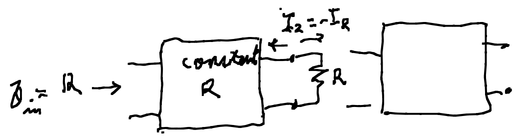
ENEE 610
10/29/20

Note Title 9/19/2020

Partial pole remaival circuit correction
Curve tracer libraries, bias

Constant R & grounding, bridged T
exp(At) from



$$z_{in} = \frac{V_1}{I_1} \Rightarrow \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} z_{11} & z_{12} \\ z_{21} & z_{22} = z_{11} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} \Rightarrow -RI_2 = z_{21} I_1 + z_{22} I_2$$

$V_2 = -RI_2$, $z_{21} = z_{12}$

$$I_2 = (-R - z_{22})^{-1} z_{21} I_1$$

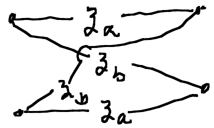
$$V_1 = z_{11} I_1 + z_{12} \left(\frac{-z_{21}}{R + z_{22}} \right) I_1 = R I_1 \quad \text{Constant } R$$

$$z_{11} R + z_{11} z_{22} - z_{12} z_{21} = R^2 + R z_{22}$$

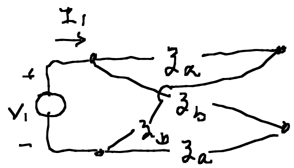
when $z_{22} = z_{11}$ $\quad z_{11} R = z_{22} R \Rightarrow \boxed{R^2 = \Delta_z}.$

use a constant R lattice

constant R 2-port

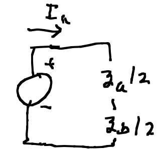


desire Z matrix



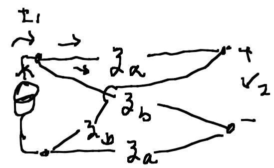
$z_{11} = \frac{V_1}{I_1}\Big|_{I_2=0 \text{ open}}$

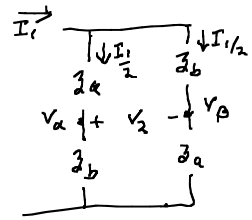
$\equiv$



$\frac{V_1}{I_1} = \frac{1}{2}(z_a + z_b) = z_{11} = z_{22}$

$z_{21} = \frac{V_2}{I_1}\Big|_{I_2=0} = z_{12} = \frac{V_1}{I_2}\Big|_{I_1=0}$





$V_2 = \underbrace{z_b \frac{I_1}{2}}_{V_\alpha} - \underbrace{z_a \frac{I_1}{2}}_{V_\beta} = \frac{1}{2}(z_b - z_a) I_1$

$\frac{V_2}{I_1}\Big|_{I_2=} = \frac{1}{2}(z_b - z_a)$

$$Z = \frac{1}{2}\begin{bmatrix} z_b + z_a & z_b - z_a \\ z_b - z_a & z_b + z_a \end{bmatrix}$$

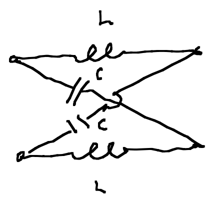
$$\Delta_z = \frac{(z_b + z_a)^2}{4} - \frac{(z_b - z_a)^2}{4}$$

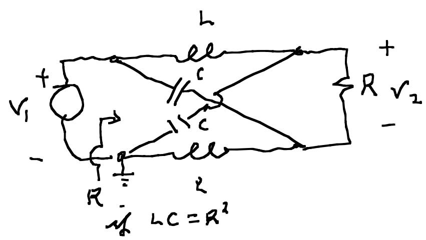
$$= \frac{(\cancel{z_b^2} + 2 z_b z_a + \cancel{z_a^2}) - (\cancel{z_b^2} - 2 z_b z_a + \cancel{z_a^2})}{4} = z_b z_a$$

for constant R then $R^2 = z_b z_a \Rightarrow \frac{z_b}{R} = \frac{R}{z_a}$ branches are duals

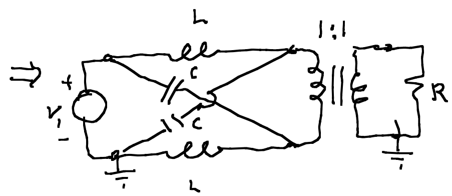
$\frac{1}{\omega C} = \frac{R^2}{\omega L} \Rightarrow LC = R^2 \Rightarrow R = \sqrt{LC}$ $\boxed{}$

