



The University of Texas at Arlington
Department of Electrical Engineering

EE5334 – Fundamentals of Radar Remote Sensing

Course Information (EE5334-001 & EE4328-009)

Fall 2016

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Class time and location:
TTh 2:00 PM – 3:20 AM, Room 110 NH
Office hours for class:
TTh 3:30 PM – 5:00 PM or by appointment

Course Description:

Active and passive remote sensing systems, platforms for remote sensing, radar equation, interaction of electromagnetic wave with matter, radar cross section, scattering from area extensive targets, surface scattering, volume scattering, radiative transfer theory, radar data collection and analysis, retrieval of target parameters.

Objective: This course is designed to give you an understanding of how to remotely (wirelessly) acquire physical information about a target using electromagnetic waves. The course focuses on the fundamental principles of radar remote sensing (active sensing) and will cover topics in the following areas (1) radar systems and sensor parameters, (2) measurements and radar signal processing, (3) forward modeling of wave-medium interactions, and (4) interpretation of remotely sensed data.

Required Text: Fawwaz T. Ulaby and David G. Long, "Microwave Radar and Radiometric Remote Sensing," The University of Michigan Press, 2014, ISBN: 978-0-472-11935-6

Grading: There will be home works, projects, and two tests. If you have a question on grading of an assignment or a test, please contact me about your question within one week of the time the grade is received. The tentative weighting and grading scales are:

Weighting of scores		Scale for letter grade	
Homeworks	10%	90—100	A
Average of 2 test scores	60%	80—89.99	B
Projects	30%	70—79.99	C
		60—69.99	D
		<60	F

Tests: All tests will be comprehensive, close book and close notes. You are allowed to bring one sheet of notes (8.5"×11", both sides.) The use of calculator is allowed in the exam. No make up exam unless approval is obtained prior to the scheduled test date.

Assignments: You must turn in your own work, not copied from someone else's. Please write (or print) legibly.

Important Dates: Test #1: October 6, 2016 (Th)
Test #2: November 17, 2016 (Th)

Lecture Topics (plan):

Lect. #	Topics	Ref
1	Fundamentals of radar and radiometer system: system block diagram, transmitter, receiver, antenna, system parameters, radar equation	Ch. 1
2	More on radar equation: antenna parameters, polarization, isotropic scatterer, radar cross section, area extensive targets (scattering coefficient)	Ch. 1
3	Radar signal processing: modulation (FMCW, pulse), demodulation, pulse duration, pulse repetition, range resolution, range ambiguity, pulse compression	Ch. 1
4	Introduction to microwave remote sensing (what and why), overview of microwave remote sensors	Ch. 1
5	Basic operation and applications of radar in remote sensing	Ch. 1
6	Electromagnetic wave propagation: Maxwell's equations, plane waves, medium properties, wave equations	Ch. 2
7	Absorption, reflection, transmission and scattering of EM wave	Ch. 2
8	Remote sensing antennas: radiation characteristics	Ch. 3
9	Remote sensing antennas: antenna arrays, antenna types	Ch. 3
10	Microwave dielectric properties of natural earth materials: pure water, saline water, ice; mixing models	Ch. 4
11	Microwave dielectric properties of natural earth materials: sea ice, snow, dry rocks, soil, and vegetation	Ch. 4
12	Wave scattering: radar equation, RCS, scattering from area extensive targets, coherent and incoherent scattering, scattering coefficient	Ch. 5
13	Wave scattering: scattering matrix, specific intensities, modified Stokes parameters	Ch. 5
14	Radar scattering: measurement configurations (monostatic, bistatic, multistatic), scatterometer, imaging radar, Doppler shift	Ch. 5
15	Radar scattering signal analysis: coherent and incoherent scattering, signal models, linear and square-law detection, fading statistics, averaging and filtering	Ch. 5
16	Polarimetric scattering: modeling and analysis	Ch. 5
17	Microwave interaction with atmospheric constituents: standard atmosphere, extinction by hydrometeors, Rayleigh and Mie scattering	Ch. 8
18	Microwave interaction with atmospheric constituents: extinction and scattering by cloud, melting layer, and rain	Ch. 8
19	Wave scattering from an inhomogeneous layer: radiative transfer formulation	Ch. 8, 11
20	Surface scattering models and land observations: randomly rough surface, surface characterization	Ch. 10
21	Surface scattering models: Kirchhoff model	Ch. 10
22	Surface scattering models: small perturbation model (SPM)	Ch. 10
23	Surface scattering models: IEM and SSA models	Ch. 10
24	Volume scattering models: coherent and incoherent scattering, heuristic	Ch. 11

