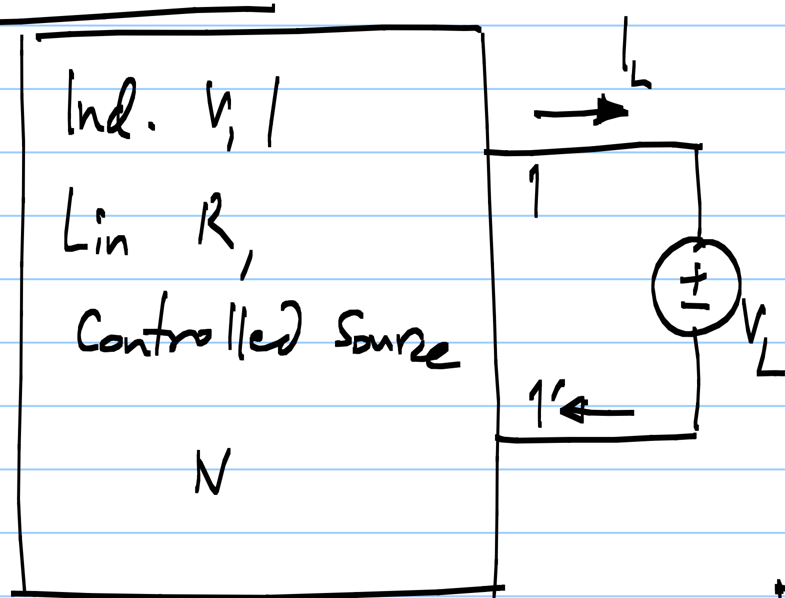
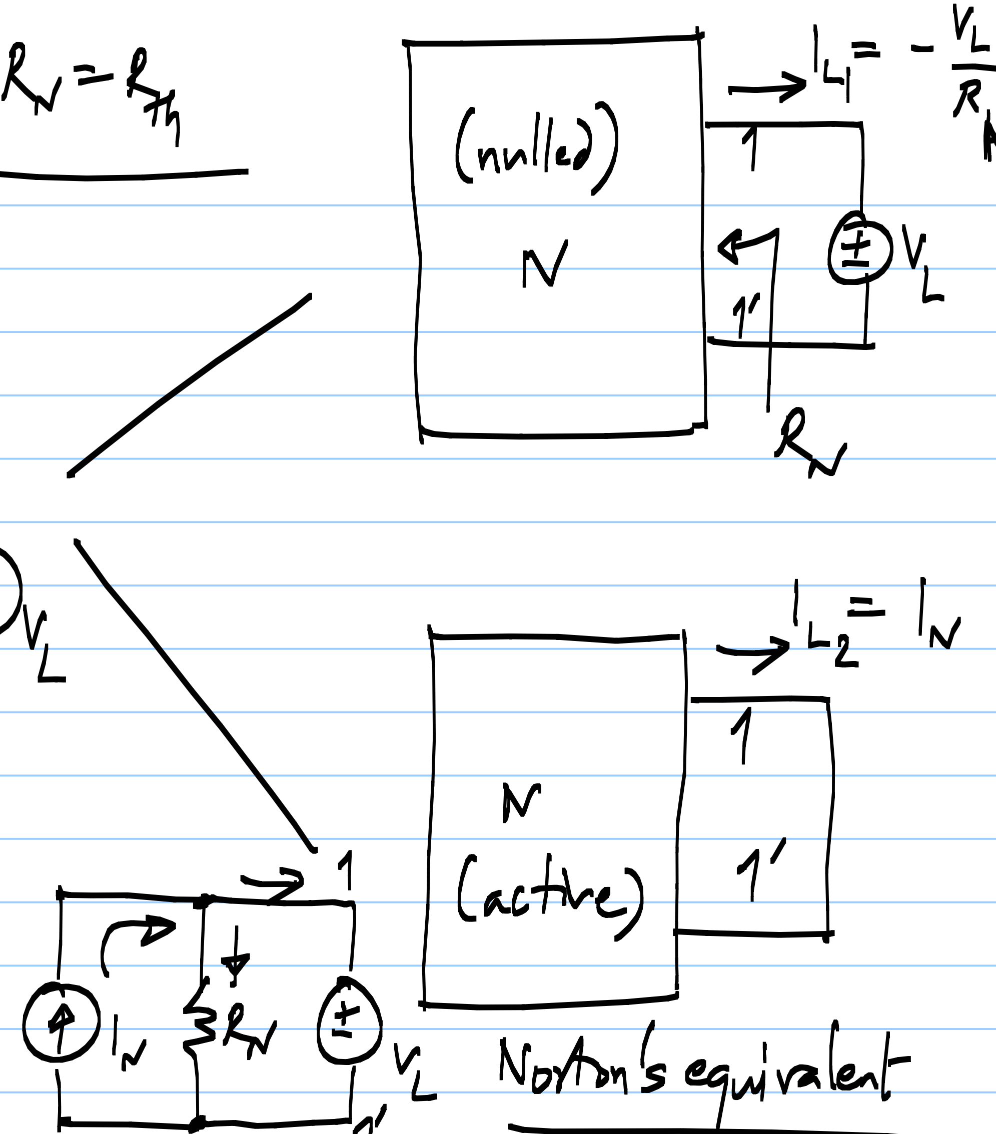
EC 1010: Lecture 13

