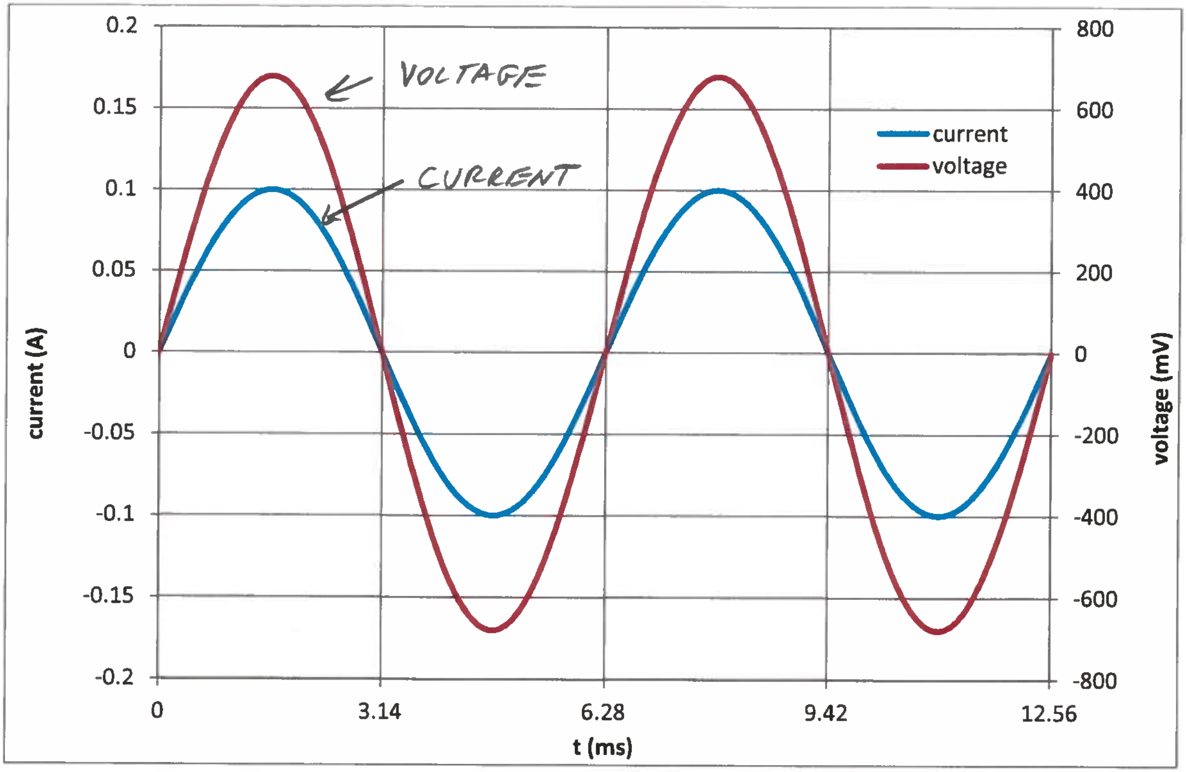
P14 – 5) The current through a 6.8 kΩ resistor is as indicated. Find the sinusoidal expression for the voltage. In addition, sketch the v and i sinusoidal waveforms on the same axis.

a. $i = 0.1 \sin(1000\,t)$ $v = \boxed{680 \sin(1000\,t)}$



7/24

P14-6

DETERMINE X_L (IN OHMS) FOR $L = 2mH$ +
$f =$

a) DC

b) 60 HZ

c) 4 kHZ

d) 1.2 MHZ

$X_L = 2\pi f L$

a) DC , $f = 0$ $\therefore$ $\boxed{X_L = 0\,\Omega}$ s/c

b) $f = 60\,HZ$, $X_L = 2\pi(60\,HZ)(2\,mH)$
$\boxed{X_L = 0.754\,\Omega}$

c) $f = 4\,kHZ$, $X_L = 2\pi(4000\,HZ)(2\,mH)$
$\boxed{X_L = 50.27\,\Omega}$

d) $f = 1.2\,MHZ$, $X_L = 2\pi(1.2E6\,HZ)(2\,mH)$
$\boxed{X_L = 15{,}080\,\Omega}$

