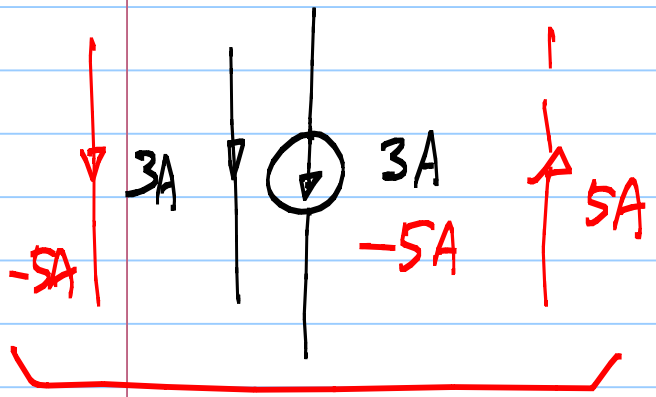
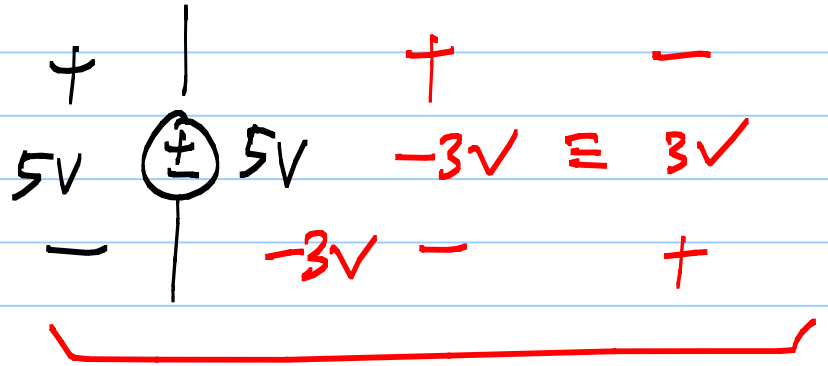