$R_N = R_{Th}$

Norton theorem





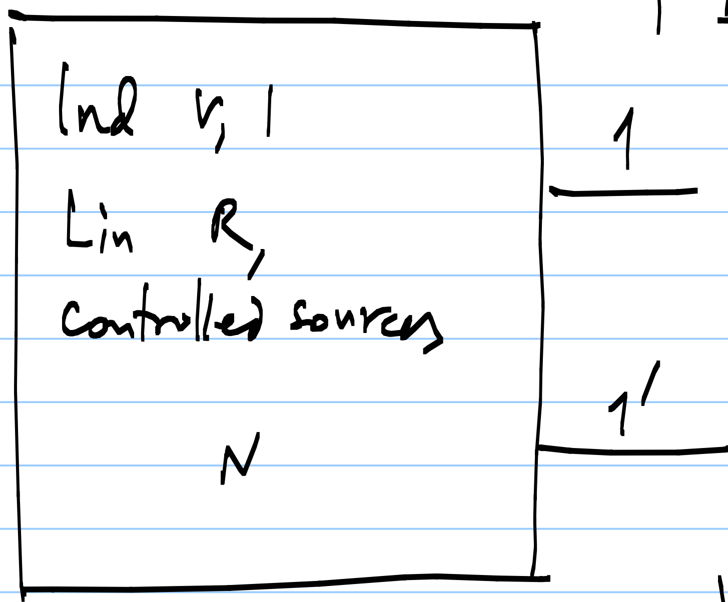
$I_L = I_N - \frac{V_L}{R_N} \equiv$

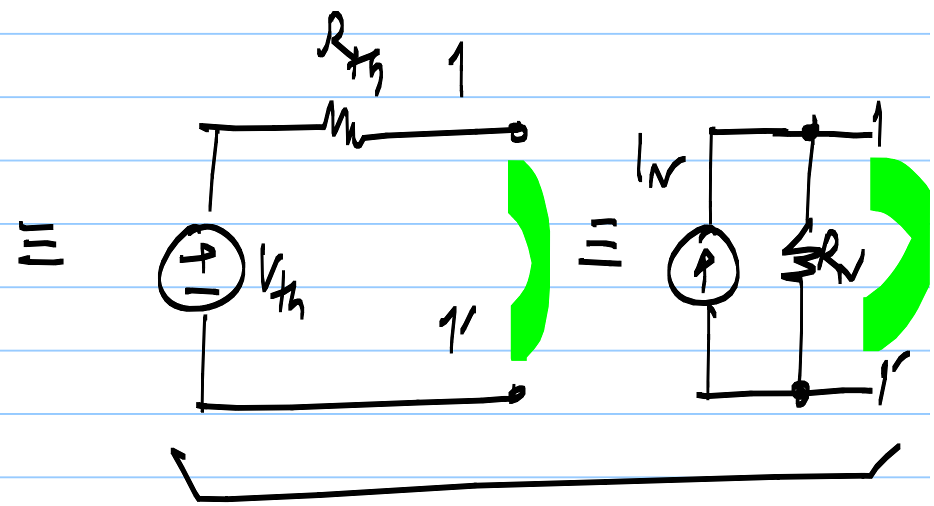
Norton's equivalent

$R_N = R_{th}$: Looking in resistance

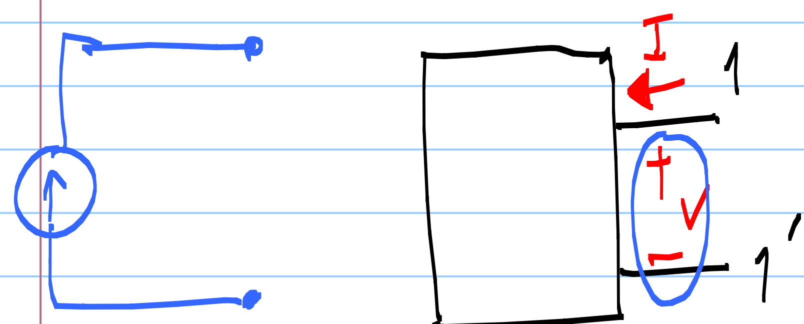
V_{th}: open ckt. voltage at 1-1'

I_N: short ckt. current from 1 → 1'

