Tarea semanal 3

(1) $T(s)$

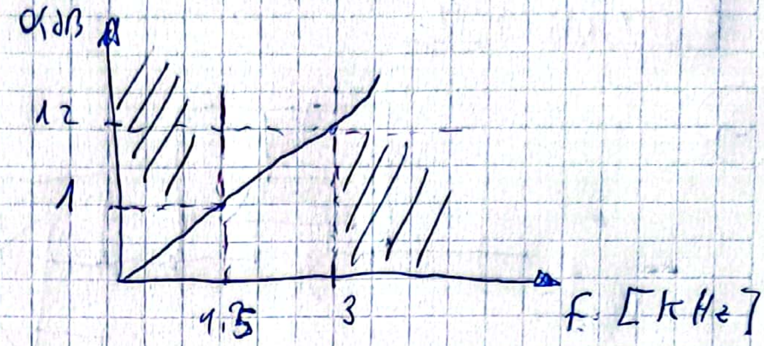
$\alpha_{max} = 1$ dB

$\alpha_{min} = 12$ dB

$f_p = 1500$ Hz

$f_s = 3000$ Hz

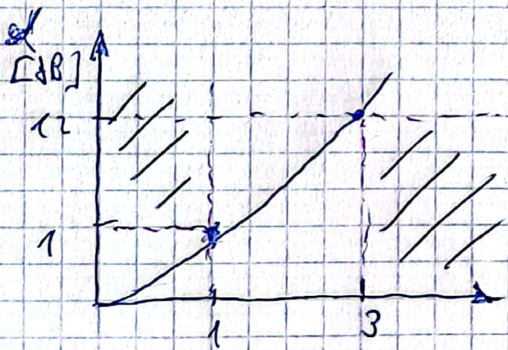
Máxima planicidad *



Normalización:

$$\Omega_W = 2\pi \cdot 1500 \text{ Hz}$$

$$\overline{W_p} = \frac{W_p}{\Omega_W} = 1 \frac{rad}{s} \qquad \overline{W_s} = \frac{W_s}{\Omega_W} = \frac{2\pi 3000}{2\pi 1500} = 2 \frac{rad}{s}$$



Obtención parámetro ε

$\alpha_{max} \neq 3$ dB $\Rightarrow$ No es Butterworth * $\Rightarrow \varepsilon \neq 1$

$$\alpha_{dB} = 10 \log\left(1 + \varepsilon^2 W^{2n}\right)$$

$$\alpha_{max} = 1 = 10 \log\left(1 + \varepsilon^2\right)$$

$$\varepsilon^2 = 10^{1/10} - 1 = 0,25$$

$$\varepsilon = 0,5$$

NOTA

Obtención del orden del filtro:

Por iteración: $\alpha_{dB}\big|_n = 10 \log(1 + \varepsilon^2 W_s^{2n}) > \alpha_{min}$

$\alpha_{dB}\big|_{n=1} = 10 \log(1 + 0,5^2 \cdot 2^2) = 3,01\ dB$

$\alpha_{dB}\big|_{n=3} = 10 \log(1 + 0,5^2 \cdot 2^3) = 4,77\ dB$

$\alpha_{dB}\big|_{n=4} = 10 \log(1 + 0,5^2 \cdot 2^4) = 6,98\ dB$

$\alpha_{dB}\big|_{n=6} = 10 \log(1 + 0,5^2 \cdot 2^6) = 12,3\ dB > 12\ dB$

$$\boxed{n = 6}$$

Normalización por Butterworth

$$|T_{jw}|^2 = \frac{1}{1 + \varepsilon^2 W^2} \implies |T_{jw}|^2 = \frac{1}{1 + W_N^{2n}}$$

Norma: $W_B = W_p \cdot \varepsilon^{-\frac{1}{n}} = 2\pi \cdot 1500\ Hz \cdot (0,5)^{-\frac{1}{6}}$

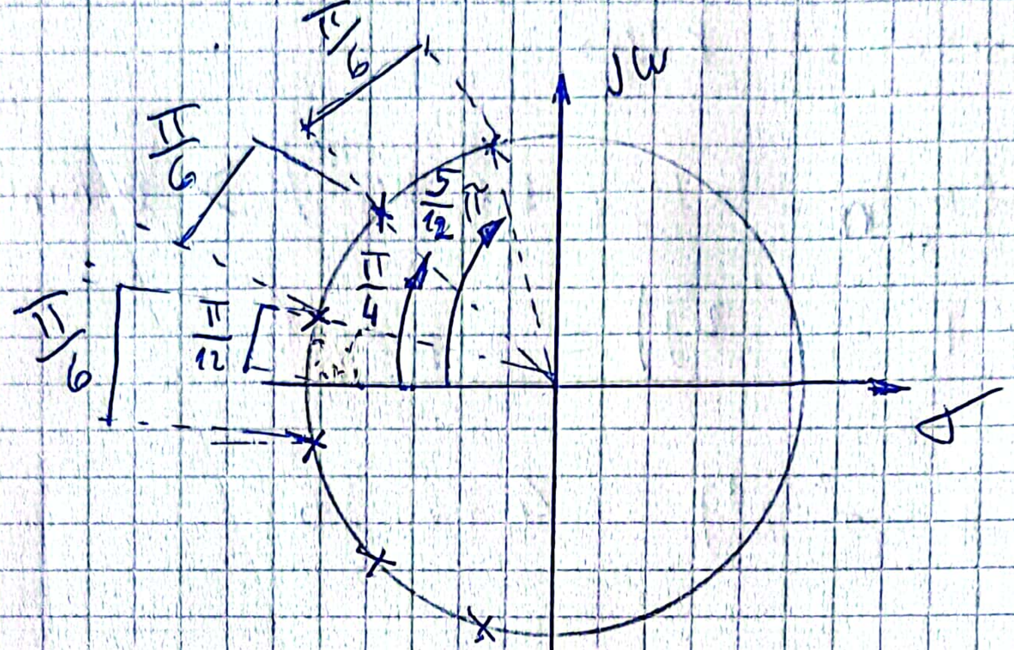
$$W_B = 10,579\ \frac{krad}{s}$$

$$T(s) = \frac{1}{(s^2 + a s + b)(s^2 + c s + d)(s^2 + e s + f)}$$

TABLA BUTTER:

$a = \frac{1}{0,52} = 1,923$ $\quad b = 1,408$ $\quad c = 0,518$

② Diagrama de polos y ceros:



$b = d = f = 1$

$a = 2\cos\frac{\pi}{12} = 1{,}9318$

$b = 2\cos\frac{\pi}{4} = 1{,}4142$

$c = 2\cos\frac{5}{12}\pi = 0{,}5176$