T87

Guía

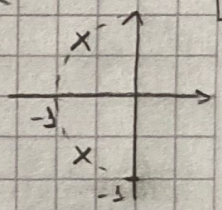
Ej 2) $n=2$ $f_c = 1kHz$ LPBW

a) $f_s = 100kHz$ L. Lineal

$$T_{Butter}\Big|_{n=2} = \frac{\omega_0^2}{s^2 + s\cdot\frac{\omega_0}{Q} + \omega_0^2}$$

normalizo $\omega_{0\,norm} = 1$ $\Omega\omega = 2\pi f_c$

$$T(s) = \frac{1}{s^2 + \sqrt{2}s + 1} \longrightarrow T(z) = T(s)\Big|_{s = k\frac{z-1}{z+1}}$$

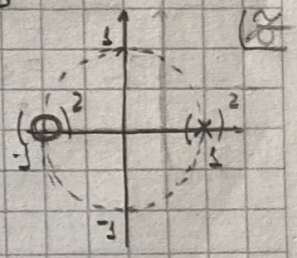


$$T(z) = \frac{1}{k^2\left(\frac{z-1}{z+1}\right)^2 + \sqrt{2}k\frac{z-1}{z+1} + 1} = \frac{z^2+2z+1}{k^2(z^2-2z+1) + \sqrt{2}k(z^2-1) + z^2+2z+1}$$

$$T(z) \quad \frac{1}{k^2+2k+1} \quad \frac{z^2+2z+1}{z^2 + 2z\frac{1-k^2}{k^2+2k+1} + \frac{k^2+1-\sqrt{2}k}{k^2+2k+1}}$$

$k = 2fs$, como normalicé por ωc, $fs = 100$ $\rightarrow k = 200$

$$T(z) \overset{\sim}{=} \frac{1}{40401}\cdot\frac{z^2+2z+1}{z^2-2z+1} = \frac{1}{40401}\cdot\frac{(z+1)^2}{(z+1)^2}$$



$k = 2fs$, si $fs = 1$, $k = 2$

$$T(z) = \frac{1}{9}\cdot\frac{z^2+2z+1}{z^2 - \frac{2}{3}z + \frac{5-2\sqrt{2}}{9}} = \frac{1}{9}\cdot\frac{(z+1)^2}{(z-\frac{1}{3}-0,36j)(z-\frac{1}{3}+0,36j)}$$

$z = e^{j\Omega}$

simetría temporal → linealidad de fase

HOJA Nº 19

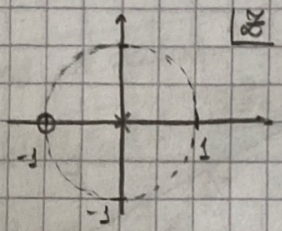
FECHA

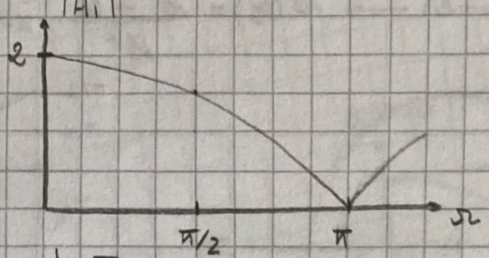
3) $H(z)$? $|H(z)|$ $\varphi(z)$

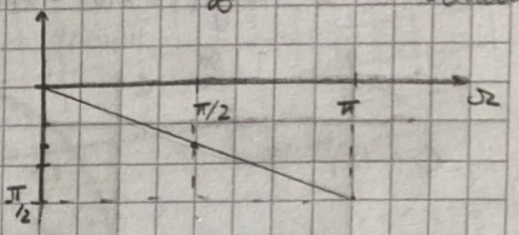
a) $h_1(k) = (1, 1)$ $h(0) = 1$ y $h(1) = 1$

$h_2(k) = (1, 1, 1)$

h_1: $y(k) = x(k) + x(k-1) \longrightarrow H_1(z) = 1 + z^{-1} = \frac{z+1}{z}$ → FIR, fase lineal





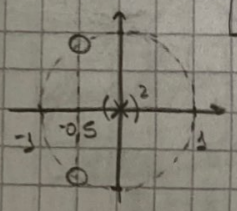


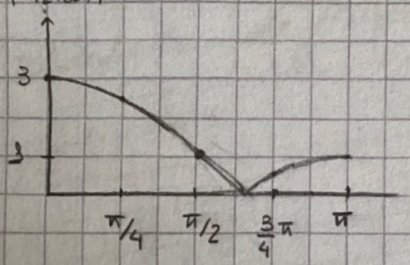
$|H_1(z)|_{\Omega=0} = 2$ $|H_1(\Omega=\pi/2)| = \sqrt{2}$