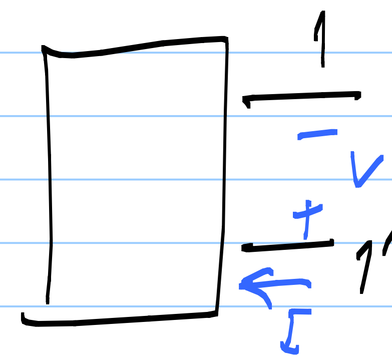


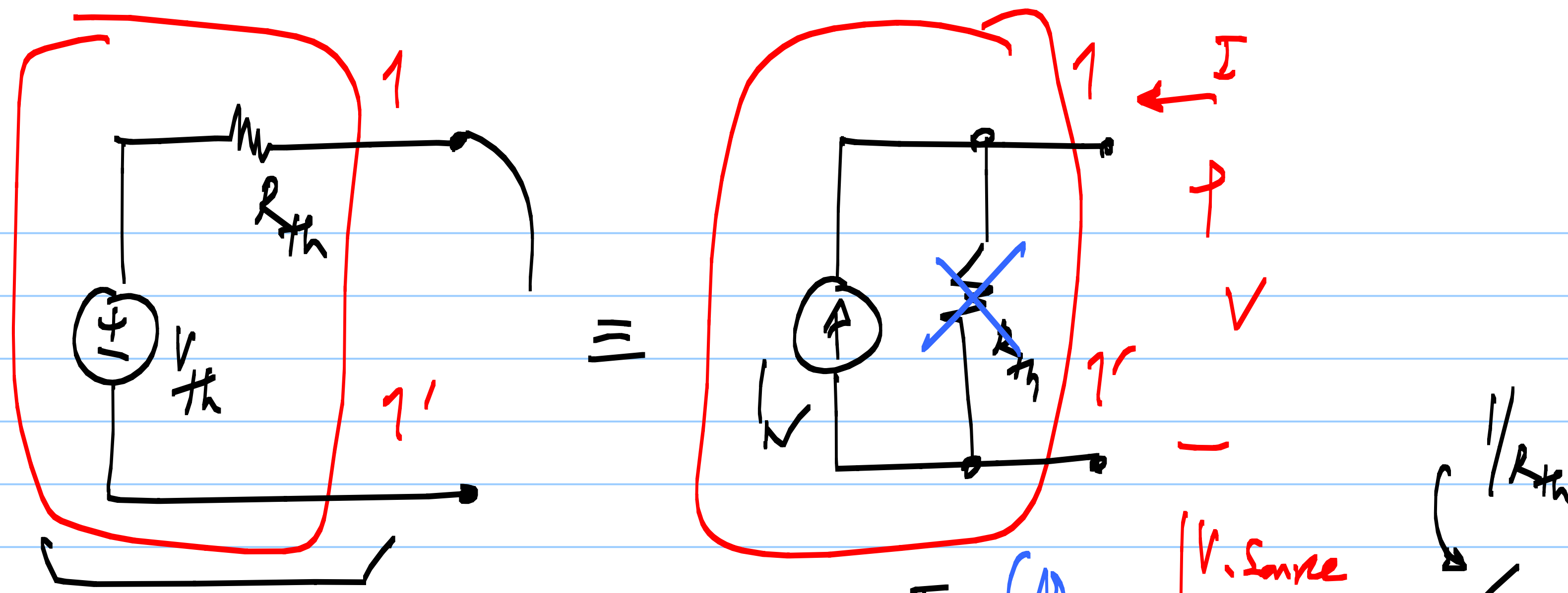


$$V_{th} = I_N \cdot R_{th}$$

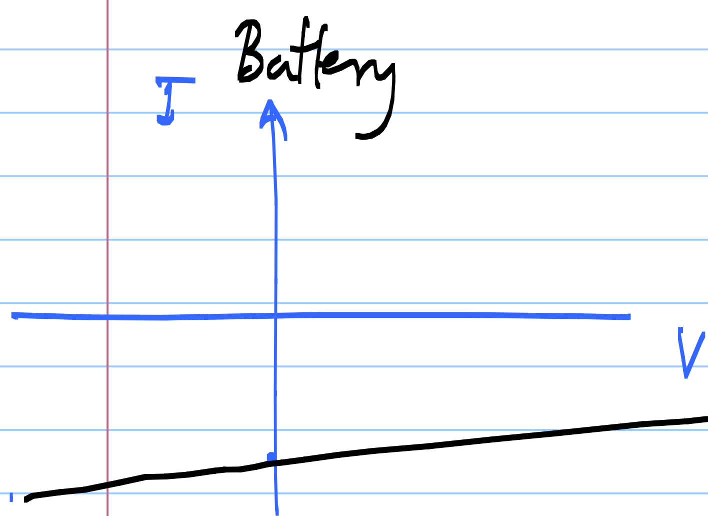


