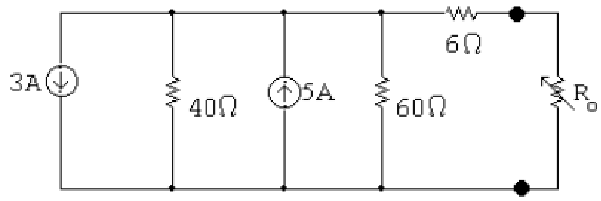
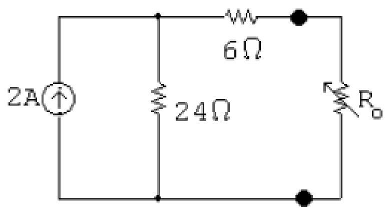
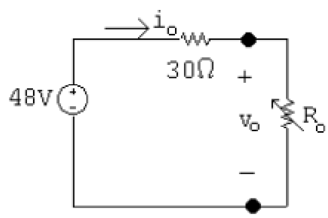
Problem #5 Solution

P 4.68 First, find the Thévenin equivalent with respect to R_o.

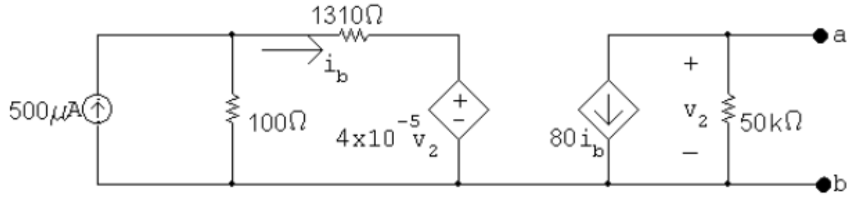






$R_o(\Omega)$	i_o(A)	v_o(V)
10	1.2	12
15	1.067	16
22	0.923	20.31
33	0.762	25.14
47	0.623	29.30
68	0.490	33.31

P 4.74



OPEN CIRCUIT

$v_2 = -80 i_b (50 \times 10^3) = -40 \times 10^5 i_b$

$4 \times 10^{-5} v_2 = -160 i_b$

$1310 i_b + 4 \times 10^{-5} v_2 = 1310 i_b - 160 i_b = 1150 i_b$

So $1150 i_b$ is the voltage across the $100\,\Omega$ resistor.

From KCL at the top left node, $500\,\mu\text{A} = \frac{1150 i_b}{100} + i_b = 12.5 i_b$

$$\therefore \quad i_b = \frac{500 \times 10^{-6}}{12.5} = 40\,\mu\text{A}$$

$$v_{\text{Th}} = -40 \times 10^5 (40 \times 10^{-6}) = -160 \text{ V}$$

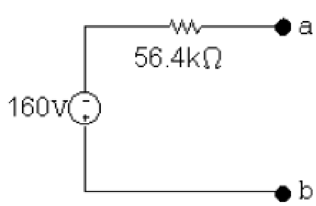
SHORT CIRCUIT

$v_2 = 0; \qquad i_{\text{sc}} = -80 i_b$

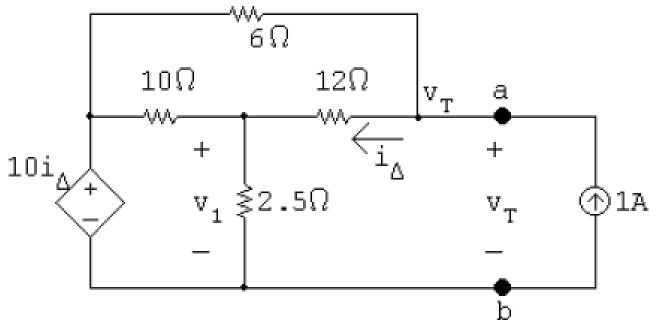
$$i_b = \frac{100}{100 + 1310}(500 \times 10^{-6}) = 35.46\,\mu\text{A}$$

$$i_{\text{sc}} = -80(35.46) = -2837\,\mu\text{A}$$

$$R_{\text{Th}} = \frac{-160}{-2837 \times 10^{-6}} = 56.4 \text{ k}\Omega$$



P 4.77 $V_{\text{Th}} = 0$, since circuit contains no independent sources.



