Announcements: Problem Set posted

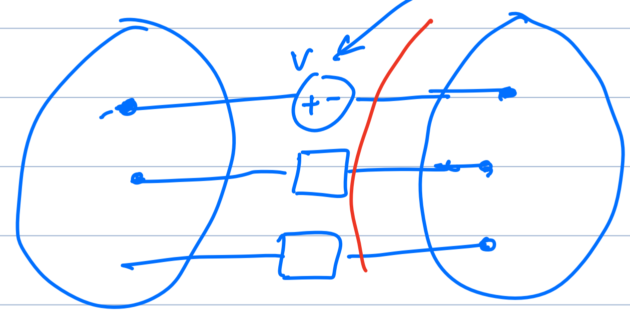
Cut-set Q_a Q_f

$$Q_f = \big[\, \underbrace{I_{n-1}}_{\leftarrow \text{tree} \rightarrow} \;\vdots\; \underbrace{Q_{fe}}_{\leftarrow \text{links} \rightarrow} \,\big]$$

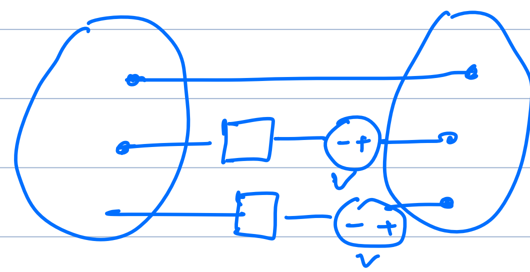
Properties [Skipping the proofs]

1. v- shift property

independent voltage source.



