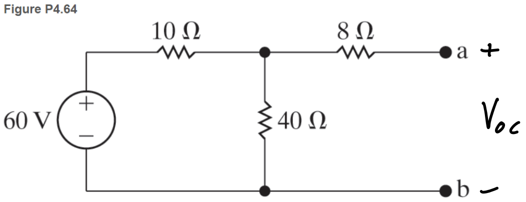
4.64 PSPICE MULTISIM Find the Thévenin equivalent with respect to the terminals a, b for the circuit in Fig. P4.64.

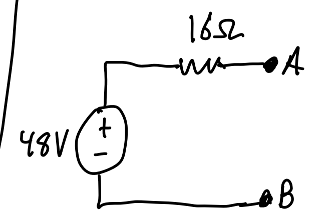
Figure P4.64



$$V_{oc} = \frac{40}{10+40}(60) = 48V$$

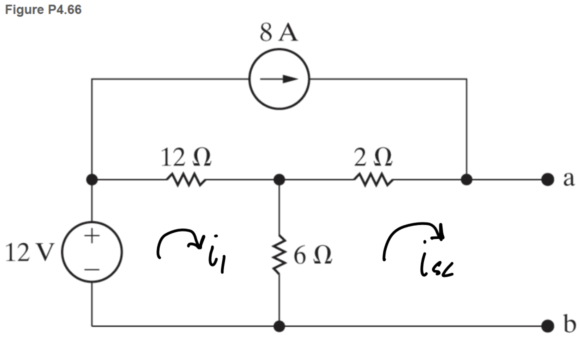
$$R_{th} = \frac{(10)(40)}{10+40} + 8 = 16\Omega$$

Thevenin Equiv Circuit



4.66 PSPICE MULTISIM Find the Norton equivalent with respect to the terminals a, b for the circuit in Fig. P4.66.

Figure P4.66



① $-12 + 12(i_1 - 8) + 6(i_1 - i_{sc}) = 0$

$-12 + 12i_1 - 96 + 6i_1 - 6i_{sc} = 0$

$18i_1 - 6i_{sc} = 108$

② $6(i_{sc} - i_1) + 2(i_{sc} - 8) = 0$

$6i_{sc} - 6i_1 + 2i_{sc} - 16 = 0$

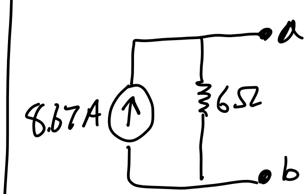
$-6i_1 + 8i_{sc} = 16$

Solve by matrix

$$\left[\begin{array}{cc|c} 18 & -6 & 108 \\ -6 & 8 & 16 \end{array}\right] \Rightarrow \begin{array}{l} i_1 = 8.89A \\ i_{sc} = 8.67A \end{array}$$

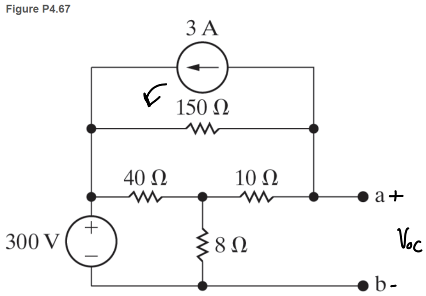
$$R_{th} = \frac{(6)(12)}{18} + 2 = 6\Omega$$

