Chapter 14

1. –

2. –

3. a. (377)(10) cos 377t = **3770 cos 377t**

   b. (400)(20) cos(400t + 60°) = **8×10^3 cos(400t + 60°)**

   c. ($\sqrt{2}$ 20)(157) cos(157t – 20°) = **4440.63 cos(157t – 20°)**

   d. (–200)(1) cos(t + 180°) = –200 cos(t + 180°) = **200 cos t**

4. a. $I_m = V_m/R$ = 160 V/20 Ω = 8 A, i = **8 sin 100t**

   b. $I_m = V_m/R$ = 60 V/20 Ω = 3 A, i = **3 sin(2000t + 45°)**

   c. $I_m = V_m/R$ = 6 V/3 Ω = 2 A, i = **2 sin(ωt + 100°)**

   d. $I_m = V_m/R$ = 12 V/3 Ω = 4 A, i = **4 sin(ωt + 220°)**

5. a. $V_m = I_m R = (0.1 \text{ A})(6.8 \times 10^3\ \Omega) = 680$ V
   υ = **680 sin 1000t**

   b. $V_m = I_m R = (2 \times 10^{-3} \text{ A})(6.8 \times 10^3\ \Omega) = 13.6$ V
   υ = **13.6 sin(400t – 120°)**

6. a. **0 Ω**

   b. $X_L = 12.56f = 12.56(60 \text{ Hz})$ = **753.6 Ω**

   c. $X_L = 12.56f = 12.56(4 \text{ kHz})$ = **50.24 kΩ**

   d. $X_L = 12.56f = 12.56(1.2 \text{ MHz})$ = **15.07 MΩ**

7. a. $L = \dfrac{X_L}{2\pi f} = \dfrac{2 \text{ k}\Omega}{2\pi(14.47 \text{ kHz})}$ = **22 mH**

   b. $L = \dfrac{X_L}{2\pi f} = \dfrac{40 \text{ k}\Omega}{2\pi(5.3 \text{ kHz})}$ = **1.2 H**

8. a. $X_L = 2\pi fL \Rightarrow f = \dfrac{X_L}{2\pi L} = \dfrac{X_L}{(6.28)(47 \text{ mH})} = \dfrac{X_L}{295.16 \times 10^{-3} \text{ H}}$

   $f = \dfrac{10\ \Omega}{295.16 \times 10^{-3} \text{ H}}$ = **33.88 Hz**

b. $f = \dfrac{X_L}{295.16 \times 10^{-3}\ \text{H}} = \dfrac{4\ \text{k}\Omega}{295.16 \times 10^{-3}\ \text{H}} = \mathbf{13.55\ kHz}$

c. $f = \dfrac{X_L}{295.16 \times 10^{-3}\ \text{H}} = \dfrac{12\ \text{k}\Omega}{295.16 \times 10^{-3}\ \text{H}} = \mathbf{40.66\ kHz}$

9. a. $V_m = I_m X_L = (25\ \text{mA})(20\ \Omega) = 500\ \text{mV}$
$\upsilon = \mathbf{0.5 \sin(\omega t + 90°)}$

b. $V_m = I_m X_L = (40 \times 10^{-3}\ \text{A})(20\ \Omega) = 0.8\ \text{V}$
$\upsilon = \mathbf{0.8 \sin(\omega t + 150°)}$

c. $i = 6 \sin(\omega t + 150°)$, $V_m = I_m X_L = (6\ \text{A})(20\ \Omega) = 120\ \text{V}$
$\upsilon = 120 \sin(\omega t + 240°) = \mathbf{120 \sin(\omega t - 120°)}$

10. a. $X_L = \omega L = (100\ \text{rad/s})(0.1\ \text{H}) = 10\ \Omega$
$V_m = I_m X_L = (10\ \text{A})(10\ \Omega) = 100\ \text{V}$
$\upsilon = \mathbf{100 \sin(100t + 90°)}$

b. $X_L = \omega L = (400\ \text{rad/s})(0.1\ \text{H}) = 40\ \Omega$
$V_m = I_m X_L = (5 \times 10^{-6}\ \text{A})(40\ \Omega) = 200\ \mu\text{V}$
$\upsilon = \mathbf{200 \times 10^{-6} \sin(400t + 110°)}$

