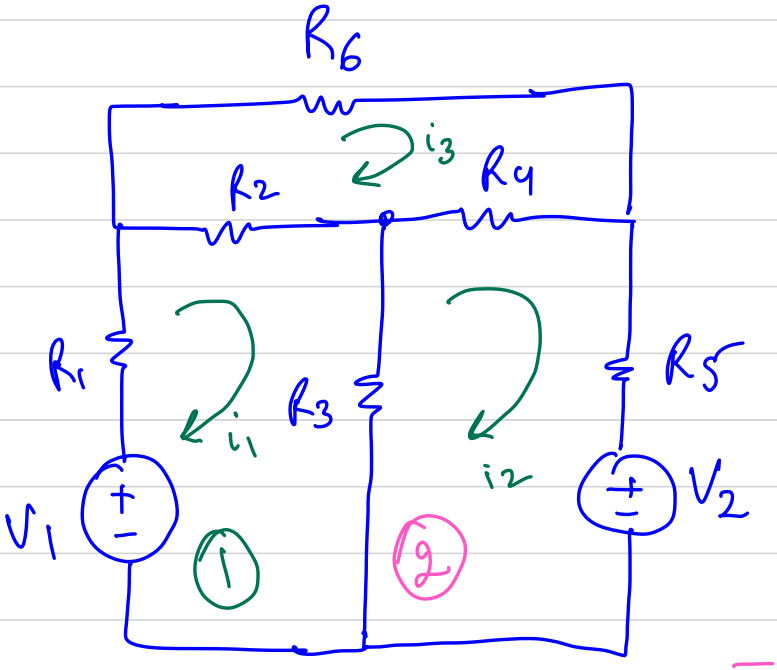
Mesh Analysis



Mesh ①

$$V_1 - i_1 R_1 - (i_1 - i_3) R_2 - (i_1 - i_2) R_3 = 0$$

$$V_1 = i_1 (R_1 + R_2 + R_3) - i_2 R_3 - i_3 R_2 \quad -①$$

$$-(i_2 - i_1) R_3 - (i_2 - i_3) R_4 - i_2 R_5 - V_2 = 0$$

$$(i_2 - i_1) R_3 + (i_2 - i_3) R_4 + i_2 R_5 = -V_2$$

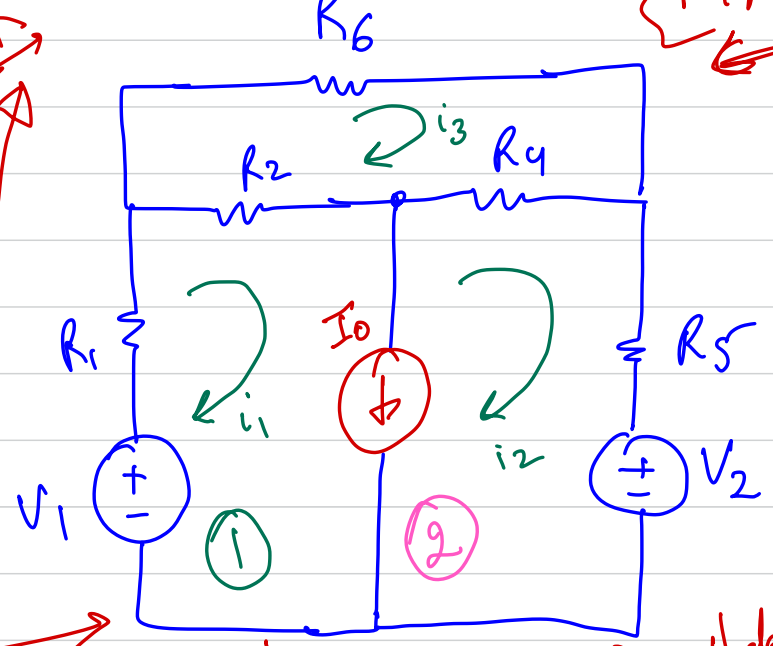
$$-i_1 R_3 + i_2 (R_3 + R_4 + R_5) - i_3 R_4 = -V_2 \quad (2)$$

$$+R_6 i_3 + R_4 (i_3 - i_2) + R_2 (i_3 - i_1) = 0$$

$$-R_2 i_1 - R_4 i_2 + i_3 (R_6 + R_4 + R_2) = 0$$

$$\begin{bmatrix} R_1+R_2+R_3 & -R_3 & -R_2 \\ -R_3 & R_3+R_4+R_5 & -R_4 \\ -R_2 & -R_4 & R_6+R_4+R_2 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} V_1 \\ -V_2 \\ 0 \end{bmatrix}$$

