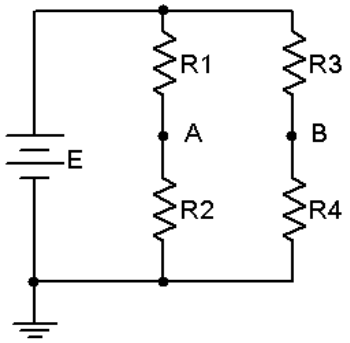
DC Circuits Self Test

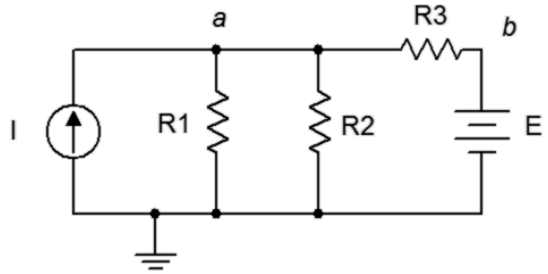
Series-parallel, source conversions, Thevenin,

superposition, nodal analysis

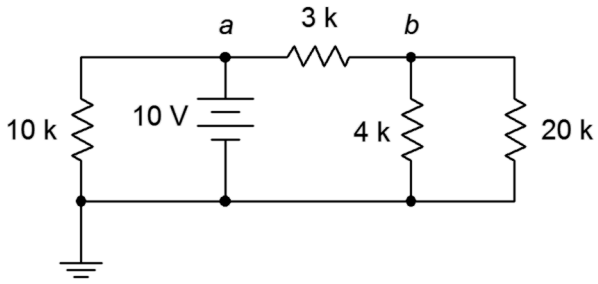
1. For the circuit below, find the voltage V_{AB}. Also find the total current exiting the supply. E=24V, R_1=100, R_2=200, R_3=650, R_4=150



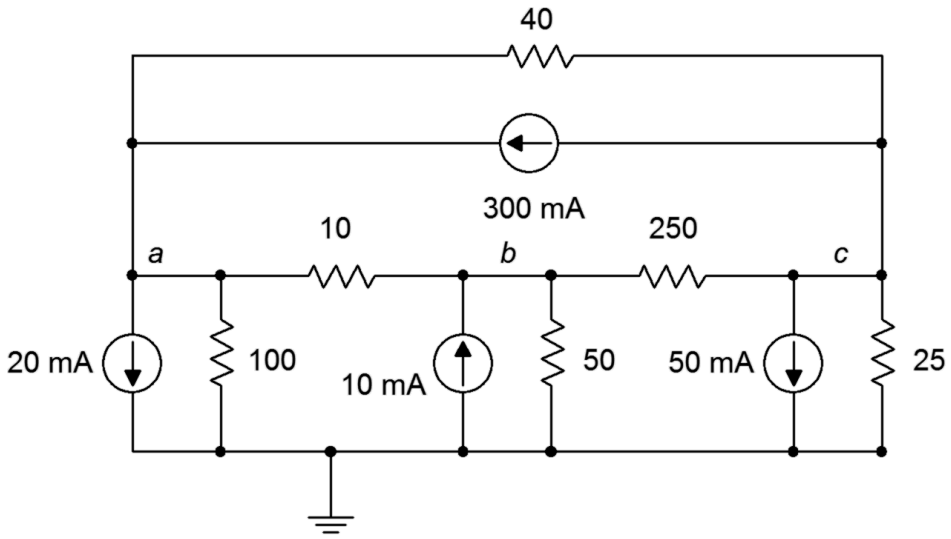
2. Using superposition, solve for the voltage across R2. E=10V, I=12mA, R1=3k, R2=6k, R3=2k. Also, determine the equivalents of the two sources.



3. Find the Thevenin equivalent of the circuit below that drives the 20k.



4. Using nodal analysis, write the equations for the circuit below. Assume that you compute the resulting node voltages to be: Va=1.5V, Vb=2.6V, Vc=5.9V. Determine if node B satisfies KCL with these values.



Answers

1. Using voltage dividers, V_A=24V*200/(100+200)=16V
V_B=24V*150/(150+650)=4.5V, V_{AB}=V_A-V_B=16-4.5=11.5V
I=24V/(300||800)=110mA, or use 16V/200 + 4.5V/150

2. For the current source, short E. This leaves the three resistors in parallel for 1k, hence, the voltage across R2 must be 12mA*1k=12V (polarity +/- top to bottom). For the voltage source, open I. This produces a voltage divider between the parallel combo of R1 and R2 (3k||6k=2k) and R3. Thus, the voltage is 10V*2k/(2k+2k)=5V (polarity +/- top to bottom). Therefore, the combined total is 17 volts. For source conversion, the current source with R1 is 12mA*3k=36V in series with 3k. The voltage source with R3 turns into a current source of 10V/2k=5mA in parallel with 2k.

3. Find the open circuit voltage (b to ground) upon removing the 20k. Note that the 10k will have no impact on this voltage, it is just the divider between the 4k and 3k for 5.71V. To find the Thevenin resistance, short the source and look in from the position of the 20k. Once again the 10k has no effect as it is shorted by the source. The result is the parallel combo of the 3k and 4k for 1.71k.

4. As this uses just current sources, format nodal may be used:

A: 300mA-20mA = (1/100+1/10+1/40)V_A – (1/10)V_B – (1/40)V_C
B: 10mA = -(1/10)V_A + (1/10+1/50+1/250)V_B – (1/250)V_C
C: -50mA-300mA = -(1/40)V_A – (1/250)V_B + (1/40+1/250+1/25)V_C

Inspecting node B using KCL, incoming currents are the 10mA source and the current through the 250 ohm resistor which is (5.9V-2.6V)/250=13.2mA, for 23.2mA total incoming. Exiting currents are through the 50 ohm which is 2.6V/50=52mA, and through the 10 ohm which is (2.6V-1.5V)/10=110mA, for 162mA total. These totals do not match and thus these voltages are not correct.