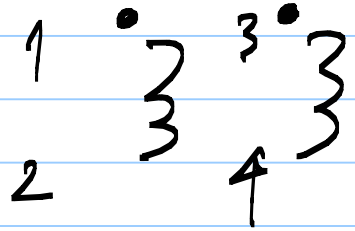
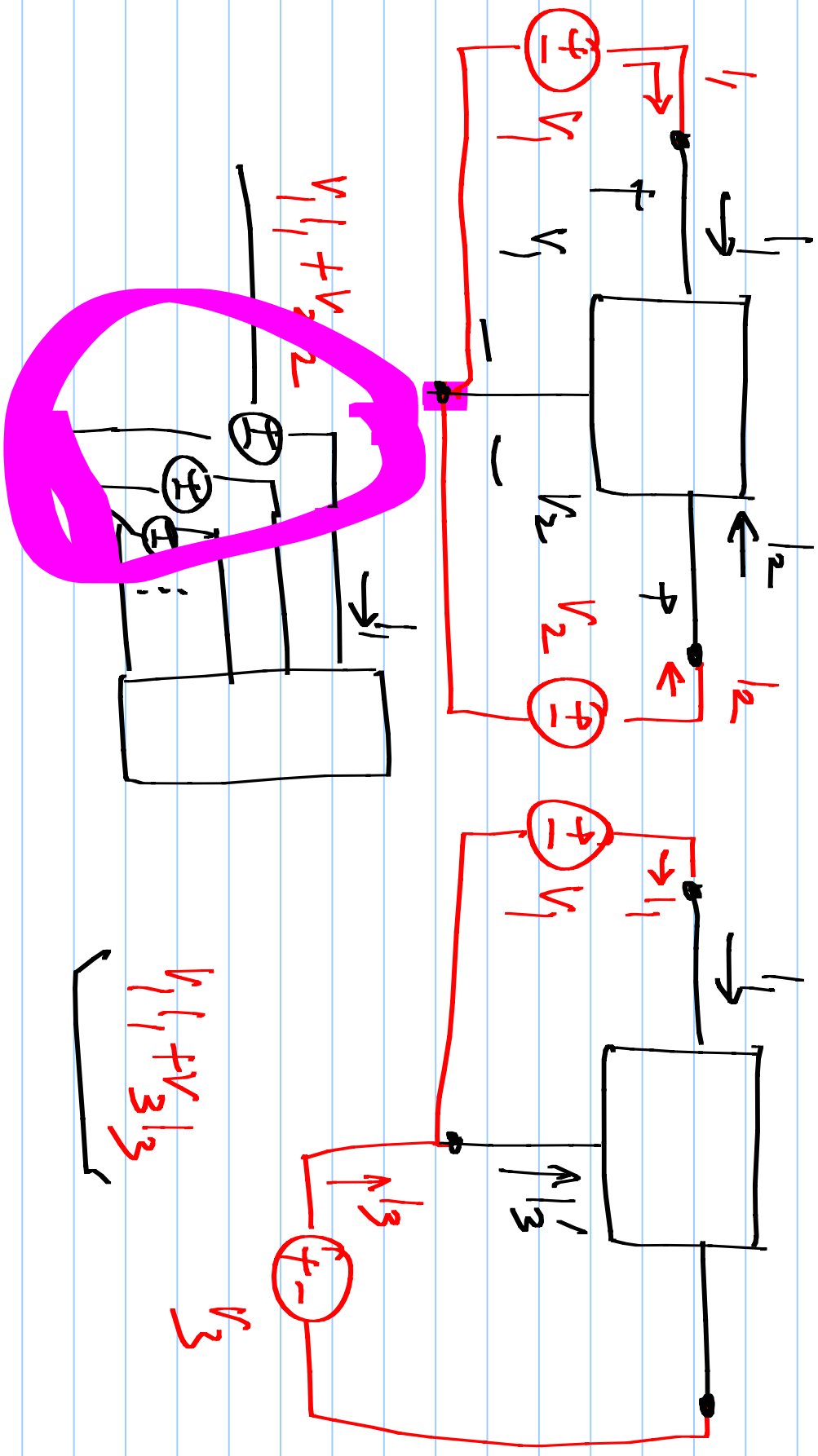
EC1010: Lecture 5