"R"



{MATLAB}

$$V_1 - i_1 R_1 - (i_1 - i_3) R_2$$

$$- (i_2 - i_3) R_4$$

$$- (i_2) R_5 - V_2 = 0$$

Super-mesh

$$A i_1 + B i_2 + C i_3 = V_2 - V_1$$

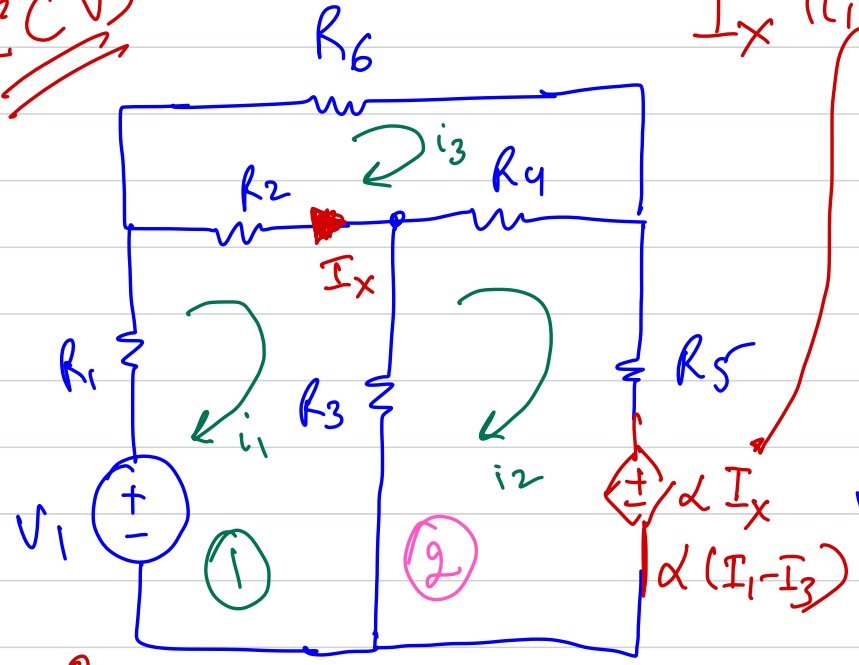
Mesh 3

$$I_0 = i_1 - i_2 + 0 i_3$$

Indeped Source

$$\begin{bmatrix} \cdots \\ \cdots \\ 1 \;\; -1 \;\; 0 \\ \cdots \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix}_{3\times 1} = \begin{bmatrix} V_2 - V_1 \\ I_0 \\ 0 \end{bmatrix}$$

CCVS



I_x (i_1-i_3)

