

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) $\oint \vec{H} dl = J$

(D) $\iint \vec{E} da = 0$

b. The unit of electric displacement density is

(A) Gauss

(B) Webers/m²

(C) Coulombs/m²

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

g. Velocity of electromagnetic wave is

- (A) $v = \sqrt{\frac{\epsilon_0}{\mu_0}}$ (B) $v = \epsilon_0 \mu_0$
(C) $v = \sqrt{\epsilon_0 \mu_0}$ (D) $v = \frac{1}{\sqrt{\epsilon_0 \mu_0}}$

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

- (A) $\phi_{av} = \frac{W_r}{2\pi}$ (B) $\phi_{av} = \frac{W_r}{4\pi}$
(C) $\phi_{av} = \frac{W_r}{6\pi}$ (D) $\phi_{av} = \frac{W_r}{8\pi}$

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 $\nabla^2\phi = \frac{-\rho}{\epsilon_0}$ (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 $H = 0.2z^2ax$ 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 $n_1 = 50, n_2 = 80$, $R_1 = 2\text{cm}$ & $R_2 = 3\text{cm}$. (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)