ENGT M12: RADAR FUNDAMENTALS

Originator
srelle

College
Moorpark College

Attach Support Documentation (as needed)
Engr Adv Comm Meet_Agenda_2019.pdf
Recommendations of the committee.pdf
Attendees for Spring 2019 Advisory Committee.pdf
ENGT M12_state approval letter_CCC000612481.pdf

Discipline (CB01A)
ENGT - Engineering Technology

Course Number (CB01B)
M12

Course Title (CB02)
Radar Fundamentals

Banner/Short Title
Radar Fundamentals

Credit Type
Credit

Start Term
Fall 2020

Catalog Course Description
Introduces the basics of radar technology, emphasizing the fundamentals of modern civilian and defense radar systems. Examines the principles governing the operations and applications of radars used in air traffic controls, ships and boats, defense industry, automotive industry, testing instrumentation, and sensors.

Taxonomy of Programs (TOP) Code (CB03)
0924.00 - *Engineering Technology, General (requires Trigonometry)

Course Credit Status (CB04)
D (Credit - Degree Applicable)

Course Transfer Status (CB05) (select one only)
B (Transferable to CSU only)

Course Basic Skills Status (CB08)
N - The Course is Not a Basic Skills Course

SAM Priority Code (CB09)
C - Clearly Occupational

Course Cooperative Work Experience Education Status (CB10)
N - Is Not Part of a Cooperative Work Experience Education Program

Course Classification Status (CB11)
Y - Credit Course

Educational Assistance Class Instruction (Approved Special Class) (CB13)
N - The Course is Not an Approved Special Class

Course Prior to Transfer Level (CB21)
Y - Not Applicable

Course Noncredit Category (CB22)
Y - Credit Course

Funding Agency Category (CB23)
A - Primarily Developed Using Economic Development Funds

Course Program Status (CB24)
1 - Program Applicable

General Education Status (CB25)
Y - Not Applicable

Support Course Status (CB26)
N - Course is not a support course

Field trips
May be required

Faculty notes on field trips; include possible destinations or other pertinent information
Naval Base in Point Mugu or in Port Hueneme; engineering firms in the area

Grading method
Letter Graded

Alternate grading methods
Credit by exam, license etc.
Student Option- Letter/Pass

Does this course require an instructional materials fee?
No

Repeatable for Credit
No

Is this course part of a family?
No

Units and Hours

Carnegie Unit Override
No

In-Class

Lecture
Minimum Contact/In-Class Lecture Hours
35
Maximum Contact/In-Class Lecture Hours
35

Activity

Laboratory
Minimum Contact/In-Class Laboratory Hours
52.5
Maximum Contact/In-Class Laboratory Hours
52.5

Total in-Class

Total in-Class
Total Minimum Contact/In-Class Hours
87.5
Total Maximum Contact/In-Class Hours
87.5

Outside-of-Class

Internship/Cooperative Work Experience

Paid

Unpaid

Total Outside-of-Class

Total Outside-of-Class
Minimum Outside-of-Class Hours
70
Maximum Outside-of-Class Hours
70

Total Student Learning

Total Student Learning
Total Minimum Student Learning Hours
157.5
Total Maximum Student Learning Hours
157.5

Minimum Units (CB07)
3
Maximum Units (CB06)
3

Prerequisites
MATH M06 - Trigonometry Or MATH M07 - Precalculus and Trigonometry

Entrance Skills

Prerequisite Course Objectives
MATH M06-identify special triangles and their related angle and side measures.
MATH M06-evaluate the trigonometric function of an angle in degree and radian measure.
MATH M06-manipulate and simplify a trigonometric expression.
MATH M06-solve trigonometric equations, triangles, and applications.
MATH M06-convert between polar and rectangular coordinates and equations.
MATH M06-graph polar equations.
MATH M06-represent a vector (a quantity with magnitude and direction) in the form and ai+bj.
MATH M07-graph functions and relations in rectangular coordinates and polar coordinates.
MATH M07-analyze and identify the features of the graphs and/or the equations of functions and relations.
MATH M07-apply transformations to the graphs of functions and relations.
MATH M07-solve and apply equations including rational, linear, polynomial, exponential, absolute value, radical, and logarithmic, and solve linear, nonlinear, and absolute value inequalities.
MATH M07-solve systems of equations and inequalities.
MATH M07-apply functions to model real world applications.
MATH M07-identify special triangles and their related angle and side measures.
MATH M07-evaluate the trigonometric function at an angle whose measure is given in degrees and radians.
MATH M07-solve trigonometric equations, triangles, and their related applications.
MATH M07-graph the basic trigonometric functions and apply changes in period, amplitude, phase shift and vertical shift to generate new graphs.
MATH M07-convert between polar and rectangular coordinates.