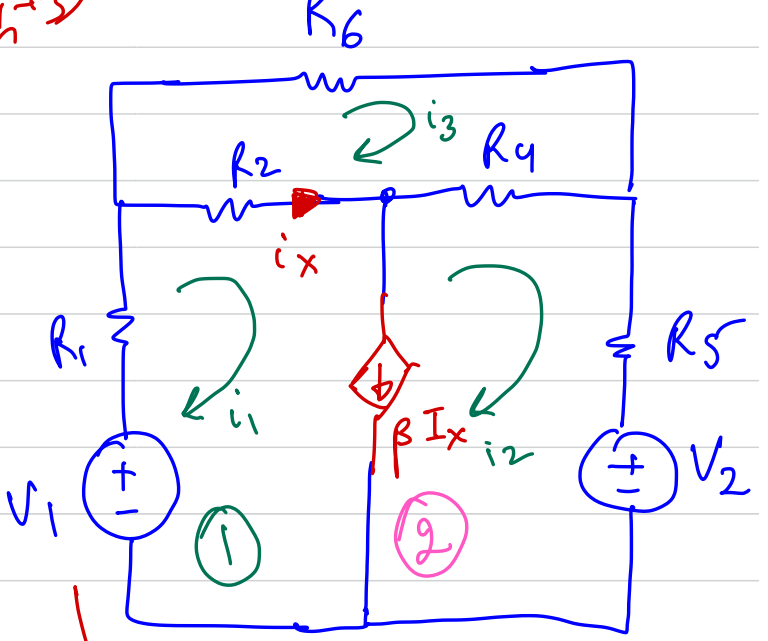
Mesh 2

$I_x = i_1 - i_3$

$-(i_2-i_1)R_3 - (i_2-i_3)R_4$

$-i_2R_5 - \alpha I_x = 0$

CCCS



$i_1 - i_2 = \beta I_x$

$i_1 - i_2 = \beta(i_1 - i_3)$

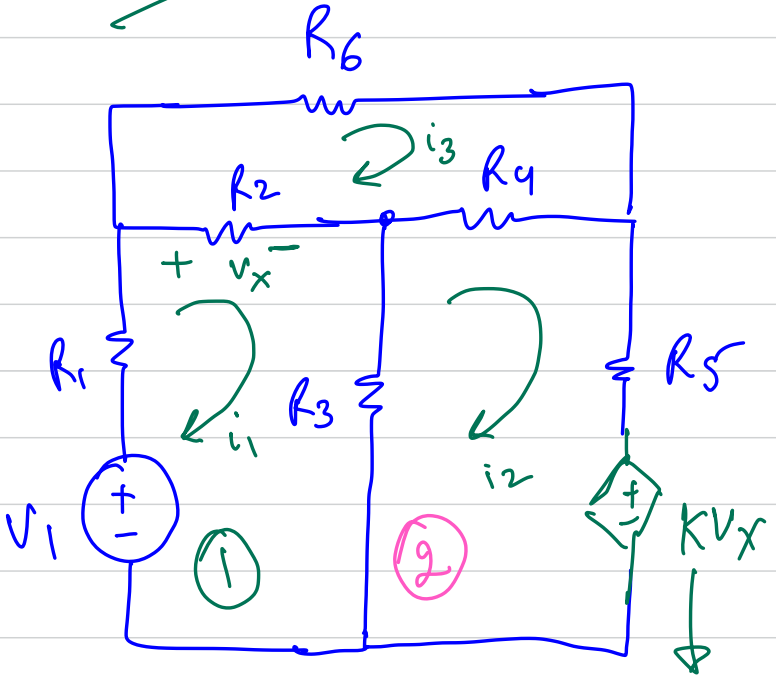
$$i_1(1-\beta) - i_2 + i_3\beta = 0$$

$$Ai_1 + Bi_2 + Ci_3 = v_2 - v_1$$

$$\alpha i_1 + \gamma i_2 + \delta i_3 = 0$$

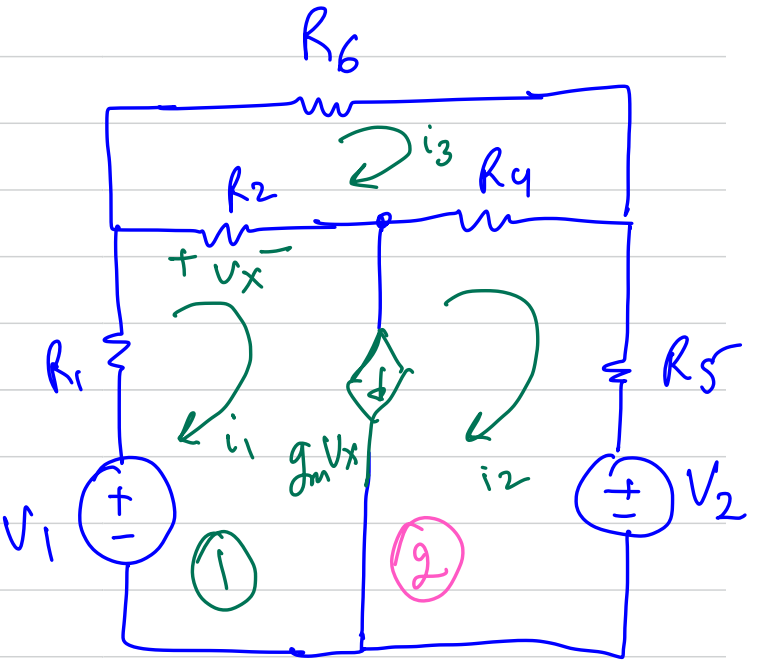
$$\begin{bmatrix} 1-\beta & -1 & \beta \\ A & B & C \\ \alpha & \gamma & \delta \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 0 \\ v_2 - v_1 \\ 0 \end{bmatrix}$$

