ELEN427 16

Course Summary

Course : ELEN427 **Title :** Radar Systems Theory
Length of Course : 16
Prerequisites : ELEN420 **Credit Hours :** 4

Description

Course Description: This course is an in-depth coverage of the theory of radar and RF signal propagation, transmission, and reception. Topics covered include the radar range equation; antenna patterns; target cross section; system losses; calculation of signal-to-interference ratios; detection probability; target scintillation; main lobe and side lobe clutter; and moving target indicator (MTI) and pulse Doppler processing. Radar system hardware including transmitters, receivers, and antennas will be introduced and system block diagrams created. Classification of radar types into search, track, or mapping systems will be discussed. NOTE: This course requires the student to purchase additional materials that are not covered by the book grant. Please refer to the Course Materials section for additional details. Prerequisites: ELEN420

Course Scope:

At the end of this course you will have a firm understanding of the key concepts and basic theories of radar theory.

Objectives

After completing the course, the student should be able to accomplish these Learning Objectives (LO):

1. Demonstrate an understanding of radar theory.
2. Analyze various radar system design approaches.
3. Explain the concepts of moving target indicator (MTI) and pulse Doppler.
4. Calculate the radar range equation to meet a given radar system requirement.
5. Classify the various types of radar systems and characterize their limitations, including early warning, target acquisition, target tracker, surface search, air intercept, navigation, and missile guidance radar.
6. Draw a basic radar block diagram and discuss the role of each part of the system.

Outline

Week 1: Introductions, Introduction to Radar

Learning Objective(s)

Basic Radar,

Signal-to-Noise Ratio, Detection,

Basic Radar Measurements,

Basic Radar functions

Radar Applications.

(LO-1, LO-5, LO-6)

Readings

Chapter 1

Assignment(s)

Week 1 Forum

Week 1 HW (Homework)

Week 2: Radar Equation

Learning Objective(s)

Received Power,

Receiver Thermal Noise,

Radar Range Equation,

Multiple Pulses,

Losses,

Link Equation.

(LO-1, LO-2, LO-4)

Readings

Chapter 2

Assignment(s)

Week 2 Forum

Week 2 HW

Week 3: Radar Search and Detection

Learning Objective(s)

Search Mode Fundamentals,

Overview of Detection

(LO-1, LO-4)

Readings

Chapter 3

Assignment(s)

Lab Report 1

Week 3 HW

Week 4: Propagation Effects

Learning Objective(s)

Propagation,

Atmospheric Attenuation and Absorption,

Refraction,

Turbulence,

Ionospheric Effects,

Multipath

(LO-1, LO-2)

Readings

Chapter 4

Assignment(s)

Week 4 Forum

Lab Report 2

Week4 HW

Week 5: Exam review, catch-up, Exam I

Learning Objective(s)

None

Readings

None

Assignment(s)

Exam I

Week 6: Review Exam, Clutter

Learning Objective(s)

Land, Sea, and Atmospheric Clutter,

Clutter Modeling.

(LO-1, LO-2, LO-3)

Readings

Chapter 5

Assignment(s)

Week 6 Forum

Lab Report 3

Week 6 HW

Week 7: Doppler Phenomenology and Data Acquisition

Learning Objective(s)

Doppler Shift,

Fourier Transform

Multiple Pulses Revisited,

Range-Doppler Spectrum

(LO-1, LO-2, LO-3)

Readings

Chapter 8

Assignment(s)

Lab Report 4

Week 7 HW

Week 8: Antennas and Transmitters

Learning Objective(s)

Antennas and Radar Performance,

Monopulse,

Reflector Antennas,

Phased Array Antennas,

Array Architecture,

Radar Transmitters,

Power Sources and Amplifiers,

Modulators,

Operational Considerations

(LO-1, LO-6)

Readings

Chapter 9, 10

Assignment(s)

Week 8 Forum

Lab Report 5

Week 8 HW

Week 9: Receivers and Exciters

Learning Objective(s)

Receiver Types and Functions,

Demodulation,

Noise Power and Dynamic Range,

A-to-D Conversion,

Exciter Design, and Components,

Timing and Control Circuits.

(LO-6)

Readings

Chapter 11, 12

Assignment(s)

Week 9 Forum

Lab Report 6

Week 9 HW

Week 10: Signal Processor and Signal and Data Processing

Learning Objective(s)

Radar Processor Structure,

Implementation Technology,

Sampling,

Quantization,

Fourier Analysis,

Digital Filtering,

Integration and Correlation,

Matched Filters.

