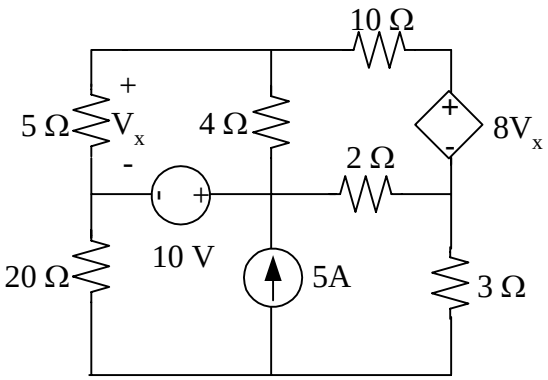
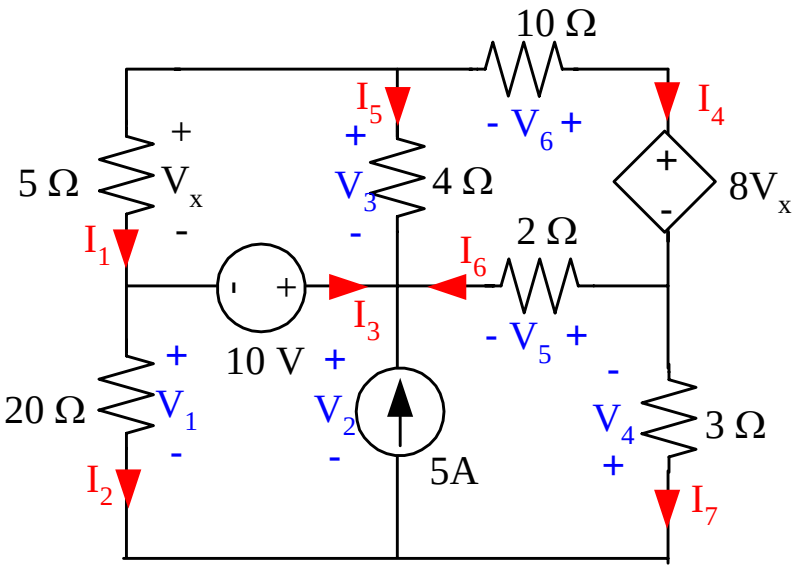
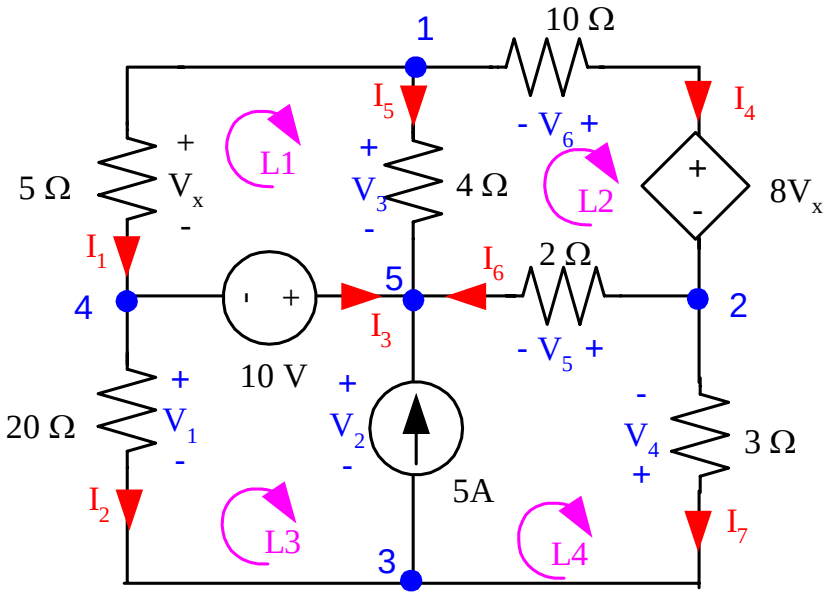
Extra Example of Brute Force Technique:
Solve for all the voltages, currents and power associated with each element.



Step 1: Label all the voltages and currents. (*Note: I have labeled a few that violate the passive sign convention for resistors*).



Step 2: Identify and denote nodes and loops.



Step 3: Write KCL and KCL equations and Ohm' Law and Step 4: Simplify and Solve.

KCL (4 nodes)

N1: $I_1 + I_4 + I_5 = 0$
N2: $I_4 = I_6 + I_7$
N3: $I_2 + I_7 = 5$
N4: $I_1 = I_2 + I_3$

KVL (4 loops)

L1: $V_x - V_3 - 10 = 0$
L2: $V_3 + V_6 - 8V_x - V_5 = 0$
L3: $V_1 + 10 - V_2 = 0$
L4: $V_2 + V_5 + V_4 = 0$

Ohm's Law

$V_x = 5I_1$
$V_1 = 20I_2$
$V_3 = 4I_5$
$V_4 = 3(-I_7)$
$V_5 = 2I_6$
$V_6 = 10(-I_4)$

Simplify Equations and Solve

$I_1 + I_4 + I_5 = 0$
$I_4 - I_6 - I_7 = 0$
$I_2 + I_7 = 5$
$I_1 - I_2 - I_3 = 0$
$V_x - 4I_5 = 10$
$4I_5 - 10I_4 - 8V_x - 2I_6 = 0$
$20I_2 - V_2 = -10$
$V_2 + 2I_6 - 3I_7 = 0$
$5I_1 - V_x = 0$

Into a matrix:

$$\begin{bmatrix} 1 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & -1 & -1 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 1 & -1 & -1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -4 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & -10 & 4 & -2 & 0 & 0 & -8 \\ 0 & 20 & 0 & 0 & 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 2 & -3 & 1 & 0 \\ 5 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \\ I_4 \\ I_5 \\ I_6 \\ I_7 \\ V_2 \\ V_x \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 5 \\ 0 \\ 10 \\ 0 \\ -10 \\ 0 \\ 0 \end{bmatrix}$$

Step 4: (continued)

Solutions:

$I_1 = -3.68A$
$I_2 = -0.26A$
$I_3 = -3.42A$
$I_4 = 10.79A$
$I_5 = -7.10A$
$I_6 = -5.53A$
$I_7 = 5.26A$
$V_2 = 4.74V$
$V_x = -18.42V$

$V_1 = 20I_2 = -5.20V$
$V_3 = 4I_5 = -28.40V$
$V_4 = 3(-I_7) = -15.78V$
$V_5 = 2I_6 = -11.06V$
$V_6 = 10(-I_4) = -107.90V$

Step 5: Check using Power:

Element	Voltage (V)	Current (A)	Power (W)	Del/Abs
5 Ω	-18.42	-3.68	67.79	Abs
4 Ω	-28.4	-7.1	201.64	Abs
10 Ω	-107.9	10.79	1164.24	Abs
2 Ω	-11.06	-5.53	61.16	Abs
20 Ω	-5.2	-0.26	1.352	Abs
3 Ω	-15.78	5.26	83.00	Abs
10 V	10	-3.42	-34.2	Del
		or	**34.2**	**Abs**
5A	4.74	5	23.7	Del
8Vx	-147.36	10.79	-1590.01	Abs
		or	**1590.01**	**Del**

sum of power delivered	1613.71
sum of power absorbed	1613.38
	Checks!!