Geology/ Geography 4113/5113
Geological Remote Sensing
Syllabus Spring 2018

Instructor: Robert Howell

Lecture: MWF 1:10 – 2:00 PM (ESB 1038)
Lab: Wed: 2:10 – 4:00 PM (ESB 1006 or alternate room)

Website: <http://geofaculty.uwyo.edu/rhowell/classes/remote_sensing/>

Office hours:
Monday 2:10 – 3:00 PM
Wednesday 11:00 – 11:50 AM
Friday 11:00 – 11:50 AM

You're welcome to call or stop by any time you can find me too.

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Lab TA:
Taylor Sullivan
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ESB 2006
Office hours: Monday and Wednesday 10-11 AM and by appointment

Overview: This course will introduce students to the fundamental principles and techniques of remote sensing. We will study basic properties of electromagnetic radiation and its interaction with matter, the instruments and platforms used for remote sensing, and the ways those systems can be used to determine geological structure, composition, and history of the Earth and other planets.

Format: Three lectures per week plus one 2 hour lab

4113 Grading: The grade will be based on the midterm exam (20%), the final exam (30%), short in-class quizzes and homework (20%) and the lab grade (30%). That lab grade will be based on both written lab reports, due one week after the lab is performed, and computer based labs, which may need to be completed during the class. As detailed below graduate students in 5113 will be assigned extra exam questions, homework, lab assignments, and reading. They will present one report to the class on that additional reading.

5113 Grading: For graduate students registered in 5113, the same breakdown of grade components outlined above will apply, but additional work will be expected in each of the components. The total additional work will represent a 20% differential from that expected of undergraduates.

1) Extra exam questions and homework will require more sophisticated analysis and a deeper understanding of fundamental geology than that expected of undergraduates.

2) Graduate students will be assigned additional reading from advanced texts and the current literature. Once during the semester they will prepare for the class a report on those additional reading topics. Credit for those reports will be included in the above "quiz + homework" grade.

3) Extra lab exercises will build upon graduate-level knowledge, such as basic principles of field geology and geologic mapping.

Special Accommodations: If you have a physical, learning, or psychological disability that requires special accommodation, please let me and the TA know as soon as possible. You will need to register with, and provide documentation of your disability to University Disabilities Support Services, in SEO, Room 109 Knight Hall.

Collaboration on Homework and Labs:

I encourage you to study together and also to discuss among yourselves how to complete homework assignments and lab reports, and to review for exams. However, the final answers for homework you turn in must be your own calculations and your own writing. On some labs you will be working in class in teams. However unless explicitly told otherwise by your TA for a specific lab, you should turn in separate lab reports. Those separate reports must be your own writing and any required after-class calculations must also be your own. The answers on the exams and quizzes must of course be your work alone.

Academic dishonesty is defined in University Regulation 802, Revision 2, as "an act attempted or performed which misrepresents one's involvement in an academic task in any way, or permits another student to misrepresent the latter's involvement in an academic task by assisting the misrepresentation." The University has procedures to judge possible violations, and can impose serious penalties.

Text: Remote Sensing: Principles and Interpretation (Third Edition)
Floyd F. Sabins <u>required</u>

Topics to be covered:

The first half of the semester will address fundamental techniques used for remote sensing, organized primarily by wavelength region. During this half we will follow the text rather closely, except for some departures to cover more recent satellites and instruments. The second half of the semester will consist of increasingly sophisticated applications of those techniques. Beyond the terrestrial examples included in the text, we will study additional planetary examples based on NASA mission data.

Part 1: Principles and Techniques Chapters 1 – 8 from Sabins

Chapter 1: Introduction
- Properties of light
- Brief overview of remote sensing systems

Chapter 2: Photographs from aircraft and Satellites
Although this chapter nominally concentrates on photographs, the topics I consider essential are the introduction to the imaging geometry and the discussion of color vision, which will be applicable to most imaging systems. You can skim over the detailed discussion of film structure and film characteristics.
- Image geometry
- Stereo imaging
- Color vision, additive and subtractive color

Chapter 3: Landsat Images
This is the one specific remote sensing system which we will discuss in considerable detail, both as an example of the general properties of a multispectral system, and because of its historical and on-going importance as a major source of remote sensing data. We will concentrate on data from the Thematic Mapper (TM) instrument. Particularly important topics are:
- Wavelength and spatial resolution characteristics of the bands
- Orbit patterns
- Overview of mineral and vegetation spectral properties
- Interpretation of geologic structures: dip, strike, folds, faults

Chapter 4: Earth Resource and Environmental Satellites

Rather than concentrate on the details of the many satellite systems discussed in this chapter, we will consider the broad classes of different systems. We will also cover from the literature newer systems such as EOS, with a discussion of hyperspectral systems and a more detailed discussion of the physical origin of the band features which can be sensed with hyperspectral systems.

- Higher spatial resolution systems (eg. SPOT, IKONOS)
- NOAA monitoring systems
  - GEOS (Geostationary) and POES (Polar) satellites
  - AVHRR (Advanced Very High Resolution Radiometer) observations
- NASA Earth Observing System (EOS) (material since publication of text)
  - Terra and Aqua Satellites
  - Aster and MODIS instruments, providing improved spectral resolution
- Newer Hyperspectral Systems: AVIRIS and Hyperion

- Spectral band formation:
  - Si-O and O-H stretch bands
  - Charge transfer bands
  - Fe crystal field bands
  - Sensitivity of above bands to mineral composition

Chapter 5: Thermal infrared imaging

Temperature and heat transfer, thermal radiation equations, thermal inertia and image interpretation. We will also cover emissivity spectra, in more detail than given in the text.

Chapter 6: Radar technology and terrain interactions and

Chapter 7: Satellite radar systems and images

- Radar imaging systems and radar interpretation
- System geometry, resolution, wavelengths
- Interaction of radio wavelengths with surfaces
- Interpretation of radar images
- We will also discuss the recent Cassini radar observations of Titan

Part 2: Applications and Interpretation of data.

For this part we will use the second half of the text by Sabins but will heavily supplement it with material from the current literature, including NASA planetary results.

Chapter 8: Digital image processing.
- Use of the ENVI software package for processing digital data
- Geometry, flux calibration
- Classification, including principal components analysis
- Spectral mixture modeling (using linear mixture modeling as an example)
- Map projections

Chapter 9: Meteorological, Oceanographic, and Environmental Applications
- We will have a brief overview of the following topics:
- Ozone mapping, Cloud, rainfall, and snow mapping, Ocean productivity

Chapter 10: Oil Exploration
- We will cover this chapter only briefly, reviewing mapping of geological structures.

Chapter 11: Mineral Exploration:
- More detailed mineral and structure identification from space.

Chapter 12: Land use and Land Cover
- Multilevel classification systems,
- Vegetation mapping and the NDVI (Normalized Difference Vegetation Index).
- We will briefly cover use of Geographic Information Systems.

Chapter 13: Natural hazards
- Earthquake, landslides, land subsidence, floods, volcanoes, fires

Chapter 14: Summary overview
- Summary of techniques, plus overview of future systems and techniques.

Lab Supplies: You will need the following supplies for some of the "non-computer" labs:
- Scale (ruler) with 10th or 20th of inches, and mm and cm.
- Protractor
- Several color pens which can write on plastic overlays.
- Pencil and soft eraser
- <u>You should also bring your textbook and a calculator to both the computer and non-computer labs.</u>