ROLL NO. _____

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

AMIETE – ET

Time: 3 Hours **DECEMBER 2013** **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. Sea clutter returns occur

. **(A)** Due to reflections from rain clouds
(B) At short ranges
(C) Due to land reflections
(D) None of these

b. Most of the aircraft surveillance RADARS operates in _____.

(A) L-band **(B)** C-band
(C) S-band **(D)** X-band

c. In RADAR , IF amplifier is tuned to the _____ local oscillator and echo frequency.

(A) Sum of **(B)** Difference between
(C) Both **(A)** & **(B)** **(D)** None of these

d. A CW RADAR cannot give information about _____

(A) Range **(B)** Direction
(C) Both range and direction **(D)** Range, direction and past track

e. The maximum range of RADAR depends on all of the following except_____

(A) Peak transmitted pulse power **(B)** Direction of movement of target
(C) Target area **(D)** Low PRF

f. STALO stands for_____

(A) Standard local oscillator
(B) Stable L-band output
(C) Stabilized local oscillator
(D) Saturated and linear oscillator

g. A RADAR is to have a maximum range of 60 km. The maximum allowable pulse repetition frequency for unambiguous reception should be_____.

(A) 25 pps **(B)** 2500 pps
(C) 250 pps **(D)** 2500000 pps

h. MTI RADAR operates at 10 GHz with PRF of 3000 pps. The lowest blind will be

(A) 40 km/hr **(B)** 66 km/hr
(C) 81 km/hr **(D)** 162 km/hr

i. Matched filter_____

(A) Filter RF signals **(B)** Optimizes SNR
(C) Removes AF signals **(D)** Is used as an amplifier

j. The minimum receivable signal in a RADAR receiver whose IF bandwidth is 1.5 MHz and which has a noise figure 9 dB will be _____

(A) 4.16×10^{-10} Watt **(B)** 4.16×10^{-12} Watt
(C) 4.16×10^{-13} Watt **(D)** 4.16×10^{-14} Watt

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

Q.2 a. List out the frequencies used for RADAR and its various applications. **(8)**

b. Explain the basic principle of radar with a simple sketch. What are various units of distance? **(8)**

Q.3 a. Derive the maximum range for a radar system from first principles. **(8)**

b. A pulse radar has peak power 5 kW and uses PRF of 10 KHz. Find the required duty cycle, peak repetition intervals, pulse width to make constant average transmitted power of 1 kW and pulse energy. **(4)**

c. A radar operating at 1.5 GHz uses a peak pulse power of 2.5 MW and have a range of 100 nmi for objects whose radar cross-section is $1m^{2.}$. if the minimum receivable power of the receiver is 2×10^{-13} W. what is the smallest diameter antenna reflector could have, assuming it to be a full paraboloid with η=0.65.**(4)**

Q.4 a. Draw the functional block diagram of an MTI radar system and explain its operation. Define the terms range tracking and MTI improvement factor. **(8)**

b. A radar installation used for air traffic control (ATC) is located at an airport and has the following parameters:

S-band surveillance radars

RF frequency	2800 MHz
Transmitter pulse power	500 KW
Prf	430 Hz
Antenna gain	36 dB
Antenna beamwidth in horizontal planets	1.5^o
Antenna rotation rate	6rpm
Receiver bandwidth	1.4 MHz
Total two way RF system losses	10 dB
Pulse width	1μsec
Receive system noise temperature	800 K
Probability of detection	95%
Time between false alarm	one day

(i) Find the number of hits on the targets and estimate the scanning loss.

(ii) Find the probability of false alarm from the receiver bandwidth and false alarm time.

(iii) Find the threshold S/N ratio in dB, for the given probability of detection and false alarm.

(iv) Find the minimum RCS of a target that can be detected at a range of 100 km assuming a constant RCS. Include scanning loss and IF filter mismatch loss of 0.9 dB. **(8)**

Q.5 a. Derive the expression for frequency response of the matched filter with non-white noise. **(8)**

b. Write a note on Neyman-Pearson observer in detection criteria. **(8)**

Q.6 a. What do you understand by the term clutter? Explain the different types of clutter. Enumerate the properties of Sea and Land clutter. **(8)**

b. Derive the equation for Surface-Clutter Radar. **(8)**

Q.7 a. A phased array antenna has a square aperture with dimensions 2.72m x 2.72m. the sides of the square are horizontal and vertical. The antenna operates at a frequency of 5.5 GHz. Each radiating element in the array has its own transmitter and receiver, and the element spacing is 0.6λ.

(i) How many elements are there in the array?

(ii) What is the gain of the antenna when the beam is broadside to the array face? Assume that the aperture efficiency of the array antenna is 60%.

(iii) What is the maximum angle to which the beam can be scanned in the horizontal or vertical plane before a grating lobe appears in the horizontal or vertical direction? **(9)**

b. Describe briefly the two different types of phased-array radar. State their functions. **(7)**

Q.8 a. State the factors influence the bandwidth of radar receiver. Write down the advantages of large bandwidth. **(8)**

b. Explain the following: **(8)**
(i) Balanced type duplexer
(ii) Branch type duplexer

Q.9 a. Write a short note on LORAN-A and LORAN-C. **(8)**

b. A monopulse tracking radar has a tracking slope of 1.0 volts per degree close to the antenna boresight. Within 0.1 degree of the boresight the antenna gain in the sum channel can be assumed to be constant 1.0 volts relative to the difference channel output.
(i) What is the output of the azimuth difference channel, in volts and in dB, relative to 1.0 volts in the sum channel when a target is 0.008 degrees away from the antenna axis in the horizontal plane?
(ii) The sum channel of the receiver has a bandwidth of 1.5 MHz. The S/N in the difference channel must be 30 dB when a target is 0.02 degrees off axis. What bandwidth is required in the difference channel to achieve this specification?**(8)**