Examp:

Let us calculate the power absorbed by each element in the circuit given in Example 4.6.

Figure 4.23 shows the circuit in the frequency domain, where the currents $I_1 = 1.30/2.49^\circ$ A and $I_2 = 1.24/-15.9^\circ$ A were previously determined.

![Circuit diagram]

Fig. 4.23 Circuit from Example 4.6.

Since $|I_2| = 1.24$ A, the average power absorbed by the 3-$\Omega$ resistor is

$$P_3 = \frac{1}{2} R_3 |I_2|^2 = \frac{1}{2} (3)(1.24)^2 = 2.31 \text{ W}$$

By Ohm's law, $V_2 = 3I_2 = 3(1.24/-15.9^\circ) = 3.72/-15.9^\circ$ V. By KVL,

$$V_2 = 2V_1 + V_1 = 3V_1 \quad \Rightarrow \quad V_1 = \frac{V_2}{3} = 1.24/-15.9^\circ \text{ V}$$

The average power absorbed by the dependent voltage source is

$$P_d = \frac{1}{2} |2V_1||I_d| \cos[\text{ang}(2V_1) - \text{ang}(I_d)]$$

Since $2V_1 = 2(1.24/-15.9^\circ) = 2.48/-15.9^\circ$ V, then $|2V_1| = 2.48$ and $\text{ang}(2V_1) = -15.9^\circ$. Also, since $I_d = -I_2 = (-1)I_2 = (1/180^\circ)(1.24/-15.9^\circ) = 1.24/164^\circ$ A, then $|I_d| = 1.24$ A and $\text{ang}(I_d) = 164^\circ$. Thus

$$P_d = \frac{1}{2}(2.48)(1.24) \cos(-15.9^\circ - 164^\circ) = -1.54 \text{ W}$$
4.18 For the circuit shown in Fig. P4.17, find the Thévenin equivalent of the circuit in the shaded box when \( v_s(t) = 4 \cos(2t - 60^\circ) \) V. Use this to determine \( v_o(t) \).

4.19 Find the frequency-domain Thévenin equivalent (to the left of terminals \( a \) and \( b \)) of the circuit shown in Fig. 4.20 on p. 211. (Hint: Use the fact that \( Z_v = V_{oc}/I_{oc} \).)

4.20 The frequency-domain Thévenin equivalent of a circuit having \( \omega = 5 \) rad/s has \( V_{oc} = 3.71 - 15.9^\circ \) V and \( Z_o = 2.38 - j0.667 \) Ω. Determine a corresponding time-domain Thévenin-equivalent circuit.

4.21 For the op-amp circuit shown in Fig. P4.21, find \( v_o(t) \) when \( v_i(t) = 6 \sin 2t \) V.

4.22 For the op-amp circuit given in Fig. P4.22, find \( v_o(t) \) when \( v_i(t) = 3 \cos 2t \) V.

4.23 For the op-amp circuit shown in Fig. P4.23, find \( v_o(t) \) when \( v_i(t) = 4 \cos(2t - 30^\circ) \) V. (See p. 258.)

4.24 For the circuit shown in Fig. P4.24, find the currents \( I_1 \) and \( I_2 \) when \( V_{s1} = 250\sqrt{2}/-30^\circ \) V, \( V_{s2} = 250\sqrt{2}/-90^\circ \) V, and \( Z = 78 - j45 \) Ω.

4.25 Use mesh analysis to find \( I_1 \) and \( I_2 \) for the circuit given in Fig. P4.25 when \( V_{s1} = 250\sqrt{2}/-30^\circ \) V, \( V_{s2} = 250\sqrt{2}/-90^\circ \) V, and \( Z = 26 - j15 \) Ω.

4.26 For the circuit shown in Fig. P4.9, when \( i_i(t) = 5 \cos 3t \) A then \( v_o(t) = 4.47 \cos(3t + 26.6^\circ) \) V. Find the average power absorbed by each element in the circuit.

4.27 For the circuit shown in Fig. P4.17, when \( v_s(t) = 10 \cos 4t \) V, then the Thévenin equivalent of the portion of the circuit in the shaded box is \( V_{oc} = \)
4.28 For the RLC circuit shown in Fig. P4.28, suppose that \( v_s(t) = 10 \cos 3t \) V. Find the average power absorbed by the 4-\( \Omega \) resistor for the case that (a) \( C = \frac{1}{8} \) F; (b) \( C = \frac{1}{18} \) F; (c) \( C = \frac{1}{10} \) F.

4.29 For the circuit shown in Fig. P4.29, suppose that \( v_s(t) = 8 \cos 2t \) V. Find the average power absorbed by each element in the circuit for the case that \( Z_L = 1 \) \( \Omega \).

4.30 For the circuit shown in Fig. P4.29, change the value of the resistor to 2 \( \Omega \) and the value of the capacitor to \( \frac{1}{4} \) F. Suppose that \( v_s(t) = 8 \cos 2t \) V. (a) Find the load impedance \( Z_L \) that absorbs the maximum average power, and determine this power. (b) Find the load resistance \( R_L \) that absorbs the maximum power for resistive loads, and determine this power.

4.31 For the op-amp circuit given in Fig. P4.21, when \( v_s(t) = 6 \sin 2t \) V, then the output voltage \( v_o(t) = 13.4 \cos(2t - 117^\circ) \) V. Find the average power absorbed by each element.

4.32 For the op-amp circuit given in Fig. P4.22, when \( v_s(t) = 3 \cos 2t \) V, then the output voltage \( v_o(t) = 10.6 \cos(2t + 135^\circ) \) V. Find the average power absorbed by each element.

4.33 For the op-amp circuit given in Fig. P4.23, when \( v_s(t) = 4 \cos(2t - 30^\circ) \) V, then \( v_1(t) = 1.6\cos(2t - 66.9^\circ) \) V and \( v_o(t) = 1.6\cos(2t + 23.1^\circ) \) V. Find the average power absorbed by each element.

4.34 For the circuit given in Fig. P4.24, when \( V_{s1} = 250\sqrt{2}/-30^\circ \) V, \( V_{s2} = 250\sqrt{2}/-90^\circ \) V, and \( Z = 78 - j45 \Omega \), then \( I_1 = 6.8/30^\circ \) A and \( I_2 = 6.8/90^\circ \) A. (a) Find the average power absorbed by each impedance. (b) Find the average power supplied by each source.

4.35 For the circuit given in Fig. P4.25, when \( V_{s1} = 250\sqrt{2}/-30^\circ \) V, \( V_{s2} = 250\sqrt{2}/-90^\circ \) V, and \( Z = 26 - j15 \Omega \), then \( I_1 = 6.8/30^\circ \) A and \( I_2 = 6.8/90^\circ \) A. (a) Find the average power absorbed by each impedance. (b) Find the average power supplied by each source.