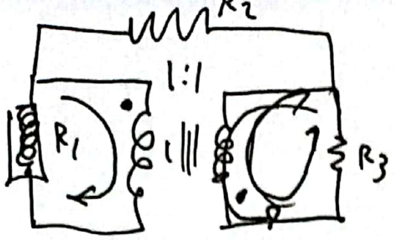
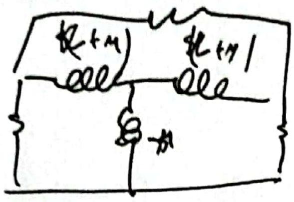


trafo ideal

$3+\frac{1}{3}=\frac{9+1}{3}=\frac{10}{3}$

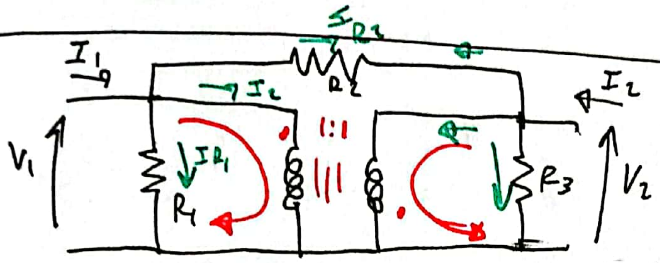
$V_1 : V_2$



$[Z]=$

$V_1 = I_1 z_{11} + I_2 z_{12}$

$V_2 = I_1 z_{21} + I_2 z_{21}$



Relación de Transformación $1:1 \Rightarrow V_1 = V_2$

$$z_{11} = \left.\frac{V_1}{I_1}\right|_{I_2=0} \qquad \boxed{I_{R_2}=0}$$

$$I_1 = \frac{V_1}{R_1} + I_x + \frac{V_1-V_2}{R_2} \qquad I_2 = \frac{V_2}{R_3} - \frac{V_1-V_2}{R_2} + I_y$$

$$I_2 = 0 \Rightarrow \qquad I_y = \frac{V_1-V_2}{R_2} - \frac{V_2}{R_3} = I_x$$

$$I_1 = \frac{V_1}{R_1} + \frac{V_1-V_2}{R_2} - \frac{V_2}{R_3} + \frac{V_1-V_2}{R_2} \qquad \boxed{V_1 = -V_2}$$

$$I_1 = \frac{V_1}{R_1} + \frac{2V_1}{R_2} + \frac{V_1}{R_3} + \frac{2V_1}{R_2} = V_1\left(\frac{1}{R_1}+\frac{4}{R_2}+\frac{1}{R_3}\right)$$

$$\frac{I_1}{V_1} = \left(\frac{1}{1}+\frac{4}{2}+\frac{1}{3}\right) = \left(1+2+\frac{1}{3}\right) = \frac{10}{3}$$

$$\frac{V_1}{I_1} = z_{11} = \frac{3}{10} = 0,\hat{3}$$

$$z_{12} = \left.\frac{V_1}{I_2}\right|_{I_1=0}$$

$$I_1 = 0 = \frac{V_1}{R_1} + \frac{V_1 - V_2}{R_2} + I_x$$

$$I_x = -\frac{V_1}{R_1} - \frac{V_1 - V_2}{R_2} = I_y$$

$$\boxed{V_1 = -V_2}$$

$$I_2 = \frac{V_2}{R_3} - \frac{V_1 - V_2}{R_2} - \frac{V_1}{R_1} - \frac{V_1 - V_2}{R_2}$$

$$I_2 = \frac{-V_1}{R_3} - \frac{4V_1}{R_2} - \frac{V_1}{R_1} = -V_1\left(1 + 2 + \frac{1}{3}\right)$$

$$\boxed{z_{12} = -\frac{3}{10}}$$

$$z_{21} = \left.\frac{V_2}{I_1}\right|_{I_2=0}$$

$$I_y = -\frac{V_2}{R_3} + \frac{V_1 - V_2}{R_2} = I_x$$

$$\boxed{I_1 = \frac{V_1}{R_1} + \frac{V_1 - V_2}{R_2} - \frac{V_2}{R_3} + \frac{V_1 - V_2}{R_2}}$$

$$I_1 = \frac{-V_2}{R_1} - \frac{2V_2}{R_2} - \frac{V_2}{R_3} - \frac{2V_2}{R_2} = -V_2\left(\frac{10}{3}\right) \qquad z_{21} = -\frac{3}{10} = -0{,}33$$