8/24

P14-7

DETERMINE THE CLOSEST STANDARD VALUE INDUCTANCE WITH:

a) $X_L = 2k\Omega$ @ $f = 14.47KHZ$

b) $X_L = 40k\Omega$ @ $f = 5.3KHZ$

$$X_L = 2\pi f L$$

$$\therefore \quad L = \frac{X_L}{2\pi f}$$

a) $$L = \frac{2000\Omega}{2\pi(14.47KHZ)} = 21.998\ mH$$

OR

$$\boxed{22\ mH}$$

b) $$L = \frac{40{,}000\Omega}{2\pi(5.3KHZ)} = 1.201\ H$$

OR

$$\boxed{1.2H}$$

(MULTIPLE ONLINE REFERENCES FOR "STANDARD" INDUCTOR VALUES)

P14-8

DETERMINE THE FREQUENCY FOR WHICH A 47 mH INDUCTOR HAS:

(a) $X_L = 10\Omega$

(b) $X_L = 4k\Omega$

(c) $X_L = 12k\Omega$

$$X_L = 2\pi f L$$

$$\therefore \quad f = \frac{X_L}{2\pi L}$$

(a) $f = \dfrac{10\Omega}{(2\pi)(47mH)} = \boxed{33.86\ Hz}$

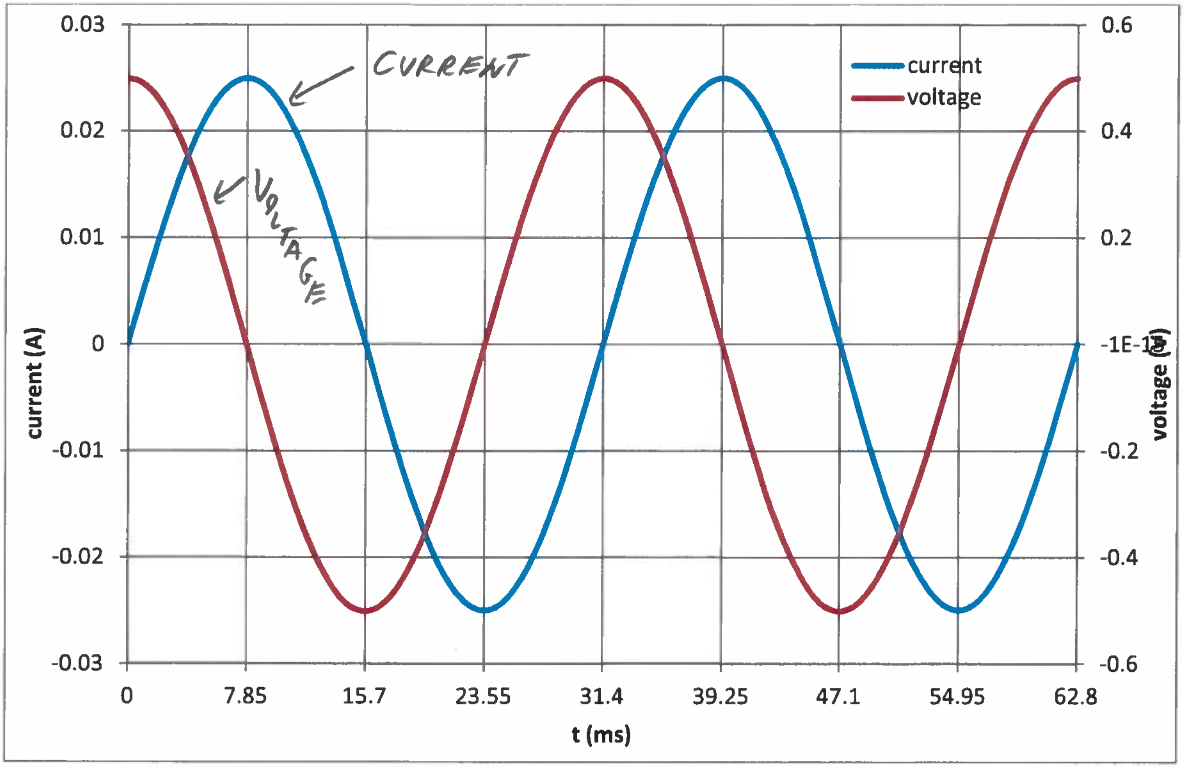
(b) $f = \dfrac{4k\Omega}{(2\pi)(47\ mH)} = \boxed{13,545\ Hz}$

