Code: AE14 **Subject: ELECTROMAGNETICS AND RADIATION**
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. By saying that the electrostatic field is conservative, we do not mean that

(A) It is gradient of a scalar potential.
(B) The work done in a closed path inside the field is zero.
(C) Its curl is identically zero.
(D) The potential difference between any two points is zero.

b. One of the following is not the a source of magnetic fields

(A) A dc current in a wire.
(B) A permanent magnet.
(C) An accelerated charge.
(D) An electric field linearly changing with time.

c. Maxwell's divergence equation for the magnetic field is given by

(A) $\overline{\nabla}\times\overline{B}=0$ **(B)** $\overline{\nabla}.\overline{B}=0$
(C) $\overline{\nabla}\times\overline{B}=\rho$ **(D)** $\overline{\nabla}.\overline{B}=\rho$

d. The electric and magnetic fields of an electromagnetic wave are related to one another by

(A) They move in the same speed in the same direction.
(B) They are always perpendicular to one another.
(C) They are both perpendicular to the direction of propagation.
(D) All of the above.

e. A 50 Ω lossless transmission line is terminated in 100 Ω load and excited by a 30 MHz source of internal resistance of 50 Ω. What should be the length of the transmission line for maximum power transfer

(A) 5.0 m **(B)** 1.25 m
(C) 2.5 m **(D)** 10.0 m

f. In which one of the following modes, transmission will be supported by a rectangular wave guide?

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

g. An antenna located in a city is a source of radio waves. How much time does it take the wave to reach a town 12,000 Km away from the city?

(A) 36s **(B)** 20 μs
(C) 20ms **(D)** 40ms

h. In Sky wave propagation, sky distance is used

(A) so as not to exceed the critical frequency.
(B) to avoid the Faraday effect.
(C) to prevent sky wave & upper ray interference.
(D) to obey tilting.

i. Magnetic flux density at a point distance R due to an infinitely long linear conductor carrying a current I^* is given by

(A) $B = \frac{I}{2\mu\pi R}$ **(B)** $\mathrm{B} = \frac{\mu \mathrm{I}}{2\mathrm{R}}$
(C) $B = \frac{\mu I}{2\pi R}$ **(D)** $B = \frac{\mu I}{2\pi R^2}$

j. Which of the following is scalar quantity?

(A) Electric field strength **(B)** Electric potential
(C) Electric displacement density **(D)** Force

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

Q.2 a. Define Electric field intensity at a point. Show & explain the variation of field with respect to distance. **(4)**

b. Two point charges Q_1=50 μC at (-1, 1, -3) m and Q_2=10μC at (3, 1, 0) Find the force on Q_1 due to Q_2 **(6)**

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

Q.3 a. Write both differential and integral form of Maxwell's equations in matter, as well as in free space. Mention clearly the notations used in the equations. **(8)**

b. Write Boundary conditions for electric and magnetic field in mathematical form & also write the related statements. **(8)**

Q.4 a. Write & explain: **(8)**
(i) Faraday's law.
(ii) Ampere's circuital law

b. (i) Explain conduction current $\overline{J}$ & its relation with $\overline{E}$ **(8)**
(ii) Explain concept of displacement current in magnetic field due to time varying electric field

Q.5 a. Explain Poynting vector related to electrical power transmission. Derive the equation for Poynting's theorem. & give the physical significance of the related terms. **(12)**

b. Define skin depth with respect to a good conductor. **(4)**

Q.6 a. For transmission line with reactive & non-linear resistive element, derive the expression for voltage across the inductor & total current through the inductor. Also show these variations graphically. **(11)**

b. What do you understand by SWR? Write the interpretation for SWR = 1 & SWR = ∞ . **(5)**

Q.7 a. What are the transmission modes that are possible at an operating frequency of 8GHz in a hollow rectangular wave guide of inner dimensions 4cm $\times$ 5cm. Find phase velocity, group velocity, cut-off wavelength & characteristic impedance for the dominant mode. **(10)**

b. Define Polarization of waves and explain the three types of polarizations. **(6)**

Q.8 a. Show that the radiation resistance of the Hertzian dipole for free space is given by **(10)**

$$R_{rad} = 80\pi^2 (\frac{dl}{\lambda})^2 \Omega$$

b. A linear array of four isotropic antennas spaced apart $\lambda/2$ are fed in phase. Obtain the resultant pattern by using pattern multiplication technique. **(6)**

Q.9 a. Define critical frequency for reflection of wave by the ionosphere. Show how it is dependent on the maximum ionization density for any given layer. **(10)**

b. What are the possible propagation paths, when the energy radiated from the transmitting antenna may reach the receiving antenna? **(6)**