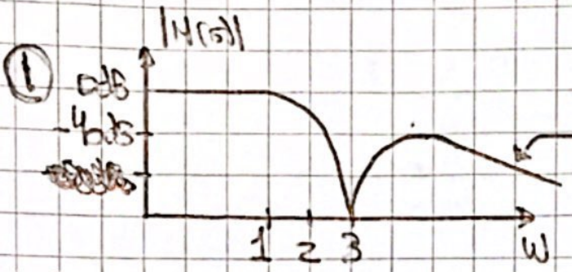
Ejercicio Semanal 5

$LP \rightarrow N=1$

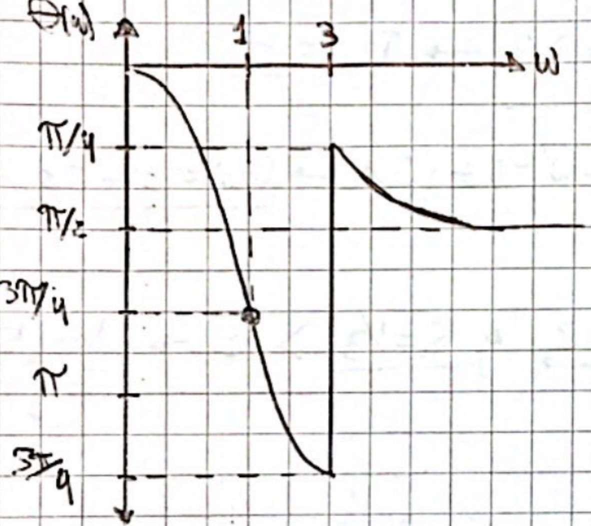
La pendiente es $-20 dB/dec$

①



$\longrightarrow$ $H(w\to 0) = 0 dB$

$H(w\to\infty) \to -\infty\, dB \Rightarrow 0$



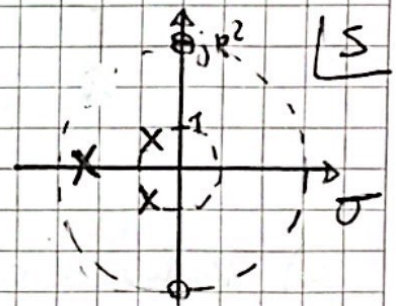
$\theta(w=1) = \frac{3\pi}{4}$

$\theta(w\to 0) = 0°$ $\longrightarrow$ Aporte de polos y ceros se cancelan.

$\theta(w\to\infty) = \pi/2$ $\longrightarrow$ Gana el aporte de ceros

Sabemos que son dos etapas: $\longrightarrow$ Notch Pasabajos Bicuad ($w_{o_1}=1$) $\longrightarrow$ LP $N=1$ ($w_{o_2} = w_{o1}$) (Max Planicidad)

$$H(s) = \frac{s^2 + k^2 (1)}{s^2 + s\, {}^{1}/_{Q_1} + 1} \cdot \frac{\sigma}{s+\sigma} \longrightarrow$$



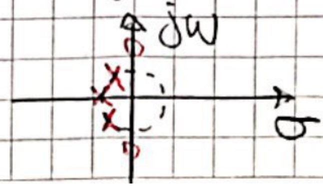
$\underline{k^2 = 9 \text{ (cero en 3)}}$

Sabemos que en $w=1 (w_o)$ la Fase es la mitad de la que se alcanza (sin contar los ceros) $\longrightarrow$ 3 polos hacen $\frac{3}{2}\pi$ en ∞

$\Downarrow$

$\boxed{\text{3 polos hacen } \frac{3}{4}\pi \text{ en } w = 1\, (w_o)}$

Como es máxima Planicidad, el Diagrama de polos y ceros queda:



Dentro de los Máximo planiedad, suponemos que es Butterworth por no tener info del ε.

$$H_{LP}(p) = \frac{1}{p+1} \cdot \frac{p^2 + k^2}{p^2 + p\,{}^1\!/_Q + 1} \qquad \boxed{Q = \frac{1}{2\cos(\pi/3)} = 1}$$