(c) $f = \dfrac{12k\Omega}{(2\pi)(47\ mH)} = \boxed{40,635\ Hz}$

10/24

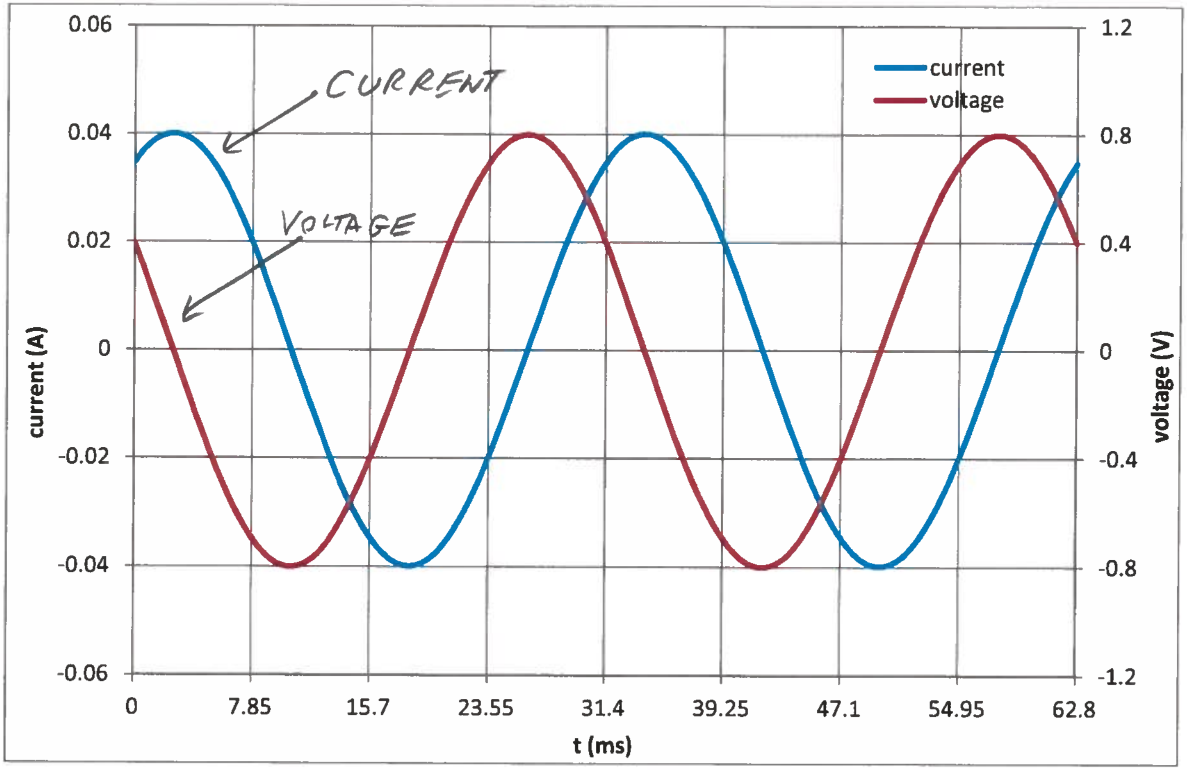
P14–9) The current thorugh a 20 Ω inductive reactance is given. What is the sinusoidal expression for the voltage? Sketch the v and i sinusoidal waveforms on the same axis.

a. $i = 25 * 10^{-3} \sin(200t)$ $v = 0.5 \sin(200t + 90°) = \boxed{0.5 \cos(200t)}$



11/24

(P14-9)
(b.) $i = 40 * 10^{-3} \sin(\omega t + 60°)$ $v = 0.8 \sin(\omega t + 150°) = \boxed{0.8 \cos(\omega t + 60°)}$



12/24

P14-13

FIND X_C, GIVEN $C = 0.2\mu F$ +

(a) $f = 0 Hz$ (DC)