11. a. $I_m = \dfrac{V_m}{X_L} = \dfrac{120\ \text{V}}{40\ \Omega} = 3\ \text{A}$, $i = \mathbf{3 \sin(\omega t - 90°)}$

b. $I_m = \dfrac{V_m}{X_L} = \dfrac{30\ \text{V}}{40\ \Omega} = 0.75\ \text{A}$, $i = \mathbf{0.75 \sin(\omega t - 70°)}$

12. a. $X_L = \omega L = (60\ \text{rad/s})(0.2\ \text{H}) = 12\ \Omega$
$I_m = V_m / X_L = 1.5\ \text{V}/12\ \Omega = 0.125\ \text{A}$
$i = \mathbf{0.125 \sin(60t - 90°)}$

b. $X_L = \omega L = (10\ \text{rad/s})(0.2\ \text{H}) = 2\ \Omega$
$I_m = V_m / X_L = 16\ \text{mV}/2\ \Omega = 8\ \text{mA}$
$i = 8 \times 10^{-3} \sin(t + 2° - 90°) = \mathbf{8 \times 10^{-3} \sin(t - 88°)}$

13. a. $X_C = \dfrac{1}{2\pi f C} = \dfrac{1}{2\pi\,(0\ \text{Hz})(0.2 \times 10^{-6}\ \text{F})} = \mathbf{\infty\ \Omega}$

b. $X_C = \dfrac{1}{2\pi f C} = \dfrac{1}{2\pi\,(60\ \text{Hz})(0.2 \times 10^{-6}\ \text{F})} = \mathbf{13.26\ k\Omega}$

c. $X_C = \dfrac{1}{2\pi f C} = \dfrac{1}{2\pi\,(2\ \text{kHz})(0.2 \times 10^{-6}\ \text{F})} = \mathbf{397.89\ \Omega}$

d. $X_C = \dfrac{1}{2\pi fC} = \dfrac{1}{2\pi\,(2\times10^{-6}\text{ Hz})(0.2\times10^{-6}\text{ F})} = \mathbf{0.398\ \Omega}$

14. $X_C = \dfrac{1}{2\pi fC} \Rightarrow C = \dfrac{1}{2\pi fX_C}$

a. $C = \dfrac{1}{2\pi\,(265\text{ Hz})(60\ \Omega)}$
$= \mathbf{10\ \mu F}$

b. $C = \dfrac{1}{2\pi\,(34\text{ kHz})(1.2\text{ k}\Omega)}$
$= \mathbf{3900\ \mu F}$

15. a. $f = \dfrac{1}{2\pi CX_C} = \dfrac{1}{2\pi(3.9\times10^{-6}\text{ F})(10\,\Omega)} = \mathbf{4.08\ kHz}$

b. $f = \dfrac{1}{2\pi\,CX_C} = \dfrac{1}{2\pi\,(3.9\times10^{-6}\text{ F})(60\text{ k}\Omega)} = \mathbf{0.68\ Hz}$

c. $f = \dfrac{1}{2\pi CX_C} = \dfrac{1}{2\pi(3.9\times10^{-6}\text{ F})(0.1\,\Omega)} = \mathbf{408.1\ kHz}$

d. $f = \dfrac{1}{2\pi CX_C} = \dfrac{1}{2\pi(3.9\times10^{-6}\text{ F})(2000\,\Omega)} = \mathbf{20.40\ Hz}$

16. a. $I_m = V_m/X_C = 120\text{ V}/2.5\ \Omega = 48\text{ A}$
$i = \mathbf{48\ \sin(\omega t + 90°)}$

b. $I_m = V_m/X_C = 4\times10^{-3}\text{ V}/2.5\ \Omega = 0.16\text{ A}$
$i = \mathbf{1.6\times10^{-3}\ \sin(\omega t + 130°)}$

17. a. $\upsilon = 30\sin 200t$, $X_C = \dfrac{1}{\omega C} = \dfrac{1}{(200)(1\times10^{-6}\text{ F})} = 5\text{ k}\Omega$