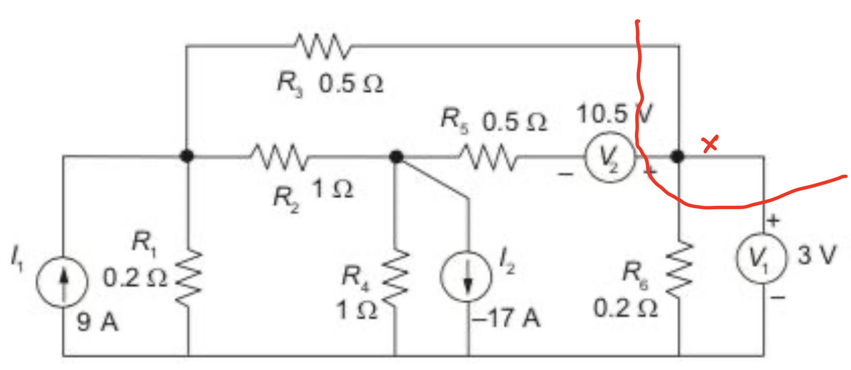
$\Longleftrightarrow$

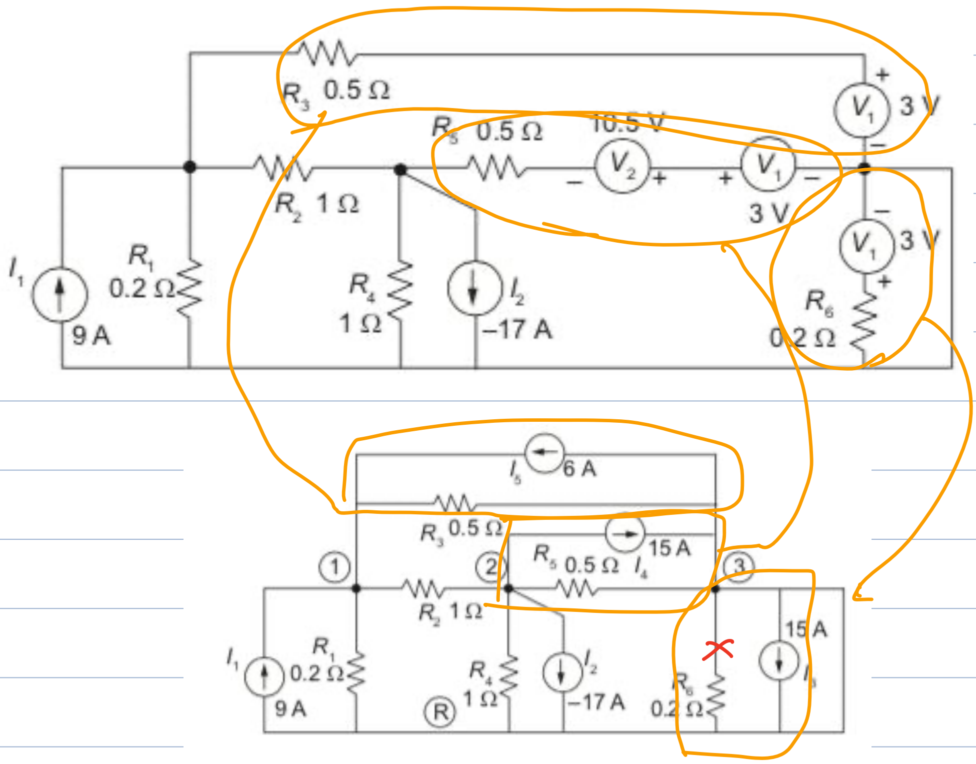


Example:

Nodal analysis (using A matrix) (current sources)

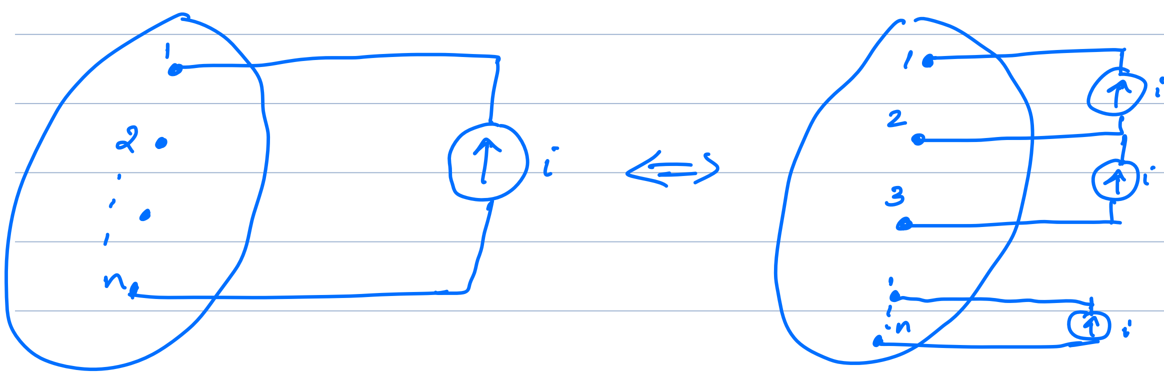
Voltage sources $\xrightarrow{\text{Source Txn}}$ Current Sources





Analyze this ckt using nodal analysis!

2. i-shift

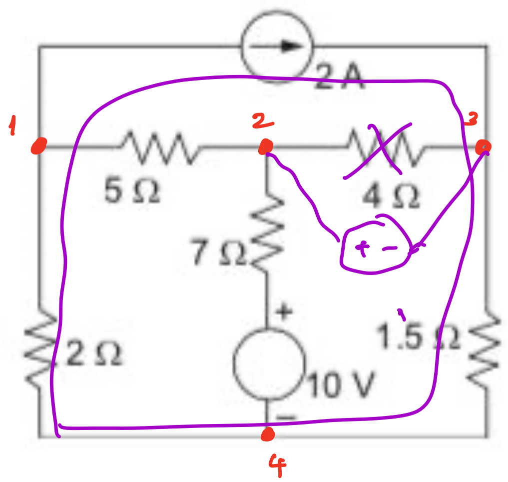


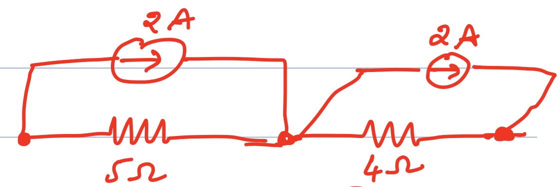
Nodes 1 to n form a loop with the current source i.

