53 (EC 810) RENS

2018

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)* What are 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 a Peak Power of $100kW$ with a Pulse width of $1{\cdot}2\mu S$ and with Pulse repetition frequency of $1kHz$. Determine *(i)* the maximum and *(ii)* minimum range of the radar *(iii)* duty cycle *(iv)* average power.

   (3+3)+(3+3)+8

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 $200W$ with a Pulse width of $1\mu S$. Its PRF is $1kHz$ 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 $1pW$. 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 $R_{max} = \left(\frac{P_t G \sigma Ae}{(4\pi)^2 S_{min}} \right)^{1/4}$ does not predict the range performance of actual radar equipment to a satisfactory degree of accuracy.

(b) What is meant by noise figure of a receiver ? Deduce its expression 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

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

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 false alarm $P_{fa} = exp\left(-\frac{V_T^2}{2\psi_0}\right)$ and false alarm time $T_{fa} = \frac{1}{BIF} exp\left(\frac{V_T^2}{2\psi_0}\right)$.

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 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

5. (a) What is meant by radar cross section of a target ? What are the different scattering regions of a target ? Explain why higher frequency has been used by a radar for weather forecasting and lower frequency is used for target detection.

(b) Show graphically and discuss how the normalized radar cross section of a sphere varying with its circumference measured in wavelength.

(c) Describe with deducing the necessary formulae how the maximum unambiguous range depends on the total transmitted power.

(3+2+4)+5+6

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

(b) Deducing the range equation $R = \frac{Cf_r}{4f_m \Delta f}$ (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) What are the different types of system losses in radar system ? Explain each of them.

(b) Explain clearly how the correct range measurement of the target avoiding multiple-time-around echoes can be done by using varying Pulse repetition frequency of the signal.

14+6
