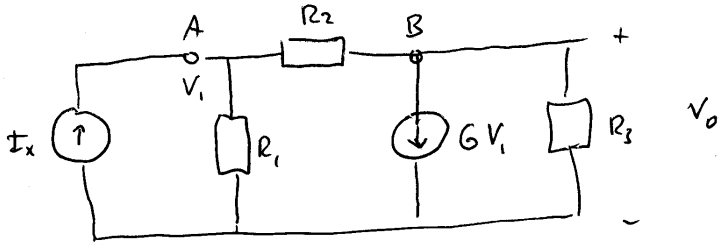
1)



$G_i = 1/R_i$

A: $I_x = G_1 V_1 + G_2 (V_1 - V_o)$

$\boxed{I_x = (G_1+G_2) V_1 - G_2 V_o}$ (I)

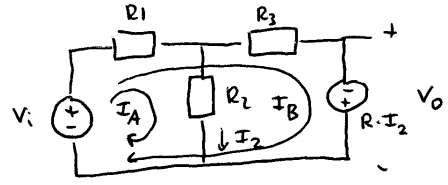
B: $G_2 (V_1 - V_o) = G V_1 + G_3 V_o$

$\boxed{0 = (G - G_2) V_1 + (G_3+G_2) V_o}$ (II)

Cramer:

$$V_{out} = \frac{\begin{vmatrix} G_1+G_2 & I_x \\ G-G_2 & 0 \end{vmatrix}}{\begin{vmatrix} G_1+G_2 & -G_2 \\ G-G_2 & G_2+G_3 \end{vmatrix}} = I_x \frac{G_2 - G}{G_1 G_2 + G_1 G_3 + G_2 G_3 + G G_2}$$

2)



$I_A = I_2$

A: $R_1 I_A + R_2 I_A + R_1 I_B = V_i$

$\boxed{V_i = (R_1+R_2) I_A + R_1 I_B}$ I

B: ~~$(R_1+R_2) I_A + R_1$~~

$I_A R_1 + I_B R_1 + I_B R_3 - I_A R = V_i$

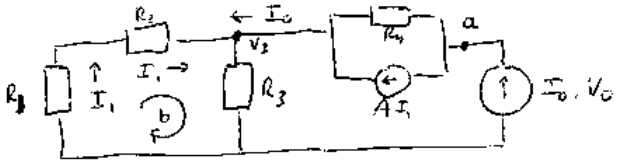
$\boxed{V_i = I_A (R_1 - R) + (R_1+R_3) I_B}$ II

Cramer:

$$I_2 = I_A = \frac{\begin{vmatrix} V_{in} & R_1 \\ V_i & R_1+R_3 \end{vmatrix}}{\begin{vmatrix} R_1+R_2 & R_1 \\ R_1-R & R_1+R_3 \end{vmatrix}} = V_i \frac{R_3}{R_1 R_3 + R_2 R_3 + R_1 R_2 + R_1 R}$$

$$V_o = -R I_2 = \frac{-R R_3}{R_1 R_3 + R_2 R_3 + R_1 R_2 + R_1 R} V_i$$

3)



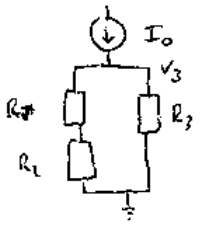
nodo a: $\dot{I}_0 = A I_1 + \frac{(V_0 - V_3)}{R_4}$ (I)

malha b: $I_1 (R_1 + R_2) + R_3 (I_1 + I_0) = 0$

$I_1 (R_1 + R_2 + R_3) = - R_3 I_0$

$I_1 = - R_3 I_0 / (R_1 + R_2 + R_3)$ (II)

ponto V_3:



$V_3 = I_0 \{ R_3 // (R_1 + R_2) \}$

$= I_0 \frac{R_1 R_3 + R_2 R_3}{R_1 + R_2 + R_3}$ (III)

(II) e (III) em (I):

$r_0 = \frac{V_0}{I_0} = \frac{(R_1 + R_2) R_3 + A R_3 R_4 + R_4 (R_1 + R_2 + R_3)}{(R_1 + R_2 + R_3)}$

4) $V_0 = A (V_b - V_a)$

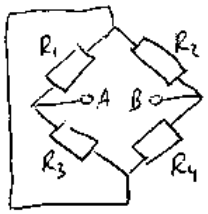
$V_b = \frac{R_4}{R_3 + R_4} V_2$

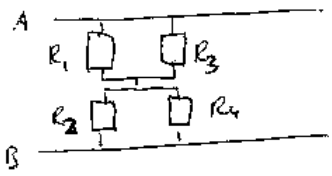
$V_a = \frac{R_2}{R_1 + R_2} V_2 + \frac{R_1}{R_1 + R_2} V_0$

$V_0 = A \left(\frac{R_4}{R_3 + R_4} V_2 - \frac{R_2}{R_1 + R_2} V_1 - \frac{R_1}{R_1 + R_2} V_0 \right)$

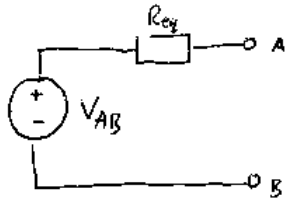
$V_0 = \frac{A}{1 + A \frac{R_1}{R_1 + R_2}} \left(\frac{R_4}{R_3 + R_4} V_2 - \frac{R_2}{R_1 + R_2} V_1 \right)$

5) curte-circuito a fonte de tensão





$$R_{eq} = R_1 /\!/ R_3 + R_2 /\!/ R_4$$

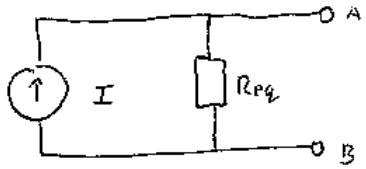


← Thévenin

$$V_A = \frac{R_3}{R_1+R_3} V \qquad V_B = \frac{R_4}{R_2+R_4} V$$

$$V_{AB} = \left(\frac{R_3}{R_1+R_3} - \frac{R_4}{R_2+R_4} \right) V$$

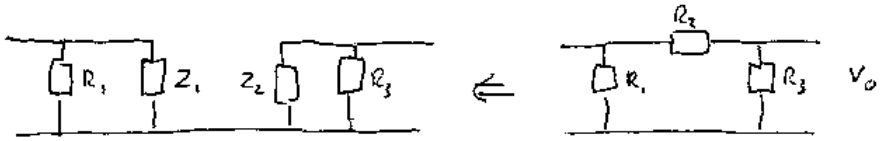
6)



← Norton

$$I = \frac{V_{AB}}{R_{eq}}$$

7)



$$Z = R_2 \quad , \quad V_0 = -G V_1 R_3 \quad (R_2 \gg R_3)$$

$$k = -G R_3 \quad (V_0/V_1)$$

$$Z_1 = \frac{Z}{1-k} = \frac{R_2}{1+GR_3} \quad , \quad Z_2 = \frac{Zk}{k-1} = \frac{G R_2 R_3}{1+GR_3} \quad (\approx R_2)$$

$GR_3 \gg 1$