ECSE-200 Electric Circuits 1
Quiz #4 (Feb. 8, 2019)

LAST NAME Solutions ______________________ MCGILL ID# ______________

FIRST NAME ______________________ SIGNATURE ______________________

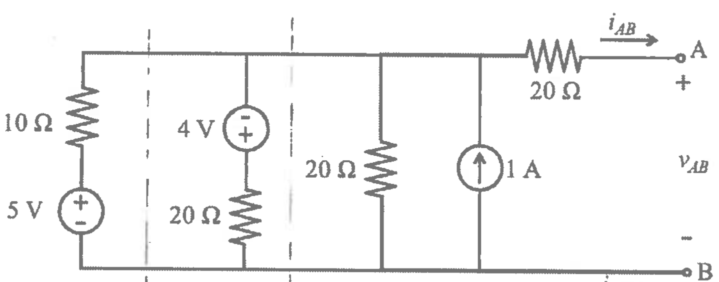
- *Only Faculty standard calculator accepted*
- *No cellphone allowed*
- *Show all your work*
- *Clearly indicate your final answer with SI units and SI multiplier*
- *You have 45 minutes to complete this quiz*

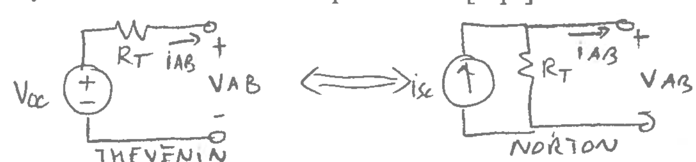
Question 1. Consider the circuit shown below. Answer the following questions.

a) Using source transformation, simplify the circuit at terminals AB into its Norton's circuit equivalent. [3 pt]

b) What resistance value should a load resistor connected across terminals AB have for the voltage v_{AB} to be 5 V? [2 pt]

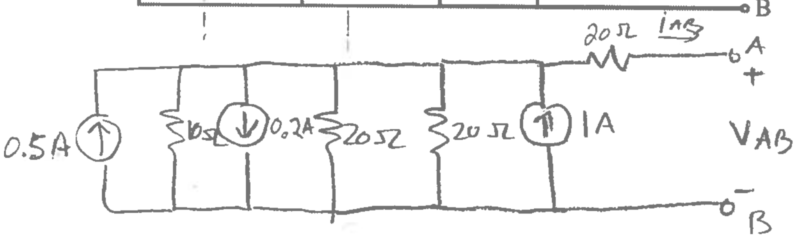
c) If the circuit is loaded with an element connected across terminals AB that has infinite conductance ($G \to \infty$), what is the power dissipated by the Thévenin resistor in your Norton's circuit equivalent? [1 pt]

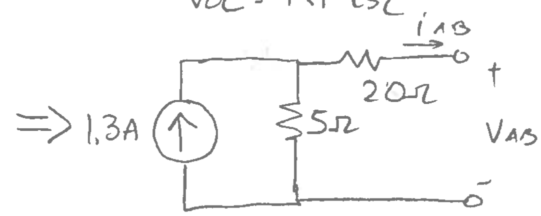


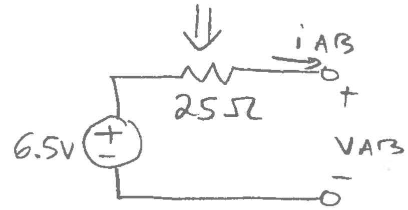


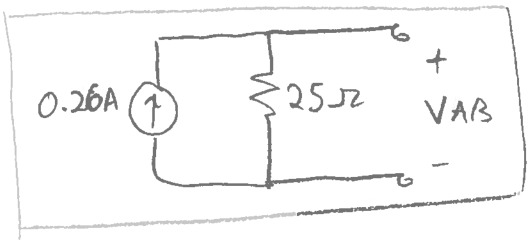
$V_{AB} = V_{oc} - i_{AB} R_T$ $\quad$ $i_{AB} = i_{sc} - \frac{V_{AB}}{R_T}$

