ECE241
HW #7
SOLUTION

Problems from "Introduction to Electric Circuits", Svoboda and Dorf, 9th ed. Pages 482-484.

1) P 10.2-2
2) P 10.2-4
3) P 10.3-2
4) P 10.3-5
5) P 10.3-7
6) P 10.3-10

SOLUTIONS:

P10.2-2 Given the sinusoids $v_1(t) = 8\cos(100t - 54°)$ V and $v_2(t) = 8\cos(100t - 102°)$ 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

$$\theta_2 - \theta_1 = -102° - (-54°) = -48°$$

The delay time is $t_d = \frac{-48°(62.8319)}{360°} = -8.3776$ ms

(The minus sign indicates a delay.) The voltage $v_2(t)$ is delayed by 48.3776 ms with respect to $v_1(t)$.

P10.2-4 Express the voltage shown in Figure P10.2-4 in the general form

$$v(t) = A\cos(\omega t + \theta) \text{ V}$$

where $A \ge 0$ and $-180° < \theta \le 180°$.

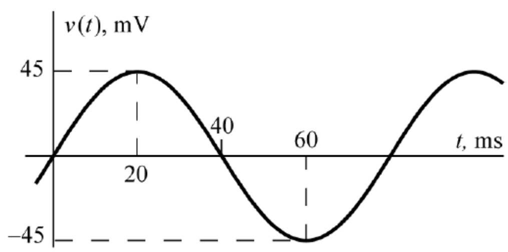

Figure P10.2-4

Solution: The amplitude is *A* = 45 mv and the period is given by $\frac{T}{2} = 60 - 20 = 40$ 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

$$v(t) = 45\sin(78.54t) = 45\cos(78.54t - 90°) \text{ mV}$$

P10.3-2 Express the voltage

$$v(t) = 5\sqrt{2}\cos(8t) + 2\sin(8t + 45°) \text{ V}$$

In the general form

$$v(t) = A\cos(\omega t + \theta) \text{ V}$$

where $A \geq 0$ and $-180° < \theta \leq 180°$.

Solution:

$$v(t) = 5\sqrt{2}\cos(8t) + 2\sin(8t + 45°)$$

$$= 5\sqrt{2}\cos(8t) + 2\cos(8t + 45° - 90°) = 5\sqrt{2}\cos(8t) + 2\cos(8t - 45°) \text{ V}$$

Representing the sinusoids using phasors gives:

$$\mathbf{V}(\omega) = 7.0711 + 10\angle -45° = 7.0711 + (7.0711 - j\,7.0711)$$

$$= 14.1422 - j\,7.0711 = 15.811\angle -26.6° \text{ V}$$

The corresponding sinusoid is:

$$v(t) = 15.811\cos(8t - 26.6°) \text{ V}$$

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

$$\frac{(60\angle 120°)(-16 + j12 + 20\angle 15°)}{5\angle -75°}$$

Solution:

$$\frac{(60\angle 120°)(-16 + j12 + 20\angle 15°)}{5\angle -75°} = \frac{(60\angle 120°)(-16 + j12 + 19.3185 + j\,5.1764)}{5\angle -75°}$$

$$= \frac{(60\angle 120°)(3.3185 + j17.1764)}{5\angle -75°}$$

$$= \frac{(60\angle 120°)(17.494\angle 79.065°)}{5\angle -75°}$$

$$= \frac{1049.6\angle -160.93°}{5\angle -75°} = 139.95\angle 109.07° = 45.714 + j\,132.28$$

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

$$i_1(t) = 0.12\cos(100t + 45°) \text{ A}$$

and the voltage source voltage

$$v_2(t) = 24\cos(100t - 60°) \text{ V}$$

Determine the current $i_2(t)$.

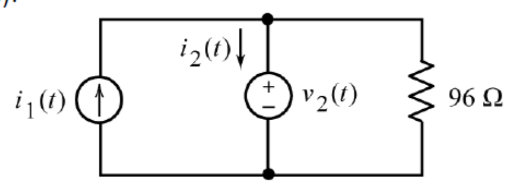

Figure P10.3-7

Solution: Using Ohm's and Kirchhoff's laws

$$i_2(t) = i_1(t) - \frac{v_2(t)}{96} = 0.12\cos(100t + 45°) - \frac{24\cos(100t - 60°)}{96}$$
$$= 0.12\cos(100t + 45°) - 0.25\cos(100t - 60°)$$

Using phasors

$$\mathbf{I}_2(\omega) = 0.12\angle 45° - 0.25\angle 60° = (0.0849 + j0.0849) - (0.1250 - j0.2165)$$
$$= -0.0401 + j0.3014 = 0.3040\angle 97.6° \text{ A}$$

The corresponding sinusoid is

$$i_2(t) = 0.3040\cos(100t + 97.6°) \text{ A}$$

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

$$v_s(t) = 7.68 \cos(2t + 47°) \text{ V}$$

and

$$v_2(t) = 1.59 \cos(2t + 125°) \text{ V}$$

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

Answer: $v_1(t) = 7.51 \cos(2t + 35°)$ V

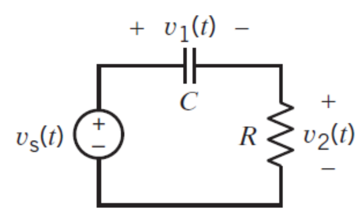

Figure P 10.3-10

Solution:

$$\mathbf{V}_1(\omega) = \mathbf{V}_s(\omega) - \mathbf{V}_2(\omega) = 7.68\angle 47° - 1.59\angle 125°$$
$$= (5.23 + j5.62) - (-0.91 + 1.30)$$
$$= (5.23 + 0.91) + j(5.62 - 1.30)$$
$$= 6.14 + j4.32$$
$$= 7.51\angle 35°$$

$$v_1(t) = 7.51\cos(2t + 35°) \text{ V}$$