Ejercicio Semana 13/05

Dada la siguiente plantilla de filtro, Implementar Topología de OTAs.

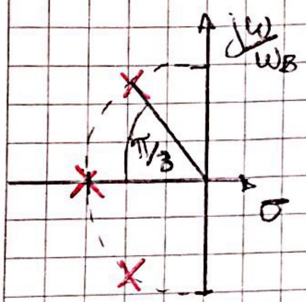
$$\begin{cases} \alpha_{mín} = 20\,dB \\ \alpha_{máx} = 0{,}5\,dB \\ f_p = 1\,KHz \\ f_s = 3{,}2\,KHz \end{cases}$$

$$\Rightarrow \boxed{\varepsilon^2 = 10^{\frac{\alpha_{máx}}{10}} - 1 = 0{,}122} \Rightarrow \boxed{\varepsilon = 0{,}349}$$

$$\alpha_{mín} = 10 \log\left(1 + \varepsilon^2 \omega_s^{2N}\right) \Rightarrow \boxed{N = 3} \longrightarrow \text{Por Calculadora}$$

Por ser un filtro de orden 3, el Diagrama de polos y ceros queda

si Normalizamos $\boxed{\omega_B = \omega_p \cdot \varepsilon^{-1/N}}$



$$|T(\omega)|^2 = \frac{1}{1 + \varepsilon^2 \omega^{2N}} \Rightarrow \boxed{\left|T\left(\frac{\omega}{\omega_B}\right)\right|^2 = \frac{1}{1 + \left(\frac{\omega}{\omega_B}\right)^{2N}}}$$

$\boxed{\text{si } \omega_p = 1} \rightarrow \boxed{\omega_s = 1{,}42}$

$\boxed{\omega_s = 3{,}2}$

En una Transferencia Butterworth:

$\boxed{\omega_B = 1} \longrightarrow \boxed{\omega_p = 0{,}704}$

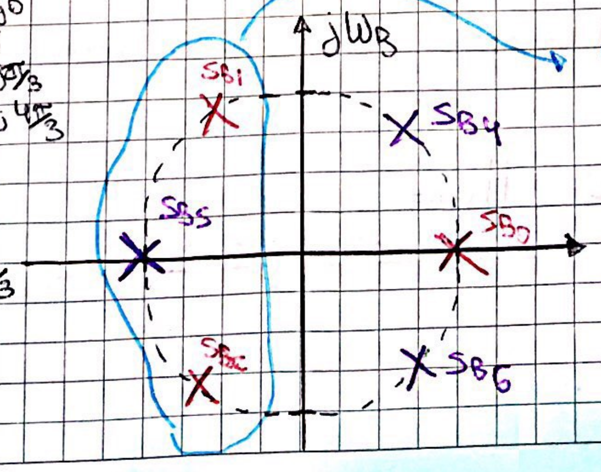
$\boxed{\omega_s = 2{,}25}$

Nosotros Vamos a tener dos etapas en Cascada, Una de 1er orden y otra de segundo orden.

$$T(s)^2 = T(s)\cdot T(-s) = \frac{1}{1 + \left(\frac{s_B}{j}\right)^6} = \frac{1}{1 - s_B^6} = \boxed{\frac{1}{1 - s_B^3}} \cdot \boxed{\frac{1}{1 + s_B^3}}$$

- $s_B^3 = 1 \Rightarrow \begin{cases} s_{B0} = 1e^{j0} \\ s_{B1} = 1e^{j2\pi/3} \\ s_{B2} = 1e^{j4\pi/3} \end{cases}$

- $s_B^3 = -1 \Rightarrow \begin{cases} s_{B4} = 1e^{j\pi/3} \\ s_{B5} = 1e^{j\pi} \\ s_{B6} = 1e^{j5\pi/3} \end{cases}$



Nosotros queremos definir una Transferencia que tenga esos polos, así que Vamos a recurrir a otro método de factorización.

$$H(s)^2 = \frac{1}{1-s^6} = \underbrace{\frac{1}{a+bs+cs^2+s^3}}_{H(s)} \cdot \underbrace{\frac{1}{a+bs+cs^2-s^3}}_{H(-s)}$$

grado	6	5	4	3	2	1	0
	-1	c	$-b$	a	0	0	0
	0	$-c$	c^2	$-cb$	ac	0	0
	0	0	$-b$	bc	$-b^2$	ab	0
	0	0	0	$-a$	ac	$-ab$	a^2
	-1	0	0	0	0	0	1

$\boxed{a = 1}$

$c^2 - 2b = 0$ (1)

$2ac - b^2 = 2c - b^2 = 0$ (2)

Por ser (1) y (2) Ecuaciones de la misma Forma,

Nos queda que $\boxed{c = b}$ (3)

(3) → (1)

$c^2 - 2c = 0 \Longrightarrow \boxed{c=0} \wedge \boxed{c=2}$

Genera la $H(s) = \frac{1}{s^3+1}$ → No sirve

Genera $H(s) = \frac{1}{s^3+2s^2+2s+1}$

Si sabemos que $s=-1$ es Raiz → Aplicamos Ruffini

$$\begin{array}{c|cccc} & 1 & 2 & 2 & 1 \\ -1 & \downarrow & -1 & -1 & -1 \\ \hline & 1 & 1 & 1 & 0 \end{array}$$

