Note Title 12/8/2016

EE 610

12/08/16

connections use KCL & KVL

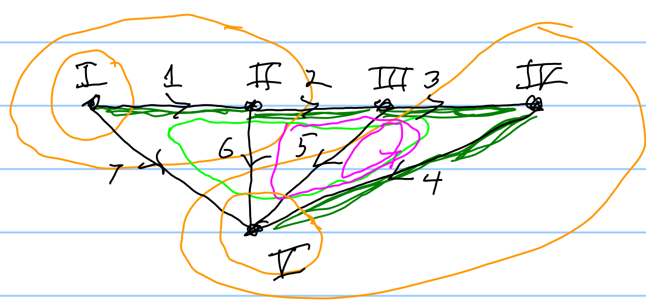
KCL : $\underset{t}{0} = C\, i_b$ t = tree or # of branches in a tree

b = branch or # " "

KVL : $\underset{l}{0} = \mathfrak{J}\, v_b$ l = links or # " " in links

for 1 separate part $b = t + l$

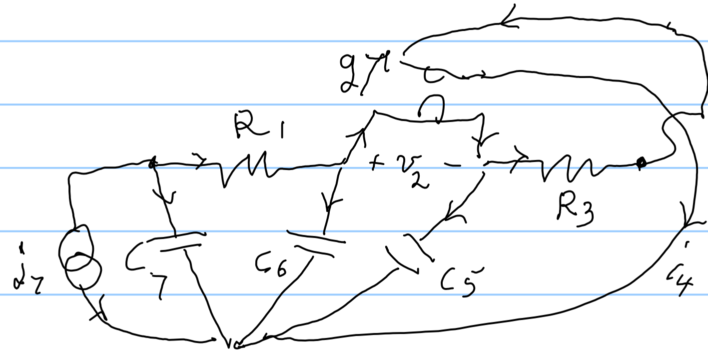
$v_b = C^T v_t \quad , \quad i_b = \mathfrak{J}^T i_l$



$$\begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} = \left[\begin{array}{cccc|ccc} 1 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 0 & 1 & 1 & 1 \\ 0 & 0 & 0 & 1 & 1 & 1 & 1 \end{array}\right] \begin{bmatrix} i_1 \\ i_2 \\ i_3 \\ i_4 \\ i_5 \\ i_6 \\ i_7 \end{bmatrix}$$

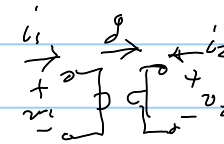
$$\begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix} = \left[\begin{array}{cccc|ccc} 0 & 0 & -1 & -1 & 1 & 0 & 0 \\ 0 & -1 & -1 & -1 & 0 & 1 & 0 \\ -1 & -1 & -1 & -1 & 0 & 0 & 1 \end{array}\right] \begin{bmatrix} v_1 \\ v_2 \\ v_3 \\ v_4 \\ v_5 \\ v_6 \\ v_7 \end{bmatrix}$$

$$A(s)V(s) = B(s)I(s)$$

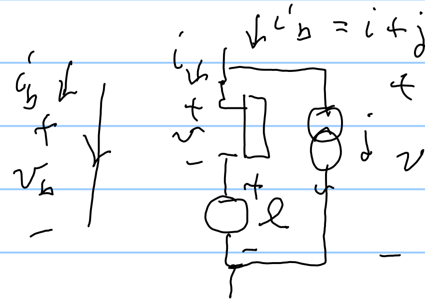


$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -g & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & g & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & C_5 s & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & C_6 s & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & C_7 s \end{bmatrix} V$$

$$= \begin{bmatrix} R_1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & R_3 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} I$$



$$\begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} 0 & -g \\ g & 0 \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \end{bmatrix}$$



$v_b = v + e$

$$e = 0, \quad j = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ j_7 \end{bmatrix}$$

$v_b = \mathcal{C}^T v_t = v, \quad i_b = \mathcal{Q}^T i_\ell = i + j$

$v = \mathcal{C}^T v_t \qquad i = \mathcal{Q}^T i_\ell - j$

$$Av = A\mathcal{C}^T v_t = Bi = B\mathcal{J}^T i_\ell - Bj$$

$$A\mathcal{C}^T v_t - B\mathcal{J}^T i_\ell = -Bj$$

$$\underbrace{\begin{bmatrix} A\mathcal{C}^T & -B\mathcal{J}^T \end{bmatrix}}_{b \times b} \begin{bmatrix} v_t \\ i_\ell \end{bmatrix} = -Bj \qquad x = \begin{bmatrix} v_t \\ i_\ell \end{bmatrix}; \ \dim x = b \ \# \text{ of unknowns}$$

= semi-state (size 7 while state is size 3)

semi-state eqs. $E s x = \mathcal{A} x + \mathcal{B} u \qquad u = j_T = \text{inputs}$

$(Es - \mathcal{A})x = \mathcal{B}u \Rightarrow (Es - \mathcal{A})^{-1}$ needed to solve

$$x = (Es - \mathcal{A})^{-1} \mathcal{B} u = \begin{bmatrix} v_t \\ i_\ell \end{bmatrix}, \quad v_b = \mathcal{C}^T v_t, \quad i_b = \mathcal{J}^T i_\ell$$

if $y = \text{output} = Cx$, C is an (dim output) $\times\, b$ matrix

Positive Real $y(s)$ or $z(s)$ if PR (= rational) can synthesize need use only 1 resistor

Sensitivity: $S_x^{T(s)} = \dfrac{dT(s)/dx}{T(s)/x}$ can find $\dfrac{dT(s)}{dx}$ via the adjoint circuit

$Y^a = Y^T$ (turns gyrators & amplifiers around & keep others)