Announcements

1. Quiz 2 (15 marks) on Nov 21 @ 2pm – 4pm
2. Change in evaluation policy [In-class qns: 5 (from 10) (best out of 7)
   Final exam: 25 (from 20)]
3. Tutorial tomorrow @ 5pm
4. Reminder: Class today @ 4.45 pm
5. Problem sheet posted today. Please try before Tutorial tmrw.

Last week: Circuit matrix B_a B_f (Tie-set)

KVL: $B_f V = 0$ $\quad B_f = [B_{ft} \mid I]$ ← tree → ← link →

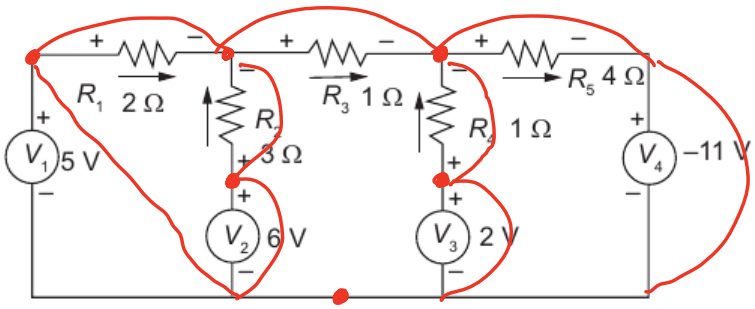
KCL: $i_t = B_{ft}^T i_\ell$

Alternate form

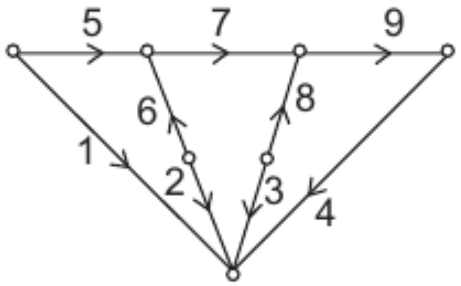
$$i = \begin{bmatrix} i_t \\ i_\ell \end{bmatrix} = \underbrace{\begin{bmatrix} B_{ft}^T \\ I \end{bmatrix}}_{B_f^T} i_\ell$$

$$i = B_f^T i_\ell$$

Example 17.7.1 in SK [Case: Only indp voltage sources]



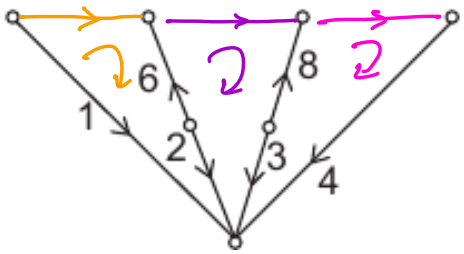
9 branches



$$B_f = \begin{array}{c} \\ f\text{-}c\text{-}1 \\ f\text{-}c\text{-}2 \\ f\text{-}c\text{-}3 \end{array} \left[\begin{array}{cccc|cccc} 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 \\ \hline -1 & 1 & 0 & 0 & -1 & 0 & 1 & 0 & 0 \\ 0 & -1 & 1 & 0 & 1 & -1 & 0 & 1 & 0 \\ 0 & 0 & -1 & 1 & 0 & 1 & 0 & 0 & 1 \end{array}\right]$$

← voltage sources → ← Passive elements →

B_{fg} B_{fp}



KVL: $B_f v = 0$

$$\begin{bmatrix} B_{fg} & B_{fp} \end{bmatrix} \begin{bmatrix} v_g \\ v_p \end{bmatrix} = 0$$

$$B_{fg} v_g + B_{fp} v_p = 0$$

$$v_g = \begin{bmatrix} 5 \\ 6 \\ 7 \\ \vdots \\ 11 \end{bmatrix}$$

Z_p = "branch impedance matrix"

$$\begin{bmatrix} z & & & & 0 \\ & & & & \\ & & & & \\ & & & & \\ 0 & & & & z \end{bmatrix}$$

" only for voltage sources "

$$v_p = Z_p \cdot i_p$$

$$B_{fg}\, v_g + B_{fp}\, Z_p\, i_p = 0$$

KCL $\quad i = B_f^T\, i_e$

$$\begin{bmatrix} i_g \\ i_p \end{bmatrix} = \begin{bmatrix} B_{fg}^T \\ B_{fp}^T \end{bmatrix} i_e$$

