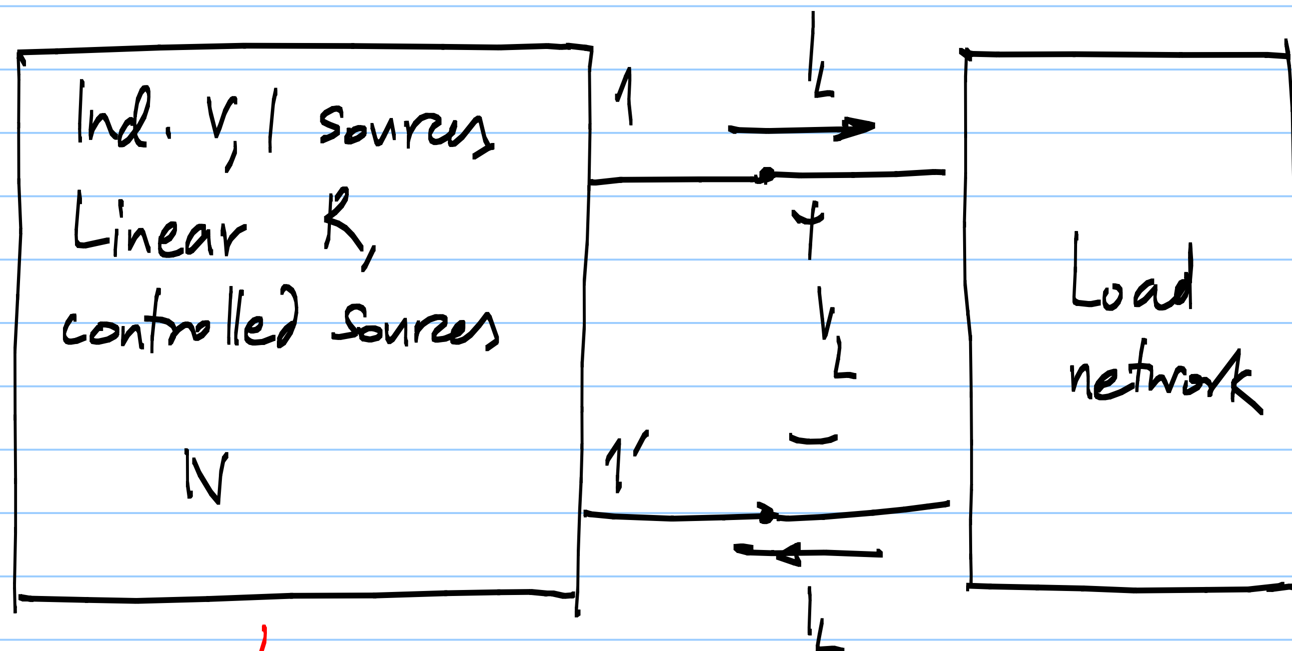
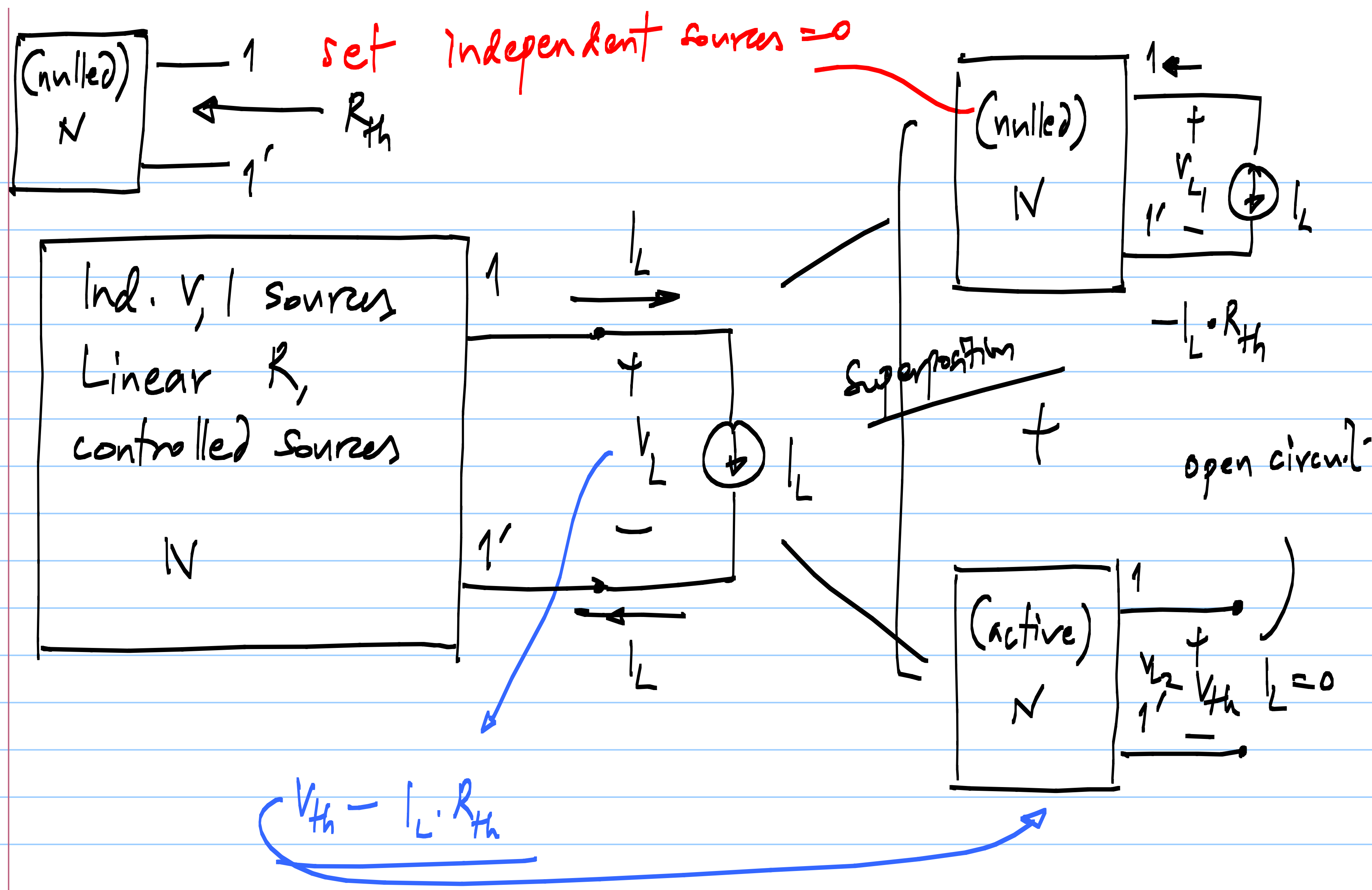
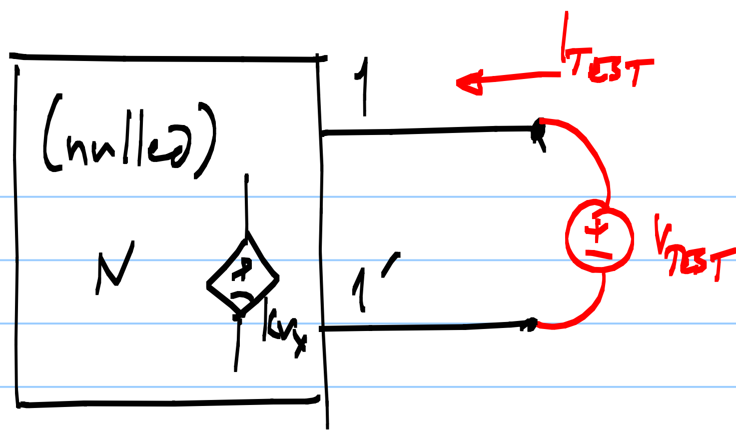
EC1010: Lecture 12



