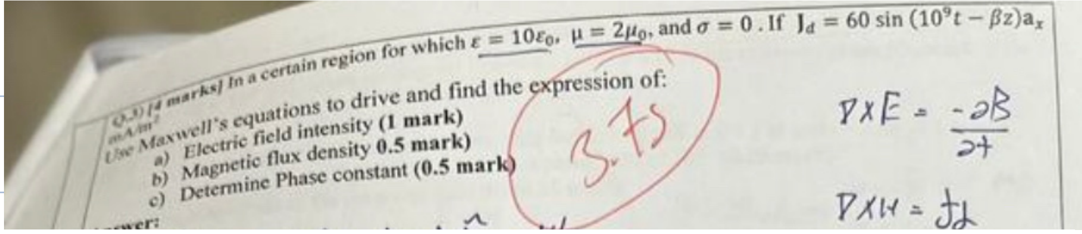

Q3) [4 marks] In a certain region for which $\varepsilon = 10\varepsilon_0$, $\mu = 2\mu_0$, and $\sigma = 0$. If $J_d = 60 \sin(10^9 t - \beta z)a_x$ mA/m²

Use Maxwell's equations to drive and find the expression of:

a) Electric field intensity (1 mark)

b) Magnetic flux density 0.5 mark)

c) Determine Phase constant (0.5 mark)

Answer:

3.75

$\nabla \times E = -\frac{\partial B}{\partial t}$

$\nabla \times H = J_d$

Q25. In a certain region for which $\varepsilon = 10\varepsilon_0$, $\mu = 2\mu_0$, and $\sigma = 0$. If $\mathbf{J}_d = 60 \sin(10^9 t - \beta z)\mathbf{a}_x$ mA/m²

Use Maxwell's equations to find:

a) Electric field intensity $\to \vec{E}$

b) Magnetic flux density H

c) Determine Phase constant $\to \beta$

Answer:

$J_d = 60 \sin(10^9 t - \beta z)\hat{a}_x$

c ln 9

$\beta = \omega\sqrt{\mu\varepsilon}$

$\alpha = 0$

$\mu = 2\mu_0$

$\varepsilon = 10\varepsilon_0$

$\boxed{\beta = 14,917}$

a) $\frac{\partial D}{\partial t} = J_d$

$$\vec{D} = \frac{-60}{10^9}\cos(10^9 t - \beta z)\hat{a}_x$$

$$\vec{E} = \frac{\vec{D}}{\varepsilon} = \frac{-60}{10^9(10\varepsilon_0)}\cos(10^9 t - \beta z)\hat{a}_x \text{ mV/m}$$

b) $\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$

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$$\nabla \times \vec{E} = \boxed{-}\frac{\partial B}{\partial t} = \frac{-60\beta}{10^9 \varepsilon}\sin(10^9 t - \beta z)\hat{a}_y$$

$10\varepsilon_0$

$$\vec{B} = \frac{-60\beta}{(10^9)^2 \varepsilon}\cos(10^9 t - \beta z)\hat{a}_y$$

$$\vec{H} = \frac{-60\beta}{(10^9)^2 \varepsilon \mu}\cos(10^9 t - \beta z)\hat{a}_y \text{ mA/m}$$

Q15. The figure shows a 10 turn square loop centered at the origin and having 20 cm sides oriented parallel to the x- and y- axis

a) Determine V_{emf} where the loop is located in the x-y plane, the magnetic flux density is $\mathbf{B} = \mathbf{a}_z 0.3t$ Wb/m², the internal resistance of the wire can be ignored.

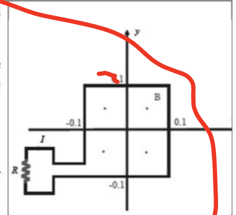
Answer:

V_{emf} =____________________

b) Find the current I and its direction (clockwise or counterclockwise) if R =1K Ohms.

I =____________________

Direction of I ____________________



Explanation (Steps to find the answers):

Q14. The figure shows a 10 turn square loop centered at the origin and having 20 cm sides oriented parallel to the x- and y- axis

a) Determine V_{emf} where the loop is located in the x-y plane, the magnetic flux density is $\mathbf{B} = \mathbf{a}_z 0.3t$ Wb/m², the internal resistance of the wire can be ignored.

Answer:

V_{emf} =____________________

b) Find the current I and its direction (clockwise or counterclockwise) if R =1K Ohms.