$I_m = \dfrac{V_m}{X_C} = \dfrac{30\text{ V}}{5\text{ k}\Omega} = 6\text{ mA}$, $i = \mathbf{6\times10^{-3}\ \sin(200t + 90°)}$

b. $\upsilon = 60\times10^{-3}\sin 377t$, $X_C = \dfrac{1}{\omega C} = \dfrac{1}{(377)(1\times10^{-6})} = 2.65\text{ k}\Omega$

$I_m = \dfrac{V_m}{X_C} = \dfrac{60\times10^{-3}\text{ V}}{2{,}650\,\Omega} = 22.64\ \mu\text{A}$, $i = \mathbf{22.64\times10^{-6}\ \sin(377t + 90°)}$

18. a. $V_m = I_mX_C = (50\times10^{-3}\text{ A})(2\text{ k}\Omega) = 100\text{ V}$
$\upsilon = \mathbf{100\ \sin(\omega t - 90°)}$

b. $V_m = I_m X_C = (2 \times 10^{-6})(2\ \text{k}\Omega) = 4\ \text{mV}$
$\upsilon = \mathbf{4 \times 10^{-3}\ sin(\omega t - 30°)}$

19. a. $i = 0.2 \sin 300t$, $X_C = \dfrac{1}{\omega C} = \dfrac{1}{(300)(0.56 \times 10^{-6}\ \text{F})} = 5.952\ \text{k}\Omega$

$V_m = I_m X_C = (0.2\ \text{A})(5.952\ \text{k}\Omega) = 1190.48\ \text{V}$, $\upsilon = \mathbf{1190.48\ sin(300t - 90°)}$

b. $i = 8 \times 10^{-3} \sin(377t - 30°)$, $X_C = \dfrac{1}{\omega C} = \dfrac{1}{(377)(0.56 \times 10^{-6}\ \text{F})} = 4.737\ \text{k}\Omega$

$V_m = I_m X_C = (8 \times 10^{-3}\ \text{A})(4.737\ \text{k}\Omega) = 37.81\ \text{V}$
$\upsilon = \mathbf{37.81\ sin(377t - 120°)}$

20. a. υ leads i by $90° \Rightarrow L$, $X_L = V_m/I_m = 550\ \text{V}/11\ \text{A} = 50\ \Omega$

$$L = \frac{X_L}{\omega} = \frac{50\ \Omega}{377\ \text{rad/s}} = \mathbf{132.63\ mH}$$

b. υ leads i by $90° \Rightarrow L$, $X_L = V_m/I_m = 36\ \text{V}/4\ \text{A} = 9\ \Omega$

$$L = \frac{1}{\omega X_L} = \frac{1}{(754\ \text{rad/s})(9\ \Omega)} = \mathbf{147.36\ \mu H}$$

c. υ and i are in phase $\Rightarrow R$

$$R = \frac{V_m}{I_m} = \frac{10.5\ \text{V}}{1.5\ \text{A}} = \mathbf{7\ \Omega}$$

21. $\left.\begin{aligned} i &= 5\sin(\omega t + 90°) \\ \upsilon &= 2000 \sin \omega t \end{aligned}\right\}$ i leads υ by $90° \Rightarrow C$

$$X_C = \frac{V_m}{I_m} = \frac{2000\ \text{V}}{5\ \text{A}} = 400\ \Omega,\ C = \frac{\text{I}}{\omega X_C} = \frac{1}{(157\ \text{rad/s})(400\ \Omega)} = \mathbf{15.92\ \mu F}$$

b. $\left.\begin{aligned} i &= 2\sin(157t + 60°) \\ \upsilon &= 80\sin(157t + 150°) \end{aligned}\right\}$ υ leads i by $90° \Rightarrow \boldsymbol{L}$

$$X_L = \frac{V_m}{I_m} = \frac{80\ \text{V}}{2\ \text{A}} = 40\ \Omega,\ L = \frac{X_L}{\omega} = \frac{40\ \Omega}{157\ \text{rad/s}} = \mathbf{254.78\ mH}$$

c. $\left.\begin{aligned} \upsilon &= 35\sin(\omega t - 20°) \\ i &= 7\sin(\omega t - 20°) \end{aligned}\right\}$ in phase $\Rightarrow \boldsymbol{R}$

$$R = \frac{V_m}{I_m} = \frac{35\ \text{V}}{7\ \text{A}} = \mathbf{5\ \Omega}$$

22. –

23. –

24. $X_C = \dfrac{1}{2\pi f C} = R \Rightarrow f = \dfrac{1}{2\pi RC} = \dfrac{1}{2\pi(2\times10^3\ \Omega)(1\times10^{-6}\ \text{F})} = \dfrac{1}{12.56\times10^{-3}}$

