

Code: AE78

Subject: RADAR AND NAVIGATIONAL AIDS

AMIETE – ET (Current Scheme)

Time: 3 Hours

JUNE 2015

Max. Marks: 100

PLEASE WRITE YOUR ROLL NO. AT THE SPACE PROVIDED ON EACH PAGE IMMEDIATELY AFTER RECEIVING THE QUESTION PAPER.

NOTE: There are 9 Questions in all.

- Question 1 is compulsory and carries 20 marks. Answer to Q.1 must be written in the space provided for it in the answer book supplied and nowhere else.
- The answer sheet for the Q.1 will be collected by the invigilator after 45 minutes of the commencement of the examination.
- Out of the remaining EIGHT Questions answer any FIVE Questions. Each question carries 16 marks.
- Any required data not explicitly given, may be suitably assumed and stated

Q.1 Choose the correct or the best alternative in the following: (2×10)

a. Range of target if the time taken by the radar signal to travel to and fro is $100\mu\text{sec}$.

- (A) 15km (B) 51km
(C) 15m (D) 51m

b. If the radar is to have a maximum range of 250km, the maximum allowable PRF for unambiguous reception is

- (A) 600 kHz (B) 600Hz
(C) 600MHz (D) None of these

c. If a radar is operating at 100 GHz and diameter of its antenna is 2m, the beam width of its antenna is

- (A) 0.105° (B) 150°
(C) 10.5° (D) None of these

d. The average power when the peak power is 200kW, pulse width is $2\mu\text{sec}$ and rest time is 2000 seconds

- (A) 200W (B) 100W
(C) 200kW (D) 100Kw

e. With a CW transmitter frequency of what is the Doppler frequency seen by a stationary radar when the target radial velocity is 100km/hr?.

- (A) 729Hz (B) 927Hz
(C) 729kHz (D) 927kHz

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- f. The lowest blind speed of a CW radar (MTI) operating at a PRF of 1 kHz and wavelength of 2 cm is
- (A) 63km/hr (B) 63m/hr
(C) 36Km/hr (D) None of these
- g. A circular loop with diameter of 2m and 10 turns is at a height of 1m. Then the operating frequency is
- (A) 18.84GHz (B) 84.81GHz
(C) 48.81GHz (D) None of these
- h. Calculate the maximum range of a radar system operating at 3 cm wavelength with a peak power of 500 kW, if it's $P_{\min}$ is 10^{-12} W, the capture area of it's antenna is 20m^2 and RCS area the target is 20m^2 .
- (A) 385Km (B) 585Km
(C) 385m (D) None of these
- i. A frequency modulated radar sweeps from 400Hz to 800MHz in $10\mu\text{sec}$. What is the maximum unambiguous range which can be measured by this radar
- (A) 51Km (B) 1.5Km
(C) 51m (D) None of these
- j. An MTI radar is used by traffic police to measure the speed of vehicles. If the Doppler frequency shift measured from the moving vehicle is 1.5 kHz, calculate the speed of the vehicle, if radar is operating at 1GHz with PRF of 1kHz.
- (A) 108Km/hr (B) 81Km/hr
(C) 810Km/hr (D) None of these

Answer any FIVE Questions out of EIGHT Questions.
Each question carries 16 marks.

- Q.2 a. Write the block diagram, principle, range equation and applications of radar. (8)
- b. A typical waveform used in radar is shown below calculate: (8)
(i) average power (ii) duty cycle (iii) maximum range of radar

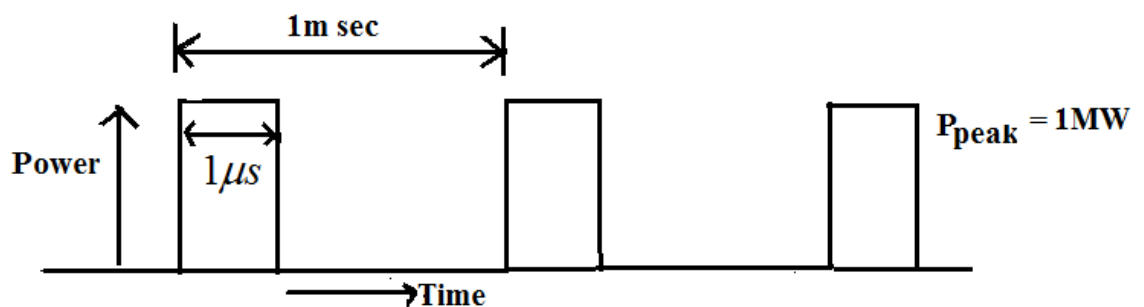


Fig.1

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- Q.3** a. With respect to radar (8)
- (i) Plumbing loss
 - (ii) Beam shape loss
 - (iii) Collapsing losses
 - (iv) Effect of noise on radar receiver performance
- b. What is the peak power of a radar whose average power is 200W, pulse width of 1μsec and has PRF of 1000Hz? Also calculate the range of this ground based air surveillance radar if it has to detect a target with a RCS of 2m² when it operates at a frequency of 2.9 GHz with a rectangular shaped antenna which is 5m wide, 2.7m height, antenna aperture efficiency of 0.6 and mds is 10⁻¹² (8)
- Q.4** a. A pulse Doppler radar has a carrier frequency of 9 GHz and PRF of 400 GHz. Find its blind Doppler frequencies and the radial velocity of target which would be undetected by the radar. (8)
- b. A target is closing on a radial of radar with a velocity of 200 knots. The radar transmits a continuous wave at a wavelength of 5 cm. What will be the Doppler shift of the target? What will be the Doppler shift if the target alters its course by 45°? Given 1 knots = 0.508m/sec. (8)
- Q.5** a. Write note on various types of detector used in Radar. (8)
- b. Describe matched filter receiver. List its important characteristics. (8)
- Q.6** a. Explain variation of surface clutter with grazing angle, with the help of diagram. (8)
- b. Describe clutter characteristics with respect to spectrum and amplitude. Explain how clutter reduction is achieved in radar systems. (8)
- Q.7** a. How does a SAR differ from a physical linear array? Show that finer resolution is achievable using smaller physical apertures in SAR. (8)
- b. Explain effective aperture and polarisation of antenna. (8)
- Q.8** a. Draw and explain TR Duplexer. (8)
- b. Write note on plan position Indicator. (8)
- Q.9** a. Explain the errors encountered in direction finding. How are these removed? (8)
- b. Write notes on - (4x2)
- (i) Radar beacons
 - (ii) Sequential Lobing