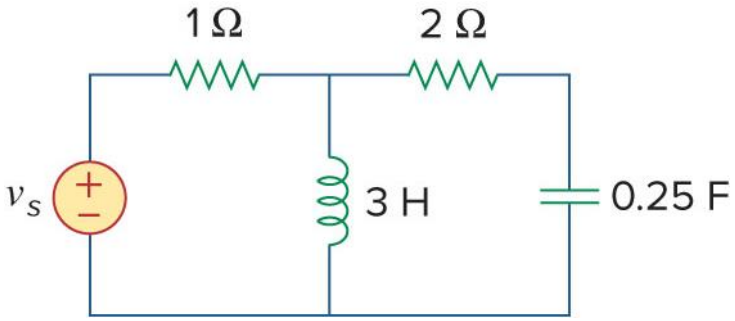
School of Electrical Engineering & Telecommunications

ELEC1111 Tutorial

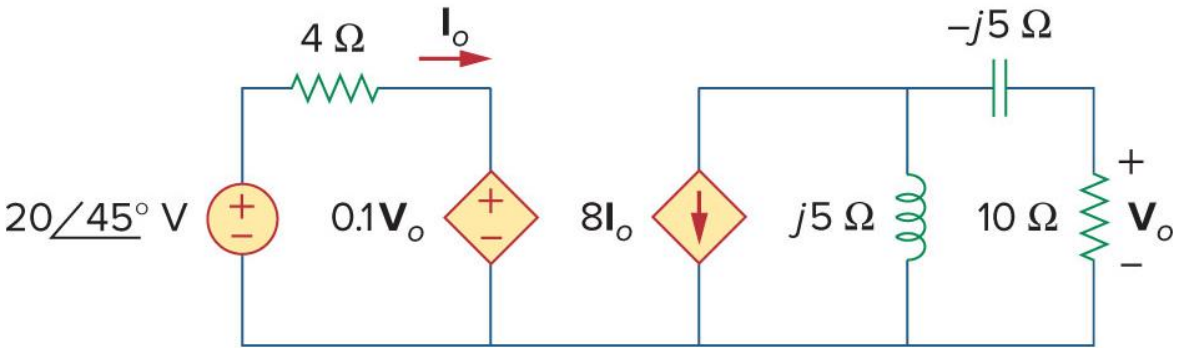
Topic 9: AC Power

1. Assuming that $v_s = 8\cos(2t - 40°)$ V in the circuit below, find the average power delivered to each of the passive elements and supplied by the voltage source. Then, verify the conservation of energy principle for average power.



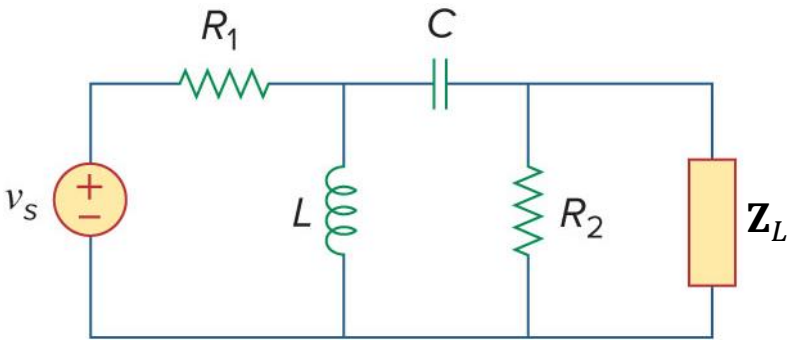
Answer: $P_{1\Omega} = 1.416$ W, $P_{2\Omega} = 5.097$ W, $P_{3\text{H}} = P_{0.25\text{F}} = 0$ W, $P_{v_s} = 6.513$ W

