ASEN 5245: Radars and Remote Sensing, Spring 2023

Class Lectures: Tuesdays and Thursdays Time=TBA
In-person and via Zoom in real-time + uploaded video for asynchronous students

Office hours: Thu 10-11am, zoom link:
And by appointment, in-person N440B or via zoom

Webpage: https://canvas.colorado.edu

Course outline:

This course will introduce radar systems from a combined theoretical and applied perspective. Students will develop a quantitative understanding of radar components, radar system design, and radar signal analysis, and apply these principles to specific applications in environmental remote sensing via 2 group projects and a final individual project.

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, and familiarity with electromagnetic (E&M) waves, E&M propagation, and digital signal processing.

The applications of radars are endless, from the detection of targets such as aircraft to the estimation of the target's parameters, electrical properties, and kinematics, to sensing the space for navigation. The purpose of this class is to provide you with a fundamental understanding of how current engineering curriculum however only a basic sophomore Physics II level understanding of the topic is expected for this course. I will provide pre-recorded lectures coving EE materials including radio-frequency circuits, EM propagation, and digital signal processing.

Working knowledge of MATLAB or Python will be needed as functions written in MATLAB will be provided and homework assignments and projects may require code development in MATLAB. If you do not have a background in one of these areas, you should expect to spend some extra time on the specific material. Some problems will require coding skills in a script-type programming language such as Matlab, Python, Scilab, IDL, etc.

There are many resources, including the library, at your disposal. If you have questions regarding your preparation for the class, you should contact the instructor. Additionally, as the radar is a broad topic, it is not unexpected that students may need to do some additional work in specific topical areas to provide a firm base in the fundamentals.

Textbook:
Class notes, shared pre-recorded lectures, and my notes cover all the necessary materials you need to succeed in this class. In addition to these notes, a free online book Principles of Modern Radar, Volume I - Basic Principles by Richards, Scheer, and Holm is available via www.knovel.com. You can access it for free using your UCB VPN. To get the VPN working for your account, please, see https://oit.colorado.edu/

Course grading

50% Quizzes: I will prepare 6-8 quizzes posted on canvas every 2-3 weeks. These quizzes are open-book, "take-home" exams with a limited time to upload answers. Quizzes won't be posted during your mid-terms, and your last one will be one week before the end of the semester ensuring you have enough time to prepare for other finals.
20% Group projects (5% each): I will share data from a pulsed doppler radar (project 1) and from CWFM radar (project 2). The class will be split into N groups, each one with 3-4 students. Each group will need to process the data themselves and submit a report.
30% Final paper: Individual projects about one radar topic or application. Students will prepare a final report in a form of an IEEE conference/letters paper (4-6 pages)
Extra 5% for in-class engagement: I will be asking questions during lectures and will give points for engagement with the discussion, and engaging extra-curricular activities supporting this class

Homework will be rolled out every other week, with solutions published online with a 14-day delay. The homework will prepare PhD students for the preliminary exam. We will discuss problems during office hours.

Course content
1) 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
2) Radar Signals: Transmitter/signal generating characteristics; pulsed waveforms; continuous waveforms; pulse modulation and compression; complex signals; digital filtering; Doppler spectrum
3) 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
4) E&M propagation and radar antennas: Radiation and propagation of radio waves, radar

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information about their rights, support resources, and reporting options. To learn more about reporting and support options for a variety of concerns, visit Don't Ignore It.

Religious Holidays

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. See Campus policy regarding religious observances for full details. Please let me know of any religious holidays by the end of January so I can plan to schedule quizzes appropriately.