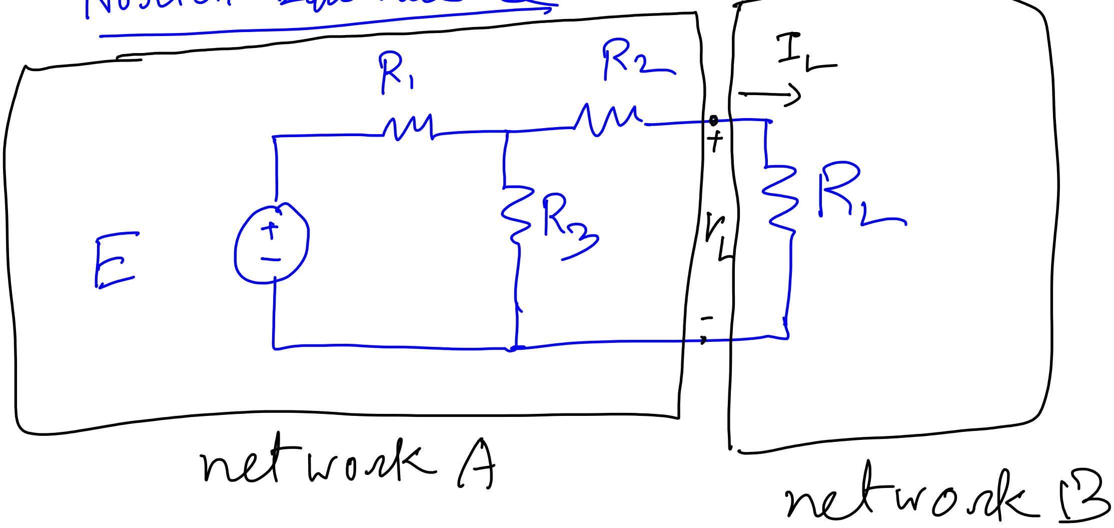
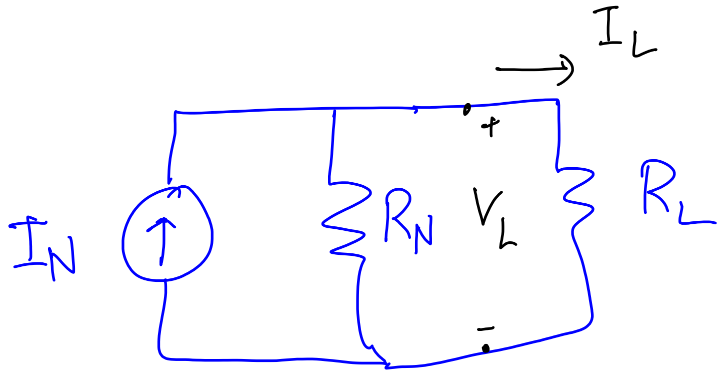
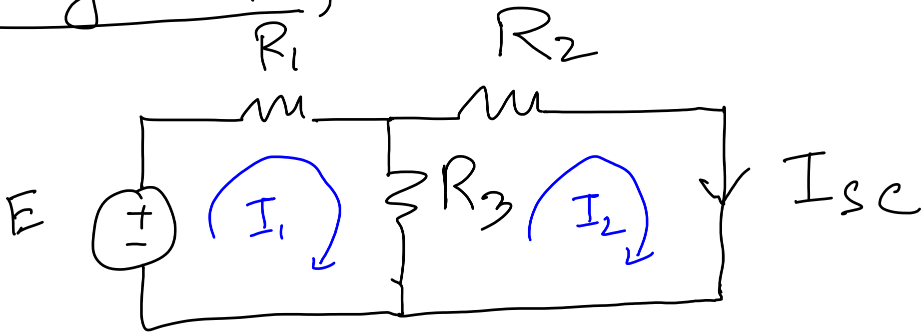
Norton Equivalence





