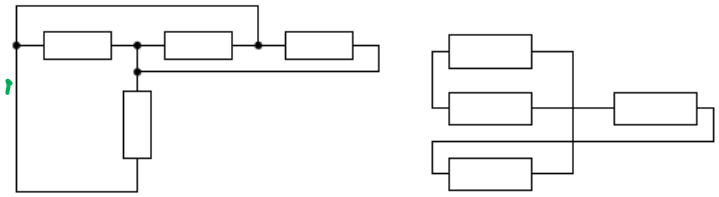
Principles of EE1 – Fall 2018
Quiz #1 SOLUTION (for both classes)
(October 9 & 10, 2018)

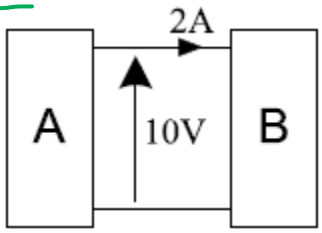
Prob. 1: One of the following circuits is a series circuit and the other is a parallel circuit. Explain which is which.



(a) (b)

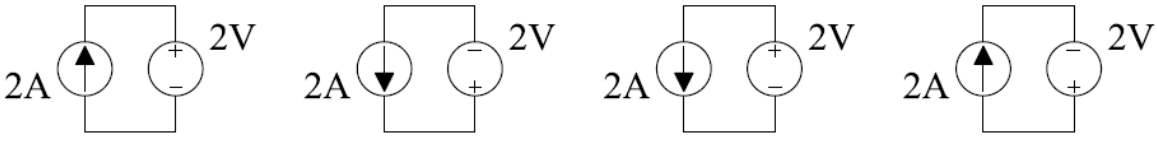
Sol.: Circuit (a) is a parallel circuit: there are only two nodes and all four components are connected between them.
Circuit (b) is a series circuit: each node is connected to exactly two components and the same current must ow through each.

Prob. 2: Find the power absorbed by each of the subcircuits A and B given that the voltage and current are 10V and 2A as shown.



Sol.: For subcircuit B the voltage and current correspond to the passive sign convention (i.e. the current arrow in the opposite direction to the voltage arrow) and so the power absorbed by B is given by V x I = 20W.
For device A we need to reverse the direction of the current to conform to the passive sign convention. Therefore the power absorbed by A is V x (- I) = - 20W.
As must always be true, the total power absorbed by all components is zero.

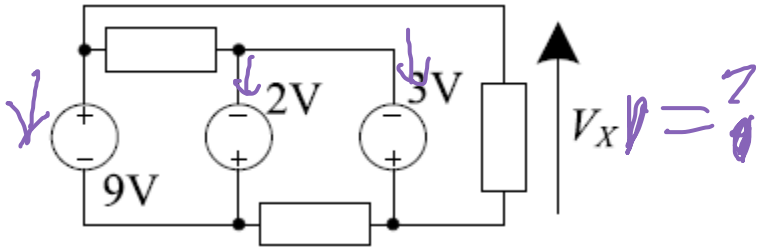
Prob. 3: For each of the four circuits below, the power absorbed by the voltage source (P_V), the
power absorbed by the current source (P_I) and the total power absorbed ($P_V + P_I$).



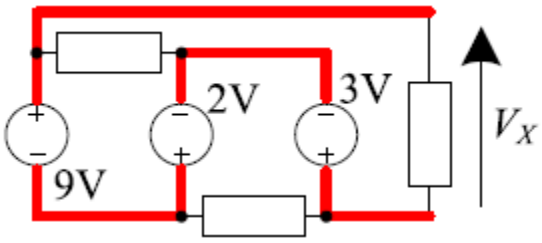
Sol.:
The power absorbed is positive if the voltage and current arrows go in opposite directions and negative if they go in the same direction.

So we get: (a) $P_V = +4$, $P_I = -4$, (b) $P_V = +4$, $P_I = -4$, (c) $P_V = -4$, $P_I = +4$, (d) $P_V = -4$, $P_I = +4$. In all cases, the total power absorbed is $P_V + P_I = 0$.

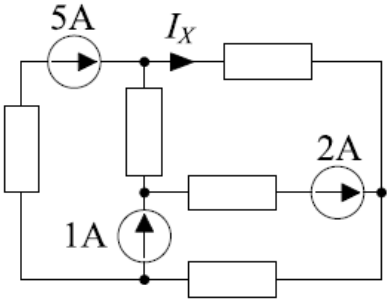
Prob. 4: Determine the voltage V_X in the following circuit.



