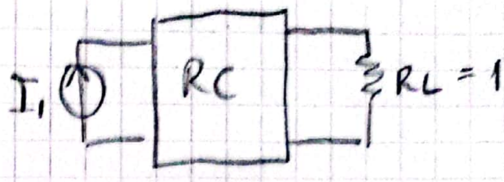
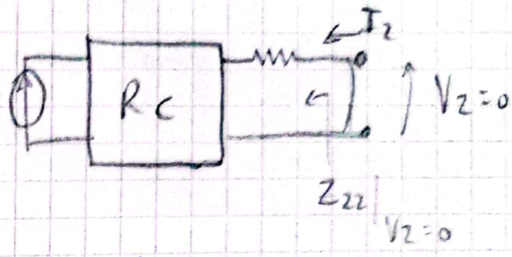
13 a) $\frac{-I_2}{I_1} = H\,\frac{(s^2+5s+4)}{s^2+8s+12}$

$Z_{21} = 6H$



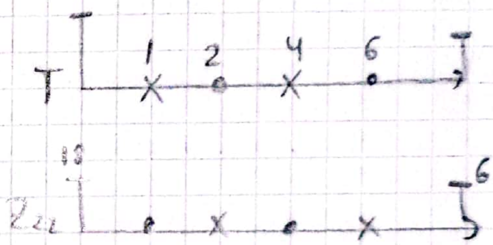
$\frac{-I_2}{I_1} = \frac{6H}{Z_{22}}$

$Z_{22} = \frac{6H}{T} = \frac{6(s^2+8s+12)}{s^2+5s+4}$



$Z_{RC}(0) > Z_{RC}(\infty)$ ✓

Considero a RL en Z_{22}



$R_L = 1$

$Z_2 = Z_{22} - 1 = \frac{5s^2+43s+68}{s^2+5s+4}$

$Z_2 = \frac{5s^2+43s+68}{(s+1)(s+4)}$

$Z_4\big|_{s=-1} = 0 = Z_2 - \frac{k_1}{s+1}$

$k_1 = \lim_{s\to -1} Z_2\,(s+1) = 10$

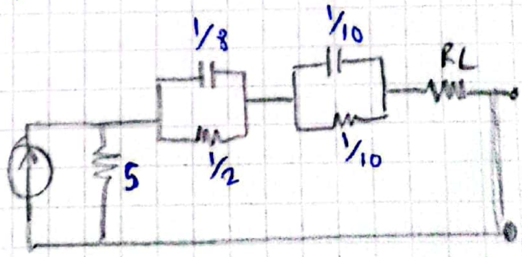
$Z_4 = \frac{5s^2+43s+68}{(s+1)(s+4)} - \frac{10}{(s+1)} = \frac{5(s+\frac{28}{5})}{(s+4)}$

$Z_6\big|_{s=-4} = 0 = Z_4 - \frac{k_2}{(s+4)} \rightarrow k_2 = \lim_{s\to -4} Z_4\,(s+4)$

$k_2 = 8$

$Z_6 = Z_4 - \frac{8}{s+4} = 5$

$Y_6 = \frac{1}{5}$ $\quad T(\infty) = H = \frac{5}{6}$



TS13) b)

$$T = \frac{V_2}{I_1} = \frac{k(s^2+9)}{s^3+2s^2+2s+1}$$

$$\frac{V_2}{I_1} = \frac{Z_{21}}{1+\frac{Z_{22}}{RL}} = \frac{M_1+N_1}{M_2+N_2} = \frac{P/N_q}{\frac{M_q}{N_q}+1}$$

$$\frac{V_2}{I_1} = \frac{\boxed{\frac{k(s^2+9)}{s^3+2s}} \rightarrow Z_{21}}{1+\boxed{\frac{2s^2+1}{s^3+2s}} \rightarrow Z_{22}}$$

