

Total number of printed pages-5

53 (EC 810) RENS

2019

**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 :  $5 \times 20 = 100$

1. (a) Describe with block diagram, the operating principles of a conventional pulse radar with a superheterodyne receiver.
- (b) What are meant by PPI and A-Scope and B-Scope?
- (c) Deduce the radar range equation given

$$\text{by } R_{\max} = \left[ \frac{P_t G A_e \sigma}{(4\pi)^2 S_{\min}} \right]^{1/4}; \text{ where the}$$

symbols have their usual meanings.

10+4+6

Contd.

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 range performance of actual radar equipment 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.



3. (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 30min and the receiver bandwidth is 0.4MHz.

(i) What is the probability of false alarm?

(ii) What is the threshold to noise

power ratio  $\left( \frac{V_T^2}{\psi_0} \right)$  ?

(iii) Assume the threshold-to-noise ratio is to be set to achieve a 30min false alarm time [values as part (ii)]; but for some reasons, the threshold is actually set lower by 0.3dB 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 0.3dB?  
6+4+10

4. (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 transmitter power.  
(3+2+4)+5+6

5. (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

6. (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

