INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous) Dundigal-500043, Hyderabad

B.Tech VII SEMESTER END EXAMINATIONS (REGULAR) - FEBRUARY 2022

Regulation: R18

RADAR SYSTEMS AND PROCESSING

Time: 3 Hours

(ECE)

Max Marks: 70

Answer FIVE Questions choosing ONE question from each module (NOTE: Provision is given to answer TWO questions from any ONE module) All Questions Carry Equal Marks All parts of the question must be answered in one place only

$\mathbf{MODULE}-\mathbf{I}$

- 1. (a) Draw the block diagram of the basic radar system and explain the operation of each block in detail. [7M]
 - (b) Calculate the duty cycle of radar which transmits a 1.5 ms pulse at a PRF of 8 kHz. If the peak power of this radar is 500 kilowatts, what is the average power? What is the resting time? [7M]
- 2. (a) List the seven basic pulse radar components and briefly describe the function of each. [7M]
 - (b) A fighter aircraft in level flight on a heading of $090^0 T$ and at an air speed of 600 m/sec is operating pulse-Doppler radar at a frequency of 800 MHz. A target is detected at the same altitude, bearing $000^0 R$, heading $030^0 T$ at a speed of 300 m/sec.
 - i) What is the relative radial velocity between the fighter and the target?
 - ii) What will the resulting Doppler shift be?

$\mathbf{MODULE}-\mathbf{II}$

- 3. (a) Explain the possible errors for measurement of altitudes accurately using a FM-CW altimeter.
 - (b) A radar system uses magnetron as high-power RF source. Its transmitter emits 300 KW RF power at 10% duty factor. If the efficiency of radar transmitter during pulse is 60% and the power required during pulse off period is 1KW. Find the average power dissipation in radar.

[7M]

[7M]

- 4. (a) What is Doppler frequency shift? Discuss the effect of receiver bandwidth on the efficiency of detection and performance of CW Doppler radar. [7M]
 - (b) Calculate the maximum range of radar which operates at a frequency of 10GHz peak pulse power of 600 KW. If the antenna effective area is 5 m^2 and the area of target is $20m^2$, minimum receivable power is 10^{-13} watts. [7M]

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[7M]

$\mathbf{MODULE}-\mathbf{III}$

- 5. (a) Describe automatic tracking of a target through range gating technique for unambiguous detection of a moving target. [7M]
 - (b) A high PRF airborne radar operating at a frequency of 10.5 GHz transmit a peak power of 10 kW has the following parameters: pulse width $\tau = 10\mu s$, pulse repetition frequency PRF = 250 kHz, antenna gain G = 35 dB, radar cross section of the target $\sigma = 10m^2$, receiver noise figure F = 3 dB, and the overall system loss including the propagation path loss L = 5 dB. Find the maximum range at which the radar can detect the target if the minimum signal-to-noise ratio (SNR) for detection is 15 dB. [7M]
- 6. (a) With the aid of the block diagram, explain fully operation of an MTI system using a power amplifier in the transmitter? [7M]
 - (b) A pulse Doppler radar is used to resolve the Doppler ambiguity, and employs two different prfs to obtain a desired unambiguous range of 120 km. Determine $f_{r1}, f_{r2}, R_{u1}, R_{u2}$. Assume N = 63. [7M]

$\mathbf{MODULE}-\mathbf{IV}$

7. (a) List the different types of clutters. Describe different radar tracking techniques with neat sketches. [7M]

- (b) A target range measured from a monostatic radar is 30 km. Find the corresponding delay time. when the range is determined by observing the target range for 2 ms. [7M]
- 8. (a) Describe sequential lobbing type of error signal generation to track a target automatically.
 - (b) For the monostatic radar, if the delay measurement system provides an RMS range error due to noise of half the off-axis error, estimate the desired smoothed values corresponding to the predicted values of a target at 12 km with a velocity of 340 m/s. [7M]

$\mathbf{MODULE}-\mathbf{V}$

- 9. (a) Explain the principle behind the operation of duplexers and receiver protectors. [7M]
 - (b) A LNB with gain of 12 dB, a bandwidth of 150 MHz and a noise figure of 4 dB feeds a receiver with equivalent noise temperature of 900 K. Determine the noise figure of the overall system.

[7M]

[7M]

- 10. (a) List and explain the applications, advantages and limitations of phased array antennas. [7M]
 - (b) Describe the principle behind the operation of a phased array antenna in a radar system. [7M]

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