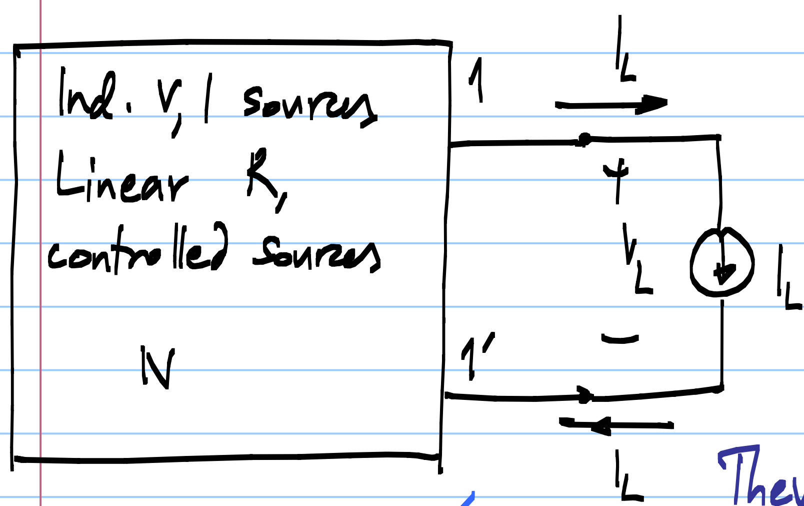
Simple model for this


(nulled)
N
1
1'
R_{th}
set independent sources = 0
Ind. V, I sources
Linear R,
controlled sources
N
1
1'
I_L
+
V_L
−
I_L
superposition
(nulled)
N
1
1'
+
V_{L_1}
−
I_L
$-I_L \cdot R_{th}$
+
open circuit:
(active)
N
1
1'
+
V_{L_2} V_{th}
−
$I_L = 0$
$V_{th} - I_L \cdot R_{th}$



