B.TECH/ECE/7TH SEM/ECEN 4126/2021

PRINCIPLES OF RADAR
(ECEN 4126)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) In a microwave RADAR, PRF is used to resolve range and Doppler ambiguities using a
(a) pulsed Doppler RADAR (b) pulsed RADAR
(c) MTI RADAR (d) CW RADAR

(ii) If the peak transmitted power in a RADAR system is increased 81 times, then the maximum range will be increased by a factor of
(a) 3 (b) 9 (c) 27 (d) 81.

(iii) An altimeter is basically
(a) a CW RADAR (b) an FM RADAR
(c) a Doppler RADAR (d) an MTI RADAR

(iv) Which one of the following is not suitable for automatic satellite tracking?
(a) Monopulse (b) Conical
(c) Sequential lobing (d) Step back.

(v) A Radome is a
(a) dome shaped RADAR antenna (b) RADAR housed in a dome
(c) protective cover for the RADAR antenna (d) dome shaped RADAR antenna

(vi) For tracking the RADAR antenna beam pattern is
(a) omni directional (b) isotropic
(c) highly directive (d) none of these.

(vii) A non-zero Doppler shift represents
(a) a static target
(b) a target moving towards the RADAR
(c) a target moving away from the RADAR
(d) either (b) or (c).

(viii) The Doppler frequency provides the
(a) range of the target (b) velocity of the target
(c) direction of the target (d) number of targets.

(ix) If both the transmitter and the receiver are placed at the same phase, then the RADAR system is called
(a) monostatic (b) bistatic
(c) multi static (d) none of these.

(x) The jammer that concentrates its noise energy within the RADAR receiver bandwidth is called
(a) a spot jammer (b) a barrage jammer
(c) a repeater jammer (d) none of these.

Group – B

2. (a) A radar operating at 10 GHz with the peak power of 500 kW, the power gain of antenna is 5000 and minimum power is -140 dB. Calculate the maximum range of radar if the effective area of antenna is 10 m^2 and radar cross section is 4 m^2. [(CO1) (Remember/LOCQ)]

(b) Explain the term 'Probability of Detection' in Radar Communication. How probability of detection affects probability of false alarm in Radar? [(CO2) (Explain/IOCQ)]

(c) What do you mean by Radar Cross section? Apply the concept of radar cross section to determine minimum detectable range of a radar system. [(CO3) (Apply/HOCQ)]

4 + 4 + 4 = 12

3. (a) A pulsed radar has the following specification: time of false alarm T_{fa} = 16.67 minutes; probability of detection P_D = 0.9 and bandwidth B = 1 GHz . Find the radar integration time t_{int}, the probability of false alarm P_{fa}. [(CO2) (Understand/LOCQ)]

(b) Analyse the effect of target shape on Pulsed Radar Performance. Suggest methods to improve performance of such a Radar System. [(CO3) (Analyse /IOCQ)]

5 + 7 = 12

Group – C

4. (a) What are the factors influencing the bandwidth of a radar receiver? [(CO4) (Solve/HOCQ)]

(b) Differentiate between SNR and SCR. What is the effect of SNR over the detection of weak signal? [(CO2) (Differentiate/IOCQ)]

(c) 'Detection of a target depends upon the material with which it is made'. Justify the statement and comment on radar absorbing material. [(CO3)(Remember/LOCQ)]

3 + 4 + 5 = 12

5. (a) What are Stalo and Coho? Draw the blow diagram of a radar receiver. Comment on the use of duplexer in radar receivers. [(CO4) (Remember/LOCQ)]
   (b) Using the concept of echo describe different Swerling models in Radar Communication. [(CO2) (Use/HOCQ)]

5 + 7 = 12

Group – D

6. (a) Briefly explain how Radar Communication is different from Data Communication. [(CO4)(Explain/IOCQ)]
   (b) What do you mean by Pulse repetition factor? Differentiate between PFR and SNR. [(CO1)(Differentiate/IOCQ)]
   (c) What do you mean by Synthetic Aperture Radar? Comment on its application. [(CO5)(Understand/LOCQ)]

3 + 4 + 5 = 12

7. (a) A target is closing on a radial of a radar with a relative velocity of 200 knots (1 knot = 0.508 m/s). The radar transmits continuous wave energy at a wave length of 5cm. What will be the doppler shift of the target? What will be the doppler shift if the target alters its target by 45°? [(CO5) (Apply/HOCQ)]
   (b) Explain the principle and working of MTI Radar. [(CO5) (Explain/IOCQ)]

5 + 7 = 12

Group – E

8. (a) What is the peak power of a radar whose average power is 200 W, pulse width is 1 μs and has PRF of 1 KHz? Also calculate the range of this ground-based air surveillance radar if it has to detect a target with RCS of 2 m^2 when it operates at a frequency of 2.9 GHz with a rectangular shaped antenna that is 5 m wide, 2.7 m height, antenna aperture efficiency of 0.6 and minimum detectable signal strength of -120 dB. [(CO1) (Differentiate/IOCQ)]
   (b) What do you understand by radar receiver and explain different types of radar receivers? [(CO4) (Understand/LOCQ)]
   (c) Analyse the role of phased antenna array (linear) in Radar Communication. [(CO6) (Analyse/IOCQ)]

4 + 4 + 4 = 12

9. (a) What do you understand by radar antenna? Explain the working of any such antenna used in Radar Communication. [(CO6) (Explain/IOCQ)]
   (b) Why VHF is not considered suitable for long range air surveillance? Using the concept of antenna resolution and range suggest an antenna to satisfy such an application need. [(CO6) (Use/HOCQ)]

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	30%	43.33%	26.67%

Course Outcome (CO):

After completing the course the student will be able to:

1. Understand the concept and characteristics of Radar operation.
2. Know the role of probability in the Radar communication.
3. Understand the importance of shape and material for Radar targets.
4. Develop the idea of Radar Transmission and Reception and in what aspects it is different from data communication.
5. Classify between different types of Radars and their distinct areas of application.
6. Have the concept of the specific design considerations of the antennas under the use for Radar communication.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question

Department & Section	**Submission link:**
ECE	https://classroom.google.com/u/1/w/NDY0MjUxNDE1NDQ5/tc/NDY0MjUxNDE2NDcw