$$\frac{V}{I} = R_N = R_{th}$$

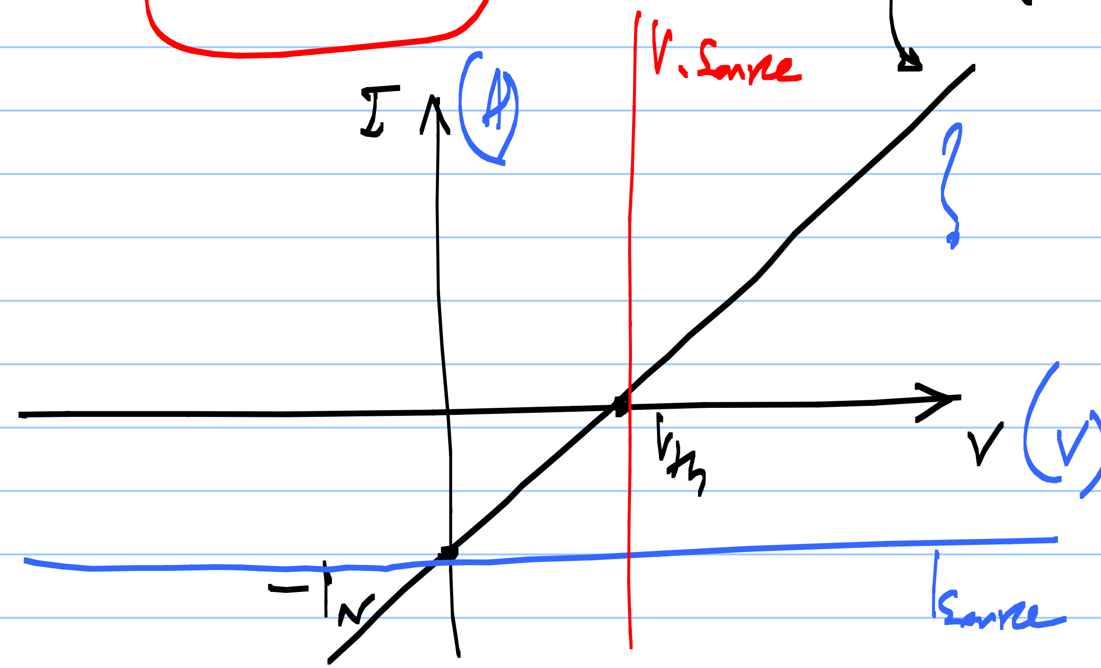




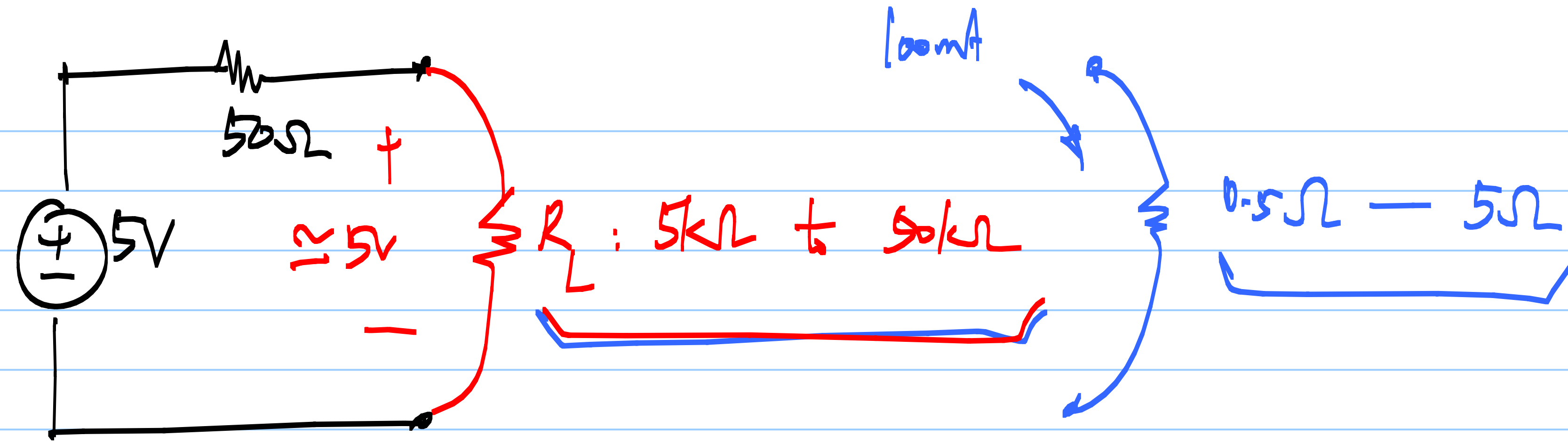
R_{th}
V_{th}
1
1'
=
I_N
R_{th}
1
1'
I
+
V