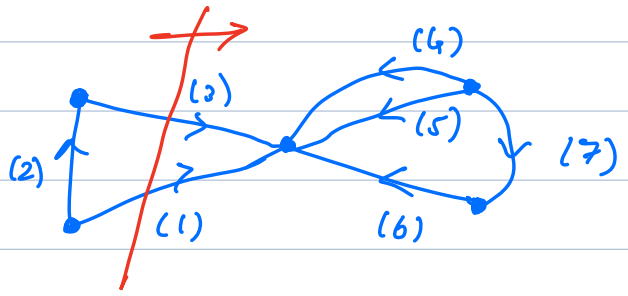
$$i_p = B_{fp}^T\, i_e$$

$$B_{fg}\, v_g + B_{fp}\, Z_p\, B_{fp}^T\, i_e = 0$$

$$i_e = -\left(B_{fp}\, Z_p\, B_{fp}^T\right)^{-1} B_{fg}\, v_g$$

KCL: $\quad i = B_f^T\, i_e$

Cut-sets

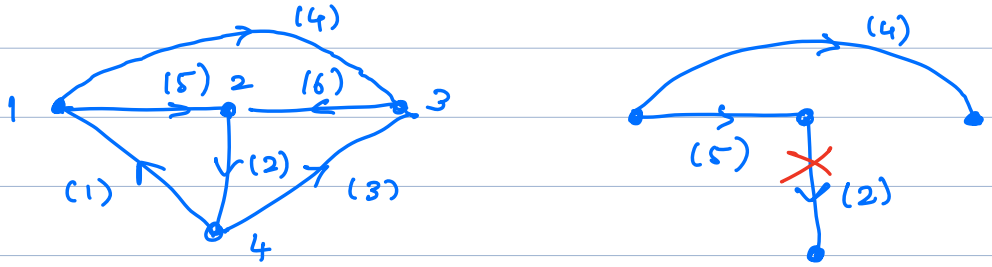


Cut set : Set of Branches such that removing the Branches disconnects the graph

$$Q_a \uparrow_{\text{all}} = \text{cut-set matrix} \quad \begin{matrix} \text{cut-set-1} \\ \text{cut-set-2} \end{matrix} \quad \begin{matrix} (1) & (2) & (3) & \cdots & (7) \end{matrix}$$

$$Q_a(i,j) = \begin{cases} 0 & \text{if branch } i \text{ is not in the cut-set} \\ +1 & \text{if the branch } i \text{ is present same direction as cut-set} \\ -1 & \text{if the branch } i \text{ is present opposite direction as cut-set} \end{cases}$$

Fundamental cut-set matrix Q_f

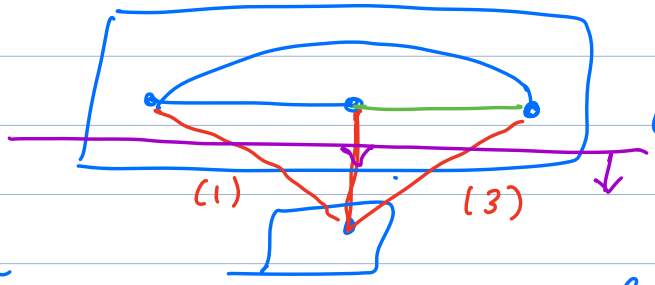


Idea: Remove one of the branches of tree

f-cut-set

= { One of the branches of tree }

∪ { All the links that go from one group to another }



Cut-set-1

= {(1), (2), (3)}

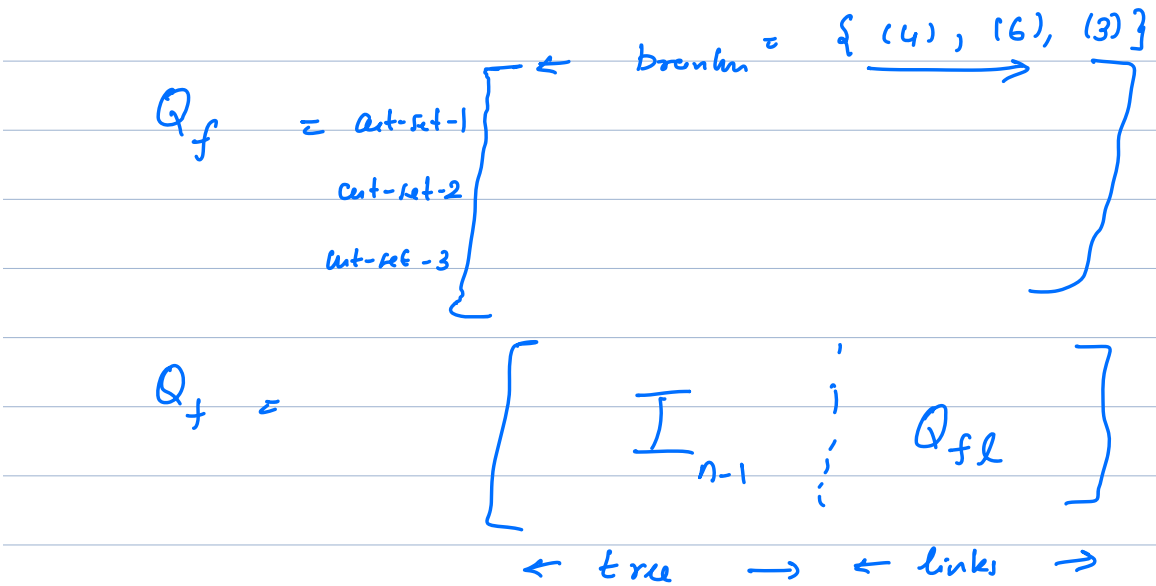
Direction "Convention"

Same as the direction of twig.

Cut-set-2

= {(5), (1), (3), (6)}

Cut-set-3



n nodes

$\text{rank}(Q_f) \geq n-1$

$\text{rank}(Q_f) = n-1$ [Proof in text book]