EJ 7) FPB f_{p_i} f_{p_s}

$f_{c_i} = 1600$ KHz y $f_{c_s} = 2500$ KHz

Máxima planicidad en la banda de paso

$\alpha_{MAX} = 3$ dB en la banda de paso

$G_{max} = 10$ dB en la banda de paso $\Rightarrow$ 3,16 veces

$\alpha_{MIN} = 20$ dB a frec de 1250 KHz y 3200 KHz
f_{s_i} f_{s_s}

Desnormalizo la plantilla

$f_0 = \sqrt{f_{p_i} \cdot f_{p_s}} = 2000$ KHz

$\Rightarrow \Omega_\omega = 2\pi f_0 \Rightarrow \omega_0 = 1$ $\omega_{p_i} = 0,8$ y $\omega_{p_s} = 1,25$

$\omega_{s_i} = 0,625$ y $\omega_{s_s} = 1,6$

Uso el núcleo de transformación

$K(s) = Q \frac{s^2-1}{s}$ siendo $Q = \frac{\omega_0}{B_w} = \frac{\omega_0}{\omega_{p_s} - \omega_{p_i}} = 2,22$

Transformo las frec.

$\Omega_{p_i} = Q \cdot \frac{\omega_{p_i}^2 - 1}{\omega_{p_i}} = -1$ $\Omega_{s_i} = Q \frac{\omega_{s_i}^2 - 1}{\omega_{s_i}} = -2,16$

$\Omega_{p_s} = Q \frac{\omega_{p_s}^2 - 1}{\omega_{p_s}} = 1$ $\Omega_{s_s} = Q \frac{\omega_{s_s}^2 - 1}{\omega_{s_s}} = 2,16$

$\Rightarrow$ Para mi paso bajo prototipo $\Omega_p = 1$ y $\Omega_s = 2,16$

Ahora diseño el FLP Butter x $\alpha_{MAX} = 3$dB $\Rightarrow \varepsilon^2 = 1$

$\alpha_{MIN} = 10 \log (1 + \varepsilon^2 \Omega_p^{2N})$

$\alpha_{MIN_2} = 13,57$ dB $\alpha_{MIN_3} = 20,11$ dB ✓

$\Rightarrow \varepsilon^2 = 1$ y $n = 3$

Filtro Butter PB conocido $T_{B3}(s) = \frac{1}{s^2+s+1} \cdot \frac{1}{s+1}$

con $Q = 1$ para el PPC y $\varphi = \pi/4$

$T_{FBP}(s) = T_{FLP}\left(Q \frac{s^2+1}{s}\right) = \frac{1}{\frac{Q^2}{s^2}(s^2+1)^2 + \frac{(s^2+1)}{s} Q + 1} \cdot \frac{1}{\frac{(s^2+1)}{s} Q + 1}$

NOTA 17:55 → 18:50

$$T_{BP}(s) = \frac{1}{\frac{Q^2}{s^2}(s^4+2s^2+1)+Qs+\frac{Q}{s}+1} \cdot \frac{s}{(s^2+1)Q+s}$$

$$T_{BP}(s) = \frac{1}{Q^2} \frac{s^2}{s^4+2s^2+1+\frac{s^2}{Q^2}(Qs+\frac{Q}{s}+1)} \cdot \frac{s/Q}{s^2+s/Q+1}$$

$$T_{BP}(s) = \frac{s^2/Q^2}{s^4+s^3/Q+s^2(2+1/Q^2)+s/Q+1} \cdot \frac{s/Q}{s^2+s/Q+1}$$