Finalmente la TransF $\boxed{H(s) = \frac{1}{s+1} \cdot \frac{1}{s^2+s+1}}$

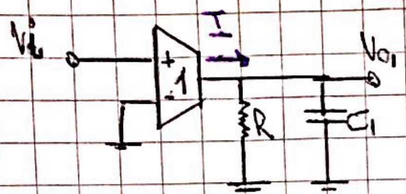
Scanned with CamScanner

$$H(s_B) = \underbrace{\frac{1}{S+1}}_{H_1(s)} \cdot \underbrace{\frac{1}{s^2+s+1}}_{H_2(s)}$$

$$\boxed{w_0 = 1}$$

$$\boxed{Q = 1 = \frac{1}{2\cos(\pi/3)}}$$

Calculamos los Valores para la H_1 en la Topología dada:

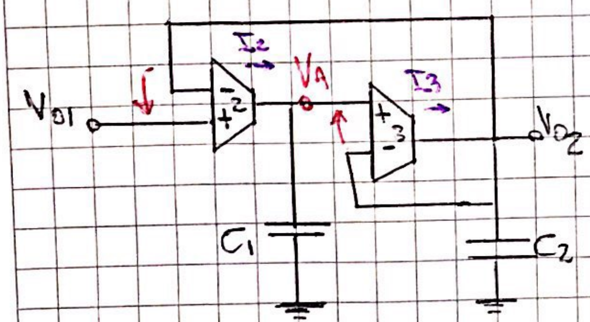


$$I = V_i \cdot g_{m1} = V_{o1} \cdot (G + S_B C_1) \Rightarrow \frac{V_{o1}}{V_i} = \frac{g_{m1}}{S_B C_1 + G} = \frac{g_{m1}/C}{S_B + G/C_1}$$

$$H_1(s) = \frac{V_{o1}}{V_i} = \frac{1}{S+1} = \frac{\frac{g_{m1}}{C_1}}{S_B + \frac{G}{C_1}} \longrightarrow \begin{cases} 1 = \frac{g_{m1}}{C} \\ 1 = \frac{1}{RC} \end{cases} \; *$$

Ahora Calculamos para la Topología H_2:

$$I_2 = (V_{o1} - V_{o2}) g_{m2} = V_A \cdot SC_1 \Rightarrow \boxed{V_A = (V_{o1} - V_{o2}) \frac{g_{m2}}{SC_1}}$$



$$I_3 = (V_A - V_{o2}) g_{m3} = V_{o2} \cdot SC_2$$

$$V_A \cdot g_{m3} = V_{o2}(SC_2 + g_{m3})$$

$$(V_{o1} - V_{o2}) \frac{g_{m2} g_{m3}}{SC_1} = V_{o2}(SC_2 + g_{m3})$$

$$V_{o1} \cdot \frac{g_{m2} g_{m3}}{SC_1} = V_{o2}\left(SC_2 + g_{m3} + \frac{g_{m2} g_{m3}}{SC_1}\right)$$

$$V_{o1} \cdot \frac{g_{m2} g_{m3}}{SC_1} = V_{o2} \cdot \left(\frac{S^2 C_1 C_2 + S C_1 g_{m3} + g_{m2} g_{m3}}{SC_1}\right)$$

$$\boxed{\frac{V_{o2}}{V_{o1}} = \frac{g_{m2} g_{m3} / C_1 C_2}{s^2 + s\frac{g_{m3}}{C_2} + \frac{g_{m2} g_{m3}}{C_1 C_2}}} \quad \begin{cases} 1 = \frac{g_{m2} g_{m3}}{C_1 C_2} \\ 1 = \frac{g_{m3}}{C_2} \end{cases} \; *$$

Diseño 1er etapa: $1 = \frac{g_{m1}}{C_1} \Rightarrow \boxed{C_1 = g_{m1} = 1}$

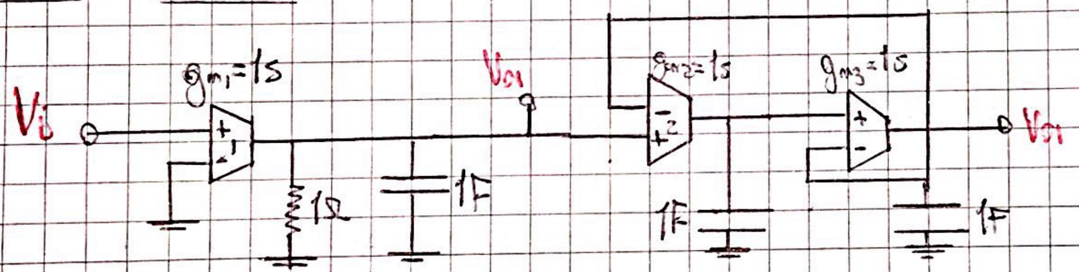
$1 = \frac{1}{RC_1} \Rightarrow \boxed{R = 1}$

Diseño 2da etapa:

$1 = \frac{g_{m2}\, g_{m3}}{C_1 C_2} \Rightarrow \boxed{C_1 = g_{m2} = 1}$

$1 = \frac{g_{m3}}{C_2} \Rightarrow \boxed{g_{m3} = C_2 = 1}$

Circuito Normalizado:



Desnormalizando:

MAL!

$C = C^\circ \cdot \frac{\Omega_W}{\Omega_Z} = 1F \cdot \frac{W_p\, \varepsilon^{-1/N}}{4{,}7k\Omega} = 1{,}89F$ ✗

$R = R^\circ \cdot \Omega_Z = 4{,}7K$

$g_m = \frac{g_m^\circ}{\Omega_Z} = 212\,\mu S$

$C = \frac{C^\circ}{\Omega_W \cdot \Omega_Z} = 1F \cdot \frac{1}{4{,}7k\Omega} \cdot \frac{1}{W_p \cdot \varepsilon^{-1/N}} = 23{,}8\,nF$ ✓