$\cong$ **79.62 Hz**

25. $X_L = 2\pi fL = R$

$$L = \frac{R}{2\pi f} = \frac{10{,}000\ \Omega}{2\pi(5\times10^3\ \text{Hz})} = \textbf{318.47 mH}$$

26. $X_C = X_L$

$$\frac{1}{2\pi fC} = 2\pi fL$$

$$f^2 = \frac{1}{4\pi^2 LC}$$

and $f = \dfrac{1}{2\pi\sqrt{LC}} = \dfrac{1}{2\pi\sqrt{(10\times10^{-3}\ \text{H})(1\times10^{-6}\ \text{F})}} = \textbf{1.59 kHz}$

27. $X_C = X_L$

$$\frac{1}{2\pi fC} = 2\pi fL \Rightarrow C = \frac{1}{4\pi^2 f^2 L} = \frac{1}{4(9.86)(2500\times10^6)(2\times10^{-3})} = \textbf{5.07 nF}$$

28. a. $P = \dfrac{(60\ \text{V})(15\ \text{A})}{2}\cos 30° = \textbf{389.7 W}$, $F_p = \textbf{0.866}$

b. $P = \dfrac{(50\ \text{V})(2\ \text{A})}{2}\cos 0° = \textbf{50 W}$, $F_p = \textbf{1.0}$

c. $P = \dfrac{(50\ \text{V})(3\ \text{A})}{2}\cos 10° = \textbf{73.86 W}$, $F_p = \textbf{0.985}$

d. $P = \dfrac{(75\ \text{V})(0.08\ \text{A})}{2}\cos 40° = \textbf{2.30 W}$, $F_p = \textbf{0.766}$

29. $R = \dfrac{V_m}{I_m} = \dfrac{48\ \text{V}}{8\ \text{A}} = 6\ \Omega$, $P = I^2R = \left(\dfrac{8\ \text{A}}{\sqrt{2}}\right)^2 6\ \Omega = \textbf{192 W}$

$$P = \frac{V_m I_m}{2}\cos\theta = \frac{(48\ \text{V})(8\ \text{A})}{2}\cos 0° = \textbf{192 W}$$

$$P = VI\cos\theta = \left(\frac{48\ \text{V}}{\sqrt{2}}\right)\left(\frac{8\ \text{A}}{\sqrt{2}}\right)\cos 0° = \textbf{192 W}$$

All the same!

30. $P = 100$ W: $F_p = \cos\theta = P/VI = 100$ W/(150 V)(2 A) = **0.333**
$P = 0$ W: $F_p = \cos\theta = \mathbf{0}$
$P = 300$ W: $F_p = \dfrac{300}{300} = \mathbf{1}$

31. $P = \dfrac{V_m I_m}{2}\cos\theta$

$500 \text{ W} = \dfrac{(50 \text{ V})I_m}{2}(0.5) \Rightarrow I_m = 40 \text{ A}$

$i = \mathbf{40 \sin(\omega t - 50°)}$

32. a. $I_m = E_m/R = 120$ V/6.8 kΩ = 17.65 mA, $i = \mathbf{17.65 \times 10^{-3} \sin(2\pi 60t + 20°)}$

b. $P = I^2R = \left(\dfrac{17.65 \text{ mA}}{\sqrt{2}}\right)^2 6.8 \text{ k}\Omega = \mathbf{1.06 \text{ W}}$

c. $T = \dfrac{2\pi}{\omega} = \dfrac{6.28}{2\pi 60 \text{ rad/s}} = \mathbf{16.67 \text{ ms}}$

6(16.67 ms) = 100.02 ms ≅ **0.1 s**

33. a. $X_L = \omega L = (1000 \text{ rad/s})(1.2 \text{ H}) = 1.2 \text{ k}\Omega$

