Subject: ELECTROMAGNETICS & RADIATION SYSTEMS

Time: 3 Hours **Max. Marks: 100**

JUNE 2011

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. Gauss's law is

(A) $\iint \vec{D} da = 0$ **(B)** $\iint \vec{B} da = 0$

(C) $\oint \vec{H} d\ell = J$ **(D)** $\iint \vec{E} da = 0$

b. The unit of electric displacement density is

(A) Gauss **(B)** Webers$/m^2$

(C) Coulombs$/m^2$ **(D)** Siemen

c. Current density is given by

(A) $I = \frac{J_o}{a}$ **(B)** $J = \frac{dI}{ds}\vec{r}$

(C) $J = IA$ **(D)** $J = RI$

d. Ampere's law of force is given by

(A) $\vec{F} = K\frac{I_1}{r}$ **(B)** $\vec{F} = K\frac{I_1 I_2}{r^2}$

(C) $\vec{F} = \frac{\mu}{r} I_1 I_2$ **(D)** $F = \frac{\mu I}{r^2}$

e. Faraday's law of electromagnetic induction can be expressed as

(A) $V_i = -\frac{dI}{dt}$ **(B)** $V_i = -\frac{1}{R}\frac{d\theta}{dt}$

(C) $V_i = -\frac{d\phi}{dt}$ **(D)** $V_i = \frac{1}{2}\theta^2 V$

f. Which of the following is not a Maxwell's equation

(A) $\text{div}\vec{D} = \rho$ **(B)** $\text{curl}\vec{H} = \vec{J} + \frac{\partial \vec{D}}{dt}$

(C) $\text{div}\vec{B} = 0$ **(D)** $\text{curl}\vec{E} = -\frac{\partial \vec{H}}{dt}$

g. Velocity of electromagnetic wave is

(A) $v = \sqrt{\frac{\epsilon_o}{\mu_o}}$ **(B)** $v = \epsilon_o \mu_o$

(C) $v = \sqrt{\epsilon_o \mu_o}$ **(D)** $v = \frac{1}{\sqrt{\epsilon_o \mu_o}}$

h. Radiation Intensity produced by an isotropic radiator, radiating the total power Wr , is

(A) $\phi_{av} = \frac{Wr}{2\pi}$ **(B)** $\phi_{av} = \frac{Wr}{4\pi}$

(C) $\phi_{av} = \frac{Wr}{6\pi}$ **(D)** $\phi_{av} = \frac{Wr}{8\pi}$

i. Which of the following is not a wideband antenna?

(A) Discone **(B)** Folded dipole
(C) Helical **(D)** Marconi

j. Frequency in the UHF range propagates by means of

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

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

Q.2 a. Determine the electric field due to line charge. **(8)**

b. What is vector operator ∇ ? Discuss Divergence Theorem. **(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. We have non uniform field E = y ax + x ay + 2 az. What is the work done in carrying 2 Coulomb from B (1, 0, 1) to A (0.8, 0.6, 1) along the shorter arc of the circle, $x^2 + y^2 = 1$ & $z = 1$? **(8)**

Q.4 a. Establish Poisson's equation for an electrostatic field in the form $\nabla^2\phi = \frac{}{\epsilon_o}$ **(8)**

b. Solve Laplace equation for the region between coaxial cones, here at $\theta = \theta_1$, $v = v_1$ & at $\theta = \theta_2$, $v = v_2 = 0$ the cone vertices are insulated at r = 0. **(8)**

Q.5 a. State and explain Stokes' theorem and show that this theorem enables us to obtain integral form of Ampere's Circuital law. **(8)**

b. Calculate curl H and line integral of H if $H = 0.2z^2 ax$ for z > 0, and H = 0 elsewhere, about a square path with side d centered at $(0,0,z_1)$ in the $y = 0$ plane where $z_1 > \frac{d}{2}$. **(8)**

Q.6 a. Calculate the self inductance of and mutual inductances between two coaxial solenoids of radius R_1 & R_2, $R_2 > R_1$, carrying currents I_1 & I_2 with n_1 & n_2 number of turns/m. Take $n_1 = 50, n_2 = 80$, $R_1 = 2cm$ & $R_2 = 3cm$. **(8)**

b. State Lorentz Force equation and determine magnetic force on a differential current element. **(8)**

Q.7 a. State and explain Faraday's Law and find expression for motional emf. **(8)**

b. Discuss Maxwell's equation in time varying field and obtain its integral form as $\oint_S B \cdot dS = 0$. What are its limitations? **(8)**

Q.8 a. Explain the following terms:
(i) Power density of electromagnetic waves.
(ii) Isotropic source and isotropic medium. **(8)**

b. Determine length of an antenna operating at frequency of 1000 KHz. Take the value of Velocity Factor as 0.95. **(4)**

c. What is characteristic impedance of a medium? Calculate its value for free space. **(4)**

Q.9 a. With the help of a neat diagram, describe fully the cassegrain method of feeding a paraboloid reflector. **(8)**

b. Calculate beamwidth and gain between nulls of a 2-m paraboloid reflector used at 6 GHz. **(4)**

c. Write applications for the following:
(i) Loop Antenna
(ii) Horn Antenna. **(4)**