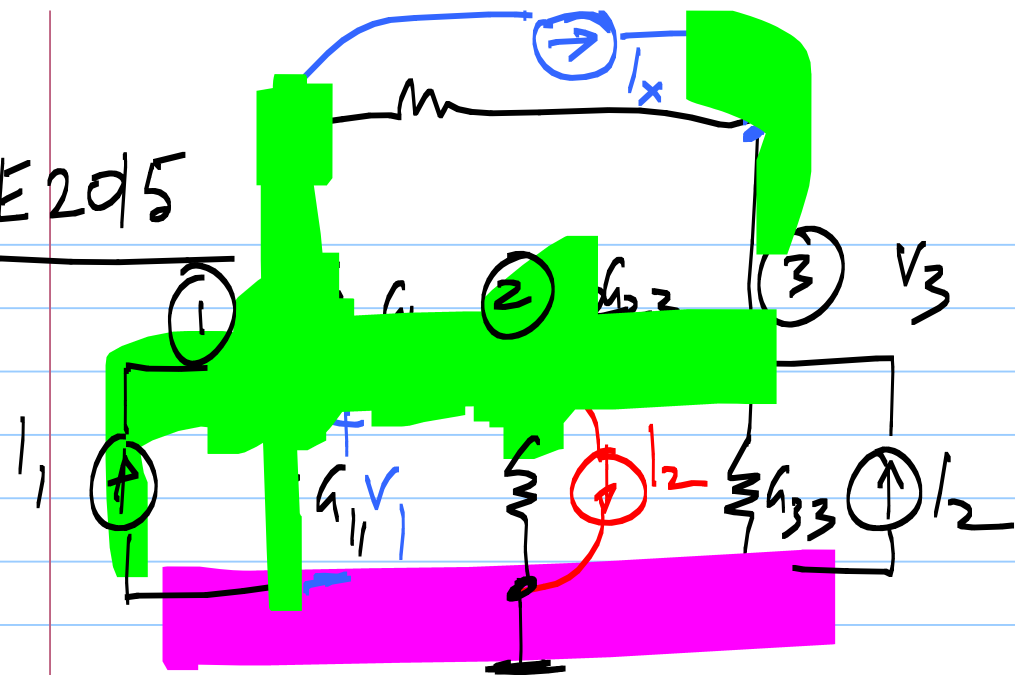
EE205

11/8/2017



Nodal analysis

KCL

① $(G_{11} + \text{[illegible]} + G_{13})\,\text{[illegible]} - G_{12}\,\text{[illegible]}_2 - G_{13} V_3 = I_1 - I_x$

② $-G_{12} V_1 + (G_{12} + G_{22} + G_{23}) V_2 - G_{23} V_3 = -I_2$

③ $-G_{13} V_1 - G_{23} V_2 + (G_{13} + G_{23} + G_{33}) V_3 = I_2 + I_x$

$$\begin{bmatrix} G_{11}+G_{12}+G_{13} & -G_{12} & -G_{13} \\ & G_{12}+G_{22}+G_{23} & -G_{23} \\ -G_{13} & -G_{23} & G_{13}+G_{23}+G_{33} \end{bmatrix} \begin{bmatrix} \\ \\ \\ \end{bmatrix} = \begin{bmatrix} \\ \\ \\ \end{bmatrix}$$