Norton Equivalent circuit

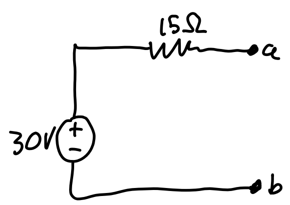


4.67 PSPICE MULTISIM Find the Thévenin equivalent with respect to the terminals a, b for the circuit in Fig. P4.67.

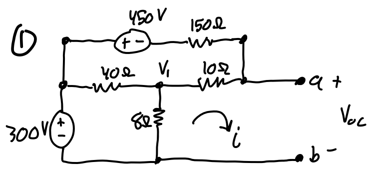
Figure P4.67



Thevenin Equivalent circuit



①



$$\frac{V_1-300}{40}+\frac{V_1}{8}+\frac{V_1+(450-300)}{(150+10)}=0$$

$$4V_1-1200+20V_1+V_1+150=0$$

$$25V_1=1050$$

① $V_1=42V$

$$i=\frac{V_1+(150)}{160}=\frac{42+150}{160}$$

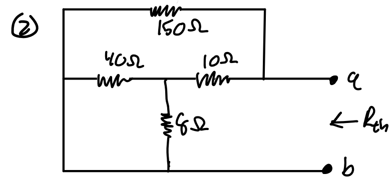
② $i=1.2A$

$$V_1-10(i)-V_{oc}=0$$

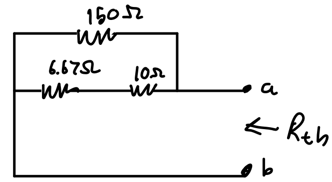
$$42-12-V_{oc}=0$$

$$V_{oc}=30V$$

②



$$\frac{8(40)}{48}=6.67\Omega$$



$$\frac{(6.67+10)(150)}{(6.67+10)+150}=15\Omega$$

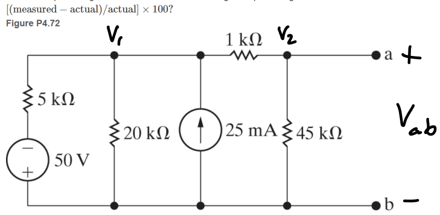
$$R_{th}=15\Omega$$

4.72 PSPICE MULTISIM A voltmeter with a resistance of 85.5 kΩ is used to measure the voltage v_{ab} in the circuit in Fig. P4.72.

a) What is the voltmeter reading?

b) What is the percentage of error in the voltmeter reading if the percentage of error is defined as $[(\text{measured}-\text{actual})/\text{actual}]\times 100$?

Figure P4.72



for V_1

$$\frac{V_1+50}{5k}+\frac{V_1}{20k}+\frac{V_1-V_2}{1k}-25mA=0$$

$$V_1\left[\frac{1}{5k}+\frac{1}{20k}+\frac{1}{1k}\right]-V_2\left[\frac{1}{1k}\right]+\frac{50}{5k}=25mA$$

$$V_1(0.00125)-V_2(0.001)=0.015$$

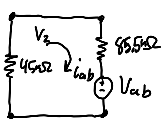
for V_2

$$\frac{V_2-V_1}{1}+\frac{V_2}{45}=0$$

$$-45V_1+46V_2=0$$

Solve w/ matrix

$$\left[\begin{array}{cc|c} 0.00125 & -0.001 & 0.015 \\ -45 & 46 & 0 \end{array}\right] \quad V_1=55.2V,\ V_2=54$$



$$i_{ab}=\frac{V_2}{45}=1.2mA$$

measured

$$V_{ab}+I(85.5k\Omega)-V_2=0$$

$$V_{ab}=54-[1.2(85.5)]$$

$$V_{ab}=-48.6V$$

a) The Voltmeter is reading −48.6 Volts

$$V_{actual}=V_2=54V$$

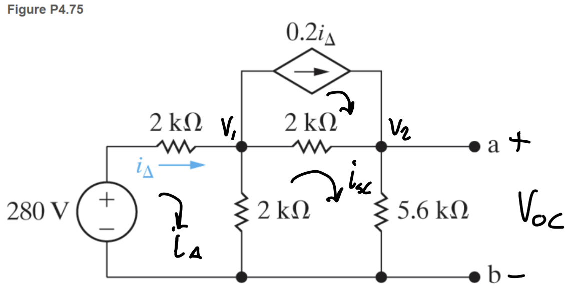
calculating error

$$\left(\frac{48.6-54}{54}\right)\times 100=10\%$$

b) the percent error in the Voltmeter is 10%

4.75 PSPICE MULTISIM Find the Norton equivalent with respect to the terminals a, b for the circuit seen in **Fig. P4.75**.

