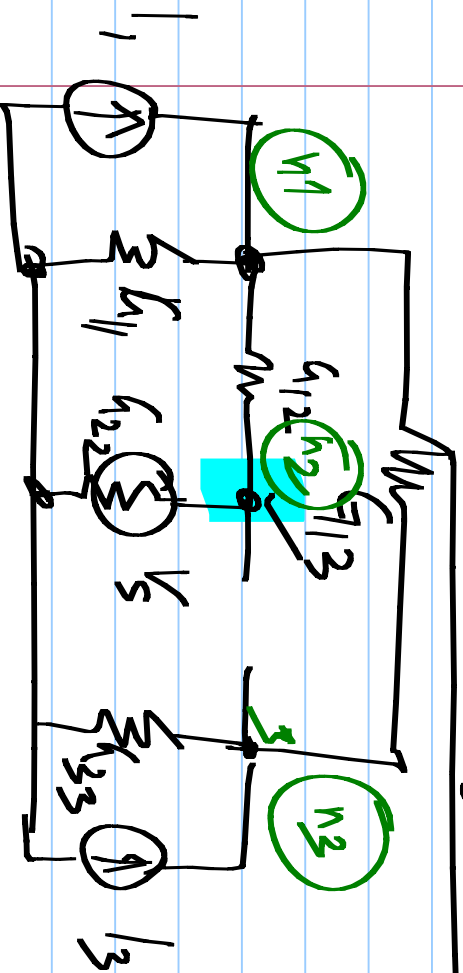


ECE 2015

14/8/2017

Nodal analysis with voltage sources



Super node enclosing n_2 & n_3

Instead of KCL @ n_2 n_3

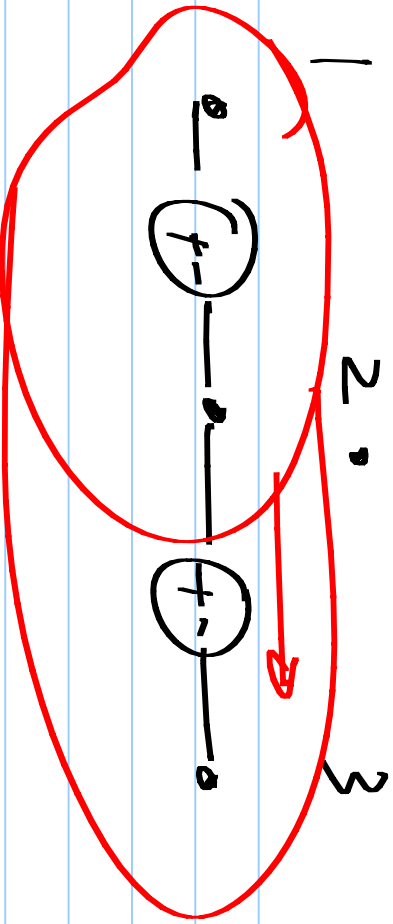
$$(g_{11} + g_{12} + g_{13})V_1 - g_{12}V_2 - g_{13}V_3 = I_1$$

$$(-g_{12} - g_{13})V_1 + (g_{12} + g_{22})V_2 + (g_{13} + g_{33})V_3 = I_3$$

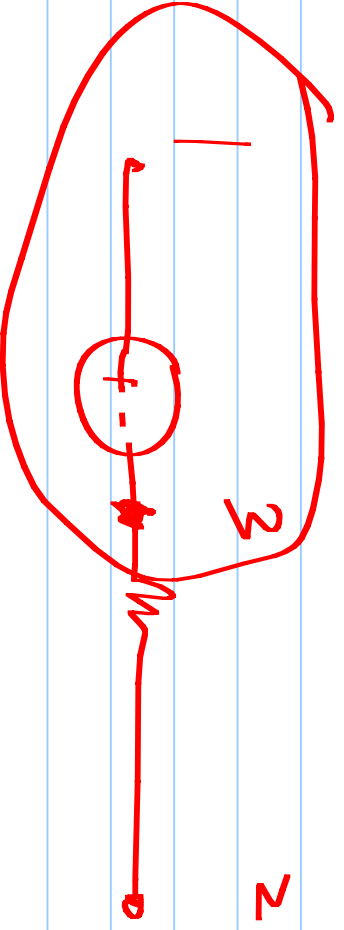
$$V_2 - V_3 = V_s$$

$$\begin{array}{l}
 \text{Node 1} \\
 \text{Supernode} \\
 \text{Voltage source}
 \end{array}
 \begin{bmatrix}
 G_{11} + G_{12} + G_{13} & -G_{12} & -G_{13} \\
 -G_{12} - G_{13} & G_{12} + G_{22} & G_{13} + G_{33} \\
 0 & 1 & -1
 \end{bmatrix}
 \begin{bmatrix}
 V_1 \\
 V_2 \\
 V_3
 \end{bmatrix}
 =
 \begin{bmatrix}
 1 \\
 1 \\
 0
 \end{bmatrix}$$

$$V_1 - V_3 = k(V_1 - V_2)$$



V_1 n_1 n_2



Modified nodal analysis

Variables: node voltages

currents through voltage sources

controlling currents of current

controlled sources

Nodal analysis:

Superposition,

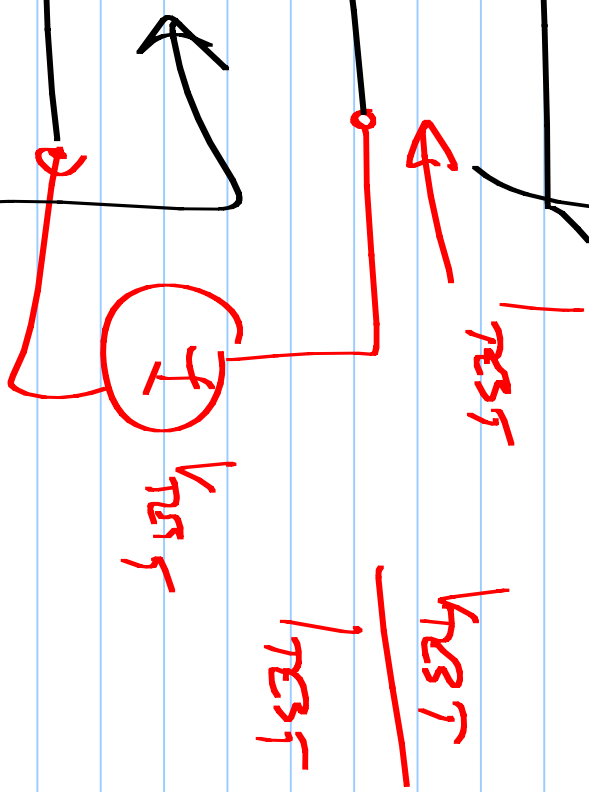
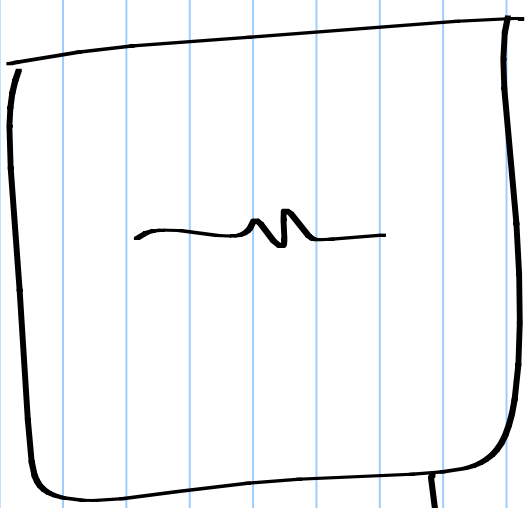
$$\begin{bmatrix} v_1 \\ v_2 \\ v_3 \end{bmatrix} = [K]^{-1} \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix} + [K]^{-1} \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix} + [K]^{-1} \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} + [K]^{-1} \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$
$$v_j = \alpha_1 I_1 + \alpha_2 I_3 + \alpha_3 v_s$$