2. In the circuit given below, determine the average power absorbed by the 10-Ω resistor.



Answer: $P_{10\Omega} = 1$ kW

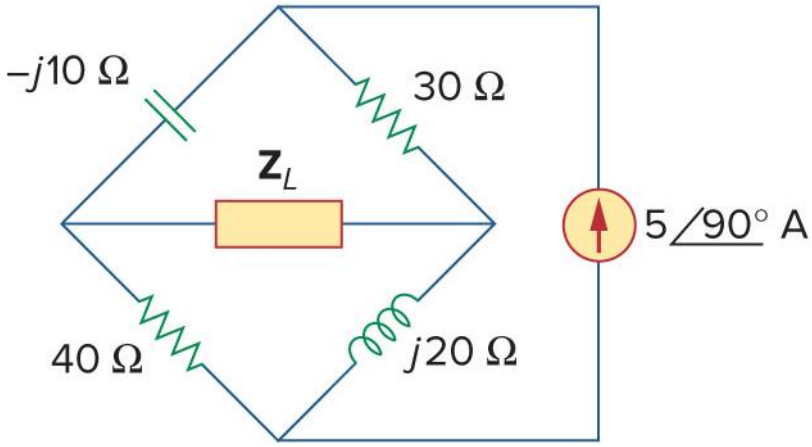
3. Determine the value of the load impedance $\mathbf{Z}_L$ such that the circuit can deliver maximum average power transfer if $R_1 = R_2 = 100\ \Omega$, $\mathbf{Z}_C = -j100\ \Omega$, $\mathbf{Z}_L = j100\ \Omega$, and $\mathbf{V}_s = 100\angle 0°\ \text{V}$. Then find the maximum average power absorbed by $\mathbf{Z}_L$



Answer: $\mathbf{Z}_L = \mathbf{Z}_{\text{Th}}^* = 40 + j20\ \Omega$, $P_{\max} = \frac{|\mathbf{V}_{\text{Th}}|^2}{8R_{\text{Th}}} = 6.25\ \text{W}$

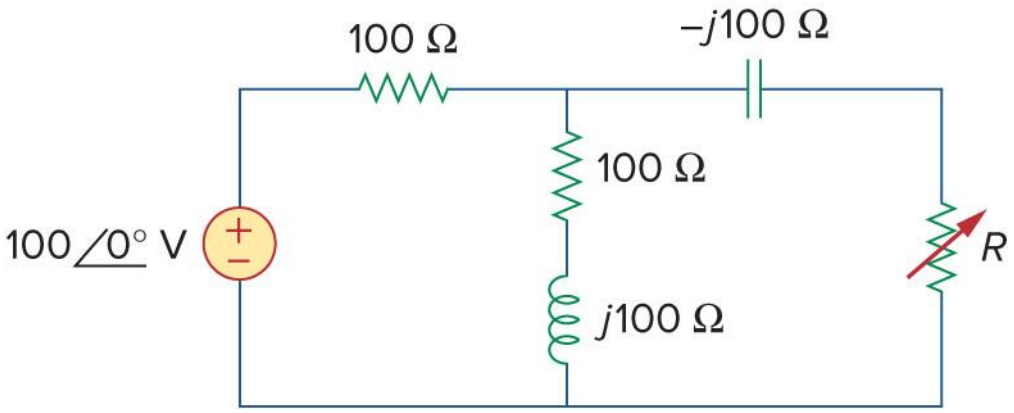
Hint: You need to find Thevenin equivalent circuit at the load terminals and use the maximum average power transfer formula given in the Answer

4. For the circuits shown below, find the value of load impedance $\mathbf{Z}_L$ for maximum average power transfer and then calculate the maximum average power absorbed by it.



