Subject: ELECTROMAGNETICS & RADIATION SYSTEMS

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

DECEMBER 2010

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 half an hour 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 electric field strength $\vec{E}$ from potential V is defined as

(A) $\vec{E} = -\nabla V$ **(B)** $\vec{E} = \nabla \times \vec{B}$

(C) $\vec{E} = \nabla \bullet V$ **(D)** $E = \rho V$

b. The power density is defined mathematically as

(A) $p = \frac{Pt}{4\pi r^2}$ **(B)** $\frac{Pt}{4\pi r^3}$

(C) $\frac{Pt}{4\pi}$ **(D)** $\frac{Pt}{r}$

c. The expression for equation of continuity is

(A) $\nabla \cdot \vec{J} = -\frac{\partial \rho V}{\partial t}$ **(B)** $\nabla \cdot \vec{J} = \frac{\partial \rho V}{\partial t}$

(C) $\nabla \cdot \vec{J} = -\frac{\partial \vec{B}}{\partial t}$ **(D)** $\nabla \cdot \vec{J} = 0$

d. The ground wave attenuates as one moves away from the transmitter, because of

(A) Interference from the sky wave **(B)** Loss of line of sight
(C) Single hop distance limitation **(D)** Wave tilt

e. Which of the antennas are wide band

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

f. The standard reference antenna for directive gain is

(A) infinitesimal dipole **(B)** isotropic antenna
(C) Doublet **(D)** $\lambda/2$ antenna

g. When a microwave signal follows the curvature of the earth this is known as

(A) Faraday effect **(B)** Troposcatter
(C) Ducting **(D)** Ionospheric reflection

h. For an antenna operating at f = 50 MHz the wave length of the operation is

(A) 600 mtr **(B)** $\frac{3\times10^8}{f}$ mtr
(C) 10 mtr **(D)** 100 mtr

i. A helical antenna is used for satellite tracking because of its

(A) Circular polarization **(B)** Manoeuvrability
(C) Broadband width **(D)** Good front to back ratio

j. As an electromagnetic wave travels in free space, only one out of these can happen

(A) Absorption **(B)** Attenuation
(C) Refraction **(D)** Reflection

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

Q.2 a. Derive Integral and differential form of Maxwell's first equation as applied to the electrostatic. **(8)**

b. The 50 cm length of co-axial cable has an inner radius of 1 mm and an outer radius of 4 mm. The space between the conductors is filled with air. The total charge on the inner conductor is 30 nano coulomb. Find the charge on each conductor, $\vec{E}$ and $\vec{D}$ fields. **(8)**

Q.3 a. Obtain Poisson's equation, from point form of Gauss's law and obtain Laplace's equation in Cartesian coordinates. **(8)**

b. State and explain BIOT-Savart's law and explain concisely the vector form of the law. **(8)**

Q.4 a. Define what is an electromagnetic boundary. State and prove the magnetic boundary conditions. **(8)**

b. Calculate the self inductance and mutual inductance between two co-solenoids of radii R_1, and $R_2\{R_2 > R_1\}$, carrying currents I_1 and I_2 wi N_1 and N_2 turns/mt, respectively. **(8)**

Q.5 a. Write down Maxwell's equations in point differential form and explain their significance. **(8)**

b. Write short notes on:
(i) Retarded potentials (ii) Displacement current **(4×2 = 8)**

Q.6 a. Apply Ampere's circuital law to obtain the expression for magnetic field in all the regions if cylindrical conductor carries a direct current 'I' and its radius is 'R' mts. **(8)**

b. The wet marshy soil is characterized by conductivity $\sigma = 10^{-2}$ mhos/mt relative permittivity $\in_r = 15$ and relative permeability $\mu_r = 1$, At frequencies 60Hz, 1MHz, 100 MHz and 10 GHz, indicate whether soil be considered a conductor or a dielectric. **(8)**

Q.7 a. Obtain an equation of transmission coefficient for vertical polarization in case of wave oblique incidence on a dielectric interface. **(10)**

b. Find the reflection and transmission coefficients at the boundary for normal incidence at an angle of incidence 10°. For region 1, $\in_{r_1} = 8.5, \mu_{r1} = 1$ and $\sigma_1 = 0$, and the region 2 is a free space. **(6)**

Q.8 a. Explain the following terms:
(i) Antenna gain and effective radiated power.
(ii) Antenna losses and efficiency. **(5+5=10)**

b. Determine the length an antenna operating at a frequency of 500 KHz. Take velocity factor $V_f = 0.95$. **(6)**

Q.9 a. Explain what are non-resonant antennas. Write and explain their radiation patterns. **(6)**

b. Explain, in detail, the propagation of ground waves. **(5)**

c. Explain with sketches the sky wave propagation. **(5)**