(b) $f = 60 Hz$

(c) $f = 2 kHz$

(d) $f = 2 MHz$

$$X_C = \frac{1}{2\pi f C}$$

$\therefore$ a) $f = 0 Hz$, $X_C = \frac{1}{2\pi(0)(0.2\mu F)} = \boxed{\infty\,\Omega \text{ OR AN O/C}}$

b) $f = 60 Hz$, $X_C = \frac{1}{(2\pi)(60Hz)(0.2\mu F)}$

$= \boxed{13,263\,\Omega}$

c) $f = 2kHz$, $X_C = \frac{1}{(2\pi)(2kHz)(0.2\mu F)}$

$\boxed{X_C = 397.9\,\Omega}$

d) $f = 2MHz$, $X_C = \frac{1}{(2\pi)(2MHz)(0.2\mu F)}$

$\boxed{X_C = 0.398\,\Omega}$

P14-15

DETERMINE THE FREQUENCY AT WHICH A 3.9μF CAPACITOR HAS:

(a) $X_c = 10\Omega$

(b) $X_c = 60k\Omega$

(c) $X_c = 0.1\Omega$

(d) $X_c = 2000\Omega$

$$X_c = \frac{1}{2\pi f C} \quad \therefore \quad f = \frac{1}{(2\pi)(X_c)(C)}$$

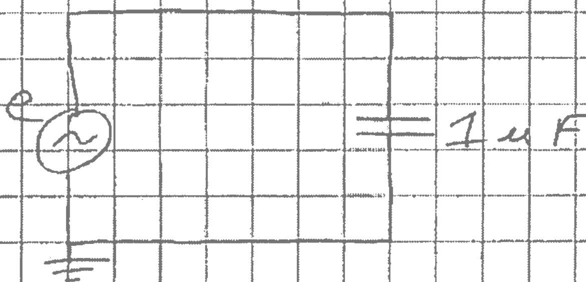
a) $X_c = 10\Omega$, $f = \frac{1}{(2\pi)(10\Omega)(3.9\mu F)} = \boxed{4{,}081\,HZ}$

b) $X_c = 60k\Omega$, $f = \frac{1}{(2\pi)(60k\Omega)(3.9\mu F)} = \boxed{0.680\,HZ}$

c) $X_c = 0.1\Omega$, $f = \frac{1}{(2\pi)(0.1\Omega)(3.9\mu F)} = \boxed{408.1\,KHZ}$

d) $X_c = 2000\Omega$, $f = \frac{1}{(2\pi)(2000\Omega)(3.9\mu F)} = \boxed{20.4\,HZ}$

14-17 The voltage across a 1 uF capacitor is given. What is the sinusoidal expression for the current



(30)
a) $3\cancel{00}$ sin 200t

$$X_C = \frac{1}{\omega C} = \frac{1}{200 \cdot 1\,\mu F} = 5\,k\Omega$$

$$I_M = \frac{V_M}{X_C} = \frac{30\cancel{0}\,V}{5\,k\Omega} = 6.0 \times 10^{-3}\,A$$

i leads v, so $\boxed{i = 6.0 \times 10^{-3} \sin(200t + 90^\circ)}$ A

b) $60 \times 10^{-3} \sin 377t$

$$X_C = \frac{1}{\omega C} = \frac{1}{377 \cdot 1\,\mu F} = 2.653\,k\Omega$$

$$I_M = \frac{V_M}{X_C} = \frac{0.060\,V}{2.653\,k\Omega} = 22.62\,\mu A$$

$\boxed{i = 22.62 \times 10^{-6} \sin(377t + 90^\circ)}$ A

14-19 The current through a 0.56 uF capacitor is given. What is the sinusoidal expression for the voltage

