Name _____

By writing or printing my name in the space above, I hereby affirm that I have neither given nor received assistance in preparing solutions for this exam.

EE 2240

Exam #1

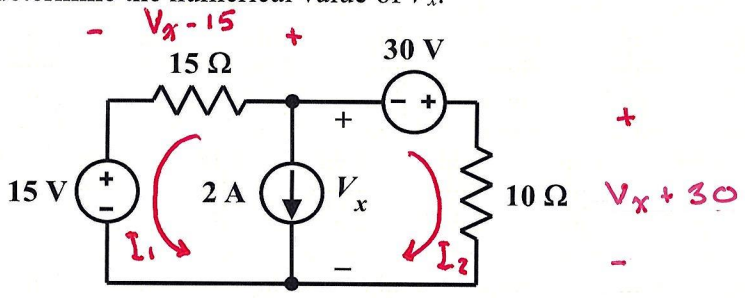
Due by 9:15AM, Tuesday, September 28, 2021

[open book, open notes, calculator and computer allowed – no internet access]

Work must be neat, orderly, and complete in order to receive partial credit.

***PLEASE* submit your solutions as a single PDF file.**

1. Use any method to determine the numerical value of V_x.



$V_x - 15$ (−, +) $V_x + 30$ (+, −)

$$I_1 = \frac{V_x - 15}{15} \qquad I_2 = \frac{V_x + 30}{10}$$

$$I_1 + 2 + I_2 = 0$$

$$\Rightarrow \frac{V_x - 15}{15} + 2 + \frac{V_x + 30}{10} = 0$$

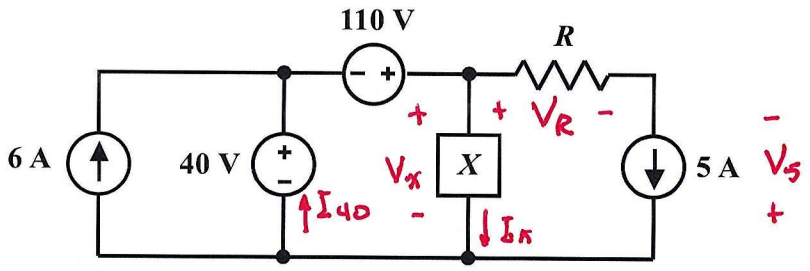
multiply through by 30:

$$2(V_x - 15) + 30(2) + 3(V_x + 30) = 0$$

$$5V_x = -120$$

$$V_x = -\frac{120}{5} = -24\ \text{V}$$

2. The 5A independent current source is delivering 100W, and the 40V independent voltage source is delivering 500W.



a. Determine the value of resistor *R*.

$V_5\,(5A) = 100\,W \Rightarrow V_5 = 20V$

$V_R = 110V + 40V + V_5 = 170V$

$R = \frac{V_R}{5A} = \frac{170V}{5A} = 34\,\Omega$

b. Is component *X* absorbing power or delivering power? How much?

$(40V)\,I_{40} = 500W \Rightarrow I_{40} = 12.5A$

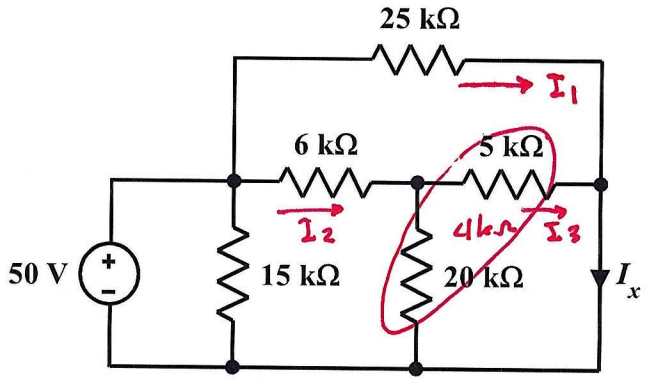
$I_X = 6A + I_{40} - 5A = 13.5A$

$V_x = V_R - V_5 = 150\,V$

V_x and I_x satisfy the Passive Sign Convention

$\Rightarrow$ X absorbs $(150V)(13.5A) = 2025\,W$

3. Determine the numerical value of the current I_x.



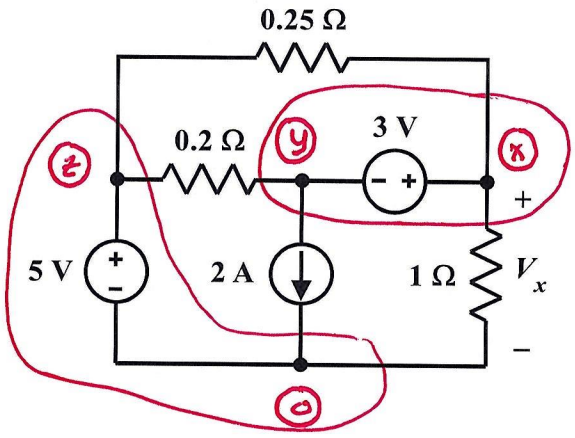
$$I_1 = \frac{50V}{25k\Omega} = 2\,mA$$

$$I_2 = \frac{50V}{6k\Omega + 4k\Omega} = 5\,mA$$

$$I_3 = \frac{20k\Omega}{20k\Omega + 5k\Omega} \cdot I_2 = 4\,mA$$

$$I_x = I_1 + I_3 = 6\,mA$$

4. Use the nodal analysis method to formulate a system of simultaneous linear equations representing the circuit shown, that can be solved to determine the numerical value of V_x directly.



$V_x - V_y = 3V$

$V_z = 5V$

$\frac{V_x - V_z}{0.25\Omega} + \frac{V_y - V_z}{0.2\Omega} + 2A + \frac{V_x}{1\Omega} = 0$

a. Express the equations in the matrix form discussed in class.

$$\begin{bmatrix} 1 & -1 & 0 \\ 0 & 0 & 1 \\ 5 & 5 & -9 \end{bmatrix} \begin{bmatrix} V_x \\ V_y \\ V_z \end{bmatrix} = \begin{bmatrix} 3 \\ 5 \\ -2 \end{bmatrix}$$

b. Solve the equations to determine the numerical value of V_x.

$$V_x = \frac{\begin{vmatrix} 3 & -1 & 0 \\ 5 & 0 & 1 \\ -2 & 5 & -9 \end{vmatrix}}{\begin{vmatrix} 1 & -1 & 0 \\ 0 & 0 & 1 \\ 5 & 5 & -9 \end{vmatrix}} = \frac{2 - 45 - 15}{-5 - 5} = 5.8\ V$$