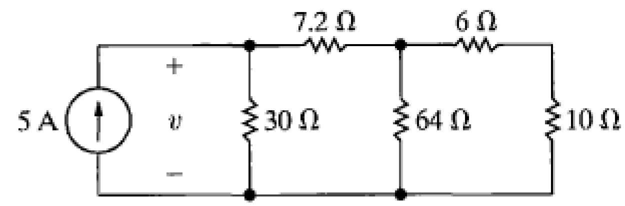
Mathcad Solutions to Assesment Problems from
Nilsson and Riedel, *Electric Circuits* 9th edition,

Chapter 3

$$\|(a,b) := \frac{a \cdot b}{a + b}$$



AP 3.1 For the circuit shown, find
(a) the voltage v,
(b) the power delivered to the circuit by the current source, and
(c) the power dissipated in the 10 Ω. resistor.

$$R := [[(10 + 6) \,\|\, 64 + 7.2] \,\|\, 30] \cdot \Omega = 12\,\Omega$$

a) $v := 5A \cdot R = 60\,V$

b) $P := v \cdot 5A = 300\,W$

c) $i_{30} := \frac{v}{30\Omega} = 2\,A$ $\quad i_{72} := 3A$ $\quad v_{72} := i_{72} \cdot 7.2\Omega = 21.6\,V$

$v_{64} := v - v_{72} = 38.4\,V$ $\quad i_{64} := \frac{v_{64}}{64\Omega} = 0.6\,A$ $\quad i_6 := i_{72} - i_{64} = 2.4\,A$

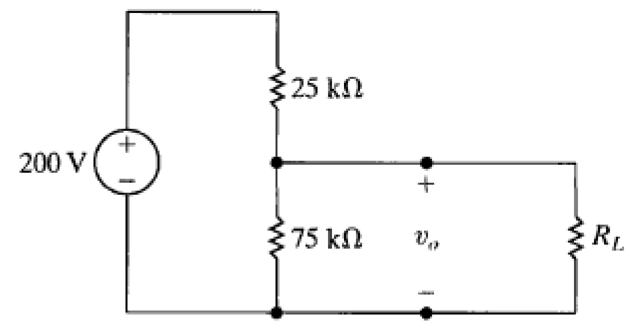
$i_{10} := i_6$ $\quad P_{10} := {i_{10}}^2 \cdot 10\Omega = 57.6\,W$

AP 3.2 a) Find the no-load value of v_o in the circuit shown.

b) Find v_o when R_L is 150 kΩ.

c) How much power is dissipated in the 25 kΩ resistor if the load terminals are accidentally short-circuited?

d) What is the maximum power dissipated in the 75 kΩ resistor?



a) $v_o := \frac{75}{75+25} \cdot 200V = 150\,V$

b) $v_{oshort} := \frac{(75k\Omega) \| (150k\Omega)}{(75k\Omega) \| (150k\Omega) + 25k\Omega} \cdot 200V = 133.33\,V$

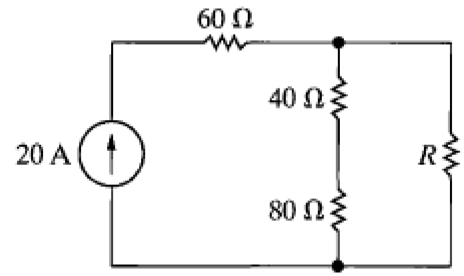
c) $p := \frac{(200V)^2}{25k\Omega} = 1.6\,W$

d) $p := \frac{v_o^{\,2}}{75k\Omega} = 0.3\,W$

AP 3.3 a) Find the value of R that will cause 4 A of current to flow through the 80 Ω resistor in the circuit shown.

b) How much power will the resistor R from part (a) need to dissipate?

c) How much power will the current source generate for the value of R from part (a)?



a) if 4A is flowing through the 40+80Ω resistors then

$$v := 4A \cdot 120\Omega = 480\,V$$

so the balance of the 20A source current must flow through R.

