

a)

$$\bullet I_{R1} = I_{C1} + I_{R2} + I_{R3A} \Rightarrow \frac{V_i}{R_1} = -V_A \cdot SC - \frac{V_A}{R_2} - \frac{V_0}{R_3} \Rightarrow \frac{V_i}{R_1} + \frac{V_0}{R_3} = -\left(SC + \frac{1}{R_2}\right) V_A = -\frac{1+SC R_2}{R_2} V_A$$

$$V_A = -\frac{R_2}{1+SC R_2} \left(\frac{V_i}{R_1} + \frac{V_0}{R_3} \right)$$

$$\bullet I_{R3A} = I_{C2} \Rightarrow \frac{V_A}{R_3} = -V_B \cdot SC \Rightarrow V_B = \frac{V_A}{-SC R_3} = \frac{R_2}{-SC R_3 (1+SC R_2)} \left(\frac{V_i}{R_1} + \frac{V_0}{R_3} \right)$$

$$\bullet I_{R4} = \frac{V_B}{R_4} = -\frac{V_0}{R_4} \Rightarrow \underline{V_B = -V_0}$$

$$\bullet V_0 = -\frac{R_2}{SC R_3 (1+SC R_2)} \left(\frac{V_i}{R_1} + \frac{V_0}{R_3} \right)$$

$$V_0 \left(1 + \frac{R_2}{SC R_3^2 (1+SC R_2)} \right) = -\frac{V_i}{R_1} \frac{R_2}{SC R_3 (1+SC R_2)}$$

$$\frac{V_0}{R_3} \frac{SC R_3^2 (1+SC R_2) + R_2}{SC R_3 (1+SC R_2)} = -\frac{V_i}{R_1} \frac{R_2}{SC R_3 (1+SC R_2)}$$

$$\frac{V_0}{V_i} = \frac{-R_2 \cdot R_3}{R_1 \cdot SC R_3^2 (1+SC R_2) + R_1 R_2} = -\frac{R_2 R_3}{SC R_1 R_3^2 + S^2 C^2 R_1 R_2 R_3^2 + R_1 R_2}$$

$$\frac{V_0}{V_i} = \frac{1}{C^2 R_1 R_3} \frac{1}{S^2 + S \frac{1}{C R_2} + \frac{1}{C^2 R_3^2}}$$

$$\frac{V_0}{V_i} = -\frac{R_3}{R_1} \frac{\frac{1}{C^2 R_3^2}}{S^2 + S \frac{1}{C R_2} + \frac{1}{C^2 R_3^2}} \Rightarrow \frac{V_0}{V_i} = -K \cdot \frac{\omega_0^2}{S^2 + S \frac{\omega_0}{Q} + \omega_0^2}$$

$$\bullet \omega_0 = \frac{1}{C R_3}$$

$$\frac{\omega_0}{Q} = \frac{1}{C R_2} \Rightarrow Q = \frac{1}{C R_2} \cdot C R_2 = \frac{R_2}{R_3}$$

$$b) \omega_0 = 1 = \frac{1}{C R_3}$$

~~Los Capacitores suelen tener mayor tolerancia, por lo que prefiero tener Resistencia alta en lugar de Cap Alto.~~
(Revisando la matemática me di cuenta de que esto no importa ↑)

• Elijo $C = 10 \mu F \Rightarrow R_3 = 100 K\Omega$

$$Q = 3 = \frac{R_2}{R_3} \Rightarrow R_2 = 300 K\Omega$$

Elijo $R_4 = R_3 = 100 K\Omega$ Para reutilizar mismo componente. (BOM. más chica)

$$c) |T(\omega)| = 20 dB = 20 \cdot \log\left(\frac{R_3}{R_1}\right) \Rightarrow \frac{R_3}{R_1} = 10 \Rightarrow R_1 = 10 K\Omega$$