Figure P4.75



① $i_A = \frac{280 - V_1}{2k}$

$V_1\left(\frac{1}{2k}\right) + i_A = \frac{280}{2k}$

② $\frac{V_1 - 280}{2k} + \frac{V_1}{2k} + \frac{V_1 - V_2}{2k} + 0.2\, i_A = 0$

$V_1\left(\frac{3}{2k}\right) - V_2\left(\frac{1}{2k}\right) + 0.2\, i_A = \frac{280}{2k}$

③ $\frac{V_2 - V_1}{2k} + \frac{V_2}{5.6k} - 0.2\, i_A = 0$

$-V_1\left(\frac{1}{2k}\right) + V_2\left(\frac{1}{2k} + \frac{1}{5.6k}\right) - 0.2\, i_A = 0$

Solving w/ matrix

$$\left[\begin{array}{ccc|c} 0.0005 & 0 & 1 & 0.14 \\ 0.0015 & 0.0005 & 0.2 & 0 \\ -0.0005 & 0.00068 & -0.2 & 0 \end{array}\right] \rightarrow \begin{array}{l} V_1 = 120V \\ V_2 = 112\,V \\ i_A = 0.08A \end{array}$$

$V_{oc} = V_2 = 112V$

mesh current equations

① $-280 + 2k\, i_A + 2k(i_A - i_{sc}) = 0$

$4k\, i_A - 2k\, i_{sc} = 280$

② $2k(i_{sc} - 0.2 i_A) + 2k(i_{sc} - i_A) = 0$

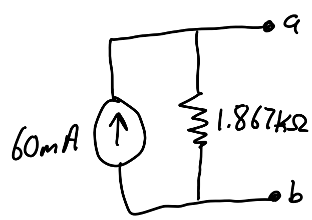
$-2.4k\, i_A + 4k\, i_{sc} = 0$

$$\left[\begin{array}{cc|c} 4k & -2k & 280 \\ -2.4k & 4k & 0 \end{array}\right] \Rightarrow \begin{array}{l} i_A = 0.1A \\ i_{sc} = 0.06A \end{array}$$

R_{th}

$R_{th} = \frac{112}{0.06} = 1866.67\Omega$

Norton Equivalent circuit

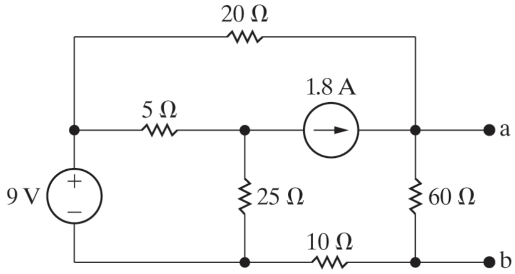


4.78 PSPICE MULTISIM

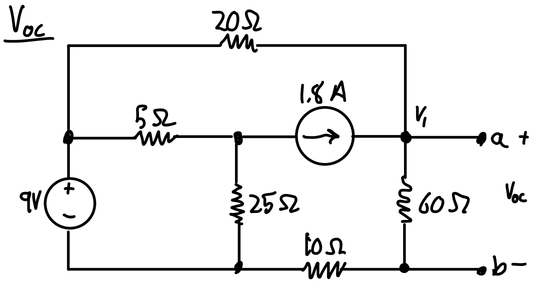
a) Find the Thévenin equivalent with respect to the terminals a, b for the circuit in Fig. P4.78 by finding the open-circuit voltage and the short-circuit current.

b) Solve for the Thévenin resistance by removing the independent sources. Compare your result to the Thévenin resistance found in (a).

Figure P4.78



a) $\underline{V_{oc}}$



$$\frac{V_1-9}{20}+\frac{V_1}{60+10}-1.8=0$$

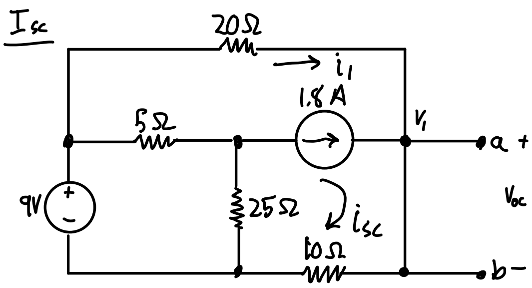
$$V_1\left(\frac{1}{20}+\frac{1}{70}\right)-\frac{9}{20}-1.8=0$$