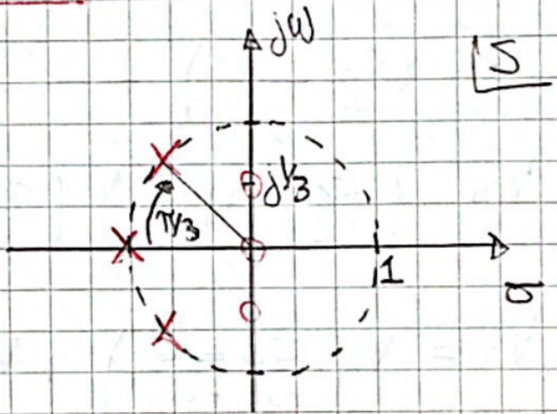
$$\boxed{k=3}$$

$p = {}^1\!/_s$

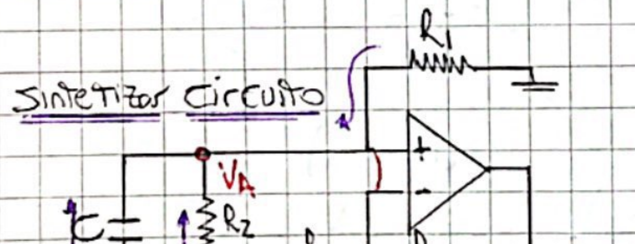
$$H_{LP}(s) = \frac{1}{{}^1\!/_s + 1} \cdot \frac{{}^1\!/_{s^2} + k^2}{{}^1\!/_{s^2} + {}^1\!/_s + 1} = \frac{s^2k^2 + 1}{s^2 + s + 1} \cdot \frac{s}{s+1}$$

$$\boxed{H_{HP}(s) = \frac{(s^2 + {}^1\!/_{k^2})\cdot s}{(s^2+s+1)(s+1)} = \frac{(s^2 + {}^1\!/_9)s}{(s^2+s+1)(s+1)}}$$

b) Diagrama de Polos y ceros



c) Sintetizar circuito



Tener en cuenta que $V_A = V_B = V_X$:

$\boxed{V_A}$ $(V_i - V_x)sC + (V_{o1} - V_x)G_2 + (-V_x)G_1 = 0$

① $V_x(G_1 + G_2 + sC) = V_i sC + V_{o1} G_2$

$\boxed{V_x}$ $(V_{o1} - V_x)G + (V_o - V_x)G = 0$

② $V_x(2G) = G(V_{o1} + V_o) \Rightarrow V_{o1} = 2V_x - V_o$ ②'

$\boxed{V_B}$ $(V_i - V_x)G_3 + (V_o - V_x)sC = 0$

③ $V_x(G_3 + sC) = V_o sC + V_i G_3$

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Retomamos el análisis

(1) $V_x(G_1+G_2+SC) = V_i \cdot SC + V_{01} \cdot G_2$

(2') $V_{01} = 2V_x - V_o$

(3) $V_x(G_3+SC) = V_o \cdot SC + V_i G_3 \Longrightarrow \boxed{V_x = V_o \dfrac{SC}{SC+G_3} + V_i \dfrac{G_3}{SC+G_3}}$ (3')

(2') → (1)

$$V_x(G_1+G_2+SC) = V_i \cdot SC + 2V_x \cdot G_2 - V_o G_2$$

$$V_x(G_1+G_2+SC-2G_2) = V_i \cdot SC - V_o G_2$$

$$\boxed{V_x(G_1-G_2+SC) = V_i SC - V_o G_2} \quad (4)$$

(3') → (4)

$$\left(V_o \frac{SC}{SC+G_3} + V_i \frac{G_3}{SC+G_3}\right)(SC+G_1-G_2) = V_i SC - V_o G_2$$

$$V_o \frac{SC(SC+G_1-G_2)}{SC+G_3} + V_i \frac{G_3(SC+G_1-G_2)}{SC+G_3} = V_i SC - V_o \cdot G_2$$