• Normalización en Frecuencia e Impedancia

$$\Omega_\omega = \omega_0 = \frac{1}{C \cdot R_3} = 1; \Omega_z = R_1 = 10 K\Omega \text{ dado que } Z_{in} = R_1$$

$$\bullet \hat{R}_1 = 1; \hat{R}_2 = \frac{R_2}{R_1} = 30; \hat{R}_3 = \hat{R}_4 = \frac{100 K\Omega}{10 K\Omega} = 10; \hat{C} = C \cdot \Omega_z \cdot \Omega_\omega$$

$$\hat{C} = 0,1$$

• Sensibilidad

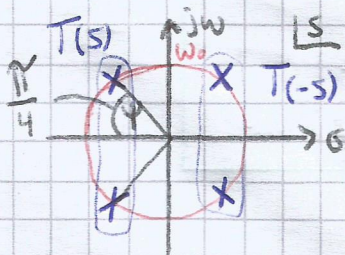
$$\omega_0 = \frac{1}{C R_3} \Rightarrow S_{\omega_0}^C = \frac{C}{\omega_0} \cdot \frac{\partial \omega_0}{\partial C} = \frac{C}{\frac{1}{C R_3}} \cdot (-1) \cdot \frac{1}{C^2 R_3} = -\frac{C^2 R_3}{C^2 R_3} = -1$$

$$Q = \frac{R_2}{R_3} \Rightarrow S_{R_1}^Q = \frac{R_2}{Q} \cdot \frac{\partial Q}{\partial R_2} = \frac{R_2}{\frac{R_2}{R_3}} \cdot \frac{1}{R_3} = 1$$

$$S_{R_3}^Q = \frac{R_3}{\frac{R_2}{R_3}} \cdot R_2 \cdot (-1) \cdot \frac{1}{R_3^2} = -1$$

• Recálculo para Transf. Butter Worth

• Se que es de 2° orden al tener 2 capacitores (no acoplables).



$$T(s) = K \frac{\omega_0^2}{s^2 + s \omega_0 \cdot 2 \cos(\gamma) + \omega_0^2}$$

$$Q = \frac{1}{2 \cdot \cos \frac{\pi}{4}} = \frac{1}{2 \cdot \frac{\sqrt{2}}{2}} = \frac{\sqrt{2}}{2} = \frac{R_2}{R_3}$$

sin modificar ω_0 (R_3 CTE) $\rightarrow R_2 = R_3 \cdot \frac{\sqrt{2}}{2} = 70,7 K\Omega$

• Salida Paso-banda

Viendo el ejemplo 4.6 del Schaumann, observo que el potencial V_A es la salida de un pasobanda.

•• Cálculo $\frac{V_A}{V_i}$: Tenía $\left\{ \begin{array}{l} V_A = -\frac{R_2}{1+SCA_2} \left(\frac{V_i}{R_1} + \frac{V_0}{R_3} \right) \\ V_0 = -V_B \wedge V_B = -\frac{V_A}{SCA_3} \end{array} \right.$

$$V_A = -\frac{R_2}{1+SCA_2} \left(\frac{V_i}{R_1} + \frac{V_A}{SCA_3 R_3} \right)$$

$$V_A \left(1 + \frac{R_2}{(1+SCA_2)SCA_3 R_3} \right) = -\frac{V_i R_2}{(1+SCA_2) R_1}$$

$$V_A \frac{(1+SCA_2)SCA_3 R_3 + R_2}{(1+SCA_2)SCA_3 R_3} = -\frac{V_i R_2}{(1+SCA_2) R_1}$$

$$\frac{V_A}{V_i} = -\frac{SC \frac{R_2}{R_1 R_3^2}}{SCA_3^2 (1+SCA_2) + R_2} = -\frac{SC \frac{R_2}{R_1 R_3^2}}{SCA_3^2 + S^2 C^2 R_2 R_3^2 + R_2}$$

$$\frac{V_A}{V_i} = -\frac{\frac{R_2}{R_1} S \frac{1}{CA_2}}{S^2 + S \frac{1}{CA_2} + \frac{1}{C^2 R_3^2}}$$

Mismo $\omega_0 = \frac{1}{CA_2}$

$\frac{\omega_0}{Q} = \frac{1}{C R_2} \Rightarrow$ mismo $Q = \frac{R_2}{R_3}$

Ahora $K = -\frac{R_2}{R_1}$

Suponiendo Valores de Componentes antes de recalcular Para Butterworth:

$\omega_0 = 1$; $Q = 3$; $K = -30$