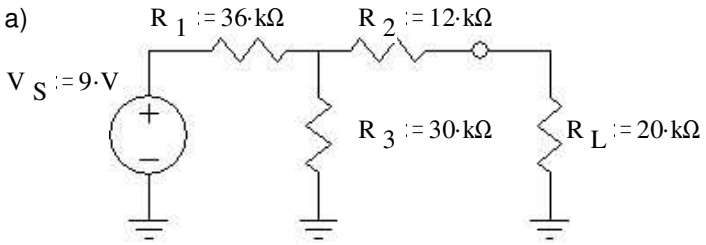
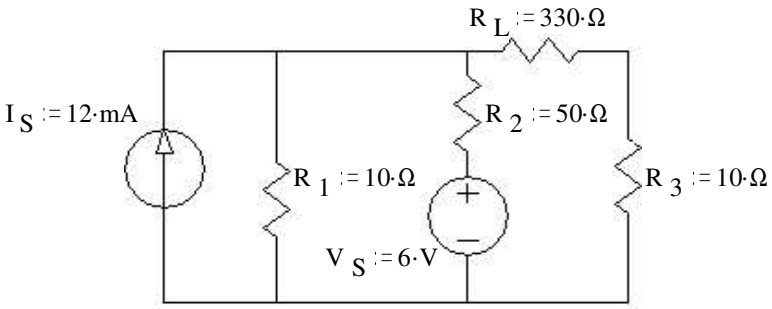
Thevenin & Norton equivalent circuits

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

a)

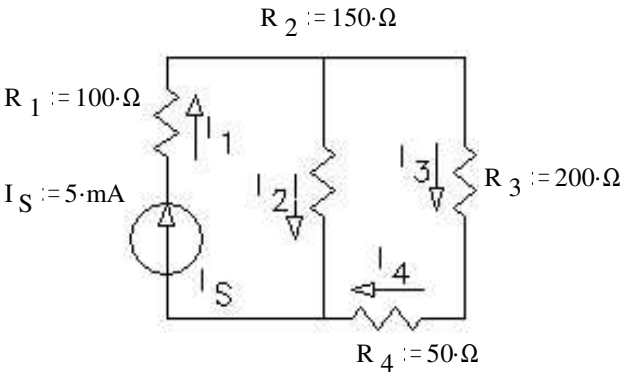


b) The load resistor is R_L, and is in a strange place in this circuit.
Hint: use superposition to find V_{Th}.

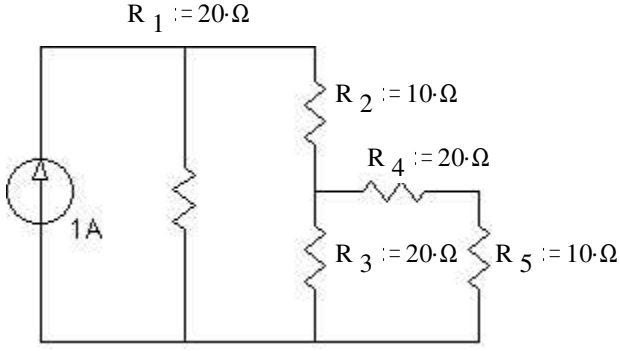


2nd hint: Nodal analysis is even easier.

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 Ω resistor R_4.



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.



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·V , 28.4·kΩ b) 1.1·V , 18.3·Ω 2. 1.69·V , 84.6·µA
3. a) 0.144·mA , 28.4·kΩ b) 60·mA , 18.3·Ω 4. 3.16·mA, 1.042·V 5. 1.88·mA
6. 0.19·A 7. a) V_S = 12.5·V R_S := 0.0667·Ω b) I_S = 187.5·A R_S := 0.0667·Ω
   c) Thevenin d) 13.83·V