VCVS



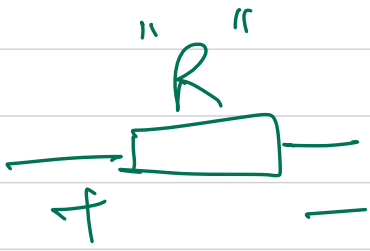
$k(i_1 - i_3)R_2$

VCCS



$g_m(i_1 - i_3)R_2$

Linearity



$V_1 \longrightarrow I_1$

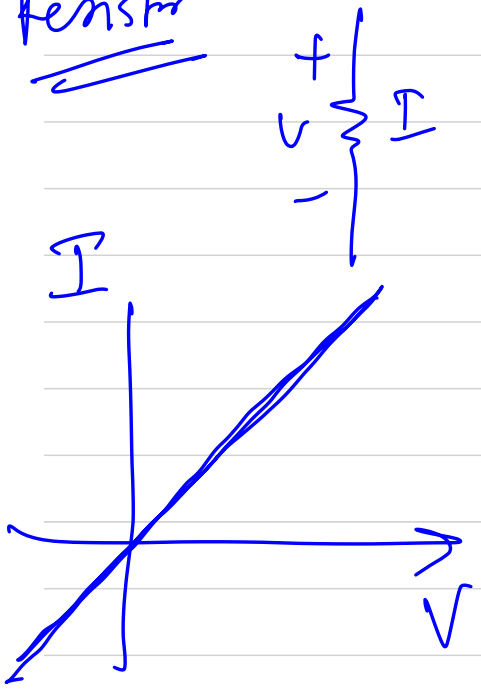
$V_2 \longrightarrow I_2$

i/p. response

$\alpha V_1 + \beta V_2 \longrightarrow \alpha I_1 + \beta I_2$

Linearity property (Superposition)