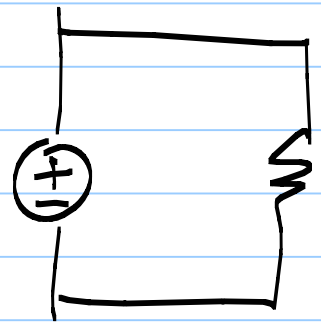


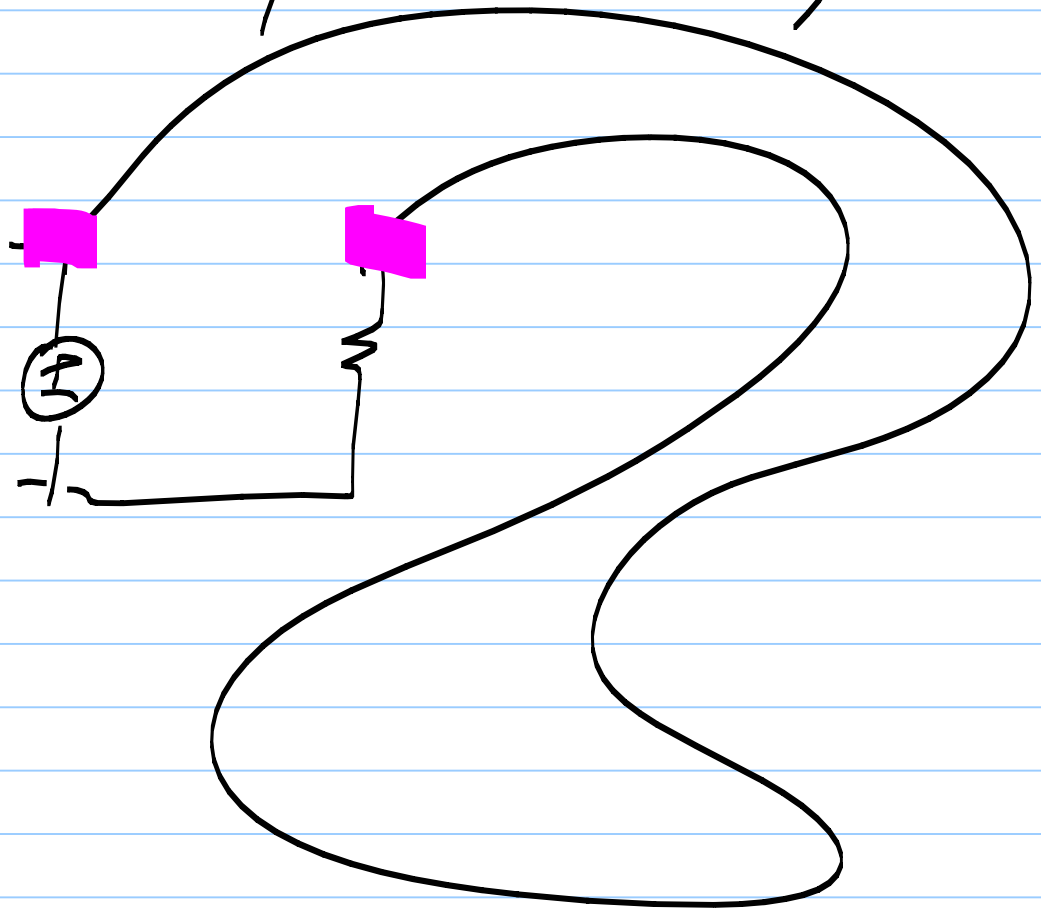




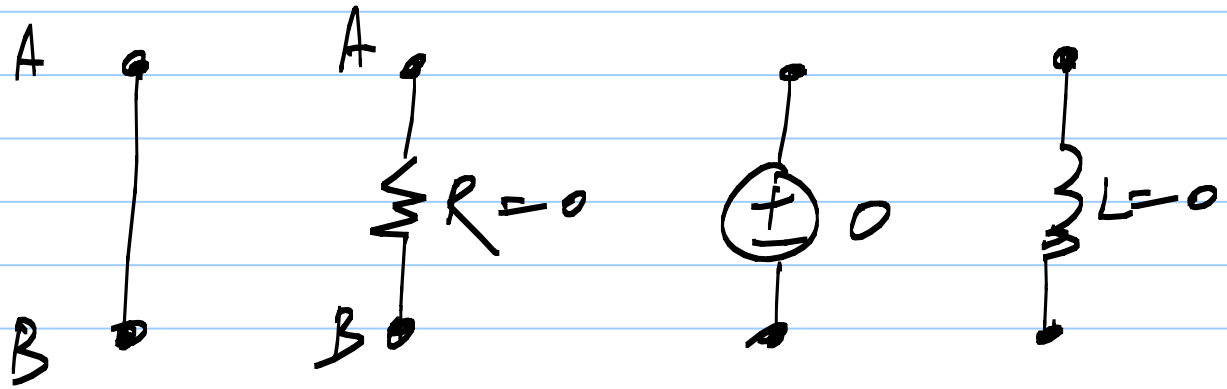


Wire: Ideal (Zero resistance/short ckt ...)

