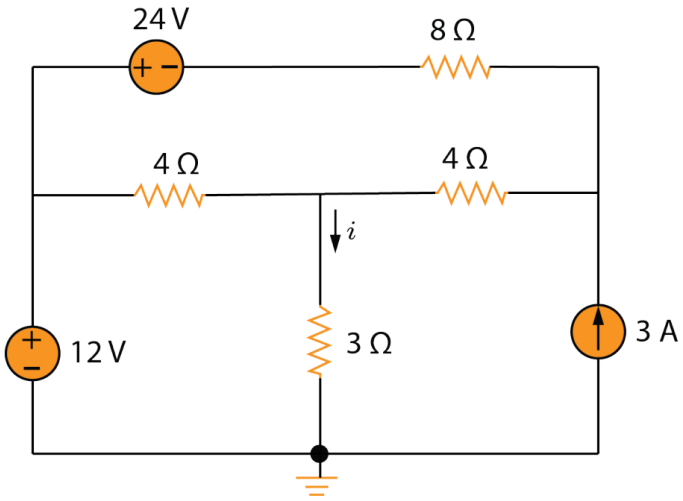
School of Electrical Engineering & Telecommunications

ELEC1111

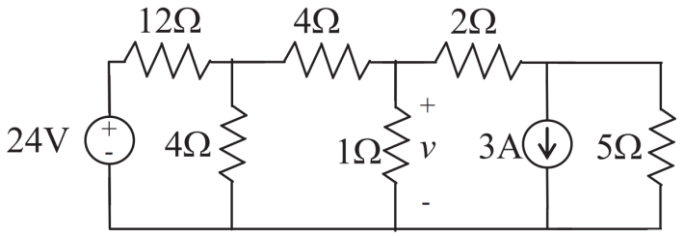
Topic 3: Circuit Theorems

1. Find the current i in the following circuit by using superposition principle.



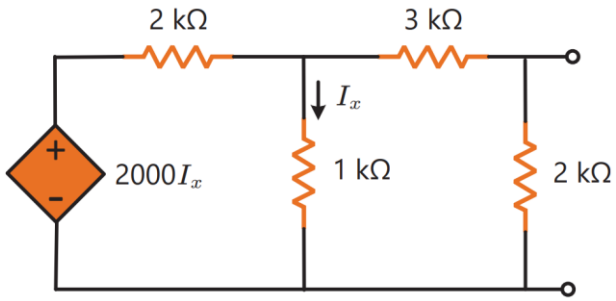
Answer: $i = i' + i'' + i''' = 2\ \text{A}$, where $i' = 2\ \text{A}$, $i'' = -1\ \text{A}$, and $i''' = 1\ \text{A}$ are the responses due to 12-V, 24-V, and 3-A sources.

2. (**Final Exam, S1, 2014**) Use source transformations to determine the voltage v shown in the following circuit.



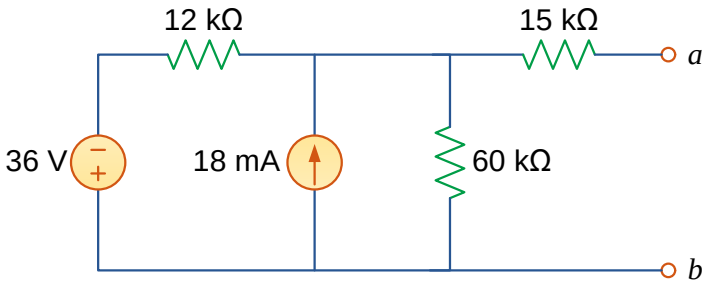
Answer: $v = -1\ \text{V}$

3. Determine R_{Th} for the following circuit. What is the value of the Thevenin equivalent voltage? Why can we find this value without any calculations?



Answer: $V_{\text{Th}} = 0\ \text{V}$, $R_{\text{Th}} = \frac{10}{7} = 1.428\ \text{k}\Omega$

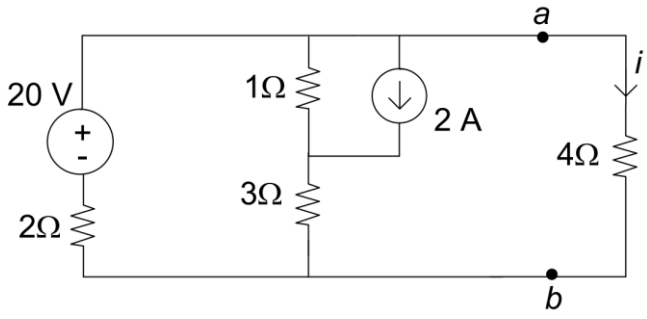
4. (**Final Exam - S2, 2015**) Find the Norton equivalent of the following circuit.



Answer: $I_N = 6\ \text{mA}$, $R_{\text{N}} = R_{\text{Th}} = 25\ \text{k}\Omega$

5. (**Mid-session Exam – S2, 2016**) For the circuit below, find the current i in the 4-Ω resistor using,

   (a) The superposition principle.
   (b) The Thevenin equivalent of the circuit to the left of terminal pair *a*-*b*.