$$Z_{22} = \frac{2s^2+1}{s^3+2s} \longrightarrow \frac{1}{Z_{22}} = \frac{s^3+2s}{2s^2+1}$$

$$Y_2\Big|_{s^2=-9} = 0 = \frac{1}{Z_{22}} - k'_\infty s$$

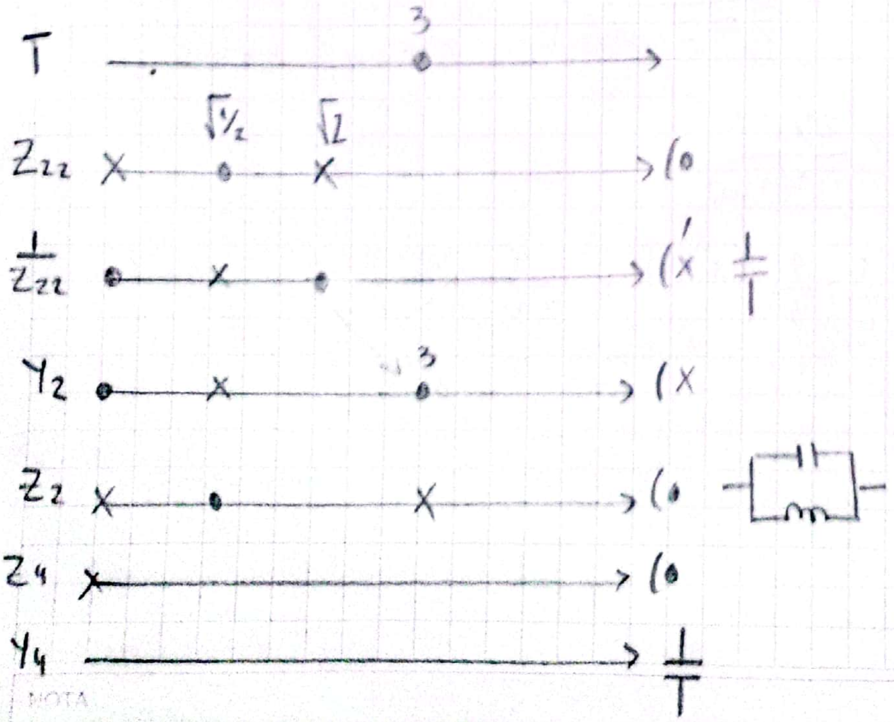
$$k'_\infty = \lim_{s^2\to -9} \frac{1}{Z_{22}\cdot s} = \frac{(-9+2)}{2(-9+1)} = \frac{7}{17}$$

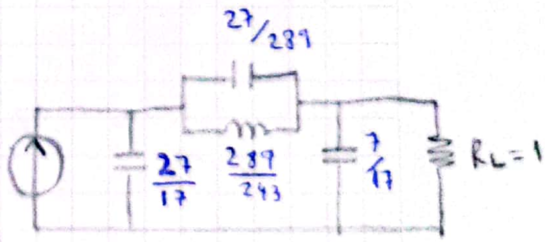
$$Y_2 = \frac{s^3+2s}{2s^2+1} - \frac{7}{17}s = \frac{3/17\,(s^2+9)\,s}{2s^2+1}$$

$$Z_2 = \frac{2s^2+1}{3/17\,(s^2+9)\,s}$$

$$Z_4 = Z_2 - \frac{2k_1 s}{(s^2+9)} \qquad 2k_1 = \lim_{s^2\to -9} \frac{2s^2+1\,(s^2+9)}{3/17\,(s^2+9)\,s^2} = \frac{289}{27}$$

$$Z_4 = Z_2 - \frac{\frac{289}{27}s}{s^2+9} = \frac{1/9\,(s^2+9)}{3/17\,s\,(s^2+9)} = \frac{17}{27s}$$





$$T(0) = 1 = k\,\frac{(9)}{1} \rightarrow \boxed{k = \frac{1}{9}}$$