a) $i = 0.20 \sin 300t$

$X_C = \frac{1}{\omega C} = \frac{1}{300 \cdot .56uF} = 5.952 k\Omega$

$V_M = I_M X_C = 0.20 \cdot 5.952k = 1190.48 V$

v lags i, so $\boxed{v = 1190.48 \sin(300t - 90°)}$ ✓

b) $i = 8 \times 10^{-3} \sin(377t - 30°)$

$X_C = \frac{1}{\omega C} = \frac{1}{377 \cdot .56uF} = 4.737 k\Omega$

$V_M = I_M X_C = 8mA \cdot 4.737k = 37.893V$

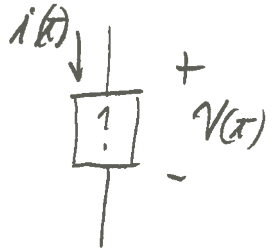
$-30° - 90° = -120°$

$\boxed{v = 37.893 \sin(377t - 120°)}$ ✓

16/24

P14-20a

INDICATE WHETHER THE ELEMENT INVOLVED IS A CAPACITOR, INDUCTOR OR RESISTOR + FIND ITS VALUE IF ENOUGH INFO IS PROVIDED:



$v(t) = 550 \sin(377t + 50°)$

$i(t) = 11 \sin(377t - 40°)$

V LEADS i BY 90° $\therefore$? = $\boxed{\text{INDUCTOR}}$

VALUE : $X_L = 2\pi f L = \omega L$

$\omega = 377$ RAD/SEC

BUT $X_L = \dfrac{V_m}{I_m} = \dfrac{550V}{11A} = 50\Omega$

$\therefore$ WE HAVE : $50\Omega = (377 \text{ RAD/SEC})(L)$

$$\boxed{L = 132.6 \text{ mH}}$$

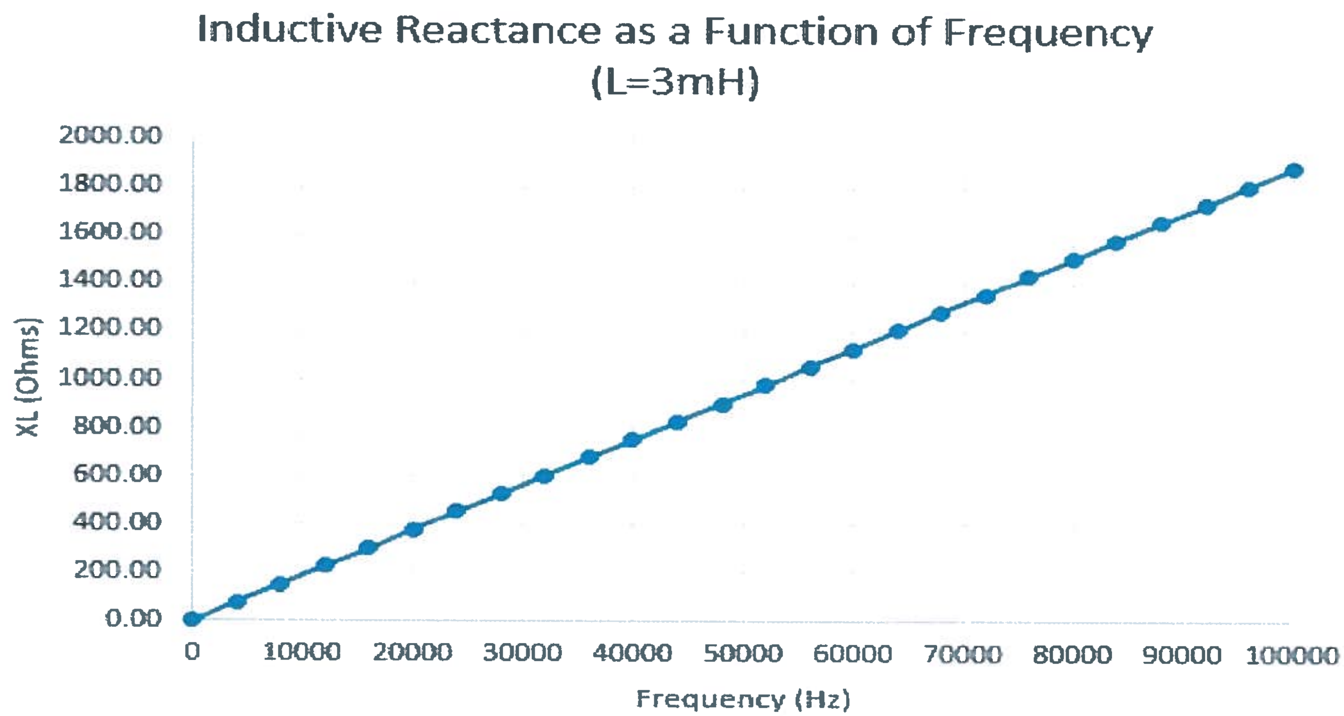
17/24

=2*PI()*C5*D2 ← * NOTE THE FORMULA FOR X_L

C	D	E
L	$\boxed{3.00E-03}$ ← 02	(H)