MATH M07-represent a vector (a quantity with magnitude and direction) in the form and ai+bj, compute the magnitude of a vector, and graph vectors on the xy-plane.
MATH M07-perform vector operations including addition, subtraction, scalar multiplication, and dot product. Determine the angle between two vectors and when vectors are parallel or perpendicular, and compute the projection vector.
MATH M07-write the standard form of a circle given the general equation.

Requisite Justification

Requisite Type
Prerequisite

Requisite
MATH M06

Requisite Description
Course not in a sequence

Level of Scrutiny/Justification
Content review

Requisite Type
Prerequisite

Requisite
MATH M07

Requisite Description
Course not in a sequence

Level of Scrutiny/Justification
Content review

Student Learning Outcomes (CSLOs)

	Upon satisfactory completion of the course, students will be able to:
1	describe the different types and functions of radar systems.
2	demonstrate knowledge of the fundamentals of radar signal processing, how signal processing is achieved, and why signal processors are needed.

Course Objectives

	Upon satisfactory completion of the course, students will be able to:
1	demonstrate knowledge of the fundamental principles of radar and radar-based systems.
2	calculate radar performance using appropriate physics and radar concepts and equations.
3	describe target echoes and interfering signals, and describe how they affect the performance of the radar system.
4	demonstrate knowledge of the functions and types of transmitters, receivers, antennas, signal processors, trackers, and other sub-systems, and describe how they each contribute to the radar system as a whole.
5	describe the different types and functions of radar systems including air-traffic control, air search, surface search, signal tracking, and modern uses in military and in everyday life such as automobile proximity sensors, automatic braking systems, and autonomous automobiles.

Course Content

Lecture/Course Content

1. **(20%) - Principles of Radar**
   a. What it is and history
   b. How it functions
   c. Targets and interference
   d. Target information and how it is extracted

   e. Radar types
   f. Frequency bands
   g. Assumptions and performance evaluation factors
2. **(45%) - Radar Systems**
   a. Block diagram descriptions
   b. Coherence and stability
   c. Waveforms
   d. Transmit functions and parameters
   e. Antenna functions and parameters
   f. Receiver functions and parameters
   g. Signal processing functions and parameters
   h. Identification, friend or foe (IFF) and auxiliary systems
3. **(20%) - Target Information Recovery**
   a. Pulse Recurrence Frequencies (PRFs) and PRF classes
   b. Detection
   c. Range and ambiguous range, angular positioning, Doppler extraction, and resolution
   d. Radar signal processing
   e. Targets and interfering signals
4. **(10%) - Tracking Radars**
5. **(5%) - Radar Equation**

Laboratory or Activity Content

Laboratory experimentation and hands-on activities related to the following topics in radar principles:

1. **(10%) - Radar Types**
   a. Ground and ship radars
   b. Airborne radars
   c. Automotive applications
2. **(20%) - Target Detection and Information Recovery**
   a. Simple and complex targets
   b. Target fluctuations and their effect on radar performance
   c. Target Echo Information Extraction
3. **(20%) - Tracking Radars**
   a. Conical scan and lobing
   b. Monopulse
   c. Range tracking
   d. Doppler tracking
   e. Tracking servos and mechanical systems
   f. Track-while-scan principles
4. **(30%) - Signal Processing**
   a. Moving target indication (MTI) and Moving Target Detection (MTD) processing
   b. Pulse Doppler processing
   c. Pulse compression processing
   d. Overview of synthetic aperture processing
5. **(20%) - Radar Testing and Troubleshooting**

Methods of Evaluation

Which of these methods will students use to demonstrate proficiency in the subject matter of this course? (Check all that apply):

Problem solving exercises
Skills demonstrations

Methods of Evaluation may include, but are not limited to, the following typical classroom assessment techniques/required assignments (check as many as are deemed appropriate):

Computational homework
Group projects
Individual projects
Laboratory activities
Laboratory reports
Objective exams
Performances

Problem-solving exams
Quizzes
Skills demonstrations
Skill tests

Instructional Methodology

Specify the methods of instruction that may be employed in this course

Computer-aided presentations
Collaborative group work
Class activities
Class discussions
Demonstrations
Field trips
Group discussions
Guest speakers
Instructor-guided interpretation and analysis
Instructor-guided use of technology
Internet research
Laboratory activities
Lecture
Practica
Small group activities

Describe specific examples of the methods the instructor will use:

The instructor will use PowerPoint presentations, problem solving exercises, and demonstrations to explain the concepts of the course. Guest speakers will also be invited to discuss the latest developments and industry needs in radar technology.

Representative Course Assignments

Writing Assignments

1. Write answers to questions from lectures, such as: Describe the differences in the operation of radars which conduct air search from ground versus air-to-air search.

