53 (EC 810) RENS

2017

RADAR AND ELECTRONIC NAVIGATION SYSTEMS

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)* Describe with block diagram the operating principles of a conventional pulse radar with a superheterodyne receiver.

   (b) What are meant by PPI, A-scope and B-scope ?

(c) Deduce the radar range equation given by $R_{max} = \left(\frac{P_t G \sigma A_e}{(4\pi)^2 S_{min}} \right)^{1/4}$; where the symbols have their usual meanings. 10+4+6

2. (a) Describe the different radar frequency bands.

(b) Discuss briefly about the main application areas of radar.

(c) A pulse radar operates at an average power of $200\,W$ with a pulse width of $1\mu s$. Its PRF is $1\,kHz$ and radar cross section of the target is $2m^2$ at an operating wavelength $0{\cdot}1m$. The effective area of the radar antenna is $10m^2$. The minimum detectable signal is $1\,pW$. Find

(i) operating frequency

(ii) radar peak power

(iii) maximum range of the radar. 3+10+7

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

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

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

(d) Derive the modified radar range equation

$$R_{max} = \left(\frac{P_t G \sigma A_e n E_i(n)}{(4\pi)^2 K T_0 B_n F_n (S/N)_1} \right)^{1/4},$$

incorporating the receiver noise and integration of pulses. The symbols have their usual meanings. 4+5+3+8

4. (a) Deduce the expression for probability of detection of a signal having amplitude A and threshold voltage V_T in presence of AWGN.

(b) Show graphically and discuss the dependencies of probability of false alarm and probability of detection on threshold voltage.

(c) The average time between false alarms is specified as 30 min and the receiver bandwidth is 0·4 *MHz*.

(i) What is the Probability of false alarm ?

(ii) What is the threshold to noise power ratio $\left(V_T^2/\psi_0\right)$?

(iii) Assume the threshold-to-noise ratio is to be set to achieve a 30*min* false alarm time (values as part (*ii*)); but for some reason, the threshold is actually set lower by 0·3*dB* than the value found in part (*ii*). What is the resulting average time between false alarms with the lower threshold ?

(iv) What would be the average time between false alarms if the threshold were to increase by 0·3*dB* ? 6+4+10

5. *(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

6. *(a)* What is the main problem of CW Doppler radar and how it can be overcome using FM-CW radar with linear frequency modulation ?

(b) Deducing the range equation $R=(Cf_r/4f_m\Delta f)$ (where the symbols have their usual meanings) clearly explain the range measurement method for a stationary target using triangular frequency modulation in FM-CW radar. 10+10

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 blind speeds can be minimized using staggered pulse repetition frequencies ?

(c) In a MTI radar the pulse repetition frequency is 200*Hz* and their carrier transmission frequency is 100*MHz*. Find the first and second blind speeds.

7+9+4