(LO-1, LO-2, LO-6)

Readings

Chapter 13,14

Assignment(s)

Week 10 Forum

Lab Report 7

Week 10 HW

Week 11: Exam Review, Review Exam

Learning Objective(s)

None

Readings

None

Assignment(s)

Exam II

Week 12: Threshold Detection

Learning Objective(s)

Detection Strategies,

Optimal Detection,

Statistical Models for Noise and Target RCS,

Threshold Detection

(LO-1, LO-2, LO-4)

Readings

Chapter 15

Assignment(s)

Week 12 Forum

Lab Report 8

Week 12 HW

Week 13: Doppler Processing

Learning Objective(s)

Doppler Shift and Pulsed Radar Data,

Data Acquisition and Characteristics,

Moving Target Indication,

Pulse-Doppler Processing,

Clutter Mapping and MTI.

(LO-1, LO-2, LO-3)

Readings

Chapter 17

Assignment(s)

Lab Report 9

Week 13 HW

Week 14: Radar Measurements

Learning Objective(s)

Precision and Accuracy,

Signal Model,

Parameter Estimation,

Range Measurements,

Phase Measurements,

Doppler and Range Rate Measurements,

RCS and Angle Measurements,

Coordinate Systems

(LO-1, LO-2)

Readings

Chapter 18

Assignment(s)

Week 14 Forum

Lab Report 10

Week 14 HW

Week 15: Radar Tracking

Learning Objective(s)

Motion Models,

Measurement Models,

Track Filtering,

Data Association,

Performance Assessment.

(LO-1, LO-2, LO-4)

Readings

Chapter 19

Assignment(s)

Week 15 Forum

Week 15 HW

Week 16: Exam Review; Catch-up

Learning Objective(s)

None

Readings

None

Assignment(s)

Lab Final Report

Exam III

Evaluation

Instructor announcements: Weekly announcements will appear on Monday of each week in the online classroom. This announcement will also be e-mailed to each student. The announcement will discuss the assignments for the week along with any other pertinent information for the week.

This is an upper-level course; all students' work is to be presented as such in terms of quality and content. The grading system will be based on your participation in the forums (12.5% of your total grade), homework assignments (25% of your grade), lab work (25% of your total grade) and three exams (37.5% of your grade).

Reading Assignments: Please refer to the Course Outline section of this syllabus for the weekly reading

assignments.

Week 1 Introduction: Within 10 days of course start, each student must log into the classroom and introduce him- or herself to the class. This is a required assignment and your introduction is due by Sunday of Week 1. Your response must be 250-300 words (a requirement) and include the following information.

a. Your name
b. Your university major or program
c. Where you are in the program of study
d. Your academic goals, to include why you are taking this class
e. Information that you would like to share about yourself

Forums: The weekly discussion forum is for students to post their questions on course content for that week. This forum should not be used to discuss specific test questions prior to receiving feedback from the instructor (after the test is graded). If there is a question on a specific question, find a similar problem in the book and ask a question on that problem or concept. Asking specific questions on test questions creates an unfair advantage and defeats the purpose of the assessment tool. Specific topics will occur throughout the course and will require critical thought/research for your input – be sure to keep up with ongoing discussions! Discussion Board posting are graded at the end of the session and will constitute 12.5% of your final grade,

Homework Assignments: There will be homework assignments during the course worth a total of 25% of your total grade. Each assignment will cover one or more chapters in the book used in this course. For all problems requiring mathematical calculations, all work must be shown.

Lab: There will be lab work assigned throughout the course. Labs will count for a total of 25% of your grade.

Exams: There will be three exams worth 37.5% of your final grade. Each exam will be worth 100 points. Exams will be open book, open note tests. Exams will be administered without a proctor. Students must complete the numbered exam by the end of the week indicated in the schedule.

Grading:

Name	Grade %

Materials

Book Title: Principles of Modern Radar: Basic Principles - e-book available in the APUS Online Library

Author: Richards

Publication Info: SciTech

ISBN: 9781891121524

Book Title: Additional required items are available to order from the APUS Bookstore. If you buy these items from other vendors, you may not receive all the parts you need for your course. These items (as noted) are not covered by the APUS Book Grant.

Author: N/A

Publication Info: N/A

ISBN: N/A

Book Title: MATLAB and Simulink Student Suite-Not covered by the APUS Grant - available to purchase at https://www.mathworks.com/store/link/products/student/SV?s_tid=ac_buy_sv_but1_2

Author:

Publication Info:

ISBN: NTMO

Book Title: NI Student Software Suite - access instructions provided inside the classroom

Author: National Instruments

Publication Info: National Instruments

ISBN: 779252-3501

Book Title: Radar Kit - purchase from list provided by Instructor. This item is not covered by the APUS Book Grant.