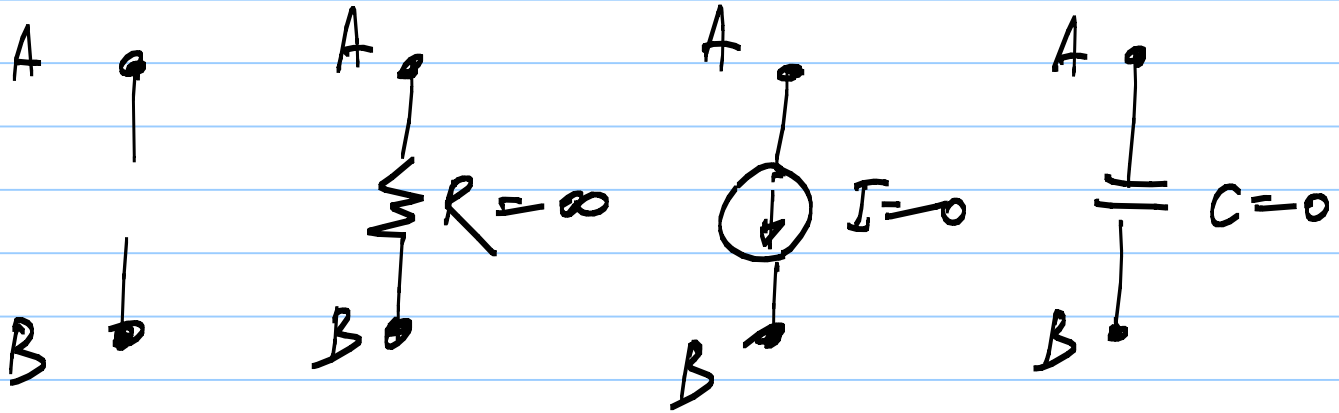


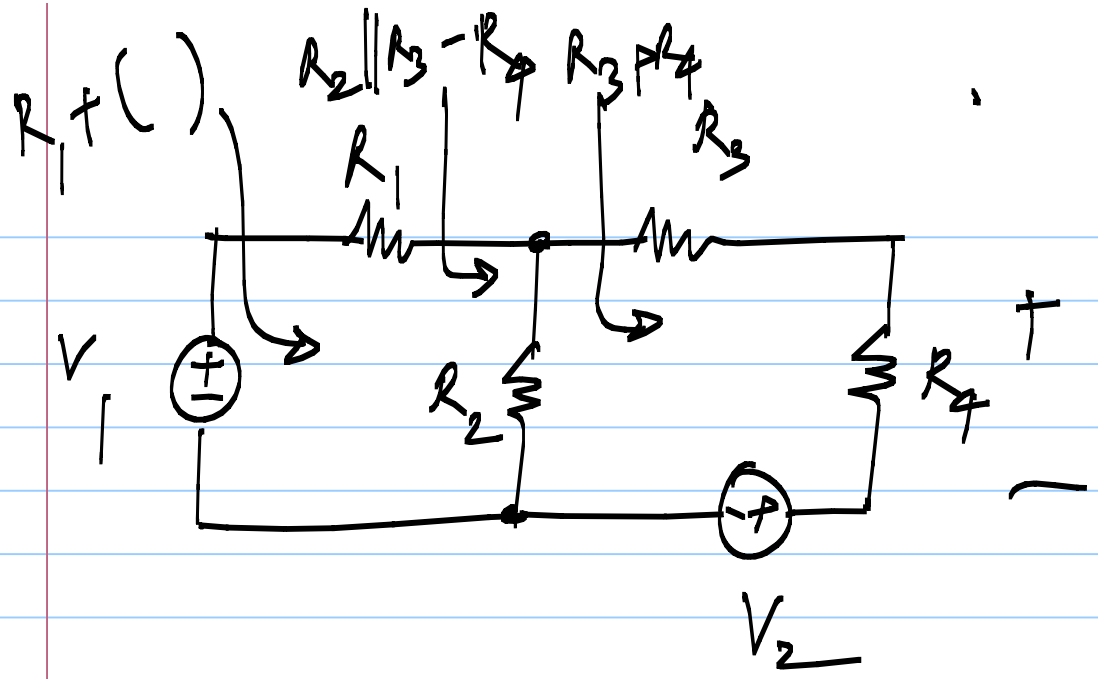


short circuit (between 2 nodes) ⇒ voltage difference between those nodes = 0



open circuit (along a branch) $\Rightarrow$ current along that branch $= 0$

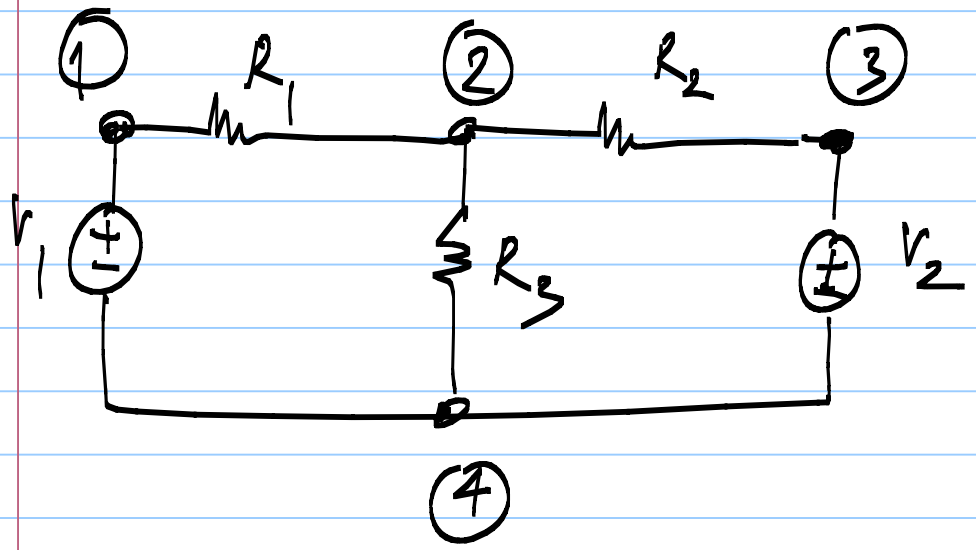



R1 + ( )
R2 || R3 - R4
R3 + R4
R1
R3
V1
R2
R4
+
-
V2

Node: point of interconnection of multiple elements (terminals)

