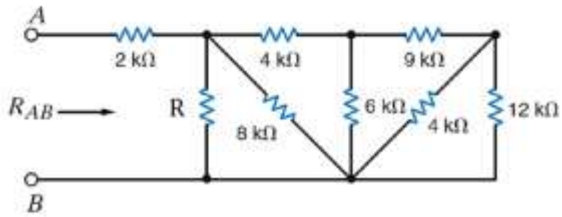
American University of Beirut
Department of Electrical and Computer Engineering
EECE 210 – Electric Circuits - Fall 2018
Quiz 1 Solutions

Problem 1 (4 pts)

If R = 8 kΩ, find the equivalent resistance, R_{AB}.



R_{AB}= ((((((12//4)+9)//6)+4)//8)//R)+2

R_{AB}= (((((3+9)//6)+4)//8)//R)+2 = ((((12//6)+4)//8)//R)+2= (((4+4)//8)//R)+2=(4R/(4+R))+2

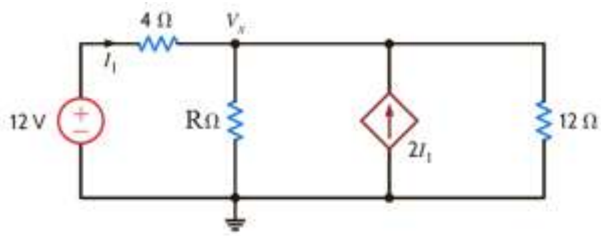
Version A; R=8kΩ, then R_{AB}= 4.7 kΩ

Version B; R=12 kΩ, then R_{AB}= 5 kΩ

Version C; R=16 kΩ, then R_{AB}= 5.2 kΩ

Problem 2 (4 pts)

Determine the power dissipated in the R Ω resistor in the network shown below.



Node equation for V_x

$$\frac{V_x - 12}{4} + \frac{V_x}{R} + \frac{V_x}{12} - 2\left(\frac{12 - V_x}{4}\right) = 0$$

Solving for V_x, we obtain

$$V_x = 108 * \left(\frac{R}{10R+12}\right) \text{ and } Pr = \frac{(V_x)^2}{R}$$

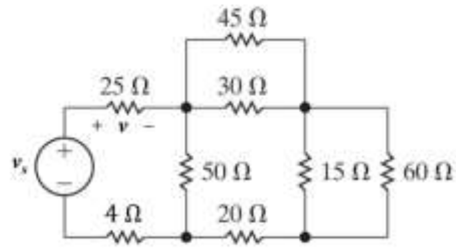
Version A: R=6 Ω, Vx=9 Volts, and $P = \frac{V_x^2}{R}$=13.5 W

Version B: R=9 Ω, Vx=9.53 Volts, and $P = \frac{V_x^2}{R}$=10.1 W

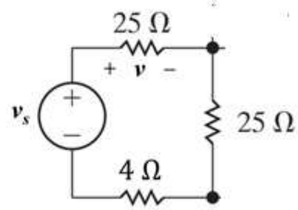
Version C: R=12 Ω, Vx=9.82 Volts, and $P = \frac{V_x^2}{R}$=8.04 W

Problem 3 (4 pts)

Find v (voltage drop across the 25 Ω resistor), when v_s =15 V.



Simplifying the above circuit, (15||60+45||30+20)||50= (12+18+20)||50 we obtain

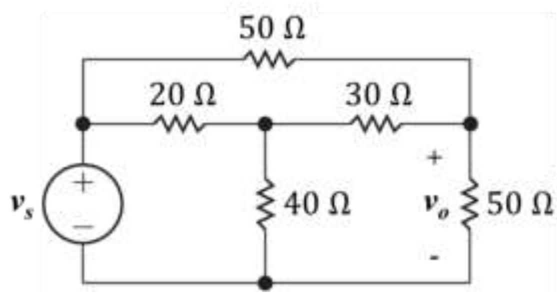


Using Voltage divider rule, we obtain: $v = v_s \frac{25}{54}$

Version A: For v_s = 15 V, then v = 6.94 V
Version B: For v_s = 25 V, then v = 11.57 V
Version C: For v_s = 15 V, then v = 6.94 V

Problem 4 (4 pts)

Solve the circuit below, find $\boldsymbol{v_o}$. Take $\boldsymbol{v_s}$ = 21 V.