−



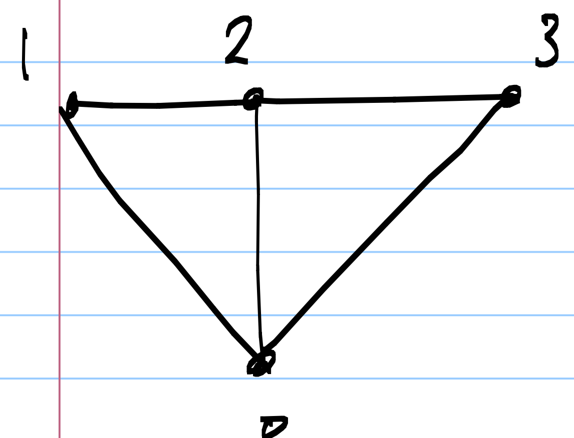
I
Battery
V



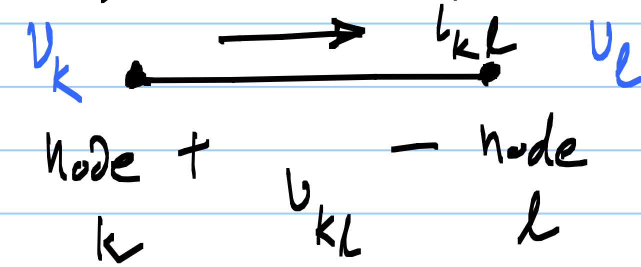
I
(A)
V. Source
$1/R_{th}$
V
(V)
V_{th}
$-I_N$
I Source