$$I_1 = 0 \Rightarrow \quad I_x = I_y = -\frac{V_1}{R_1} - \frac{V_1 - V_2}{R_2}$$

$$I_2 = \frac{V_2}{R_3} - \frac{V_1}{R_1} - \frac{V_1 - V_2}{R_2} - \frac{V_1 - V_2}{R_2} = \frac{V_2}{R_3} + \frac{V_2}{R_1} + \frac{4V_2}{R_2} = V_2\left(\frac{10}{3}\right)$$

$$z_{22} = \frac{3}{10}$$

CS CamScanner

$$T_1 : \begin{bmatrix} 1 & s\frac{3}{2} \\ 0 & 1 \end{bmatrix} \checkmark \qquad T_2 \begin{bmatrix} 1 & 0 \\ s\frac{4}{3} & 1 \end{bmatrix} \qquad T_3 : \begin{bmatrix} 1 & s\frac{1}{2} \\ 0 & 1 \end{bmatrix}$$

$$\begin{matrix} 1 & s\frac{3}{2} \\ 0 & 1 \end{matrix} \qquad \begin{bmatrix} 1 + s^{2}\frac{12}{6} & \frac{3}{2}s \\ s\frac{4}{3} & 1 \end{bmatrix} = \begin{matrix} 1 + 2s^{2} & \frac{3}{2}s \\ s\frac{4}{3} & 1 \end{matrix}$$

$$\begin{bmatrix} 1 & \frac{s}{2} \\ 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 1 + 2s^{2} & \frac{3}{2}s \\ \frac{4}{3}s & 1 \end{bmatrix} \begin{bmatrix} 1+2s^{2} & (1+2s^{2})\frac{s}{2} + \frac{3}{2}s \\ \frac{4}{3}s & \frac{4}{3}s^{2}\frac{1}{2} + 1 \end{bmatrix} = \begin{bmatrix} 1+2s^{2} & \frac{s + 2s^{3} + 3s}{2} \\ \frac{4}{3}s & \frac{\cancel{4}\,2}{\cancel{6}\,3}s^{2} + 1 \end{bmatrix}$$

$$\begin{bmatrix} 1 & 0 \\ 1 & s \end{bmatrix}$$

$$\begin{bmatrix} 1+2s^{2} & \frac{4s+2s^{3}}{2} \\ \frac{4}{3}s & \frac{4s^{2}+6}{6} \end{bmatrix} = \begin{bmatrix} 1+2s^{2} & s^{3}+2s \\ \frac{4}{3}s & \frac{4s^{2}+6}{6} \end{bmatrix} \qquad \begin{bmatrix} 1+2s^{2}+2s+s^{3} & s^{2}+2s \\ \frac{4}{3}s + \frac{4s^{2}+6}{6} & \frac{4s^{2}+6}{6} \end{bmatrix}$$

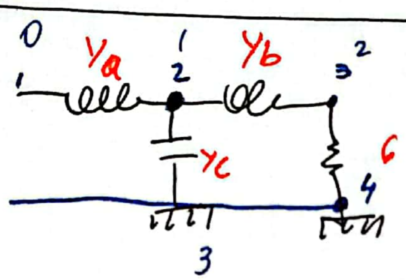
$$\frac{V_0}{V_1} : \frac{1}{\cancel{s^{2}+4s+1}} = \frac{1}{s^{3}+2s^{2}+2s+1} \quad / \text{Butter}$$

$$V_1 = V_2 A + I_2 B$$

$$I_1 = V_2 C + I_2 D$$

$$\frac{V_2}{V_1} = \frac{1}{A}$$

For MAI



$Y_1 = \frac{2}{3s}$

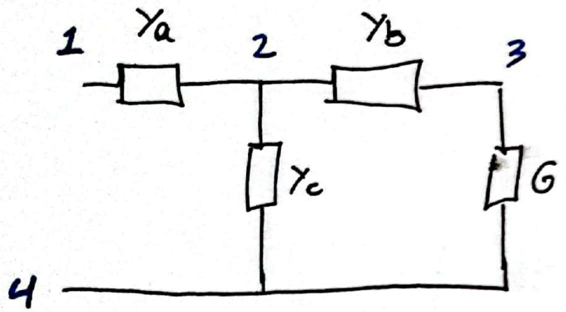
$Y_2 = \frac{4}{3}s$

$Y_3 = \frac{2}{s}$

$Y_4 = 1$

$$\begin{array}{c|cccc} & \phi & 2 & 3 & 4 \\ \hline \phi & s\frac{3}{2} & -s\frac{3}{2} & 0 & 0 \\ 2 & s\frac{3}{2} + s\frac{3}{2} + & & & \\ 3 & & & & \\ 4 & & & & \end{array}$$

