Puntos 4 y 5)

Si dispusimos capacitores de 100nf debemos normalizar de tal manera que la Z_{norm} dependa de los valores a la frecuencia butterworth.

Tenemos

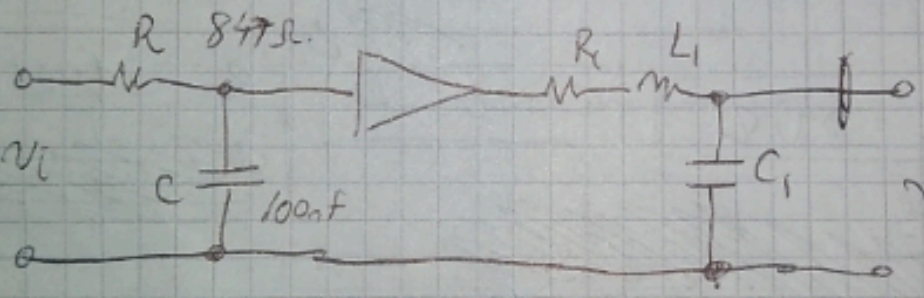
$$C_1 = 1 \quad , \quad \omega_B = 1{,}252$$

Si $f_0 = 1{,}5\,KHz \Rightarrow \quad \omega_{0_B} = 2\pi f_0\, \omega_B \Rightarrow \quad \omega_{0B} = 11{,}799\,kS^{-1}$

Si $C = 10^{-7}\,F \Rightarrow \quad Z_n = \dfrac{1}{\omega C} \Rightarrow \quad Z_n = \dfrac{1}{11{,}799 \cdot 10^3 [S^{-1}]\, 10^{-7}[F]}$

$$Z_n = 847{,}5\,\Omega$$

Luego normalizamos las etapas



$$\frac{1}{RC} = \omega \Rightarrow \quad C = 1 \Rightarrow \quad R = \frac{1}{\omega_B} \Rightarrow \quad R = 0{,}798$$

$C = 10^{-7}$ $\Rightarrow$ para $\omega_c = 1500 \cdot 2\pi \Rightarrow \quad Z_n = \dfrac{1}{\omega_0 C} \Rightarrow Z_n = 1061$

$R = 0{,}798 \cdot 1061 \Rightarrow \boxed{R = 846{,}67\,\Omega}$

Luego a

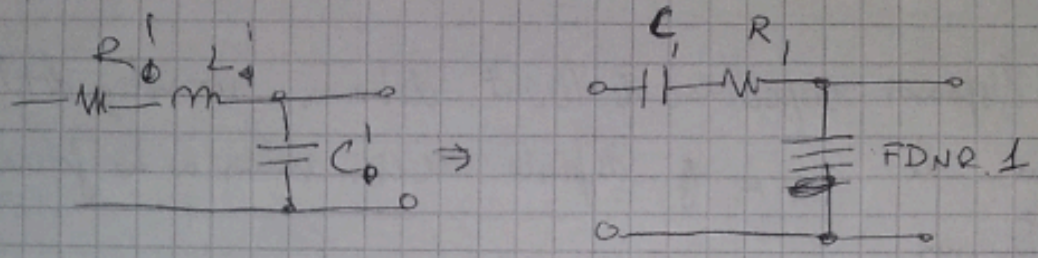
$C_0 = 1$ y $C = 10^{-7} \Rightarrow$ si $\dfrac{C_n}{C} = \dfrac{1}{Z_n \omega_B} \Rightarrow \left(\dfrac{C_0}{C}\omega_B\right)^{-1} = Z_n$

$Z_n = 1061\,\Omega \Rightarrow$

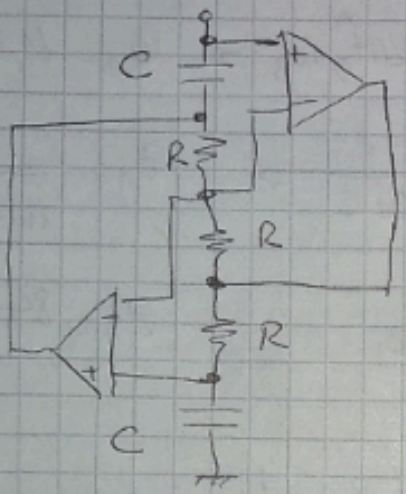
$$L_1 = (C\omega_0^2)^{-1} \Rightarrow L_1 = 0{,}637 \cdot \Rightarrow L_1 = \frac{0{,}637}{2\pi} \cdot \frac{Z_0}{f_0}$$

$$R_f = \frac{\omega_0 \cdot L_1}{Q} Z_n \Rightarrow \boxed{R_f = 0{,}798 \cdot Z_n}$$

Para cambiar a FDNR



Para el FDNR 1:



donde $\Rightarrow$ $C = \frac{1}{\Omega_z \Omega_\omega}$

$R = \Omega_z$

con $\Omega_\omega = 1{,}252 * 1{,}5\,KHz * 2\pi$

luego $\Omega_z = 847\,\Omega$ | $C = 100\,nf$