Branches: Elements between nodes

2B variables



N = 4 nodes

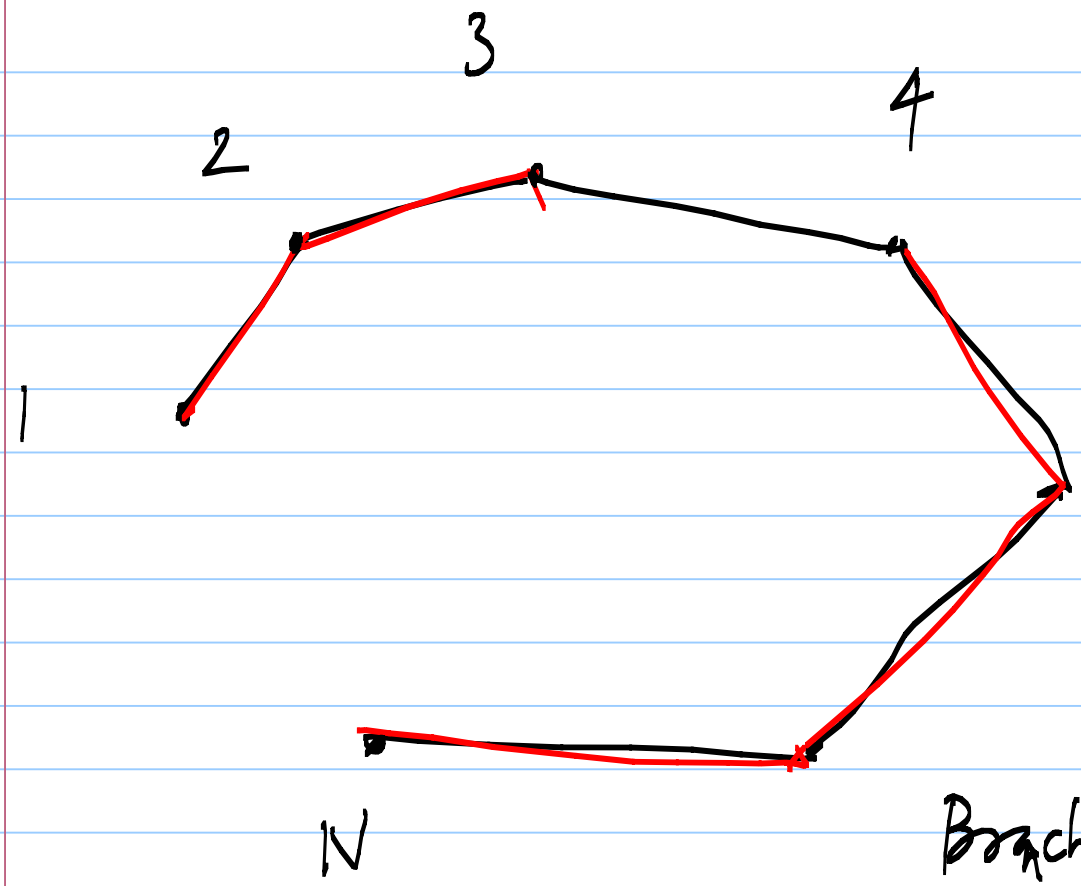
B = 5 branches

N − 1

B − N + 1

KCL, KVL, B

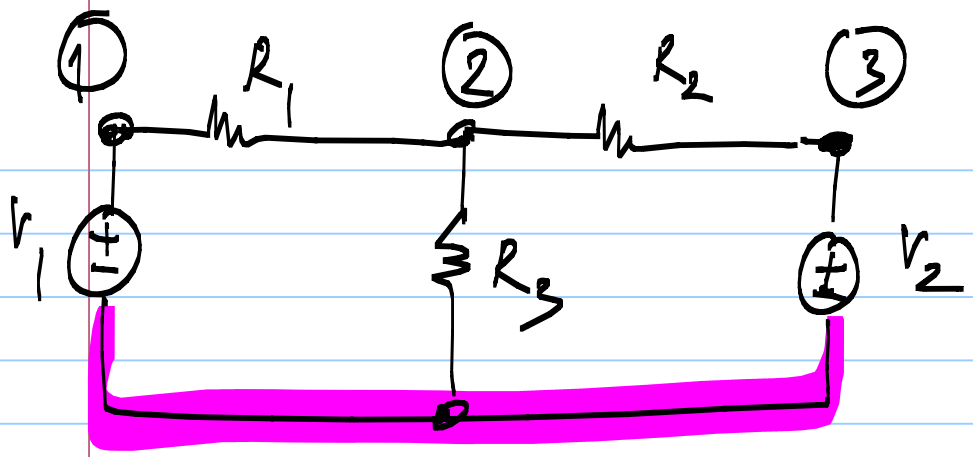
Element relationships

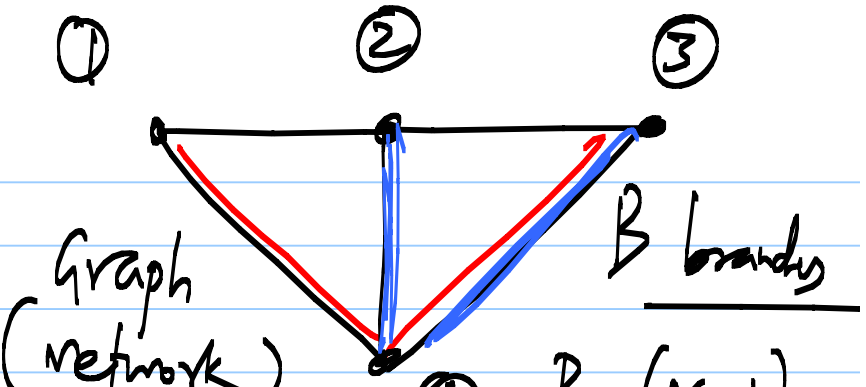


Sub-Tree: Network (of the original) Connecting N nodes without forming a loop (contains N-1 branches)