Calculating I_N,



$$E = I_1 R_1 + (I_1 - I_2) R_3 \qquad I_{sc} = I_2$$

$$(I_1 - I_2) R_3 = I_2 R_2$$

$$\Rightarrow \quad I_1 R_3 = (R_2 + R_3) I_2$$

$$\Rightarrow \quad I_1 = \frac{R_2 + R_3}{R_3} I_2$$

$$E = I_1 (R_1 + R_3) - I_2 R_3$$

$$E = \frac{(R_1+R_3)(R_2+R_3)}{R_3} I_2 - I_2 R_3$$

$$= I_2 \left[\frac{R_1R_2 + R_2R_3 + R_1R_3}{R_3} \right]$$

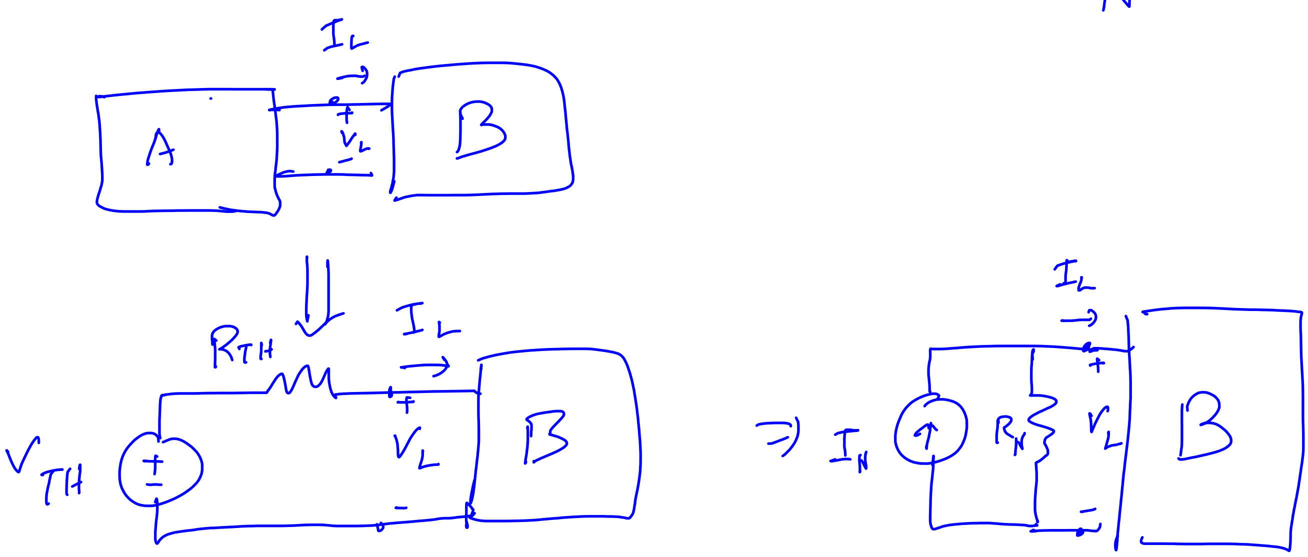
$$I_N = I_{SC} = I_2 = \frac{R_3 E}{R_1R_2 + R_2R_3 + R_1R_3} \Bigg\}$$

$$V_{TH} = I_N . R_{TH}, \qquad R_N = R_{TH}$$

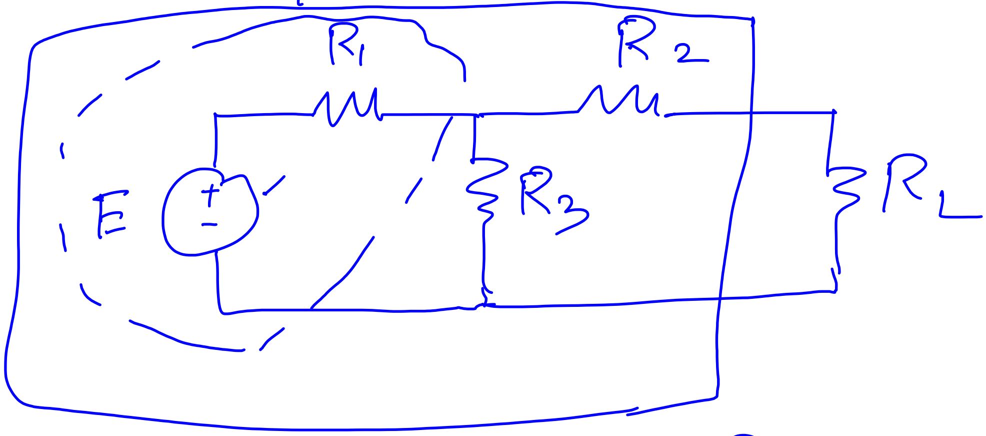
$$V_{TH} = \frac{R_3 E}{R_1 + R_3} \qquad R_{TH} = R_2 + \frac{R_1 R_3}{R_1 + R_3}$$

