Remote Sensing of Planetary Surfaces (3 Credits)

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Overview:
Remote-sensing based exploration of planetary surfaces, including the Earth and other planets. Emphasis will be on geologic, geophysical, and compositional interpretations via remote sensing throughout the electromagnetic spectrum. Course will cover basic principles, image and spectroscopic analysis techniques, case studies in planetary remote sensing, and many examples from spacecraft missions. Equivalent to GEOS 551.

Expected Outcomes:
Students will learn the fundamentals of remote sensing of planetary surfaces with an emphasis on practical aspects of planetary data handling and analysis using ESRI ArcGIS, BAE Systems Socet Set, IDL/ENVI, and other commonly used software.

Course Structure:
• Lecture Times: Two lectures will be held per week on Tuesdays and Thursdays from 11:00 A.M. to 12:15 P.M. The Tuesday class will be held in Room 450A and provide a practical laboratory session enabling students work with planetary data and analysis tools. The Thursday lecture will be in Room 301 and cover the theoretical underpinnings of remote sensing.

• Office Hours: I will be available for questions and discussion after lectures on Tuesdays and Thursdays. If you require additional assistance, I am available on a walk-in basis between 2:00–3:00 pm on Tuesday. Otherwise, meetings are by appointment only.

• Course Website: Lectures, homework assignments and general information on the course will be available online on a class website at: http://www.lpl.arizona.edu/~hamilton/PTYS_551.

• Scope of Course: This first part of this course will introduce the basic concepts in geological remote sensing and introduce the fundamentals properties of a variety of data types (e.g., visible imagery, lidar, radar, infrared, multi-spectral, hyperspectral, and other forms spectrometer data). Concurrently, there will be weekly practical laboratory exercises to explore these data types. Following the mid-term exam, the emphasis will shift to learning about advanced image processing techniques and students will develop an independent research project and report (due at the end of the semester).
• This course is intended for beginning graduate students with little previous exposure to geosciences and remote sensing. The course is complementary with PTYS/GEOS 554 (Planetary Surfaces). There are no course prerequisites.

• Grading:
  - Homework / Laboratory Assignments 40%
  - Mid-term Exam: 20%
  - Project: Oral Presentation 10%
  - Project: Final Write-up 30%
  - There will be no final exam.

  Grades are assigned as follows:
  - A ≥90%
  - B ≥75 <90%
  - C ≥60 <75%
  - D ≥50 <60%
  - F <50%

Due dates, Absences, and Late Work:
• Assignments are due at the beginning of class on the due date (or before). If an assignment is due, you are responsible for turning it in, even if you are absent from class. Late work will generally not be accepted. If it is accepted, a penalty of 20% will be applied to the assignment’s score (out of 100%). For exams and quizzes, absences for university-approved activities for which you have in advance a note of dean’s approval will be excused, or other arrangements will be made. If you will be absent due to a religious holiday, please let me know in advance. Absences for other reasons will not be excused unless special dispensation was received prior to the deadline.

Academic Integrity:
• Students are encouraged to discuss approaches to solving homework problems and class projects with each other; however, previously completed class projects may not be submitted for credit and answers on exams and all other evaluated material are expected to be your work and your work only.

• You are expected to know and to abide by the University’s Academic Integrity policy. The details are at http://deanofstudents.arizona.edu/codeofacademicintegrity.

• The instructor reserves the right to utilize electronic means to help prevent plagiarism. Students agree that by taking this course, all assignments are subject to submission for textual similarity review to turnitin.com. Assignments submitted to turnitin.com will be included as source documents into turnitin.com’s restricted access database solely for the purpose of detecting plagiarism in such documents.

Students with Disabilities:
• If you anticipate barriers related to the format or requirements of this course, please meet with me so that we can discuss ways to ensure your full participation in the course. If you determine that disability-related accommodations are necessary, please register with Disability Resources (621-3268; http://drc.arizona.edu) and notify me of your eligibility for reasonable accommodations.
Class Schedule:

**Week 1**  
*Introduction*  
Tuesday, August 26: Presentation of the syllabus, creation of computer accounts for students, and assignment of the first project.  
Thursday, August 28: Electromagnetic waves in free space and interactions with matter.