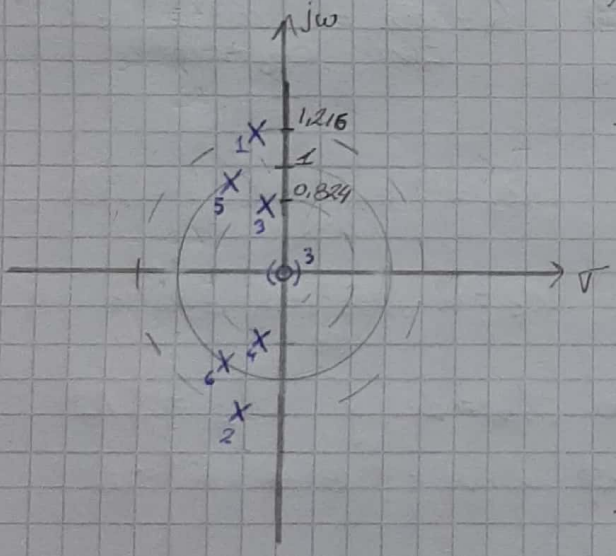
$$T_{BP}(s) = \frac{s^2 \cdot 0{,}203}{s^4+s^3 0{,}45+s^2 \cdot 2{,}203+s \cdot 0{,}45+1} \cdot \frac{s \cdot 0{,}45}{s^2+s \cdot 0{,}45+1}$$

$P_{1,2} = -0{,}134 \pm j1{,}21 \qquad P_{3,4} = -0{,}09 \pm j0{,}82 \qquad P_{5,6} = -0{,}225 \pm j0{,}97$

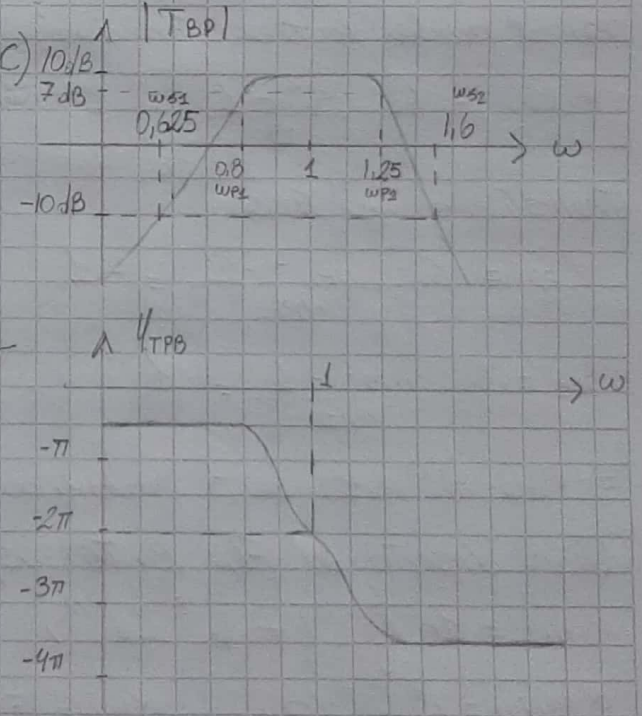
$$T_{BP}(s) = K \cdot \frac{s\,0{,}45}{s^2+s\,0{,}45+1} \cdot \frac{s\,0{,}23}{s^2+s \cdot 0{,}18+0{,}68} \cdot \frac{s\,0{,}86}{s^2+s \cdot 0{,}27+1{,}48}$$

siendo $K = 3{,}16$ veces $K[dB] = 10\,dB$

b)