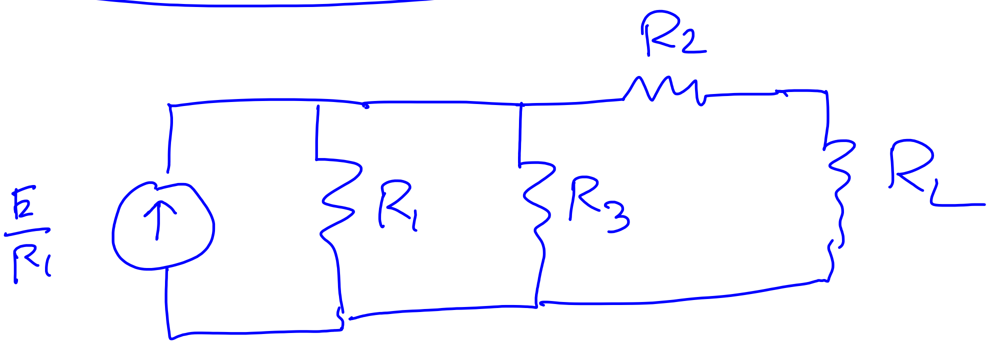
$$\frac{V_{TH}}{R_{TH}} = \frac{R_3 E/(R_1+R_3)}{R_2 + \frac{R_1R_3}{R_1+R_3}} = \frac{R_3 E}{R_1R_2 + R_2R_3 + R_1R_3}$$

