ROLL NO. _____

Code: AE63 Subject: ELECTROMAGNETICS & RADIATION SYSTEMS

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. Which one of the following is a scalar quantity?

(A) Electric field strength **(B)** Electric potential
(C) Electric displacement density **(D)** Force

b. The equation $\overline{\nabla} \cdot \overline{J} = 0$ is called

(A) Laplacian equation **(B)** Kirchoff's node equation
(C) Poisson's equation **(D)** Equation of continuity for direct current

c. An electric field of 50 V/m has charges of $0.3\mu C$ what is the force on that charge

(A) 15 μN **(B)** 12.5 μN
(C) 18 μN **(D)** 10.5 μN

d. Intrinsic or Characteristic impedance of free space has a value of

(A) Zero **(B)** π ohm
(C) 73 ohm **(D)** 120π ohm

e. For normal incidence, the angle of incidence is

(A) 90° **(B)** 180°
(C) 0° **(D)** 45°

f. The direction of propagation of electromagnetic wave, is given by

(A) $\overline{E}$ **(B)** $\overline{H}$
(C) $\left(\overline{E} \times \overline{H}\right)$ **(D)** $\overline{E} \cdot \overline{H}$

g. _____ wave propagate in UHF

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

h. Which one is correct

(A) MUF = $f_c \sec\psi$ **(B)** MUF = $f_c \sin\psi$
(C) MUF = f_c **(D)** MUF = $f_c \cos\psi$

i. The concept of displacement current was a major contribution attributed to

(A) Faraday **(B)** Lenz
(C) Maxwell **(D)** Lorentz

j. Indicate the antenna that is not wideband

(A) Disc one **(B)** Folded dipole
(C) Helical **(D)** Marconi

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

Q.2 a. State and explain Gauss Law for electrostatic and derive its differential form. **(8)**

b. Define potential and electric flux density. Also derive expression for a point charge in electric field. Point charges 1 mC and -2 mC are located at (3, 2, -1) and (-1, -1, 4), respectively. Calculate the electric force on a 10-nC charge located at (0, 3, 1) and the electric field intensity at that point. **(8)**

Q.3 a. Derive the relationship between normal and tangential components at the boundary region in case of perfect dielectrics. **(10)**

b. A wire of diameter 1 mm and conductivity $5\times10^7 S/m$ has 10^{29} free electron s/m^3 when an electric field of 10 mV/m is applied. Determine
(i) The charge density of free electrons
(ii) The current density
(iii) The current in the wire
(iv) The drift velocity of the electrons. Take the electronic charge as $e = -1.6\times10^{-19} C$. **(6)**

Q.4 a. Derive the Poisson's and Laplace Equation. Represent Laplace Equation in all three co-ordinate systems. **(10)**

b. Given potential field $V = \left[A\rho^4 + B\rho^{-4}\right]\sin 4\phi$

(i) show that $\nabla^2 V = 0$

(ii) find A and B so that V = 100 volts and $\left|\overline{E}\right| = 500\frac{V}{m}$ at $P\left(\rho = 1, \phi = 22.5^\circ, z = 2\right)$. **(6)**

Q.5 a. State and explain Ampere's Circuit law. **(10)**

b. Explain the concept of Scalar and Vector Magnetic potential. **(6)**

Q.6 a. State and explain the magnetic Boundary condition. **(8)**

b. Let us $\mu_1 = 4\times10^{-6}$ H/m in Region 1 :- z > 0, $\mu_2 = 7\times10^{-6}$ H/m in Region 2 :- z < 0. Let $K = .80\hat{o}_x$ A/m on the surface z = 0 and Field $B_1 = 2\hat{a}_x - 3\hat{a}_y + \hat{a}_z$ mT in Region 1. Find B_2 in Region 2. **(8)**

Q.7 a. Express Maxwell's equation in both differential and integral form for a time varying field and explain it. **(10)**

b. The electric field in free space is given by

$$\mathbf{E = 50 \cos (10^8 t + \beta x)\ \hat{a}_y\ V/m}$$

(i) Find the direction of wave propagation.
(ii) Calculate β and the time it takes to travel a distance of (λ/2). **(6)**

Q.8 With reference to ionosphere and skywave propagation, explain the following terms:
(i) The virtual height
(ii) The critical frequency
(iii) The maximum usable frequency
(iv) The skip distance **(4*4)**

Q.9 Write short note on:

(i) Antenna Coupling
(ii) Microwave Antennas **(8+8)**