ASEN 5245 ï Radar and Remote Sensing

Syllabus, Spring 2019

Outline

The subject of radars is extremel q t chri ÷ Š Ø ⁎ l Mtheory porti
l basis and foundation of radar systems. This
of fundamental radar knowledge needed for a
r systems. The analysis portion will consist of
ons from ground-based, airborne, and space-
uired theoretical knowledge to solve real-life
nthesis portion will consist of simulating key
anding between radar theory and application.

Course Objective

This course will introduce radar systems from a combined theoretical and applied perspective. Students will develop a quantitative understanding of radar system design and radar signal analysis, and apply these principles to specific applications in environmental remote sensing.

The subject of radars is extremely broad, and a wide range of topics will be treated in this course. It is unlikely that any student will be prepared for all topics, but the particular expertise of individual students will be cultivated through a semester project on a particular radar application. The course is intended for any graduate student with a solid background in mathematics, familiarity with electromagnetic waves and wave propagation, and a background in undergraduate signal analysis.

Course Content

The course is divided into several sections, which consist of the following topics:

Radar fundamentals
Radar basics; pulsed radar; target ranging; range ambiguity; pulse-to-pulse motion; signal, noise and loss; target detection; receiver components and processing; Doppler radar; Doppler velocity ambiguity

Radar sensitivity
Radar power equation: derivation and application for point targets; Radar power equation for area targets; Radar power equation for volume targets; radar power losses; radio and receiver noise

Radar Antenna
Directivity; gain; illumination; antenna patterns; aperture antennas; phased array antennas

Scattering Processes
Radar cross section; Rayleigh; Mie; geometric; Bragg; rough surfaces; polarization, propagation

Radar Signals
Transmitter/signal generating characteristics; pulsed waveform; continuous waveform; pulse modulation and compression; complex signals including I and Q signals; digital filtering; Doppler spectrum

Remote Sensing Applications including data analysis
Tracking radars; scanning weather radar; vertically pointing cloud and precipitation radar; airborne radars; space borne radars (e.g., TRMM, GPM, and CloudSat); synthetic aperture radar (SAR)

Texts

Required Text:

Title:	**Principles of Modern Radar, Volume I - Basic Principles**
Author(s) / Editor(s):	Richards, Mark A.; Scheer, James A.; Holm, William A.
Publisher:	SciTech Publishing
Copyright Date:	2010 with updates in 2015
ISBN:	978-1-891121-52-4
Electronic ISBN:	978-1-61344-155-8
Online:	www.Knovel.com

Principles of Modern Radar (POMR) is available online through an agreement between the University of Colorado and www.knovel.com. Once connected to the internet via a CU connection (either physically on the CU campus or via a CU VPN connection [see http://www.colorado.edu/oit for the latest on VPN services] using your CU user ˊ pQ r ⁱ ˊ ɹ ɣ ˬ ʈV ! s

It is difficult to find a textbook that covers the topic of radar from a remote sensing perspective. Additionally, many radar texts are written as reference books for practicing engineers and not specifically designed as a textbook for students. As reference books, they do not clearly develop subjects from first principles and do not provide problems that can worked by the student. Furthermore, many radar textbooks are written specifically for electrical engineers and assume a significant depth of understanding in electromagnetics and wave propagation, which are not required for this course.

Depending on your specific background, you may need to draw from other supplementary material to provide more clarity or depth to a topic. One complication of supplying supplemental material is that the notation may change. Since this is a graduate course, you should be able to figure out changes in notations used in different books. Many books on radar fundamentals are available through the Engineering Library and through www.knovel.com. Some good references include:

Introduction to Radar Analysis, 2nd Edition, by Majafza
Introduction to Airborne Radar, 2nd edition, by Stimson
Radar Principles, by Peyton Z. Peebles, Jr.
Radar System Principles, by Harold R. Raemer
Radar Handbook, by Skolink
Introduction to Radar Systems, by Skolink
Tools of Radio Astronomy, by Rohlfs and Wilson
Modern Radar System Analysis, by Marton
Radio Techniques for Probing the Terrestrial Ionosphere, by Hunsucker
Fundamentals of Applied Electromagnetics, by Fawwaz T. Ulaby
Elements of Engineering Electromagnetics, 6th edition, by Rao
Antenna Theory ï Analysis and Design, 3rd edition, by Constantine A Balanis (2005)

There are many other textbooks in the library, however, they are usually checked out. If you are interested in finding one of the other books, you should put a recall request into the library. Be prepared as it can take a couple weeks for the books to be recalled. Several radar books are available online through an agreement between the University of Colorado and www.knovel.com.

Class Format

The class format will consist of both pre-recorded lectures and in-person lectures/discussions. The pre-recorded lectures will cover technical aspects of radar systems. The students are expected to watch the approximately 1-hour of technical lectures before attending class on Thursday evening. Benefits of pre-recorded technical lectures include watching them multiple times, and on your own schedule, before we discuss the material in-person. The in-person lectures/discussions will focus on salient features covered in the pre-recorded technical lectures in addition to answering questions and working through example problems. On Thursday evening, we will meet in-person (or on-line) for 1.5 hours.

Classroom and On-Campus Behavior

Students and faculty each have responsibility for maintaining an appropriate learning environment, not only while in class,

. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. Class rosters are provided to the instructor with the student's legal name. I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the semester so that I may make appropriate changes to my records. For more information, see the policies on classroom behavior (http://www.colorado.edu/policies/student-classroom-and-course-related-behavior) and the Student Code of Conduct (http://www.colorado.edu/osccr/).

Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation

The University of Colorado Boulder (CU Boulder) is committed to fostering a positive and welcoming learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct (including sexual assault, exploitation, harassment, dating or domestic violence, and stalking), discrimination, and harassment by members of our community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-3 MI | 2 it ʒ