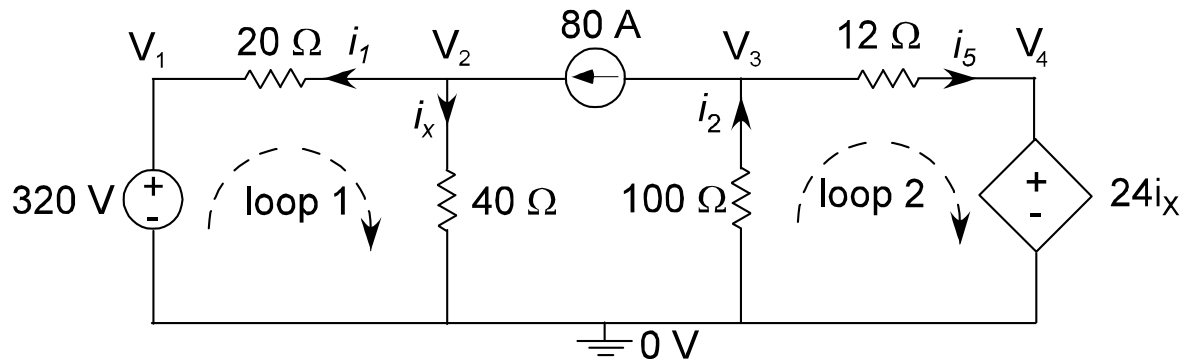


Homework Set #3
Coverage: KCL, KVL, Dependent Sources
DUE Tuesday, March 14, 2017

1. Consider the following network:



- a) Write KCL equations at nodes V_2 and V_3 in terms of the nodal voltages (V_1 , V_2 , V_3 , and V_4) defined above. (HINT: You need to write i_x as $i_x = V_2/40$.)

$$\text{Node '2'} \quad \frac{V_2 - V_1}{20} + \frac{V_2}{40} - 80 = 0 \quad \text{where } V_1 = 320 \text{ V}$$

$$\text{Node '3'} \quad 80 + \frac{V_3}{100} + \frac{V_3 - V_4}{12} = 0 \quad \text{where } V_4 = 24i_x \text{ and } i_x = \frac{V_2}{40}$$

- b) Write KVL equations for loops 1 and 2 in terms of the branch currents (i_1 , i_2 , i_x , and i_5) defined above. (HINT: Leave i_x alone here.)

$$\text{Loop 1} \quad -320 - 20i_1 + 40i_x = 0$$

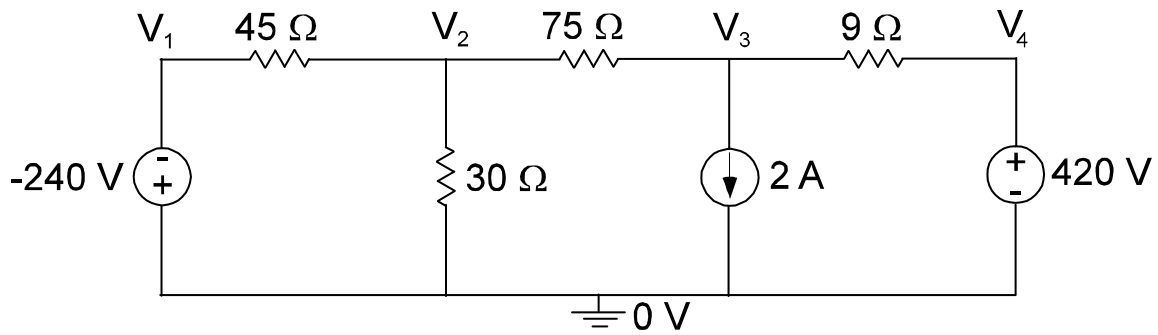
$$\text{Loop 2} \quad 100i_2 + 12i_5 + 24i_x = 0$$

- c) Write an equation for i_5 in terms of i_x and V_3 .

$$i_5 = \frac{V_3 - V_4}{12} = \frac{V_3 - 24i_x}{12}$$

You don't need to solve the equations.

