Name ____________________

EE/EET 2240

Exam #1

Thursday, February 14, 2019

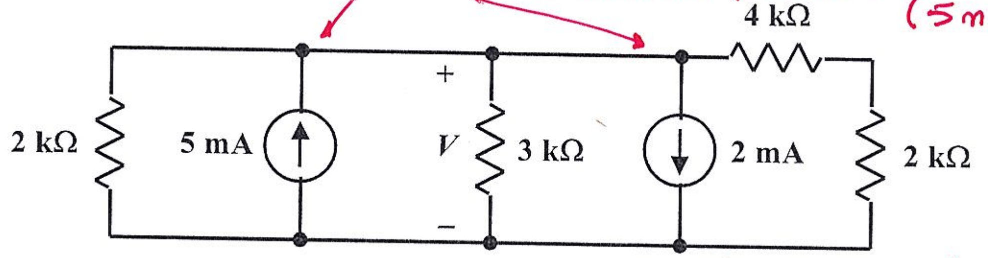
BA 302 (Pocatello) and TAB 115 (Idaho Falls), 9:30AM – 10:45AM

[closed book – one one-sided 8½”×11” page of notes and calculator allowed, nothing else]

1. Determine the value of the voltage, V. **SHOW YOUR WORK, and include units and proper signs with your answers.**

Two current sources in parallel.

$(5\,mA\uparrow) + (2\,mA\downarrow) = 3\,mA\uparrow$



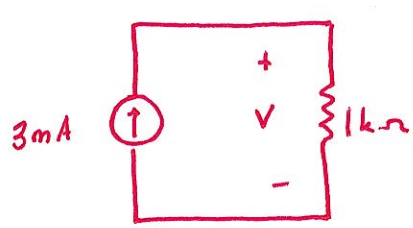
Two resistors in series.

$R_{eq} = 4k\Omega + 2k\Omega = 6k\Omega$

Three resistors in parallel.

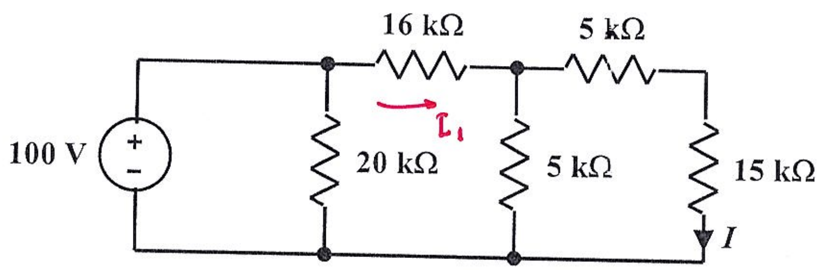
$$R_{eq} = \frac{1}{\frac{1}{2k\Omega} + \frac{1}{3k\Omega} + \frac{1}{6k\Omega}} = 1k\Omega$$

Equivalent Circuit:



$V = (1k\Omega)(3\,mA) = 3\,V$

2. Determine the value of the current, I. **SHOW YOUR WORK, and include units and proper signs with your answers.**



Two resistors in series.

$R_{eq1} = 5k\Omega + 15k\Omega = 20k\Omega$

Two resistors in parallel.

$$R_{eq2} = \frac{(5k\Omega)(R_{eq1})}{5k\Omega + R_{eq1}} = 4k\Omega$$

Two resistors in series.

$R_{eq3} = 16k\Omega + R_{eq2} = 20k\Omega$

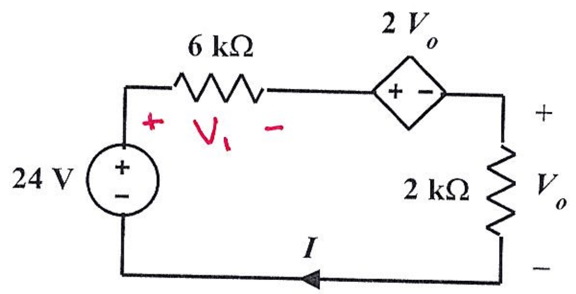
From Ohm's Law:

$$I_1 = \frac{100V}{R_{eq3}} = 5mA$$

From the Current Divider Rule:

$$I = \frac{\frac{1}{20k\Omega}}{\frac{1}{5k\Omega} + \frac{1}{20k\Omega}} \cdot I_1 = \frac{1}{5}(5mA) = 1mA$$