$$\begin{array}{c|cccc} & 1 & 2 & 3 & 4 \\ \hline 1 & \frac{2}{3s} & -\frac{2}{3s} & 0 & 0 \\ 2 & -\frac{2}{3s} & \frac{2}{3s} + \frac{4s}{3} + \frac{2}{s} & -\frac{2}{s} & -\frac{4}{3}s \\ 3 & 0 & -\frac{2}{s} & 1 + \frac{2}{s} & -1 \\ 4 & 0 & -\frac{4}{3}s & -1 & 1 + \frac{4}{3}s \end{array}$$



$$\frac{2}{3s} + \frac{4s}{3} + \frac{2}{s} = \frac{2 + 4s^2 + 6}{3s} = \frac{4s^2 + 8}{3s}$$

$$1 + \frac{4s}{3} = \frac{3 + 4s}{3}$$

$$1 + \frac{2}{s} = \frac{s + 2}{s}$$

Muy linda la Tarea I y ahora?

$$Y_{qj}^{d} = (-1)^{i+j} \Delta Y_{j}^{i}$$

$$Y_{ij}^{mn} = (-1)^{i+j+m+n} \Delta Y_{mn}^{ij}$$

$$V_{mn}^{ij} = \frac{V_{ij}}{V_{mn}}$$

$$V_{ij} = V_{34} \qquad V_{mn} = V_{14}$$

$$\frac{V_{34}}{V_{14}} = (-1)^{3+4}(-1)^{1+4} \cdot \Delta$$

$$Y_{mn}^{ij} = \frac{4}{3s^2}$$

$$Y_{mn}^{mn} = \left(\frac{2}{3s} + \frac{4}{3}s + \frac{2}{s}\right)\left(1 + \frac{2}{s}\right) - \frac{2}{s} = \frac{2 + 4s^2 + 6}{3s} \cdot \frac{s+2}{s} - \frac{2}{s}$$

$$\frac{(4s^2+8)(s+2)}{3s^2} - \frac{2}{s} = \frac{4s^3+8s^2+8s+16}{3s^2} - \frac{2}{s} = \frac{4s^3+8s^2+8s+16-6s}{3s^2}$$

$$\frac{4s^3+8s^2+2s+16}{3s^2} =$$

$$\cancel{\frac{4}{3s^2}\left(4s^3+8s^2\right)} \quad \frac{4}{3s^2} \cdot \frac{3s^2}{4s^3+8s^2+2s+16} = \frac{4}{4s^3+8s^2+2s+16}$$

$$\frac{2}{3s} + \frac{4s}{3} + \frac{2}{s} = \frac{2+4s^2+6}{3s} = \frac{8+4s^2}{3s}$$

$$1 + \frac{2}{s} = \frac{s+2}{s}$$

$$\frac{8+4s^2}{3s} \cdot \frac{s+2}{s} = \frac{8s+16+4s^3+8s^2}{3s^2}$$

$$\frac{4s^3+8s^2+8s+16}{3s^2} - \frac{4}{s^2} = \frac{4s^3+8s^2+8s+16-12}{3s^2} = \frac{4s^3+8s^2+8s+4}{3s^2}$$

$$\frac{V_0}{V_1} = \frac{4}{3s^2} \cdot \frac{3s^2}{4s^3+8s^2+8s+4} = \boxed{\frac{1}{s^3+2s^2+2s+1}}$$

1 2 2 1 → Butterworth de orden 3

Y_1

$$z^{ij}_{mn} = \frac{V_{ij}}{I_{mn}} = \operatorname{sgn}(i-j)\operatorname{sgn}(m-n)\frac{Y^{ij}_{mn}}{Y^{m}_{m}} = \cancel{\quad}$$

$$Y^{ij}_{mn} = \frac{4s^3+8s^2+8s+16}{3s^2}$$

$$Z_1 = \frac{4s^3+8s^2+8s+16}{3\cancel{s^2}} \cdot \frac{\cancel{3s^2} \cdot 3s}{2(4s^3+8s^2+6s+12)}$$

$$Z^{ij}_{mn} = \frac{V_{ij}}{I_{mn}} = \text{sign}(i-j)\,\text{sign}(m-n)\,\frac{\underline{Y}^{ij}_{mn}}{\underline{Y}^{m}_{m}}$$