Solution with only I_1 active

Solution with only I_3 active

Solution with only v_s active

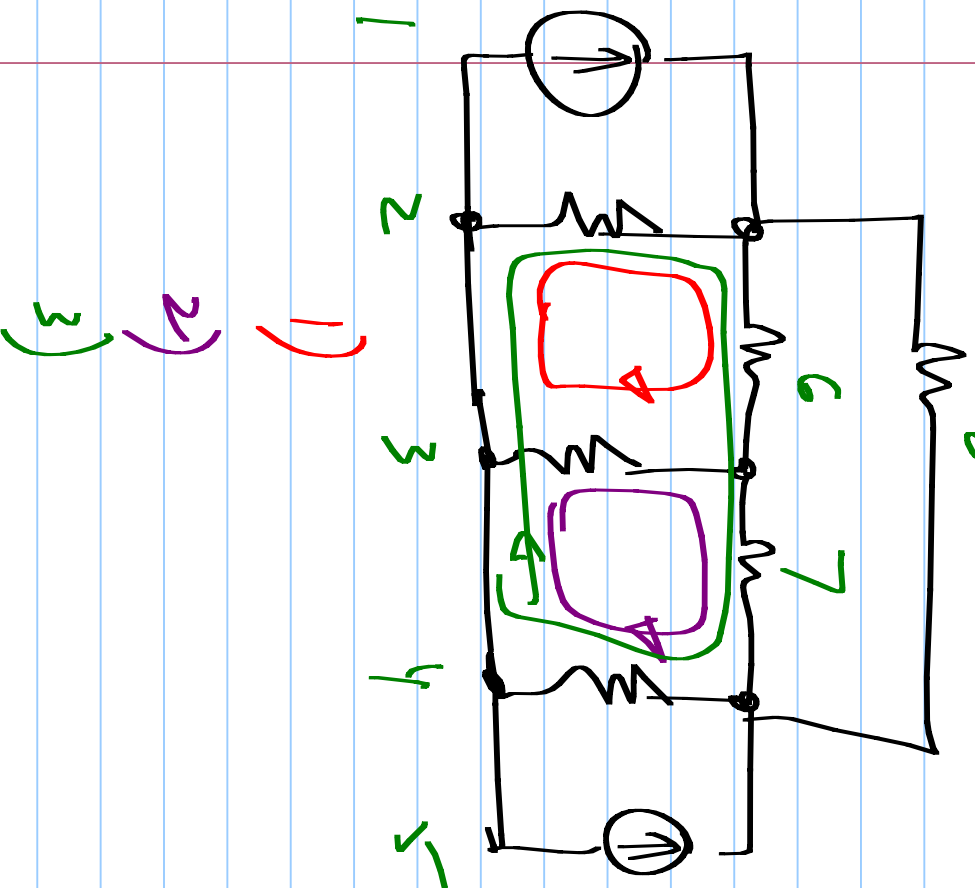
$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} \frac{V_1 + V_2}{2} \\ \frac{V_1 + V_2}{2} \end{bmatrix} + \begin{bmatrix} \frac{V_1 - V_2}{2} \\ -\frac{V_1 - V_2}{2} \end{bmatrix}$$

