

Problem 4)

a) $P(s) = s^4 + 3s^3 + 10s^2 + 12s + 9$

Ev $(P(s)) = s^4 + 10s^2 + 9$

, odd $(P(s)) = 3s^3 + 12s$

$$\Rightarrow \frac{\text{odd}}{\text{Even}} = \frac{3s^3 + 12s}{s^4 + 10s^2 + 9}$$

$$\begin{array}{r} \frac{1}{3}s \\ 3s^3 + 12s \overline{) s^4 + 10s^2 + 9} \\ \underline{s^4 + 4s^2} \\ 6s^2 + 9 \end{array} \quad \begin{array}{r} \frac{1}{2}s \\ 3s^3 + 12s \overline{) 6s^2 + 9} \\ \underline{3s^3 + 9/2s} \\ 15/2s \end{array} \quad \begin{array}{r} \frac{4}{15}s \\ 15/2s \overline{) 6s^2 + 9} \\ \underline{6s^2} \\ 9 \end{array} \quad \begin{array}{r} \frac{5}{6}s \\ 9 \overline{) 15/2s} \\ \underline{15/2s} \\ 0 \end{array}$$

$$\Rightarrow \frac{\text{odd}}{\text{Even}} = \frac{1}{\frac{1}{3}s + \frac{1}{\frac{1}{2}s + \frac{1}{\frac{4}{15}s + \frac{1}{\frac{5}{6}s}}}}$$

$\Rightarrow$ Thus, $P(s)$ is Hurwitz.

$$b) \frac{v_2}{v_1} = \frac{K S (S^2 + 4)}{S^4 + 3S^3 + 10S^2 + 9} = \frac{K \frac{S(S^2 + 4)}{S^4 + 10S^2 + 9}}{1 + \frac{3S(S^2 + 4)}{S^4 + 10S^2 + 9}}$$

$$G = \frac{1}{10}, \quad \frac{v_2}{v_1} = \frac{-y_{21}}{G + y_{22}} = \frac{-(\frac{y_{21}}{G})}{1 + \frac{y_{22}}{G}} \rightarrow \frac{-K y_{21}}{G} = \frac{y_{22}}{G} = \frac{3S(S^2 + 4)}{S^4 + 10S^2 + 9}$$

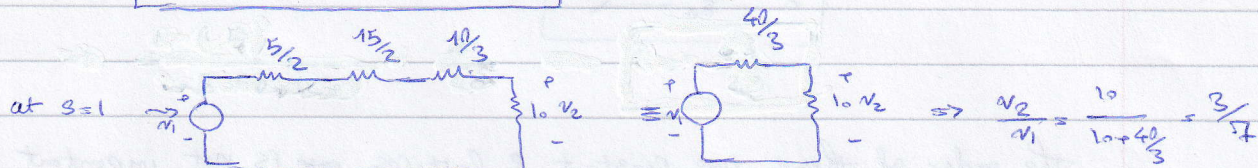
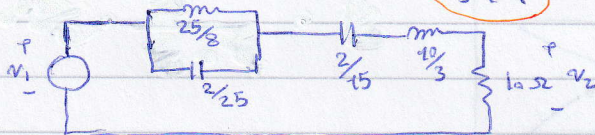
$$\Rightarrow y_{22} = \frac{3G S(S^2 + 4)}{S^4 + 10S^2 + 9} = \frac{3S(S^2 + 4)}{10(S^4 + 10S^2 + 9)}$$

$$\Rightarrow Z_{22} = \frac{10(S^4 + 10S^2 + 9)}{3S(S^2 + 4)} = \frac{10(S^2 + 9)(S^2 + 1)}{3S(S^2 + 4)}$$

$$= K_{\infty} S + \frac{K_0}{S} + \frac{2K_1 S}{S^2 + 4}$$

$$K_{\infty} = \frac{10}{3}, \quad K_0 = S Z_{22} \Big|_{S=0} = \frac{15}{2}, \quad 2K_1 = \frac{S^2 + 4}{S} Z_{22} \Big|_{S^2=4} = \frac{25}{2}$$

$$\Rightarrow Z_{22} = \frac{10}{3} S + \frac{15}{2S} + \frac{25/2 S}{S^2 + 4} \Rightarrow \frac{1}{\frac{2}{25} S + \frac{8}{25 S}}$$



$$\Rightarrow \frac{K(5)}{35} = \frac{3}{17} \Rightarrow \boxed{K=3} \checkmark$$

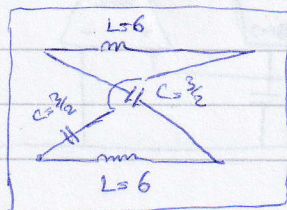
Problem 2)

$$\frac{v_2}{v_1} = \frac{(1-3s)(4s^3 - 6s^2 + 8s - 3)}{(1+3s)(4s^3 + 6s^2 + 8s + 3)}$$

we know that for each constant R lattice: $A_v = \frac{1 - \frac{Z_a}{R}}{1 + \frac{Z_a}{R}}, \quad Z = \frac{Z_a}{R} = \frac{R}{Z_b}$

