

# REMOTE SENSING IN ENGINEERING: SCIENCE, SENSORS, & APPLICATIONS

ABE 4034; EEL 3402

**Class Periods:** TR, 8:30-9:45am (10:25am for exams, make-up classes, & presentations)

**Location:** Rogers Hall, Room 129

**Academic Term:** Spring 2023

## Instructor

Prof. Jasmeet Judge, Rogers Hall-205

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Office hours: TR after class (9:45-10:45am) or by appointment

## Course Description

Develop an understanding of science and theory of remote sensing, systems used in remote sensing, and applications from information obtained in the visible/near infrared, thermal infrared and microwave regions of the EM spectrum.

## Course Pre-Requisites/Co-Requisites

MAP 2302 or the equivalent

## Course Objectives

The main objective of the course is to develop an understanding of remote sensing theory, systems, and applications in visible, infrared, and microwave regions of the EM spectrum. The course is divided into three parts. The first part includes science and theoretical basis of remote sensing. The second part of the course involves system characteristics of sensors used in the three regions, including sensor design, calibration, and performance issues. The third part includes student presentations on various applications of remote sensing.

The course is designed for upper division undergraduate students in the College of Engineering who have a strong background in differential/integral calculus, and preferably, in applied physics. It is primarily a lecture-based course with in-class problems, exams, homework assignments, and a project.

## Relation to Program Outcomes (ABET)

Outcome	Coverage*
An ability to identify, formulate, and solve engineering problems by applying principles of engineering, science, and mathematics.	High
An ability to apply both analysis and synthesis in the engineering design process, resulting in designs that meet desired needs.	Medium
An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.	

An ability to communicate effectively with a range of audiences	Medium
An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.	Medium
An ability to recognize the ongoing need for additional knowledge and locate, evaluate, integrate, and apply this knowledge appropriately.	Medium
An ability to function effectively on teams that establish goals, plan tasks, meet deadlines, and analyze risk and uncertainty	

### Text Recommendations

There is no required text. Handouts will be provided on course website from the following:

(C) Elachi, C., Introduction to the Physics and Techniques of Remote Sensing, John Wiley & Sons, 1987.

(LK) Lilesand and Keifer, Remote Sensing and Image Interpretation, John Wiley & Sons, 2003.

(MRS1) Ulaby, Moore, and Fung, Microwave Remote Sensing: Volume I, Fundamentals and Radiometry, Addison-Wesley, 1981.

(MRS2) Ulaby, Moore, and Fung, Microwave Remote Sensing: Volume II, Active, Addison-Wesley, 1981.

(S) Schott, J., Remote Sensing: The image change approach, Oxford University Press, 1997.

(SE) Schultz and Engman, Remote Sensing in Hydrology and Water Management, Springer, 2000.

(U) Ulaby, F., Fundamentals of Applied Electromagnetics, Prentice Hall, 2006.

All relevant materials and handouts are provided on the Canvas course website: <http://elearning.ufl.edu/>

### Course Schedule:

*PART I: Science and Theory of Remote Sensing: (Weeks 1-6)*

#### 1. Introduction

Electromagnetic (EM) spectrum

Applications of remote sensing

#### 2. Radiative transfer theory in VI, IR, & Microwave

#### Exam I

*PART II: Sensors in Remote Sensing (Weeks 7-13)*

1. Passive sensors used in the Visible, IR, & Microwave regions

2. Active Sensors in Visible/NIR and Microwave regions

*PART III: Remote Sensing Applications to Engineering (Weeks 12-15)*

Project and student presentations. Examples include applications in environment, ecology, agriculture, hydrology, wireless communication, defense, archaeology, etc

#### Exam II

## **Attendance Policy, Class Expectations, and Make up Policy**

Classes will be primarily lecture-based, with material presented and discussed in-person. Unless a legitimate reason is provided *prior* to the due date, homework assignments turned in after the due date will count for 50% less than the scored points if turned in *before* the next class past the due date. The assignments turned in after the next class past the due date or after the grades and solutions have been posted will not be graded. An exam or a project for another course *is not a legitimate reason* to miss due dates for this course.

In-class problems will be completed and discussed during class. The students are expected to turn in their solutions via Canvas course website within 10 minutes following the class period. No makeup will be offered for missed in-class problems.

No makeup will be offered for missed quizzes/exams unless agreed upon by the instructor based upon a legitimate reason/documentation provided *prior* to the date of the quiz/exam.

Additional information can be found at <https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/>

## **Evaluation of Grades**

Final grades will be assigned based upon homework assignments (20%), in-class problems (10%), two quizzes (10% each), two exams (15% each), project (total = 20%, *with topic 2%; references 6%; outline 2%; presentation 10%*).

## **Grading Policy**

$$\begin{aligned} 90 \leq A- < 93 \leq A \leq 100 \\ 80 \leq B- < 83 \leq B < 85 \leq B+ < 90 \\ 70 \leq C- < 73 \leq C < 75 \leq C+ < 80 \\ 60 \leq D- < 63 \leq D < 65 \leq D+ < 70 \\ < 60 E \end{aligned}$$

More information on UF grading policy may be found at:

<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

## **Students Requiring Accommodations**

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting <https://disability.ufl.edu/students/get-started/>. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

## **Course Evaluation**

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.ua.ufl.edu/students/>. Students will be

notified when the evaluation period opens and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

### **In-class Recording**

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A “class lecture” is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publishing without permission of the instructor is prohibited. To “publish” means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third-party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

### **University Honesty Policy**

UF students are bound by The Honor Pledge which states, “We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: “On my honor, I have neither given nor received unauthorized aid in doing this assignment.” The Honor Code (<https://sccr.dso.ufl.edu/process/student-conduct-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor in this class.

### **Commitment to a Safe and Inclusive Learning Environment**

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is

expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Jennifer Nappo, Director of Human Resources, 352-392-0903, [rbielling@eng.ufl.edu](mailto:rbielling@eng.ufl.edu)
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, [taylor@eng.ufl.edu](mailto:taylor@eng.ufl.edu)
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, [nishida@eng.ufl.edu](mailto:nishida@eng.ufl.edu)

### **Software Use**

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

### **Student Privacy**

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <https://registrar.ufl.edu/ferpa.html>

### **Campus Resources:**

#### Health and Wellness

#### **U Matter, We Care:**

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact [umatter@ufl.edu](mailto:umatter@ufl.edu) so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

**Counseling and Wellness Center:** <https://counseling.ufl.edu>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

#### **Sexual Discrimination, Harassment, Assault, or Violence**

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, [title-ix@ufl.edu](mailto:title-ix@ufl.edu)

#### **Sexual Assault Recovery Services (SARS)**

Student Health Care Center, 392-1161.

**University Police Department** at 392-1111 (or 9-1-1 for emergencies), or

<http://www.police.ufl.edu/>.

### Academic Resources

**E-learning technical support**, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu.  
<https://lss.at.ufl.edu/help.shtml>.

**Career Resource Center**, Reitz Union, 392-1601. Career assistance and counseling;  
<https://career.ufl.edu>.

**Library Support**, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

**Teaching Center**, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring.  
<https://teachingcenter.ufl.edu/>.

**Writing Studio, 302 Tigert Hall**, 846-1138. Help brainstorming, formatting, and writing papers.  
<https://writing.ufl.edu/writing-studio/>.

**Student Complaints Campus:** <https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>; <https://care.dso.ufl.edu>.

**On-Line Students Complaints:** <http://www.distance.ufl.edu/student-complaint-process>.