

AMIETE – ET

Time: 3 Hours

DECEMBER 2014

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. Duplexer is called

- | | |
|---------------|---------------|
| (A) Switch | (B) Coupler |
| (C) TR switch | (D) Amplifier |

b. Most of the weather radars use_____

- | | |
|-----------------------------|---------------------------|
| (A) Linear polarization | (B) Circular polarization |
| (C) Horizontal polarization | (D) Vertical polarization |

c. Pulse compression

- | | |
|--------------------------------|--------------------------------------|
| (A) Increases bandwidth | (B) Decreases bandwidth |
| (C) Increases range resolution | (D) Increases cross-range resolution |

d. Phased array radar is used for

- | | |
|-------------------------|-----------------------|
| (A) Fast scanning | (B) Non-scanning only |
| (C) Weather forecasting | (D) Speed trapping |

e. MTI radar is

- | | |
|----------|----------------------|
| (A) CW | (B) Pulsed radar |
| (C) FMCW | (D) CW doppler radar |

f. Radome is made of

- | | |
|-----------------------|-------------------|
| (A) Insulator | (B) Conductor |
| (C) Magnetic material | (D) Semiconductor |

g. Blind speed is

- | | |
|-----------------------|-----------------------|
| (A) $PRF(n\lambda/2)$ | (B) $PRF(\lambda/2)$ |
| (C) $PW(n\lambda/2)$ | (D) $PRT(n\lambda/2)$ |

Code: AE78

Subject: RADAR AND NAVIGATIONAL AIDS

- h. Which of the following navigational aids operates by measuring the time difference between signals transmitted from master-slave transmitters?
- (A) Omni-range (B) LORAN
(C) TACON (D) Ground- controlled apparatus
- i. Which of the following pairs is used as interlocking letters in range beacon system?
- (A) G-H (B) H-K
(C) X-Z (D) A-N
- j. Which of the following types of presentation for a RADAR system displays elevation and azimuth?
- (A) PPI presentation (B) A-scan presentation
(C) B-scan presentation (D) C-scan presentation

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

- Q.2** a. Explain about six applications of radars. (6)
- b. What are the desirable pulse characteristics and the factors that govern them in a Radar system? (5)
- c. Draw the functional block diagram of simple pulse radar and explain the purpose and functioning of each block in it. (5)
- Q.3** a. Derive the maximum range for a radar system from first principles. (6)
- b. Describe how threshold level for detection is decided in the presence of receiver noise for a specified probability of occurrence of false alarms by applying statistical noise theory. (6)
- c. An X band monopulse tracking radar operates at 9.7 GHz and is required to have $S/N=30$ db in the receiver sum channel when a 1 m^2 constant RCS target is engaged at range of 40 Km. The radar has an antenna with a diameter of 1.8m and an efficiency of 65%. The transmitter has pulse duration of $0.5 \mu\text{s}$ and the system noise temperature for all channels is 1540 K, the radar integrates 40 pulses. RF losses are 5 dB on transmit and 4 dB on receive. Do not add any miscellaneous losses. Use the optimum receiver bandwidth and taking account of the receive filter mismatch loss; determine the transmitter pulse power required to meet this specification. (4)

Code: AE78**Subject: RADAR AND NAVIGATIONAL AIDS**

- Q.4** a. Explain with necessary block diagram, how doppler direction is identified with CW radar. (6)
- b. Explain in detail the Filter characteristics of the delay-line canceller. (6)
- c. Explain the Butterfly effect that is produced by MTI. (4)
- Q.5** a. Derive the expression for frequency response of the matched filter with non-white noise. (8)
- b. Derive the surface clutter radar equation. (8)
- Q.6** a. A weather radar operates at a frequency of 2.85 GHz. At this frequency, the radar cross section of an individual spherical drop is given by
$$\sigma_{\text{drop}} = \pi^5 D^6 |k^2| / \lambda^4 \text{m}^2$$

(i) What radar band is being used by this radar? Calculate the RCS of a spherical drop with diameter of 1, 3 and 5 mm.
(ii) A weather has a beam with a circular cross-section and beamwidth of 1.5 degrees. The pulse length is 1 μ s. calculate target volume of the radar at a range of 50 Km. On average there are 8000 drops per cubic meter in a rainstorm. Determine the number of drops in the target volume and hence the rain radar cross sectional area in meters squared and dB meters² assuming all drops are 1 mm in diameter. Ignore all the beam shape factors. (8)
- b. Explain various reflector antennas. (8)
- Q.7** a. Explain Balanced type duplexer. (8)
- b. What are Radar displays? Explain their principle of Operation with examples and sketches. (8)
- Q.8** a. Describe the principle behind the operation of a phased array antenna in a radar system. Explain its radiation pattern. (8)
- b. List out the applications of phased array antennas. (8)
- Q.9** a. Explain the block diagram of the AGC portion of tracking radar receiver. (8)
- b. What is an instrument landing system? Explain how elevation guidance is provided in this system. Give the configuration of localizer antenna also. (8)