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HOJA Nº 1

FECHA

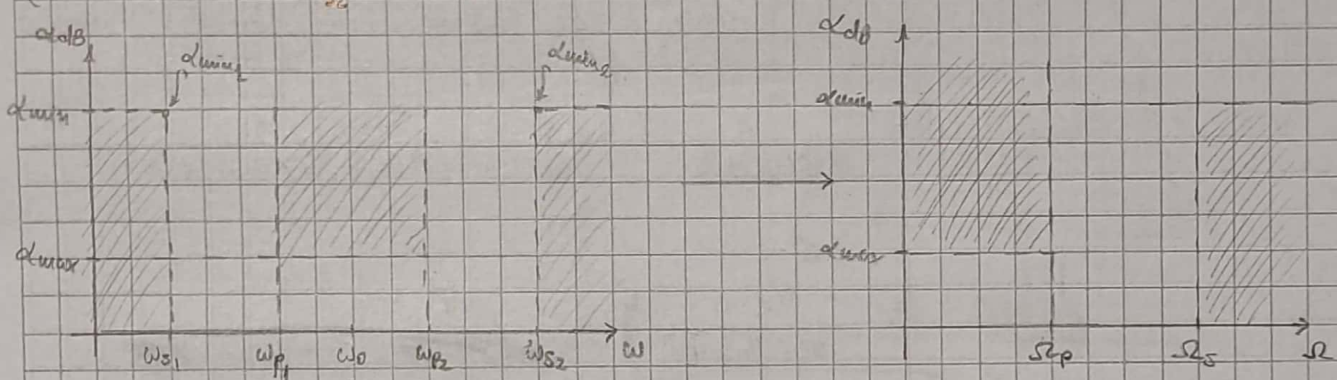
▸ Tarea semanal 4 bis

$f_{c_i} = 1600\ KHz\ (f_{p_1})$

$f_{c_s} = 2500\ KHz\ (f_{p_2})$

$\alpha_{min} = 20\ dB$ a $f_{s_1} = 1250\ KHz$, $f_{s_2} = 3200\ KHz$

- Ripple máximo banda de pase $\alpha_{max} = 3\ dB$
- Máxima planicidad banda de paso
- Ganancia máxima banda de paso $= 10\ dB$



$$f_0 = \sqrt{f_{p_1} \cdot f_{p_2}} = \sqrt{1600\ kHz \cdot 2500\ kHz} = 2\ MHz$$

$$\Omega_\omega = 2\pi f_0 \rightarrow \omega_0 = 1,\ \omega_{p_1} = 4/5,\ \omega_{p_2} = 5/4,\ \omega_{s_1} = 5/8,\ \omega_{s_2} = 8/5$$

$$BW = \omega_{p_2} - \omega_{p_1} = 9/20 \rightarrow Q = \frac{\omega_0}{BW} = 20/9$$

Ahora calculo Ω_s y Ω_p para el filtro pasabajos prototipo

$$\Omega_{p_1} = \frac{Q}{\omega_0} \frac{\omega_{p_1}^2 - \omega_0^2}{\omega_{p_1}} = Q \frac{\omega_{p_1}^2 - 1}{\omega_{p_1}} = -1$$

$$\Omega_{p_2} = Q \frac{\omega_{p_2}^2 - 1}{\omega_{p_2}} = 1$$

$$\left.\right\} \Omega_p = 1$$

$$\Omega_{s_1} = Q \frac{\omega_{s_1}^2 - 1}{\omega_{s_1}} = -13/6 \approx -2{,}17$$

$$\Omega_{s_2} = Q \frac{\omega_{s_2}^2 - 1}{\omega_{s_2}} = 13/6 \approx 2{,}17$$

$$\left.\right\} \Omega_s = 13/6$$

▸ Ahora puedo diseñar el LPF:

Para MP:

$$\varepsilon^2 = 10^{\alpha_{max}/10} - 1 = 1 \Rightarrow \text{Es Butterworth!}$$

$$\alpha_{min_n} = 10 \log(1 + \Omega_s^{2n}) \rightarrow \alpha_{min_3} = 20{,}1893\ dB$$

$$\left.\right\} \varepsilon^2 = 1 \text{ y } n = 3 \rightarrow$$

NOTA

$$T_{B_3}(p) = \frac{1}{(p+1)(p^2+p+1)}$$

Ahora uso el núcleo de transformación:

$$k(s) = Q\,\frac{s^2+\omega_0^2}{s\,\omega_0} = Q\,\frac{s^2+1}{s}$$

$$T_{BP}(s) = T_{B_3}(p)\Big|_{p=k(s)} = \frac{1}{\left(Q\frac{(s^2+\omega_0^2)}{s\omega_0}+1\right)\left[\left(\frac{Q(s^2+\omega_0^2)}{s\omega_0}\right)^2 + \frac{Q(s^2+\omega_0^2)}{s\omega_0}+1\right]}$$

$$= \frac{1}{\left[\frac{Q(s^2+\omega_0^2)+s\omega_0}{s\omega_0}\right]\left\{\frac{[Q(s^2+\omega_0^2)]^2}{(s\omega_0)^2} + \frac{Q(s^2+\omega_0^2)s\omega_0}{(s\omega_0)^2} + \frac{(s\omega_0)^2}{(s\omega_0)^2}\right\}} \quad ,\ \omega_0 = 1$$

$$= \frac{s}{Qs^2+Q+s}\ \frac{s^2}{Q^2(s^4+2s^2+1)+Qs^3+Qs+s^2}$$

$$= \frac{1/Q\ s}{s^2+1/Q\,s+1}\ \frac{1/Q^2\ s^2}{s^4+2s^2+1+1/Q\,s^3+1/Q\,s+1/Q^2 s^2}$$

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

$$T_{BP}(s) = \frac{0{,}45\ s}{s^2+0{,}45\,s+1}\ \frac{0{,}2025\ s^2}{s^4+0{,}45\,s^3+2{,}2025\,s^2+0{,}45\,s+1}$$

Me ayudo con numpy:

$p_{1,2} = -0{,}13 \pm j\,1{,}21$; $p_{3,4} \cong -0{,}1 \pm j\,0{,}82$ → del orden 4

$p_{5,6} = 0{,}22 \pm j0{,}97$ → del orden 2

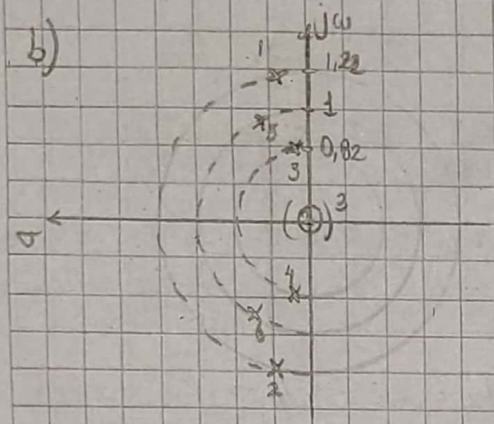
La ganancia $k_{dB} = 10\ dB$ → $k = 3{,}16$ veces

Como tengo que implementarlo después con Ackerberg-Mossberg, tengo que factorizar en sos:

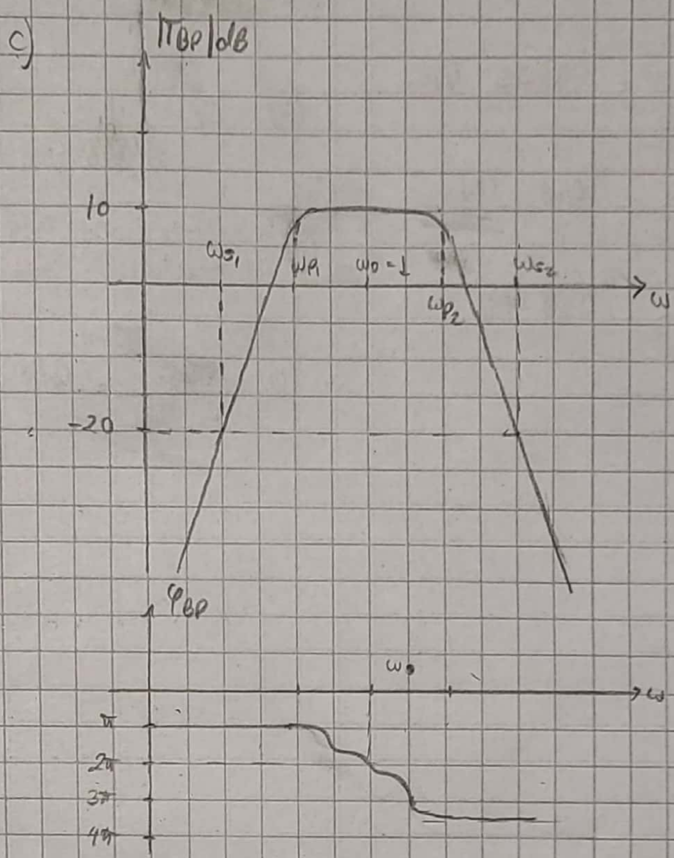
$$T_{BP}(s) = \underbrace{k\,\frac{0{,}45\,s}{s^2+0{,}45s+1}}_{1era\ etapa}\ \underbrace{\frac{s\,.\,0{,}23}{s^2+0{,}13s+0{,}68}}_{2^a\ etapa}\ \underbrace{\frac{s\,.\,0{,}86}{s^2+0{,}27s+1{,}48}}_{3^a\ etapa}$$