$$\frac{V_{TEST}}{I_{TEST}} = R_{th}$$

Resistance looking into 1-1' with ind. sources set to zero

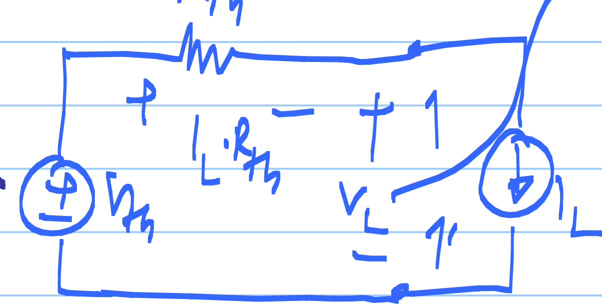


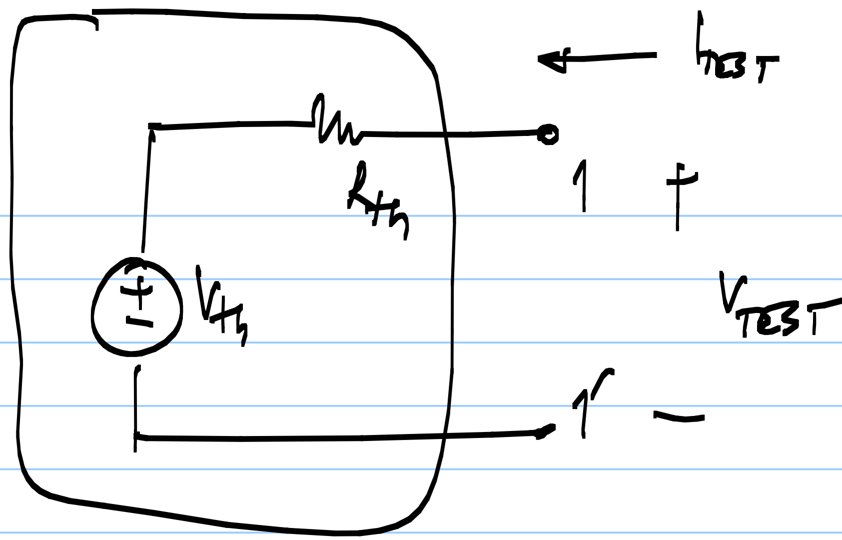
Thevenin's theorem

Thevenin's voltage

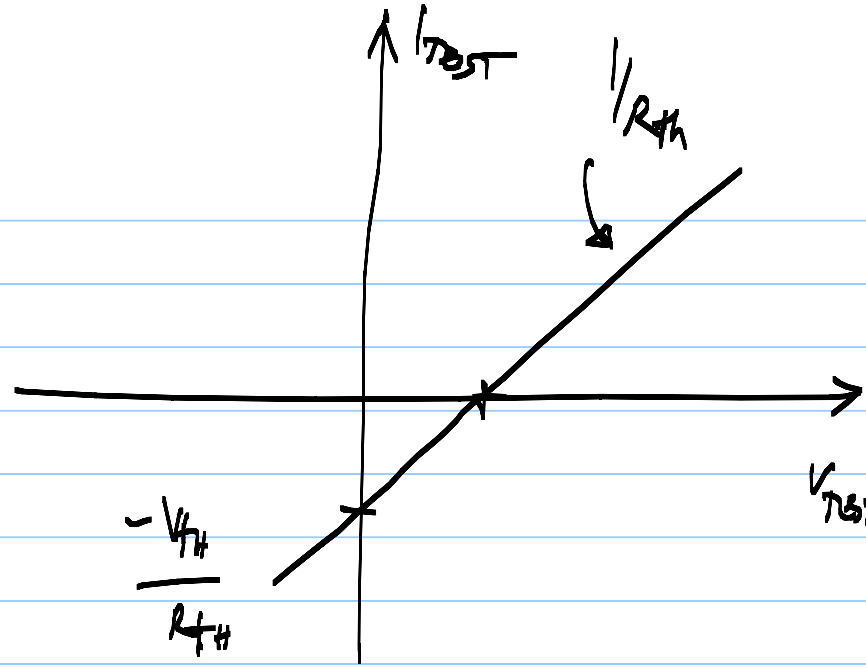
Thevenin resistance

$V_L = V_{th} - R_{th} \cdot I_L$

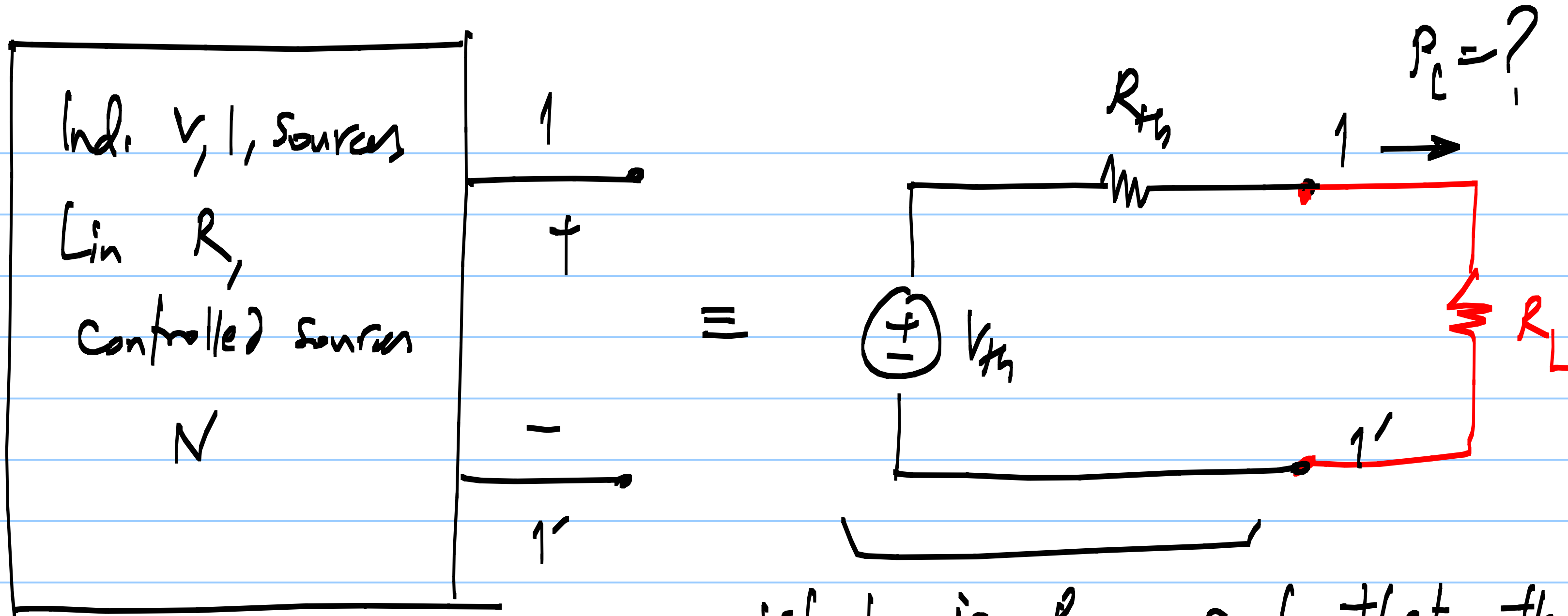




I_{TEST}
R_{th}
V_{th}
1
1'
+
−
V_{TEST}



I_{TEST}
$1/R_{th}$
V_{TEST}
$-\frac{V_{TH}}{R_{TH}}$



What is R_L such that the maximum power is drawn from $\{V_{Th}, R_{Th}\}$?

$$P_L = V_{Th} \cdot \frac{R_L}{R_{Th}+R_L} \cdot \frac{V_{Th}}{R_{Th}+R_L}$$

