

EE2015

Circuit: N nodes

B branches

18/8/2017

Nodal analysis

$N-1$ KCL

$B-N+1$ KVL

Mesh analysis

* $N-1$ nodes (KCL)

* $[G] \cdot \underline{V} = \underline{I}_s$

* Easier for resistors

& ind. current sources; V

* Voltage source - supernode

* Loop analysis - planar circuits

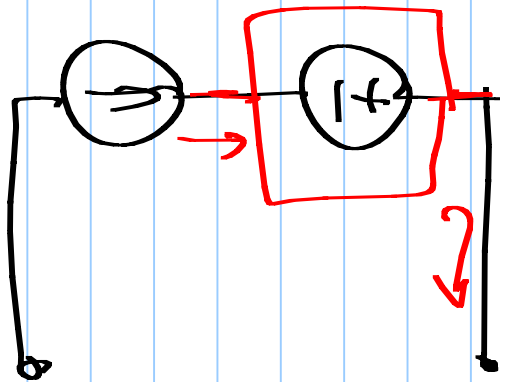
* $[R] \underline{i} = \underline{V}_s$

mesh currents

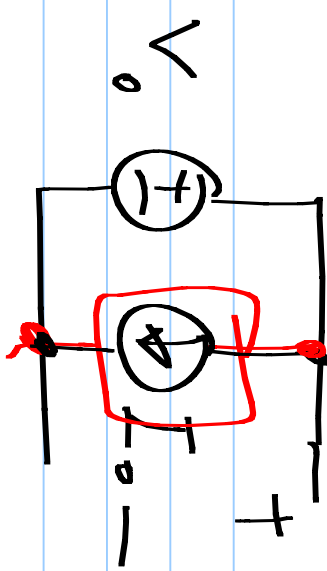
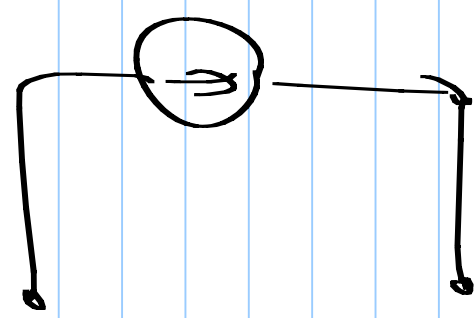
* Easier for resistors & voltage source

CVS

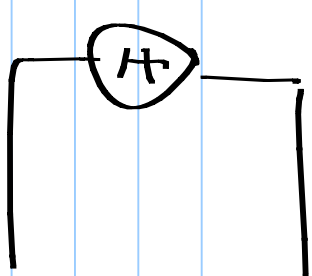
* ind. current source: supernode

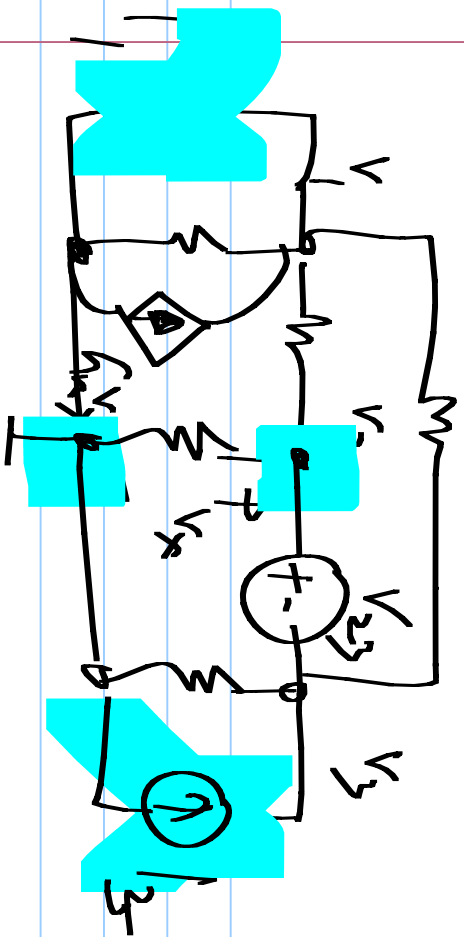


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$$\begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} = [G]^{-1} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix}$$

$$[G]^{-1} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix}$$

$$\begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix}$$

$$[G]^{-1} \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix} + [G]^{-1} \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} 0 \\ 1/3 \\ 0 \end{bmatrix} + [G]^{-1} \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} 0 \\ 0 \\ V_{23} \end{bmatrix}$$

$$\begin{aligned}
 & [G]^{-1} \begin{bmatrix} \frac{1+1/3}{2} \\ \frac{1+1/3}{2} \\ 0 \end{bmatrix} + [G]^{-1} \begin{bmatrix} \frac{1-1/3}{2} \\ \frac{1-1/3}{2} \\ 0 \end{bmatrix} + [G^{-1}] \begin{bmatrix} 0 \\ 0 \\ \sqrt{23} \end{bmatrix}
 \end{aligned}$$


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Modified nodal analysis:

* Variables: $N-1$ node voltages wrt ref. node

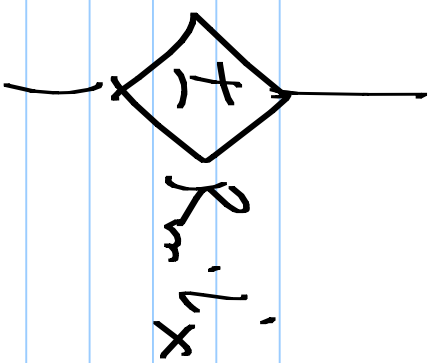
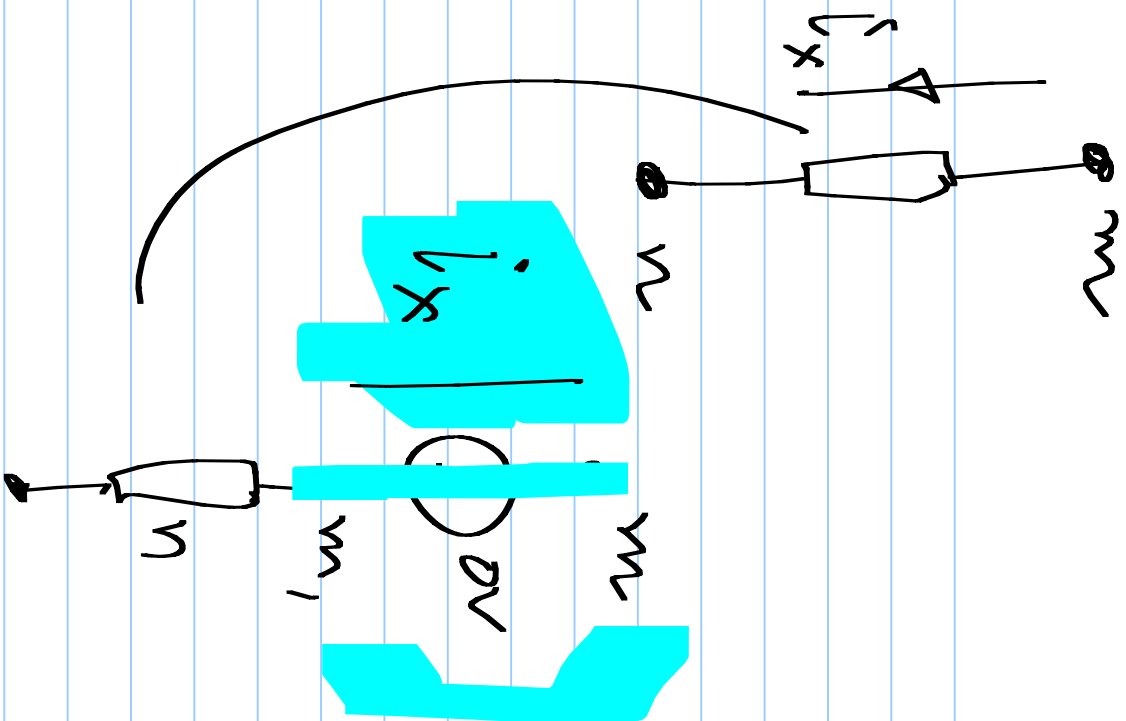
* P voltage sources (ind. & dependent)

P currents through voltage sources I_{VS}



The diagram shows a voltage source represented by a circle with a plus sign (+) on the top and a minus sign (-) on the bottom. A vertical line with an arrow pointing downwards is drawn through the center of the circle, labeled with I_{VS} next to it.

* Q controlling currents } additional variables



$$[G]^{-1} I_s$$

$$[G] \circledast \underline{v} = \underline{I}_s$$

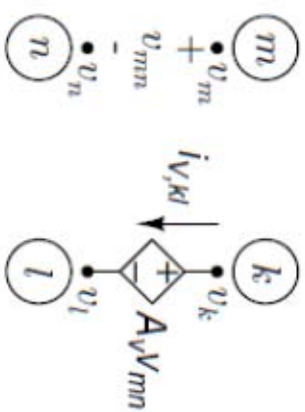
$$\begin{array}{c}
 \text{node } k \\
 i_{v,k}
 \end{array}
 \begin{bmatrix}
 v_k & v_l \\
 0 & 0 \\
 0 & 0 \\
 +1 & -1
 \end{bmatrix}
 \begin{array}{c}
 i \\
 \text{node } l \\
 -1 \\
 0
 \end{array}
 \begin{bmatrix}
 v_k \\
 v_l \\
 i_{v,k} \\
 i_{v,l}
 \end{bmatrix}
 =
 \begin{bmatrix}
 0 \\
 0 \\
 0 \\
 v_s
 \end{bmatrix}$$

KCL @

$$\begin{array}{c}
 \text{node } k \\
 \text{node } l
 \end{array}
 : \quad () + () + i_{v,k} = () + 0$$

$$\begin{array}{c}
 \text{node } k \\
 \text{node } l
 \end{array}
 : \quad () + () - i_{v,k} = () + 0$$

$$v_k - v_l = v_s$$



$$V_k - V_l = A_v (V_m - V_n)$$

$$V_k - V_l - A_v \cdot V_m + A_v \cdot V_n = 0$$