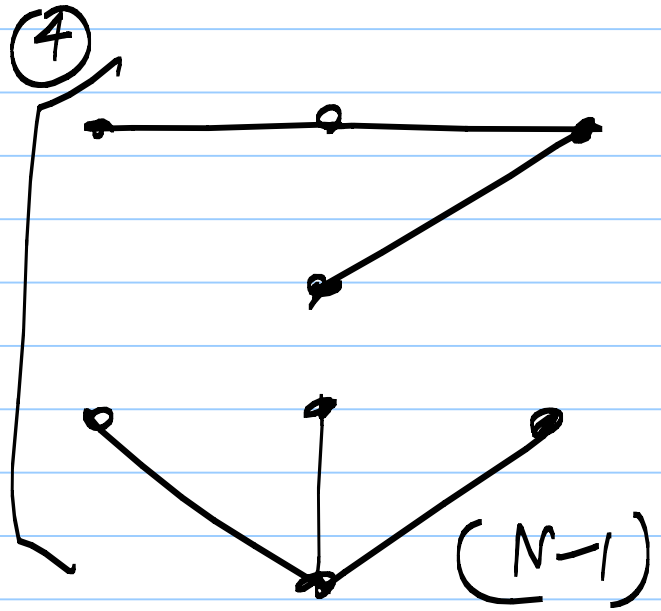
∴ 1

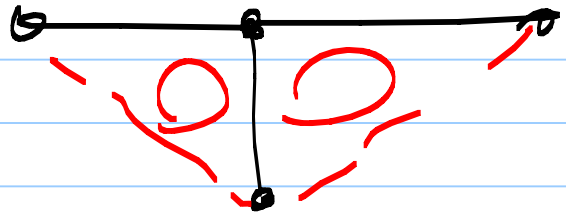
Braches not in a tree ≡ links

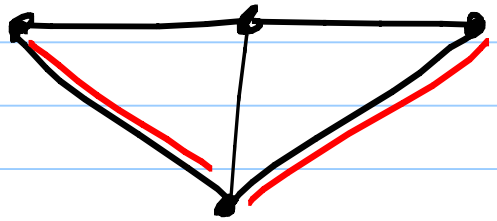

1
2
3
R_1
R_2
R_3
V_1
V_2


1
2
3
Graph
(network)
B branches
4
B-(N-1)
= B-N+1
Links

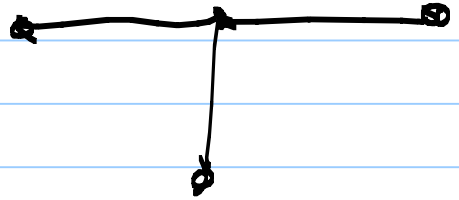
Trees


4
(N-1)



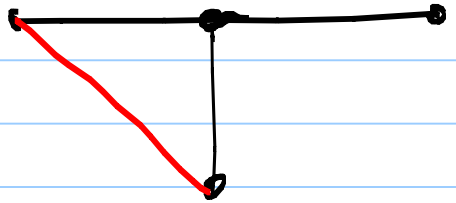


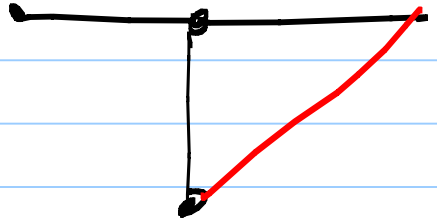
original network: B (=5) branches
N (=4) nodes



