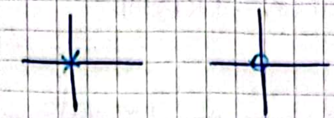
Clase 7 Youtube.

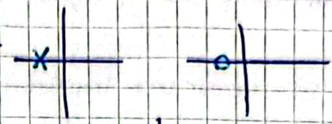
Funciones Bilineales: Transferencia de dos polinomios de primer orden. Puede darse el caso que haya ganancia K o que algún polinomio sea de grado "0" (sólo 1 de los dos)

$T(s) = K \cdot \frac{s+z}{s+p}$

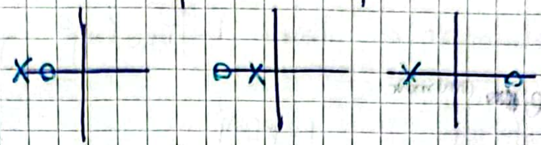
$T_I(s) = \frac{K}{s}$ $\quad T_D = s \cdot K \rightarrow$ Ideales



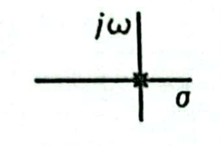
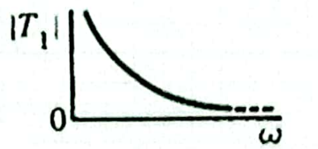
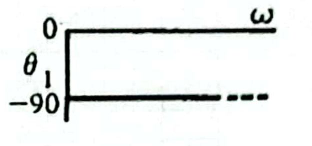
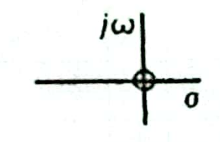
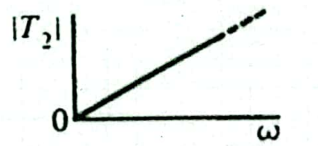
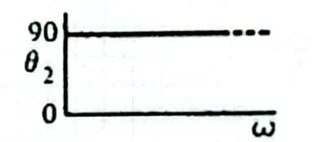
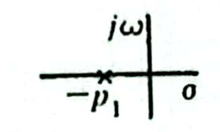
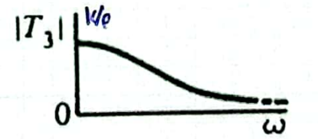
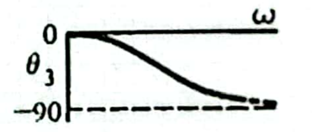
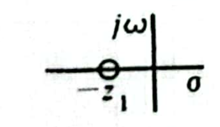
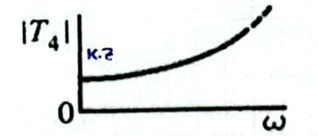
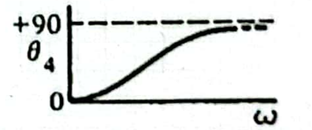
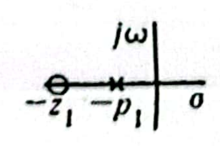
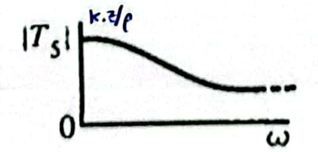
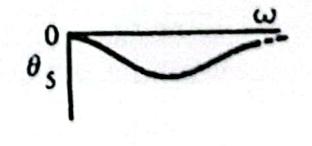
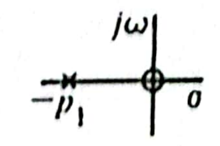
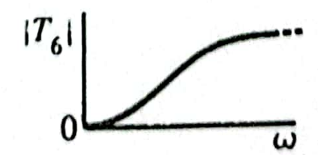
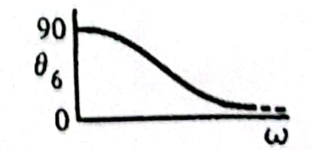
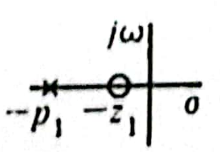
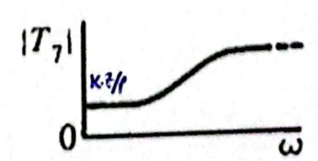
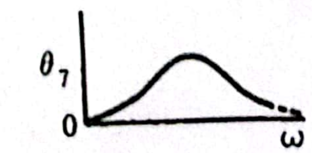
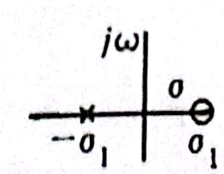
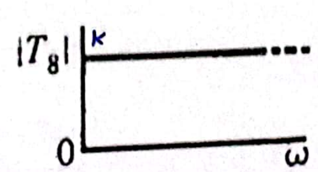
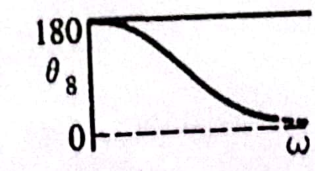
$T_I(s) = \frac{K}{s+a}$ $\quad T_D = (s+a) \cdot K \rightarrow$ Reales



