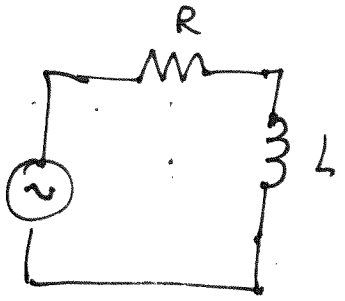
Ch. 15 Prob. 26



$V(t) = V_0 \cos \omega t$

$V_0 = 120\,V$

$\omega = 120\pi\ rad/s$

$R = 400\,\Omega$

$L = 1.5\,H$

a) What is the impedance of the circuit?

$$X_L = \omega L = \left(120\pi \frac{rad}{s}\right)(1.5\,H) = \boxed{565\,\Omega}$$

$$Z = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{(400)^2 + (565 - 0)^2}$$

$$\boxed{Z = 692\,\Omega}$$

b) What is the amplitude of the current

$$I_0 = \frac{V_0}{Z} = \frac{120\,V}{692\,\Omega} = \boxed{0.173\,A}$$

c) Write an expression for the current through the resistor

$$\phi = \tan^{-1}\left(\frac{X_L - X_C}{R}\right) = \tan^{-1}\left(\frac{565 - 0}{400}\right) = +0.955\ rad$$

$$\boxed{i(t) = (0.173\,A)\cos(120\pi \cdot t - 0.955)}$$

d) Write voltage across the resistor and the inductor

$$V_R = i \cdot R = (0.173A)\cos(120\pi \cdot t - 0.955)(400\,\Omega)$$

$$\boxed{V_R = (69.2\,V)\cos(120\pi t - 0.955)}$$

Voltage leads current by $\pi/2$ in the inductor so $\phi = \frac{\pi}{2} - 0.955 = 0.616\,rad$

$$V_L = i \cdot X_L = (0.173A)\cos(120\pi t - 0.955)(565)$$

$$\boxed{V_L = (97.7\,V)\cos(120\pi t + 0.616)}$$