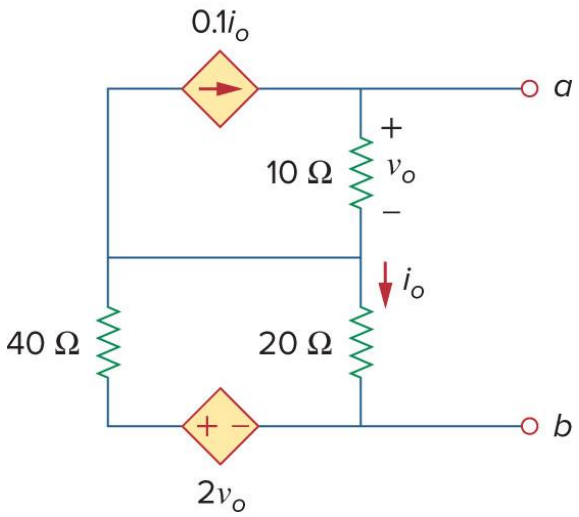


Answer:

(a) $i = i' + i'' = 2.375\ \text{A}$, where $i' = 2.5\ \text{A}$ and $i'' = -0.125\ \text{A}$ are the responses due to 20-V and 2-A sources.

(b) $V_{\text{Th}} = 12.66\ \text{V}$, $R_{\text{Th}} = \frac{4}{3} = 1.33\ \text{k}\Omega$

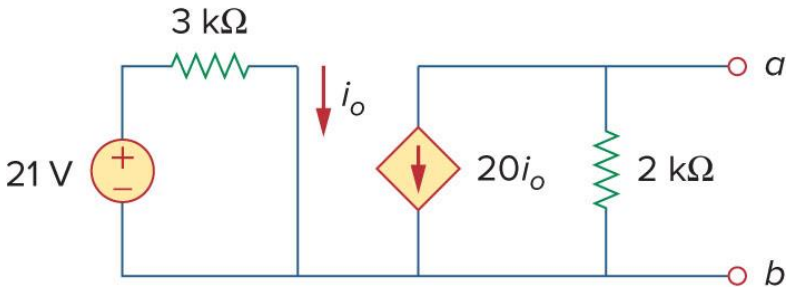
6. Find the Thevenin equivalent of the circuit given below.



Answer: $V_{\text{Th}} = 0\ \text{V}$, $R_{\text{Th}} = 31.73\ \text{k}\Omega$

7. For the transistor model given below, do the following,

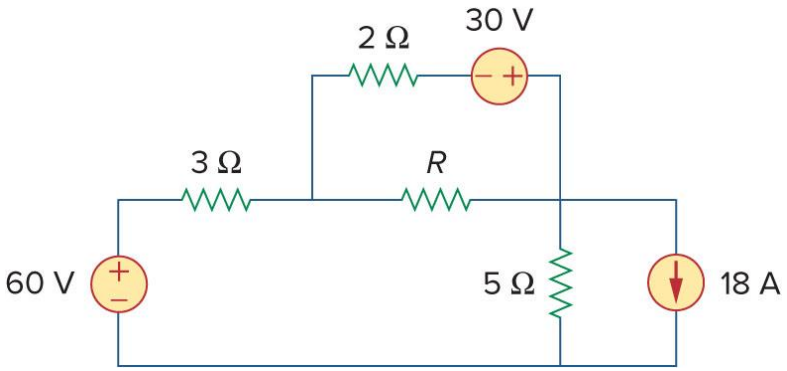
   (a) Obtain the open-circuit voltage v_{oc} across terminals a-b.
   (b) Calculate the short-circuit current i_{sc} at terminals a-b.
   (c) Find the equivalent resistance R_{eq} seen from the terminals a-b (use the results from previous parts)



Answer:

a) $v_{oc} = -280\ \text{V}$
b) $i_{sc} = -140\ \text{mA}$
c) $R_{\text{eq}} = 2\ \text{k}\Omega$

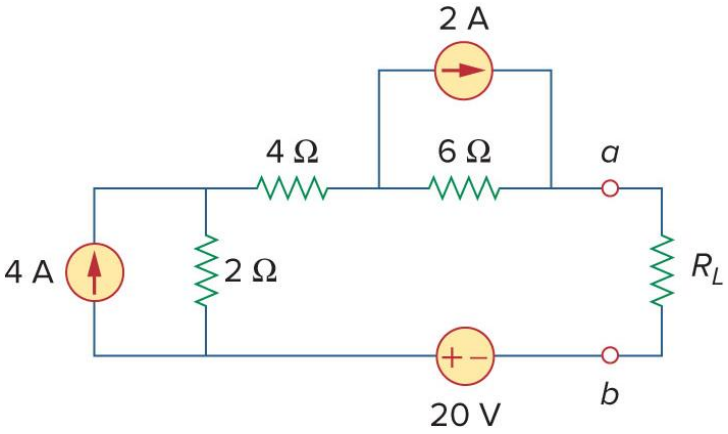
8. In the following circuit, find the maximum power that can be delivered to the resistor R in the circuit below. What should be the value of R for maximum power transfer?



Answer: $R_{\text{Th}} = 1.6\ \Omega$, $V_{\text{Th}} = 6\ \text{V}$, $P_{\max} = 5.625\ \text{W}$, $R = 1.6\ \Omega$
Hint: Find the Thevenin equivalent circuit from the terminals across the load R.

9. For the circuit below,

(a) Obtain the Norton equivalent circuit at terminals a-b.
(b) Calculate the current in $R_L = 13\ \Omega$.
(c) Find R_L for maximum power deliverable to R_L.
(d) Determine that maximum power.



Answer:

a) $R_N = 12\ \Omega$, $I_N = \frac{10}{3} = 3.33\ \text{A}$

b) $I_L = \frac{8}{5} = 1.6\ \text{A}$

c) $R_L = 12\ \Omega$

d) $P_{\max} = \frac{100}{3} = 33.33\ \text{W}$