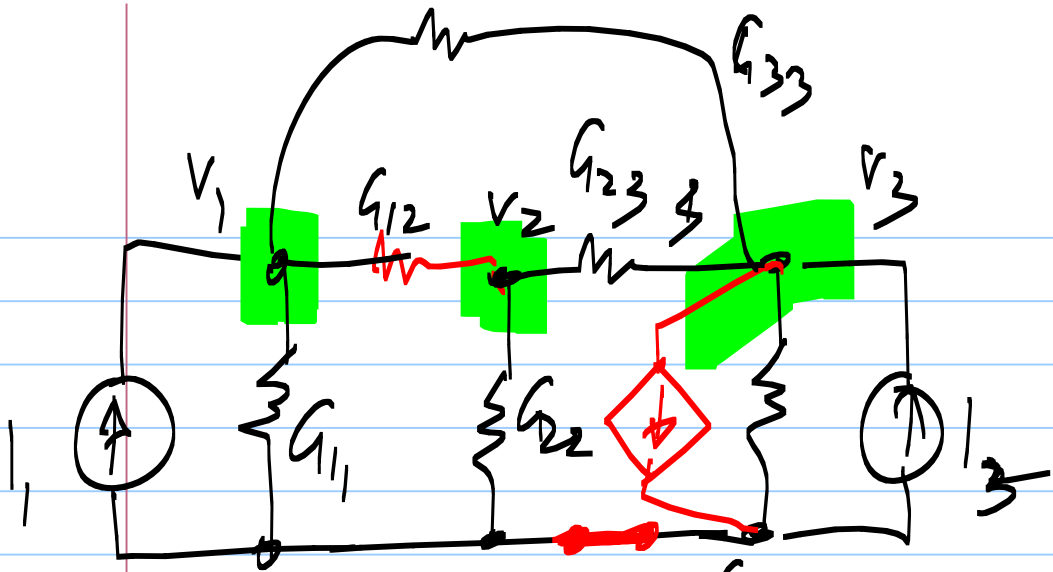
Symmetric — Conductance matrix — node voltage vector — Source vector

Diagonal: $\sum_i G$

$[G]_{ij}$: $-$(conductance from node i to node j)

$$[G]\,\underline{V} = \underline{I} \qquad \underline{V} = [G]^{-1} \cdot \underline{I}$$

By solving $[G]\underline{v} = \underline{I}$ we get $\underline{v_1, v_2, v_3}$



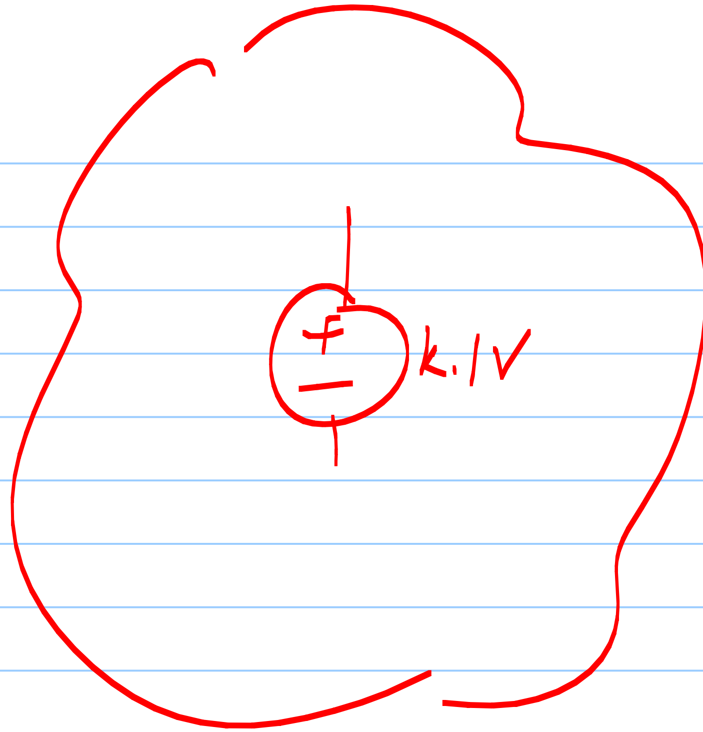
Current out of node 3:

