Hall Ticket No | | | | | | | | | | | Question Paper Code: AEC521

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

MODEL QUESTION PAPER-II

Four Year B. Tech VI Semester End Examinations, December – 2019

Regulation: R16

RADAR SYSTEMS

Time: 3 Hours **Max Marks: 70**

Answer any ONE question from each Unit All questions carry equal marks All parts of the question must be answered in one place only

UNIT - I

1 a) Discuss about the parameters on which maximum unambiguous range of a radar system depends. [7M]

b) Find the maximum unambiguous range of a pulse radar system whose operating wavelength is 2 cm, peak transmitter power is 100kW, minimum detectable signal power is 10^{-13} W, area of the antenna aperture is 2sqm, assuming a target of cross-sectional area of 40sqm. [7M]

2 a) Discuss how the integration of radar echo pulses is helpful in a pulse radar system. [7M]

b) Find the minimum detectable signal power of a pulse radar whose operating wavelength is 4.2 cm, peak transmitter power is 7200W, area of the antenna aperture is 12 sqm, assuming a target of cross-sectional area of 90sqm and required maximum range of 40kms. If the range is to be increased twice, how the transmitter power required, keeping all other parameter same. [7M]

UNIT - II

3 a) With the help of a suitable block diagram. Explain the operation of CW radar with non-zero IF in the receiver. [7M]

b) Find the doppler frequency caused by a target approaching a CW radar with a relative velocity of 120m/s radar operating at a carrier frequency of 6GHz. If the target takes a U turn and is receding from the radar with the twice its previous speed, what happens to its doppler spectrum? What is the maximum unambiguous range of this radar? [7M]

4 a) What is disadvantage of a CW radar transmitting a linear FM waveform ? How it is alleviated by transmitting FM wave with a triangular frequency profile? [7M]

b) Determine the carrier frequency shift of a CW radar operating at a carrier frequency of 90GHz due to a moving target with a relative speed of 600m/s radar. If a two-frequency CW Radar is used to increase the maximum unambiguous range to 16m/s, what could be the second transmission frequency? [7M]

UNIT – III

5 a) What is the purpose of staggering multiple pulse repetition frequencies in an MTI radar? Explain in detail. [7M]

b) An MTI radar has its 6th blind speed of 2160km/hour and is operating at a transmitter frequency of 30GHz. Determine its maximum unambiguous range. [7M]

6 a) Explain in detail how a transversal filter could be used as a delay line canceller in an MTI Radar. [7M]

b) A pulse doppler radar used a PRF of 40KHz, doppler filter bank was implemented digitally using a 1024-point discrete fourier transform (DFT). What is the bandwidth of each filter? If a moving target had a relative speed of 250m/s, in which filter the echo signal power appears dominantly? The radar used a carrier frequency of 4GHz. [7M]

UNIT – IV

7 a) Explain in detail how a target is tracked in range using early-late gate techniques. [7M]

b) What is the target glint? Compute the improvement in tracking accuracy that is possible when a tracking radar uses pulse-to-pulse frequency agility. It is given that the agility bandwidth is 400MHz, target depth is 4m, glint bandwidth is 3000Hz and the pulse repetition frequency is 50KHz. [7M]

8 a) Compare and contrast the radar receivers using correlation and matched filter techniques. [7M]

b) Derive an expression for the detection statistic in a likelihood ratio receiver for a pulse radar. [7M]

UNIT – V

9 a) Discuss about the grating lobes in the phased array antennas used in radar systems. [7M]

b) A receiver with a mixer front end has noise figure of 8dB. An LNA with a noise figure of 0.8dB and a gain of 10 dB is inserted ahead of mixer to reduce the overall receiver noise figure. (i). How much of the new noise figure is due to mixer and what is dynamic range of the receiver? (ii). If LNA gain is increased to 30 dB, what would be the new receiver noise figure and the dynamic range. [7M]

10 a) What are the two popular types of duplexers used in a pulse radar? Briefly describe them. [7M]

b) Explain with the help of an expression how the beamwidth changes in electronically scanned phased array antennas used in radar. [7M]

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

OBJECTIVES:

