P14-37

CONVERT FROM RECTANGULAR TO POLAR FORM:

a) $4 + j3 \rightarrow \boxed{5.00 \angle 36.87^\circ}$

b) $2 + j2 \rightarrow \boxed{2.83 \angle 45^\circ}$

c) $4 + j12 \rightarrow \boxed{12.65 \angle 71.57^\circ}$

d) $1000 + j50 \rightarrow \boxed{1001 \angle 2.86^\circ}$

e) $-1000 + j4000 \rightarrow \boxed{4{,}123 \angle 104.0^\circ}$

f) $-0.4 + j0.8 \rightarrow \boxed{0.894 \angle 116.6^\circ}$

P14-40

CONVERT THE FOLLOWING FROM POLAR TO RECTANGULAR FORM:

a) $42 \angle 0.15^\circ \rightarrow \boxed{42 + j0.11}$

b) $2002 \angle -60^\circ \rightarrow \boxed{1001 - j1{,}734}$

c) $0.006 \angle -120^\circ \rightarrow \boxed{-3.000 \times 10^{-3} - j5.196 \times 10^{-3}}$

d) $8 \times 10^{-3} \angle -220^\circ \rightarrow \boxed{-6.128 \times 10^{-3} + j5.142 \times 10^{-3}}$

e) $15 \angle 180^\circ \rightarrow \boxed{-15}$

f) $1.2 \angle -89.9^\circ \rightarrow \boxed{2.094 \times 10^{-3} - j1.200}$

P14-42

PERFORM THE SUBTRACTION IN RECTANGULAR FORM

a) $(9.8 + j6.2) - (4.6 + j4.6) = \boxed{5.20 + j1.60}$

b) $(167 + j243) - (-42.3 - j68) = \boxed{209.3 + j311.0}$

c) $(-36.0 + j78) - (-4 - j6) + (10.8 - j72) = \boxed{-21.2 + j12.0}$

(43) Perform the following operations with polar numbers, and leave the answer in polar form

a) $6\angle 20^\circ + 8\angle 80^\circ$

$= (5.638 + j2.052) + (1.389 + j7.878)$

$= (7.027 + j9.93)$

$= \boxed{12.164\angle 54.7^\circ}$

b) $42\angle 45^\circ + 62\angle 60^\circ - 70\angle 120^\circ$

$= (29.698 + j29.698) + (31.0 + j53.694) - (-35.0 + j60.622)$

$= (95.698 + j22.77)$

$= \boxed{98.369\angle 13.4^\circ}$

c) $20\angle -120^\circ - 10\angle -150^\circ + 8\angle -210^\circ + 8\angle 240^\circ$

$\downarrow =$

$20\angle 240^\circ + 8\angle 240^\circ = 28\angle 240^\circ$

$= -10\angle -150^\circ + 8\angle -210^\circ + 28\angle 240^\circ$

$= (8.66 + j5) + (-6.928 + j4) + (-14 - j24.249)$

$= (-12.268 - j15.249)$

$= \boxed{19.571\angle -129^\circ}$

(47) Perform the following divisions, and leave your answer in rectangular form

a) $\frac{(8+j8)}{(2+j2)} = \frac{11.314\angle 45^\circ}{2.828\angle 45^\circ} = 4\angle 0 = \boxed{(4+j0)}$

b) $\frac{(8+j42)}{(-6-j4)} = \frac{42.755\angle 79.2^\circ}{7.211\angle -146^\circ} = 5.929\angle 225^\circ = \boxed{(-4.192-j4.192)}$

c) $\frac{(-4.5-j6)}{(0.1-j0.8)} = \frac{7.5\angle -127^\circ}{0.806\angle -82.9^\circ} = 9.305\angle -44.1^\circ = \boxed{(6.682-j6.475)}$

(48) Perform the following operations and express your answer in rectangular form

a) $$\frac{(4+j3)+(6-j8)}{(3+j3)-(2+j3)} = \frac{(10-j5)}{(1+j0)} = 11.18\angle -26.6^\circ = \boxed{(10-j5)}$$

b) $$\frac{8\angle 60^\circ}{(2\angle 0^\circ)+(100+j400)} = \frac{8\angle 60^\circ}{(102+j400)} = \frac{8\angle 60^\circ}{412.8\angle 75.7^\circ} = 0.019\angle -15.4^\circ$$

$$= \boxed{(0.018-j0.005)}$$

c) $$\frac{(6\angle 20^\circ)(120\angle -40^\circ)(3+j8)}{2\angle -30^\circ} = \frac{(6\angle 20^\circ)(120\angle -40^\circ)(8.544\angle 69.4^\circ)}{2\angle -30^\circ}$$

$$= \frac{6152\angle 49.4}{2\angle -30^\circ} = 3076\angle 79.4 = \boxed{(565.8+j3023)}$$

