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)* 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 at 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 with block diagram the operating principles of a conventional pulse radar with a super heterodyne receiver.

(b) What is 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

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 of $B = 50kHz$, 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) was $1kHz$ and if the first $15nmi$ of range was gated out (receiver turned off) because of the use of long pulses, 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

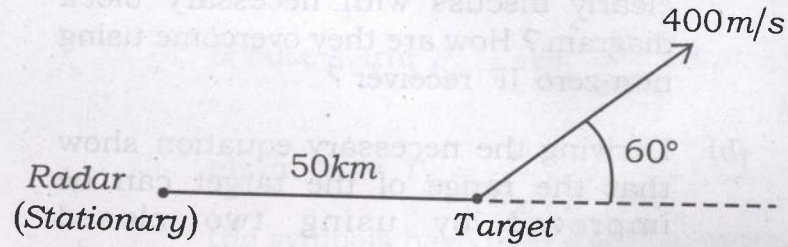
4. *(a)* What are the main problems of CW Doppler radar with zero IF receiver and clearly discuss with necessary block diagram ? How are they overcome using non-zero IF receiver ?

(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 frequency of 100*MHz* with triangular frequency variation 20*kHz* and triangular modulation rate 20*Hz*. Calculate the beat frequencies during the increasing and decreasing portions of the FM cycle. The radar target configuration is shown below :



5+10+5

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 $R = \frac{cf_r}{4f_m \Delta f}$ (where the symbols have their usual meanings) clearly explain the range measurement method for a stationary target using traingular frequency modulation in FM-CW radar.

10+10

7. (a) Derive the expression of the single delay line canceller in connection with the 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 the carrier transmission frequency is 100*MHz*. Find the first and second blind speeds.

7+9+4