

graph (oriented)
 | = tree
 numbered

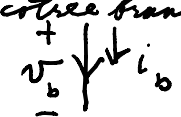
$n = \# \text{ of nodes} = 4$

$b = \# \text{ of branches} = 7$

$t = \# \text{ of tree branches} = 3 \Rightarrow t = n - 1$

$l = \# \text{ of cotree branches} = 4 \Rightarrow l = b - t = 4$
 $= l = \# \text{ of links (cotree branch)}$

KVL
 KCL



$v_b = \begin{bmatrix} v_t \\ v_l \end{bmatrix}, i_b = \begin{bmatrix} i_t \\ i_l \end{bmatrix}$

$v_b = [v_1 \ v_2 \ v_3 \ v_4 \ v_5 \ v_6 \ v_7]^T_b$
 $i_b = [i_1 \ i_2 \ i_3 \ i_4 \ i_5 \ i_6 \ i_7]^T_b$
 $v_t = [v_1 \ v_2 \ v_3]^T$
 $v_l = [v_4 \ v_5 \ v_6 \ v_7]^T$

transpose
 ↓
 T

links: #4 KVL = 0 = $v_4 - v_3 + v_1 - v_2 \Rightarrow v_4 = -v_1 + v_2 + v_3$ (links in terms of tree voltage)

#5: $v_5 = v_1$

#6: $v_6 = -v_2$

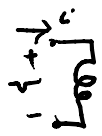
#7: $v_7 = v_1 - v_3; v_1 = v_1$

$v_2 = v_2$

$v_3 = v_3$

$\begin{bmatrix} v_1 \\ v_2 \\ v_3 \\ v_4 \\ v_5 \\ v_6 \\ v_7 \end{bmatrix}_b = v_b = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & 1 & 1 \\ 1 & 0 & 0 \\ 0 & -1 & 0 \\ 1 & 0 & -1 \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \\ v_3 \end{bmatrix}_t \Rightarrow$

$v_b = C^T v_t; C = \left[\begin{array}{c|ccc} 1_3 & -1 & 1 & 0 & 1 \\ \hline & 1 & 0 & -1 & 0 \\ & & 1 & 0 & 0 & -1 \end{array} \right] = \text{cut set matrix}$
 $= [1_t \ ; \ K]$



$$\Rightarrow v = L \frac{di}{dt} = RL \cdot i \quad \equiv \quad v = RL \dot{i}$$

$$\begin{bmatrix} 1 & 0 \\ 0 & RL \end{bmatrix} v = \begin{bmatrix} RL & 0 \\ 0 & 1 \end{bmatrix} \dot{i}$$

$$Av = Bi$$

