Problem Solution #7

Problem 1

$V = V_0 \sin \omega t = 120\sqrt{2}\sin(2\pi \times 60t)$ $\quad B = B_0 \cos \omega t = 1.8\cos(2\pi \times 60t)$

$V = -N\dfrac{d\Phi}{dt} = -N\dfrac{dB}{dt}S = NSB_0\omega \sin \omega t$ $\quad$ So $\quad N = \dfrac{120\sqrt{2}}{6\times10^{-4}\times1.8\times2\pi\times60} \approx 417(turns)$

Problem 2

$\vec{E} = \dfrac{Q}{2\pi\varepsilon r}\hat{r}$ $\quad V = \dfrac{Q}{2\pi\varepsilon}\ln(\dfrac{b}{a}),$ $\quad$ So $\quad E = \dfrac{V}{r\ln(b/a)} = \dfrac{100\cos(12\pi\times10^6 t)}{r\ln(4/2)}$

$\vec{D} = \varepsilon\vec{E} = \varepsilon_0\varepsilon_r\vec{E}$

$$I_d = \frac{d\vec{D}}{dt}\cdot\vec{A} = 8.85\times10^{-12}\times3.7\times\frac{-100\times12\pi\times10^6\sin(12\pi\times10^6 t)}{r\ln(4/2)}\hat{r}\cdot2\pi r\hat{r}$$

$$= 2\pi\times8.85\times10^{-12}\times3.7\times\frac{-100\times12\pi\times10^6\sin(12\pi\times10^6 t)}{\ln(4/2)} \approx -1119\sin(12\pi\times10^6 t) \text{ mA}$$

$I_c = I_d \Rightarrow \dfrac{\sigma}{\omega\varepsilon} = 1 \Rightarrow \sigma \approx 1.23\times10^{-3}(S/m)$

Problem 3

Lossless Medium:

$\beta = \omega\sqrt{\mu\varepsilon} = 2\pi f\sqrt{\mu_0\varepsilon_r\varepsilon_0} \approx 53.5(rad/m)$ $\quad u = \omega/\beta = c/\sqrt{\varepsilon_r} \approx 1.76\times10^8(m/s)$

$\lambda = 2\pi/\beta \approx 0.117(m)$ $\quad \eta = \sqrt{\dfrac{\mu}{\varepsilon}} \approx 221(\Omega)$

Problem 4

Linear polarization (K>0, in-phase; K<0, out-phase)