ROLL NO. ________________

Code: AE63 Subject: ELECTROMAGNETICS & RADIATION SYSTEMS

AMIETE – ET

Time: 3 Hours **DECEMBER 2012** **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. Coulomb's law states that

(A) $\oint F.dl = 0$ **(B)** $F = \dfrac{Q_1Q_2}{4\pi \in r^2}$

(C) $E = -\nabla V$ **(D)** $F = I(l \times B)$

b. A vector field ρ is solenoidal if

(A) $\oint \rho.ds = 0$ **(B)** $\oint \rho.dl = 0$

(C) $\nabla \times \rho = 0$ **(D)** $\nabla \times \rho \neq 0$

c. Which of the following is correct?

(A) $\nabla\nabla.A = 0$ **(B)** $\nabla.\nabla A = 0$

(C) $\nabla.\nabla \times A = 0$ **(D)** $\nabla \times \nabla \times A = 0$

d. The boundary condition valid at boundary between two dielectric I and II is

(A) $\begin{matrix} E_{t1} = E_{t2} \\ D_{n1} = D_{n2} \end{matrix}$ **(B)** $\begin{matrix} E_1 = E_2 \\ H_1t = H_2t \end{matrix}$

(C) $\begin{matrix} H_1t = H_2t \\ E_{n1} = E_{n2} \end{matrix}$ **(D)** $\begin{matrix} E_{t1} \neq E_{t2} \\ D_{n1} \neq D_{n2} \end{matrix}$

e. The ratio of electrostatic and magnetic energy densities in free space is

(A) zero **(B)** one

(C) two **(D)** 1.5

f. The velocity of electromagnetic wave in free space is equal to

(A) $\sqrt{\in_o / \mu_o}$ **(B)** $\in_o \mu_o$
(C) $\sqrt{\in_o \mu_o}$ **(D)** $\frac{1}{\sqrt{\mu_o \in_o}}$

g. Two concentric hollow spheres of radii R_1 and R_2 $(R_1 > R_2)$ have charges Q_1 and Q_2 respectively distributed uniformly over their surface. The electric flux density D at Gaussian surface of radius r such that $R_1 < r < R_2$ is

(A) $\frac{Q_1}{4\pi R_1^{\,2}}$ **(B)** $\frac{Q_1}{4\pi r^2}$
(C) $\frac{Q_2}{4\pi R_2^{\,2}}$ **(D)** $\frac{Q_2}{4\pi r^2}$

h. An electromagnetic wave has electric field component along Y-direction and magnetic field component along X-direction. The electromagnetic wave is propagating along

(A) –Z direction **(B)** X-direction
(C) Y-direction **(D)** XY direction

i. The length of antenna depends on

(A) wavelength of radiation **(B)** current distribution
(C) angle of radiation **(D)** area of cross-section

j. The resultant force experienced by two parallel wires carrying current along opposite direction is

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

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

Q.2 a. Determine the electric field due to continuous volume charge distribution. **(8)**

b. Using Gauss's law in integral form obtain the electric field due to following charge distribution in spherical coordinates

$$\rho(r, Q, \phi) = \begin{cases} \rho_0\left(1 - \frac{r^2}{a^2}\right); & 0 < r < a \\ 0 \quad ; & \text{otherwise} \end{cases}$$ **(8)**

Q.3 a. Using boundary conditions show that

(i) The static electric field intensity inside a conductor is zero.
(ii) The conductor surface is an equipotential surface. **(8)**

b. Find the work in moving a $4\,\mu C$ charge from origin to point $(2,-1,4)$ through field $E = 2\,xyz\,a_x + x^2 z\,a_y + x^2 y\,a_z$ via a straight line $x = -2y, z = 2x$. **(8)**

Q.4 a. Explain product solution of Laplace's equation. **(8)**

b. Two metal plates having area A and separation d form a parallel plate capacitor. One plate is held at potential of V_o and other plate is grounded. Using Laplace equation, calculate the capacitance of parallel plate capacitor. **(8)**

Q.5 a. State and explain Ampere's Circuital law. **(8)**

b. The magnetic vector potential is given by $A = 10 r \sin\theta\, a_\theta$. Calculate the flux density at a point $\left(2, \frac{\pi}{2}, 0\right)$. **(8)**

Q.6 a. Explain the boundary conditions for magnetic fields. **(8)**

b. Find the force per unit length on two long straight parallel conductors carrying a current of 10A each in the same direction and separated by a distance of 0.2m. **(8)**

Q.7 a. Derive an expression for displacement current and give its physical significance. **(8)**

b. State and explain Faraday's law and the significance of Maxwell's equation in Integral form. **(8)**

Q.8 a. Derive an expression for wave equation in free space and show that field vectors E and H are in same phase. **(8)**

b. Explain resonant antennas with radiation patterns. **(8)**

Q.9 a. Write short note on the following:

(i) Log-Periodic Antenna
(ii) Discone Antenna **(5+5)**

b. Calculate the gain and bandwidth between nulls of a 2m paraboloid reflector used as 6 GHz. **(6)**