$$\frac{9}{140}V_1=\frac{9}{4}$$

$$V_1=35V$$

$$\boxed{V_{oc}=\frac{60}{70}(35)=30V}$$

$\underline{I_{sc}}$



$$\frac{V_1-9}{20}+\frac{V_1}{10}-1.8=0$$

$$V_1\left(\frac{3}{20}\right)-\frac{9}{20}-1.8=0$$

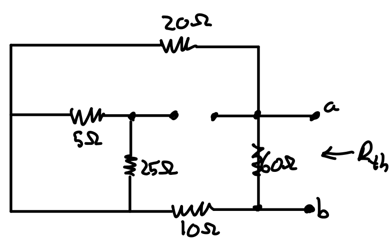
$$V_1=15V$$

$$i_1=\frac{9-15}{20}=0.3A$$

$$i_{sc}=1.8-0.3=1.5A$$

$$\therefore \boxed{R_{th}=\frac{30}{1.5}=20\Omega}$$

b)



$$R_{th}=(20+10)\,||\,60$$

$$=\frac{(30)(60)}{90}=20\Omega$$

$$R_{th}=20\Omega$$

The thevenin Resistances match

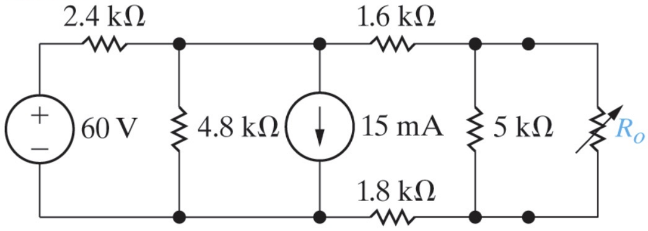
4.82 PSPICE MULTISIM The variable resistor in the circuit in **Fig. P4.82** is adjusted for maximum power transfer to R_o.

a) Find the value of R_o.

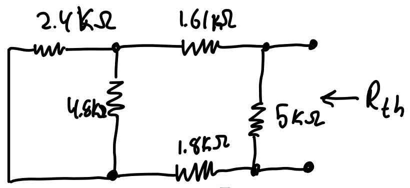
b) Find the maximum power that can be delivered to R_o.

c) Find a resistor in **Appendix H** closest to the value in part (a). How much power is delivered to this resistor?

Figure P4.82



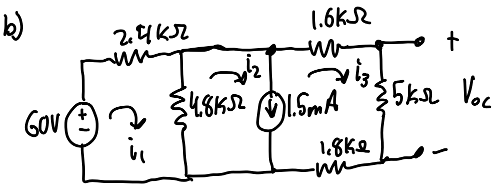
a)



$$\left[(2.4 \| 4.8)+1.6+1.8\right] \| 5 = 5 \| 5 = 2.5\,k\Omega = R_{th}$$

$$\boxed{R_{th} = R_o = 2.5\,k\Omega}$$

b)



① $-60 + 2.4k(i_1) + 4.8k(i_1 - i_2) = 0$

$7.2k\,i_1 - 4.8k\,i_2 = 60$

② $4.8k(i_2 - i_1) + (1.6+1.8+5)k\,i_3 = 0$

$-4.8k\,i_1 + 4.8k\,i_2 + 8.4k\,i_3 = 0$

③ $i_2 - i_3 = 1.5mA$

Solving w/ matrix

$$\begin{bmatrix} 7.2K & -4.8K & 0 & 60 \\ -4.8K & 4.8K & 8.4K & 0 \\ 0 & 1 & -1 & 0.015 \end{bmatrix} \Rightarrow \begin{aligned} i_1 &= 19.4mA \\ i_2 &= 16.6mA \\ i_3 &= 1.6mA \end{aligned}$$

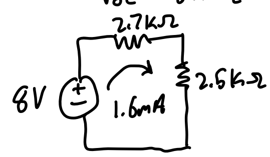
$P_{max} = i^2 R_o$

i_3 is current across V_{oc}

$$\therefore \boxed{P_{max} = (1.6mA)^2(2.5k\Omega) = 6.4\,mW}$$

c) by appendix H the closest value to my calculated value $R_o = 2.5\,k\Omega$ is $2.7\,k\Omega$

