ROLL NO. _____

Code: AE63 Subject: ELECTROMAGNETICS & RADIATION SYSTEMS

AMIETE – ET

Time: 3 Hours **JUNE 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. The total charge within some finite volume is

(A) $\int_{vol} \rho_v dv$ **(B)** $\int_{vol} \frac{\rho_v dv}{r}$

(C) $\int_{vol} \frac{\rho_v}{r^2} dv$ **(D)** $\int_s D.ds$

b. The electric flux density at a point r from the point charge is

(A) $\frac{q}{4\pi \in r}$ **(B)** $\frac{q}{4\pi r^2}$

(C) $\frac{q}{4\pi r}$ **(D)** $\frac{qr}{4\pi \in}$

c. The potential difference between two points a and b is

(A) $-\int_a^b E.d\ell$ **(B)** $-q\int_a^b E.d\ell$

(C) $\int_a^b E.ds$ **(D)** $q\int_a^b E.ds$

d. The capacitance of an isolated spherical conductor of radius a is

(A) $\frac{a}{4\pi \in}$ **(B)** $\frac{q}{4\pi \in a}$

(C) $\frac{4\pi \in}{a}$ **(D)** $4\pi \in a$

e. The poission's equation is

(A) $\nabla^2 V = -\frac{\rho}{c}$ **(B)** $\nabla^2 V = 0$

(C) $\nabla^2 \overline{D} = \rho$ **(D)** $\nabla \times \nabla \times \nabla = \rho$

f. The magnetic vector potential A and magnetic field B are related as

(A) $A = \nabla \times B$ **(B)** $B = \nabla \times A$
(C) $B = \nabla \cdot A$ **(D)** $A = \nabla \cdot B$

g. Lorentz force Equation is

(A) $F = q(E + v \times B)$ **(B)** $F = q(v \times B)$
(C) $F = q(B + v \times E)$ **(D)** $F = qE$

h. The characteristics impedance of free space is

(A) 277Ω **(B)** 377Ω
(C) 477Ω **(D)** None of these

i. The maximum usable frequency is

(A) $f_c \sec\theta$ **(B)** $f_c \cos\theta$
(C) $f_c \sin\theta$ **(D)** $f_c \cot\theta$

j. The length of antenna operating at a frequency of 50MHz is

(A) 5.7m **(B)** 57m
(C) 570m **(D)** None of these

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

Q.2 a. Find the expression for Electric field due to line charge. **(8)**

b. In the region of free space that includes the volume, $2 < x, y, z < 3$, $D = \frac{2}{z^2}\left(yza_x + xza_y - 2xya_z\right) C/m^2$.

(i) Evaluate the volume integral side of the divergence theorem for the volume defined here.
(ii) Evaluate the surface integral side for the corresponding closed surface. **(8)**

Q.3 a. Derive an expression for calculating the capacitance of a parallel-plate capacitor. **(8)**

b. A non uniform electric field is given by E= yi+xj+zk. Determine the work expended in carrying a charge of 2 column from B(1,0,1) to A (0.8,0.6,1) along the shorter path of circle $x^2+ y^2 =1$, z=1. **(8)**

Q.4 a. Show that the capacitance varies inversely as the square root of the voltage. **(8)**

b. Using the Laplace equation, find the capacitance per unit length of a capacitor formed by two concentric circular cylinders of radius a and b (a< b). **(8)**

Q.5 a. The magnetic vector potential in spherical coordinates is given by A=10r $\sin\theta\, I_\theta$. Find the flux density at $\left(2,\frac{\pi}{2},0\right)$.where I_θ is unit vector in the direction of θ. **(8)**

b. Calculate curl H at origin, where
H= $2y\, i-(x^2+z^2)j+3yk$ **(8)**

Q.6 a. Calculate the force between two linear, parallel, long conductors carrying currents in opposite direction. **(8)**

b. Calculate self inductances and mutual inductances between two co-axial solenoids of radius 2 cm and 3cm carrying currents 2A and 3A having 50 and 80 turns/m respectively. **(8)**

Q.7 a. Let $\mu=10^{-5}$ H/m, $\in=4\times10^{-9}$ F/m, $\sigma=0$ and $\rho_v=0$. Find k (including units) so that each of the following pairs of fields satisfies Maxwell's equations:

(i) $\overline{D}=6\bar{a}_x-2y\bar{a}_y+2z\bar{a}_z$ nC/m^2, $\overline{H}=kx\bar{a}_x+10y\bar{a}_y-25z\bar{a}_z$ A/m

(ii) $\overline{E}=(20y-kt)\bar{a}_x$ V/m, $\overline{H}=\left(y+2\times10^6 t\right)\bar{a}_z$ A/m **(8)**

b. Explain briefly about Retarded Potentials. **(8)**

Q.8 a. Describe the following terms in connection with electro-magnetic waves: **(8)**
(i) Transverse waves (ii) Power density
(iii) Wave impedance (iv) Polarization

b. Discuss the characteristics of antennas isolated from surfaces which will alter or change their radiation patterns and efficiency. **(8)**

Q.9 a. Explain the radiation resistance of an antenna. **(4)**

b. With sketch, describe the feed mechanism of a parabolic reflector **(4)**

c. Write short notes on: **(8)**
(i) Horn Antenna
(ii) Helical Antenna