	single scattering model for vegetation and snow	
25	Radiative transfer theory: phase matrix, iterative solution method, scattering operator formulation	Ch. 11
26	Applications: radar observation of scattering from vegetation canopies, soil layer, and snow	Ch. 11
27	Radar measurements and scatterometers: FMCW, pulsed, range and Doppler resolution, matched filtering, waveform design	Ch. 13
28	Radar calibration; VNA as scatterometer	Ch. 13

----- IMPORTANT INFORMATION -----

Attendance:

At The University of Texas at Arlington, taking attendance is not required but attendance is a critical indicator in student success. Each faculty member is free to develop his or her own methods of evaluating students' academic performance, which includes establishing course-specific policies on attendance. As the instructor of this section, I will take attendance sporadically. However, while UT Arlington does not require instructors to take attendance in their courses, the U.S. Department of Education requires that the University have a mechanism in place to mark when Federal Student Aid recipients "begin attendance in a course." UT Arlington instructors will report when students begin attendance in a course as part of the final grading process. Specifically, when assigning a student a grade of F, faculty report the last date a student attended their class based on evidence such as a test, participation in a class project or presentation, or an engagement online via Blackboard. This date is reported to the Department of Education for federal financial aid recipients.

Drop Policy:

Students may drop or swap (adding and dropping a class concurrently) classes through self-service in MyMav from the beginning of the registration period through the late registration period. After the late registration period, students must see their academic advisor to drop a class or withdraw. Undeclared students must see an advisor in the University Advising Center. Drops can continue through a point two-thirds of the way through the term or session. It is the student's responsibility to officially withdraw if they do not plan to attend after registering.

Students will not be automatically dropped for non-attendance. Repayment of certain types of financial aid administered through the University may be required as the result of dropping classes or withdrawing. For more information, contact the Office of Financial Aid and Scholarships (<http://wweb.uta.edu/aao/fao/>).

Electronic Communication:

UT Arlington has adopted MavMail as its official means to communicate with students about important deadlines and events, as well as to transact university-related business regarding financial aid, tuition, grades, graduation, etc. All students are assigned a MavMail account and are responsible for checking the inbox regularly. There is no additional charge to students for using this account, which remains active even after graduation. Information about activating and using MavMail is available at <http://www.uta.edu/oit/cs/email/mavmail.php>.

Academic Integrity:

Students enrolled all UT Arlington courses are expected to adhere to the UT Arlington Honor Code:

I pledge, on my honor, to uphold UT Arlington's tradition of academic integrity, a tradition that values hard work and honest effort in the pursuit of academic excellence.

I promise that I will submit only work that I personally create or contribute to group collaborations, and I will appropriately reference any work from other sources. I will follow the highest standards of integrity and uphold the spirit of the Honor Code.

UT Arlington faculty members may employ the Honor Code in their courses by having students acknowledge the honor code as part of an examination or requiring students to incorporate

the honor code into any work submitted. Per UT System *Regents' Rule* 50101, §2.2, suspected violations of university's standards for academic integrity (including the Honor Code) will be referred to the Office of Student Conduct. Violators will be disciplined in accordance with University policy, which may result in the student's suspension or expulsion from the University. Additional information is available at <https://www.uta.edu/conduct/>

Student Feedback Survey:

At the end of each term, students enrolled in face-to-face and online classes categorized as "lecture," "seminar," or "laboratory" are directed to complete an online Student Feedback Survey (SFS). Instructions on how to access the SFS for this course will be sent directly to each student through MavMail approximately 10 days before the end of the term. Each student's feedback via the SFS database is aggregated with that of other students enrolled in the course. Students' anonymity will be protected to the extent that the law allows. UT Arlington's effort to solicit, gather, tabulate, and publish student feedback is required by state law and aggregate results are posted online. Data from SFS is also used for faculty and program evaluations. For more information, visit <http://www.uta.edu/sfs>.

