SCHEME OF COURSE WORK

Course Title	: Radar Engineering		
Course Code	: 13EC1129	L T P C	4 1 0 3
Program:	:B.Tech		
Specialization:	: Electronics and Communication Engineering		
Semester	: VII		
Prerequisites	: EM Waves and Transmission Lines, Antennas and Wave Propagation, Analog Communications		
Courses to which it is a prerequisite	: -----		

Course Outcomes (COs):

1	Enumerate the different Radar Constants, Block diagrams, frequencies and simple range equation
2	Elucidates the basic Principles of CW radar and Frequency modulated radars, MTI Principles and its performance
3	Elucidates the different types of tracking radars and its principles
4	Synthesize the detection of radar signals in noise.
5	Analyze different display systems, duplexers of radar receivers and phased array radars.

Course Outcomes versus Program Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	S	S	S	S	S					S
CO2	S	S	S	S	S	S	S					S
CO3	S	S	S	S	S	S	S		S			S
CO4	S	S	S	S	S	S	M	M	S			S
CO5	S	S	M	S	S	S	M	M	S			S

S - Strongly correlated, M - Moderately correlated, Blank - No correlation

Assessment Methods:	Assignment/ Quiz/Mid Exam/Surprise test/Open book test

Week	Topic /Contents	Course Outcomes	Sample questions	Teaching-Learning Strategy	Assessment Method & Schedule
1	Nature of Radar, Maximum Unambiguous Range, Radar Waveforms, Simple form of Radar Equation	CO - 1	1. Calculate the maximum unambiguous range of low PRF pulse radar with a prf of 500 Hz. 2. Mention the frequencies used for radar applications. 3. Enlist different applications of radar.	Lecture/ Problem solving	Assignment I/Quiz-I/Mid-I
2	Radar Block Diagram and Operation, Radar Frequencies and Applications Radar equation**:** Prediction of Range Performance, Minimum Detectable Signal	CO - 1	1. Enlist the factors that determine the detection range of the radar 2. Define multiple time around echoes. 3. For a radar peak transmitted power is 1MW; pulse width is 1 sec and PRF is 1 KHz. Calculate the average transmitted power.	Lecture/ Problem solving	Assignment I/Quiz-I/Mid-I

3	Receiver Noise and SNR, Integration of Radar Pulses, Radar Cross Section of Targets (simple targets - sphere, cone-sphere), Transmitter Power, PRF and Range Ambiguities, System Losses	CO - 1	1. Define integration improvement factor. 2. Consider a radar with multiple PRF ranging using f1=13.770 KHz and f2=14.580 KHz. Calculate the unambiguous range of each prf. Discuss the need of multiple PRF. 3. With the help of suitable graph explain the radar cross section of a sphere.	Lecture/ Problem solving	Assignment I/Quiz-I/Mid-I
4	CW AND FREQUENCY MODULATED RADAR**:** Doppler Effect, CW Radar – Block Diagram, Isolation between Transmitter and Receiver, , Receiver Bandwidth Requirements, Applications	CO - 2	1. State Doppler principle of velocity determination. 2. Why is multiple frequency CW radar employed? Explain its principle of operation. 3. How will you find out sign of radial velocity with the help of CW radar?	Lecture/ Problem solving	Assignment I/Quiz-I/Mid-I
5	FM-CW Radar, Range and Doppler Measurement, Block Diagram and Characteristics , FM-CW altimeter, Measurement Errors, Multiple Frequency CW Radar	CO - 2	1. Explain the principle of working of FM CW radar. How will you modify it for using as an altimeter? 2. Consider FM CW radar in which triangular shaped modulation is used. Draw the waveforms for (a) Transmitted signal. (b) Beat frequency signal when the target is approaching radar.	Lecture/ Problem solving	Assignment I/Quiz-I/Mid-I
6	MTI AND PULSE DOPPLER RADAR: Introduction, Principle, MTI Radar with - Power Amplifier Transmitter and Power Oscillator Transmitter, Delay Line Cancellers – Filter Characteristics	CO - 2	1. An MTI radar is operated at 9GHz with a PRF of 3000 pps. Calculate the first two lowest blind speeds for this radar. Derive the formula used. 2. An aircraft is flying at a speed of 250 Km/h. Compute the Doppler frequency for radar operating at a wavelength of 5 cm. 3. Give the function of delay line canceller.	Lecture/ Problem solving	Assignment I/Quiz-I/Mid-I