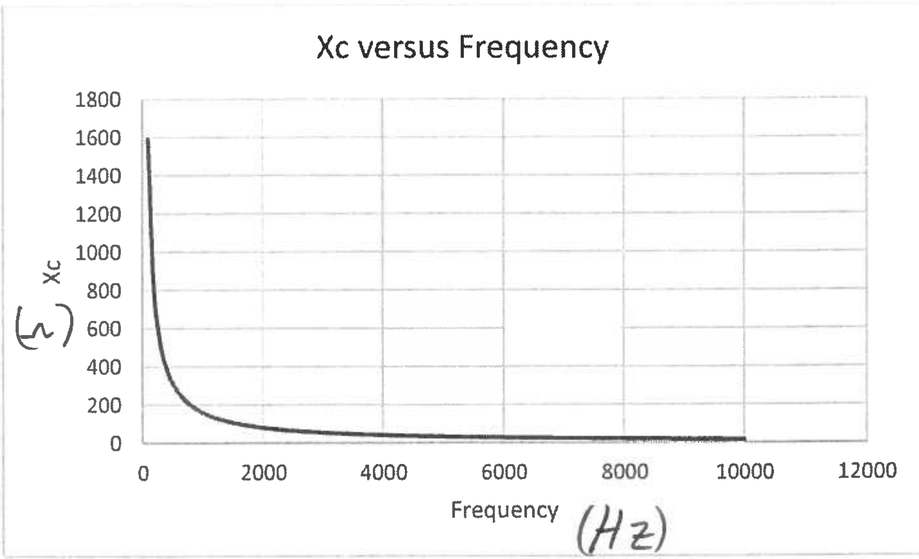
P14-22: Plot XL versus frequency for a 3mH coil using a frequency range of zero to 100kHz on a linear scale

f (Hz) ↓ C5	Xl (Ohms) ← ANS CELL
0	0.00
4000	75.40
8000	150.80
12000	226.19
16000	301.59
20000	376.99
24000	452.39
28000	527.79
32000	603.19
36000	678.58
40000	753.98
44000	829.38
48000	904.78
52000	980.18
56000	1055.58
60000	1130.97
64000	1206.37
68000	1281.77
72000	1357.17
76000	1432.57
80000	1507.96
84000	1583.36
88000	1658.76
92000	1734.16
96000	1809.56
100000	1884.96



18/24

14-23 Plot X_C versus frequency for a 1μF capacitor using a frequency range of zero to 10 kHz on a linear scale.



19/24

P14-25

THE REACTANCE OF A COIL EQUALS THE RESISTANCE OF A $10k\Omega$ RESISTOR AT $f = 5kHz$. DETERMINE THE INDUCTANCE OF THE COIL.

$$X_L = 10k\Omega \ @ \ f = 5kHz$$

BUT $X_L = 2\pi f L$

$$\therefore 10k\Omega = (2\pi)(5kHz)(L)$$

HENCE $\boxed{L = 318.3\,mH}$

P14-27

FIND C SUCH THAT $X_C = X_L$ FOR $L = 2mH$ & $f = 50kHz$

$$X_C = \frac{1}{2\pi f C}$$

$$X_L = 2\pi f L$$

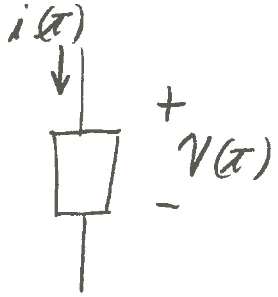
EQUATING @ 50kHZ W/ $L = 2mH$:

$$\frac{1}{(2\pi)(50kHz)(C)} = 2\pi(50kHz)(2mH)$$

YIELDS $\boxed{C = 5.07nF}$

P14-28 (a+b)