$I_m = \dfrac{V_m}{X_L} = \dfrac{220 \text{ V}}{1.2 \text{ k}\Omega} = 183.33 \text{ mA}$, $i = \mathbf{183.33 \times 10^{-3} \sin(1000t - 30°)}$

b. **0 W**

34. a. $X_C = \dfrac{1}{\omega C} = \dfrac{1}{(2\pi 500)(1200 \text{ pF})} = 265.26 \text{ k}\Omega$

$E_m = I_m X_C = (30 \times 10^{-3} \text{ A})(265.26 \text{ k}\Omega) = 7.95 \text{ kV}$

$e = 7.95 \times 10^3 \sin(2\pi 500t - 20° - 90°) = \mathbf{7.95 \times 10^3 \sin(2\pi 500t - 110°)}$

b. $P = \mathbf{0 \text{ W}}$

35. a. $X_{C_1} = \dfrac{1}{2\pi f C_1} = \dfrac{1}{\omega C_1} = \dfrac{1}{(10^4 \text{ rad/s})(2\ \mu\text{F})} = 50\ \Omega$

$X_{C_2} = \dfrac{1}{\omega C_2} = \dfrac{1}{(10^4)(10\,\mu F)} = 10\ \Omega$

$\mathbf{E} = 84.85 \text{ V} \angle 60°$ $\qquad \mathbf{I}_1 = \dfrac{\mathbf{E}}{\mathbf{Z}_{C_1}} = \dfrac{84.85 \text{ V} \angle 60°}{50\ \Omega \angle -90°} = 1.697 \text{ A} \angle 150°$

$\mathbf{I}_2 = \dfrac{\mathbf{E}}{\mathbf{Z}_{C_2}} = \dfrac{84.85 \text{ V} \angle 60°}{10\ \Omega \angle -90°} = 8.485 \text{ A} \angle 150°$

$i_1 = \mathbf{2.4 \sin(10^4 t + 150°)}$
$i_2 = \mathbf{12 \sin(10^4 t + 150°)}$

b. $C_T = 2\ \mu\text{F} \parallel 10\ \mu\text{F} = 12\ \mu\text{F}$

$$X_C = \frac{1}{\omega C} = \frac{1}{(10^4\ \text{rad/s})(12\ \mu\text{F})}$$

$$\mathbf{I}_s = \frac{\mathbf{E}}{\mathbf{X}_{C_T}} = \frac{84.85\angle 60°}{8.33\ \Omega\angle -90°}$$

$$= 10.19\ \text{A}\angle 150°$$

$i_s = \mathbf{14.4\ \sin\ (10^4 t + 150°)}$

36. a. $L_1 \parallel L_2 = 60\ \text{mH} \parallel 120\ \text{mH} = 40\ \text{mH}$

$X_{L_T} = 2\pi f L_T = 2\pi(10^3\ \text{Hz})(40\ \text{mH}) = 251.33\ \Omega$

$V_m = I_m X_{L_T} = (80\ \text{A})(251.33\ \Omega) = 20.11\ \text{kV}$

and $\upsilon_s = 20.11\ \text{kV}\ \sin(10^3 t + 30° + 90°)$

so that $\upsilon_s = \mathbf{20.11 \times 10^3\ \sin(10^3 t + 120°)}$

b. $I_{m_1} = \dfrac{V_m}{X_{L_1}}$, $X_{L_1} = 2\pi f L_1 = 2\pi(10^3\ \text{Hz})(60\ \text{mH}) = 376.99\ \Omega$

$$I_{m_1} = \frac{6.03 \times 10^3\ \text{V}}{376.99\ \Omega} = 16\ \text{A}$$

and $i_1 = \mathbf{16\ \sin(10^3 t + 30°)}$

$X_{L_2} = 2\pi f L_2 = 2\pi(10^3\ \text{Hz})(120\ \text{mH}) = 753.98\ \Omega$

$$I_{m_2} = \frac{6.03 \times 10^3\ \text{V}}{753.98\ \Omega} = 8\ \text{A}$$

and $i_2 = \mathbf{8\ A\ sin(10^3 t + 30°)}$

37. a. $\mathbf{5.0\ \angle 36.87°}$ b. $\mathbf{2.83\ \angle 45°}$
c. $\mathbf{12.65\ \angle 7.57°}$ d. $\mathbf{1001.25\ \angle 2.86°}$
e. $\mathbf{4123.11\ \angle 104.04°}$ f. $\mathbf{0.894\ \angle 116.57°}$