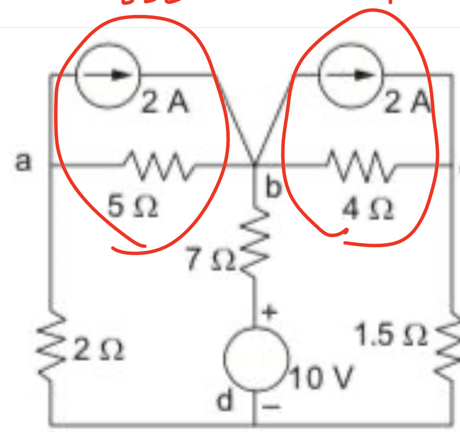
Example:

Mesh analysis using B matrix + Voltage sources

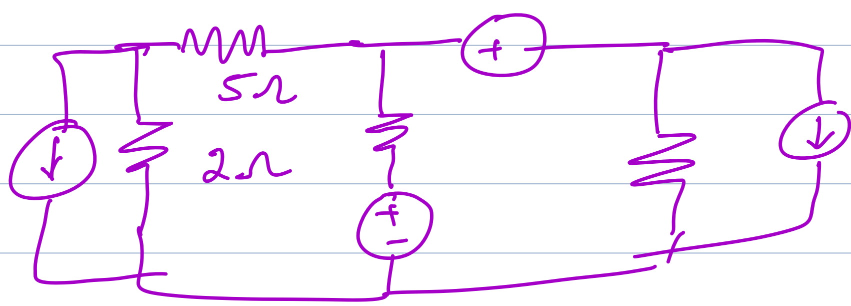
Current sources $\Longrightarrow$ Voltage Sources







Do analysis using B matrix!



3. Orthogonal relation b/w Q & B matrix

Fix a tree $\rightarrow$ $Q_f \, B_f^T = 0$

$\dim(Q_f) = (n-1) \times b$

$\dim(B_f) = (b-(n-1)) \times b$

tree , links

$$\begin{cases} Q_f = [\ I_{n-1} \ \vdots \ Q_{fe}\ ] \\ B_f = [\ B_{ft} \ \vdots \ I\ ] \end{cases}$$

$$[\ I \quad Q_{fe}\ ] \begin{bmatrix} B_{ft}^T \\ I \end{bmatrix} = 0$$

$$B_{ft}^T + Q_{fe} = 0$$

$$Q_{fe} = -B_{ft}^T$$

KCL equations (in terms of Q)

$$i_t = B_{ft}^T \, i_e$$

$$\boxed{i_t = -Q_{fe}\, i_e}$$

$$i = \begin{bmatrix} i_t \\ i_e \end{bmatrix} = \begin{bmatrix} -Q_{fe}\, i_e \\ i_e \end{bmatrix}$$

$$= \begin{bmatrix} -Q_{fe} \\ I \end{bmatrix} i_e$$

$$Q_f\, i = [\ I \ \vdots \ Q_{fe}\ ]\, i$$

$$= [\ I \ \vdots \ Q_{fe}\ ] \begin{bmatrix} -Q_{fe} \\ I \end{bmatrix} i_e$$

$$\boxed{Q_f\, i = 0}$$

KVL equations (in terms of Q)

$B_f \cdot v = 0$ (KVL eqn in terms of B)

$$[\ B_{ft} \ \vdots \ I\ ] \begin{bmatrix} v_t \\ v_e \end{bmatrix} = 0$$

$$B_{ft} v_t + v_\ell = 0$$

$$\boxed{v_\ell = -B_{ft} \cdot v_t = Q_{f\ell}^T v_t}$$

$$v = \begin{bmatrix} v_t \\ v_\ell \end{bmatrix} = \begin{bmatrix} v_t \\ Q_{f\ell}^T v_t \end{bmatrix}$$

$$= \begin{bmatrix} I \\ Q_{f\ell}^T \end{bmatrix} v_t$$

$$\boxed{v = Q_f^T v_t}$$

Analysis using Q matrix $\Rightarrow$ Do next class