2. Use KCL and/or KVL to derive 2 equations in 2 unknowns for the following circuit and then solve for all nodal voltages.

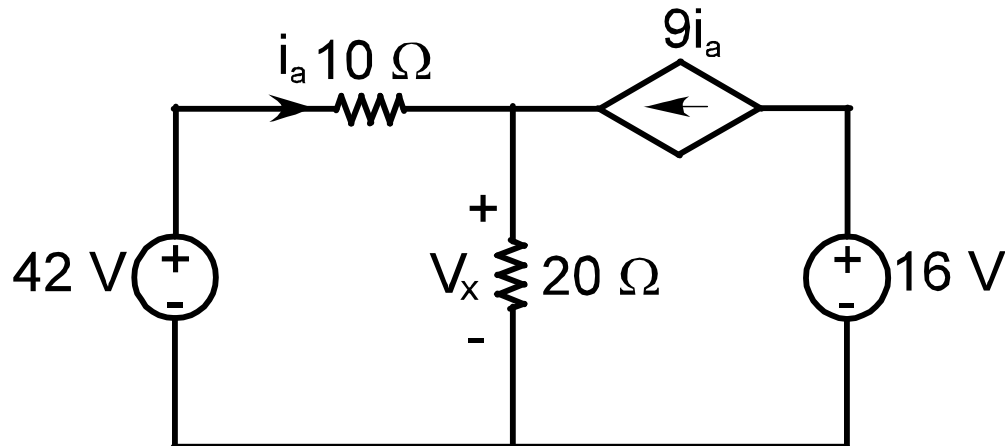


$$\frac{V_2 + 240}{45} + \frac{V_2}{30} + \frac{V_2 - V_3}{75} = 0 \quad \text{this becomes: } 0.0689V_2 - 0.0133V_3 = 5\frac{1}{3}$$

$$\frac{V_3 - V_2}{75} + 2 + \frac{V_3 - 420}{9} = 0 \quad \text{this becomes: } -0.0133V_2 + 0.1244V_3 = 44\frac{2}{3}$$

Solves to: $V_1 = 240 \text{ V}$, $V_2 = 150 \text{ V}$, $V_3 = 375 \text{ V}$, $V_4 = 420 \text{ V}$

3. Find the value of V_X and calculate the power dissipated in each element



Apply KCL at node 1: $-i_a - 9i_a + \frac{V_X}{20} = 0$

$$\therefore V_X = 200 i_a$$

We need a second equation that links V_X and i_a . This is obtained by applying KVL to the left-hand loop:

$$-42 + 10i_a + V_X = 0$$

Re-arranging to form simultaneous equations gives:

$$\begin{array}{r} -V_X = 10i_a - 42 \\ \frac{V_X = 200i_a}{0 = 210i_a - 42} \end{array} \quad) +$$

$$\therefore i_a = 0.2 \text{ A} \quad \text{and} \quad \boxed{V_X = 40 \text{ V}}$$

Applying KVL to the right-hand loop: $-V_X + V_{\text{Dep}} + 16 = 0, \therefore V_{\text{Dep}} = 24 \text{ V}$

The power associated with each element is calculated as follows:

42 V source:	P_{42}	$= -42 \times 0.2$	$= -8.4 \text{ W}$
10 Ω resistor:	$P_{5\Omega}$	$= 0.2^2 \times 10$	$= 0.4 \text{ W}$
20 Ω resistor:	$P_{10\Omega}$	$= 2^2 \times 20$	$= 80 \text{ W}$
Dependent source:	P_{Dep}	$= -24 \times 9 \times 0.2$	$= -43.2 \text{ W}$
16 V source:	P_{16}	$= -16 \times 9 \times 0.2$	$= -28.8 \text{ W}$
		<u>Total =</u>	<u>0 W</u>