7	Blind Speeds, Double Cancellation, Staggered PRFs. Range Gated Doppler Filters. MTI Radar Parameters, Limitations to MTI Performance, Non-coherent MTI, MTI versus Pulse Doppler Radar	CO - 2	1. What is blind speed in MTI radar? What is the method of overcoming blind speed problem? 2. Why is the range gating necessary in MTI radar? What are the limitations to MTI performance? 3. What does a medium PRF pulse Doppler radar do better than a high PRF pulse Doppler radar?	Lecture/ Problem solving	Assignment I/Quiz-I/Mid-I
8	TRACKING RADAR**:** Tracking with Radar, Sequential Lobing, Conical Scan,	CO - 3	1. With the help of block diagram explain the operation of conical scan tracking radar. 2. What is Sequential Lobing?	Lecture	Assignment I/Quiz-I/Mid-I/ Open book test
9	Mid-Test-1				
10	Monopulse Tracking Radar – Amplitude Comparison,Monopulse (one&two coordinates), Phase Comparison,Monopulse, Target Reflection Characteristics	CO - 3	1. What two measures might be taken to reduce the effects of the glint error in both angle and range? 2. With the help of block diagram explain the operation of amplitude comparison monopulse tracking radar for two coordinates. How can a target be tracked by using the phase information of a single pulse?	Lecture	Assignment II/Quiz-II/Mid-II
11	Angular Accuracy, Tracking in Range, Acquisition and Scanning Patterns. Comparison of Trackers.	CO - 3	1. How is tracking in range achieved? 2. Compare the merits and demerits of the four tracking methods . 3. Discuss the following (a)Target acquisition (b)Tracking in Doppler	Lecture	Assignment II/Quiz-II/Mid-II
12	DETECTION OF RADAR SIGNALS IN NOISE**:** Introduction, Matched Filter Receiver – Response Characteristics and Derivation, Correlation	CO – 4	1. What is the relation between Cross-correlation Receiver and Matched Filter Receiver. 2. Explain the design criterion of a Matched filter to obtain maximum	Lecture/ Problem solving	Assignment II/Quiz-II/Mid-II

	Function		signal-noise ratio at the receiver output.		
13	Cross-correlation Receiver, Efficiency of Non-matched Filters, Matched Filter with Non-white Noise, Noise Figure and Noise Temperature.	CO – 4	1. Explain about efficiency of Non-matched filters. 2. Discuss the significance of Noise Figure and Noise temperature in radar receivers.	Lecture/ Problem solving	Assignment II/Quiz-II/Mid-II/ Open book test
14	RADAR RECEIVERS**:** Displays – types, Duplexers – Branch type and Balanced type, Circulators as Duplexers	CO - 5	1. How are A, B and PPI radar displays different from each other? 2. Explain the operation of different types of Duplexers.	Lecture	Assignment II/Quiz-II/Mid-II
15	PHASED ARRAY ANTENNAS Basic Concepts, Radiation Pattern, Beam Steering and Beam Width changes	CO - 5	1. What is Beam Steering? How is it achieved 2. Explain the changes in the Beam Width of Phased Array Antennas	Lecture	Assignment II/Quiz-II/Mid-II
16	Series versus Parallel Feeds, Applications, Advantages and Limitations	CO - 5	1. Illustrate the differences between Series and Parallel feeds of Phase Array Antenna 2. Write the applications of Phased Array Antennas.	Lecture	Assignment II/Quiz-II/Mid-II
17	RADAR STUDIES OF ATMOSPHERE: MST radar, meteor wind radar, other radar studies of the atmosphere	CO – 5	1. Explain about different Scattering mechanisms in free space. 2. How Meteor wind radar is used in the study of Atmosphere	Lecture	Assignment II/Quiz-II/Mid-II
18	Mid-Test 2				
19/20	END EXAM				

Course Coordinator

Module Coordinator