[This question paper contains 4 printed pages.]

1018 *Your Roll No.* .....

B.Sc. (Hons.) / III **C**

ELECTRONICS – Paper 3.4 (XVIII)

(Electromagnetism and Antennas)

Time : 3 Hours *Maximum Marks : 38*

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt **five** *questions in all, including Question No.* **1** *is compulsory and carries* **10 (ten)** *marks. Rest of questions are of* **seven** *marks each. Use of scientific calculator is permitted.*

1. Attempt any **five** :–

   (a) What do you mean by the intrinsic impedance of a medium ? Give the expression for the same in free space.

   (b) Write the expression for Poynting theorem and discuss physical meaning of each term of the expression.

   (c) A K-band rectangular waveguide with dimensions 1.067 cm and 0.4372 cm operates in the dominant mode at 18 GHz. Find the cut-off frequency considering the medium within the waveguide to be freespace.

P.T.O.

(d) What is Brewster's angle ?

(e) Briefly explain what is meant by the method of electrical images in electrostatics.

(f) What do you understand by retarded current ?

(2×5=10)

2. (a) Show that the electric and magnetic field vectors of a plane wave propagating in a non-conducting isotropic medium are transverse in nature, moving perpendicular with respect to each other along the direction of propagation. Also, show that these field vectors are in phase.

(b) Given $\vec{E} = E_0 \sin(\omega t - kz)\hat{j}$ in a non-conducting isotropic medium. Write expression for $\vec{D}$, $\vec{B}$, $\vec{H}$.

(5,2)

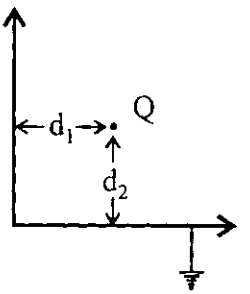
3. (a) Derive Fresnel's equations for reflection and refractions of plane electromagnetic wave at an interface between two dielectric media when electric field is normal to the plane of incidence.

(b) Potential or the surface of a hollow sphere a radius R is $V_0(\theta)$. Find the potential inside the sphere. What will be the potential if $V_0(\theta) = K \sin^2\left(\frac{\theta}{2}\right)$ where k is a constant.

(4,3)

4. (a) Using Maxwell's equations, show the formation of spherical and elliptical wavefronts in a non-conducting anisotropic medium which has different refractive index along one of the principal axes ($n_x = n_y \neq n_z$).

(b) A positive point charge Q is located at distances d_1 and d_2 respectively from two grounded perpendicular conducting plates as shown in the Figure.



Determine the force on 'Q caused by the charges induced on the plates. (4,3)

5. (a) Derive expressions for the various components of electric and magnetic fields for TM mode of electromagnetic wave propagating in a rectangular waveguide made up of perfectly conducting walls.

(b) Consider a hypothetical situations where the skin depth in a given metal for a wave transmitted along the waveguide is 6 μm. If two waveguides of this material having thicknesses (a) 4 μm (b) 10 μm are available, which one would you prefer & why ? (6,1)

P.T.O.

6. (a) Derive an expression for refractive index of the ionosphere and explain based on the expression how this layer is transparent for some frequencies while it reflects others.

(b) Describe ground wave propagation. What is the angle of tilt ? How does it affect the field strength at a distance from the transmitter ? (4,3)

7. (a) What is a Hertzian dipole ? Derive the far field expressions of electric and magnetic field due to Hertzian dipole.

(b) A magnetic field strength of 5 μA/m is required at a point or $\theta = \pi/2$, which is 2 km from an antenna in air. Neglecting the ohmic losses, how much power must the Hertzian dipole of length '$\lambda/25$' transmit ? (4,3)

Physical constants :

$\epsilon_0 = 8.85 \times 10^{-12}$ F/m

$\mu_0 = 4\pi \times 10^{-7}$ H/m

$c = 3 \times 10^8$ m/s