5V
50Ω
+
≃5V
−
R_L : 5kΩ to 50kΩ
100mA
0.5Ω — 5Ω



$$\sum_{\text{branches}} v_{kl}\, i_{kl} = 0$$



i_{kl}: leaving node k & entering node l

$$= \sum_{\text{branches}} (v_k - v_l)\, i_{kl}$$

$$\text{node } m: \quad \sum_{\text{nodes}} \Big(v_m \underbrace{\sum i_{mn}}_{\text{Currents leaving node } m} - v_m \underbrace{\sum i_{nm}}_{\text{Currents entering node } m} \Big) = 0$$

Tellegen's theorem:

1. $$\sum_{\text{all branches of a circuit}} v_k \cdot i_k = 0$$

2. $$\sum_{\text{all branches}} v_k \hat{i}_k = 0$$

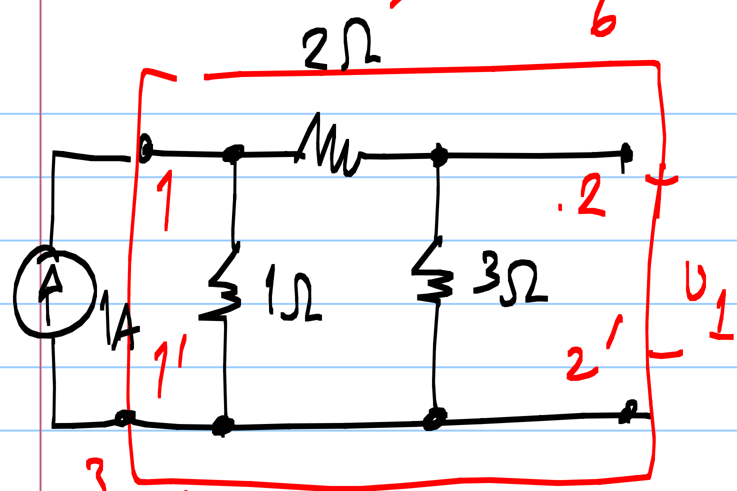
$$\sum_{\text{all branches}} \hat{v}_k i_k = 0$$

$N, \hat{N}$: same graph

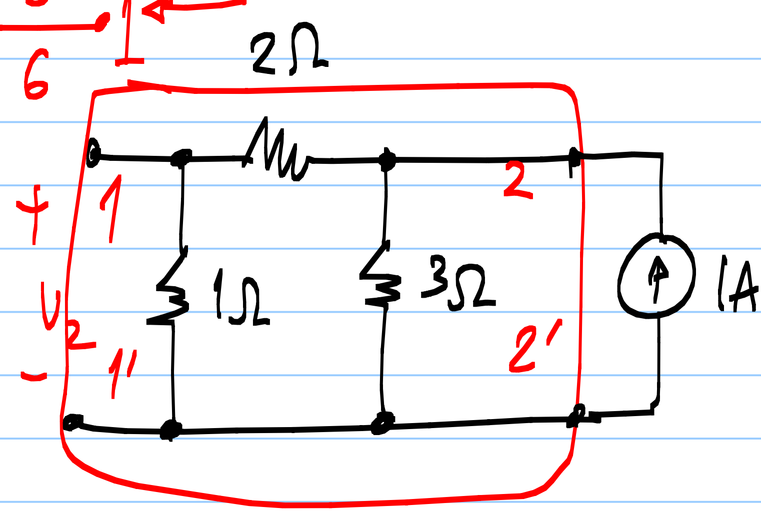
v_k, i_k : branch voltages & currents of N