Answer: $\mathbf{Z}_L = \mathbf{Z}_{\text{Th}}^* = 20\ \Omega$, $P_{\max} = \frac{|\mathbf{V}_{\text{Th}}|^2}{8R_{\text{Th}}} = 31.25\ \text{W}$

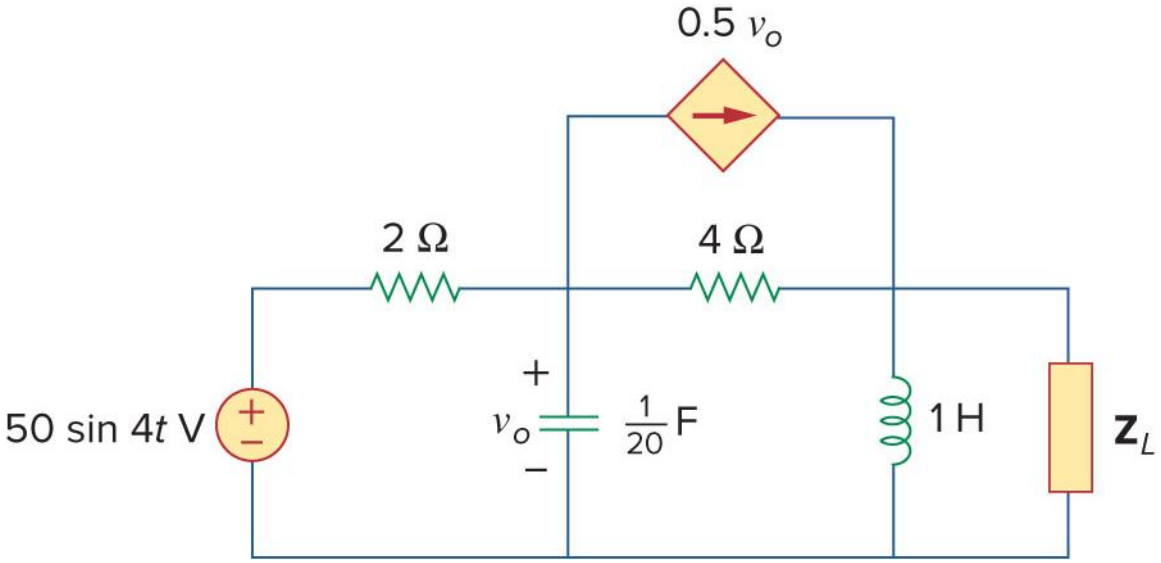
5. If the load is pure resistive R_L, what should be the value of R_L that it will receive the maximum average power from the circuit. Then calculate the power absorbed by R_L.



Answer: $R_L = |\mathbf{Z}_{\text{Th}}| = 100\ \Omega$, $P_{\max} = \frac{1}{2} R_L |\mathbf{I}_L|^2 = 6.25\ \text{W}$

Hint: For a pure resistive load, the condition for maximum average power transfer is $R_L = |\mathbf{Z}_{\text{Th}}|$. Then, simply find the average power absorbed by R_L as the maximum average power.

6. For the circuit shown below,
   a) Find the Thevenin equivalent circuit as seen from the terminals of the load impedance $\mathbf{Z}_L$, and draw the equivalent circuit.
   b) Determine the value of the load $\mathbf{Z}_L$ for maximum average power transfer.
   c) Calculate the maximum average power that can be delivered to the load $\mathbf{Z}_L$ from this circuit.



Answer:

a) $\mathbf{V}_{\mathrm{Th}} = 59.43\angle(-33.69°)\ \mathrm{V} = 49.45 - j32.96\ \mathrm{V}$,

$\mathbf{Z}_{\mathrm{Th}} = 1.67 + j3.648\ \Omega = 4.0125\angle 65.4°\ \Omega$

b) $\mathbf{Z}_L = \mathbf{Z}_{\mathrm{Th}}^* = 1.67 - j3.648\ \Omega = 4.0125\angle(-65.4°)\ \Omega$

c) $P_{\max} = \frac{|\mathbf{V}_{\mathrm{Th}}|^2}{8R_{\mathrm{Th}}} = 264.34\ \mathrm{W}$