3. Determine the value of the current, I. Then, determine whether the dependent source ***delivers*** or ***absorbs*** power, and how much. **SHOW YOUR WORK, and include units and proper sign with your answer.**



$V_1 = (6\,k\Omega)\,I$ (Ohm's Law)

$V_1 + 2V_o + V_o = 24V$ (KVL)

$V_o = (2\,k\Omega)\,I$ (Ohm's Law)

Substituting: $(6k\Omega)I + 2(2k\Omega)I + (2k\Omega)I = 24V$

or $(12k\Omega)\,I = 24V$

$\rightarrow \quad I = 2\,mA$

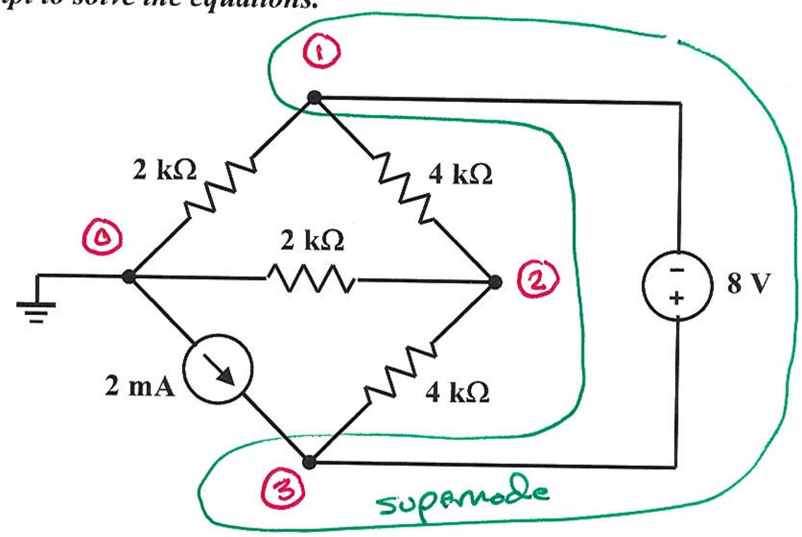
The voltage of the VCVS is $2(2k\Omega)I = 8V$.

Checking signs and reference directions, we see that the VCVS's voltage and current satisfy the Passive Sign Convention. Therefore, it <u>absorbs</u>

$P = (8V)(2mA) = 16\,mW$

4. Use the ***nodal analysis method*** to formulate a system of simultaneous linear equations representing the circuit shown below. Express the equations in the standard matrix form discussed in class. **SHOW YOUR WORK.**

Do not attempt to solve the equations.



$V_3 - V_1 = 8\text{ V}$ (constraint equation for supernode)

$$\frac{V_2 - V_1}{4k\Omega} + \frac{V_2}{2k\Omega} + \frac{V_2 - V_3}{4k\Omega} = 0$$ (KCL for node 2)

$$\frac{V_1}{2k\Omega} + \frac{V_1 - V_2}{4k\Omega} + \frac{V_3 - V_2}{4k\Omega} - 2\text{mA} = 0$$ (KCL for the supernode)

In matrix form:

$$\begin{bmatrix} -1 & 0 & 1 \\ -\frac{1}{4000} & \frac{1}{4000} + \frac{1}{2000} + \frac{1}{4000} & -\frac{1}{4000} \\ \frac{1}{2000} + \frac{1}{4000} & -\frac{1}{4000} - \frac{1}{4000} & \frac{1}{4000} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} = \begin{bmatrix} 8 \\ 0 \\ \frac{2}{1000} \end{bmatrix}$$

or

$$\begin{bmatrix} -1 & 0 & 1 \\ -\frac{1}{4000} & \frac{1}{1000} & -\frac{1}{4000} \\ \frac{3}{4000} & -\frac{1}{2000} & \frac{1}{4000} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} = \begin{bmatrix} 8 \\ 0 \\ \frac{1}{500} \end{bmatrix}$$