$\hat{v}_k \; \hat{i}_k$: branch voltages & currents of $\hat{N}$

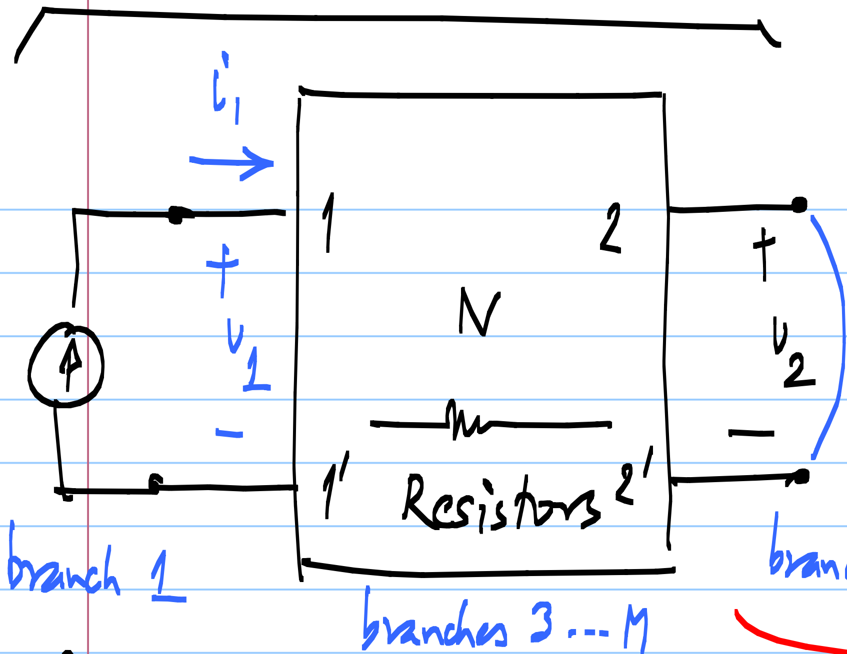
$1 \cdot \frac{1}{6} \cdot 3\Omega = \frac{1}{2}$

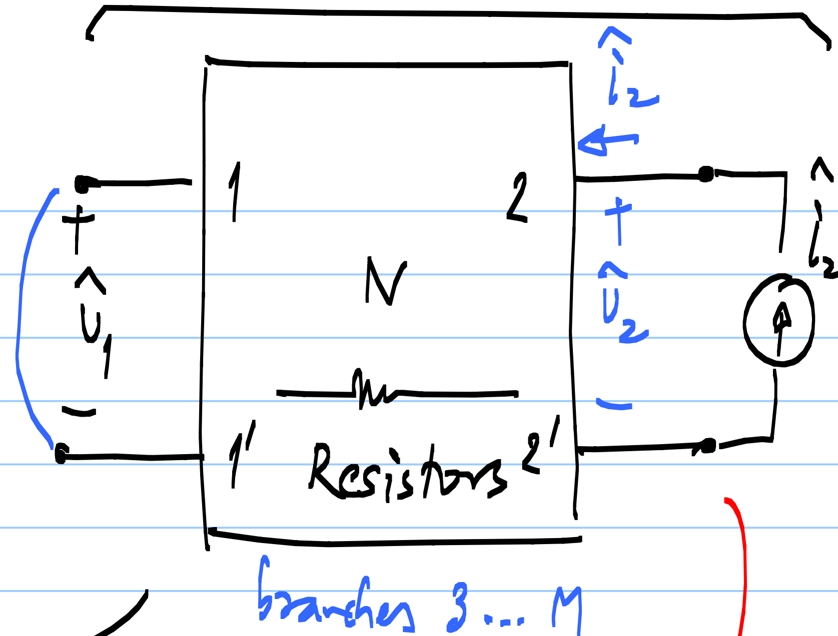


$1 \cdot \frac{3}{6} \cdot 1$



$\frac{1}{2} V = u_2$





currents

voltages

Voltages currents:

$R_k \cdot i_k$

$$v_1 \cdot 0 + v_2(-\hat{i}_2) + \sum_3^M v_k \hat{i}_k = 0$$

$R_k \cdot \hat{i}_k$

$$(-i_1)\hat{v}_1 + (0)\cdot\hat{v}_2 + \sum_3^M \hat{v}_k i_k = 0$$