Code: AE14 **Subject: ELECTROMAGNETICS AND RADIATION**
Time: 3 Hours **Max. Marks: 100**

DECEMBER 2007

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.**
- **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. Lorentz force law is

(A) $\vec{F} = Q\vec{E}$ **(B)** $\vec{F} = \vec{V} * \vec{B}$
(C) $\vec{F} = Q(\vec{E} + \vec{V} * \vec{B})$ **(D)** $\vec{F} = Q(\vec{V} * \vec{B})$

b. The equation $\nabla \times \vec{E} = \frac{-\partial \vec{B}}{\partial t}$ is the generalization of

(A) Amperes Law **(B)** Faraday Law
(C) Gauss's Law **(D)** Biot-Saverts Law

c. For a transmission line terminated by a load, the reflection co-efficient magnitude $|\Gamma|$ and the voltage standing wave ration S are related as:

(A) $S = 1/(1+|\Gamma|)$ **(B)** $S = 1/(1-|\Gamma|)$
(C) $S = (1-|\Gamma|)/(1+|\Gamma|)$ **(D)** $S = (1+|\Gamma|)/(1-|\Gamma|)$

d. Unit of relative permeability is

(A) Henry **(B)** Henry/meter
(C) Henry/meter^2 **(D)** It is dimensionless

e. Reciprocal of reluctance is

(A) Henry/meter **(B)** Henry
(C) meter/Henry **(D)** Henry^{-1}

f. Which of the following conditions will not guarantee a distortionless transmission line?

(A) R = 0, G = 0
(B) RC = GL.
(D) Very low frequency range (R >> ωL, G >> ωC)
(E) Very high frequency range (R << ωL, G << ωC).

g. For a rectangular wave guide, 2.5cm x 1.2cm, dominant cut off wavelength is

(A) 5 cm **(B)** 2.5 cm
(C) 2.4 cm **(D)** 3.7 cm

h. For a line of characteristic impedance, Z_0 terminated in a load Z_R such that $Z_R = Z_0/3$, the reflection coefficient is

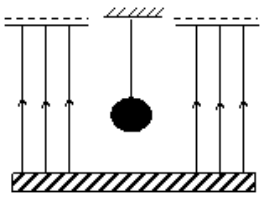
(A) $\frac{1}{3}$ **(B)** $\frac{2}{3}$

(C) $-\frac{1}{3}$ **(D)** $-\frac{1}{2}$

i. Plane z=10m carries charge 20nC/m^2. The electric field intensity at the origin is

(A) $-10\hat{i}_z$ v/m **(B)** $-18\pi\hat{i}_z$ v/m

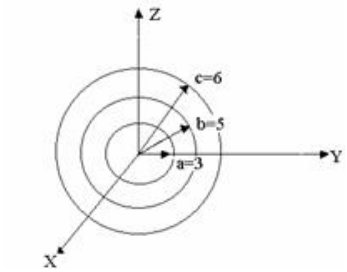
(C) $-72\pi\hat{i}_z$ v/m **(D)** $-360\pi\hat{i}_z$ v/m



j. A positive charged pendulum is oscillating in a uniform electric field (Fig. 1). Its time period as compared to that when it was unchanged

(A) will increase
(B) will decrease
(C) will not change
(D) will first increase and then decrease

Answer any [illegible] **stions.**
E



Q.2 a. What is Gauss law? How gauss law is ap[illegible] charge. **(4)**

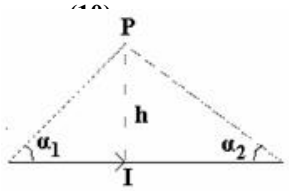
b. The spherical region $0 \le r \le 3$ [illegible] nsity of $\rho_v = 2\ C/m^3$ and $\rho_v = 1\ C/m^3$ fo[illegible] $3 \le r \le 6$. Use law to find $-r$ for

(i) $r \le 3$
(ii) $3 \le r \le 5$
(iii) $5 \le r \le 6$
(iv) r>>6 **(8)**

c. Write Laplaces equation in Cartesian, Cylindrical, Spherical coordinates. **(4)**

Q.3 a. Define Biot Savert law. Calculate the magnetic field of line current along a thin straight wire of infinite length. **(6)**

b. Find the magnetic flux density and field intensity at a point P due to a straight conductor carrying a current I as **(10)**



Q.4 a. Derive the wave equation using Maxwell Equation. **(8)**

b. Given that $E = 50\pi e^{j(\omega t-\beta z)}(u_x)$

$H = H_m e^{j(\omega t-\beta z)}(u_y)$ in free space where $\omega = 10^9$.

Evaluate H_m and β $(\beta > 0)$ **(8)**

Q.5 a. State poynting Theorem considering a closed surface. **(4)**

b. Show that E and H fields constitute a wave travelling in Z-direction. Verify that the wave speed and E/H depend only on the properties of free space. **(8)**

c. Define polarization of waves, linear polarization, elliptical polarization, circular polarization. **(4)**

Q.6 a. Discuss the slotted line technique for performing standing wave measurement on a line and the determination of unknown load impedance from the standing wave measurement. **(8)**

b. Find the characteristic impedance of lossless transmission line having R=5Ω, L=40H and C=10F having frequency of 10Hz. **(4)**

c. What is standing wave ratio? Calculate reflection coefficient having SWR of 1.5. **(4)**

Q.7 a. Define cut-off wavelength for a rectangular wave guide. A rectangular wave guide measures 3 x 4.5 cm internally and has a 10GHz signal propagated in it. Calculate the cut-off wavelength, the guide wavelength and characteristic wave impedance for TE_{10} mode. **(8)**

b. The dimensions of a rectangular cavity resonator with air dielectric are $a = 4$ cm, $b = 2$ cm, and $d = 4$cm. It is desired to determine the three lowest frequencies of oscillation for modes TE_{101}, TE_{011}, TE_{111}, transverse with respect to the z-direction, for each frequency. **(8)**

Q.8 a. Explain Hertizan dipole. Show time variation of current and charge in Hertizan dipole. **(8)**

b. Define radiation resistance and directivity. Calculate the radiation resistance of an antenna having wavelength $\lambda = 5$ and length 25cm. **(8)**

Q.9 Write short notes

(i) Space wave propagation
(ii) Skip distance
(iii) Ground wave propagation
(iv) Antenna Array **(16)**