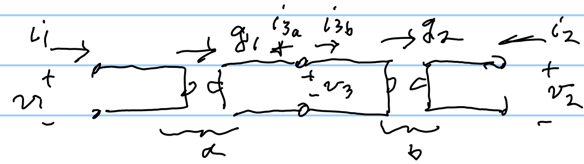
Note Title 9/7/2017

EE610

09/07/17 6



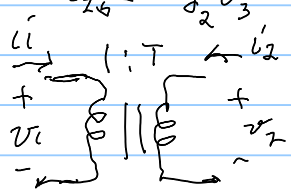

$-g_1 v_1 + 0 = i_{2a} = i_{3a} = -i_{3b} = -i_{1b} = 0 - (-g_2) v_2$

$g_1 v_1 \cong g_2 v_2 \Rightarrow \boxed{v_2 = (g_1/g_2) v_1}$

$i_{1a} = g_1 v_{1a} = g_1 v_3$

$i_{2b} = -g_2 v_3$

ratio $\Rightarrow \frac{i_{1a}}{i_{2b}} = \frac{i_1}{i_2} = -g_1/g_2 \Rightarrow 0 = -i_1 - \frac{g_1}{g_2} i_2$



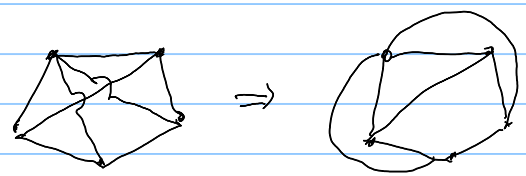

$\Rightarrow v_2 = T v_1, \quad 0 = i_1 + T i_2 \Rightarrow -i_1 = T i_2$

$\Rightarrow i_1 = -T i_2$

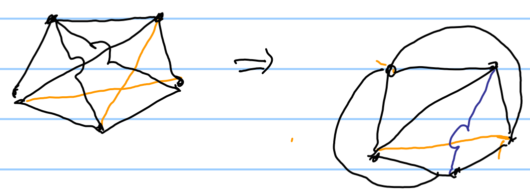
$T = g_1/g_2$

$P_{in}(t) = v_1(t) i_1(t) + v_2(t) \cdot i_2(t) = v_1 \cdot i_1 + v_1\left(\frac{g_1}{g_2}\right) \cdot \left(-\frac{1}{g_1/g_2}\right) i_1 = 0 \Rightarrow$ lossless

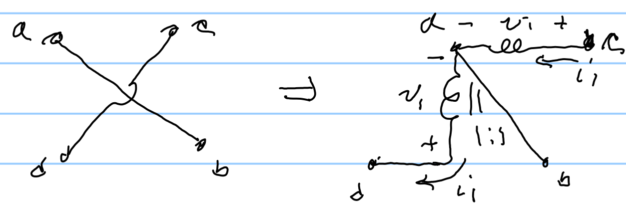
Planar graph vs non-planar



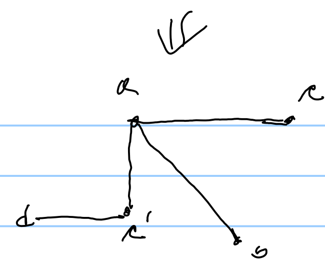
$\Leftarrow$ planar



$\Leftarrow$ non-planar




branch c-d has same $v$ & $i$ as before insert the transformer & branch a-b is unchanged




graph gets an extra branch.

dual of gyrator $Y = \begin{bmatrix} 0 & g \\ -g & 0 \end{bmatrix}$, $Z_d = Y = \begin{bmatrix} 0 & r \\ -r & 0 \end{bmatrix}$

