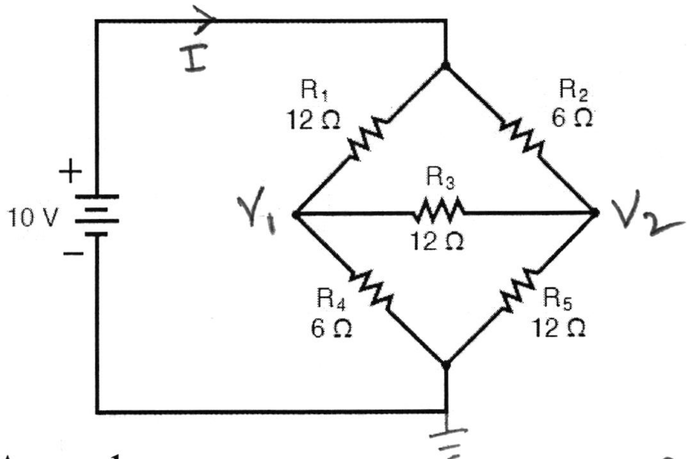
Student Name:____

EE2001 Midterm Exam Nov. 12, 2019

(25 pts.) **1)** For the circuit below, find the power delivered by the voltage source.



Answer 1: Using Node Voltage Analysis:

$$\frac{V_1-10}{12}+\frac{V_1-V_2}{12}+\frac{V_1}{6}=0$$

$$\frac{V_2-10}{6}+\frac{V_2-V_1}{12}+\frac{V_2}{12}=0$$

$$\Rightarrow \quad 4V_1-V_2=10$$
$$-V_1+4V_2=20$$

$$\Rightarrow \quad V_1=4\,V, \quad V_2=6\,V$$

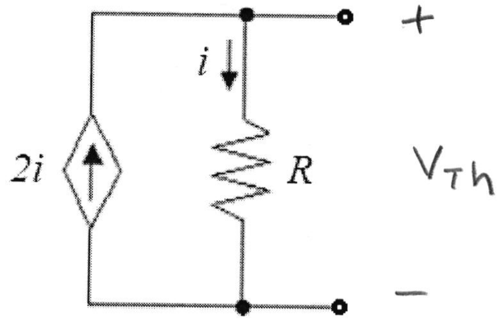
$$\Rightarrow \quad I=\frac{10-V_1}{12}+\frac{10-V_2}{6}=\frac{7}{6}\,A$$

$$\Rightarrow \quad \text{Power}=10\cdot I=\frac{35}{3}\,W$$

Note: Total time allowed is 100 min. Please show all your work and write legibly.

(25 pts.) **2)** Find Thevenin equivalent for the circuit shown. (Assume, R is a known resistor value.)

Hint: If V_{TH} value is found to be zero, the circuit is equivalent to a pure resistor. In this case, the equivalent resistance value can be found by applying a voltage source to the terminals, and calculating the current supplied.



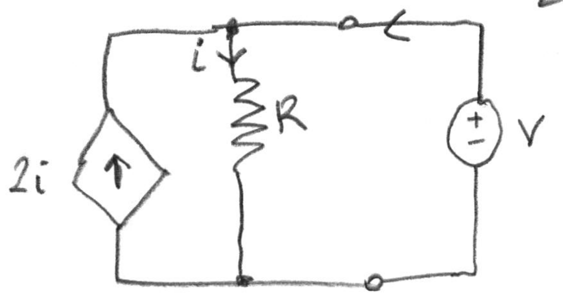
Answer 2:

Open Circuit:

$$2i - i = 0 \Rightarrow \underline{i = 0} \Rightarrow V_{Th} = 0$$

$\Rightarrow$ The circuit is equivalent to a pure resistance.

← Apply a voltage source



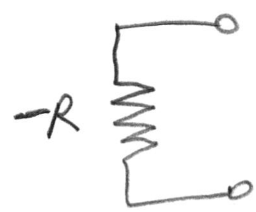
$$2i + I = i \Rightarrow i = -I$$

From Ohm's law: $V = i \cdot R$

$$\Rightarrow V = -I \cdot R$$

$$\Rightarrow \frac{V}{I} = -R$$ ← The equivalent resistance value

Therefore, the circuit is equivalent to:

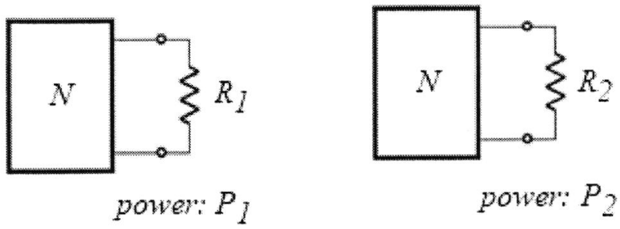


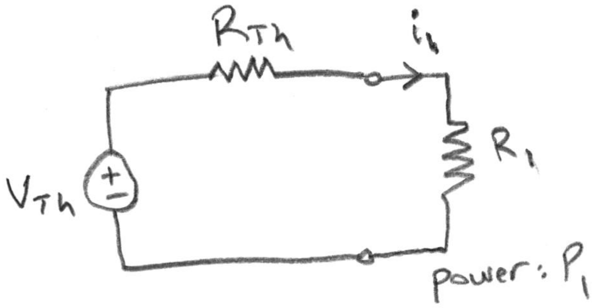
← Negative R resistance

(25 pts.) **3)** A linear network *N* produces powers P_1 and P_2 when resistances R_1 and R_2 connected to it correspondingly. What should be the resistor value to obtain the maximum power from that network?

Hint: Use a Thevenin equivalent model for the circuit and find the parameters V_{TH} and R_{TH} using the given data.

Answer 3:





$$\Rightarrow i_1 = \sqrt{\frac{P_1}{R_1}}$$

$$\Rightarrow V_{Th} = (R_{Th} + R_1) \cdot \sqrt{\frac{P_1}{R_1}}$$

Similarly:

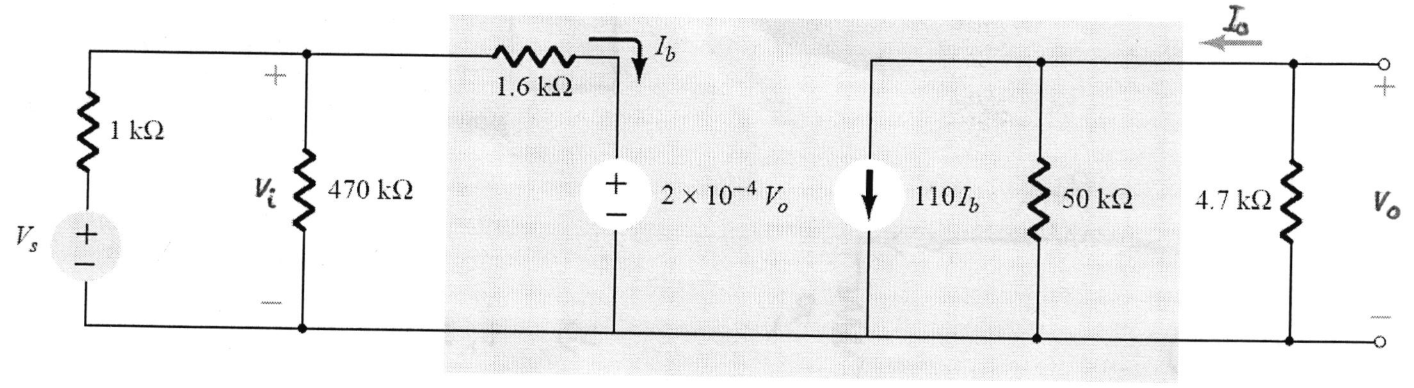
$$\Rightarrow V_{Th} = (R_{Th} + R_2) \cdot \sqrt{\frac{P_2}{R_2}}$$

If we equate these two equations, we obtain:

$$\Rightarrow R_{Th} = \frac{\sqrt{P_1 \cdot R_1} - \sqrt{P_2 \cdot R_2}}{\sqrt{P_2 / R_2} - \sqrt{P_1 / R_1}}$$

To obtain the maximum power, this resistor value should be used.

(25 pts.) **4)** For the circuit shown, assume V_s value is known. Write four equations which are necessary to solve for the unknowns V_i, V_o, I_b, and I_o. Also, write an expression (in terms of the variables used) for the amount of power generated by the input voltage source V_S. **Do not** solve the equations; just write them correctly and completely.



Equation 1:

$$\frac{V_i - V_s}{1K} + \frac{V_i}{470K} + \frac{V_i - 2\cdot10^{-4} V_o}{1.6K} = 0$$

Equation 2:

$$\frac{V_o}{4.7K} + \frac{V_o}{50K} + 110 I_b = 0$$

Equation 3:

$$i_b = \frac{V_i - 2\cdot10^{-4} V_o}{1.6K}$$

Equation 4:

$$I_o = -\frac{V_o}{4.7K}$$

An expression for the power generated by the source V_S:

$$V_s \cdot \left(\frac{V_s - V_i}{1K} \right)$$