P14-50

a) DETERMINE A SOLUTION FOR x & y IF

$$(x + j4) + (3x + jy) - j7 = 16 \angle 0^\circ$$

COLLECTING TERMS:

$$(x + 3x) + (j4 + jy - j7) = 16 + j0$$

OR $$4x + j(y - 3) = 16 + j0$$

EQUATING TERMS:

$$4x = 16 \quad \therefore x = \frac{16}{4} = \boxed{4}$$

$$(y - 3) = 0 \quad \therefore \boxed{y = 3}$$

b) DETERMINE x IF

$$(10 \angle 20^\circ)(x \angle -60^\circ) = 30.64 - j25.72$$

$$10x \angle (20^\circ + (-60^\circ)) = 40.00 \angle -40.0^\circ$$

$$10x \angle -40^\circ = 40 \angle -40^\circ$$

$$\therefore 10x = 40$$

OR $\boxed{x = 4}$

P14-52

EXPRESS IN PHASOR FORM:

a) $\sqrt{2}(160) \sin(\omega t + 30^\circ)$

$$226.3 \sin(\omega t + 30^\circ) \longrightarrow \boxed{226.3_{pk} \angle 30^\circ}$$

b) $\sqrt{2}(25 \times 10^{-3}) \sin(157t - 40^\circ)$

$$35.36 \sin(157t - 40^\circ) \longrightarrow \boxed{35.36_{pk} \angle -40^\circ}$$

c) $100 \sin(\omega t - 90^\circ) \longrightarrow \boxed{100_{pk} \angle -90^\circ}$

P14-54

EXPRESS THE FOLLOWING AS SINE WAVES AT 60HZ:

a) $\vec{I} = 40 A_{pk} \angle 20°$, $f = 60Hz$

$\therefore \omega = 2\pi(60\,Hz) = 377$ RAD/SEC

$\therefore \boxed{i(t) = 40 \sin(377t + 20°)\ A}$

b) $\vec{V} = 120 V_{pk} \angle 10°$

$\therefore \boxed{v(t) = 120 \sin(377t + 10°)\ V}$

c) $\vec{I} = 8 \times 10^{-3} A_{pk} \angle -110°$

$\therefore \boxed{i(t) = 8 \times 10^{-3} \sin(377t - 110°)\ A}$

d) $\vec{V} = \frac{6000}{\sqrt{2}} V_{pk} \angle -180°$

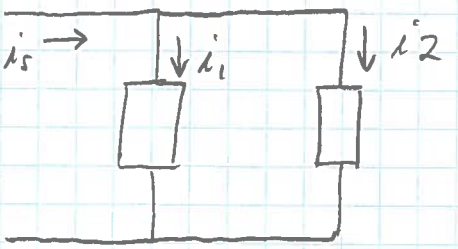
$\therefore \boxed{v(t) = 4{,}243 \sin(377t - 180°)\ V}$

P14-56

FIND $i_1(t)$ GIVEN:

$i_s(t) = 20 \times 10^{-6} \sin(\omega t + 60°)\ A$

$i_2(t) = 6 \times 10^{-6} \sin(\omega t - 30°)\ A$



KCL: $\vec{I}_s = \vec{I}_1 + \vec{I}_2$

$\therefore \vec{I}_1 = \vec{I}_s - \vec{I}_2$

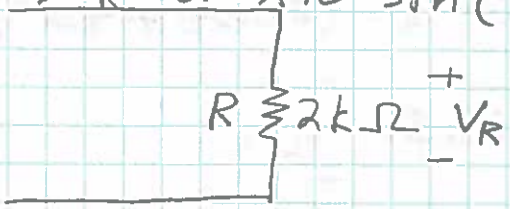
$= 20 \times 10^{-6}_{pk} \angle 60° - 6 \times 10^{-6}_{pk} \angle -30°$