$$R := \frac{v}{20A - 4A} = 30\,\Omega$$

b) $P := 16A \cdot v = 7.68\,kW$

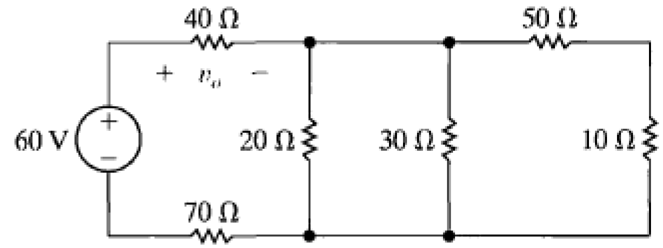
c) $P := (20A \cdot 60\Omega + v) \cdot 20A = 33.6\,kW$

$$(20A)^2 (30 \,||\, 120 + 60)\Omega = 33.6\,kW$$

AP 3.4 a) Use voltage division to determine the voltage v_o across the 40 Ω resistor in the circuit shown.

b) Use v_o from part (a) to determine the current through the 40 Ω resistor, and use this current and current division to calculate the current in the 30 Ω resistor.

c) How much power is absorbed by the 50 Ω resistor?



a) $$[(50+10)\parallel 30 \parallel 20]\Omega = 10\,\Omega$$

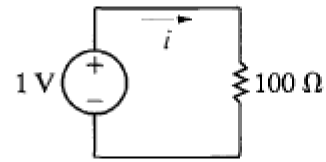
$$v_o := \frac{40}{40+10+70}\cdot 60\text{V} = 20\,\text{V}$$

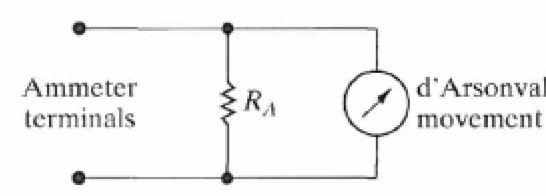
b) $$i := \frac{v_o}{40\Omega} = 0.5\,\text{A}$$

$$i_{30} := i\cdot\frac{[(50+10)\parallel 20]}{[(50+10)\parallel 20]+30} = 166.67\,\text{mA}$$

c) $$\frac{\left(i_{30}\cdot 30\Omega\cdot\frac{50}{50+10}\right)^2}{50\Omega} = 347.22\,\text{mW}$$

AP 3.5 a) Find the current in the circuit shown.
b) If the ammeter in Example 3.5(a) is used to measure the current, what will it read?





a) $i := \frac{1V}{100\Omega} = 10\,mA$

From example 3.5(a) $R_A := \frac{50}{9}\Omega$

the movement is $R_m := \frac{50mV}{1mA} = 50\,\Omega$

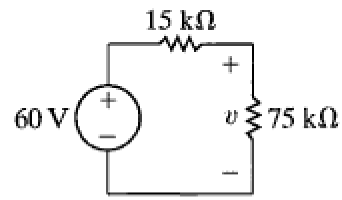
$$R_{meter} := \left[\left(\frac{50}{9}\right) \parallel 50\right]\Omega = 5\,\Omega$$

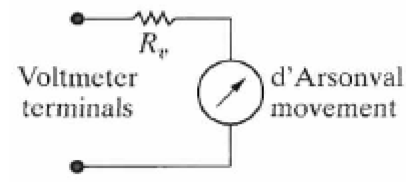
so the current that will flow with the meter in series with the load resistor will be

$$i := \frac{1V}{105\Omega} = 9.524\,mA$$

AP 3.6 a) Find the voltage v across the 75 kΩ resistor in the circuit shown.

b) If the 150 V voltmeter of Example 3.6(a) is used to measure the voltage, what will be the reading?





a) $v := \frac{75}{75+15} \cdot 60V = 50\,V$

$R_V := 1\Omega$

given $\quad 50mV = \frac{50\Omega}{50\Omega + R_V} \cdot 150V \qquad find(R_V) = 149950\,\Omega$