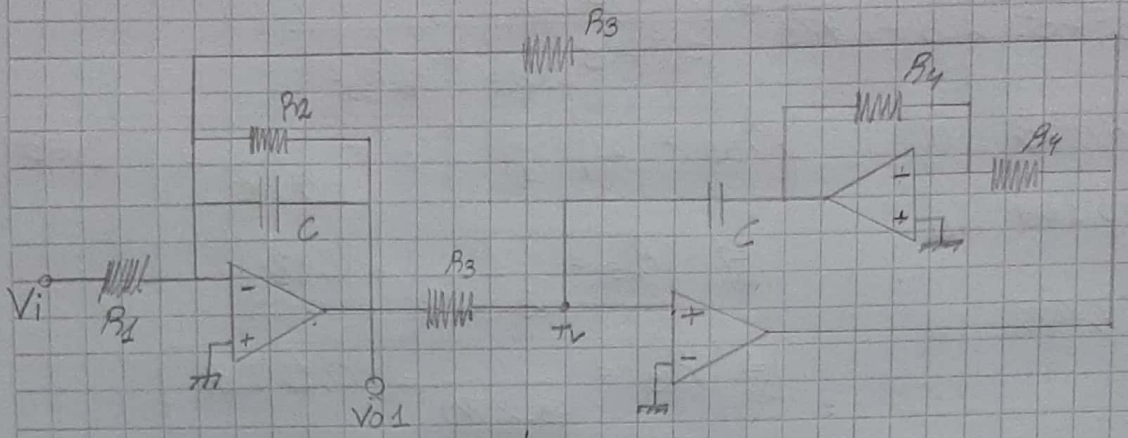


c)



NOTA 22:40 → 23:30 ; 2:00 → 5:00

d) Filtro Ackerberg - Mossberg



$$T_{FPB}(s) = (-1)\frac{s\frac{1}{CR_{11}}}{s^2 + s\frac{1}{CR_{12}} + \frac{1}{(CR_{31})^2}} \quad \text{(lo saco de la T52)}$$

1° SOS

$$|T_1(s)| = \frac{5,045}{s^2 + 5.0,45 + 1} = \frac{s\frac{1}{C_1R_{11}}}{s^2 + s\frac{1}{C_1R_{21}} + \frac{1}{C_1R_{31}^2}} = \frac{s\frac{\omega_0}{Q}}{s^2 + s\frac{\omega_0}{Q} + \omega_0^2}$$

$$\begin{cases} \frac{1}{C_1R_{11}} = \frac{1}{C_1R_{21}} = 0,45 \\ \frac{1}{(C_1R_{31})^2} = 1 \end{cases}$$

$R_Z = R_{3x} = 1\,\Omega$

$C_1 = 1\,F$

y $R_{11} = R_{21} = \frac{1}{0,45} = 2,22 = Q$

2° SOS

$$|T_2(s)| = \frac{5.0,23}{s^2 + 5.0,18 + 0,68} = \frac{s\frac{1}{C_2R_{12}}}{s^2 + s\frac{1}{C_2R_{22}} + \frac{1}{C_2R_{32}^2}}$$

$$\begin{cases} \frac{1}{C_2R_{12}} = 0,23 \quad (1) \\ \frac{1}{C_2R_{22}} = 0,18 \quad (2) \\ \frac{1}{(C_2R_{32})^2} = 0,68 \quad (3) \end{cases}$$

$R_{32} = 1 \overset{(3)}{\Rightarrow} C_2 = \frac{1}{\sqrt{0,68}} = 1,213$

$\overset{(2)}{\Rightarrow} R_{22} = \frac{1}{C_2.0,18} = 4,58$

$\overset{(1)}{\Rightarrow} R_{12} = \frac{1}{C_2.0,23} = 3,58$

NOTA

3° SOS

$T_3(s) = K \cdot \frac{5,086}{s^2 + s \cdot 0,27 + 1,48} = \frac{s \cdot 2,718}{s^2 + s \cdot 0,27 + 1,48}$

$T_3(s) = \frac{s \cdot 2,718}{s^2 + s \cdot 0,27 + 1,48} = \frac{s \frac{1}{C_3 R_{13}}}{s^2 + s \frac{1}{C_3 R_{23}} + \frac{1}{C_3 R_{33}^2}}$

$\begin{cases} \frac{1}{C_3 R_{13}} = 2,718 & (1) \\ \frac{1}{C_3 R_{23}} = 0,27 & (2) \\ \frac{1}{C_3 R_{33}^2} = 1,48 & (3) \end{cases}$

$\boxed{R_{33} = 1} \overset{(3)}{\Rightarrow} \boxed{C_3 = \frac{1}{\sqrt{1,476}} = 0,823}$

$\overset{(2)}{\Rightarrow} \boxed{R_{23} = \frac{1}{C_3 \cdot 0,268} = 4,53}$

$\overset{(1)}{\Rightarrow} \boxed{R_{13} = \frac{1}{C_3 \cdot 2,718} = 0,447}$

$R_4 = 1$ para todos los circuitos