Genéricamente $T(s) = K \cdot \frac{s+z}{s+p}$



Análisis de Módulo y Fase

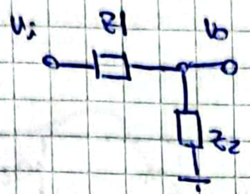
$T_n(s)^a$	Pole and Zero	Magnitude Response	Phase Response
$k > 0$			
$\frac{K_1}{s}$			
$K_2 s$			
$\frac{K_3}{s+p_1}$			
$K_4(s+z_1)$			
$K_5\frac{s+z_1}{s+p_1}$			
$K_6\frac{s}{s+p_1}$			
$K_7\frac{s+z_1}{s+p_1}$			
$K_8\frac{s-\sigma_1}{s+\sigma_1}$			

Implementacions passives

$$T(s) = K \cdot \frac{s+z}{s+p}$$

$\downarrow$

$K \leq 1$



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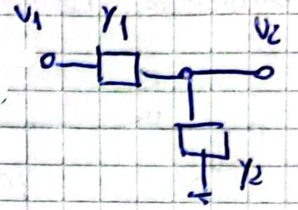
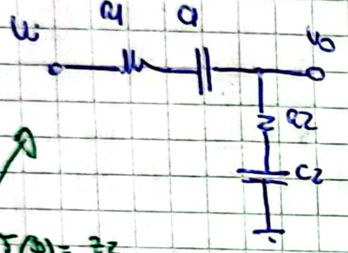


- O capacitor o bobina
- Per integració → hauríem d'usar capacitors.



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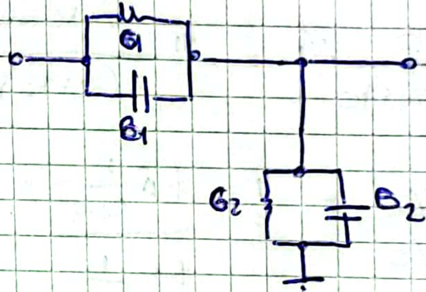


$$T(s) = \frac{Z_2}{Z_1+Z_2}$$

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

$$T(s) = \frac{R_2 + 1/sC_2}{R_1+R_2+\frac{1}{sC_1}+\frac{1}{sC_2}} = \frac{sR_2 + 1/C_2}{s(R_1+R_2)+\frac{1}{C_1}+\frac{1}{C_2}} = \frac{\frac{R_2}{R_1+R_2}\left(s+\frac{1}{C_2R_2}\right)}{s+\left[\frac{1\,C_2}{(R_1+R_2)C_1C_2}+\frac{1\,C_1}{(R_1+R_2)C_1C_2}\right]}$$

$$\boxed{T(s) = \frac{R_2}{R_1+R_2}\cdot\frac{s+\frac{1}{C_2R_2}}{s+\frac{C_1+C_2}{C_1C_2(R_1+R_2)}}}$$

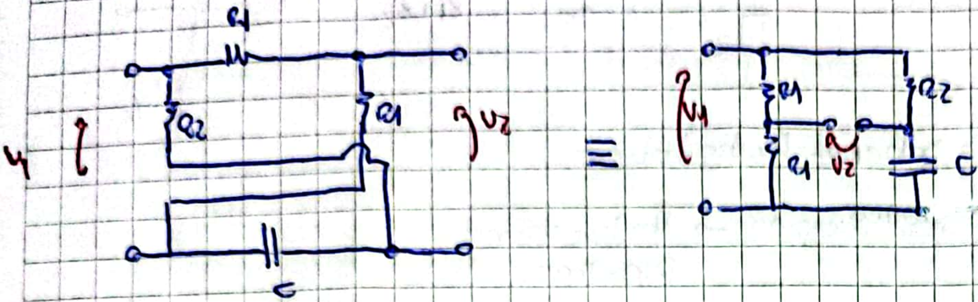
$$T(s) = \frac{G_1+sC_1}{G_1+sC_1+G_2+sC_2} = \frac{C_1}{C_1+C_2}\cdot\frac{s+\frac{G_1}{C_1}}{s+\frac{G_1+G_2}{C_1+C_2}}$$

$$\boxed{T(s) = \frac{C_1}{C_1+C_2}\cdot\frac{s+G_1/C_1}{s+\frac{G_1+G_2}{C_1+C_2}}}$$

Con estas dos formas no conseguís el pasatodo.