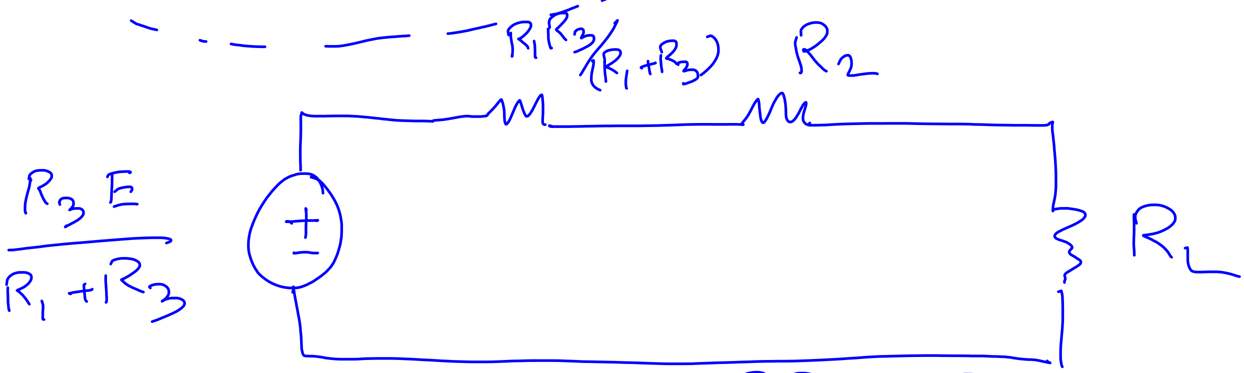
$$= I_N$$

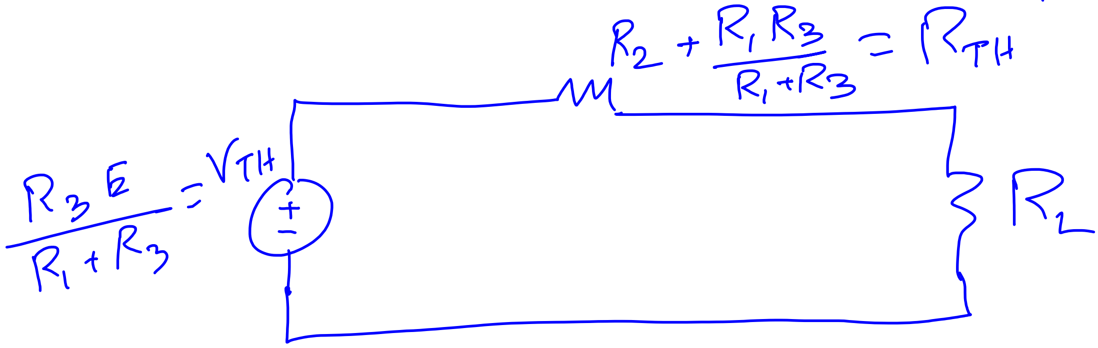


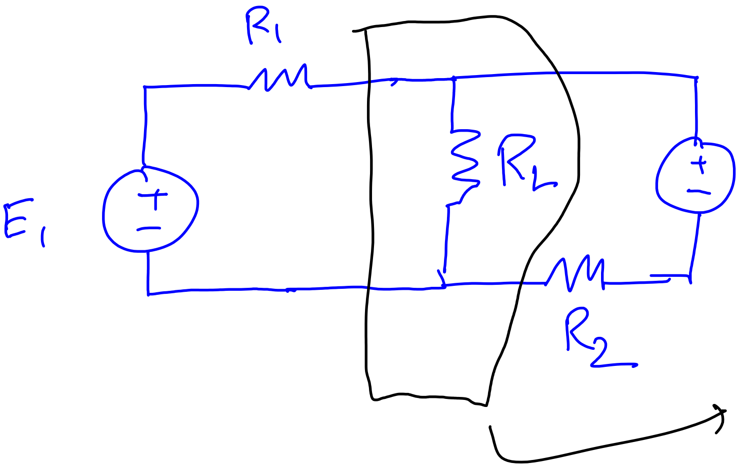
Alternative Approach to figure out Thevenin / Norton Equivalent network





