ROLL NO. _____

Code: AE63 Subject: ELECTROMAGNETICS & RADIATION SYSTEMS

AMIETE – ET

Time: 3 Hours **JUNE 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. The work done by the force $\vec{F} = 4a_x - 3a_y + 2a_z$ N in giving a 1 nC charge a displacement of $10a_x + 2a_y - 7a_z$ is

(A) 103 n J **(B)** 60 n J
(C) 64 n J **(D)** 20 n J

b. By saying that the electrostatic field is conservative, we do not mean that

(A) Its circulation is identically zero.
(B) The potential difference between any two points is zero.
(C) Its curl is identically zero.
(D) It is the gradient of a scalar potential.

c. If $\nabla.\vec{D} = \varepsilon\nabla.\vec{E}$ and $\nabla.\vec{J} = \sigma\nabla.\vec{E}$ in a given material, the material is said to be

(A) Linear **(B)** Isotropic
(C) Linear and homogeneous **(D)** Linear and isotropic

d. Given field $\vec{A} = 3x^2yza_x + x^3za_y + (x^3y - 2z)a_z$. It can be said that $\vec{A}$ is

(A) Conservative **(B)** Rotational
(C) Harmonic **(D)** Solenoidal

e. Which of the following potential does not satisfy Laplace's equation

(A) V = 10/r **(B)** V = $\rho\cos\varphi$ + 10
(C) V = 2x + 5 **(D)** V = r cos φ

f. Which one of these equation is not Maxwell's equation for a static electromagnetic field in a linear homogeneous medium?

(A) $\nabla . \vec{B} = 0$ **(B)** $\nabla^2 . \vec{A} = \mu_0 \vec{J}$

(C) $\nabla \times \vec{D} = 0$ **(D)** $\oint \vec{B} . d\vec{l} = \mu_0 I$

g. Which of these formula is wrong?

(A) $\vec{B}_{1n} = \vec{B}_{2n}$ **(B)** $\vec{H}_1 = \vec{H}_{1n} + \vec{H}_{1t}$

(C) $B_2 = \sqrt{B_{2n}^2 + B_{2t}^2}$ **(D)** $\hat{a}_{n_{21}} \times (H_1 - H_2) = K$

h. Which of the following is not Maxwell's equation for time – varying fields..

(A) $\nabla . \vec{J} + \frac{\partial \rho_v}{\partial t} = 0$ **(B)** $\nabla . \vec{D} = \rho_v$

(C) $\nabla . \vec{E} = -\frac{\partial \vec{B}}{\partial t}$ **(D)** $\oint \vec{B} . d\bar{s} = 0$

i. In a certain medium $\vec{E}$ = 10 cos (10^8t -3y) a_x V/m. What type of medium is it

(A) Free space **(B)** Lossy dielectric
(C) Perfect conductor **(D)** Lossless dielectric

j. A very small, thin wire of length $\frac{\lambda}{100}$ has a radiation resistance of

(A) $\approx 0\Omega$ **(B)** 7.9Ω
(C) $0.08\,\Omega$ **(D)** $790\,\Omega$

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

Q.2 a. A circular ring of radius a carries a uniform charge ρ_L C/m and is placed on the xy – plane with axis the same as the z – axis. Show that $\vec{E}(0,0,h) = \frac{\rho_L ah}{2\epsilon_0 \left[h^2 + a^2\right]^{3/2}} \hat{a}_z$ **(8)**

b. A charge distribution with spherical symmetry has density

$$\rho_v = \begin{cases} \frac{\rho_0 r}{R} & 0 \le r \le R \\ 0 & r > R \end{cases}$$. Determine $\vec{E}$ everywhere **(8)**

Q.3 a. Discuss the boundary condition at a conductor and free space boundary in electrostatics. **(8)**

b. Given the potential $V = \frac{10}{r^2}\sin\theta\cos\phi$

(i) Find the electric flux density D at $(2, \pi/2, 0)$

(ii) Calculate the work done in moving a $10\,\mu C$ charge from the point

$A(1, 30^0, 120^0)$ to B $(4, 90^0, 60^0)$ **(8)**

Q.4 a. State and derive the uniqueness theorem. **(8)**

b. In spherical coordinates V = 0 at r = 0.2m and V = 200 at r = 4m. Calculate the potential in various regions. Assume free space between these concentric spherical shells. **(8)**

Q.5 a. Explain the scalar and magnetic potentials with the help of one example of each. **(8)**

b. Given the volume current density distribution in cylindrical coordinates as.

$J(r, \phi, z) = 0 \quad 0 < r < a$

$= J_0\left(\frac{r}{a}\right)a_z \quad a \le r \le b$

$= 0 \quad b < r < \infty$

Find the magnetic field intensity H in various regions. **(8)**

Q.6 a. Find the expression of torque acting on a differential current loop in a magnetic field B. **(8)**

b. Given that $H_1 = -2a_x + 6\,a_y + 4\,a_z$ A/m in region $y - x - 2 \le 0$ where $\mu_1 = 5\mu_0$ calculate (i) M_1 & B_1

(ii) H_2 & B_2 in region $y - x - 2 \ge 0$ where $\mu_2 = 2\mu_0$ **(8)**

Q.7 a. Write the integral and differential form of Maxwell's equations for time varying fields. **(5)**

b. A parallel – plate capacitor with plate area of $5\,cm^2$ and plate separation of 3 mm has a voltage 50 sin 1000t volt applied to its plates. Calculate the displacement current. Assume $\epsilon = 2\epsilon_0$. **(6)**

c. State and explain Faraday's law and find expression for the emf. **(5)**

Q.8 Explain the following:

(i) Polarization of waves (ii) Tropospheric scatter propagation

(iii) Skip distance (iv) Radiation Resistance **(16)**

Q.9 a. Define the following

(i) Directive gain (ii) Resonant Antenna

(iii) End-fire array (iv) Horn Antenna **(8)**

b. Explain working principle and constructional features of Helical Antenna, also write its applications. **(8)**