$$\frac{v_1 - 10i_\Delta}{10} + \frac{v_1}{2.5} + \frac{v_1 - v_T}{12} = 0$$

$$\frac{v_T - v_1}{12} + \frac{v_T - 10i_\Delta}{6} - 1 = 0$$

$$i_\Delta = \frac{v_T - v_1}{12}$$

In standard form:

$$v_1\left(\frac{1}{10} + \frac{1}{2.5} + \frac{1}{12}\right) + v_T\left(-\frac{1}{12}\right) + i_\Delta(-1) = 0$$

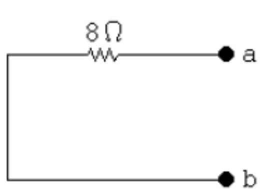
$$v_1\left(-\frac{1}{12}\right) + v_T\left(\frac{1}{12} + \frac{1}{6}\right) + i_\Delta\left(-\frac{10}{6}\right) = 1$$

$$v_1(1) + v_T(-1) + i_\Delta(12) = 0$$

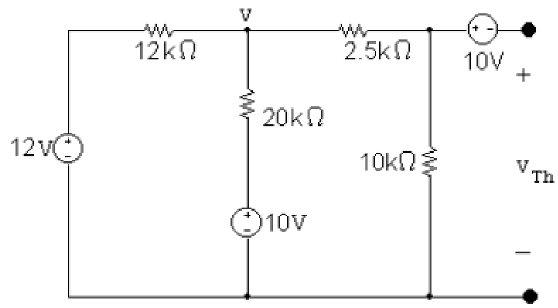
Solving,

$$v_1 = 2 \text{ V}; \qquad v_T = 8 \text{ V}; \qquad i_\Delta = 0.5 \text{ A}$$

$$\therefore \quad R_{\text{Th}} = \frac{v_T}{1 \text{ A}} = 8\,\Omega$$



P 4.79 [a]

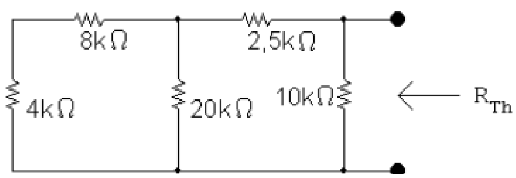


$$\frac{v-12}{12{,}000}+\frac{v-10}{20{,}000}+\frac{v}{12{,}500}=0$$

Solving, $v = 7.03125$ V

$$v_{10k} = \frac{10{,}000}{12{,}500}(7.03125) = 5.625 \text{ V}$$

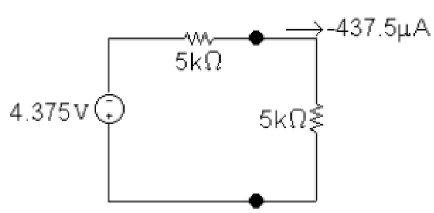
$$\therefore \quad V_{Th} = v - 10 = -4.375 \text{ V}$$



$$\boldsymbol{R_{Th} = [(12000//20000) + 2500]//10000 = 5\ k\Omega}$$

$$R_o = R_{Th} = 5 \text{ k}\Omega$$

[b]



$$p_{max} = (-437.5 \times 10^{-6})^2(5000) = 957\,\mu\text{W}$$

[c] The resistor closest to 5 kΩ from Appendix H has a value of 4.7 kΩ. Use voltage division to find the voltage drop across this load resistor, and use the voltage to find the power delivered to it:

$$v_{4.7k} = \frac{4700}{4700+5000}(-4.375) = -2.12 \text{ V}$$

$$p_{4.7k} = \frac{(-2.12)^2}{4700} = 956.12\,\mu\text{W}$$

The percent error between the maximum power and the power delivered to the best resistor from Appendix H is

$$\%\text{ error} = \left(\frac{956}{957}-1\right)(100) = -0.1\%$$

P 4.81 [a] Since $0 \le R_o \le \infty$ maximum power will be delivered to the 6 Ω resistor when $R_o = 0$.

[b] $P = \dfrac{30^2}{6} = 150$ W