53 (EC 810) RENS

2018

RADAR AND ELECTRONIC NAVIGATION SYSTEM

Paper : EC 810

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

*Answer **any five** questions* : 5×20=100

1. *(a)* What is meant by unambiguous range of a target and range resolution in Radar ?

   (b) Derive the expressions of unambiguous range of a target and range resolution.

   (c) A pulse radar transmits at a peak power of $100kW$ with a pulse width of $1.2\mu s$ and with pulse repetition frequency of $1kHz$. Determine the (*i*) maximum and (*ii*) minimum range of the radar, (*iii*) duty cycle (*iv*) average power. (3+3)+(3+3)+8

2. *(a)* Explain why the simple radar range equation $R_{max} = \left(\frac{P_t G \sigma A e}{(4\pi)^2 S_{min}} \right)^{1/4}$ does not predict the performance of actual radar equipments to a satisfactory degree of accuracy.

(b) What is meant by noise figure of a receiver? Deduce the expression in terms of SNR of input and output signals.

(c) What is meant by integration of radar pulses? What are the advantages of it?

(d) Derived the modified radar range equation $R_{max} = \left(\frac{P_t G \sigma A e \eta E_i(n)}{(4\pi)^2 K T_o B_n F_n \left(S/N\right)_n} \right)^{1/4}$ incorporating the receiver noise and integration of Pulses. The symbols have their usual meanings. 4+5+3+8

3. *(a)* Deduce the expression for probability of false alarm $P_{fa} = exp\left(-\frac{V_T^2}{2\Psi_0} \right)$ and false alarm time $T_{fa} = \frac{1}{B_{IF}} exp\left(\frac{V_T^2}{2\Psi_0} \right)$ where the symbols have their usual meanings.

(b) A radar has a bandwidth $B = 50kHz$. An average time between false alarms of 10 minutes. Determine:

(i) What is the probability of false alarm?

(ii) If the Pulse Repetition Frequency (PRF) were $1kHz$ and if the first 15nmi of range were gated out (receiver turned off) because of the use of long pulse, what would be the new probability of false alarm? (Assume the false alarm time has to remain constant).

(iii) Is there any significant difference?

(iv) What is the pulse width that results in a minimum range of $15nmi$? (7+5)+8

4. *(a)* What are the main problems of CW Doppler radar with zero IF receiver and clearly discuss with necessary block diagram how are they overcome using non-zero IF receiver?

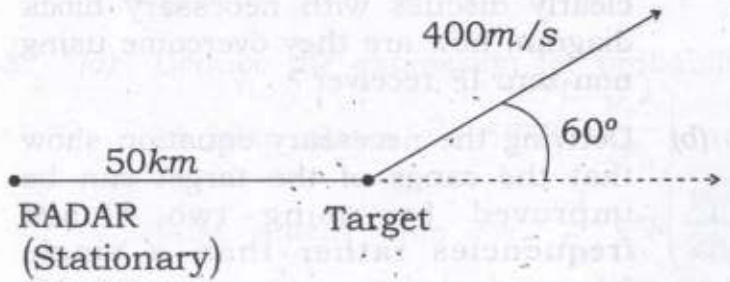
(b) Deriving the necessary equation show that the range of the target can be improved by using two closed frequencies rather than a single frequency. (10+10)

5. *(a)* Draw the block diagram of a FM-CW radar and discuss the working principle.

(b) With the help of timing diagram explain clearly how the range and speed of a moving target (approaching and receding) can be found out in a FM-CW radar.

(c) In a FM-CW radar, transmitting at an average frequencey of 100*MHz* with traingular frequency variation 20*kHz* and traingular modulation rate 20*Hz*. Calculate the beat frequencies during the increasing and decreasing portions of the FM cycle. The radar target configuration is as shown below.

5+10+5



6. *(a)* What are the basic differences between the Pulse-Doppler radar and MTI radar?

(b) Discuss the basic operation of Pulse-Doppler radar using the block diagram.

(c) Draw the block diagram of a MTI radar with Power amplifier transmitter and explain its operation. 4+8+8

7. *(a)* Derive the expression of the single delay line canceller in connection with MTI radar.

(b) What is meant by blind speeds and how the problem related to the blind speeds can be minimized using staggered pulse repetition frequencies?

(c) In a MTI radar the Pulse repetition frequencey is 200*Hz* and the carrier transmission frequencey is 100*MHz*. Find the first and second blind speeds. 7+9+4