FIND THE AVERAGE POWER LOSS + POWER FACTOR FOR EACH CIRCUIT WITH:



(a) $v(t) = 60 \sin(\omega t + 30°)$ V

$i(t) = 15 \sin(\omega t + 60°)$ A

(b) $v(t) = -50 \sin(\omega t - 20°)$ V

$i(t) = -2 \sin(\omega t - 20°)$ A

$$P_{AVE} = \frac{V_m I_m}{2} \cos(\theta), \quad \theta = \theta_v - \theta_i$$

$$PF = \cos\theta$$

a) $P_{AVE} = \frac{(60V)(15A)}{2} \cos(30° - 60°)$

$$\boxed{P_{AVE} = 389.7W}$$

$PF = \cos(-30°) = \boxed{0.866}$

b) $P_{AVE} = \frac{(50V)(2A)}{2} \cos(-20° - (-20°))$

$$\boxed{P_{AVE} = 50W}$$

$PF = \cos(0°) = \boxed{1}$

21/24

14-29 If the current through and the voltage across an element are $i = 8\sin(\omega t + 40°)$ and $v = 48\sin(\omega t + 40°)$, compute the power by I^2R, $(V_M I_M/2)\cos\theta$, and $VI\cos\theta$, and compare answers.

$$R = \frac{V_M}{I_M} = \frac{48\ V}{8\ A} = 6\ \Omega$$

$$P = I^2R \overset{*}{=} \left(\frac{8\ A}{\sqrt{2}}\right)^2 \cdot 6\ \Omega = \boxed{192\ W}$$ $*$RMS Values

$$P = \frac{V_M I_M}{2}\cos\theta = \frac{48\ V \cdot 8\ A}{2} \cdot \cos 0 = \boxed{192\ W}$$

$$P = V\overset{*}{I}\cos\theta = \left(\frac{48\ V}{\sqrt{2}}\right)\left(\frac{8\ A}{\sqrt{2}}\right)\cos 0 = \boxed{192\ W}$$

<u>Same</u>

22/24

P14-31

THE POWER FACTOR OF A CIRCUIT IS 0.5 LAGGING.
$P_{DELIVERED}$ = 500W.

GIVEN : $v_{IN}(t) = 50 \sin(\omega t + 10°)$ V

FIND : $i_{IN}(t)$

$PF = \cos(\theta)$

$\therefore \; 0.5 = \cos(\theta)$, $\theta = |\theta_v - \theta_i| = \underline{60°}$

LAGGING PF $\Rightarrow$ I LAGS V

$P = 500W = \frac{V_m I_m}{2} \cos(\theta)$

OR $500W = \frac{50V(I_m)}{2}(0.5)$

YIELDS : $\underline{I_m = 40A}$

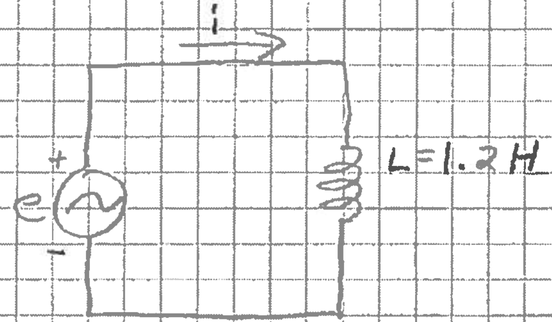
HENCE $i(t) = 40 \sin(\omega t + 10° - 60°)$

OR

$$\boxed{i(t) = 40 \sin(\omega t - 50°) \quad A}$$

23/24

14-33



$e = 220 \sin(1000t + 60°)$

a) Find the sinusoidal expression for i

$X_L = \omega L = 1000 \cdot 1.2H = 1.2k\Omega$

$I_M = \frac{V_M}{X_L} = \frac{220V}{1.2k\Omega} = 183.33\, mA$

For an inductor, i lags e by 90°, so the phase angle of i is $60° - 90° = -30°$

$\boxed{i = 183.33 \times 10^{-3} \sin(1000t - 30°)}$ A

b) Find the average power loss by the inductor

$P = \frac{V_M I_M}{2} \cos\theta$

$\cos(90°) = 0$ $\boxed{P = 0\,W}$

24/24