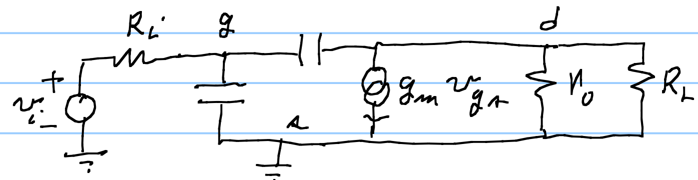
EE610
08/30/16

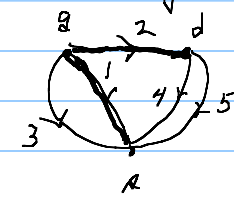
Note Title 8/30/2016

Due to lack of computer facility in classroom this is a summary of blackboard

Circuit graph example, linearized MOS amplifier



$\Rightarrow$



tree = branches 1 & 2

co-tree = links = branches 3, 4, 5

KCL, cut I around branch 1 avoiding 2 $\quad 0 = i_1 + i_3 + i_4 + i_5$

cut II around branch 2 avoiding 1 $\quad 0 = i_2 - i_4 - i_5$ $\Big\}$ in direction of tree current

or $\begin{bmatrix} 0 \\ 0 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 1 & 1 & 1 \\ 0 & 1 & 0 & -1 & -1 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \\ i_4 \\ i_5 \end{bmatrix} = \mathcal{C}\, i_b$, $\mathcal{C}$ = cut set matrix $= [\,1_2 \,\vdots\, K\,]$

general $= [\,1_t \;\; K\,]$, t = # of tree branches

KVL for branch 3, take away 4 & 5, in direction of branch 3
then for 4 & then 5

$\begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} -1 & 0 & 1 & 0 & 0 \\ -1 & 1 & 0 & 1 & 0 \\ -1 & 1 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} v_t \\ v_\ell \end{bmatrix} = \mathcal{J} v_b$, $\mathcal{J}$ = tie set matrix $= [\,-K^T \,\vdots\, 1_3\,]$

general $= [\,-K^T \;\; 1_\ell\,]$, ℓ = # links

$$\mathcal{C}\cdot\mathcal{J}^T = \begin{bmatrix} 1_t & K \end{bmatrix}\begin{bmatrix} -K \\ 1_\ell \end{bmatrix} = -\cancel{K} + K = 0_{t\times\ell}\,,$$

$t = \#$ of tree branches
$\ell = \#$ of link branches
$b = \ell + t = \#$ of branches
$n = \#$ of nodes
$\Rightarrow\ t = n+1$
for a connected graph
(= 1 separate part)

also follows from total power in from outside a covering sphere as

$P_{in}(t) = $ sum of power in branches
$= v_b^T i_b$

using $v_b = \mathcal{C}^T v_t\,,\ i_b = \mathcal{J}^T i_\ell\,,\quad {}^T = $ transpose

also holds if use one tree for KCL & one for KVL and if $\mathcal{C}$ is for one circuit and $\mathcal{J}$ another if the circuits have the same graph.

$\mathcal{C}$ and $\mathcal{J}$ connect individual parts.