B.E. (ETC) Part-II 4th Semester Examination, 2010

Electromagnetic Theory and Radio Wave Propagation (ET-404)

Time : 3 **hours** **Full Marks** : 70

Answer O.No, 1 and any FOUR from the rest

1. Choose ihe correct answer(s) (any sfcven) 2x7 - i **J**

(a) D-layer exists
(i) during day time, (ii) during night time, (iii) round the clock, (iv) none of these.

(b) Maxwell's equations are

(i) $V.£ = p/*$, (H) $Vj = \wedge_{i}'$ (iii) $Vxf = \sim$, (iv) $Vx£ = -\wedge$ dt dt dt

(c) The permittivity of free space is

fi) 8.85x10⁻°° F/m, (ii) 471X10"' F/m, (iii) $\frac{}{471x10}$ F/m (iv) $\frac{}{36rcxl0}$ F/m

(J) An electron with velocity v is injected into a uniform field *B*. The force on it is
(i) perpendicular to the direction of motion of the electron,
(ii) perpendicular to the direction of magnetic field,
(iii) perpendicular to both *the* direction of motion of the electron and of the magnetic field.
(iv) none of these.

(e) The dimensions of potential are same as that of
(i) work, (ii) electric field per unit charge, (iii) work per unit charge (iv) force per unit charge.

(0 Velocity of plane electromagnetic wave in vacuum if given by:

(i) $C = 7/4,\wedge 0 \cdot 00\wedge = 7/\wedge 0.$ (iii) $C = l/V/V\wedge$. (iv) none of these,

(g) $J = aE$ is
(i) Maxwell's equation, (ii) continuity equation, (iii) Ohms' law, (iv) Ampere's law

(h) When the distance between two equal charges is decreased to half and their magnitude of charge also decreased to half, the force between them
(i) remains unchanged, (ii) reduces to half, (iii) becomes double, (iv) becomes four times.

2. (a) By using Lorentz force law explain both physically and mathematically how a semiconductor can be recognized as n-type and p-type

(b) Straight from the Maxwell's equations derive the differential and integral forms of Poynting theorem. Interpret each term of this theorem. What is the Poynting vector? What is its importance? 7+7=14

(a) What are the different modes of propagating radio waves? Give a pictorial representation. Specify the frequency of operation for each of the modes.

(b) With the help of a neat diagram and explanation derive an expression giving the horizon distance in terms of the antenna height and the modified earth radius for space wave propagation.

(c) What are the factors influencing the magnitude of the space wave?

(d) Two aircrafts are Hying at altitudes of 3000m and 5000m respectively. What is the maximum possible distance over which they can have point to point microwave communication? Calculate this with and without incorporating the change in refractive index in space. Radius of earth = 6.37×10^{6} m. 4+4+2+4=14

(a) Give the statement and the proof of the electric boundary condition involving normal component of displacement density vector. What would be the statement of this boundary condition when one of the two media is a metal conductor?

(b) Illustrate the depth of penetration. Show from the general expression for y that in a good conductor the skin depth is

$$\delta \cong \sqrt{\frac{2}{\omega\mu\sigma}}$$

The symbols have their usual significance.

(c) Calculate the depth of penetration of a 2 MHz wave into copper which has a conductivity c - 5.8×10^{7} mhos per meter and a permeability approximately equal to that of free space.

5+5+4=14

(a) What is the difference between induced electric field and field due to static charges?

(b) Write the time-harmonic Maxwell's equations in (i) differential and (ii) integral forms (indicating vector sign).

(c) Expand the two Maxwell's curl equations into component fields for a uniform plane wave propagating in the z-direction. Derive from it the relation between E_y and H, in terms of intrinsic impedance of the medium. (Assume $E_y = f(z - v_0 t)$, where $v_0 = 1 / \sqrt{\mu\varepsilon}$)

2+5+7=14

(a) Consider two concentric spherical metallic shells having radii $r\backslash$ and n {r2>r\) with charge $q\backslash$ and qi uniformly distributed, respectively. By using the Gauss's law first find the expression for the electric field E and then the potential V at any point (i) outside the outer shell, (ii) between the two shells and (iii) inside the inner shell.

Plot the variations against radial distance.

(b) Using Gauss's theorem, calculate the electric field intensity £ at a point (i) outside the sphere, (ii) on the surface, (iii) inside the sphere due to a charge uniformly distributed within a sphere.

Sketch the variation of electric field as a function of radial distance. 8+6=14

7. (a) Derive the Poisson's equation.

(b) State the physical and mathematical reasoning of generation of emf including sign in a wire when it moves across a magnetic field. Draw the necessary diagram in this respect.

Will the Lena's law be violated in this case? Justify your answer.

(c) Describe the principle of AC generator when a rectangular loop rotates with a uniform angular velocity in a steady magnetic field. 3+6+5 = 14

8. (a) What are the sources of magnetostatic field? Give at least five applications of electrostatics.

(b) Prove by using Biot-Savart law that the magnetic field at a point *P* near a finite linear conductor carrying current / (Fig.8b) is given by

S*2

$$Z? = — (c o s 0_{i} - \cos 8_{2})$$

What is the direction of this *B* ? Explain the right hand rule and right-handed screw rule in determining this direction.

R T P

Fig.8(b)

(c) Diagrammaticaliy explain the force of attraction or repulsion between two parallel wires carrying the current in the same direction. (Use of mathematics is restricted). . 4+6+4=14