$\vec{I}_1 = 20.88 \times 10^{-6}_{pk} \angle 76.70°$

$\therefore \boxed{i_1(t) = 20.88 \times 10^{-6} (\sin \omega t + 76.70°)\ A}$

15-1

$\Rightarrow i_R = 20 \times 10^{-3} \sin(1000t + 30°)$



For the resistive element;

a) Write the current in phasor form

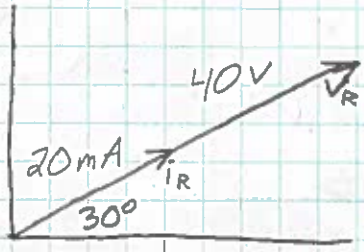
$\boxed{i_R \quad 20\,mA_p \angle 30°}$

b) Calculate the voltage across the resistor in phasor form

$V_R = i_R \cdot R = 20\,mA_p \angle 30° \cdot 2k\Omega \angle 0°$

$= \boxed{40\,V_p \angle 30°}$

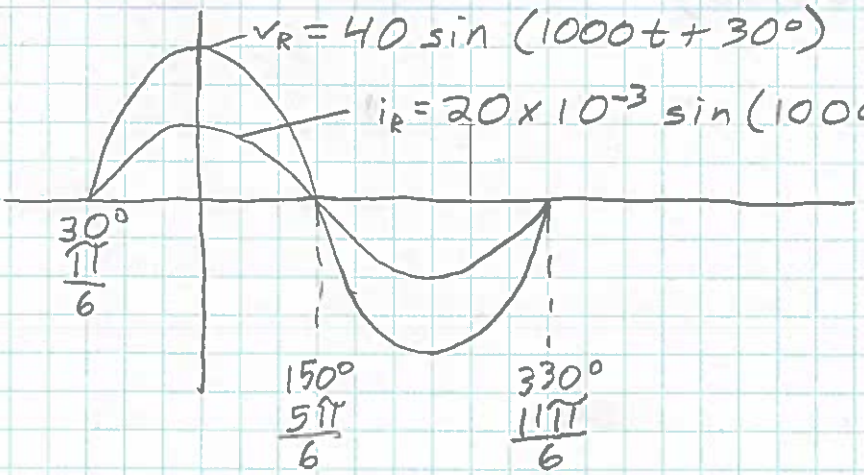
c) Sketch the phasor diagram of the voltage and current



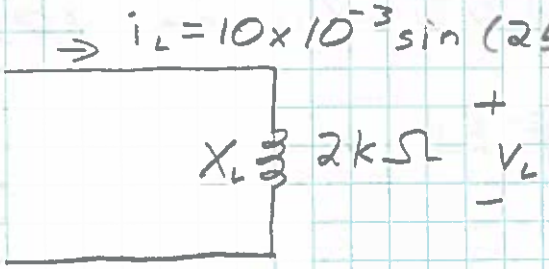
d) Write the voltage in sinusoidal format

$\boxed{v_R = 40 \sin(1000t + 30°)}$

e) Sketch the waveform of the voltage and current



15-3



For the inductive element:

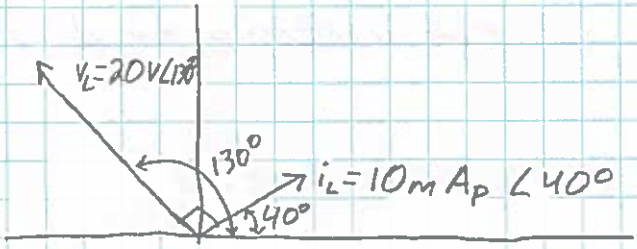
a) Write the current in phasor form

$i_L = 10 mA_P \angle 40°$

b) Calculate the voltage across the inductor in phasor form

$V_L = i_L \cdot X_L = 10 mA_P \angle 40° \cdot 2k\Omega \angle 90° = 20 V_P \angle 130°$

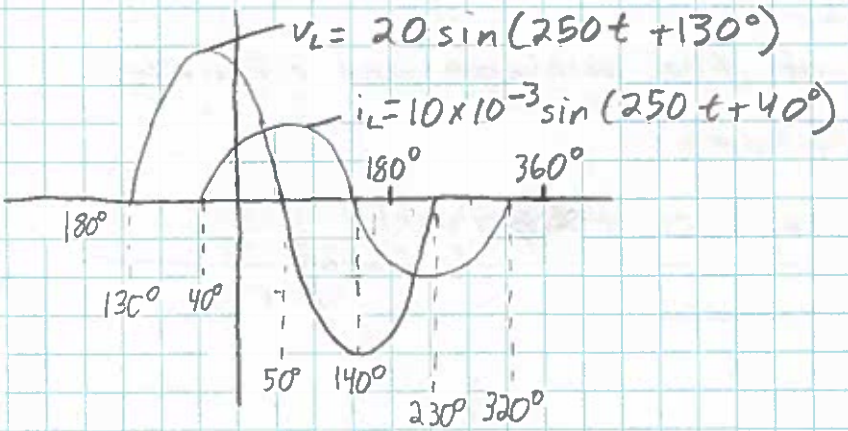
c) Sketch the phasor diagram of the voltage and current