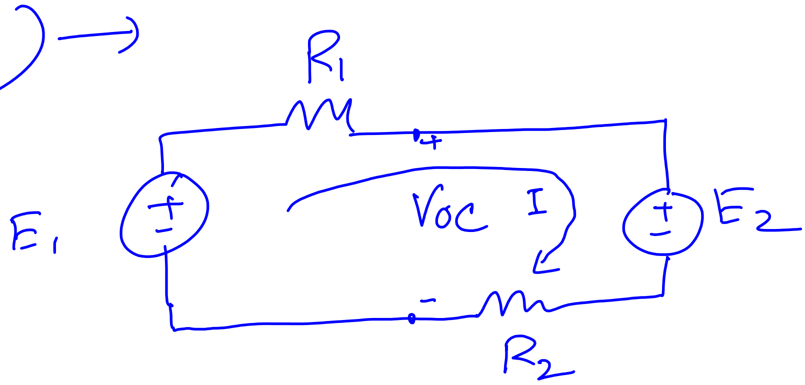






network B

V_{TH} →

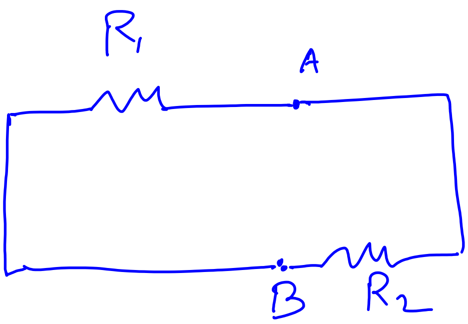


$$E_1 - E_2 = I(R_1 + R_2)$$

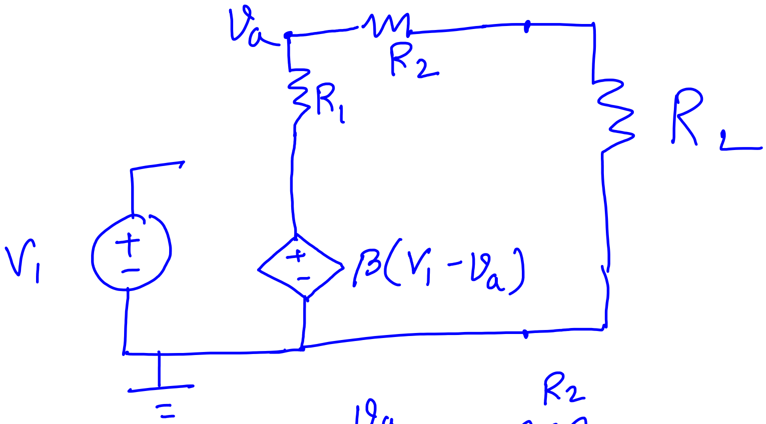
$$V_{TH} = V_{oc} = E_1 - I R_1$$

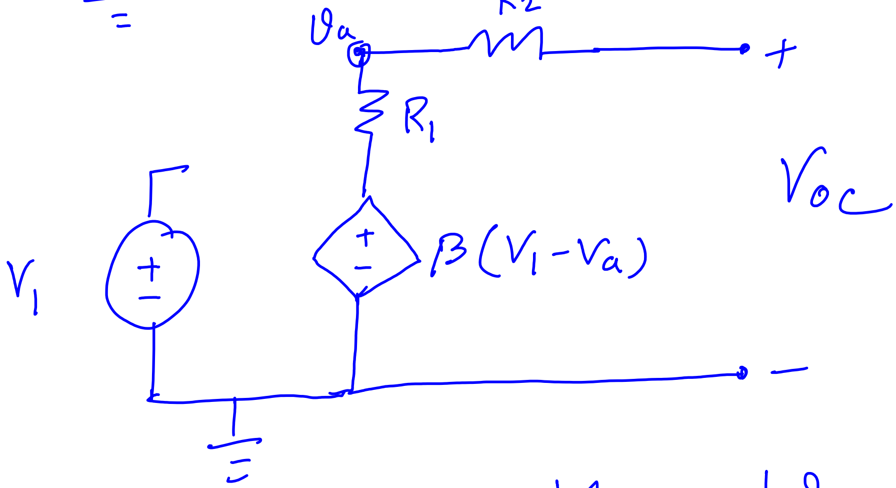
$$= E_1 - \frac{E_1 - E_2}{R_1 + R_2} \cdot R_1 \quad ✓$$

