PROBLEMS

Section 11.3 Instantaneous Power and Average Power

P 11.3-1 An *RLC* circuit is shown in Figure P 11.3-1. Find the instantaneous power delivered to the inductor when $i_s = 1 \cos \omega t$ A and $\omega = 6283$ rad/s.

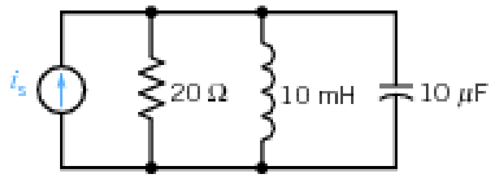
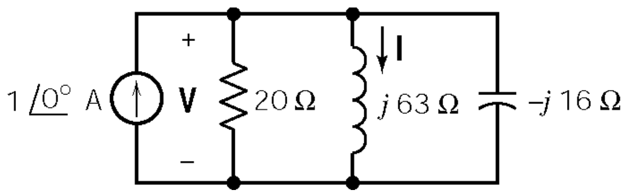


Figure P 11.3-1

Solution:



$$1\angle 0° = \frac{\mathbf{V}}{20} + \frac{\mathbf{V}}{j63} + \frac{\mathbf{V}}{-j16} \Rightarrow \mathbf{V} = 14.6\angle -43° \text{ V}$$

$$\mathbf{I} = \frac{\mathbf{V}}{j63} = 0.23\angle -133° \text{ A}$$

$$\begin{aligned} p(t) = i(t)v(t) &= 0.23\cos\ (2\pi \cdot 10^3 t - 133^\circ) \times 14.6\ \cos\ (2\pi \cdot 10^3 t - 43^\circ) \\ &= 3.36\ \cos\ (2\pi \cdot 10^3 t - 133^\circ)\ \cos\ (2\pi \cdot 10^3 t - 43^\circ) \\ &= 1.68\ (\cos\ (90^\circ) + \cos\ (4\pi \cdot 10^3 t - 176^\circ)) \\ &= 1.68\ \cos\ (4\pi \cdot 10^3 t - 176^\circ) \end{aligned}$$

P 11.3-8

(a) Find the average power delivered by the source to the circuit shown in Figure P 11.3-8.

(b) Find the power absorbed by resistor R_1.

Answer: (a) 30 W

(b) 20 W

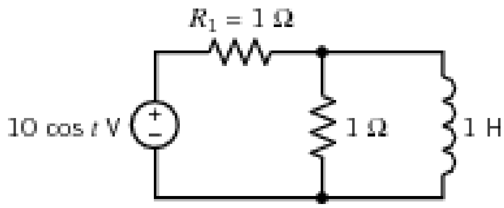
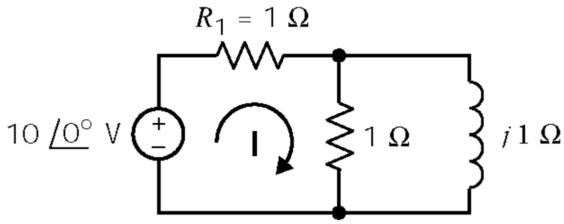


Figure P 11.3-8

Solution:



The equivalent impedance of the parallel resistor and inductor is $\mathbf{Z} = \dfrac{(1)(j)}{1+j} = \dfrac{1}{2}(1+j)\ \Omega$. Then

$$\mathbf{I} = \frac{10\angle 0^\circ}{1+\frac{1}{2}(1+j)} = \frac{20}{3+j} = \frac{20}{\sqrt{10}}\angle -18.4^\circ \text{ A}$$

(a) $P_{\text{source}} = \dfrac{|\mathbf{I}||\mathbf{V}|}{2}\cos\theta = \dfrac{(10)\left(\frac{20}{\sqrt{10}}\right)}{2}\cos(-18.4^\circ) = 30.0\ \text{ W}$

(b) $P_{R_1} = \dfrac{|\mathbf{I}|^2 R_1}{2} = \dfrac{\left(\frac{20}{\sqrt{10}}\right)^2 (1)}{2} = 20 \text{ W}$

P 11.3-2 Find the average power absorbed by the 0.6-kΩ resistor and the average power supplied by the current source for the circuit of Figure P 11.3-2.

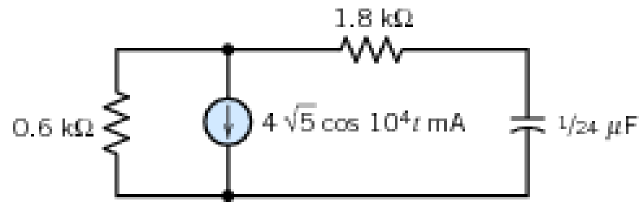
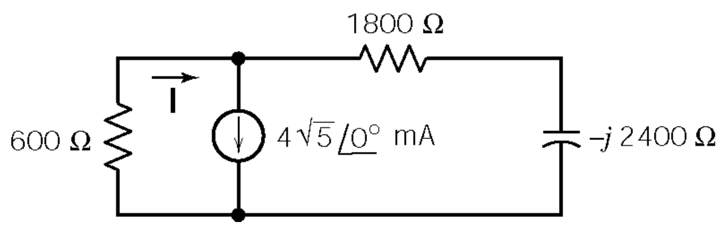


Figure P 11.3-2

Solution:



Current division:

$$\mathbf{I} = 4\sqrt{5}\left[\frac{1800 - j2400}{1800 - j2400 + 600}\right] = 5\sqrt{\frac{5}{2}}\angle -8.1° \text{ mA}$$

$$P_{600\Omega} = \frac{|\mathbf{I}|^2\, 600}{2} = 300(25)\left(\frac{5}{2}\right) = 1.875\times10^4 \ \mu\text{W} = 18.75 \text{ mW}$$

$$P_{\text{source}} = \frac{|\mathbf{V}||\mathbf{I}|\cos\theta}{2} = \frac{1}{2}(600)\left(5\sqrt{\frac{5}{2}}\right)\left(4\sqrt{5}\right)\cos(-8.1^\circ) = 2.1\times10^4 \ \mu\text{W} = 21 \text{ mW}$$