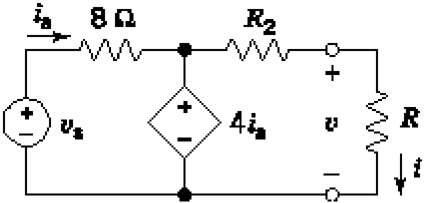
ECSE 200 - Electric Circuits 1
Tutorial 7

ECE Dept., McGill University

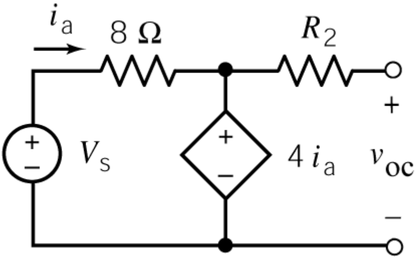
Problem P 5.6-1

The circuit model for a photovoltaic cell is given in figure. The current i_a is proportional to the solar insolation (kW/m^2).
(a) Find the load resistance, R, and maximum power transfer when $i_a = 1$ A and R_2 =4 Ω



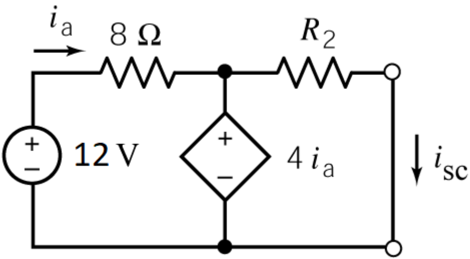
Problem P 5.6-1 Solution

(a) The value of the current in R_2 is 0 A so $v_{oc} = 4i_a = 4$ V. Then KVL gives
$8i_a + 4i_a - V_s = 0 \Rightarrow V_s = 12i_a = 12$ V



Problem P 5.6-1 Solution

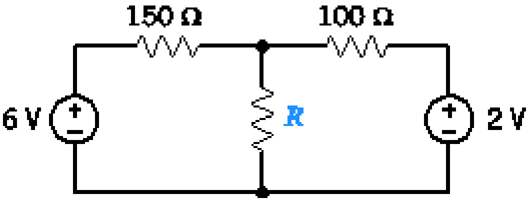
Next, KVL gives,
$4i_a = R_2 i_{sc} \Rightarrow i_{sc} = 1$ A



(b) The power delivered to the resistor to the right of the terminals is maximized by setting R equal to the Thevenin resistance of the part of the circuit to the left of the terminals:
$R = R_t = \frac{V_{oc}}{i_{sc}} = \frac{4}{1} = 4\ \Omega$. and $P_{max} = \frac{v_{oc}^2}{4R_t} = 2$ W

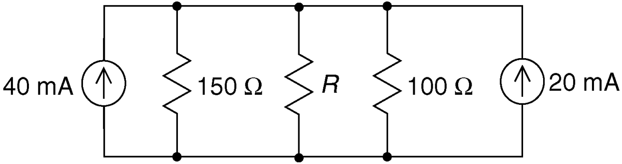
Problem P 5.6-3

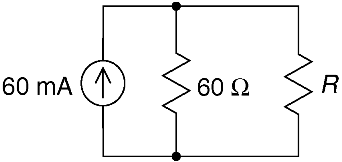
Find the maximum power transfer to R in the figure.



Problem P 5.6-3 Solution

Reduce the circuit using source transformations:



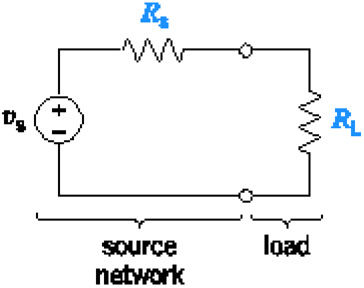


Then maximum power will be dissipated in resistor R when: R $= R_t = 60$ Ωand the value of that maximum power is

$P_{max} = {i_R}^2 = (0.03)^2(60) =$54 mW

Problem P 5.6-4

For the circuit in figure, prove that for R_s (source resistance) variable and R_L fixed, the power dissipated in R_L is maximum when $R_s = 0$.

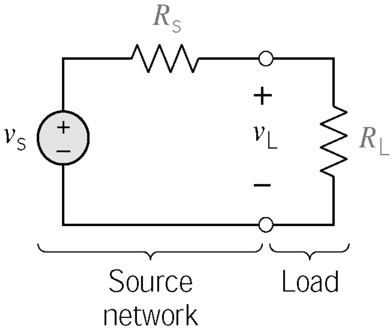


Problem P 5.6-4 Solution

$$V_L = V_s \frac{R_L}{R_s + R_L}$$

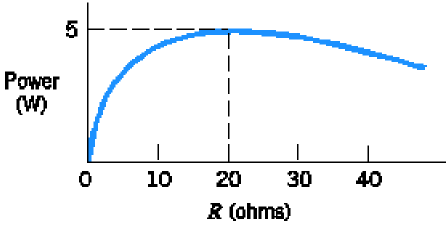
$$\therefore p_L = \frac{{V_L}^2}{R_L} = \frac{{V_s}^2 R_L}{(R_s + R_L)^2}$$

By inspection, p_L is max when you reduce R_s to get the smallest denominator. $\therefore$ set $R_s = 0$



Problem P 5.6-9

A resistive circuit was connected to a variable resistor, and the power delivered to the resistor was measured as shown in Figure. Determine the Thevenin equivalent circuit.



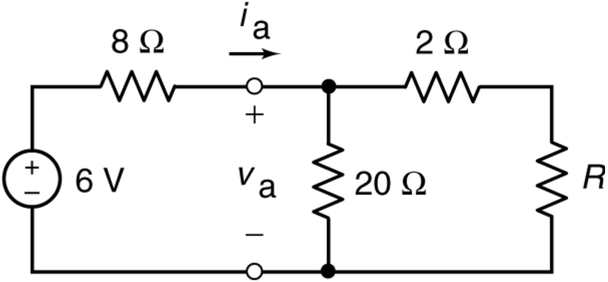
Problem P 5.6-9 Solution

From the plot, the maximum power is 5 W when R = 20 Ω. Therefore: R_t = 20 $\Omega$and

$$p_{max} = \frac{(v_{oc})^2}{4R_t} \Rightarrow v_{oc} = \sqrt{p_{max} 4R_t} = \sqrt{5(4)20} = 20 \text{ V}$$

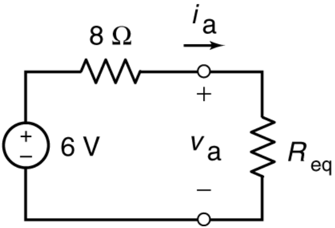
Problem P 5.6-12

Given that $0 \leq R \leq \infty$ in the circuit shown in Figure, determine value of R that maximizes the power $p_a = i_a V_a$ and the corresponding maximum value of p_a .



Problem P 5.6-12 Solution

Replace the combination of resistor R and the 20 Ωand 2 Ωresistors by an equivalent resistance.



Problem P 5.6-12 Solution

The maximum power theorem indicates that the maximum value of occurs when $R_{eq} = R_t$. In this case, $R_t = 8\ \Omega$. We require

$$8 = R_{eq} = \frac{20(R+2)}{20+(R+2)} \Rightarrow R = 11.333\ \Omega$$

This isnt a standard resistance value but it is an acceptable value for this problem since $0 \leq 11.333 \leq \infty$. Then

$$p_a = \frac{(V_a)^2}{R_{eq}} = \frac{(3)^2}{8}\ 1.125\ \text{W}$$

Thank you !