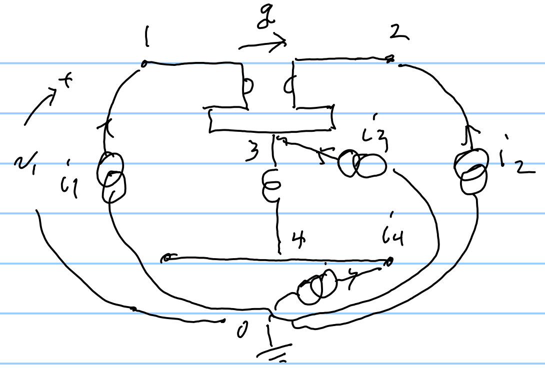
$Z = Y^{-1} = +\frac{1}{g^2}\begin{bmatrix} 0 & -g \\ +g & 0 \end{bmatrix}$ check $ZY = 1_2 = \begin{bmatrix} 0 & -1/g \\ +1/g & 0 \end{bmatrix}\begin{bmatrix} 0 & g \\ -g & 0 \end{bmatrix} = \begin{bmatrix} +1 & 0 \\ 0 & +1 \end{bmatrix}$

$= \begin{bmatrix} 0 & 1/g \\ -1/g & 0 \end{bmatrix} = \begin{bmatrix} 0 & r \\ -r & 0 \end{bmatrix}$, $r = 1/g$

$\therefore$ the dual of a gyrator is another gyrator $r = 1/g$

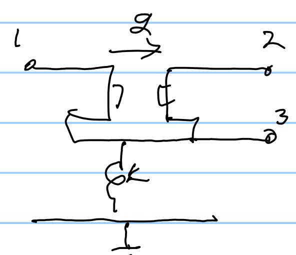
Indefinite admittance matrix: $Y_{ind}$

entries in a row add to zero & also in any column



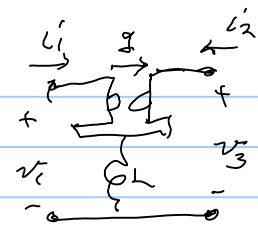

$$\begin{bmatrix} i_1 \\ i_2 \\ i_3 \\ i_4 \end{bmatrix} = \underbrace{\begin{bmatrix} 0 & g & -g & 0 \\ -g & 0 & +g & 0 \\ +g & -g & 1/R_L & -1/R_L \\ 0 & 0 & -1/R_L & 1/R_L \end{bmatrix}}_{Y_{ind}} \begin{bmatrix} v_1 \\ v_2 \\ v_3 \\ v_4 \end{bmatrix}$$

move ground onto circuit then $v_4 = 0 \Rightarrow$ can cross out last column; can ignore $i_4$ (as $= \sum i_j$) $\Rightarrow$ can cross out last row $\Rightarrow$ gives a node by node admittance for all other nodes




$$Y_{def} = \begin{bmatrix} 0 & g & -g \\ -g & 0 & g \\ g & -g & 1/R_L \end{bmatrix}$$

If want the 2-port admittance for




i.e. desire to "eliminate" the 3rd node

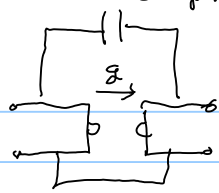
$$\begin{bmatrix} i_1 \\ i_2 \\ \hline 0 \end{bmatrix} = \left[\begin{array}{cc|c} 0 & g & -g \\ -g & 0 & g \\ \hline g & -g & 1/sL \end{array}\right] \begin{bmatrix} v_1 \\ v_2 \\ \hline v_3 \end{bmatrix} \Rightarrow 0 = \begin{bmatrix} g & -g \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \end{bmatrix} + \begin{bmatrix} 1/sL \end{bmatrix} v_3$$

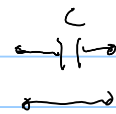
$$v_3 = sL \begin{bmatrix} -g & +g \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \end{bmatrix} = \begin{bmatrix} gsL & -gsL \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \end{bmatrix}$$

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

$$= \begin{bmatrix} +g^2 sL & g - g^2 sL \\ -g - g^2 sL & +g^2 sL \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \end{bmatrix} \Rightarrow Y_{2\,port} = \begin{bmatrix} g^2 L s & g - g^2 L s \\ -g - g^2 L s & g^2 L s \end{bmatrix}$$

$C = g^2 L$




$$\Rightarrow Y = C\dot{\alpha}\begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix}$$