Final Review Week:

A period of five class days prior to the first day of final examinations in the long sessions shall be designated as Final Review Week. The purpose of this week is to allow students sufficient time to prepare for final examinations. During this week, there shall be no scheduled activities such as required field trips or performances; and no instructor shall assign any themes, research problems or exercises of similar scope that have a completion date during or following this week unless specified in the class syllabus. During Final Review Week, an instructor shall not give any examinations constituting 10% or more of the final grade, except makeup tests and laboratory examinations. In addition, no instructor shall give any portion of the final examination during Final Review Week. During this week, classes are held as scheduled. In addition, instructors are not required to limit content to topics that have been previously covered; they may introduce new concepts as appropriate.

Student Support Services:

UT Arlington provides a variety of resources and programs designed to help students develop academic skills, deal with personal situations, and better understand concepts and information related to their courses. Resources include [tutoring](#), [major-based learning centers](#), developmental education, [advising and mentoring](#), personal counseling, and [federally funded programs](#). For individualized referrals, students may visit the reception desk at University College (Ransom Hall), call the Maverick Resource Hotline at 817-272-6107, send a message to resources@uta.edu, or view the information at <http://www.uta.edu/universitycollege/resources/index.php>.

Disability Accommodations:

UT Arlington is on record as being committed to both the spirit and letter of all federal equal opportunity legislation, including The Americans with Disabilities Act (ADA), The Americans with Disabilities Amendments Act (ADAAA), and Section 504 of the Rehabilitation Act. All instructors at UT Arlington are required by law to provide "reasonable accommodations" to students with disabilities, so as not to discriminate on the basis of disability. Students are responsible for providing the instructor with official notification in the form of a letter certified by the Office for Students with Disabilities (OSD). Only those students who have officially

documented a need for an accommodation will have their request honored. Students experiencing a range of conditions (Physical, Learning, Chronic Health, Mental Health, and Sensory) that may cause diminished academic performance or other barriers to learning may seek services and/or accommodations by contacting:

The Office for Students with Disabilities (OSD), www.uta.edu/disability or calling 817-272-3364. Information regarding diagnostic criteria and policies for obtaining disability-based academic accommodations can be found at www.uta.edu/disability.

Counseling and Psychological Services (CAPS), www.uta.edu/caps/ or calling 817-272-3671 is also available to all students to help increase their understanding of personal issues, address mental and behavioral health problems and make positive changes in their lives.

Non-Discrimination Policy:

The University of Texas at Arlington does not discriminate on the basis of race, color, national origin, religion, age, gender, sexual orientation, disabilities, genetic information, and/or veteran status in its educational programs or activities it operates. For more information, visit uta.edu/eos.

Title IX Policy:

The University of Texas at Arlington ("University") is committed to maintaining a learning and working environment that is free from discrimination based on sex in accordance with Title IX of the Higher Education Amendments of 1972 (Title IX), which prohibits discrimination on the basis of sex in educational programs or activities; Title VII of the Civil Rights Act of 1964 (Title VII), which prohibits sex discrimination in employment; and the Campus Sexual Violence Elimination Act (SaVE Act). Sexual misconduct is a form of sex discrimination and will not be tolerated. For information regarding Title IX, visit www.uta.edu/titleIX or contact Ms. Jean Hood, Vice President and Title IX Coordinator at (817) 272-7091 or jmhood@uta.edu.

Campus Carry:

Effective August 1, 2016, the Campus Carry law (Senate Bill 11) allows those licensed individuals to carry a concealed handgun in buildings on public university campuses, except in locations the University establishes as prohibited. Under the new law, openly carrying handguns is not allowed on college campuses. For more information, visit <http://www.uta.edu/news/info/campus-carry/>

Emergency Exit Procedures:

Should we experience an emergency event that requires us to vacate the building, students should exit the room and move toward the nearest exit. When exiting the building during an emergency, one should never take an elevator but should use the stairwells. Faculty members and instructional staff will assist students in selecting the safest route for evacuation and will make arrangements to assist individuals with disabilities.