

ASTE 553 2024

SYSTEMS FOR REMOTE SENSING

FROM SPACE

Syllabus

Instructors: Professors Steve Matousek
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TA: Adarsh Rajguru
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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 (1 of 2)

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.**

Use the forum provided by DEN for class discussions.

General Logistics (2 of 2)

Email the Adarsh Rajguru (TA) arajguru@usc.edu or the instructors for questions at matousek@usc.edu, or biocpu@yahoo.com (make sure you include USC ASTE 553 in the beginning of the subject line).

Office hours:

Wednesdays 9-10 AM (virtual, email Adarsh for link): Adarsh Rajgura, arajguru@usc.edu

Tuesdays, 5-6 PM (virtual, email Professor Kim or Professor Matousek for link):
biocpu@yahoo.com, matousek@usc.edu

Other times for office hours can be arranged if you email in advance

Professor Matousek

Steve Matousek is currently the Jet Propulsion Laboratory (JPL) Mars Exploration Program advanced studies office manager. Recently, he was the planetary science program engineer and 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 3 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 small satellite and nanosat applications for solar system exploration, and advanced methods of sustained innovation and creativity.

Professor Kim

Seung-bum Kim received the B.Sc. degree in electrical engineering from the Korea Advanced Institute of Science and Technology (KAIST) and the M.S. and Ph.D. degrees in satellite engineering and remote sensing from the Physics department of the University College London, England. He was a scientist at Remote Sensing Systems, California, developing the L-band radiometry of the ocean salinity observations by the NASA Aquarius mission and its instrument design. Since joining JPL, he has focused on the design and remote-sensing of the radar and radiometer satellite missions for earth observations (Aquarius, SMAP, CYGNSS, NISAR, and Sentinel-1) by NASA and ESA. The research also included the evaluation and use of the small-satellite radars (Capella, ICEYE, and Umbra) and NASA's airborne radars (Earth Venture Suborbital). As a member of the science teams of these missions, he performed the electromagnetic modeling, retrieval of earth hydrological parameters, and applications (soil moisture, precision irrigation, landslide, wild fire). He received dozen awards from JPL and NASA including a JPL Voyager award. He has served various panels and review boards of NASA's satellite developments, and as a project scientist at UCLA.

Class Procedure

The class textbook is “Introduction to the Physics and Techniques of Remote Sensing (2nd edition, though the first edition is useful, too), 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.

Extensive notes will be provided for each lecture. In most areas these are based on the instructors’ 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 since 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 participation is encouraged during the lectures, during office hours, or via email the instructors or TA. Attendance and class participation do not count directly towards your grade, though they do contribute directly to your understanding and enjoyment.

If you have time, we would like to meet you either in the classroom at USC, or via zoom.

Thank you for signing up for this course. Without you, space systems for remote sensing would not exist!

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 **very** good reason for late homework we can be flexible if you contact us ahead of time.

Course Grade:

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

Instructors: Occasionally, because of our schedules, 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.

By the end of this course, students will be able to design a remote sensing system in space.

Course Outline

Class #	Date	Instructor	Subject	Reading	Homework
1	08/29	Professor Matousek	Course Introduction Remote Sensing Overview Nature and Properties of EM waves Part I	Elachi and van Zyl Chapter 1	Yes – due date 09/12
2	09/05	Professor Kim	Orbital Mechanics Featured System: MODIS	Elachi and van Zyl Appendix B Chapter 2	None
3	09/12	Professor Matousek	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 09/26 08/29 assignment due
4	09/19	Professor Matousek	Solid Surfaces – Visible and Near Infrared 2: Icesat – an example of active remote sensing	Elachi and van Zyl Chapter 3	None
5	09/26	Professor Matousek	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 10/17 09/12 assignment due
6	10/03	Professor Kim	Solid Surfaces – Passive Microwave, Active Microwave I Altimeters, Sounders, and Scatterometers Aquarius – requirements and error budgets OSTM measuring sea level; GPS Reflections; Radar Sounding or Equivalent Examples	Elachi and van Zyl Chapter 5, Chapter 7	None
	10/10		Fall recess – no class or class lecture	None	09/26 assignment due

Course Outline (2)

Class #	Date	Instructor	Subject	Reading	Homework
7	10/17	Professor Kim	Solid Surfaces - Active Microwave II: Real and Synthetic Aperture Radars SAR systems - present and future	Elachi and van Zyl Chapter 6	Note: This lecture material not on mid-term but on final Study for mid-term
9	10/24		Mid-term exam	Course work through Class 6	None
10	10/31	Professor Matousek	Telecom DSN – NASA’s Deep Space Network, Ground Networks, Telecom trades	Wertz and Larson Ch. 13, Notes will be provided	Yes – due date 11/10
11	11/07	Professor Kim	Remote Sensing of Atmospheres I: Passive Greenhouse Gases	Elachi and van Zyl Chapters 8/10/11	None
12	11/14	Professor Kim	Putting It All Together in a System I	Class Notes	Yes – due date 12/01 10/27 assignment due
13	11/21	Professor Kim	Putting It All Together in a System II	Class Notes	None
	11/28		Thanksgiving		None
14	12/05	Professor Matousek	Juno Mission to Jupiter, visible, IR, UV, gravity science or Equivalent Lecture System Topic	Class notes	11/10 assignment due. Note no homework on this lecture, but material on final. Extra credit due.
15	12/12		Final exam, 7 PM – 9 PM Pacific	All coursework	None, covers all coursework

Academic Integrity

[This text is required by USC to be included in syllabi]

The University of Southern California is foremost a learning community committed to fostering successful scholars and researchers dedicated to the pursuit of knowledge and the transmission of ideas. Academic misconduct is in contrast to the university's mission to educate students through a broad array of first-rank academic, professional, and extracurricular programs and includes any act of dishonesty in the submission of academic work (either in draft or final form).