$V_{oc} = 5k\Omega(1.6mA) = 8V$



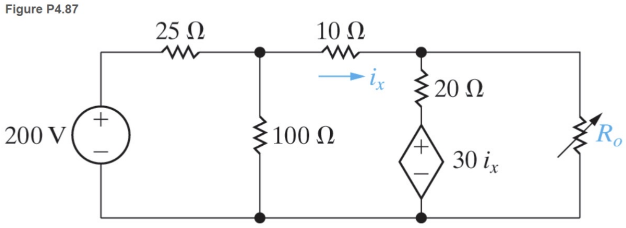
$$V_{2.7k\Omega} = \frac{2.7K}{2.7K+2.5K}(8V) = 4.15\,V$$

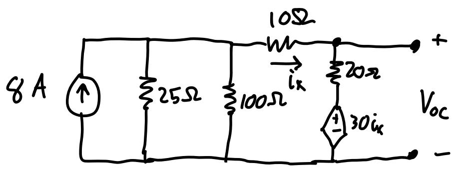
$$P = \frac{V^2}{R} = \frac{(4.15V)^2}{2.7k\Omega}$$

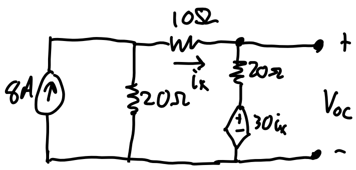
$$\boxed{P_{2.7k\Omega} = 6.38\,mW}$$

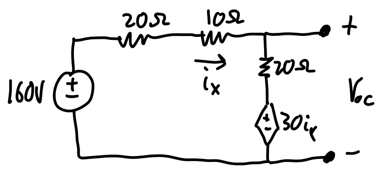
4.87 PSPICE MULTISIM The variable resistor (R_o) in the circuit in **Fig. P4.87** is adjusted until the power dissipated in the resistor is 250 W. Find the values of R_o that satisfy this condition.

Figure P4.87







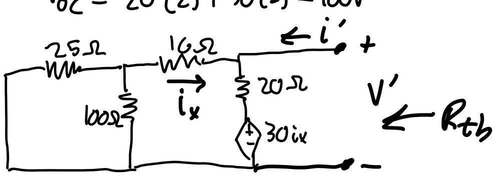


$$i_x = \frac{160 - 30i_x}{(20+10)+20}$$

$$50i_x + 30i_x = 160$$

$$i_x = 2A$$

$$V_{oc} = 20(2) + 30(2) = 100V$$



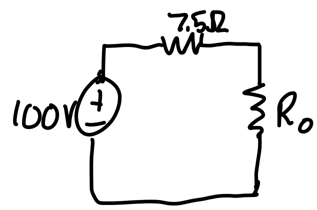
$$i' = \frac{V'}{30} + \frac{V'+V'}{20} = \frac{2V'}{60} + \frac{6V'}{60}$$

$$i' = \frac{8V'}{60} = \frac{2V'}{15}$$

$$\frac{i'}{V'} = \frac{2}{15}$$

$$R_{th} = \frac{V}{i} = \frac{15}{2} = 7.5\Omega$$

Thevenin equiv circuit



$$P = i^2 R_o = 250$$

$$P = \left(\frac{100}{7.5+R_o}\right)^2 R_o = 250$$

$$P = \frac{10000}{R_o^2 + 15R_o + 56.25} \cdot R_o = 250$$

$$\frac{10000R_o}{250} = R_o^2 + 15R_o + 56.25$$

$$40R_o = R_o^2 + 15R_o + 56.25$$

$$R_o^2 - 25R_o = -56.25 \Rightarrow R_o^2 - 25 + 56.25$$

$$R_o = \frac{+25 \pm \sqrt{(25)^2 - 4(1)(56.25)}}{2}$$

$$= \frac{25 \pm 20}{2} = 12.5 \pm 10$$

$$\boxed{R_o = 22.5\Omega \text{ or } R_o = 2.5\Omega}$$