Tutorial - 1-02-g

Question 0

Find the relationship between dc supply power and ac supply power, by using the setup shown below:

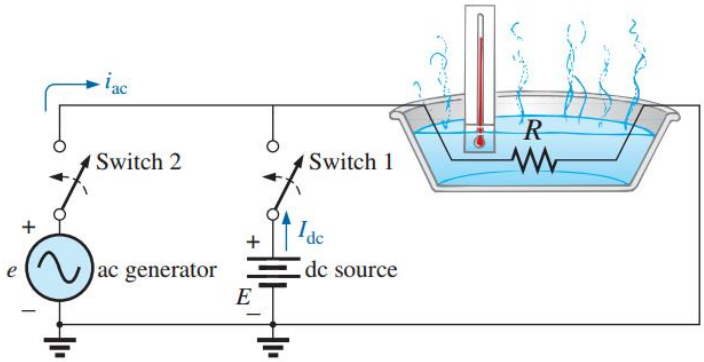
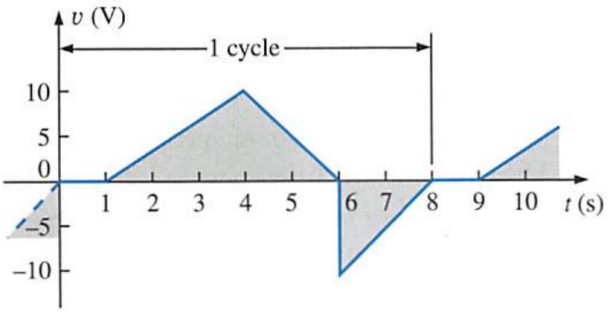


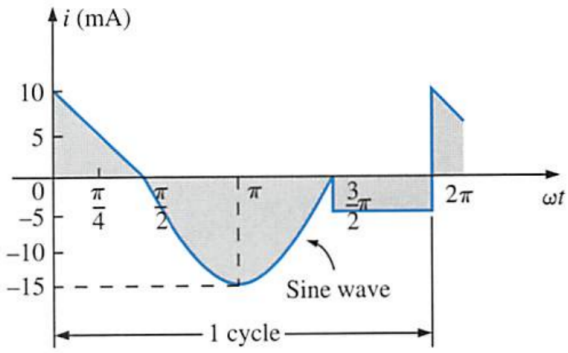
FIG. 13.59
An experimental setup to establish a relationship between dc and ac quantities.

Question 1 (13-39)

39. Find the average value of the periodic waveforms of Fig. 13.92 over one full cycle.



(a)



(b)

FIG. 13.92
Problem 39.

Question 2 (13-45)

45. Find the effective value of the periodic waveform of Fig. 13.96 over one full cycle.

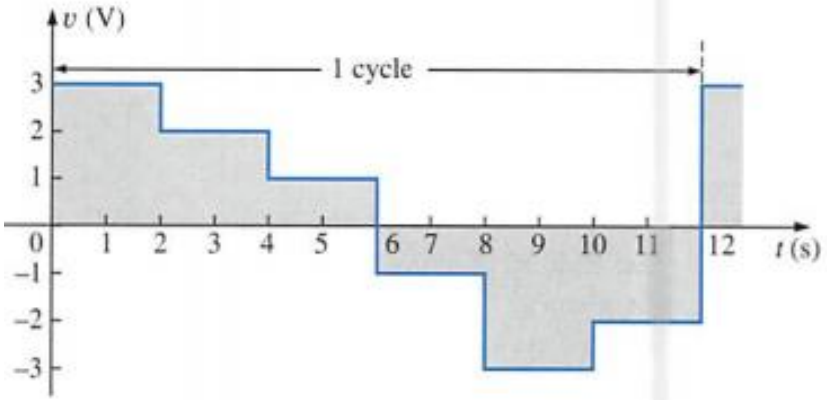


FIG. 13.96
Problem 45.

Question 3 (14-35)

35. In Fig. 14.75, $e = 100 \sin(157t + 30°)$.

a. Find the sinusoidal expression for i.

b. Find the value of the inductance L.

c. Find the average power loss by the inductor.

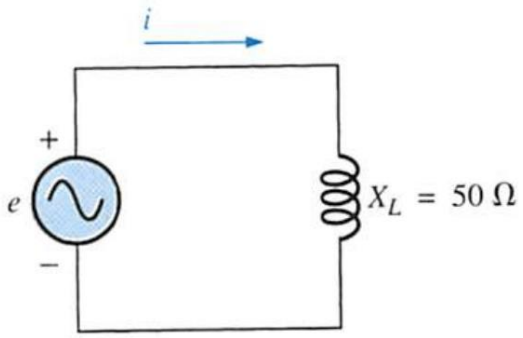


FIG. 14.75

Question 4 (14-47)

47. **a.** Determine a solution for x and y if

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

b. Determine x if

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

c. Determine a solution for x and y if

$$(5x + j10)(2 - jy) = 90 - j70$$

d. Determine θ if

$$\frac{80\angle 0^\circ}{20\angle \theta} = 3.464 - j2$$

Question 5 (14-52)

52. Find the sinusoidal expression for the applied voltage e for the system of Fig. 14.81 if

$$v_a = 60\sin(\omega t + 30^\circ)$$
$$v_b = 30\sin(\omega t - 30^\circ)$$
$$v_c = 40\sin(\omega t + 120^\circ)$$