Author:

Publication Info:

ISBN: Note

Book Title: To find the library e-book(s) req'd for your course, please visit http://apus.libguides.com/er.php to locate the eReserve by course #. You must be logged in to eCampus first to access the links.

Author: N/A

Publication Info: N/A

ISBN: N/A

Book Title: Dual-band Vertical Antenna - students should purchase two antennas. This item is not covered by the APUS Book Grant.

Author: National Instruments.

Publication Info: National Instruments

ISBN: 783642-01

Course Guidelines

Citation and Reference Style

- Attention Please: Students will follow the APA Format as the sole citation and reference style used in written work submitted as part of coursework to the University. Assignments completed in a narrative essay or composition format must follow the citation style cited in the APA Format.

Tutoring

- Tutor.com offers online homework help and learning resources by connecting students to certified tutors for one-on-one help. AMU and APU students are eligible for 10 free hours* of tutoring provided by APUS. Tutors are available 24/7 unless otherwise noted. Tutor.com also has a SkillCenter Resource Library offering educational resources, worksheets, videos, websites and career help. Accessing these resources does not count against tutoring hours and is also available 24/7. Please visit the APUS Library and search for 'Tutor' to create an account.

Late Assignments

- Students are expected to submit classroom assignments by the posted due date and to complete the course according to the published class schedule. The due date for each assignment is listed under each Assignment.

- Generally speaking, late work may result in a deduction up to 15% of the grade for each day late, not to exceed 5 days.
- As a working adult I know your time is limited and often out of your control. Faculty may be more flexible if they know ahead of time of any potential late assignments.

Turn It In

- Faculty may require assignments be submitted to Turnitin.com. Turnitin.com will analyze a paper and report instances of potential plagiarism for the student to edit before submitting it for a grade. In some cases professors may require students to use Turnitin.com. This is automatically processed through the Assignments area of the course.

Academic Dishonesty

- Academic Dishonesty incorporates more than plagiarism, which is using the work of others without citation. Academic dishonesty includes any use of content purchased or retrieved from web services such as CourseHero.com. Additionally, allowing your work to be placed on such web services is academic dishonesty, as it is enabling the dishonesty of others. The copy and pasting of content from any web page, without citation as a direct quote, is academic dishonesty. When in doubt, do not copy/paste, and always cite.

Submission Guidelines

- Some assignments may have very specific requirements for formatting (such as font, margins, etc) and submission file type (such as .docx, .pdf, etc) See the assignment instructions for details. In general, standard file types such as those associated with Microsoft Office are preferred, unless otherwise specified.

Disclaimer Statement

- Course content may vary from the outline to meet the needs of this particular group.

Communicating on the Forum

- Forums are the heart of the interaction in this course. The more engaged and lively the exchanges, the more interesting and fun the course will be. Only substantive comments will receive credit. Although there is a final posting time after which the instructor will grade comments, it is not sufficient to wait until the last day to contribute your comments/questions on the forum. The purpose of the forums is to actively participate in an on-going discussion about the assigned content.
- “Substantive” means comments that contribute something new and hopefully important to the discussion. Thus a message that simply says “I agree” is not substantive. A substantive comment contributes a new idea or perspective, a good follow-up question to a point made, offers a response to a question, provides an example or illustration of a key point, points out an inconsistency in an argument, etc.
- As a class, if we run into conflicting view points, we must respect each individual's own opinion. Hateful and hurtful comments towards other individuals, students, groups, peoples, and/or societies will not be tolerated.

Identity Verification & Live Proctoring

- Faculty may require students to provide proof of identity when submitting assignments or completing assessments in this course. Verification may be in the form of a photograph and/or video of the student’s face together with a valid photo ID, depending on the assignment format.
- Faculty may require live proctoring when completing assessments in this course. Proctoring may include identity verification and continuous monitoring of the student by webcam and microphone during testing.

University Policies

Student Handbook

- Drop/Withdrawal policy
- Extension Requests
- Academic Probation
- Appeals
- Disability Accommodations

The mission of American Public University System is to provide high quality higher education with emphasis on educating the nation's military and public service communities by offering respected, relevant, accessible, affordable, and student-focused online programs that prepare students for service and leadership in a diverse, global society.