$R_V := 149950\Omega \qquad R_V + 50\Omega = 150\,k\Omega$

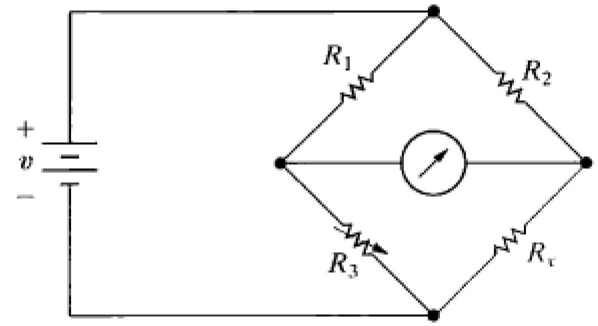
b) $v_{reading} := 60V \cdot \frac{[(75k\Omega) \parallel (150k\Omega)]}{[(75k\Omega) \parallel (150k\Omega)] + 15k\Omega} = 46.15\,V$

$\frac{v_{reading}}{v} - 1 = -7.692\,\%$ error

AP 3.7 The bridge circuit shown is balanced when $R_1 = 100\ \Omega$, $R_2 = 1000\ \Omega$, and $R_3 = 150\ \Omega$. The bridge is energized from a 5 V dc source.

a) What is the value of R_x?

b) Suppose each bridge resistor is capable of dissipating 250 mW. Can the bridge be left in the balanced state without exceeding the power-dissipating capacity of the resistors, thereby damaging the bridge?

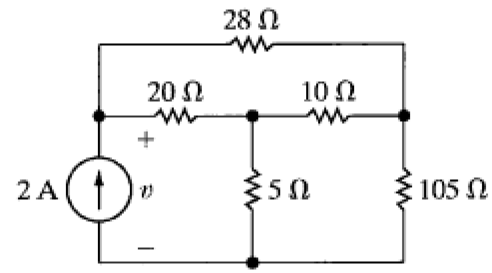


$R_1 := 100\Omega$ $R_2 := 1000\Omega$ $R_3 := 150\Omega$

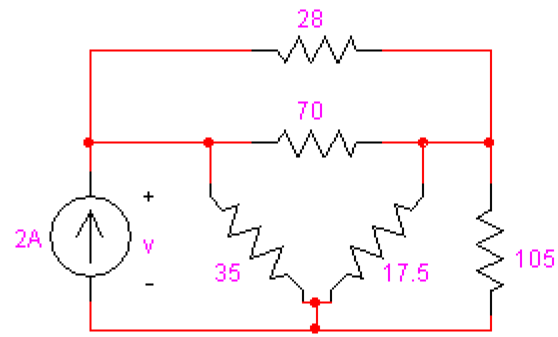
a) $$\frac{R_1}{R_3} = \frac{R_2}{R_x} \quad \text{so} \quad R_x := \frac{R_2 \cdot R_3}{R_1} = 1.5\,k\Omega$$

b) $$\frac{(5V)^2}{R_1 + R_3} = 100\,mW \quad \text{so yes!}$$

AP 3.8 Use a Y-to-Δ transformation to find the voltage v in the circuit shown.



$$Y2\Delta(R) := \begin{pmatrix} \dfrac{R_0 \cdot R_1 + R_1 \cdot R_2 + R_2 \cdot R_0}{R_0} \\ \dfrac{R_0 \cdot R_1 + R_1 \cdot R_2 + R_2 \cdot R_0}{R_1} \\ \dfrac{R_0 \cdot R_1 + R_1 \cdot R_2 + R_2 \cdot R_0}{R_2} \end{pmatrix}$$



$$Y2\Delta\left[\begin{pmatrix} 20 \\ 10 \\ 5 \end{pmatrix} \Omega\right] = \begin{pmatrix} 17.5 \\ 35 \\ 70 \end{pmatrix} \Omega$$

$$R := [(28 \parallel 70 + 17.5 \parallel 105) \parallel 35]\Omega = 17.5\,\Omega$$

$$v := 2A \cdot R = 35\,V$$