$+ G_m (V_1 - V_2)$

$\cdot (V_1 - V_2)$

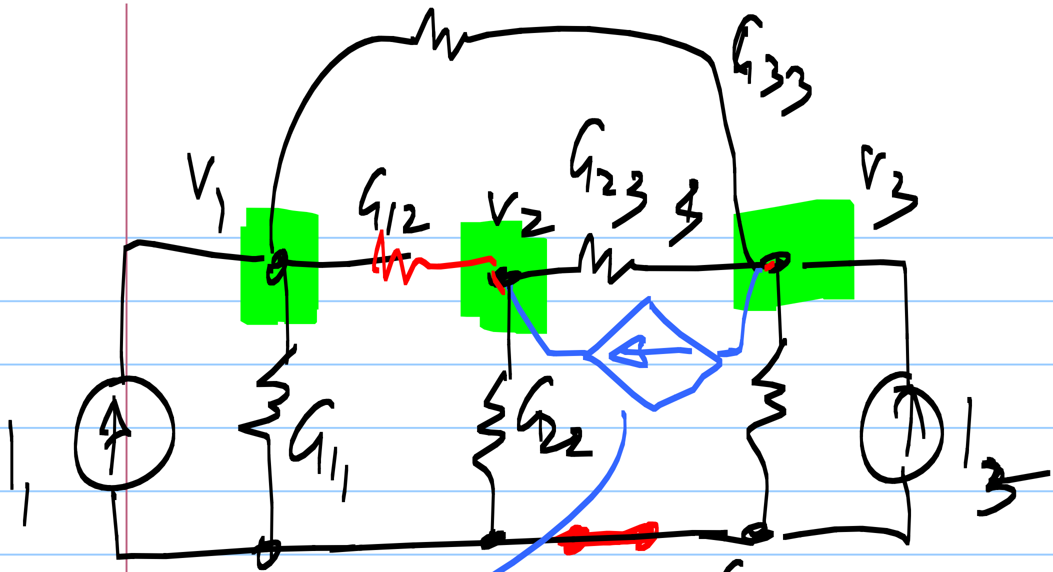
$$\begin{bmatrix} G_{11}+G_{12}+G_{13} & -G_{12} & -G_{13} \\ -G_{12} & G_{12}+G_{22}+G_{23} & -G_{23} \\ & & G_{13}+G_{23}+G_{33} \end{bmatrix} \begin{bmatrix} V_1 \\ \\ V_3 \end{bmatrix} = \begin{bmatrix} I_1 \\ \\ I_3 \end{bmatrix}$$