**Week 2**  
*Introduction to Geographic Information Systems (GIS)*  
Tuesday, September 2: Introduction to ArcGIS 1/5 (ArcMAP, and project management).  
Thursday, September 4: Vectors and Rasters, Coordinate Systems, Datums, Projections, and Spacecraft Orbits.

**Week 3**  
*Introduction to ISIS and Planetary Mission Data*  
Tuesday, September 9: Guest Lecturer (Chris Okubo), Introduction to USGS Integrated Software for Imagers and Spectrometers (ISIS).  
Thursday, September 11: Guest Lecturer (Alfred McEwen), the Mars Reconnaissance Orbiter (MRO) mission.

**Week 4**  
*Visible Imagery, Orthorectification, Photoclinometry, and Photogrammetry*  
Tuesday, September 16: Introduction to ArcGIS 2/5 (ArcMAP tools).  
Thursday, September 18: Visible Imagery, Orthorectification, Photoclinometry, and Photogrammetry.

**Week 5**  
*Light Detection And Ranging (LIDAR) and Digital Terrain Models (DTMs)*  
Tuesday, September 23: Introduction to Socet Set 1/3.  
Thursday, September 25: LiDAR and DTMs.

**Week 6**  
*Radio Detection And Ranging (RADAR)*  
Tuesday, September 30: Introduction to Socet Set 2/3.  
Thursday, October 2: Synthetic Aperture Radar (SAR) and Ground Penetrating Radar (GPR).

**Week 7**  
*Infrared Imagery and Thermal Remote Sensing*  
Tuesday, October 7: Introduction to Socet Set 3/3.  
Thursday, October 9: Blackbodies, Temperature, and Thermal Inertia.

**Week 8**  
*Multispectral and Hyperspectral Remote Sensing*  
Tuesday, October 14: Introduction to ArcGIS 3/5.  
Thursday, October 16: Multispectral and Hyperspectral Remote Sensing.

**Week 9**  
*Gamma Ray, Neutron, Ultraviolet, and Other Forms of Spectroscopy*  
Tuesday, October 21: Introduction to ArcGIS 4/5.  
Thursday, October 23: Gamma Ray, Neutron, Ultraviolet, and Other Forms of Spectroscopy.
Week 10  Mid-Term
  Tuesday, October 28: Introduction to ArcGIS 5/5.
  Thursday, October 30: Mid-Term Exam.

Week 11  Techniques 1
  Tuesday, November 4: Project Development 1/3. Project Abstracts are
  Due along with a Short Presentation, and Group Discussion.
  Thursday, November 6: Introduction to Machine Learning, Computer
  Vision, and Informatics.

Week 12  Techniques 2
  Tuesday, November 11: No Classes (Veteran’s Day).
  Thursday, November 13: Guest Lecturer (Leon Palafax) Generative
  Models and Artificial Neural Networks.

Week 13  Techniques 3
  Tuesday, November 18: Project Development 2/3.
  Thursday, November 20: Geospatial Analysis.

Week 14  Techniques 4
  Tuesday, November 25: No Classes (Thanksgiving Day).
  Thursday, November 27: Guest Lecturer (Clayton Morris) Bayesian
  Inference.

Week 15  Techniques 5
  Tuesday, December 2: Project Development 3/3.
  Thursday, December 4: Spectral Data Analysis.

Week 16  Presentations
  Tuesday, December 9: Last Class. Term Paper and Presentations Due.

Textbook Requirements:
• The following textbook is recommended for the course and is available through the
  University of Arizona bookstore:


Purchase of this textbook is at each student’s discretion, but assignments and
examinations will be drawn from material within the book, with supplemental
information provided in class and as reading assignments.

Revision of the Syllabus:
• The course content, reading materials, and graded assignments are subject to change,
  with reasonable advanced notice, as deemed appropriate by the instructor.