Total number of printed pages–4

53 (EC 810) RENS

2021

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.*

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

   (3+3)+(3+3)+8=20

Contd.

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 $1kHz$ and radar cross section of the target is $2m^2$ at an operating wavelength $0{\cdot}1\ m$. The effective area of the radar antenna is $10\ m^2$. The minimum detectable signal is $1\ pW$. Find *(i)* operating frequency *(ii)* radar peak power *(iii)* maximum range of the radar. 3+10+7=20

3. *(a)* What is meant by radar cross section of a target? What are the different scattering regions of 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 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=20

4. (a) Prove that the Doppler frequency shift for a target moving with radial velocity $\frac{dR}{dt}$ is given by $f_d = \pm\frac{2\left(dR/dt\right)}{\lambda}$, where λ is the wavelength of the radar.

(b) Draw the block diagram of a CW Doppler radar with zero IF receiver and explain its operation.

(c) Discuss about the isolation required between the transmitter and receiver for a given application.

(d) Discuss the applications of CW radar.

5+7+3+5=20

5. (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 $R = \frac{cf_r}{4f_m \Delta f}$ (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=20

6. (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 carrier transmission frequency is 100 *MHz*. Find the first and second blind speeds.

7+9+4=20