1

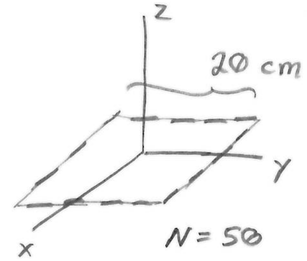
$$I = \frac{1}{R} V_{emf} = \frac{-1}{R} \frac{\partial}{\partial t} \iint \vec{B} \cdot d\vec{s}$$

$$= \frac{-1}{4} \frac{\partial}{\partial t} \left[40 \sin 10^4 t \right] \left[\pi (.2)^2 \right] \times 10^{-3}$$

$$= \frac{-40 \cdot \pi \cdot (.2)^2}{4} 10^4 \cos(10^4 t) \times 10^{-3}$$

$$\approx \boxed{-12.6 \cos(10^4 t) \ \text{A}}$$

2



$$\vec{B} = 2\cos(y)\cos(10^3 t)\ \hat{z}$$

$$\Psi = \iint \vec{B}\cdot d\vec{s} \qquad d\vec{s} = \hat{z}\,dx\,dy$$

$$= \int_{-.1}^{+.1}\int_{-.1}^{+.1} 2\cos(y)\cos 10^3 t \;\; dx\,dy$$

$$= 2(.2)\cos 10^3 t \cdot \int_{-.1}^{+.1} \cos(y)\,dy$$

$$= 0.4\cos(10^3 t)\cdot\Big[\sin(y)\Big]_{-.1}^{.1}$$

$$= 0.08\cos(10^3 t)$$

$$V = -N\frac{\partial\Psi}{\partial t} = -50\cdot\frac{\partial}{\partial t}\Big[.08\cos 10^3 t\Big]$$

$$= +(4)(10^3)\sin(10^3 t)$$

$$= \boxed{4\sin(10^3 t)\quad kV}$$

3

$$\vec{J}_{conduction} = \sigma \vec{E}$$

$$\vec{J}_{displacement} = \frac{\partial \vec{D}}{\partial t} = j\omega \vec{D}$$

$$= j\omega\varepsilon \vec{E}$$

$$\left| \frac{\vec{J}_c}{J_d} \right| = \frac{\sigma \vec{E}}{\omega \varepsilon \vec{E}} = \frac{\sigma}{\omega \varepsilon}$$

(a)

$$\frac{2 \times 10^{-3}}{(2\pi)(10^9)(81)(8.854 \times 10^{-12})} \approx \boxed{4.4 \times 10^{-4}}$$

(b)

$$\frac{25}{(2\pi)(10^9)(81)(8.854 \times 10^{-12})} \approx \boxed{5.5}$$

(c)

$$\frac{2 \times 10^{-4}}{(2\pi)(10^9)(5)(8.854 \times 10^{-12})} \approx \boxed{7.2 \times 10^{-4}}$$

4

$$\nabla \times \vec{E} = \frac{-\partial B}{\partial t} \Rightarrow \nabla \times \tilde{E} = -j\omega \vec{B}$$

$$\nabla \times \vec{H} = \frac{\partial \vec{D}}{\partial t} \Rightarrow \nabla \times \tilde{H} = +j\omega \vec{D}$$

$$\vec{B} = \frac{\nabla \times \tilde{E}}{-j\omega} = +\frac{j}{\omega} \nabla \times \tilde{E} = \frac{j}{\omega \varepsilon} \nabla \times \tilde{D}$$

$$\vec{D} = D_o \cos(\omega t + kz)\,\hat{y}$$

$$\tilde{D} = D_o e^{jkz}\,\hat{y}$$

$$\nabla \times \vec{D} = \begin{vmatrix} \hat{x} & \hat{y} & \hat{z} \\ \partial/\partial x & \partial/\partial y & \partial/\partial z \\ \emptyset & D_o e^{jkz} & \emptyset \end{vmatrix}$$

$$= \frac{-\partial}{\partial z}\left[D_o e^{jkz} \right] \hat{x} = -jk D_o e^{kz}\,\hat{x}$$

$$\tilde{B} = \frac{j}{\omega \varepsilon}\left[-jk D_o e^{kz} \right] \hat{x} = \frac{k}{\omega \varepsilon} D_o e^{kz}\,\hat{x}$$

$$= \boxed{\frac{k}{\omega \varepsilon_o} D_o \cos(\omega t + kz)\,\hat{x} \quad (\mathrm{wb}/m^2)}$$

5

$$\Psi = l w B_o \cos(2\pi \cdot f \cdot t)$$

$$V_{emf} = \frac{-\partial}{\partial t} \Psi$$

$$= +2\pi f \cdot l \cdot w \cdot B_o \cdot \sin(2\pi f \cdot t)$$

$$I = \frac{1}{R}(2\pi f)(l)(w)(B_o) \sin(2\pi f \cdot t)$$

$$I_{max} = \frac{(2\pi)(f)(l)(w)(B_o)}{R}$$

$$= (2\pi)(3000/60)(.02)(.03)(75)/2$$

$$\approx \boxed{7.1 \text{ mA}}$$