∴

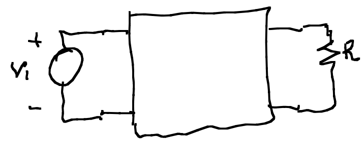




$\Rightarrow$



allows output & input grounded

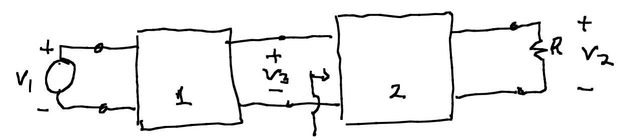


$V_2 = -RI_2$, $V_2 = -RI_2 = z_{21}I_1 + z_{22}I_2$ desire $\frac{V_2}{V_1}$

$V_1 = z_{11}I_1 + z_{21}I_2 = RI_1$

$I_1 = V_1/R \Rightarrow -RI_2 = z_{21}\frac{V_1}{R} + z_{22}I_2 \Rightarrow (-R - z_{22})I_2 = \frac{z_{21}}{R}V_1 \Rightarrow I_2 = \frac{z_{21}}{R} \cdot \frac{-1}{R+z_{22}} V_1$

$V_2 = -RI_2 = -R\left(\frac{-z_{21}}{R(R+z_{22})}\right)V_1 \Rightarrow \frac{V_2}{V_1} = \frac{z_{21}}{R+z_{22}} = \frac{\frac{1}{2}(z_b - z_a)}{R+\frac{1}{2}(z_b+z_a)} = \frac{z_b - z_a}{z_b + 2R + z_a} = A_v$



$\frac{V_3}{V_1} \cdot \frac{V_2}{V_3} = A_{v_1} \cdot A_{v_2}$

load is R

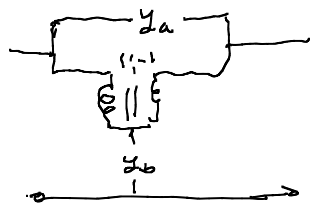
$\therefore$ constant R lattices multiply gain; stable if z_a & z_b are PR and $R > 0$.

$\frac{z_b}{R} = \frac{R}{z_a}$

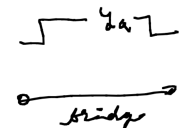
$A_v = \frac{z_b/R - z_a/R}{z_b/R + 2R/R + z_a/R} = \frac{\frac{1}{R}A_v}{1/R} = A_v$

$= \frac{R/z_a - z_a/R}{R/z_a + 2 + z_a/R} = \frac{1 - (z_a/R)^2}{(z_a/R)^2 + 2(z_a/R) + 1} = \frac{(1-(z_a/R)^2)}{(1+(z_a/R))^2}$

Look at constant with a common ground



$\Rightarrow$ add admittances



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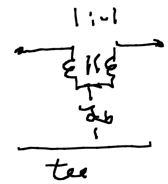
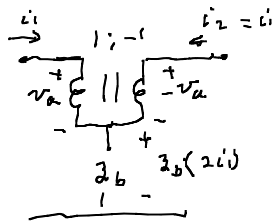


$$Y_B = y_a \begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix}$$



$$\Rightarrow Y \Rightarrow \begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \frac{1}{4z_b} \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \end{bmatrix}$$

$$\Rightarrow Y_{te} = \frac{1}{4z_b} \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$$

$v_a i_1 + (-v_a) i_2$
$= 0 =$ power in
$i_1 - i_2 = 0$

$v_1 = v_a + z_b(2i_1)$
$v_2 = -v_a + z_b(2i_1)$
or add
$v_1 + v_2 = 4z_b \cdot i_1$

$$\underset{\text{bridged tee}}{Y} = \begin{bmatrix} \frac{y_b}{4} - y_a & \frac{y_b}{4} - y_a \\ \frac{y_b}{4} - y_a & \frac{y_b}{4} - y_a \end{bmatrix} = \frac{1}{2} \begin{bmatrix} \frac{y_b}{2} + 2y_a & \frac{y_b}{2} - 2y_a \\ \frac{y_b}{2} - 2y_a & \frac{y_b}{2} - 2y_a \end{bmatrix}$$

$$= \frac{1}{2} \begin{bmatrix} Y_a + Y_b & Y_a + Y_b \\ Y_a - Y_b & Y_a + Y_b \end{bmatrix} \text{ where } Y_a = y_b/2,\ Y_b = 2y_a$$

$\therefore$ a constant circuit as Y matrices agree

$$\underset{\text{const} \cdot R}{Z} = \frac{1}{2} \begin{bmatrix} z_b + z_a & z_b - z_a \\ z_b - z_a & z_b + z_a \end{bmatrix} ; \Delta = R^2 = z_a z_b = \frac{1}{y_a y_b}$$

$$= \frac{z_b^2 + 2z_a z_b + z_a^2}{4} - \frac{(z_b^2 + z_a^2 - 2z_a z_b)}{4}$$

$$\underset{\text{const}\,R}{Y} = \frac{1/2}{z_a z_b} \begin{bmatrix} z_b + z_a & -z_b + z_a \\ -z_b + z_a & z_b + z_a \end{bmatrix} = \frac{1}{2} \begin{bmatrix} y_a + y_b & y_a - y_b \\ y_a - y_b & y_a + y_b \end{bmatrix}$$