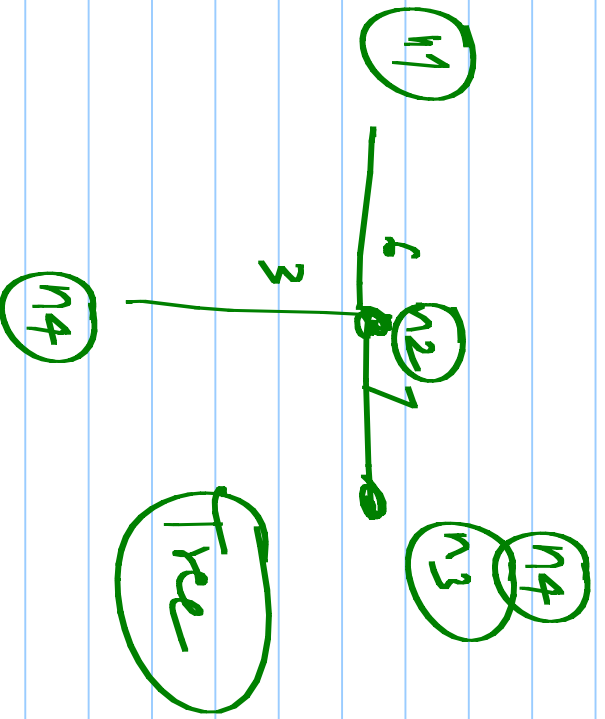
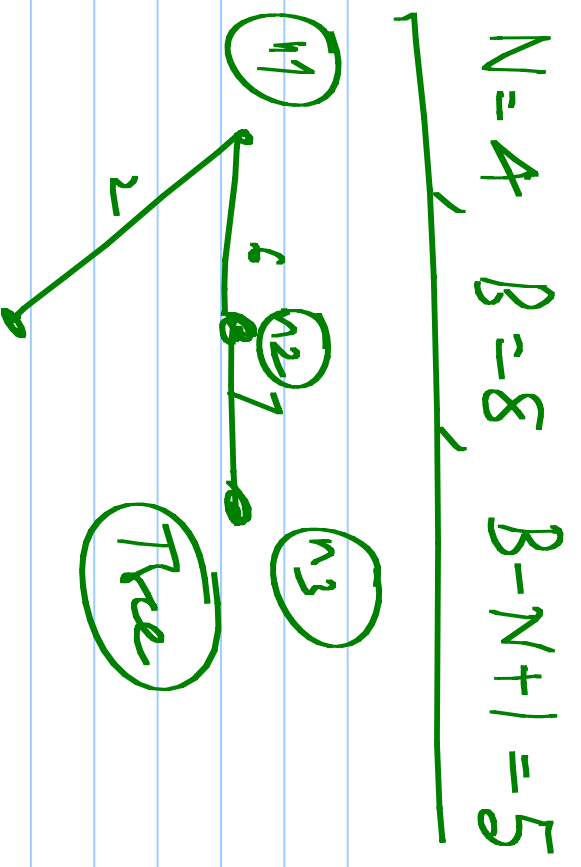
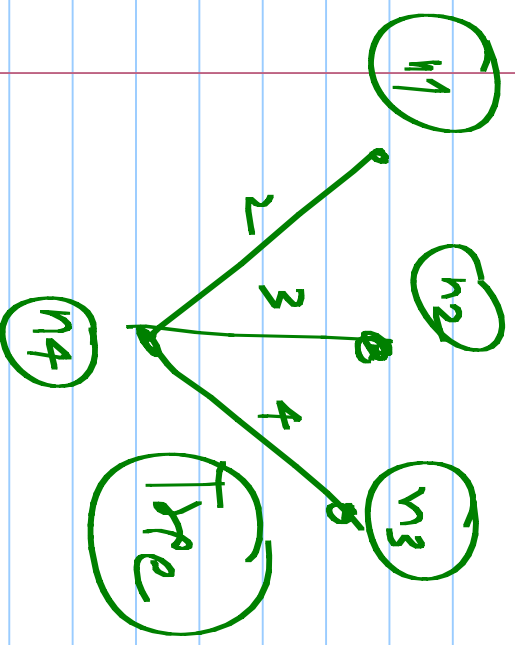
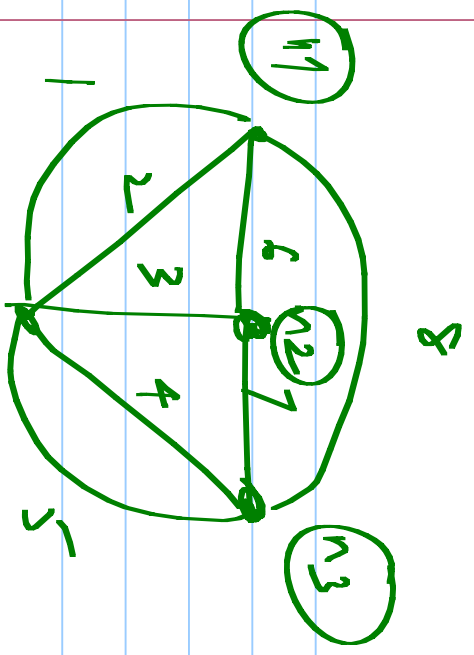


