Thevenin & Norton equivalent circuits
1. For each of the circuits below, find and draw the Thevenin equivalent circuit.

a) \( R_1 = 36\, \text{k}\Omega \) \( R_2 = 12\, \text{k}\Omega \)

b) The load resistor is \( R_L \), and is in a strange place in this circuit. Hint: use superposition to find \( V_{\text{th}} \).

V \(_S\) := 9\, \text{V} \hspace{1cm} R \(_3\) := 30\, \text{k}\Omega \hspace{1cm} R \(_L\) := 20\, \text{k}\Omega

2. For the circuit of problem 1a, find the voltage across \( R_L \) (\( V_L \)) and the current through \( R_L \) (\( I_L \)) using your Thevenin equivalent circuit.

3. For each of the circuits in problem 1, find and draw the Norton equivalent circuit.

4. For the circuit of problem 1b, find \( V_L \) and \( I_L \) using your Norton equivalent circuit.

5. For the circuit shown at right, use Thevenin’s theorem to find the current through the 50 \( \Omega \) resistor \( R_4 \).

\( R_1 = 100\, \text{\Omega} \)

\( I \(_S\) = 5\, \text{mA} \)

\( R \(_3\) = 200\, \text{\Omega} \)

6. For the circuit shown, use Norton’s theorem to find the value of the current in \( R_5 \). Hint: You can find \( I_N \) either by calculation of the open circuit voltage \( (V_{OC}) \) and \( R_N \) or by direct calculation of the short-circuit current \( (I_{SC}) \), however, there is something about the values of the resistors which makes the second method easier than it would at first appear.

\( R \(_1\) = 20\, \text{\Omega} \)

\( R \(_2\) = 10\, \text{\Omega} \)

\( R \(_3\) = 20\, \text{\Omega} \)

\( R \(_4\) = 20\, \text{\Omega} \)

\( R \(_5\) = 10\, \text{\Omega} \)

Source resistance
7. The terminal voltage of a car’s battery drops from 12.5 V to 8.5 volts when starting. The starter motor draws 60 A of current.

a) Draw the voltage-source model (Thevenin equivalent) of this battery. Include the values of \( V_S \) and \( R_S \).

b) Draw the current-source model (Norton equivalent) of this battery. Include the values of \( I_S \) and \( R_S \).

c) Which of these two models is more appropriate for the car battery?

d) What terminal voltage would you expect if this battery were being charged at 20 A?

Answers
1. a) 4.091\, \text{V} , 28.4\, \text{k}\Omega  \hspace{1cm} b) 1.1\, \text{V} , 18.3\, \text{\Omega}  \hspace{1cm} 2. 1.69\, \text{V} , 84.6\, \mu\text{A}

3. a) 0.144\, \text{mA} , 28.4\, \text{k}\Omega  \hspace{1cm} b) 60\, \text{mA} , 18.3\, \text{\Omega}  \hspace{1cm} 4. 3.16\, \text{mA} , 1.042\, \text{V}  \hspace{1cm} 5. 1.88\, \text{mA}

6. 0.19\, \text{A}  \hspace{1cm} 7. a) V \(_S\) = 12.5\, \text{V} \hspace{1cm} R \(_S\) := 0.0667\, \text{\Omega}  \hspace{1cm} b) I \(_S\) = 187.5\, \text{A} \hspace{1cm} R \(_S\) := 0.0667\, \text{\Omega}  \hspace{1cm} c) Thevenin  \hspace{1cm} d) 13.83\, \text{V}

ECE 2210 / 00 homework # 5