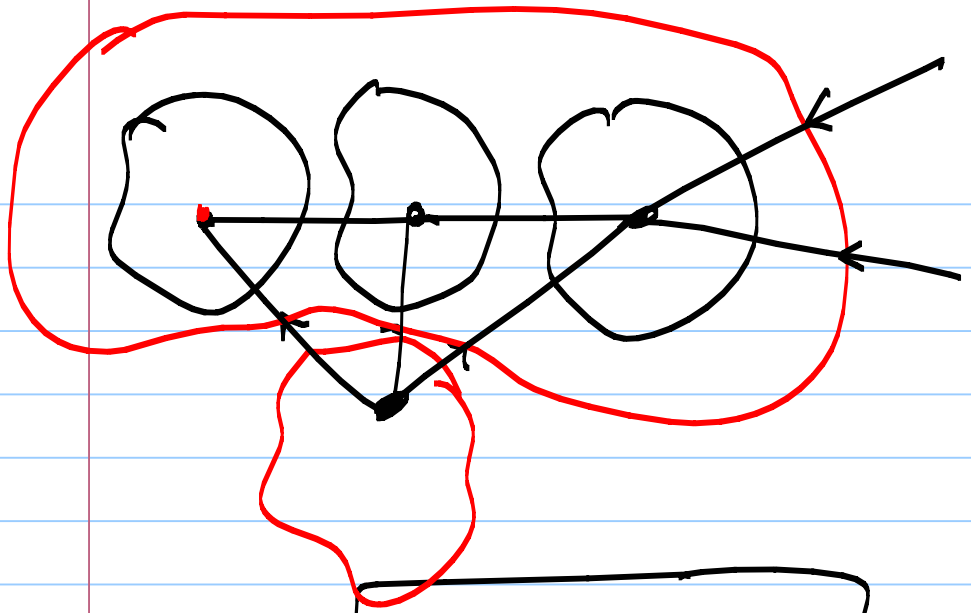
Tree : N-1 branches

Links : B − (N−1) branches left out



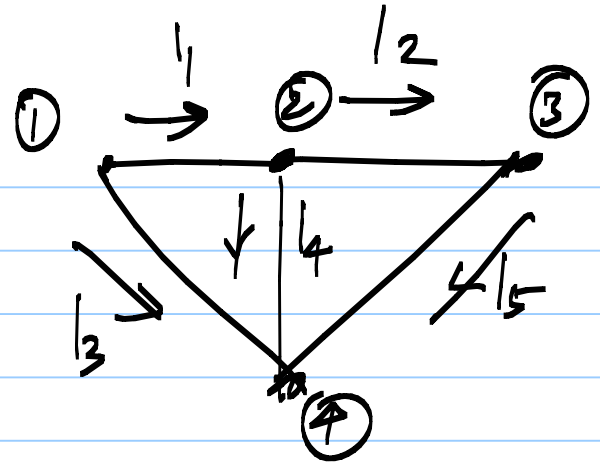


B − N + 1 Loops



$$-I_3 - I_4 - I_5 = 0$$

N-1 KCL eq.

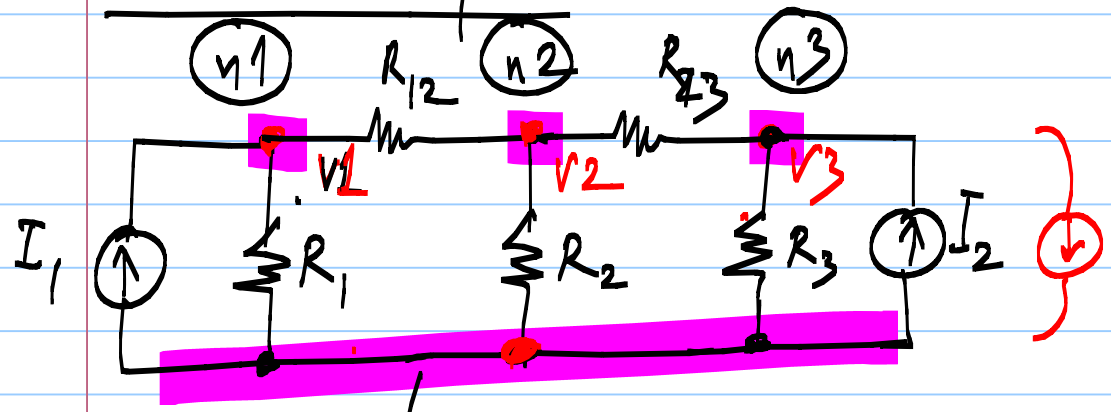


N-1 KCL eq.

$$\begin{cases} I_1 + I_3 = 0 \\ -I_1 + I_2 + I_4 = 0 \\ -I_2 + I_5 = 0 \end{cases}$$

$$I_3 + I_4 + I_5 = 0$$

Nodal analysis: KCL at N-1 nodes



$$\frac{V_1}{R_1} + \frac{V_1 - V_2}{R_{12}} = I_1$$

reference node

$$\frac{V_2 - V_1}{R_{12}} + \frac{V_2}{R_2} + \frac{V_2 - V_3}{R_{23}} = 0$$

$$\frac{V_3 - V_2}{R_2} + \frac{V_3}{R_3} = I_2$$

$$\begin{matrix} n1 \\ n2 \\ n3 \end{matrix} \begin{bmatrix} \frac{1}{R_1} + \frac{1}{R_{12}} & -\frac{1}{R_{12}} & 0 \\ -\frac{1}{R_{12}} & \frac{1}{R_{12}} + \frac{1}{R_2} + \frac{1}{R_{23}} & -\frac{1}{R_{23}} \\ 0 & -\frac{1}{R_{23}} & \frac{1}{R_3} + \frac{1}{R_{23}} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} = \begin{bmatrix} I_1 \\ 0 \\ I_2 \end{bmatrix} \quad -I_2$$