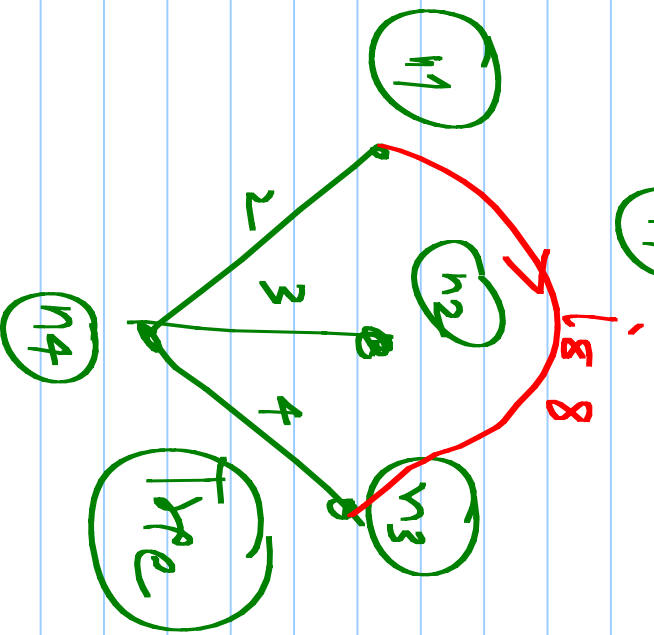
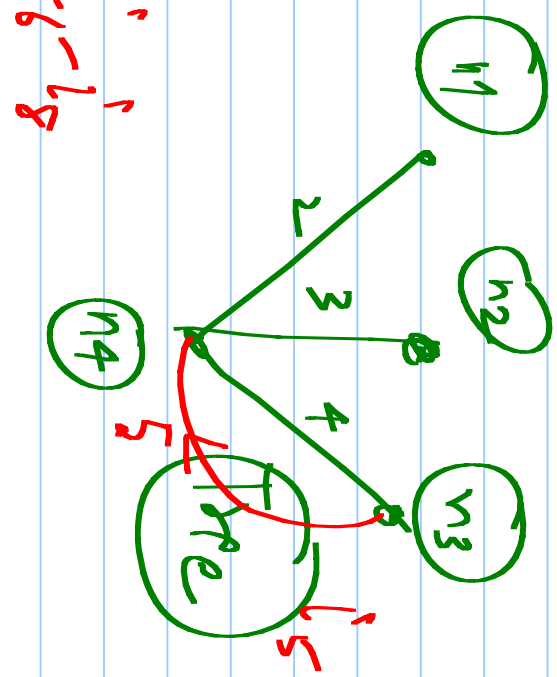
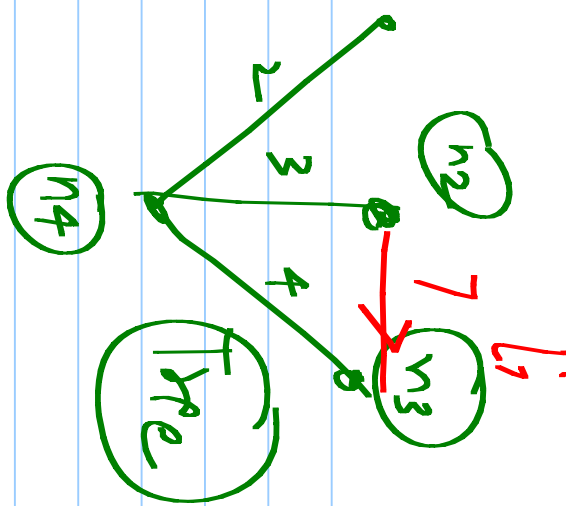
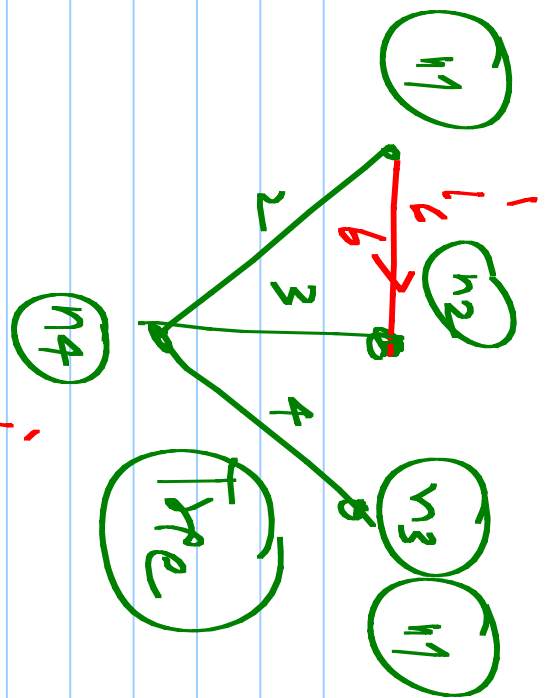
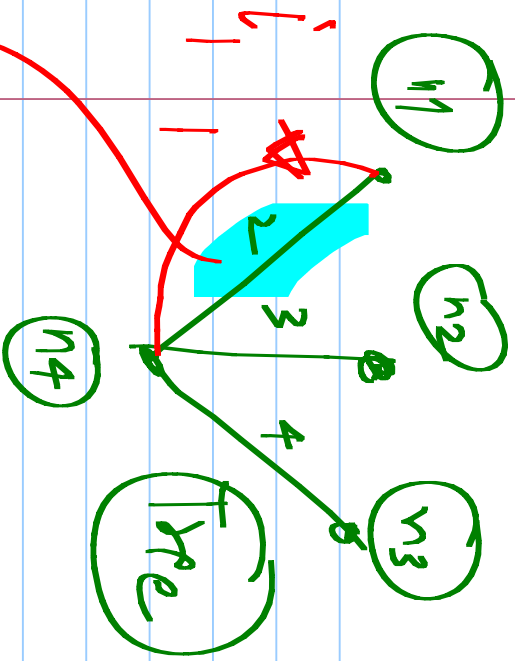
Start with loop equations: (KVL) $N = 4$

$$B = 8$$

$$B - N + 1 = 5$$







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one by one
to form
links

l_1, l_6, l_8