I =____________________

Direction of I ____________________

Explanation (Steps to find the answers):

$N = 10 \quad , \quad \vec{B} = 0{,}3t \ \hat{a}_z$

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i) $V_{emf} = -N \dfrac{\partial \phi}{\partial t}$

$$\phi = \int \vec{B} \cdot ds = \int_{-0{,}1}^{0{,}1}\int_{-0{,}1}^{0{,}1} 0{,}3t \ dx\,dy$$

$$V_{emf} = -(10)(0{,}04)(0{,}3)$$

$$= 0{,}12 \ V$$

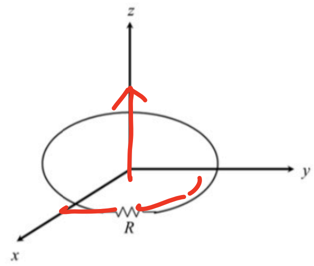
ii) $I = \dfrac{V_{emf}}{R}$

$$I = \frac{0{,}12}{1k} = 0{,}12 \ mA$$

direction of I clockwise

Q22. A circuit conducting loop lies in the xy-plane as shown the Figure. The loop has the radius of 0.2 m and resistance $R = 4$ Ohms. If $\mathbf{B} = 40 \sin 10^4 t\ \mathbf{a}_z$ mWb/m^2, find the current and its direction (draw it on the figure).

$N=1$



Answer:

Explanation (Steps to find the answers):

ridius = 0,2 , $R = 4\ \Omega$

$\vec{B} = 40 \sin 10^4 t\ \hat{a}_z$

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so $N = 1$

$$V = -N \frac{\partial \phi}{\partial t}$$

$$\phi = \int \vec{B} \cdot ds$$

$\boxed{* \ S = \pi (0,2)^2}$

$$= \vec{B} \cdot S$$

$$\phi = (40 \sin 10^4 t)(\pi\, 0,2^2)$$

اشتق بالنسبة ل t

$$V = (-1) \left[40 * 10^4 \cos(10^4 t)\ (\pi\, 0,2^2) \right] \text{ mV}$$

$$V = 16\pi \cos(10^4 t)$$

$$I = \frac{V}{R} = \frac{-40 * 10^4 * \pi * 0,2^2 \cos(10^4 t)}{4}$$

$$I = \frac{16\pi \cos(10^4 t)}{4}, \quad I = 4\pi \cos(10^4 t) \text{ A}$$

The ϕ $\hat{a}_z$ direction Then I will be clock wise by RHL

Q16. A 125-turn rectangular coil of wire with sides of 250 mm and 400 mm rotates about a horizontal axis in a vertical magnetic field of magnitude 0.0035 Wb/m^2. How fast must this coil rotate in r/s for the induced emf to reach a maximum of 1 Volts? What is the frequency in Hz?

(i) Answer:

The angular velocity is ________________ r/s

(ii) Frequency:

f = ____________ Hz

Explanation (Steps to find the answers):

$\vec{B} = 35\times10^{-4}$ wb/m^2 , $N = 125$

$V_{emf} = 1$

S (Area) = 250mm x 400 mm

= 0,1 m

$\phi = \vec{B} \cdot S$

$V_{emf} = -N \dfrac{\partial \phi}{\partial t}$

$1 = 125 \left(\dfrac{35\times10^{-4} \times 0{,}1}{t} \right)$

$t = 0{,}04383$

$f = \dfrac{1}{t} = 22{,}857$ Hz

Q24. For a source-free region ($\mathbf{J} = 0, \rho_v = 0, \varepsilon = \varepsilon_0$, and $\mu = \mu_0$) show that the fields

$\mathbf{E} = E_0 \cos x \cos t\, \mathbf{a}_y$ and $\mathbf{H} = \frac{E_0}{\mu_0} \sin x \sin t\, \mathbf{a}_z$

do not satisfy all of Maxwell's equations.

Answer:

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a) $\nabla \cdot \vec{D} = \rho_v$

b) $\nabla \cdot \vec{B} = 0$ Maxwell equation

c) $\nabla \times \vec{E} = -\frac{\partial B}{\partial t}$

d) $\nabla \times \vec{B} = J + \frac{\partial D}{\partial t}$

$$\nabla \times \vec{E} = E_0 \sin x \cos t\ \hat{a_z} \quad (1)$$

$$\frac{\partial B}{\partial t} = \frac{E_0}{\mu_0} \sin x \cos t\ \hat{a_z} \quad (2)$$

$$-E_0 \sin x \cos t\ \hat{a_z} \neq \frac{-E_0}{\mu_0} \sin x \cos t\ \hat{a_z}$$

$$\therefore \quad \nabla \times \vec{E} \neq -\frac{\partial B}{\partial t}$$

Then $\vec{E}$ and $\vec{H}$ does not satisfy maxwell equation.

c) $\boxed{Q_3, Q_{25}}$

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c)

$$\boxed{\nabla \times \vec{H} = J_d}$$

$$\nabla \times \vec{H} = \frac{60\,\beta^2}{(10^9)^2 \varepsilon \mu} \sin(10^9 t - \beta z)\, a_x = J_d$$

$$J_d = 60 \sin(10^9 t - \beta z)\, a_x$$

$$\frac{60\,\beta^2}{(10^9)^2 \varepsilon \mu} \cancel{\sin(10^9 t - \beta z)} = 60 \cancel{\sin(10^9 t - \beta z)}$$

$$\frac{60\,\beta^2}{(10^9)^2 \varepsilon \mu} = 60$$

$$\beta = 14{,}9z$$

$\omega\sqrt{\mu\varepsilon}$

$$\boxed{= 14{,}91}$$