Unit 27 – Homework Solution

33 – 9

$$u^{mag} = u^{elec} \Rightarrow \frac{1}{2}\frac{B^2}{\mu_0} = \frac{1}{2}\epsilon_0 E^2$$

$$\Rightarrow E = \frac{1}{\sqrt{\epsilon_0 \mu_0}} B = 3\times10^8 \times 0.50 = 1.50\times10^8 \ (V/m)$$

33 – 12

a) $$B = \frac{\mu_0 I}{2R} = \frac{4\pi\times10^{-7}\times 100}{2\times 0.05} = 4\pi\times10^{-4} \ \text{T}$$

b) $$u^{mag} = \frac{1}{2}\mu_0^{-1}B^2 = \frac{1}{2}\times\frac{1}{4\pi\times10^{-7}}\times(4\pi\times10^{-4})^2 = 2\pi\times10^{-1} \ \text{J}$$

$$= 0.2\pi \ (\text{J})$$

33 – 47

$$\mathcal{E} = \mathcal{E}^{max}\sin(\omega t - \frac{\pi}{4}) = 30\sin(350t - \frac{\pi}{4})$$

$$i(t) = (620 \text{ mA})\sin(\omega t - \frac{3\pi}{4}) = (620 \text{ mA})\sin(350t - \frac{3\pi}{4})$$

a) $$\mathcal{E} = \mathcal{E}^{max} \Rightarrow \sin(\omega t - \frac{\pi}{4}) = 1 \Rightarrow \omega t - \frac{\pi}{4} = \frac{\pi}{2}$$

$$\Rightarrow \omega t = \frac{3\pi}{4} \Rightarrow t = \frac{3\pi}{4\omega} = \frac{3\pi}{4\times350} = 6.73\times10^{-3} \ (s) = 0.00673$$

b) $$I = I^{max} \Rightarrow \sin(\omega t - \frac{3\pi}{4}) = 1 \Rightarrow \omega t - \frac{3\pi}{4} = \frac{\pi}{2}$$

$$\Rightarrow t = \frac{1}{\omega}\frac{5\pi}{4} = \frac{1}{350}\frac{5\pi}{4} = 0.011 \ s$$

c) From parts (a) anb (b), you can see that I becomes maximum later than $\mathcal{E}$. In other words, $\mathcal{E}$ leads I. This happens when you have an inductor.

d) $I^{max} = \dfrac{\mathcal{E}^{max}}{X_L} = \dfrac{\mathcal{E}^{max}}{L\omega} \Rightarrow 0.620 = \dfrac{30.0}{L(350)}$

$\Rightarrow L = 0.138\ H = 138\ mH$

33 - 50

a) $R = 200\,\Omega$, $C = 15.0\,\mu F$, $f = 60.0\,Hz$, $\mathcal{E}^{max} = 36.0\,V$

$$Z = \sqrt{R^2 + X_c^2} = \sqrt{R^2 + \left(\frac{1}{C\omega}\right)^2} = \sqrt{200^2 + \left(\frac{1}{15\times10^{-6}\times2\pi\times60}\right)^2} = 267\,\Omega$$

$$\tan\phi = \frac{-X_c}{R} = -\frac{1}{C\omega R} = -\frac{1}{15\times10^{-6}\times2\pi\times60\times200} \Rightarrow \phi = -41.5^\circ = 0.724\ (rad)$$

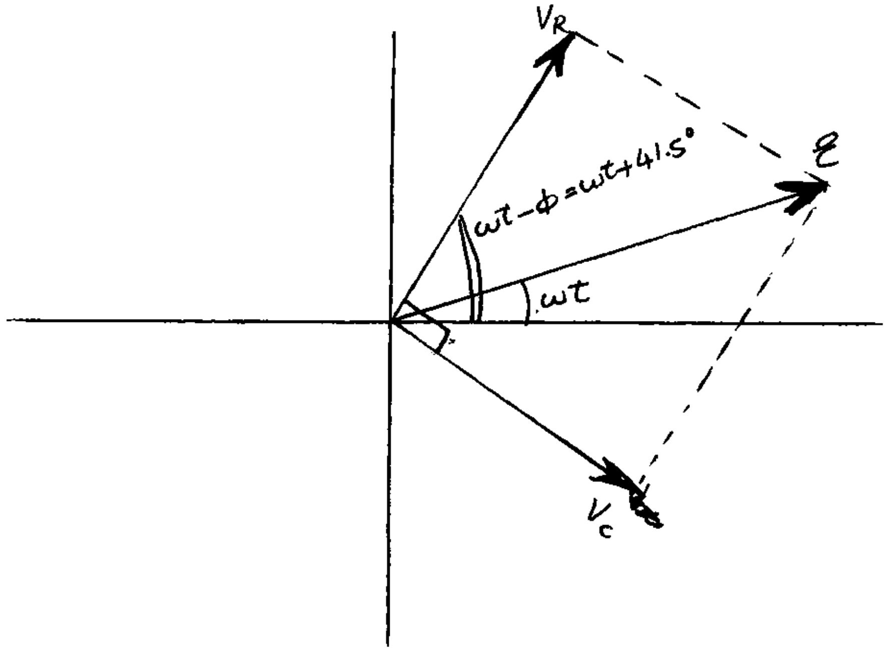
$$I = I^{max}\sin(\omega t - \phi) = \frac{\mathcal{E}^{max}}{Z}\sin(\omega t - \phi)$$

$$I = \frac{36}{267}\sin(2\pi\times60t + 0.724) = (0.135A)\sin(120\pi t + 0.724)$$

b) $V_R^{max} = R I^{max} = 200\times0.135 = 27\,V$

$V_c^{max} = X_c I^{max} = 177\times0.135 = 23.9\ V$

{1 cm = 6 V}



33 - 56

a) $X_c = \frac{1}{C\omega} = \frac{1}{C2\pi f} = \frac{1}{(24\times10^{-6})(2\pi\times400)} = 16.6\,\Omega$

b) $Z = \sqrt{R^2 + (X_L - X_c^2)}$

$X_L = L(2\pi f) = (150\times10^{-3})\times 2\pi\times 400 = 377\,\Omega$

$\Rightarrow Z = \sqrt{220^2 + (377 - 16.6)^2} = 422\,\Omega$

c) $I^{max} = \frac{\mathcal{E}^{max}}{Z} = \frac{220}{422} = 0.521\ A$

d) $C_{eq} < C_1 \Rightarrow X_c' > X_{c1}$ X_c increases.

$C_{eq} = \frac{1}{2}C \Rightarrow X_c' = 2X_{c1}$

e)

$Z' = \sqrt{R^2 + (\underset{377}{X_L} - \underbrace{2X_c}_{23.2})^2} < Z$ Z decreases.

f) I increases because impedance (Z) decreases.