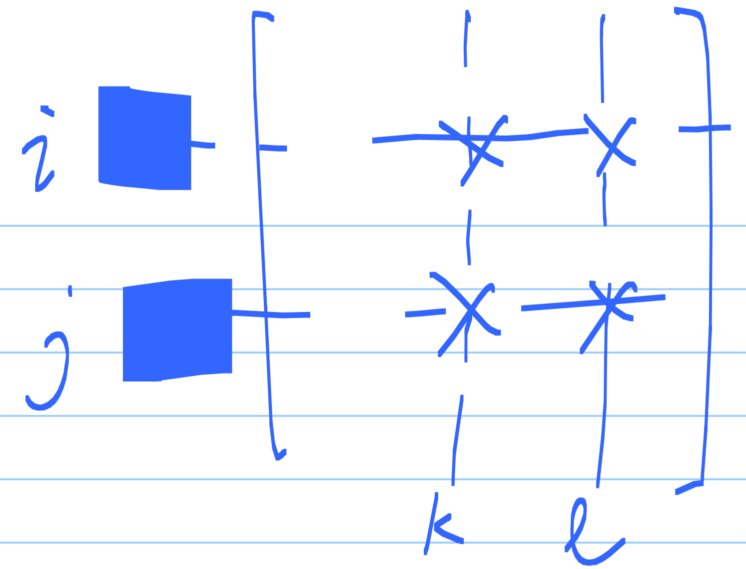
matrix   node voltage



\+ 1V

−

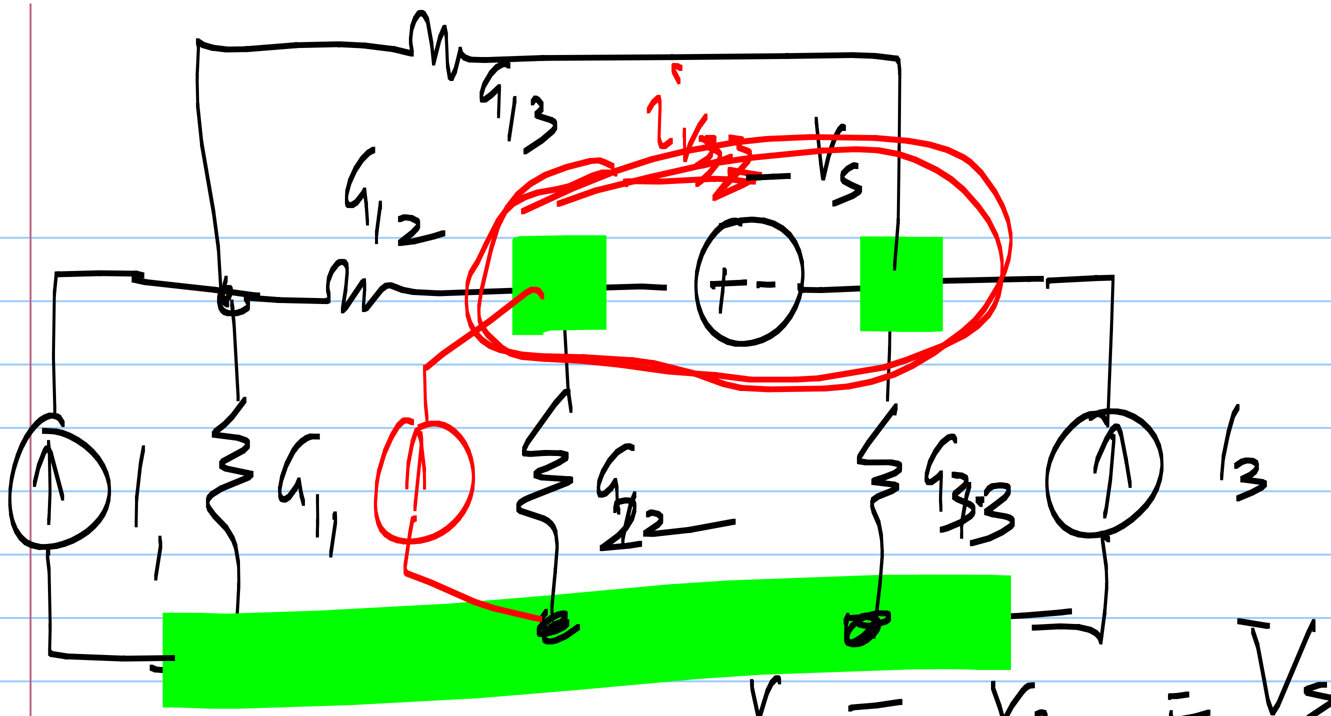




$G_m(V_1 - V_2)$

$$\begin{bmatrix} G_{11}+G_{12}+G_{13} & -G_{12} & -G_{13} \\ -G_{12}-G_m & G_{12}+G_{22}+G_{23}+G_m & -G_{23} \\ -G_{13}+G_m & -G_{23}-G_m & G_{13}+G_{23}+G_{33} \end{bmatrix} \begin{bmatrix} V_1 \\ \\ V_3 \end{bmatrix} = \begin{bmatrix} I_1 \\ \\ I_3 \end{bmatrix}$$

matrix node voltage



$$V_2 - V_3 = V_s$$

$$(G_{11} + G_{12} + G_{13})\, V_1 - G_{12} \cdot V_2 - G_{13} \cdot V_3 = I_1$$

$$-G_{12} \cdot V_1 + (G_{12} + G_{22}) \cdot V_2 + i_{v_{23}} = \cancel{0}\; I_2$$

$$-G_{13} \cdot V_1 - i_{v_{23}} \quad (G_{13} + G_{33})\, V_3 = I_3$$