NOTA

b)



c)



d) De la tarea semanal 2:

$$T_{BP}(s) = -\frac{1}{R_1 C} \frac{s}{s^2 + \frac{1}{R_2 C} + \frac{1}{R_3^2 C^2}}$$

Ahora hallo los componentes por etapas:

- Etapa 1:

$$T_{BP_1}(s) = 3{,}16 \cdot 0{,}45 \frac{s}{s^2+0{,}45s+1} = 1{,}422 \frac{s}{s^2+0{,}45s+1}$$

$$\begin{cases} \frac{1}{R_1 C_1} = 1{,}422 \quad (1) \\ \frac{1}{R_2 C_1} = 0{,}45 \quad (2) \\ \frac{1}{R_3 C_1} = 1 \quad (3) \end{cases}$$

(3) $C_1 = \frac{1}{R_{3_1}}$, $\Omega z = R_{3_1} \rightarrow \boxed{C_1' = 1}$

(2) $R_{3_1} = 0{,}45 R_{2_1} \rightarrow \boxed{R_{2_1}' = 2{,}2\overline{2}}$

(1) $R_1 = \frac{1}{1{,}422} R_{3_1} \rightarrow \boxed{R_1' = 0{,}703}$

$\boxed{R_{3_1}' = 1}$

Etapa 2

$$T_{BP_2}(s) = \frac{0,23\ s}{s^2 + 0,18s + 0,68}$$

$\Omega_Z = R_{32}$

$$\begin{cases} \dfrac{1}{R_{12}C_2} = 0,23 \quad (1) \\ \dfrac{1}{R_{22}C_2} = 0,18 \quad (2) \\ \dfrac{1}{R_{32}^2 C_2^2} = 0,68 \quad (3) \end{cases}$$

(3) $C_2 = \dfrac{1}{\sqrt{0,68}\, R_{32}} = 1,2126 \dfrac{1}{R_{32}} \rightarrow \boxed{C_2' = 1,2126}$

(2) $\dfrac{R_{32}}{R_{22}\, 1,21} = 0,18 \rightarrow R_{22} = 4,5913 R_{32} \rightarrow \boxed{R_{22}' = 4,5913}$

(1) $\dfrac{R_{32}}{R_{12}\, 1,21} = 0,23 \rightarrow R_{12} = 3,5932 R_{32} \rightarrow \boxed{R_{12}' = 3,5932}$

$\boxed{R_{32}' = 1}$

Etapa 3:

$$T_{BP_3}(s) = \frac{0,86\ s}{s^2 + 0,27s + 1,48}$$

$\Omega_Z = R_{33}$

$$\begin{cases} \dfrac{1}{R_{13}C_3} = 0,86 \quad (1) \rightarrow \dfrac{R_{33}}{0,82} = R_{13}\, 0,86 \rightarrow R_{13} = 1,4180 R_{33} \rightarrow \boxed{R_{13}' = 1,4180} \\ \dfrac{1}{R_{23}C_3} = 0,27 \quad (2) \xrightarrow{(3)} \dfrac{R_{33}}{0,82} = R_{23}\, 0,27 \rightarrow R_{23} = 4,5167 R_{33} \rightarrow \boxed{R_{23}' = 4,5167} \\ \dfrac{1}{R_{33}^2 C_3^2} = 1,48 \quad (3) \rightarrow C_3 = \dfrac{1}{\sqrt{1,48}\, R_{33}} = 0,8219 \dfrac{1}{R_{33}} \rightarrow \boxed{C_3' = 0,8219} \end{cases}$$

$\boxed{R_{33}' = 1}$

$R_4' = 1$ para todos

NOTA

Escaneado con CamScanner