38. a. $\mathbf{17.89\ \angle -116.57°}$ b. $\mathbf{8.94\ \angle -26.57°}$
c. $\mathbf{20.22 \times 10^{-3}\ \angle -8.53°}$ d. $\mathbf{8.49 \times 10^{-3}\ \angle -135°}$
e. $\mathbf{\cong 200\ \angle 0°}$ f. $\mathbf{1000\ \angle -178.85°}$

39. a. $\mathbf{4.6 + j3.86}$ b. $\mathbf{-6.0 + j10.39}$
c. $\mathbf{-j2000}$ d. $\mathbf{-6 \times 10^{-3} - j2.2 \times 10^{-3}}$
e. $\mathbf{47.97 + j1.68}$ f. $\mathbf{4.7 \times 10^{-4} - j1.71 \times 10^{-4}}$

40. a. $\mathbf{42 + j0.11}$ b. $\mathbf{1 \times 10^3 - j1.73 \times 10^3}$
c. $\mathbf{-3 \times 10^{-3} - j5.20 \times 10^{-3}}$ d. $\mathbf{-6.13 \times 10^{-3} + j5.14 \times 10^{-3}}$
e. $\mathbf{-15}$ f. $\mathbf{2.09 \times 10^{-3} - j1.20}$

41. a. $\mathbf{11.8 + j7.0}$

b. $\mathbf{151.90 + j49.90}$

c. $\mathbf{4.72 \times 10^{-6} + j71}$

42. a. $\mathbf{5.20 + j1.60}$

b. $\mathbf{209.30 + j311.0}$

c. $\mathbf{-21.20 + j12.0}$

43. a. $\mathbf{12.17 \angle 54.70°}$

b. $\mathbf{98.37 \angle 13.38°}$

c. $\mathbf{28.07 \angle -115.91°}$

44. a. $\mathbf{-12.0 + j34.0}$

b. $\mathbf{86.80 + j312.40}$

c. $\mathbf{-283.90 - j637.65}$

45. a. $\mathbf{8.00 \angle 20°}$

b. $\mathbf{49.68 \angle -64.0°}$

c. $\mathbf{40 \times 10^{-3} \angle 40°}$

46. a. $\mathbf{6.0 \angle -50°}$

b. $\mathbf{200 \times 10^{-6} \angle 60°}$

c. $\mathbf{109 \angle -170°}$

47. a. $\mathbf{4}$

b. $\mathbf{-4.15 - j4.23}$

c. $\mathbf{6.69 - j6.46}$

48. a. $\dfrac{10 - j5}{1 + j0} = \mathbf{10.0 - j5.0}$

b. $\dfrac{8 \angle 60°}{102 + j400} = \dfrac{8 \angle 60°}{412.80 \angle 75.69°} = \mathbf{19.38 \times 10^{-3} \angle -15.69°}$

c. $\dfrac{(6 \angle 20°)(120 \angle -40°)(8.54 \angle 69.44°)}{2 \angle -30°} = \dfrac{6.15 \times 10^{3} \angle 49.44°}{2 \angle -30°} = \mathbf{3.07 \times 10^{3} \angle 79.44°}$

49 a. $\dfrac{(0.16\angle 120°)(300\angle 40°)}{9.487\angle 71.565°} = \dfrac{48\angle 160°}{9.487\angle 71.565°} = \mathbf{5.06\angle 88.44°}$

b. $\left(\dfrac{1}{4\times 10^{-4}\angle 20°}\right)\left(\dfrac{8}{j(j^2)}\right)\left(\dfrac{1}{36-j30}\right)$

$(2500\angle -20°)\left(\dfrac{8}{-j}\right)\left(\dfrac{1}{46.861\angle -39.81°}\right)$