Resistor



$V_1 = I_1 R$

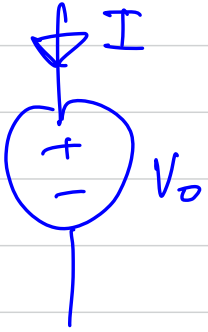
$V_2 = I_2 R$

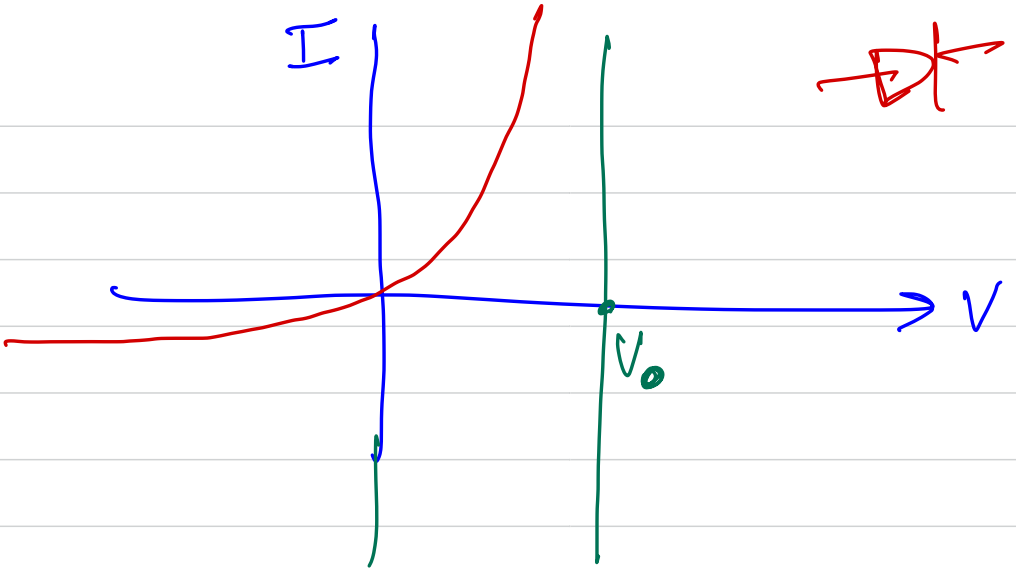
$V' = (\alpha I_1 + \beta I_2) R$

$= \alpha (I_1 R) + \beta (I_2 R)$

$V' = \alpha V_1 + \beta V_2$

Voltage source

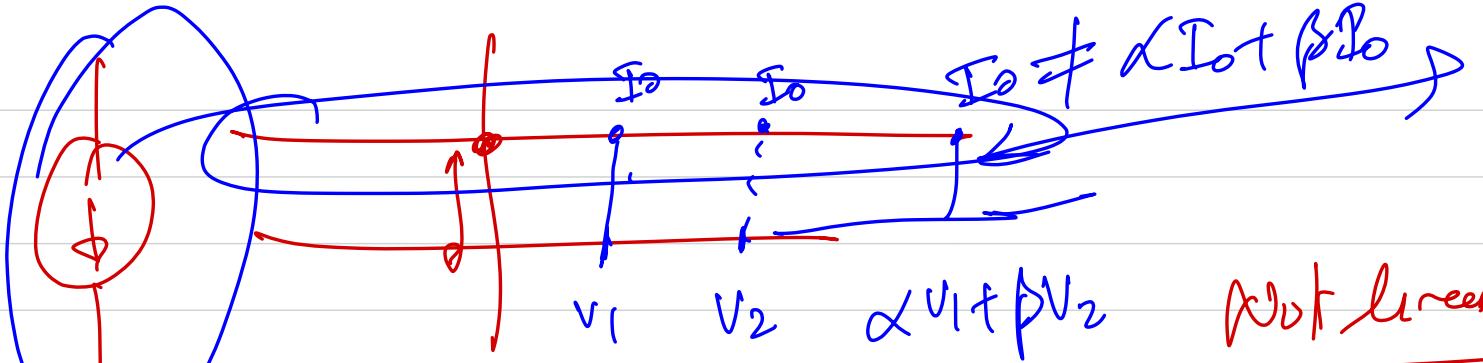




$I_1 \rightarrow V = V_0$

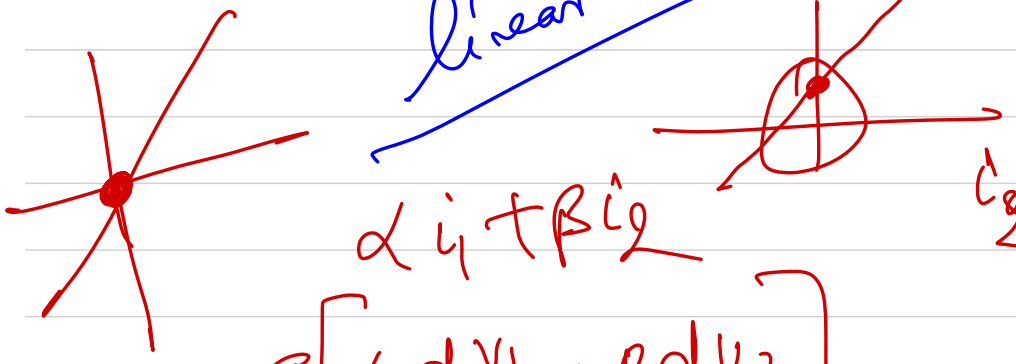
$I_2 \rightarrow V_0$

$(\alpha I_1 + \beta I_2) \rightarrow V_0 \neq \alpha V_0 + \beta V_0$



$$i = C\frac{dv_1}{dt} + i(0^-)$$

NOT linear device



$\alpha i_1 + \beta i_2$

$$i_2 = C\frac{dv_2}{dt}$$

$$C\left[\alpha\frac{dv_1}{dt} + \beta\frac{dv_2}{dt}\right] = C\frac{d}{dt}(\alpha v_1 + \beta v_2)$$


$V_L = L\frac{di}{dt}$
$(\alpha i_1 + \beta i_2)$
$\alpha V_{L_1} + \beta V_{L_2}$