Grounding the negative terminal of the voltage source, the two nodal equations read:

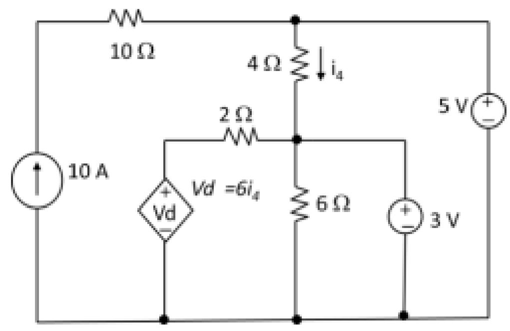
$$\frac{V_A - v_s}{20} + \frac{V_A}{40} + \frac{V_A - v_0}{30} = 0$$

$$\frac{v_0 - V_a}{30} + \frac{v_0}{50} + \frac{v_0 - v_s}{50} = 0$$

Solving, we obtain

Version A: For v_s = 21, v_0 = 11.78 V
Version B: For v_s = 24, v_0 = 13.46 V
Version C: For v_s = 35, v_0 = 19.6 V

Problem 5 (4 pts)
Find the power supplied/absorbed by the 3V source

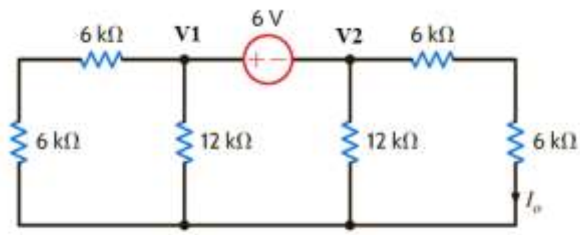


The current i_4=(5-3)/4=0.5 A. The Voltage V_d=3 volts. The current in the 2Ω resistor is 0A. The current in the 6Ω resistor is 0.5 A.

Using KCL, the current leaving the 3V source is 0 A. Therefore, the power associated with this source is 0Watts.

The answer is: None of the above for all versions (0)

Problem 6 (7 pts)
We want to determine the value of I_0 in the circuit shown below:



a. Write nodal equations for the node voltages V1 and V2. (2 pts)

$$\frac{V_1}{12}+\frac{V_1}{12}+\frac{V_2}{12}+\frac{V_2}{12}=0 \xrightarrow{yields} 2V_1+2V_2=0 \quad (1)$$

$$V_1-V_2=6 \qquad (2)$$

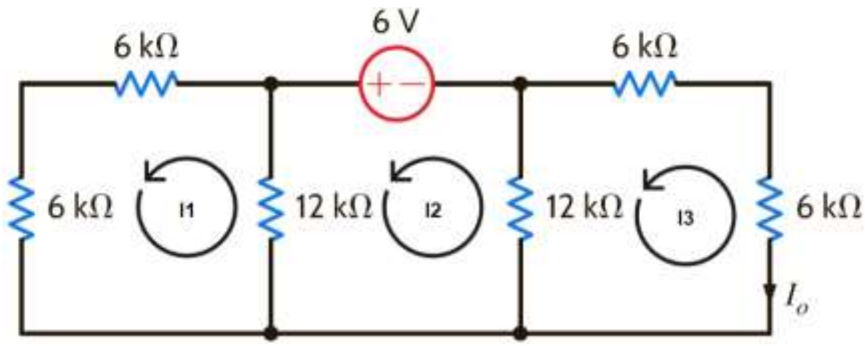
b. Solve for the node volatge V1 and V2. (1 pt)

$$V_1=3\,V \qquad V_2=-3\,V$$

c. Deduce the current I_0 (1 pt)

$$I_0=\frac{V_2}{12*1000}=-0.25\,mA$$

d. Resolve the circuit using mesh analysis and write the three mesh equations.(3 pt)

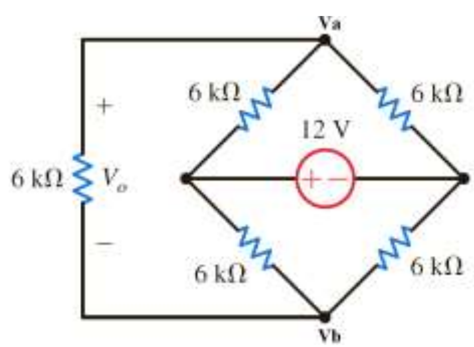


Mesh 1: $24I_1 - 12I_2 + 0I_3 = 0$
Mesh 2: $-12I_1 + 24I_2 - 12I_3 = 6$
Mesh 3: $0I_1 - 12I_2 + 24I_3 = 0$

Solving 1, 2, and 3 yields: I_1 =0.25 mA, I_2 =0.5 mA, I_3 =0.25 mA.

e. Verify the value of I_0 obtained in (c). (1 pt)
Therefore $I_0 = -I_3 = -0.25mA$

Problem 7 (6 pts)
We would like to find the value of V_0 in the circuit below,



a. Write the node voltage equation. (3 pts)

$$\frac{V_a}{6} + \frac{V_a - 12}{6} + \frac{V_a - V_b}{6} = 0$$

$$\frac{V_b - V_a}{6} + \frac{V_b}{6} + \frac{V_b - 12}{6} = 0$$

b. Solve for voltages V_a and V_b. (2 pts)