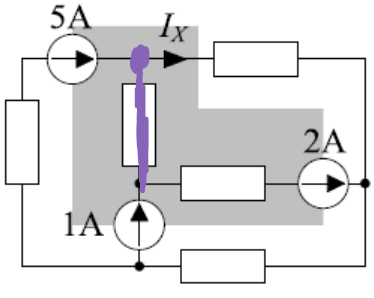
Sol.: We can find a path (shown highlighted below) from the bottom to the top of the V_X arrow that passes only through voltage sources and so we just add these up to get the total potential difference:
$V_X = (-3) + (+2) + (+9) = +8V$.



Prob. 5: Determine the current I_X in the following circuit.



Sol.: If we add up the currents flowing out of the region shown highlighted below, we obtain I_X-5-1+2 = 0. Hence $I_X = 4$ A.



Prob. 6:

a) Use the node-voltage method to find v_1, v_2, and v_3 in the circuit in Fig. P.1.
b) How much power does the 40 V voltage source deliver to the circuit?

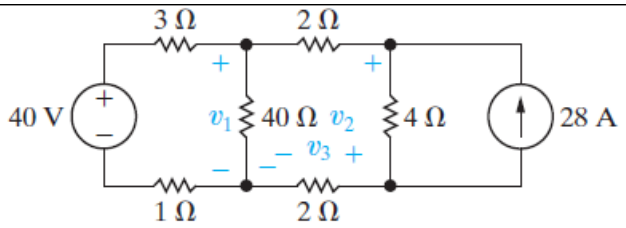
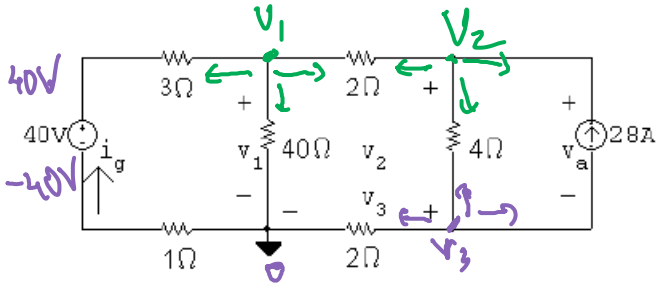


Fig. P.1

Sol.:

[a]



$$\frac{v_1}{40} + \frac{v_1 - 40}{4} + \frac{v_1 - v_2}{2} = 0, \quad \text{so } 31v_1 - 20v_2 + 0v_3 = 400$$

$$\frac{v_2 - v_1}{2} + \frac{v_2 - v_3}{4} - 28 = 0, \quad \text{so } -2v_1 + 3v_2 - v_3 = 112$$

$$\frac{v_3}{2} + \frac{v_3 - v_2}{4} + 28 = 0, \quad \text{so } 0v_1 - v_2 + 3v_3 = -112$$

Solving, $v_1 = 60$ V; $v_2 = 73$ V; $v_3 = -13$ V,

[b] $i_g = (40 - 60) / 4 = -5$ A

$p_g = (40)(-5) = -200$ W

➔ the 40 V source delivers 200 W of power.

Prob. 7:

a) Use the mesh-current method to find the branch currents i_a, i_b, and i_c in the circuit in Fig. P.2.
b) Repeat (a) if the polarity of the 140 V source is reversed.

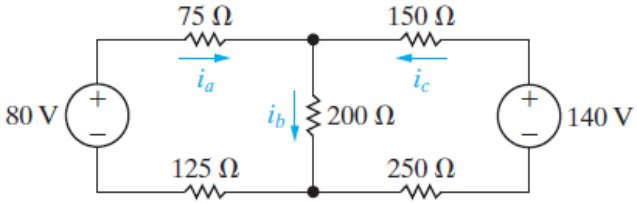
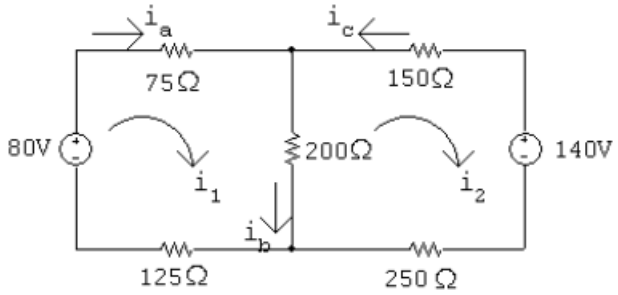


Fig. P.2

Sol.:

[a]



$80 = 400i_1 - 200i_2$

$-140 = -200i_1 + 600i_2$

Solving, $i_1 = 0.1A$; $i_2 = -0.2A$

$i_a = i_1 = 0.1A$; $i_b = i_1 - i_2 = 0.3A$; $i_c = -i_2 = 0.2A$

[b] If the polarity of the 140 V source is reversed, we have

$80 = 400i_1 - 200i_2$

$140 = -200i_1 + 600i_2$

$i_1 = 0.38A$ and $i_2 = 0.36A$

$i_a = i_1 = 0.38A$; $i_b = i_1 - i_2 = 0.02A$; $i_c = -i_2 = -0.36A$