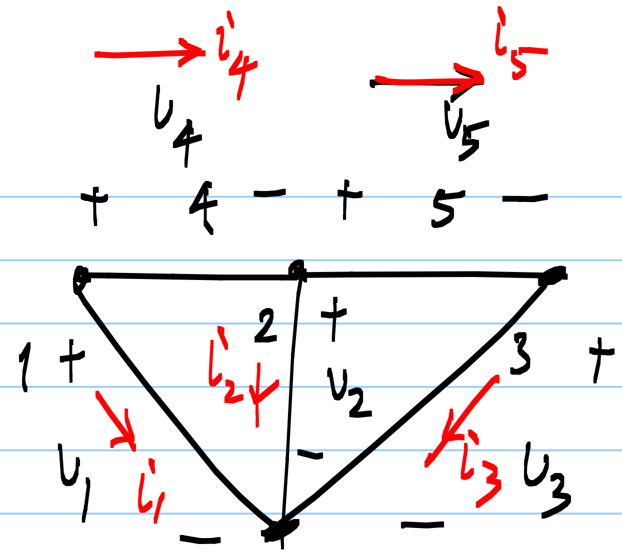
Maximum power transfer theorem :

$$P_L = V_{th}^2 \cdot \frac{R_L}{(R_{th}+R_L)^2} = \frac{V_{th}^2}{R_{th}} \cdot \frac{R_L R_{th}}{(R_{th}+R_L)^2}$$

$P_L = P_{L,max}$ when $R_L = R_{th}$ (matching the load ~~to~~ the source)

$$= \frac{V_{th}^2}{R_{th}} \cdot \frac{1}{\left(\frac{R_{th}+R_L}{\sqrt{R_{th}R_L}}\right)^2} = \frac{V_{th}^2}{R_{th}} \cdot \frac{1}{\underbrace{\left(\sqrt{\frac{R_{th}}{R_L}}+\sqrt{\frac{R_L}{R_{th}}}\right)^2}_{\text{minimum when } \sqrt{\frac{R_{th}}{R_L}} = 1, \; \underline{\underline{R_L = R_{th}}}}}$$

