$$I_d = J_d A = \frac{dD(A)}{dt} = -\frac{\varepsilon A}{d} V_o \omega \sin \omega t$$

$$= \frac{4 \times 8.854 \times 10^{-12} \times 10 \times 10^{-4}}{1 \times 10^{-2}} \times 20 \times 2\pi \times 10^{6} \sin \omega t$$

$$= -445 \sin(2\pi \times 10^{6} t) \ \mu A$$

2. $$\Psi_m = \int B \cdot ds = 50 \times 10^{-3} \hat{a}_y \cdot 2 \times 3 \times 10^{-4} \cos\theta \ \hat{a}_y$$

$$= 3 \times 10^{-5} \cos\theta$$

$$\theta = \omega t = \frac{2\pi \times 6 \times 10^{3}}{60} t = 200\pi t \quad \text{rad/sec.}$$

$$\Psi_m = 3 \times 10^{-3} \cos(200\pi t) \ \text{Wb.}$$

$$EMF = -\frac{d\Psi_m}{dt} = 3 \times 10^{-5} \times 200\pi \sin 200\pi t$$

$$= 18.85 \times 10^{-3} \sin(200\pi t)$$

3. $\mathcal{E}MF = -N \frac{d}{dt} \iint B \cdot ds = -N \frac{d}{dt} \int_{-0.125}^{0.125} \int_{-0.125}^{0.125} B \cdot \hat{a}_z \, dx dy$

ⓐ $\mathcal{E}MF = -100 \frac{d}{dt}(10e^{-2t})(0.25)^2 = 125e^{-2t} V$

ⓑ $\mathcal{E}MF = -100 \frac{d}{dt}(10\cos 10^3 t \int_{-.125}^{.125} \cos x \, dx \int_{-.125}^{.125} dy$

$= 62.3 \sin 10^3 t$ KV

ⓒ $\mathcal{E}MF = -100 \frac{d}{dt}(10 \cos 10^3 t \int_{-.125}^{.125} \cos x dx \int_{-.125}^{.125} \sin 2y \, dy = 0$

a) $\psi_m = \int B \cdot dS = \int_a^b \frac{\mu I}{2\pi r} \cdot c\, dr = \frac{\mu c I}{2\pi} \ln b/a$

$$\mathcal{E}mF = -N \frac{d\psi_m}{dt} = -\frac{\mu c N}{2\pi} \ln\frac{b}{a}\frac{dI}{dt}$$

$$= \frac{\mu c N \omega I_0}{2\pi} \ln\left(\frac{b}{a}\right) \sin \omega t \quad V$$

$$V = \frac{4000 \times 4\pi \times 10^{-7}}{2\pi} \times 2 \times 10^{-2} \times 100 \times 2\pi \times 60 \times 50 \ln 6/5 \sin \omega t$$

$$= 5.5 \sin 377t \quad V$$

6 $\mathcal{E}MF = -N \frac{d\Psi_m}{dt} = -A \frac{d}{dt} B_0 \cos(\omega t + \theta_0) N$

$= A B_0 \underbrace{\sin(\omega t + \theta_0)}_{1 \text{ (for peak)}} \omega$

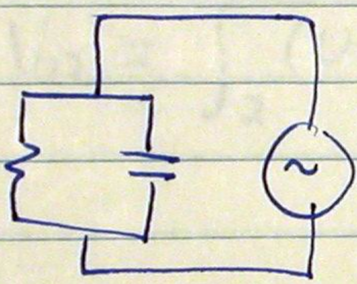
$20 \times 10^{-3} = 10^{-2} \times B_0 \times 6\pi \times 10^8$

$B_0 = 1.06 \times 10^{-9}$ T

7. a) $R = \dfrac{d}{\sigma A}$, $I_c = \dfrac{V}{R} = \dfrac{V\sigma A}{d}$, $J_c = \dfrac{V\sigma}{d}$

b) $E = \dfrac{V}{d}$, $I_d = \dfrac{\partial D}{\partial t}A = \epsilon A \dfrac{\partial E}{dt} = \dfrac{\varepsilon A}{d}\dfrac{dV}{dt}$, $J_d = \dfrac{\epsilon}{d}\dfrac{dV}{dt}$

c)



d) $R = \dfrac{0.5 \times 10^{-2}}{2.5 \times 2 \times 10^{-4}} = 10\,\Omega$

$C = \dfrac{4 \times 8.85 \times 10^{-12} \times 2 \times 10^{-4}}{0.5 \times 10^{-2}} = 1.42 \times 10^{-12}\,F$

$$U = r\omega$$

$$\omega = \frac{2\pi \times 180}{60} = 6\pi \text{ rad/sec.}$$

$$V_{12} = \int_2^1 (U \times B) \cdot dl = \int_{0.5}^{0} (6\pi r \hat{a}_\phi \times 3 \times 10^{-4} \hat{a}_z) \cdot dr\, \hat{a}_r$$

$$= 18\pi \times 10^{-4} \int_{0.5}^{0} r\,dr$$

$$= -9\pi \times 10^{-4} \times 0.25 = -707\,\mu V$$

$$B = \frac{\mu_0 I}{2\pi r}\,\hat{a}_\phi$$

$$\psi_m = \int B \cdot ds = \int_5^{15} -\frac{\mu_0 I}{2\pi y}\,\hat{a}_x \cdot -\hat{a}_x \; 10(\text{cm})\,dy$$

$$= \frac{\mu_0 I \times 10^{-1}}{2\pi}\ln\frac{15}{5}$$

$$= \frac{4\pi \times 10^{-7} \times 2.5\cos(2\pi \times 10^4 t) \times 10^{-1}}{2\pi} * 1.1$$

$$= .55 \times 10^{-7}\cos(2\pi \times 10^4 t)\ \text{Wb}$$

$$\text{EMF} = -\frac{d\psi_m}{dt} = 0.55 \times 2\pi \times 10^4 \sin(2\pi \times 10^4 t) \times 10^{-7}$$

$$= 3.45 \times 10^{-3}\sin(2\pi \times 10^4 t)\ \text{V}$$

$$J_d = \epsilon \frac{d}{dt} E = j\omega\epsilon E$$

$$J_c = \sigma E$$

$$\left| \frac{J_c}{J_d} \right| = \frac{\sigma}{\omega\epsilon}$$

a) 1 kHz $\quad \dfrac{4}{2\pi \times 10^3 \times 81 \times 8.854 \times 10^{-12}} = 888 \times 10^3$

b) 1 MHz $\quad \Rightarrow 888$

c) 1 GHz $\quad \Rightarrow 0.888$

d) 100 GHz $\quad \Rightarrow 8.88 \times 10^{-3}$