$$Z^{14}_{14} = \text{sign}(1-4)\,\text{sign}(1-4)\,\frac{\underline{Y}^{14}_{14}}{\underline{Y}^{4}_{4}}$$

$$\underline{Y}^{14}_{14} = \left(\frac{2}{3\phi}+\frac{4}{3}\phi+\frac{2}{\phi}\right)\left(1+\frac{2}{\phi}\right)-\frac{4}{\phi^2} = \left(\frac{2+4\phi^2+6}{3\phi}\cdot\frac{\phi+2}{\phi}\right)-\frac{4}{\phi^2} =$$

$$= \frac{2\phi+4+4\phi^3+8\phi^2+6\phi+12}{3\phi^2}-\frac{4}{\phi^2} = \frac{4\phi^3+8\phi^2+8\phi+16}{3\phi^2}-\frac{4}{\phi^2}$$

$$\underline{Y}^{14}_{14} = \frac{4\phi^3+8\phi^2+8\phi+16-12}{3\phi^2} = \frac{4\phi^3+8\phi^2+8\phi+4}{3\phi^2} \quad ①$$

$$\underline{Y}^{4}_{4} = \frac{2}{3\phi}\left(\frac{4\phi^3+8\phi^2+8\phi+4}{3\phi^2}\right)① - 1\left(-\frac{2}{3\phi}\right)\left(-\frac{2}{3\phi}\right)\left(\frac{\phi+2}{\phi}\right) = \frac{2}{3\phi}\left(\quad\right)-\frac{2}{3\phi}\left(\frac{2\phi+4}{3\phi^2}\right)$$

$$\underline{Y}^{4}_{4} = \frac{2}{3\phi}\left[\frac{4\phi^3+8\phi^2+8\phi+4}{3\phi^2}-\frac{2\phi+4}{3\phi^2}\right] = \frac{2}{3\phi}\left[\frac{4\phi^3+8\phi^2+\cancel{8}^{6}\phi+\cancel{4}-\cancel{2\phi}-\cancel{4}}{3\phi^2}\right]$$

$$\underline{Y}^{4}_{4} = \frac{2}{3\cancel{\phi}}\;\frac{4\phi^{\cancel{3}\,2}+8\phi^{\cancel{2}}+6\cancel{\phi}}{3\phi^2} = \frac{4\phi^2+8\phi+6}{3\phi^2}\;\frac{2}{3}$$

$$\frac{\underline{Y}^{14}_{14}}{\underline{Y}^{4}_{4}} = \frac{4\phi^3+8\phi^2+8\phi+4}{\cancel{3\phi^2}}\cdot\frac{\cancel{3\phi^2}\;3}{2(4\phi^2+8\phi+6)} = \frac{\cancel{4}(\phi^3+2\phi^2+2\phi+1)\,3}{\cancel{4}\left(\phi^2+2\phi+\frac{\cancel{6}^{3}}{\cancel{4}_{2}}\right)\,2}$$

$$Z_1 = \frac{3}{2}\;\frac{\phi^3+2\phi^2+2\phi+1}{\phi^2+2\phi+\frac{3}{2}}$$

$$\boxed{Y_1 = \frac{2}{3}\;\frac{\phi^2+2\phi+3/2}{\phi^3+2\phi^2+2\phi+1}}$$

Wi!!!!

$$1 + \$\frac{1}{2} = \frac{\$+2}{2} = y_{b}$$

$$\cancel{z_c} // z_c = \left(\frac{2}{\$+2} + \frac{\$4}{3}\right)^{-1} = \left(\frac{6+4\$^2+8\$}{3(\$+2)}\right)^{-1} = \frac{3\$+6}{4\$^2+8\$+6}$$

$$\frac{3\$+6}{4\$^2+8\$+6} + \$\frac{3}{2} = \frac{3\$+6+3\$(2\$^2+4\$+3)}{2(2\$^2+4\$+3)}$$

$$z_1 = \frac{3\$+6+6\$^3+12\$^2+9\$}{4\$^2+8\$+6} = \frac{6\$^3+12\$^2+12\$+6}{4(\$^2+2\$+\frac{6}{4})} = \frac{6(\$^3+2\$^2+2\$+1)}{4(\$^2+2\$+\frac{3}{2})}$$

$$y_1 = \frac{2}{3}\,\frac{(\$^2+2\$+\frac{3}{2})}{\$^3+2\$^2+2\$+1}$$

matchea yendo por rai o por zi (Fuerza bruta)