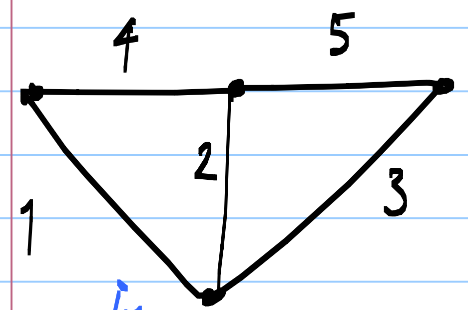
$$P_{L,max} = \frac{V_{th}^2}{4R_{th}}$$; Available power of the source



$$\sum_{\text{all branches}} v_k i_k' = 0$$

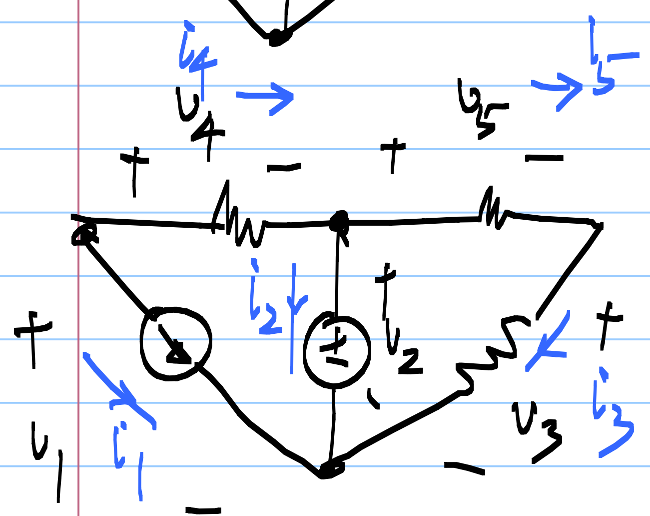
Prove it

KVL, KCL

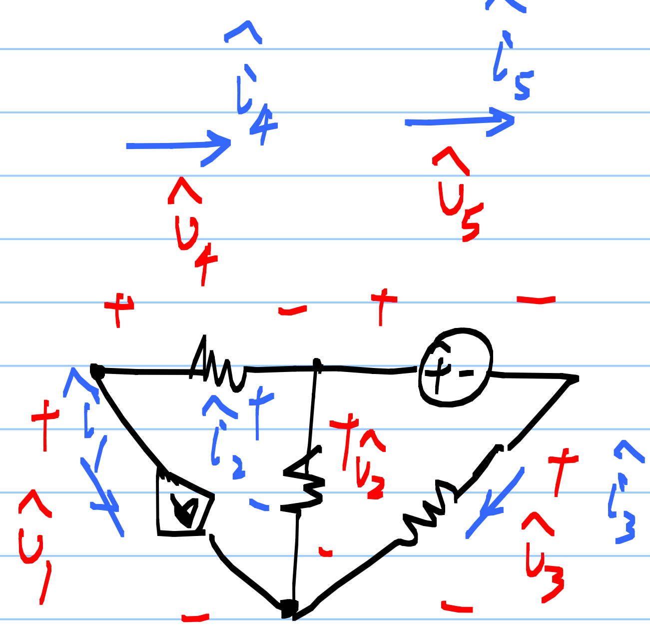


$$\sum_{\text{all branches}} v_k \hat{i}_k$$

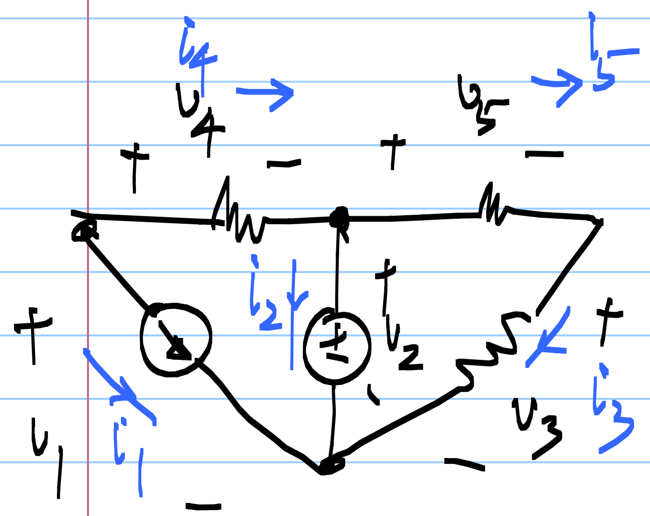
$$\sum v_k i_k = 0$$



