Chapter 11, Solution 16.

For the circuit in Fig. 11.47, find the maximum power that can be delivered to the load $\mathbf{Z}_L$.

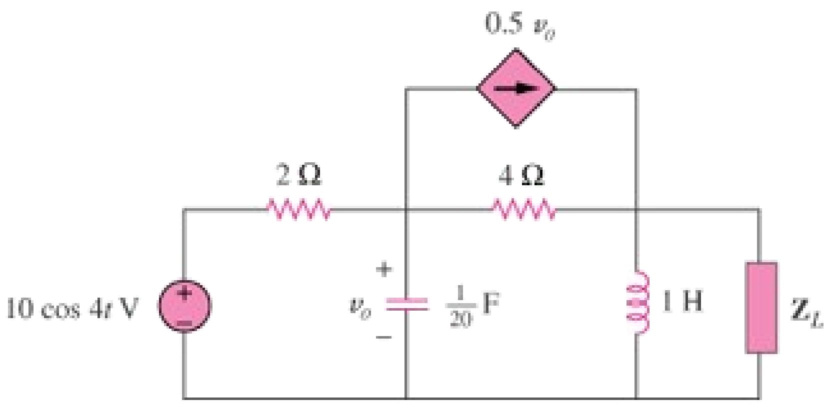
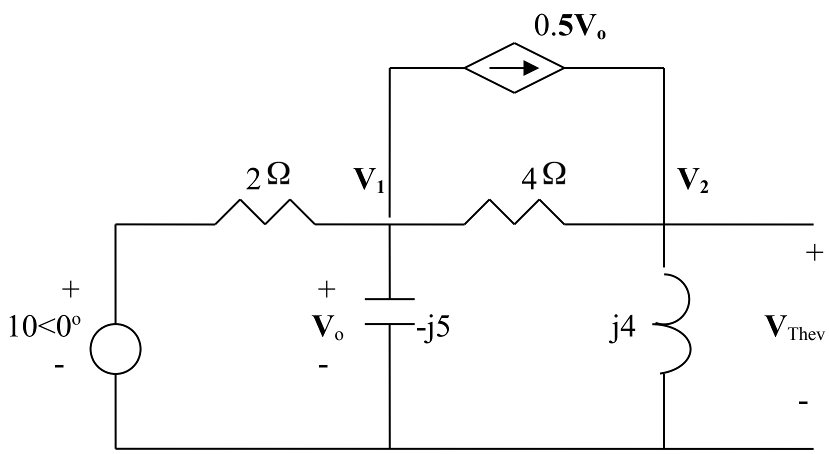


Figure 11.47
For Prob. 11.16.

Solution

$$\omega = 4, \quad 1\text{H} \longrightarrow j\omega L = j4, \quad 1/20\text{F} \longrightarrow \frac{1}{j\omega C} = \frac{1}{j4x1/20} = -j5$$

We find the Thevenin equivalent at the terminals of Z_L. To find V_{Thev}, we use the circuit shown below.



At node 1,

$$\frac{10 - V_1}{2} = \frac{V_1}{-j5} + 0.5V_1 + \frac{V_1 - V_2}{4} \longrightarrow 5 = V_1(1.25 + j0.2) - 0.25V_2 \qquad (1)$$

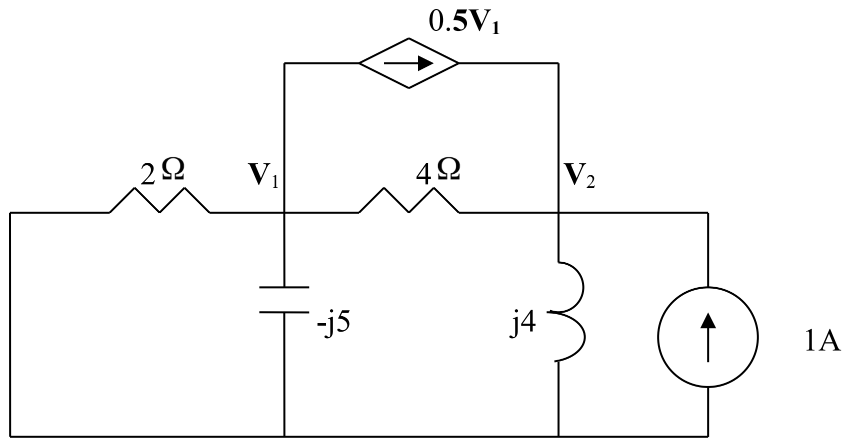
At node 2,

$$\frac{V_1 - V_2}{4} + 0.25V_1 = \frac{V_2}{j4} \longrightarrow 0 = 0.5V_1 + V_2(-0.25 + j0.25) \qquad (2)$$

Solving (1) and (2) leads to

$$V_{Thev} = V_2 = 6.1947 + j7.0796 = 9.4072\angle 48.81^o$$

To obtain R_{eq}, consider the circuit shown below. We replace Z_L by a 1-A current source.



At node 1,

$$\frac{V_1}{2}+\frac{V_1}{-j5}+0.25V_1+\frac{V_1-V_2}{4}=0 \longrightarrow 0=V_1(1+j0.2)-0.25V_2 \qquad (3)$$

At node 2,

$$1+\frac{V_1-V_2}{4}+0.25V_1=\frac{V_2}{j4} \longrightarrow -1=0.5V_1+V_2(-0.25+j0.25) \qquad (4)$$

Solving (1) and (2) gives

$$Z_{eq}=\frac{V_2}{1}=1.9115+j3.3274=3.837\angle 60.12^o$$

and $\mathbf{Z_L} = 3.837\angle{-60.12^\circ}\ \Omega$

$$P_{max}=\frac{|V_{Th}|^2}{2|Z_{eq}-Z_L|^2}1.9115=\frac{9.4072^2}{2x4x1.9115}=$$ **5.787 W**