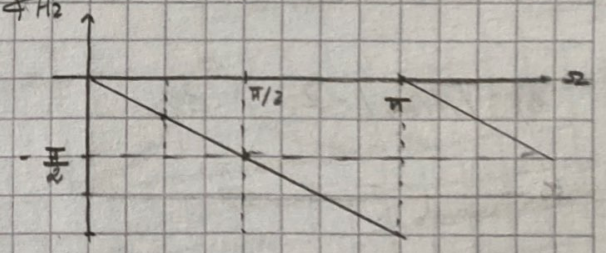
$\measuredangle H_1(\Omega=0) = 0$ $\measuredangle H_1(\Omega=\pi/2) = -\frac{1}{4}\pi$

$\measuredangle H_1(\Omega=\pi) = -\pi/2$

h_2: $y(k) = x(k) + x(k-1) + x(k-2) \longrightarrow H_2(z) = 1 + z^{-1} + z^{-2} = \frac{z^2+z+1}{z^2}$ → FIR, fase lineal







1) Tendría que multiplicar la transferencia por $1/N$, siendo N la cantidad de muestras.

2) Los ceros se encuentran en $\Omega = \frac{2}{3}\pi$

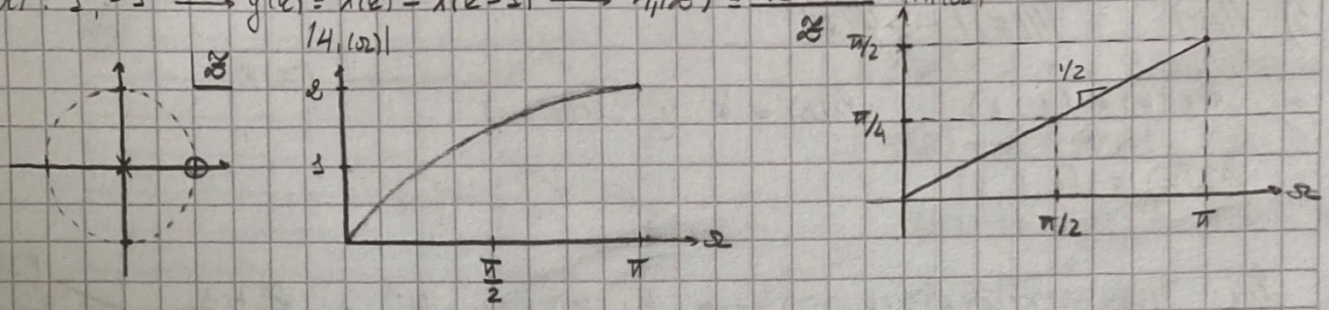
$\pi \longrightarrow f_s/2$

$\frac{2\pi}{3} \longrightarrow 50Hz \Longrightarrow f_s = 2\left(\frac{\pi \cdot 50Hz}{2/3\,\pi}\right) = 150Hz$

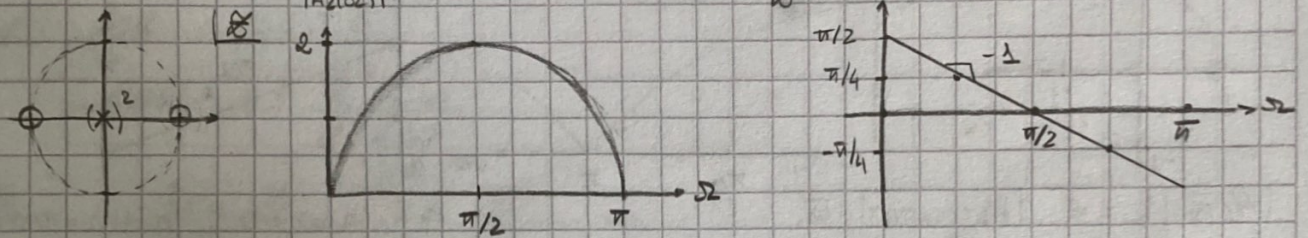
$\pi \longrightarrow x$

b) — fase lineal, FIR

$h_1: 1, -1 \longrightarrow y(k) = x(k) - x(k-1) \longrightarrow H_1(z) = \frac{z-1}{z}$ $\quad \measuredangle H_1(\Omega)$



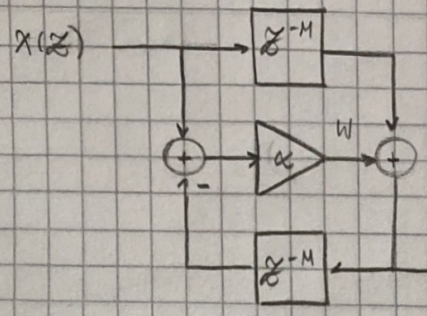
$h_2: 1, 0, -1 \longrightarrow y(k) = x(k) - x(k-2) \longrightarrow H_2(z) = \frac{z^2-1}{z^2}$ $\quad \measuredangle H_2$



