ASTE 553
SYSTEMS FOR REMOTE SENSING FROM SPACE

Instructor: Steve Matousek

e-mail: stevematousek@gmail.com

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, SITE OF CLASS, 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 be on the USC campus.

Homework can be faxed to USC.

Plan on attending at least one lecture live at USC. I'd like to meet you.

Use the forum provided by DEN for class discussions.

Email the instructor for questions at stevematousek@gmail.com (make sure you include USC ASTE 553 in the beginning of the subject line)

Instructor

Steve Matousek is currently the Mission Systems and Operations Assistant Division Manager for Formulation and the proposed NASA Small Explorer mission SPHEREx capture lead. He recently led JPL formulation training. He led the creation of new advanced concept concurrent teams including the JPL A-Team and Team Xc (CubeSat). 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.

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 6:30 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 **very** good reason for late homework I can be flexible.

Course Grade:

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

Instructors: Occasionally, because of my travel 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 **GOSAT Fluorescence measurements**	Elachi and van Zyl Chapter 1	None
2	09/01	Orbital Mechanics	Elachi and van Zyl Appendix B Chapter 2	Yes – due date 09/18
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	None
4	09/15	Solid Surfaces – Visible and Near Infrared 2: **Icesat – an example of active remove sensing**	Elachi and van Zyl Chapter 3	Yes – due date 10/02 09/04 assignment due
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	None
6	09/29	Solid Surfaces – Passive Microwave **SMAP Soil Moisture measurements** **Aquarius – requirements and error budgets**	Elachi and van Zyl Chapter 5	Yes – due date 10/16 09/18 assignment due
7	10/06	Solid Surfaces – Active Microwave I: Altimeters, Sounders, and Scatterometers **OSTM measuring sea level;** **GPS Reflections; Radar Sounding**	Elachi and van Zyl Chapter 7	None

Course Outline (2)

Class #	Date	Subject	Reading	Homework
8	10/13	Solid Surfaces - Active Microwave II: Real and Synthetic Aperture Radars! **SAR systems - present and future**	Elachi and van Zyl Chapter 6	Study for mid-term
9	10/20	Mid-term exam	Course work to date	none
10	10/27	Polarimetric and Interferometric SAR **UAVSAR and Tandem-X**	Notes will be provided	Yes, due 11/13
11	11/03	Telecom **DSN – NASA's Deep Space Network, Ground Networks, Telecom trades**	Wertz and Larson Ch. 13, Notes will be provided	None
12	11/10	Remote Sensing of Atmospheres I: Passive **Greenhouse Gases**	Elachi and van Zyl Chapters 8/10/11	Yes, due date 12/04 10/30 assignment due
13	11/17	Putting It All Together in a System	Class Notes	None
	11/24	Thanksgiving		None
14	12/01	Juno Mission to Jupiter, visible, IR, UV, gravity science, SPHEREx astrophysics proposed SMEX mission all-sky near-IR survey for cosmology	Class notes	Study for final, 11/13 assignment due
15	12/08	Final exam (see USC schedule)	All coursework	None