ECE-678 Radar Engineering

Fall 2024

Instructor: Prof. Mark R. Bell
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Prerequisites: ECE600 or consent of instructor.
Lectures: M, W, F: 10:30–11:20am, Room BHEE 222
Alternative Lectures: A set of pre-recorded course lectures covering all course material will be available on the course website. (these are optional)
Zoom Office Hours: T: 11:00am–Noon, Th: 1:30–2:30pm.

Course Website: The course will be administered through my personal ECE website, which can be found at: **https://engineering.purdue.edu/~mrb/**

Brightspace will **not** be used in this course, and a *Brightspace* page will not be maintained for this course. All Course materials will be available at the above website from the ECE678 dropdown menu.

Text: Draft text by Mark R. Bell and Chieh-Fu Chang (made available to registered students)

Nadav Levanon, *Radar Principles*, Wiley-Interscience, 1988. Not required, but highly recommended. (Used copies can be found at reasonable prices at abebooks.com and Amazon)

Grading Policy

There will be one midterm exam worth 40% of the final grade, a final exam worth 45% of the final grade, and homework worth 15% of the final grade.

The course will be graded on the curve, with a target GPA of 3.5.

Midterm Exam

The midterm exam will be a one week take-home exam which students are to work on by themselves. The Midterm typically takes between 10 and 20 hours to complete. The exam is tentatively scheduled for the week of October 14–21, 2024.

Course Policies

1. Homework will be assigned *approximately* every other week and will be submitted as a pdf scan of the student's solution prior to midnight on the assignment due date. *Late homework will not be accepted*.

2. I allow and encourage collaboration on the homework problems. However, I expect you to write up your own solutions and understand what you hand in.

Course Policies (continued)

3. Regrade requests for the midterm exam must be filed in writing within two weeks of the date the examination has been returned to you.

Additional References

The following references may be useful studying the course material. Most of them are available online through the Purdue Library.)

1. J. Minkoff, *Signal Processing Fundamentals and Applications for Communications and Sensing Systems,* Artech House, 2002.
   (Available online from the Purdue Library.)

2. G. W. Stimson, *Introduction to Airborne Radar,* Hughes Aircraft Company, 1983. 2nd Edition, SciTech Publishing, 1998; 3rd Edition, SciTech Publishing, 2014.
   (You can download a PDF file of the 2nd edition from the Purdue Library. The 3rd edition is also available from the Library in Electronic form.)

3. H. V. Poor, *An Introduction to Signal Detection and Estimation,* 2Ed., Springer-Verlag, 1994.
   (Available online from the Purdue Library.)

4. L. L. Scharf, *Statistical Signal Processing,* Addison-Wesley, 1990.

5. C.W. Helstrom, *Elements of Signal Detection and Estimation,* 1995.

6. F. E. Nathanson, *Radar Design Principles,* 2nd Edition, SciTech Publishing, 1999.
   (Available online from the Purdue Library)

7. N. Levanon nd Eli Mozeson, *Radar Signals,* Wiley-Interscience, 2004.
   (Available online though the Purdue Library)

Academic Dishonesty: As graduate students, you are expected to behave with honesty and academic integrity in this course. In this respect, any action that would give any student an unfair grade advantage in this course will be considered *academic dishonesty*. Any case of academic dishonesty may result in a grade penalty on the assignment or in the course, as well as being reported to the Student Office of Rights and Responsibilities. Examples of academic dishonesty include, but are not limited to the following:

- Sharing information during an exam;
- Using forbidden material or a forbidden device during an exam;
- Viewing or working on an exam before or after the official time allowed;
- Requesting a regrade of work that has been altered;
- Submitting work that is not your own.

Copyright of Course Material: All ECE678 course material, including lecture notes, homework assignments, exams, and homework and exam solutions are protected by copyright law. Without Prof. Bell's permission, you are not allowed to distribute this material through any media, including online sources.

Emergency Procedures: Purdue is a relatively safe campus, however, we want to emphasize our emergency procedures for evacuation and shelter in place incidents in the event they are needed. To this end, we review the following procedures:

- To report an emergency, call 911. To obtain updates regarding an ongoing emergency, sign up for Purdue Alert text messages and view the current emergency status at **www.purdue.edu/ea**.
- There are approximately 300 Emergency Telephones distributed across campus and in parking garages. These connect directly to the Purdue University Police Department (PUPD). To use these, push the button on the phone and you will be connected to the PUPD immediately.
- If a fire alarm goes off during class, class will stop immediately. Evacuate the classroom immediately and head outdoors. Do not use the elevators.
- If we are notified during class of a Shelter in Place for a Tornado Warning, we will suspend class and shelter in the basement.
- If we are notified during class of a Shelter in Place for a hazardous material release, or a civil disturbance—including a shooting or other use of weapons, we will suspend class and shelter in the classroom, shutting and locking the doors and turning off the lights.
- Please review the Emergency Preparedness website for additional information: http://www.purdue.edu/ehps/emergency_preparedness/index.html

In the event of a major campus emergency, course requirements, deadlines and grading criteria are subject to changes that may be required by changes in the semester calendar or other circumstances. In such an event, information will be provided by email and the ECE642 course website.

ECE678 Radar Engineering Course Outline

1. Introduction to Radar and Radar Measurement
2. Range Measurement
3. The Doppler Effect and its Measurement
4. Angle Measurement
5. Electromagnetic Waves and Antenna Fundamentals
6. The Friis Equation and the Radar Range Equation
7. Radar Cross-Section
8. Radar Signals and Noise
9. Detection Theory
10. The Matched Filter.
11. The Ambiguity Function and Radar Target Resolution
12. Radar Waveforms:
    (a) The LFM Chirp
    (b) Frequency-Coded Waveforms
    (c) Phase Coded Waveforms
    (d) Coherent Pulse Trains
13. Pulse-Doppler Processing
14. Array Antennas
15. Synthetic Aperture Radar
16. Constant False Alarm Rate (CFAR) Detectors
17. Fluctuating Target Models and Radar Target Detection
18. Biologically Inspired Radar Processing
19. The Modern Digital Array Radar