R_{TH} →



$$R_{TH} = R_{AB} = \frac{R_1 R_2}{R_1 + R_2}$$





$$V_{oc} = v_a = \beta(V_1 - v_a)$$

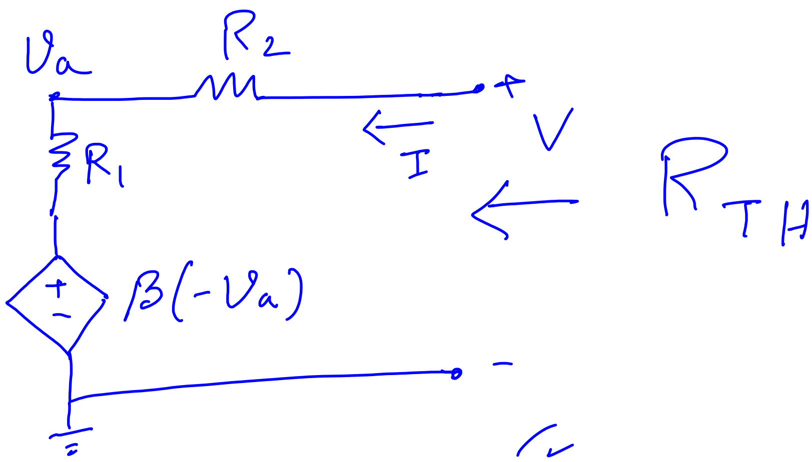
$$v_a = \beta(V_1 - v_a)$$

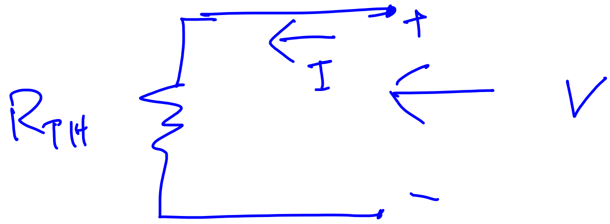
$$(1+\beta)\, v_a = \beta V_1$$

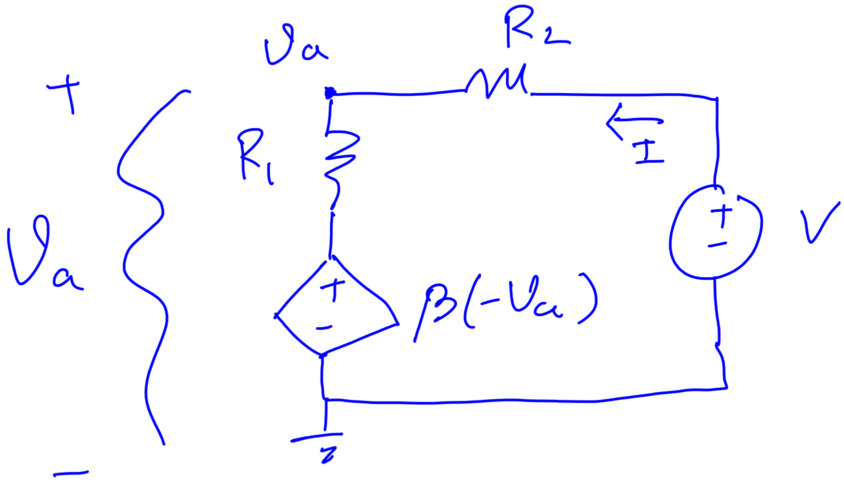
$$v_a = \frac{\beta}{1+\beta} V_1$$

$$V_{TH} = V_{oc} = \frac{\beta}{1+\beta} V_1$$

R_{TH} $\rightarrow$







$$V = I R_2 + I R_1 - \beta v_a$$

$$v_a = I R_1 - \beta v_a$$

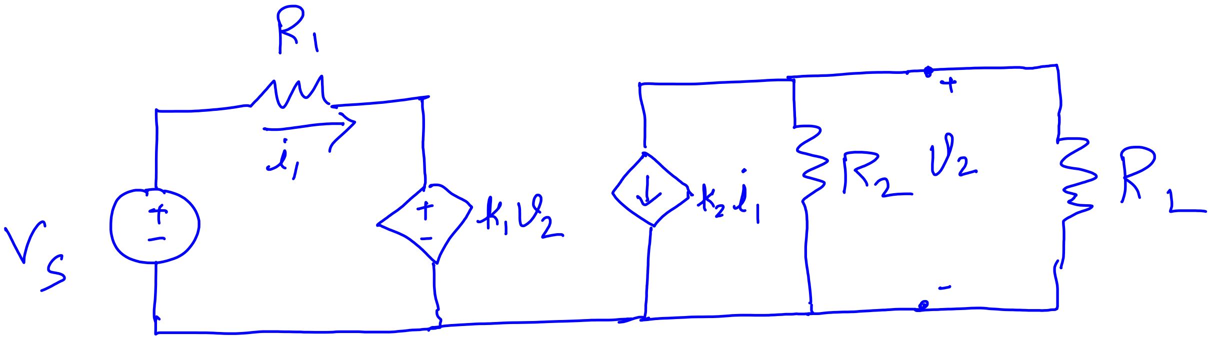
$$(1+\beta) v_a = I R_1$$

$$V = I(R_1 + R_2) - \frac{\beta}{1+\beta} I R_1$$

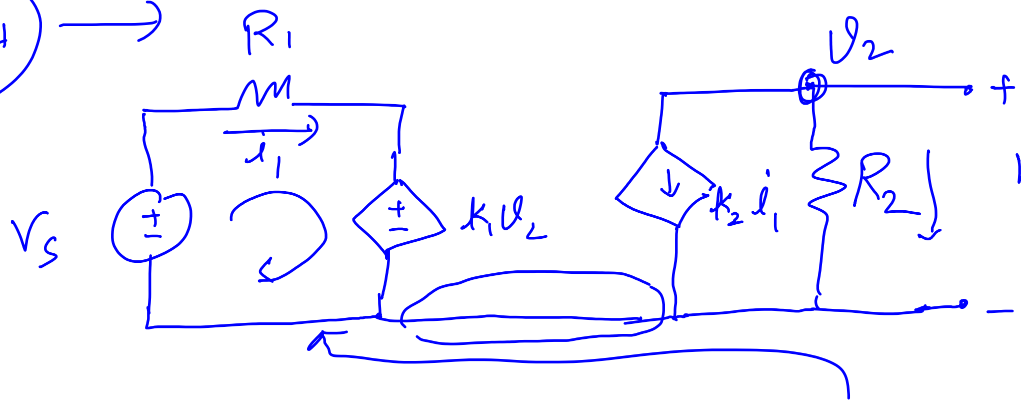
$$= I\left[R_1 + R_2 - \frac{\beta}{1+\beta} R_1\right]$$

$$= I\left[R_2 + \frac{1}{1+\beta} R_1\right]$$

$$\Rightarrow \quad R_{TH} = \frac{V}{I} = \left(R_2 + \frac{1}{1+\beta} R_1\right)$$



$\boxed{V_{TH}} \longrightarrow$



$V_{oc} = v_2$

$$V_S = i_1 R_1 + k_1 v_2 \qquad \text{(KVL)}$$

$$k_2 i_1 + \frac{v_2}{R_2} = 0 \qquad \text{(KCL at node 2)}$$

$$i_1 = -\frac{1}{k_2 R_2} v_2$$

$$V_S = -\frac{R_1}{k_2 R_2} v_2 + k_1 v_2$$

$$\Rightarrow \quad v_2 = \frac{V_S}{k_1 - \frac{R_1}{k_2 R_2}}$$

$$V_{TH} = V_{oc} = v_2$$