ASTE 553
SYSTEMS FOR REMOTE SENSING FROM SPACE
Syllabus

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Overview

The approach for this class is to start with the electromagnetic spectrum and:

1. Go over the basic physics that applies to each part.
2. Study the techniques used to collect the data.
3. Examine the applications for that type of Remote Sensing.
4. Analyze the particular challenges associated with this kind of system using examples of current or planned investigations via spacecraft.

(1) – (3) can be found in the class text. (4) is unique to this class.

Everything is then tied together in an exercise to design a spaceborne remote sensing system in the last few homework assignments.

General Logistics

Write your NAME and COURSE NUMBER on all homework pages.

Homework will be reviewed in class 2 weeks after the due date. Your graded homework will be returned to you in time for the review.

Class will begin at 6:40 PM on Thursdays. There will be a break of ~15 min. roughly halfway through the class.

The mid-term and final exams will use the procedures given by USC. **It is expected that students will take the exams on the date and time specified by USC. The only exception is for documented work conflicts through the instructor and USC approval process.**

Homework will be turned in using the procedures provided by USC.

**Note that when homework and exams are returned you have one week to look it over and report any discrepancies with rationale to the instructor or TA.

Plan on attending at least one office hour or pre-arranged videocon. I'd like to meet you.

Use the forum provided by DEN for class discussions.

Email the instructor for questions at matousek@usc.edu (make sure you include USC ASTE 553 in the beginning of the subject line)

Instructor

Steve Matousek is currently the Jet Propulsion Laboratory (JPL) Planetary Science formulation program engineer and Enceladus New Frontiers 5 capture lead. Recently, he was the Advanced Concept Methods and Tools Manager (A-Team). He led the creation of new advanced concept concurrent teams including the JPL A-Team and Team Xc (CubeSat/SmallSat). He leads numerous advanced study teams across the areas of Earth Science, Astrophysics, Planetary Science, and technology infusion. Before his current assignments, Steve was the Juno proposal manager and then mission manager responsible for the development of the Juno mission and operations. He has led over 20 major mission proposals over 2 decades. He was section manager of JPL's Mission and Systems Architecture section. He was a trajectory engineer on the Voyager 2 Uranus and Neptune encounters. He started his aerospace career as an undergraduate command controller of the Solar Mesospheric Explorer at the Laboratory for Atmospheric and Space Physics. He received the NASA Exceptional Service medal in 2012 for his role leading the Juno proposal and mission system development efforts. He is an Associate Fellow of the AIAA. His research interests include novel smallsat and nanosat applications for solar system exploration, and advanced methods of sustained innovation and creativity.

Class Procedure

The class textbook is "Introduction to the Physics and Techniques of Remote Sensing (2nd edition), by Charles Elachi and Jakob van Zyl, published by John Wiley and Sons 2006. The textbook is used for the basic physics of remote sensing throughout the class.

The original publication date for the Elachi and van Zyl text was 1987. Many current remote sensing systems were only dreamed about at that time.

Notes reflect the current state-of-the-art and introduce current and future systems.

Notes will be provided for each lecture. In most areas these are based on the instructor's experience. The class notes contain a lot of material so that you can see many examples of space systems. It is not intended that you will remember all the content of the class notes. Thinking and showing your path to solutions is important as many times there is more than one way to create a functioning space system.

We will also use Chapters 9 and 13 of "Space Mission Analysis and Design (3rd Edition), Wertz and Larson (Ed.), published Microcosm Press Space Technology Library in two of the classes.

Class Procedure (2)

Homework:

- Homework assignments will be given every other week (see schedule)
- You will have two weeks to complete each assignment – but they must be submitted before class on that date (before 6:40 PM Pacific time)
- Homework will then be reviewed 2 weeks after the due date.
- Homework received late by up to two weeks before the in-class review will be graded and reduced by 50%.
- Homework more than two weeks late will not be graded.
- If you have a **<u>very</u>** good reason for late homework I can be flexible if you contact me ahead of time.

Course Grade:

- 50% homework
- 20% mid-term
- 30% final

Instructors: Occasionally, because of my schedule, guest instructors who are experts in that week's topic will present.

Course Objective

This course will provide a basic engineering and scientific overview of the physics and techniques of remote sensing systems. The following topics will be covered:

- Remote sensing orbits
- Basic properties of electromagnetic waves and their interaction with matter
- How photons are turned into information
- Remote sensing of surfaces
- Remote sensing of atmospheres
- Remote sensing instruments as part of a system

It is assumed that students have Senior or Graduate standing in Engineering or Physics.

Course Outline

Class #	**Date**	**Subject**	**Reading**	**Homework**
1	08/25	Course Introduction Remote Sensing Overview Nature and Properties of EM waves Part I	Elachi and van Zyl Chapter 1	Yes – due date 09/08
2	09/01	Orbital Mechanics Featured System: MODIS	Elachi and van Zyl Appendix B Chapter 2	None
3	09/08	Solid Surfaces – Visible and Near Infrared 1: **AVIRIS – the state-of-the-art in Hyperspectral Visible/IR imaging**	Elachi and van Zyl Chapter 3	Yes – due date 09/22 08/25 assignment due
4	09/15	Solid Surfaces – Visible and Near Infrared 2: **Icesat – an example of active remote sensing**	Elachi and van Zyl Chapter 3	None
5	09/22	Nature and Properties of EM waves Part II Solid Surfaces: Thermal Infrared **ASTER – state-of-the-art in Thermal Imaging** **Cooling IR Focal Planes**	Elachi and van Zyl Chapter 4	Yes – due date 10/06 09/08 assignment due
6	09/29	Solid Surfaces – Passive Microwave, Active Microwave I Altimeters, Sounders, and Scatterometers **SMAP Soil Moisture measurements** **Aquarius – requirements and error budgets** **OSTM measuring sea level;** **GPS Reflections; Radar Sounding**	Elachi and van Zyl Chapter 5, Chapter 7	None
7	10/06	Solid Surfaces - Active Microwave II: Real and Synthetic Aperture Radars **SAR systems - present and future**	Elachi and van Zyl Chapter 6	09/22 assignment due Note: This lecture material not on mid-term but on final Study for mid-term

Course Outline (2)

Class #	Date	Subject	Reading	Homework
8	10/13	Mid-term exam	Course work through Class 6	none
9	10/20	Telecom **DSN – NASA's Deep Space Network, Ground Networks, Telecom trades**	Wertz and Larson Ch. 13, Notes will be provided	Yes – due date 11/03
10	10/27	Remote Sensing of Atmospheres I: Passive **Greenhouse Gases**	Elachi and van Zyl Chapters 8/10/11	None
11	11/03	Putting It All Together in a System I	Class Notes	Yes – due date 11/17 10/20 assignment due
12	11/10	Putting It All Together in a System II	Class Notes	None
13	11/17	Putting It All Together in a System III	Class notes	11/03 assignment due.
	11/24	Thanksgiving		None
14	12/01	Juno Mission to Jupiter, visible, IR, UV, gravity science	Class notes	Note no homework on this lecture, but material on final. Extra credit due.
15	12/08	Final exam (see USC schedule)	All coursework	None, covers all coursework