This course will follow the expectations for academic integrity as stated in the USC Student Handbook. All students are expected to submit assignments that are original work and prepared specifically for the course/section in this academic term. You may not submit work written by others or "recycle" work prepared for other courses without obtaining written permission from the instructor(s). Students suspected of engaging in academic misconduct will be reported to the Office of Academic Integrity.

Other violations of academic misconduct include, but are not limited to, cheating, plagiarism, fabrication (e.g., falsifying data), knowingly assisting others in acts of academic dishonesty, and any act that gains or is intended to gain an unfair academic advantage.

Academic dishonesty has a far-reaching impact and is considered a serious offense against the university. Violations will result in a grade penalty, such as a failing grade on the assignment or in the course, and disciplinary action from the university itself, such as suspension or even expulsion.

For more information about academic integrity see the student handbook or the Office of Academic Integrity's website, and university policies on Research and Scholarship Misconduct.

Please ask your instructor if you are unsure what constitutes unauthorized assistance on an exam or assignment or what information requires citation and/or attribution.

Policy on Use of AI Generators in ASTE 553

This course aims to develop creative, analytical, and critical thinking skills. Therefore, all assignments should be prepared by the student working individually or in groups. Students may not have another person or entity complete any substantive portion of the assignment. Developing strong competencies in these areas will prepare you for a competitive workplace. Therefore, using AI-generated text, code, or other content is prohibited in this course, will be identified as plagiarism, and will be reported to the Office of Academic Integrity.

Course Content Distribution and Synchronous Session Recordings Policies

USC has policies that prohibit recording and distribution of any synchronous and asynchronous course content outside of the learning environment.

Recording a university class without the express permission of the instructor and announcement to the class, or unless conducted pursuant to an Office of Student Accessibility Services (OSAS) accommodation. Recording can inhibit free discussion in the future, and thus infringe on the academic freedom of other students as well as the instructor. (Living our Unifying Values: The USC Student Handbook, page 13).

Distribution or use of notes, recordings, exams, or other intellectual property, based on university classes or lectures without the express permission of the instructor for purposes other than individual or group study. This includes but is not limited to providing materials for distribution by services publishing course materials. This restriction on unauthorized use also applies to all information, which had been distributed to students or in any way had been displayed for use in relation to the class, whether obtained in class, via email, on the internet, or via any other media. Distributing course material without the instructor's permission will be presumed to be an intentional act to facilitate or enable academic dishonesty and is strictly prohibited. (Living our Unifying Values: The USC Student Handbook, page 13).

Other Important Information (1)

Statement on University Academic and Support Systems

Students and Disability Accommodations:

USC welcomes students with disabilities into all of the University's educational programs. [The Office of Student Accessibility Services](#) (OSAS) is responsible for the determination of appropriate accommodations for students who encounter disability-related barriers. Once a student has completed the OSAS process (registration, initial appointment, and submitted documentation) and accommodations are determined to be reasonable and appropriate, a Letter of Accommodation (LOA) will be available to generate for each course. The LOA must be given to each course instructor by the student and followed up with a discussion. This should be done as early in the semester as possible as accommodations are not retroactive. More information can be found at osas.usc.edu. You may contact OSAS at (213) 740-0776 or via email at osasfrontdesk@usc.edu.

Student Financial Aid and Satisfactory Academic Progress:

To be eligible for certain kinds of financial aid, students are required to maintain Satisfactory Academic Progress (SAP) toward their degree objectives. Visit the [Financial Aid Office webpage](#) for [undergraduate](#)- and [graduate-level](#) SAP eligibility requirements and the appeals process.

Support Systems:

[Counseling and Mental Health](#) - (213) 740-9355 – 24/7 on call

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

[988 Suicide and Crisis Lifeline](#) - 988 for both calls and text messages – 24/7 on call

The 988 Suicide and Crisis Lifeline (formerly known as the National Suicide Prevention Lifeline) provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week, across the United States. The Lifeline consists of a national network of over 200 local crisis centers, combining custom local care and resources with national standards and best practices. The new, shorter phone number makes it easier for people to remember and access mental health crisis services (though the previous 1 (800) 273-8255 number will continue to function indefinitely) and represents a continued commitment to those in crisis.

Other Important Information (2)

[Relationship and Sexual Violence Prevention Services \(RSVP\)](#) - (213) 740-9355(WELL) – 24/7 on call

Free and confidential therapy services, workshops, and training for situations related to gender- and power-based harm (including sexual assault, intimate partner violence, and stalking).

[Office for Equity, Equal Opportunity, and Title IX \(EEO-TIX\)](#) - (213) 740-5086

Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

[Reporting Incidents of Bias or Harassment](#) - (213) 740-2500

Avenue to report incidents of bias, hate crimes, and microaggressions to the Office for Equity, Equal Opportunity, and Title for appropriate investigation, supportive measures, and response.

[The Office of Student Accessibility Services \(OSAS\)](#) - (213) 740-0776

OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy.

[USC Campus Support and Intervention](#) - (213) 740-0411

Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

[Diversity, Equity and Inclusion](#) - (213) 740-2101

Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

[USC Emergency](#) - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call

Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

[USC Department of Public Safety](#) - UPC: (213) 740-6000, HSC: (323) 442-1200 – 24/7 on call

Non-emergency assistance or information.

[Office of the Ombuds](#) - (213) 821-9556 (UPC) / (323-442-0382 (HSC)

A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

[Occupational Therapy Faculty Practice](#) - (323) 442-2850 or otfp@med.usc.edu

Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.