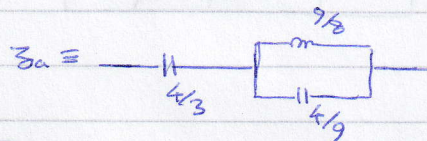
$$A_v = \frac{1-3s}{1+3s}, \quad \frac{Z_a}{R} = 3s, \quad R=2 \Rightarrow \boxed{Z_a = 6s} \quad \text{--- } L=6 \text{ mH}$$

$$Z_b = \frac{R^2}{Z_a} = \frac{4}{6s} \Rightarrow \boxed{Z_b = \frac{2}{3s}} \quad \text{--- } C=3/2 \mu F$$

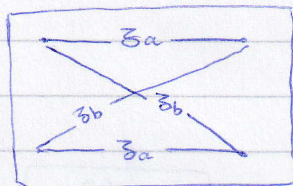
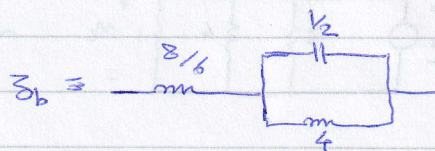


$$A_{v2} = \frac{1 - \frac{6s^2+3}{4s^3+8s}}{1 + \frac{6s^2+3}{4s^3+8s}}$$

$$\frac{Z_a}{R} = \frac{6s^2+3}{4s^3+8s}, R=2 \Rightarrow Z_a = \frac{6s^2+3}{2s^3+4s} = \frac{3/4}{s} + \frac{9/4}{s^2+2}$$

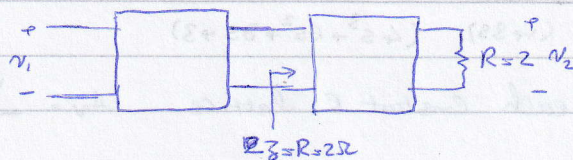


$$Z_b = \frac{R^2}{Z_a} = \frac{4}{Z_a} = \frac{8s^3+16s}{6s^2+3} = \frac{8}{3}s + \frac{4s}{2s^2+1}$$

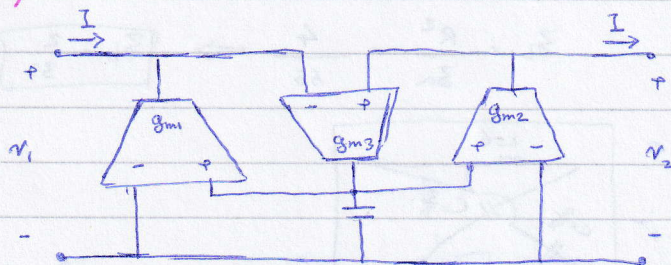


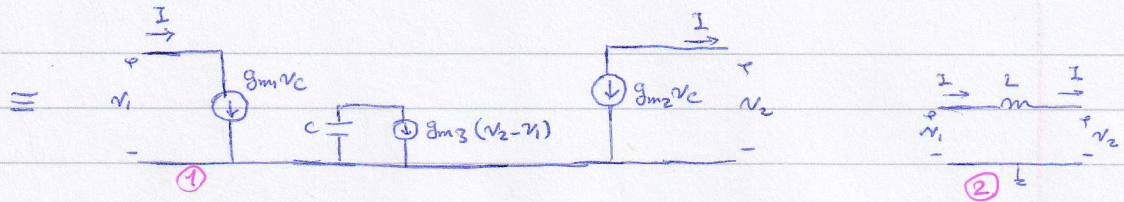
the order of these two constant R lattices ~~are~~ is not important, because

the load of both of them will be $R=2$.



problem 3)





For this equality we must have $g_{m1} v_c = -g_{m2} v_c \Rightarrow g_{m1} = -g_{m2} = g_m$

$$i_c = C \frac{dv_c}{dt} \rightarrow -g_{m3} (v_2 - v_1) = C s v_c$$

$$\Rightarrow v_c = \frac{-g_{m3} (v_2 - v_1)}{C s} = \frac{g_{m3} (v_1 - v_2)}{C s}$$

$$I = g_{m1} v_c = \frac{g_{m1} g_{m3} (v_1 - v_2)}{C s}$$

For (1) $\Rightarrow v_1 - v_2 = \frac{C s I}{g_{m1} g_{m3}}$

For (2) $\Rightarrow v_1 - v_2 = L s I$

$$L = \frac{C}{g_{m1} g_{m3}} \quad , \quad g_{m1} = -g_{m2}$$

$\Rightarrow$ if $g_{m1} = g_{m2} = g_{m3} = g_m \Rightarrow L = \frac{C}{g_m^2}$