2. Write short essays based on topics in radar technology, such as: Explain the principles that govern Doppler tracking, and describe the circumstances under which Doppler tracking is the ideal choice. Be sure to provide at least two examples.

Critical Thinking Assignments

1. Analysis of radar detection capability based on given parameters. An example would be: Consider a radar with the following parameters: Chirp slope = 4.189166×10^{11} Hz/s; Pulse length = 37.12 ms; Sample rate fs = 18.96 MHz; PRF = 1679.9 Hz; Wavelength = 5.66 cm; Platform velocity = 7550 m/s; Antenna length = 10 m; Earth radius = 6378 km; Look angle = 23 degrees. Calculate the following: a) What is the minimum Fast Fourier Transform (FFT) size for the range processor? b) What is the effective aircraft velocity? c) What is the range resolution? Give both slant range and ground range results.

2. Design of radar systems by student teams which meet the goals of a given project. An example would be: Design and build a radar system that tracks a target either by range, angle, or a Doppler frequency shift. Include block diagram descriptions with your design.

Reading Assignments

1. Read assigned chapters from the Radar textbook to prepare for the lecture and the accompanying laboratory experiments.

2. Read scientific and technical journal articles relevant to advances in radar technology to expand understanding of their usage in military and industry.

Skills Demonstrations

1. Illustrate the ability to construct and test a radar system in the lab using the materials provided.

2. Illustrate the ability to troubleshoot a radar system that is malfunctioning using appropriate analytical and testing tools.

Outside Assignments

Representative Outside Assignments

1. Write a technical report documenting the design and feasibility of a new radar technology that is used in the automotive industry.

2. Read a research article provided by the instructor from such publications as the Journal of Sensors, Journal of Lightwave Technology, Proceedings of IEEE, etc., identify two concepts in the article that have also been discussed in class, and then summarize how the authors have used those concepts or have expanded on them.

Articulation

Equivalent Courses at other CCCs

College	Course ID	Course Title	Units
Orange Coast College	MARA A157	Radar Observer	2

District General Education

A. Natural Sciences

B. Social and Behavioral Sciences

C. Humanities

D. Language and Rationality

E. Health and Physical Education/Kinesiology

F. Ethnic Studies/Gender Studies

Course is CSU transferable
Yes

CSU Baccalaureate List effective term:
Fall 2020

CSU GE-Breadth

Area A: English Language Communication and Critical Thinking

Area B: Scientific Inquiry and Quantitative Reasoning

Area C: Arts and Humanities

Area D: Social Sciences

Area E: Lifelong Learning and Self-Development

CSU Graduation Requirement in U.S. History, Constitution and American Ideals:

IGETC

Area 1: English Communication

Area 2A: Mathematical Concepts & Quantitative Reasoning

Area 3: Arts and Humanities

Area 4: Social and Behavioral Sciences

Area 5: Physical and Biological Sciences

Area 6: Languages Other than English (LOTE)

Textbooks and Lab Manuals

Resource Type
Textbook

Classic Textbook
No

Description
Edde, Byron. *Radar: Principles, Technology, Applications.* Prentice Hall, 1992.

Resource Type
Textbook

Classic Textbook
No

Description
Wang, Wen-qin, ed. *Radar Systems: Technology, Principles and Applications.* Nova Science Pub Inc; UK edition, 2013.

Resource Type
Textbook

Classic Textbook
No

Description
Richards, Mark A., James Scheer, and William Holm, eds. *Principles of Modern Radar: Basic Principles.* Scitech Publishing, 2010.

Resource Type
Textbook

Classic Textbook
No

Description
Richards, Mark A. *Fundamentals of Radar Signal Processing.* 2nd ed. McGraw-Hill, 2014.

Resource Type
Textbook

Classic Textbook
No

Description
Skolnik, Merrill. *Introduction to Radar Systems*. 2nd ed. McGraw-Hill India, 2006.

Library Resources

Assignments requiring library resources
Research projects and written assignments requiring information beyond the textbook.

Sufficient Library Resources exist
Yes

Example of Assignments Requiring Library Resources
Research, using the Library's print and online resources, particularly Elsevier's ScienceDirect Database, to find relevant peer-reviewed journal articles or books to successfully complete the required design project pertaining to advances in radar technology and their usage in the military or in industry.

Primary Minimum Qualification
ENGINEERING TECHNOLOGY

Review and Approval Dates

Department Chair
10/30/2019

Dean
10/30/2019

Technical Review
11/07/2019

Curriculum Committee
11/19/2019

DTRW-I
12/12/2019

Curriculum Committee
MM/DD/YYYY

Board
01/21/2020

CCCCO
01/28/2020

Control Number
CCC000612481

DOE/accreditation approval date
MM/DD/YYYY