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Subject :- Introduction to field waves and antennas

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Q1:- Answer the following short questions briefly each equestion carries equal marks:-

1:- ~~Answer~~:- write down the maxwell's equations?
maxwell's equation comprise the fundamental tenets of electromagnetic theory Explain:-

Answer:- Maxwell's equations are set of four differential equations that form the theoretical basis for describing classical electromagnetism.

:- maxwell demonstrated that electric and magnetic fields travel through space as a waves moving at the speed of light.

2 part:- Explain the coulumbs law? Also state it with the help of expression?

Ans:- The coulumb's law state the magnitude of The electrostatic force of attraction or repulsion between two points charges is directly proportional to the product of magnitude of charges and

- inversely proportional to the sequre of the distance between them.

Coulomb's law formula

$$F = \frac{1}{4\pi\varepsilon_0 \varepsilon_r} \cdot \frac{q_1 q_2}{d^2} = \frac{1}{4\pi\varepsilon_0 k} \cdot \frac{q_1 q_2}{d^2}$$

$$F = \frac{1}{4\pi\varepsilon} \cdot \frac{q_1 q_2}{d^2}$$

P3:- What is different b/w convection and conduction currents?

Ans <u>Convection current:</u>

Convection occurs in fluids by mass motion of molecules in the same direction. in convection the heat energy is transmitted by way of intermediate medium.

- <u>Conduction current:</u>

conduction usually occurs in solid, through molecular collision. The Transfer of heat is through heated solid substance. in conduction

P4:- State the principles of linear Superposition as its applies to the electric field due to a distribution of electric charge?

Answer:- The principles of superposition states that every charge in space creates an electric field at point independent of the presence of other charges in that medium. The resultant electric field is a vector sum of the electric field due to individual charges.

P5:- What is Biot-stavart law? state it with expression?

Ans:- Biot stavart states that it is a mathematical expression which illustrates the magnetic field produced by stable electric current in the particular electromagnetism of physics it tells the magnetic field toward the magnitude length, direction as well as closeness of the electric current.

Expression For Biot-Savart law.

$B = \oint dB\sin\theta$

$= \oint \frac{\mu_0}{4\pi}\left[\frac{Idl}{r^2+a^2}\right]\frac{a}{\sqrt{r^2+a^2}}$

$[\because \sin\phi = \frac{a}{\sqrt{r^2+a^2}}$ in $\Delta PLM]$

$= \frac{\mu_0 Ia}{4\pi(r^2+a^2)^{\frac{3}{2}}}\oint dl$

$B = \frac{\mu_0}{4\pi}\frac{Ia}{(r^2+a^2)^{\frac{3}{2}}}(2\pi a)$

Question 9a ::

a 2mm diameter copper wrie ----------

------------------------- Free electrons

Ans (a) $P_{ve} = \frac{\sigma}{\mu_e} = \frac{5.8\times10^{7}}{0.0032} = -1.81\times10^{10}(C/m^3)$

(b) $J = \sigma E = 5.8\times10^7 \times 20\times10^{-3} = 1.16\times10^6 (A/m^2)$

(c) $I = JA = 1.16\times10^6\left(\frac{\pi\times4\times10^{-6}}{4}\right) = 3.64\ A$

(d) $U_e = \mu_e E = -0.0032\times20\times10^{-3} = 6.4\times10^{-5}\ m/s$

(e) $N_e = \frac{P_{we}}{e} = \frac{1.81\times10^{10}}{1.6\times10^{-19}} = 1.13\times10^{29}$ electrons/m^3

Question 2 part b: The x-y plane is a charge free ----
------------------- ε1 and ε2.

Answer: we know that $E_{1t} = E_{2t}$ for any 2 media. Hence $E_{1t} = E_{2t} = x3 - y2$

Also $(D_1 - D_2)\cdot\hat{n} = \rho_s$ (~~From~~ Hence

$$E_{1z} = \frac{\rho_s + \varepsilon_2 E_2}{\varepsilon_1} = \frac{3.54\times10^{-11}}{2\varepsilon_0} + \frac{18(2)}{2} = -$$

$$\frac{3.54\times10^{-11}}{2\times8.85\times10^{-12}} + 18 = 20 \ (V/m)$$

Hence $E_1 = x3 - y2 + z20 \ (V/m)$ Finding the angle E_2 makes with z-axis

$E_2 \cdot z = |E_2| \cos\theta$, $2 = \sqrt{9+4+4}\cos\theta$, $\theta = \cos^{-1}\left(\frac{2}{\sqrt{17}}\right)$

$= 61^\circ$ Answer.

Question 3a: The semi-circular conductor - - - - - - - - - -

- - - - - - - - - - - - - - - - cured section :-

Answer: The Force on the straight portion of the wire has the following magnitude because $L = 2R$ and the wire is perpendicular to $\bar{B}$

$$F_1 = ILB = \boxed{I\,2RB}$$

$$dF_2 = I(ds \times B) = IB\sin\theta\, ds$$

$$dF_2 = IRB\sin\theta\, d\theta$$

$$F_2 = IRB\int_0^{\pi} \sin\theta\, d\theta = IRB(-\cos\theta)\Big|_0^{\pi} = IRB(\cos\pi - \cos 0)$$

$$F_2 = IRB(-1-1)$$

$$F_2 = 2IBR$$

$$|\vec{F}_{net}| = |\vec{F}_1 + \vec{F}_2| = \boxed{4IRB}$$

Question 3 part b

A Free standing linear conductor of length .... x, y plane:

Answer:

From Fig 5-10 the differential length vector $dl = \hat{z} dz$. Hence $dl \times \hat{R} = dz(\hat{z} \times R) = \hat{\phi}\, \sin\theta\, dz$ where $\hat{\phi}$ is the azimuth direction and θ is the angle between dl and $\hat{R}$

$$B = \mu_0 H = \hat{\phi} \frac{\mu_0 I l}{2\pi r \sqrt{4r^2 + l^2}} \ (T)$$

Q4a: Explain the Faraday's law? Also Explain in brief its differential and integral forms:

Answer: Faraday's law:

Faraday's law states that the absolute value or magnitude of the circulation of the electric field E around a closed loop is loop is equal to the rate of change of the magnetic flux through the area enclosed by the loop. The equation below expresses Farday's law

Differential and integral form of Faraday's law

- The magnetic flux is $\Phi_B = \int_S B \cdot d\vec{A}$ where $\vec{A}$ is a vector area over a closed surfaces S. A device that can maintain a potential difference, despite the flow of current is a source of electromotive force (EMF). The difination is mathematically $E = \oint_L \vec{E} \cdot d\vec{s}$ is known as differential where integral is evaluated over a closed loop L.

Q4b:- Determine voltage V1 - - - - - - - - - -
- - - - - - - - - - - - - - may be ignored.

Answer The Flux flowing through the loop is

$$\Phi = \int_S B \cdot ds = \int_S (-\hat{z}0.3t) \cdot \hat{z} ds$$

$$= -0.3t \times 4 = -1.2t \quad (Wb).$$

$$V_{emf}^{tr} = \frac{d\Phi}{dt} = 1.2 \quad (V).$$

$$I = \frac{V_{emf}^{tr}}{R_1 + R_2}$$

$$= \frac{1.2}{2+4} = 0.2A$$

$$V_1 = IR_1 = 0.2 \times 2 = 0.4V \quad = \boxed{V_2 = IR_2 = 0.2 \times 4 = 0.8V}$$