The course should enable the students to:	
I	Learning and understanding of operation of basic types of radar systems.
II	Learning and understanding of detection and processing of radar signals
III	Learning and understanding of various types of targets, interferences, noises and losses encountered in radars.
IV	Learning and understanding of some important aspects radar transmitters and receivers

COURSE OUTCOMES:

CO 1	Learning and Understanding of Pulse radar systems
CO 2	Understanding of CW and FMCW radar systems.
CO 3	Exploration of Moving Target Indication and Pulse Doppler Radar systems
CO 4	Analysis of Target detection techniques and Understanding of Tracking Radar
CO 5	Discussion of subsystems of a typical Radar Transmitter and Receiver

COURSE LEARNING OUTCOMES:

AEC521.01	Learning of the operating principles of Pulse & CW radars
AEC521.02	Understanding of various types of radar targets: point and fluctuating
AEC521.03	Appreciate various types of clutters, noises, losses involved in radar systems
AEC521.04	Preliminary System design of Pulse and Pulse Compression radars
AEC521.05	Preliminary System design of CW and FM-CW radars
AEC521.06	Appreciate various interferences encountered in radar target detection
AEC521.07	Understanding of the operating principles of MTI & Pulse Doppler radars
AEC521.08	Preliminary System design of MTI and Pulse Doppler radars
AEC521.09	Understanding of the operating principles of search and tracking radars
AEC521.10	Understanding & Analysis of detection techniques of target echo signal
AEC521.11	Understanding of tracking techniques of target echo signal
AEC521.12	Understanding of different subsystems of a typical Radar transmitter
AEC521.13	Appreciate the concept of Noise Figure and the estimating the performance of radar receivers
AEC521.14	Understanding of different subsystems of a typical Radar Receiver

MAPPING OF SEMESTER END EXAMINATION TO COURSE LEARNING OUTCOMES:

SEE Question No.		CLO Code	Course learning Outcomes	CO code	Blooms Taxonomy Level
1	a	AEC521.01	Learning of the operating principles of Pulse & CW radars	CO 1	Remember
	b	AEC521.04	Preliminary System design of Pulse and Pulse Compression radars	CO 1	Understand
2	a	AEC521.03	Appreciate various types of clutters, noises, losses involved in radar systems	CO 1	Remember
	b	AEC521.04	Preliminary System design of Pulse and Pulse Compression radars	CO 1	Understand
3	a	AEC521.05	Preliminary System design of CW and FM-CW radars	CO 2	Understand
	b	AEC521.05	Preliminary System design of CW and FM-CW radars	CO 2	Understand
4	a	AEC521.05	Preliminary System design of CW and FM-CW radars	CO 2	Understand
	b	AEC521.05	Preliminary System design of CW and FM-CW radars	CO 2	Understand
5	a	AEC521.08	Preliminary System design of MTI and Pulse Doppler radars	CO 3	Understand
	b	AEC521.07	Understanding of the operating principles of MTI & Pulse Doppler radars	CO 3	Understand
6	a	AEC521.08	Preliminary System design of MTI and Pulse Doppler radars	CO 3	Understand
	b	AEC521.08	Preliminary System design of MTI and Pulse Doppler radars	CO 3	Understand
7	a	AEC521.09	Understanding of the operating principles of search and tracking radars	CO 4	Remember
	b	AEC521.11	Understanding of tracking techniques of target echo signal	CO 4	Understand
8	a	AEC521.10	Understanding & Analysis of detection techniques of target echo signal	CO 4	Understand
	b	AEC521.10	Understanding & Analysis of detection techniques of target echo signal	CO 4	Understand
9	a	AEC521.12	Understanding of different subsystems of a typical Radar transmitter	CO 5	Remember
	b	AEC521.13	Appreciate the concept of Noise Figure and the estimating the performance of radar receivers	CO 5	Remember
10	a	AEC521.14	Understanding of different subsystems of a typical Radar Receiver	CO 5	Remember
	b	AEC521.12	Understanding of different subsystems of a typical Radar transmitter	CO 5	Remember

Signature of Course Coordinator **HOD, ECE**