d) Write the voltage in sinusoidal format

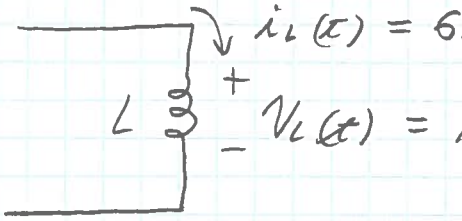
$V_L = 20 \sin(250t + 130°)$

e) Sketch the waveform of the voltage and current



P15-5

FOR THE INDUCTIVE ELEMENT SHOWN:



$i_L(t) = 6\times10^{-3}\sin(1200t + 20°)$ A

$v_L(t) = 16\sin(1200t + 110°)$ V

(a) WRITE $i_L(t)$ + $v_L(t)$ IN PHASOR FORM

$$\vec{I}_L = 6\times10^{-3}\text{A}_{pk} \angle 20°$$

$$\vec{V}_L = 16\text{V}_{pk} \angle 110°$$

NOTE $\vec{V}_L$ LEADS $\vec{I}_L$ BY 90° (E ↑ L I)

(b) CALCULATE IN INDUCTOR'S IMPEDANCE

$$\vec{Z}_L = \frac{\vec{V}_L}{\vec{I}_L} = \frac{16\text{V}_{pk} \angle 110°}{6\times10^{-3}\text{A}_{pk} \angle 20°} = 2{,}667\,\Omega \angle 90°$$

NOTE

$$\vec{Z}_L = X_L \angle 90°$$

(c) FIND THE INDUCTANCE OF THE COIL

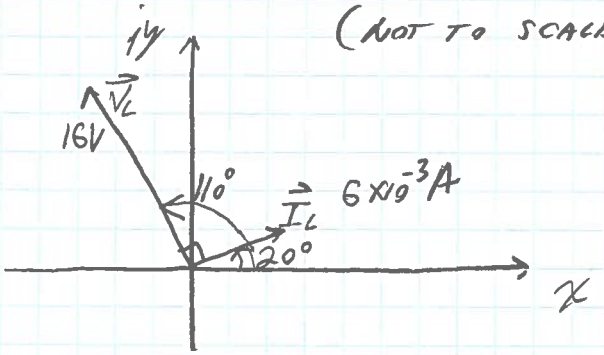
$X_L = \omega L = 2{,}667\,\Omega$

$\omega = 1200$ RAD/SEC

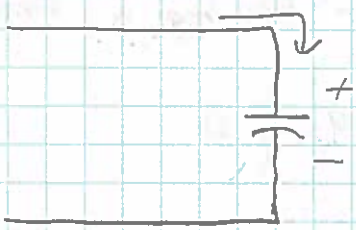
$$L = \frac{2{,}667\,\Omega}{1200 \text{ RAD/SEC}} = 2.22\text{H}$$

(d) SKETCH THE PHASOR DIAGRAM OF VOLTS & CURRENT

(NOT TO SCALE)



15- 8



$i_c = 60 \times 10^{-6} \sin(2000t + 80°)$

$v_c = 24 \times 10^{-3} \sin(2000t - 10°)$

For the capacitive element:

a) Write the voltage and current in phasor form

$\boxed{i_c = 60\mu A_P \angle 80°}$ $\boxed{v_c = 24mV_P \angle -10°}$

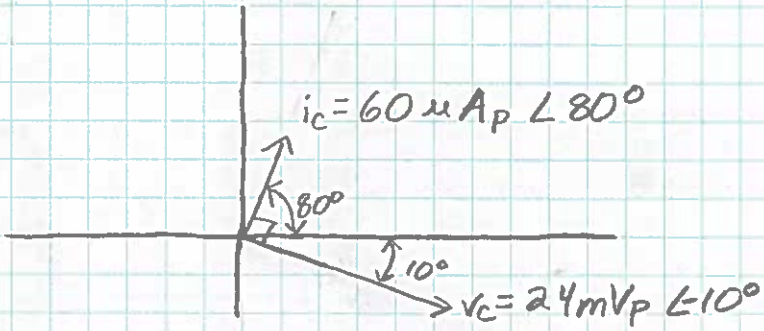
b) Calculate the impedance of the capacitor

$$X_C = \frac{v_c}{i_c} = \frac{24mV\angle -10°}{60\mu A \angle 80°} = 400\angle -90 \quad \boxed{X_C = 400\Omega}$$