$$\sum v_k i_k = 0$$



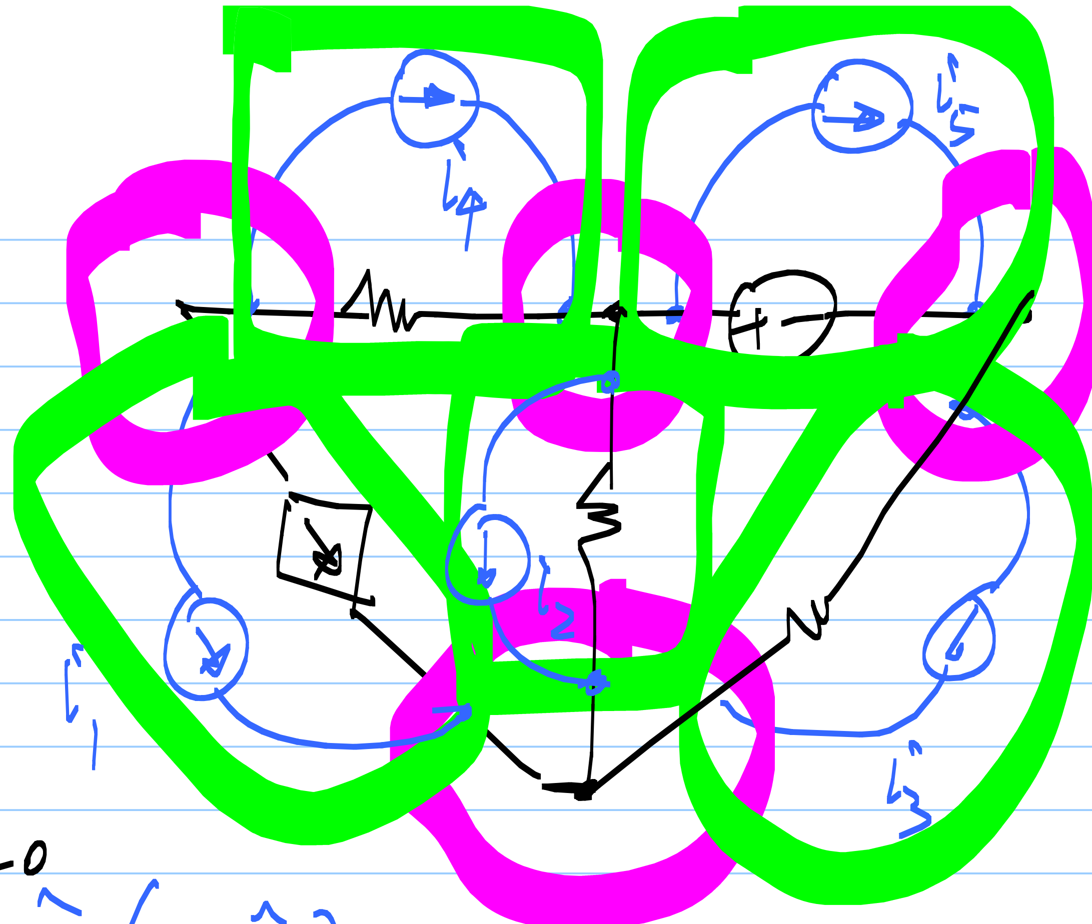
$$\sum \hat{v}_k \hat{i}_k = 0$$



$$\sum \underbrace{v_k \left(i_k + \hat{i}_k \right)}_{} = 0$$

$\hat{v}_4 \left(i_4 + \hat{i}_4 \right)$

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



Tellegen's theorem

Exercises:

1: Prove $\sum_{\text{all branches}} v_k i_k = 0$

2: Derive eq. ckt with a current source