ROLL NO. ___________________

Code: AE63/AE114 Subject: ELECTROMAGNETICS & RADIATION SYSTEMS

AMIETE – ET (CURRENT & NEW SCHEME)

Time: 3 Hours **JUNE 2016** 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. The electric field lines and equipotential lines

(A) are parallel to each other
(B) cut each other orthogonally
(C) can be inclined to each other at any angle
(D) are one and the same

b. Maxwell's equation $\nabla \times \vec{H} = \vec{J} + \dot{\vec{D}}$ represents

(A) Gauss's law in magnetism
(B) Kirchoff's current law for direct current
(C) Biotsavart law
(D) Generalized Ampere's circuital law

c. Ohm's law is obeyed by

(A) conduction current
(B) convection current
(C) conduction current and convection current
(D) none of these

d. Two parallel wires carry current along opposite directions. The resultant force experienced by two wires is

(A) zero **(B)** attractive
(C) repulsive **(D)** none of these

e. The work and power required to move a conductor carrying fixed current is negative. It implies that

(A) Energy has been dissipated by conductor
(B) Energy has been generated by conductor
(C) Energy stored in the magnetic field is used
(D) All of these

f. Farady's law is valid for both open and closed loops. The Lenz's law is valid for

(A) only open loop **(B)** only closed loop
(C) both open and closed loops **(D)** none of these

g. For a dielectric –conductor interface, the boundary condition that is not satisfied is

(A) $E_{t1}=E_{t2}$ **(B)** $D_{n1}=0$
(C) $H_{t1}=H_{t2}$ **(D)** $B_{n1}=B_{n2}$

h. Frequencies in the UHF range normally propagate by means of

(A) ground waves **(B)** sky waves
(C) surface waves **(D)** space waves

i. Antenna 1 has radiation resistance twice that of antenna 2. It implies that

(A) Antenna 2 delivers double power to space than antenna 1
(B) Antenna 2 delivers half power to space than antenna 1
(C) Antenna 2 delivers quarter power to space than antenna 1
(D) Antenna 2 delivers equal power to space than antenna 1

j. Which of the following terms does not apply to the Yagi-Uda array?

(A) Good Bandwidth **(B)** Parasitic elements
(C) Fold Dipole **(D)** High Gain

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

Q.2 a. State coulomb's law.
Four like charges of 30.4C each are located at the four corners of a square, lying on xy plane with one corner at origin, the diagonal measures 8m. Find the force on a 100µC located at 3m above the centre of the square. **(2+8)**

b. State Gauss' law and use this law to show that **D** and **E** are zero at all points in the plane of a uniformly charged circular ring that are inside the ring. **(2+4)**

Q.3 a. Explain electric potential and electric field intensity. Derive a relation between them. **(8)**

b. Find the conductivity of n-type germanium (Ge) at 300K, assuming one donor atom in each 10^8 atoms. The density of Ge is 5.32×10^3 kg/m^3 and the atomic weight is 72.6 kg/kmol. [$n_i=2.5\times10^{19}$ m^{-3} ; $\mu_e=0.38$ m^2/V] **(8)**

Q.4 a. What are the significant physical differences between Poisson's and Laplace's equation. Derive the Poisson's equation for various coordinate systems. **(7)**

b. The region $-\frac{\pi}{2} < \frac{z}{z_0} < \frac{\pi}{2}$ has a charge density $\rho = 10^{-8} \cos(z/z_0)$ C/m^3. Elsewhere the charge density is zero. Find V and E from Poisson's equation and compare with the results given by Gauss' law. **(9)**

Q.5 a. Determine magnetic vector potential for (i) line current (ii) sheet current (iii) volume current. **(8)**

b. Consider an 8 A filamentary current directed inward from infinity to the origin on the positive x-axis and then outward to infinity along the y axis. Determine magnetic field intensity for this filamentary current at P(0.4, 0.3, 0). **(8)**

Q.6 a. Derive the expression for force required to move a differential current element in presence of a steady magnetic field. **(6)**

b. A conductor lies along z axis at $-1.5 \le z \le 1.5$ m and carries a fixed current of 10A in the $-\mathbf{a}_z$ direction. For a field $B = 3.0 \times 10^{-4} e^{-0.2x} \mathbf{a}_y$ Tesla find the work and power required to move the conductor at constant speed to x=2.0 m, y=0 in 5×10^{-3} s. Assume parallel motion along x axis. **(6)**

c. Find the inductance per unit length of two parallel cylindrical conductors, where the conductor radius is 1 mm and center to center separation is 12 mm. **(4)**

Q.7 a. Write down Maxwell's equations for time varying electromagnetic fields. Explain Maxwell's fourth equation of modified Ampere's circuital law. What is displacement current? **(8)**

b. Given $\mathbf{E} = E_m \sin(\omega t - \beta z)\, \mathbf{a}_y$ in free space, find **D**, **B**, **H**. Sketch **E** and **H** at t=0. **(8)**

Q.8. a. Describe ground-wave propagation. What is the angle of tilt? How does it affect field strength at a distance from transmitter? **(6)**

b. Define skip distance, and show how it is related to the maximum usable frequency. **(4)**

c. Two points on earth are 1500 km apart and are to communicate by means of HF. Given that this is to be a single-hop transmission, the critical frequency at that time 7 MHz and conditions are idealized, calculate the MUF for those two points if the height of the ionosphere layer is 300 km. **(6)**

Q.9 a. An antenna has a radiation resistance of 72Ω, a loss resistance 8Ω, and a power gain of 16. What efficiency and directivity does it have? **(6)**

b. What is a parabola? With sketches, show why its geometry makes it a suitable basis for antenna reflectors. Explain why an antenna using paraboloid reflector is likely to be highly directive receiving antenna. Describe fully the Cassegrain method of feeding a paraboloid reflector, including a sketch of the geometry of this feeding arrangement. **(10)**