$(2500\angle -20°)(8j)(0.0213\angle 39.81°) = \mathbf{426\angle 109.81°}$

50. a. $x + j4 + 3x + jy - j7 = 16$

$(x + 3x) + j(4 + y - 7) = 16 + j0$

$x + 3x = 16$ $\qquad$ $4 + y - 7 = 0$

$4x = 16$ $\qquad$ $y = +7 - 4$

$x = \mathbf{4}$ $\qquad$ $y = \mathbf{3}$

b. $(10\angle 20°)(x\angle -60°) = 30.64 - j25.72$

$10x\angle -40° = 40\angle -40°$

$10x = 40$

$x = \mathbf{4}$

51. a. $5x + j10$

$2 - jy$

———

$10x + j20 - j5xy - j^2 10y = 90 - j70$

$(10x + 10y) + j(20 - 5xy) = 90 - j70$

$10x + 10y = 90$

$x + y = 9$

$x = 9 - y \Rightarrow$

$20 - 5xy = -70$

$20 - 5(9 - y)y = -70$

$5y(9 - y) = 90$

$y^2 - 9y + 18 = 0$

$$y = \frac{-(-9) \pm \sqrt{(-9)^2 - 4(1)(18)}}{2}$$

$$y = \frac{9 \pm 3}{2} = 6, 3$$

For $y = 6$, $x = 3$

$y = 3$, $x = 6$

($x = 3$, $y = 6$) or ($x = 6$, $y = 3$)

b. $\dfrac{80\angle 0°}{40\angle \theta} = 4\angle -\theta = 3.464 - j2 = 4\angle -30°$

$\theta = \mathbf{30°}$

52. a. **$160.0\angle 30°$**

b. **$25\times 10^{-3}\angle -40°$**

c. **$70.71\angle -90°$**

53. a. $\mathbf{14.14 \angle -180°}$

b. $\mathbf{4.24 \times 10^{-6} \angle 90°}$

c. $\mathbf{2.55 \times 10^{-6} \angle 70°}$

54. a. $\mathbf{56.57 \sin(377t + 20°)}$ b. $\mathbf{169.68 \sin(377t + 10°)}$

c. $\mathbf{11.31 \times 10^{-3} \sin(377t - 110°)}$ d. $\mathbf{6000 \sin(377t - 180°)}$

55. (Using peak values)

$e_{in} = v_a + v_b \Rightarrow v_a = e_{in} - v_b$

$= 60 \text{ V} \angle 90° - 20 \text{ V} \angle -45° = j60 \text{ V} - (14.142 \text{ V} - j14.142 \text{ V})$

$= j60 \text{ V} - 14.142 \text{ V} + j14.142 \text{ V} = -14.142 \text{ V} + j74.142 \text{ V}$

$= 75.479 \text{ V} \angle 100.8°$

and $\boldsymbol{v}_a = \mathbf{75.48 \sin(377t + 100.8°)}$

56. $i_s = i_1 + i_2 \Rightarrow i_1 = i_s - i_2$

(Using peak values) $= (20 \times 10^{-6} \text{ A} \angle 60°) - (6 \times 10^{-6} \text{ A} \angle -30°) = 20.88 \times 10^{-6} \text{ A} \angle 76.70°$

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

57. (Using peak values)

$e_{in} = v_a + v_b + v_c$

$v_a = e_{in} - v_b - v_c$

$= 120 \text{ V} \angle 30° - 30 \text{ V} \angle 60° - 40 \text{ V} \angle -90°$

$= (103.92 \text{ V} + j60 \text{ V}) - (15 \text{ V} + j25.981 \text{ V}) - (-j40 \text{ V})$

$= 88.92 \text{ V} + j74.02 \text{ V} = 115.70 \text{ V} \angle 39.775°$

$\boldsymbol{v_a = 115.70 \sin(377t + 39.78°)}$

58. (Using effective values)

$\mathbf{I}_s = \mathbf{I}_1 + \mathbf{I}_2 + \mathbf{I}_3$

$\mathbf{I}_1 = \mathbf{I}_s - \mathbf{I}_2 - \mathbf{I}_3$

$= 12.73 \text{ A} \angle 180° - 5.66 \text{ A} \angle 90° - 2[5.66 \text{ A} \angle 90°]$

$= 12.73 \text{ A} \angle 180° - 5.66 \text{ A} \angle 90° - 11.32 \text{ A} \angle 90°$

$= -12.73 \text{ A} - (j5.66 \text{ A}) - (j11.32 \text{ A}) = -12.73 \text{ A} - j16.98 \text{ A}$

$= 21.22 \text{ A} \angle -126.86°$

$= (1.414)(21.22 \text{ A}) \sin 377t$

$i_1 = \mathbf{30 \sin 377t}$