3) $\tau_{H_1} = 1/2$ $\quad \tau_{H_2} = -1$ $\longrightarrow$ no deseable, $\measuredangle z$ y no puedo determinar cuantos intervalos tardará en aparecer la salida

4) $|H(\Omega)| = 2$ $\quad 5\%$

2)



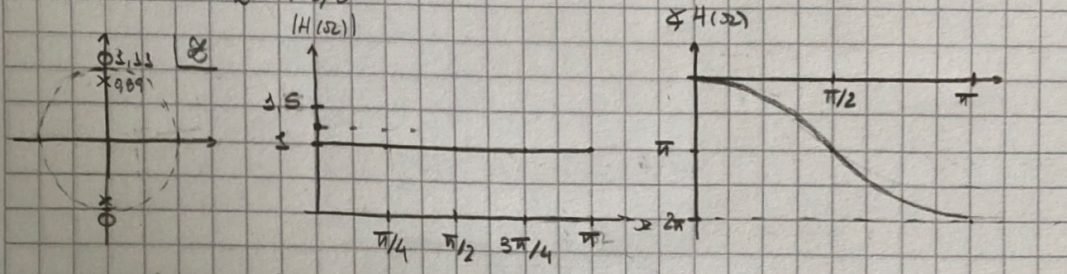
$$\begin{cases} Y(z) = W(z) + X(z)\,z^{-M} \\ W(z) = \alpha\,(X(z) - Y(z)\,z^{-M}) \end{cases}$$

$$Y(z)(1+\alpha z^{-M}) = X(z)(\alpha + z^{-M})$$

$$H(z) = \frac{\alpha + z^{-M}}{1+\alpha z^{-M}} = \frac{\alpha\,(z^M + 1/\alpha)}{z^M + \alpha}$$

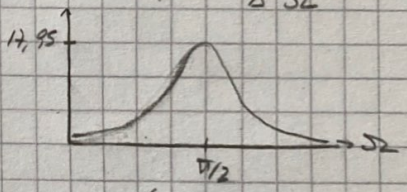
$M=2 \wedge \alpha = 0,8$

$$H(z) = 0,8\,\frac{z^2 + 1,25}{z^2 + 0,8}$$



Analizo el retardo de grupo haciendo $-\frac{\Delta H(\Omega)}{\Delta \Omega}$

$$-\frac{H(\pi/2) - H(\pi/2 + 0,01)}{\frac{\pi}{2} - \frac{\pi}{2} - 0,01} = 17,95$$

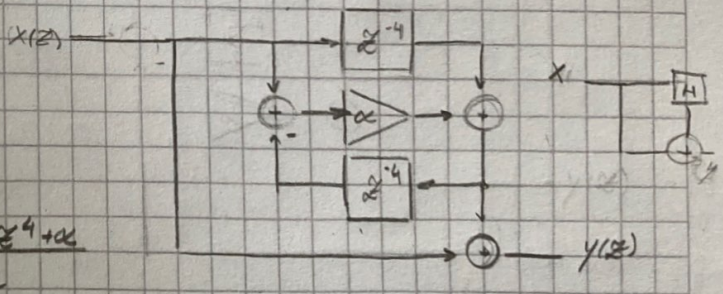


b) anular $f = 125Hz$ y respuesta armónica 1 sumador y filtro $M \leq 4$.

$$H(z)\Big|_{M=4} = \alpha\,\frac{z^4 + 1/\alpha}{z^4 + \alpha}$$

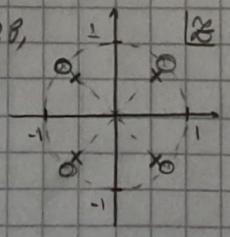
$$Y(z) = H(z)\,X(z) + X(z)$$

$$H'(z) = H(z) + 1 = \frac{\alpha(z^4 + 1/\alpha) + z^4 + \alpha}{z^4 + \alpha}$$



$$H'(z) = \frac{\alpha z^4 + 1 + z^4 + \alpha}{z^4 + \alpha} = \frac{(\alpha+1)(z^4+1)}{z^4+\alpha} = (\alpha+1)\,\frac{z^4+1}{z^4+\alpha} \quad \text{con } -1 < \alpha < 1$$

Si $\alpha = 0,8$,



NOTCH

Tendría una ganancia de $1+\alpha$, por lo que tendría que atenuar la señal para mantener ganancia 1.

Además, $f_s = 2\left(\frac{\pi \cdot 125Hz}{\pi/4}\right) = 8 \cdot 125Hz = 1\,kHz$

Variando α, cambio la selectividad del filtro, $\uparrow \alpha$, $\uparrow$ selectividad

NOTA