$$V_o\left[\frac{SC(SC+G_1-G_2)}{SC+G_3} + G_2\right] = V_i\left[SC - \frac{G_3(SC+G_1-G_2)}{SC+G_3}\right]$$

$$V_o\left[\frac{sC(sC+G_1-G_2)}{sC+G_3}+G_2\right]=V_i\left[sC-\frac{G_3(sC+G_1-G_2)}{sC+G_3}\right]$$

$$V_o\left[\frac{s^2C^2+sCG_1-\cancel{sCG_2}+\cancel{sCG_2}+G_2G_3}{sC+G_3}\right]=V_i\left[\frac{s^2C^2+\cancel{sCG_3}-\cancel{sCG_3}-G_1^{G_3}+G_2^{G_3}}{sC+G_3}\right]$$

$$\frac{V_o}{V_i}=H(s)=\frac{s^2C^2+\left(\frac{1}{R_2}-\frac{1}{R_1}\right)\cdot\frac{1}{R_3}}{s^2C^2+sC/R_1+1/R_2R_3}$$

$$\boxed{H(s)=\frac{s^2+\frac{1}{R_3C^2}\left(\frac{1}{R_2}-\frac{1}{R_1}\right)}{s^2+s\,\frac{1}{R_1C}+\frac{1}{R_2R_3C^2}}}$$

$$\underline{W_o^2=\frac{1}{R_2R_3C^2}}$$

$$\underline{\frac{W_o}{Q}=\frac{1}{R_1C}}$$

$$\underline{W_z^2=\frac{1}{R_3C^2}\left(\frac{1}{R_2}-\frac{1}{R_1}\right)}=\frac{1}{R_3C^2}\cdot\frac{R_1-R_2}{R_1\cdot R_2}$$

Nosotros Necesitamos: $\underline{W_o=1}$ $\underline{1/Q=1}$ $\underline{W_z=1/3}$ $\underline{\Omega_W=300\,Hz\cdot 2\pi}$

$\underline{\Omega_Z=1K}$

$$W_z^2=\frac{1}{9}=\frac{1}{R_3C^2}\left(\frac{1}{R_2}-\frac{1}{R_1}\right)=\frac{R_2}{R_2R_3C^2}\left(\frac{1}{R_2}-\frac{1}{R_1}\right)=W_o^2\cdot\cancel{R_2}\left(\frac{R_1-R_2}{R_1\cancel{R_2}}\right)$$

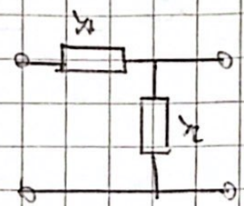
$\underline{si\ W_o=1}\Rightarrow 9=\frac{R_1}{R_1-R_2}\Rightarrow si\ \underline{R_1=1\Omega}\Rightarrow \underline{R_2=1-\frac{1}{9}=\frac{8}{9}\simeq 0{,}88\,\Omega}$

$si\ \frac{W_o}{Q}=1=\frac{1}{R_1C}\Rightarrow \underline{C=1F}\Rightarrow \underline{R_3}=\frac{1}{R_2}=\frac{9}{8}\simeq\underline{1{,}125\Omega}$

<u>Desnormalizando:</u>

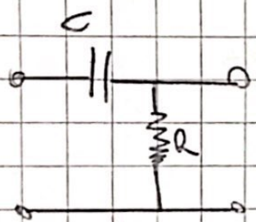
$$\begin{cases}C=0{,}53\,\mu F\\R_1=1K\\R_2=0{,}88K\\R_3=1{,}12K\\R=1K\end{cases}$$

Para $H_2(s) = \frac{s}{s+1}$ $\longrightarrow$



$H_2(s) = \frac{Y_1}{Y_1+Y_2}$

Si $Y_1 = sC$ y $Y_2 = G$



$H_2(s) = \frac{sC}{sC + 1/R} = \frac{s}{s + 1/RC} \longrightarrow \frac{1}{RC} = 1 \Rightarrow$ $C = 0{,}53\ \mathrm{NF}$

$R = 1K$

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