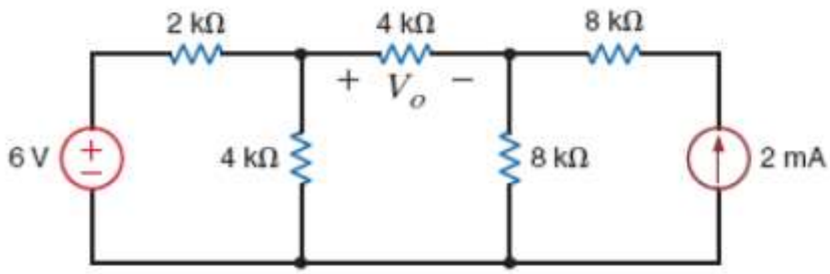
$$V_a = V_b = 6\,Volts$$

c. Deduce the value of V_0 (1 pt)

$$V_0 = V_a - V_b = 0\,Volts$$

Problem 8 (5 pts)

We would like to find the value of V_0 in the circuit below:



a. Would you use mesh or nodal analysis? Why? (1 pt)
   Two nodes vs 3 branches. Nodal analysis.

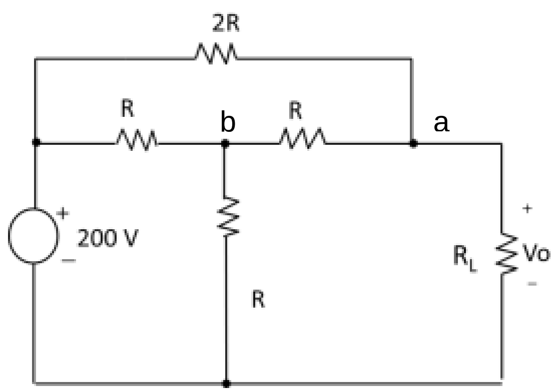
b. Solve for V_0 using the method you specified in a. (4 pts)

$$\frac{V_1 - 6}{2} + \frac{V_1}{4} + \frac{V_1 - V_2}{4} = 0$$
$$\frac{V_2 - V_1}{4} + \frac{V_2}{8} - 2 = 0$$

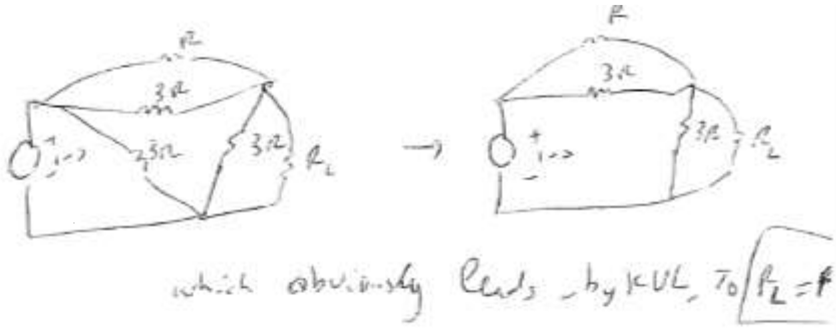
Solving, we obtain V_1=5.2 Volts and V_2=8.8 Volts .
Therefore, V_0=5.2 - 8.8 = - 3.6 Volts

Problem 9 (6 pts)

Find R_L such that the voltage Vo=100 Volts



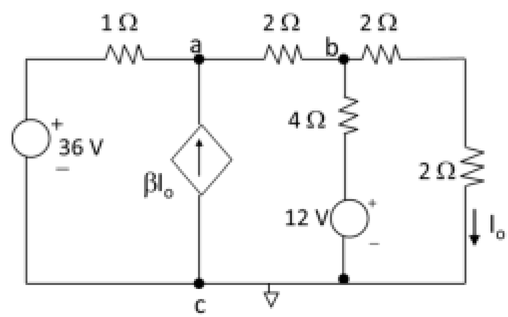
Transform the Y in the middle to a Delta:



-> R_L=2R

Problem 10 (6 pts)

If you are told that node c is a reference (V_c=0 Volts).



a. Write nodal equations at nodes a and b. (3 pts)

$$\frac{V_a-36}{1}+\frac{(V_a-V_b)}{2}-\beta I_0=0$$

$$\frac{(V_b-V_a)}{2}+\frac{(V_b-12)}{4}+\frac{(V_b)}{4}=0$$

b. Find β such that V_b=12 Volts. (3 pts)

$I_o=\frac{(V_b)}{4}$=3 A. Solving for 1 and 2, we obtain: β=-5

OR from first principles:

Vb=12 V, then $I_{4\Omega}=0$, so $I_{a\to b}=I_o$; Now KCL at node a: $I_{a\to b}=\beta I_o+I_{36V}$, then

$$I_{36V}=\frac{36-6I_o}{1}=18A$$

So $\beta=(-18/I_o)+1=-5$