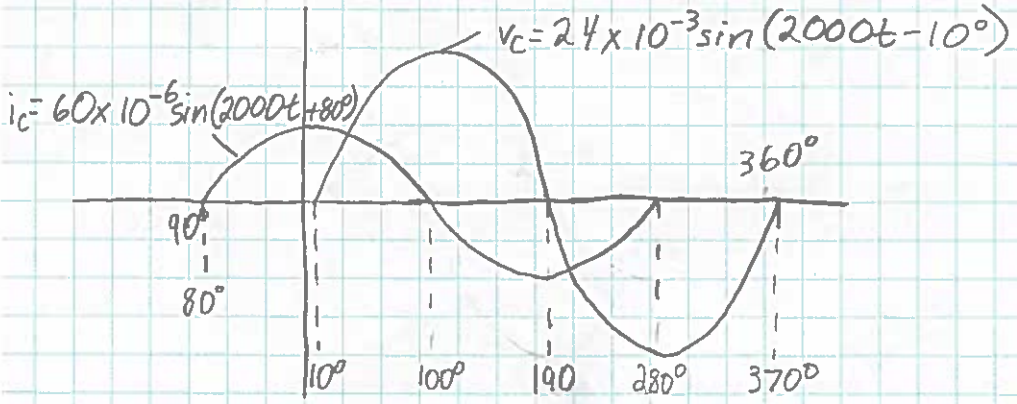
c) Find the capacitance of the capacitor

$$X_C = \frac{1}{\omega C} \qquad 400\Omega = \frac{1}{2000 \cdot C} \qquad \boxed{C = 1.25\mu F}$$

d) Sketch the phasor diagram of the voltage and current

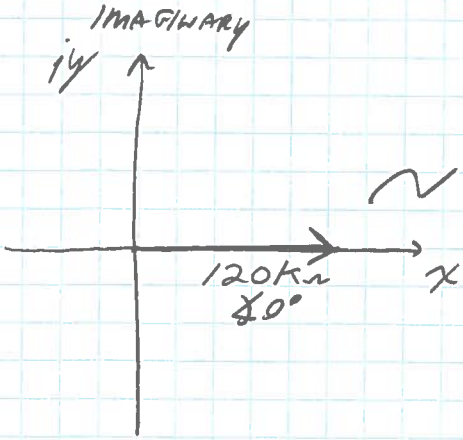


e) Sketch the waveform of the voltage and current



15-9

SKETCH THE IMPEDANCE DIAGRAM FOR A 120kΩ RESISTOR



ALSO WRITTEN $(R + j0)_{\Omega}$

OR

$(120k + j0)_{\Omega}$

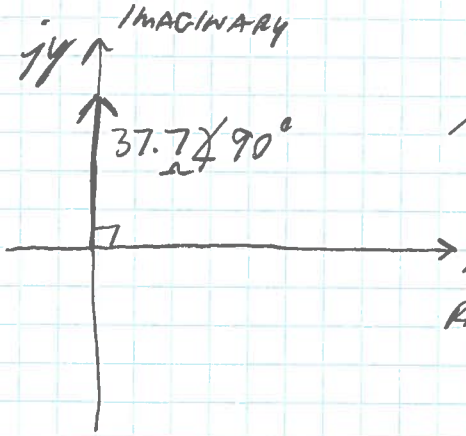
15-10

SKETCH THE IMPEDANCE DIAGRAM OF A 5 mH COIL RESPONDING TO A SOURCE WITH f = 1.2 kHz

$$\vec{Z}_L = X_L \angle 90^\circ$$

$$X_L = 2\pi f L = (2\pi)(1200\,Hz)(5\,mH) = 37.7\,\Omega$$

$$\therefore \vec{Z}_L = 37.7\,\Omega \angle 90^\circ$$



ALSO WRITTEN

$(0 + jX_L)_{\Omega}$

OR

$(0 + j37.7)_{\Omega}$

5-11 Sketch the impedance diagram of a 0.02 μF capacitor responding to a source having a frequency of 100 kHz.

$$X_C = \frac{1}{2\pi f C} = \frac{1}{2\pi \cdot 100k \cdot .02\mu F} = 79.58\,\Omega$$