Solutions:

P10.2-2 Given the sinusoids \(v_1(t) = 8\cos(100t - 54^\circ)\) V and \(v_2(t) = 8\cos(100t - 102^\circ)\) V, determine the time by which \(v_2(t)\) is advanced or delayed with respect to \(v_1(t)\).

Solution:
The period of both sinusoids is \(T = \frac{2\pi}{100} = 62.8319\) ms
The difference in the phase angles is
\[\theta_2 - \theta_1 = -102^\circ - (-54^\circ) = -48^\circ\]
The delay time is
\[t_d = \frac{-48^\circ(62.8319)}{360^\circ} = -8.3776\] ms
(The minus sign indicates a delay.) The voltage \(v_2(t)\) is delayed by 8.3776 ms with respect to \(v_1(t)\).

P10.2-4 Express the voltage shown in Figure P10.2-4 in the general form
\[v(t) = A\cos(\omega t + \theta)\] V
where \(A \geq 0\) and \(-180^\circ < \theta \leq 180^\circ\).

![Figure P10.2-4](image)

Solution: The amplitude is \(A = 45\) mv and the period is given by \(T = 60 - 20 = 40\) ms so the period is \(T = 80\) ms. The frequency is given by \(\omega = \frac{2\pi}{80 \times 10^{-3}} = 78.54\) rad/s. Noticing that \(v(t)\) is 0 at time 0 and is increasing at time 0, we can write
\[v(t) = 45\sin(78.54t) = 45\cos(78.54t - 90^\circ)\] mV
P10.3-2 Express the voltage

\[ v(t) = 5\sqrt{2}\cos(8t) + 2\sin(8t + 45^\circ) \quad \text{V} \]

In the general form

\[ v(t) = A\cos(\omega t + \theta) \quad \text{V} \]

where \( A \geq 0 \) and \(-180^\circ < \theta \leq 180^\circ\).

Solution:

\[ v(t) = 5\sqrt{2}\cos(8t) + 2\sin(8t + 45^\circ) \]
\[ = 5\sqrt{2}\cos(8t) + 2\cos(8t + 45^\circ - 90^\circ) = 5\sqrt{2}\cos(8t) + 2\cos(8t - 45^\circ) \quad \text{V} \]

Representing the sinusoids using phasors gives:

\[ V(\omega) = 7.0711 + 10\angle -45^\circ = 7.0711 + (7.0711 - j7.0711) \]
\[ = 14.1422 - j7.0711 \approx 15.811\angle -26.6^\circ \quad \text{V} \]

The corresponding sinusoid is:

\[ v(t) = 15.811\cos(8t - 26.6^\circ) \quad \text{V} \]

P 10.3-5 Determine the polar and rectangular form of the expression

\[ \frac{(60 \angle 120^\circ)(-16 + j12 + 20\angle 15^\circ)}{5\angle -75^\circ} \]

Solution:

\[ \frac{(60 \angle 120^\circ)(-16 + j12 + 20\angle 15^\circ)}{5\angle -75^\circ} = \frac{(60 \angle 120^\circ)(-16 + j12 + 19.3185 + j5.1764)}{5\angle -75^\circ} \]
\[ = \frac{(60 \angle 120^\circ)(3.3185 + j17.1764)}{5\angle -75^\circ} \]
\[ = \frac{(60 \angle 120^\circ)(17.494 \angle 79.065^\circ)}{5\angle -75^\circ} \]
\[ = \frac{1049.6 \angle 160.93^\circ}{5\angle -75^\circ} = 139.95 \angle 109.07^\circ = 45.714 + j132.28 \]
P10.3-7 The circuit shown in Figure 10.3-7 is at steady state. The inputs to this circuit are the current source current

\[ i_1(t) = 0.12 \cos(100t + 45^\circ) \text{ A} \]

and the voltage source voltage

\[ v_2(t) = 24 \cos(100t - 60^\circ) \text{ V} \]

Determine the current \( i_2(t) \).

![Figure P10.3-7](image)

**Solution:** Using Ohm’s and Kirchhoff’s laws

\[
i_2(t) = i_1(t) - \frac{v_2(t)}{96} = 0.12 \cos (100t + 45^\circ) - \frac{24 \cos (100t - 60^\circ)}{96} = 0.12 \cos (100t + 45^\circ) - 0.25 \cos (100t - 60^\circ)
\]

Using phasors

\[
I_2(\omega) = 0.12 \angle 45^\circ - 0.25 \angle 60^\circ = (0.0849 + j0.0849) - (0.1250 - j0.2165) = -0.0401 + j0.3014 = 0.3040 \angle 97.6^\circ \text{ A}
\]

The corresponding sinusoid is

\[ i_2(t) = 0.3040 \cos (100t + 97.6^\circ) \text{ A} \]

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P 10.3-10 The circuit shown in Figure P 10.3-10 is at steady state. The voltages \( v_1(t) \) and \( v_2(t) \) are given by

\[ v_1(t) = 7.68 \cos (2t + 47^\circ) \text{ V} \]

\[ v_2(t) = 1.59 \cos (2t + 125^\circ) \text{ V} \]

Find the steady-state voltage \( v_1(t) \).

**Answer:** \( v_1(t) = 7.51 \cos (2t + 35^\circ) \text{ V} \)

**Solution:**

\[
V_1(\omega) = V_s(\omega) - V_2(\omega) = 7.68 \angle 47^\circ - 1.59 \angle 125^\circ = (5.23 + j5.62) - (-0.91 + 1.30) = (5.23 + 0.91) + j(5.62 - 1.30) = 6.14 + j4.32 = 7.51 \angle 35^\circ
\]

\[ v_1(t) = 7.51 \cos (2t + 35^\circ) \text{ V} \]