Code: AE14 **Subject: ELECTROMAGNETICS AND RADIATION**
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 best alternative in the following: (2x10)

a. The surface charge density at the surface of a sphere of 2.5 m radius is 94.2 pc/m^2. The electric flux density at the surface of the sphere will be

(A) 0 **(B)** 94.2 pc/ m^2
(C) 4.8 pc/ m^2 **(D)** 30 pc/ m^2

b. Two identical coaxial circular coil carry the same current I but in opposite direction. The magnitude of the magnetic field $\vec{B}$ at a point on the axis midway between the coil is

(A) zero
(B) the same as that produced by one coil
(C) twice that produced by one coil
(D) half that produced by one coil

c. One of the following equations is not Maxwell's equation for a static electromagnetic field in a linear homogeneous medium

(A) $\overline{\nabla}.\vec{B} = 0$ **(B)** $\overline{\nabla}.\vec{D} = \rho_v$
(C) $\overline{\nabla} X \overline{E} = 0$ **(D)** $\nabla^2 \vec{A} = \mu_o \vec{J}$

d. What is/are the major factor/s for determining whether a medium is dielectric or good conductor?

(A) attenuation constant **(B)** constitutive parameters(σ, ε, μ)
(C) loss tangent **(D)** reflection coefficient

e. A transmission line of characteristic impedance 50 ohm is terminated in a load of j100 ohm. The VSWR on the line is

(A) 1 **(B)** 2
(C) ∞ **(D)** none of the above

f. The lowest order TM mode in rectangular wave guide of cross sectional dimension $a \times 0.5a$ is

(A) TM_{01} **(B)** TM_{11}
(C) TM_{10} **(D)** TM_{20}

g. Which term is the radiation term?

(A) $\frac{1}{r} term$ **(B)** $\frac{1}{r^2} term$
(C) $\frac{1}{r^3} term$ **(D)** all of the above

h. The critical frequency of an ionospheric layer depends upon

(A) only height
(B) only electron density
(C) both height & electron density & nothing else
(D) height, electron density & angle of incidence

i. What is the unit of magnetic charge?

(A) ampere-meter square **(B)** coulombs
(C) amperes **(D)** ampere-meter

j. The property of a material which opposes the production of magnetic flux in it, is known as

(A) permittivity **(B)** permeance
(C) reluctance **(D)** mmf

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

Q.2 a. Find the force on a 100μC charge at (0, 0, 3) m if four like charges of 20μC are located on the x & y axes at $\pm$4m. **(8)**

b. Explain Gauss's law with appropriate equation. Also give its modified version. **(6)**

c. Determine the capacitance of a parallel plate capacitor composed of tin-foil sheets of $20cm^2$,separated by a 0.6 cm thick glass dielectric of relative permittivity 6. **(2)**

Q.3 a. Write Biot-Savart's law to find magnetic flux density due to a current element. Also explain Ampere's law for current element**.** **(6)**

b. Develop an expression for the magnetic field at any point on the line through the centre, at a distance 'h' from the centre & perpendicular to the plane of a circular loop of radius 'a' & carrying current I. **(10)**

Q.4 a. Write Maxwell's equations in point form & integral form for static field, with the related law. Also give the equation of continuity for steady current. **(7)**

b. Write and derive Stoke's and Diveregence theorem. **(9)**

Q.5 a. The magnetic field intensity of a uniform plane wave in air is 20A/m in y direction. The wave is propagating in z direction at a frequency of 2×10^9 rad/sec. **(5)**

Find : (i) frequency in Hz.
(ii) period
(iii) wavelength
(iv) amplitude of electric field intensity
(v) direction of $\overline{E}$

b. The material parameters of a certain food item are given by $\sigma = 2.17 S/m$, $\varepsilon = 47\varepsilon_\circ$, and $\mu = \mu_\circ$ at the operating frequency f = 2.45 GHz of a microwave oven. Find the propagation parameters $\alpha, \beta, \lambda, v_p$ & $\overline{\eta}$. **(8)**

c. Define three types of Polarization of waves. **(3)**

Q.6 a. Discuss two applications of properties of the input impedance of a short circuited line. **(12)**

b. Explain the block diagram of a time-domain reflectometer to locate discontinuities in transmission line system. **(4)**

Q.7 a. What do you understand by rectangular cavity resonator? **(9)**
Derive the expression for the frequencies of oscillation for it.

b. A hollow rectangular wave-guide has inner dimension of 8cm×4cm. Find the cut-off frequency in TE_{10}, TE_{01} & TE_{11} mode. Why TE_{10} modes is dominant mode. **(7)**

Q.8 a. Discuss the principal of a broadband array using as an example of the log periodic dipole array**.** **(6)**

b. Derive the equation of effective area for Hertzian dipole. **(10)**

Q.9 Write notes on **(16)**

(i) Maximum usable frequency & optimum frequency of a layer.
(ii) Voltage Standing Wave Ratio (VSWR) and reflection coefficient