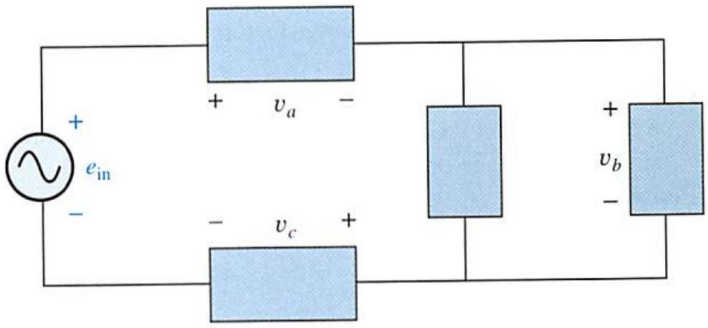


FIG. 14.81
Problem 52.

SOLUTION

Q0

The power delivered by the ac supply at any instant of time is

$$P_{ac} = (i_{ac})^2 R = (I_m \sin \omega t)^2 R = (I_m^2 \sin^2 \omega t) R$$

However,

$$\sin^2 \omega t = \frac{1}{2}(1 - \cos 2\omega t) \qquad \text{(trigonometric identity)}$$

Therefore,

$$P_{ac} = I_m^2 \left[\frac{1}{2}(1 - \cos 2\omega t)\right] R$$

and

$$\boxed{P_{ac} = \frac{I_m^2 R}{2} - \frac{I_m^2 R}{2} \cos 2\omega t} \qquad \textbf{(13.30)}$$

Equating the average power delivered by the ac generator to that delivered by the dc source,

$$P_{av(ac)} = P_{dc}$$

$$\frac{I_m^2 R}{2} = I_{dc}^2 R$$

and

$$I_{dc} = \frac{I_m}{\sqrt{2}} = 0.707 I_m$$

which, in words, states that

the equivalent dc value of a sinusoidal current or voltage is $1/\sqrt{2}$ or 0.707 of its peak value.

Q1

39. a. $$G = \frac{\frac{1}{2}(3\text{ s})(10\text{ V}) + \frac{1}{2}(2\text{ s})(10\text{ V}) - \frac{1}{2}(2\text{ s})(10\text{ V})}{8\text{ s}}$$
$$= \frac{15\text{ V} + 10\text{ V} - 10\text{ V}}{8} = 1.875\text{ V}$$

b. $$G = \frac{\frac{1}{2}\left[\frac{\pi}{2}\right](10\text{ mA}) - 2(15\text{ mA}) - \frac{\pi}{2}(5\text{ mA})}{2\pi}$$
$$= \frac{2.5\pi\text{ mA} - 30\text{ mA} - 2.5\pi\text{ mA}}{2\pi}$$
$$= \frac{-30\text{ mA}}{2\pi} = -4.775\text{ mA}$$

Q2

45. $$V_{\text{eff}} = \sqrt{\frac{(3\text{ V})^2(2\text{ s}) + (2\text{ V})^2(2\text{ s}) + (1\text{ V})^2(2\text{ s}) + (-1\text{ V})^2(2\text{ s}) + (-3\text{ V})^2(2\text{ s}) + (-2\text{ V}^2(2\text{ s})}{12\text{ s}}}$$
$$= +2.16\text{ V}$$

Q3

35. a. $$I_m = \frac{V_m}{X_L} = \frac{100\text{ V}}{50\ \Omega} = 2\text{ A},\ i = 2\sin(157t - 60°)$$

b. $$X_L = \frac{V_m}{I_m} = \frac{100\text{ V}}{2\text{ A}} = 50\ \Omega,\ L = \frac{X_L}{\omega} = \frac{50\ \Omega}{157\text{ rad/s}} = 318.47\text{ mH}$$

c. $L \Rightarrow 0$ W

Q4

47. a. $$x + j4 + 3x + jy - j7 = 16$$
$$(x + 3x) + j(4 + y - 7) = 16 + j0$$
$$x + 3x = 16 \qquad 4 + y - 7 = 0$$
$$4x = 16 \qquad y = +7 - 4$$
$$x = 4 \qquad y = 3$$

b. $$(10\ \angle 20°)(x\ \angle -60°) = 30.64 - j25.72$$
$$10x\ \angle -40° = 40\ \angle -40°$$
$$10x = 40$$
$$x = 4$$

c. $5x + j10$
$2 - jy$

$10x + j20 - j5xy - j^2 10y = 90 - j70$
$(10x + 10y) + j(20 - 5xy) = 90 - j70$
$10x + 10y = 90$ $\qquad$ $20 - 5xy = -70$
$x + y = 9$
$x = 9 - y \Rightarrow$ $\qquad$ $20 - 5(9 - y)y = -70$
$5y(9 - y) = 90$
$y^2 - 9y + 18 = 0$

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

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

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

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

Q5

52. $e = v_a + v_b + v_c$
$= 60 \text{ V} \angle 30° + 30 \text{ V} \angle -30° + 40 \text{ V} \angle 120°$
$= (51.96 + j30) + (25.98 - j15) + (-20 + j34.64)$
$= 57.94 + j49.64$
$= 76.297 \text{ V} \angle 40.59°$
and $e = 76.297 \sin(\omega t + 40.59°)$