EQUIVALENT IF
$V_{oc} = R_T \cdot i_{sc}$

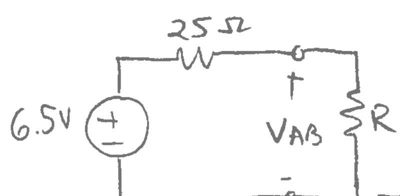








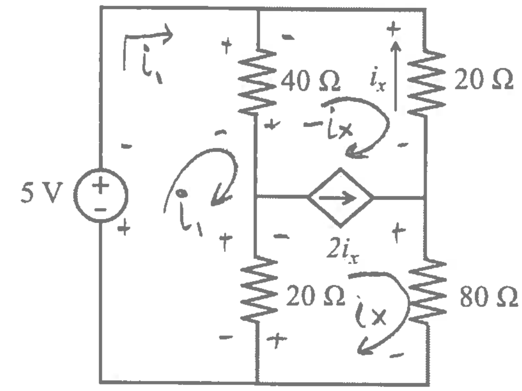
b) use thevenin form + voltage division

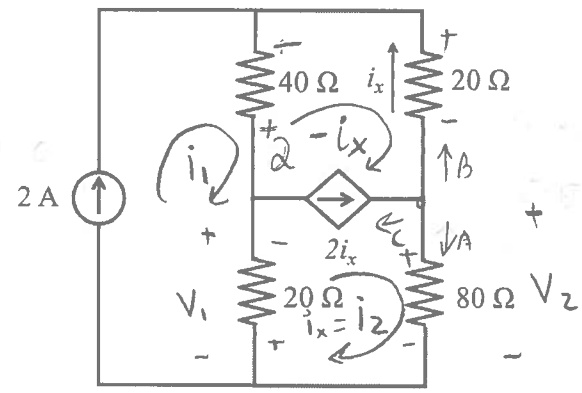


$$V_{AB} = 6.5\text{V} \cdot \frac{R_L}{R_L + 25\,\Omega} = 5\text{V} \rightarrow R_L - \frac{5}{6.5} R_L = \frac{5}{6.5} \cdot 25 \qquad \boxed{R_L = 83\tfrac{1}{3}\,\Omega}$$

c) $G = \frac{1}{R} = \infty$ $\quad R_L = 0 \rightarrow$ short-circuit
no current flows in the thevenin resistor of the Norton's Circuit $\boxed{P_{W} = 0\text{W}}$

Question 2. Consider the two circuits shown. Answer the following questions.





a) If you are solving for the circuit variables in the **left** circuit, which circuit method requires fewer equations, the node voltage method or the mesh current method? Justify your answer. [1 pt]

b) If you are solving for the circuit variables in the **right** circuit, which circuit method requires fewer equations, the node voltage method or the mesh current method? Justify your answer. [1 pt]

c) What is the power dissipated by the dependent current source in the **right** circuit? [3 pt]

d) What is the power dissipated by the independent voltage source in the **left** circuit? [3 pt]

a) 2 nodes ; one mesh + one super-mesh
both method requires same number of equations

b) 3 nodes ; one mesh + one super-mesh
the mesh current method should be used.

c) current in top mesh of the supermesh $i_A + i_B + i_C = 0$

$i_2 + i_x - 2i_x = 0$

$\therefore i_2 = i_x$

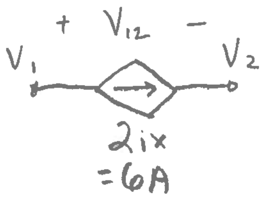
KVL on super-mesh

$40(-i_x - i_1) + 20(-i_x) + 80(i_x) + 20(i_x - i_1)$

$-40i_x - 80 - 20i_x + 80i_x + 20i_x - 40 = 0$

$40i_x = 120 \quad i_x = 3\text{ A} = i_2$

from the other mesh $i_1 = 2\text{A}$



$V_1 = 20\Omega(i_1 - i_2) = 20\Omega(2-3) = -20V$

$V_2 = 80\Omega \cdot i_2 = 240\text{ V}$

$V_{12} = V_1 - V_2 = -20V - 240V = -260V$

$P = (6A)(-260V)$

$\boxed{P = -1.56\text{kW dissipated}}$

d) To find i_1 using mesh analysis

KVL on super-mesh

$$40(-i_x - i_1) + 20(-i_x) + 80(i_x) + 20(i_x - i_1) = 0$$
$$-40i_x - 40i_1 - 20i_x + 80i_x + 20i_x - 20i_1 = 0$$
$$40i_x = 60i_1 \qquad \underbrace{i_x = \frac{3}{2}i_1}$$

KVL on other mesh

$$-5 + 40(i_1 - (-i_x)) + 20(i_1 - i_x) = 0$$
$$-5 + 40i_1 + 40i_x + 20i_1 - 20i_x = 0$$
$$-5 + 40i_1 + 60i_1 + 20i_1 - 30i_1 = 0$$
$$90i_1 = 5 \qquad i_1 = \frac{5}{90}\text{ A}$$

$$P = \left(\frac{5}{90}\text{A}\right)(5\text{V}) = 277.8\text{ mW}$$

+ 277.8 mW delivered

− 277.8 mW dissipated/absorbed