' work as one's own, using Internet sources without citation, taking or having another student take your exam, tampering with the work of another student, facilitating other students' acts of academic dishonesty, etc. All students are responsible for upholding the highest standards of student behavior, as specified under the University Code of Student Conduct (http://studentconduct.rutgers.edu/) , including but not limited to strict adherence to the terms of the University's Academic Integrity Policy (http://academicintegrity.rutgers.edu/).

- *What happens if I am caught cheating?*

I do not tolerate cheating. If you are caught cheating, I will give you '0' for the assignment and give you an official warning. If I catch you cheating again then I WILL fail you and report you.

- *What procedures will be used to detect cheating in this course?*

All assignments (including case studies) will be submitted via the TurnitIn feature on Canvas. I will not accept work that includes copied and pasted information; all information or ideas included in your assignments must be in your own words.

Your Rights: If you feel that you have been treated unfairly, contact the department chair, Dr. Gregory Mountain (gmtn@eps.rutgers.edu)

Course Evaluation: Both undergraduate and graduate students will be asked to evaluate the instructors' teaching and course organization and content at the conclusion of the class. The graduate students and undergraduate students will also receive a separate set of questionnaires about the different grading rubrics, homework problems, class projects, and exams. For example, the graduate students may be asked to rate the extra homework problems' effectiveness in their understanding of the course content. Both the graduate and undergraduate students may be asked about the course difficulty. The instructor will also utilize 'BluePulse' (https://rutgers.m.bluepulse.com/) to collect anonymous feedback from students and engage in two-way communication with those students while maintaining the student anonymity.

Day	Date	Agenda	Structure
Thursday	21-Jan	Electromagnetic Spectrum Overview	Lecture + Activity
Thursday	28-Jan	Radiative Transfer	Lecture + Activity
Thursday	4-Feb	Photometry	Lecture + Activity
Thursday	11-Feb	Imaging Systems and Processing	Lecture + Activity
Thursday	18-Feb	Visible/NIR Reflectance Spectroscopy	Lecture + Activity
Thursday	25-Feb	Thermal IR Spectroscopy	Lecture + Activity
Thursday	3-Mar	Thermal Inertia	Lecture + Activity
Thursday	10-Mar	Midterm	Midterm
Thursday	17-Mar	Spring Recess	
Thursday	24-Mar	Gravity	Lecture + Activity
Thursday	31-Mar	Magnetics	Lecture + Activity

Thursday	7-Apr	Radar, Lidar	Lecture + Activity
Thursday	14-Apr	X-ray, γ-ray Spectroscopy	Lecture + Activity
Thursday	21-Apr	Neutron Spectroscopy	Lecture + Activity
Thursday	28-Apr	Class Project Presentation	Lecture + Activity
Final Exam Period	Thursday, May 6 - Wednesday, May 12		