Code: A-14 **Subject: ELECTROMAGNETICS AND RADIATION**
Time: 3 Hours **June 2006** **Max. Marks: 100**

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.**
- **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 best alternative in the following: (2x10)

a. Electric field intensity due to line charge of infinite length is.

(A) $\frac{\rho_L}{2\pi\varepsilon R}$. **(B)** $\frac{\rho_L}{4\pi\varepsilon R}$.
(C) $\frac{2\rho_L}{\pi\varepsilon R}$. **(D)** $\frac{2\rho_L}{4\pi\varepsilon R}$.

b. With respect to equipotential surface pick the odd one out.

(A) Potential is same every where
(B) Work done in moving charge from one point to another is zero
(C) Potential is different every where
(D) No current flows on this surface

c. Energy stored in a magnetic field is

(A) $W=\frac{1}{2}\sqrt{\frac{\mu H}{4}}$. **(B)** $W=\mu\sqrt{\frac{H^2}{2}}$.
(C) $W=\frac{\mu H^2}{2}$. **(D)** $W=\frac{\mu\sqrt{H}}{2}$.

d. The intrinsic impedance of free space is

(A) 75 ohm. **(B)** 73 ohm.
(C) 120 πohm. **(D)** 377ohm.

e. During night which layer does not exist?

(A) D layer **(B)** F_1 layer
(C) F_2 layer **(D)** E layer

f. The characteristic impedance is given by

(A) $Z_0 = \frac{\sqrt{Zoc}}{Zsc}$ **(B)** $\frac{\sqrt{Zsc}}{Zoc}$

(C) $\sqrt{Zsc\ Zoc}$ **(D)** $(Zsc \cdot Z_{oc})$

g. Transverse electric wave traveling in z- direction satisfies

(A) $E_z = 0;\ H_z = 0$ **(B)** $E_z = 0;\ H_z \neq 0$

(C) $E_z \neq 0;\ H_z = 0$ **(D)** $E_z \neq 0;\ H_z \neq 0.$

h. Radiation resistance of a $\lambda/2$ dipole is

(A) 73 Ω. **(B)** 75 ohm

(C) 120 πohm **(D)** 377 ohm

i. The VSWR of a transmission line is

(A) directly proportional to load impedance and inversely to characteristic impedance.
(B) directly proportional to characteristic impedance and inversely to load impedance.
(C) Proportional to load and characteristic impedance.
(D) Directly proportional to voltage minimum and inversely to voltage maximum.

j. Poynting vector gives

(A) rate of energy flow.
(B) direction of polarization.
(C) intensity of electric field.
(D) intensity of magnetic field.

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

Q.2 a. Using Gauss theorem, derive an expression for the electric field intensity due to a line charge of infinite length at distance R. **(8)**

b. A positive charge density of Q_v C/m^3 occupies a solid sphere. At a point in the interior at a distance 'r' from the center a small probe charge of +q is inserted. What is the force acting on the probe charge? **(8)**

Q.3 a. Prove Ampere's circuital law for time varying field condition in differential form. **(7)**

b. A circular conductor of 1cm radius has an internal magnetic field

$$\bar{H} = \frac{1}{r}\left\{\frac{1}{a^2}\sin ar - \frac{r}{a}\cos ar\right\}\bar{i\phi}$$

where $a = \pi/2\, r_o$ and r_o is the radius of the conductor. Calculate the total current in the conductor ($\bar{i\phi}$ is unit vector). **(9)**

Q.4 a. Prove the electric field normal components are discontinuous across the boundary of separation between two dielectrics. **(6)**

b. Measurement made in the atmosphere show that there is an electric field which varies widely from time to time particularly during thunderstorms. Its average values on the surface of the earth and at a height of 1500m are found to be 100 V/m and 25 V/m directed downward respectively. Using Poisson's equation calculate i) the mean space charge in the atmosphere between 0 and 1500 m altitude ii) surface charge density on earth. **(10)**

Q.5 a. Derive an expression for equation of continuity and explain its significance. **(6)**

b. Do the fields $\bar{E} = E_m \sin x \sin t\, a_y$ and $\bar{H} = \frac{E_m}{m}\cos x \cos t\, a_z$, satisfy Maxwell's equation? **(10)**

Q.6 a. Write short notes on skin depth and skin effect **(4)**

b. Prove for a travelling uniform plane wave

$$\frac{\bar{E}}{\bar{H}} = \sqrt{\frac{\mu}{\varepsilon}}$$

where $\bar{E}$ and $\bar{H}$ are amplitudes of $\vec{E}$ and $\vec{H}$, respectively. **(12)**

Q.7 a. Discuss the following terms

(i) Wavelength (ii) Phase velocity
(iii) Group velocity (iv) Propagation constant **(8)**

b. A high frequency transmission line consists of a pair of open wires having a distributed capacitance of 0.01 μF per Km and a distributed inductance of 3mH per Km. What is the characteristic impedance and propagation constant at f=10MHz? **(4)**

c. Comment on Impedance matching device. **(4)**

Q.8 a. Derive the condition for a distortionless line and comment on the result. **(8)**

b. An antenna array presents an impedance of 300 ohms to the transmission line feeding it. The transmission line consists of two open wire lines whose spacing is 9" apart and the diameter of the wire is 0.1", calculate the dimension of a quarter wave line required for matching. **(8)**

Q.9 a. Derive the wave equation for a TE wave and obtain all the field components in a rectangular wave guide. **(11)**

b. Find the cut-off wavelength in a standard rectangular wave guide for the TE_{11} mode. **(5)**