① → Pasa todo pasivo:

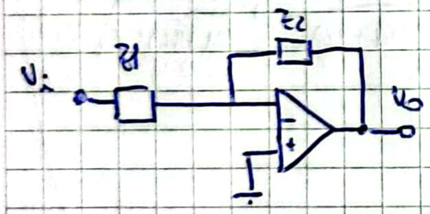
Circuito de Lattice



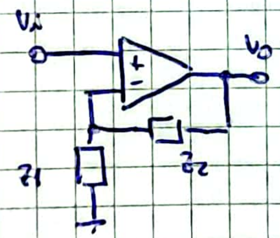
$$V_2 = \frac{V_1}{2} - \frac{G_2}{G_2+sC} \cdot V_1 = V_1 \frac{G_2+sC-G_2 \cdot 2}{2(G_2+sC)} = V_1 \cdot \frac{1 \cdot C}{2C} \cdot \frac{s-\frac{G_2}{C}}{s+\frac{G_2}{C}}$$

$$T(s) = \frac{1}{2} \cdot \frac{s - G_2/C}{s+G_2/C} = \frac{1}{2} \cdot \frac{s - \frac{1}{R_2 \cdot C}}{s + \frac{1}{R_2 \cdot C}}$$

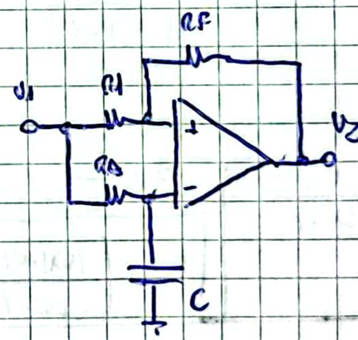
Implementación activa



$$T(s) = -\frac{Z_2}{Z_1}$$



$$T(s) = 1 + \frac{Z_2}{Z_1} = \frac{Z_1+Z_2}{Z_1}$$



$$T(s) = -K \cdot \frac{s - \frac{1}{K \cdot C R_A}}{s + \frac{1}{K \cdot C \cdot R_A}}$$

$$K = \frac{R_F}{R_1}$$

- Si cambias → R_A por C
  → C por R_A

Circuito no inversor

Función Bicuadrática $T(s) = \dfrac{s^2 + s \cdot \frac{\omega_z}{Q_z} + \omega_z^2}{s^2 + s \cdot \frac{\omega_p}{Q_p} + \omega_p^2}$

TABLE 5.1 Standard Forms of Second-Order Responses

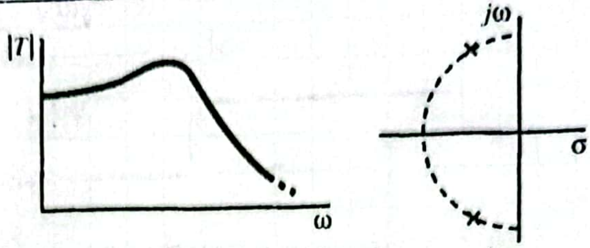
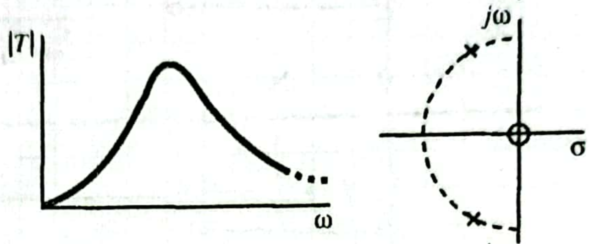
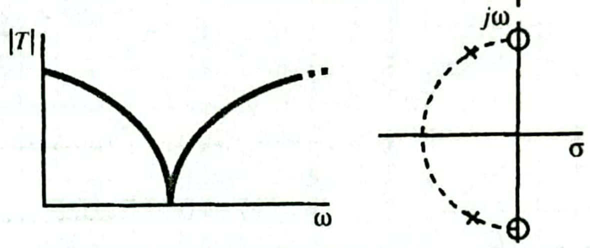
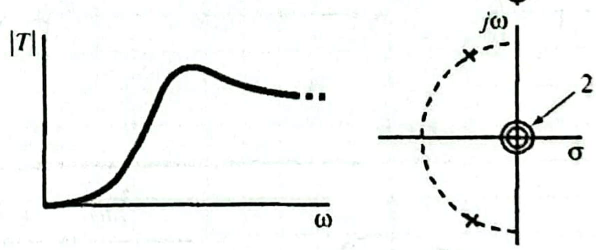
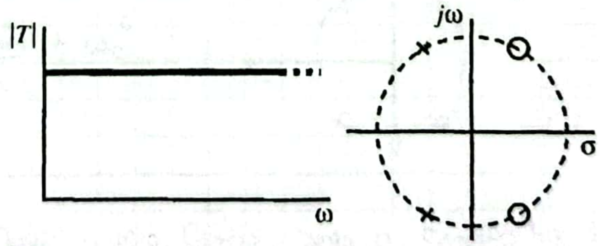
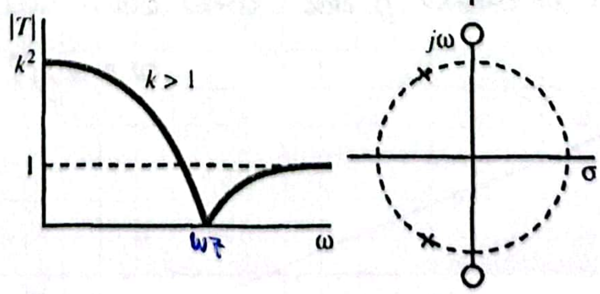
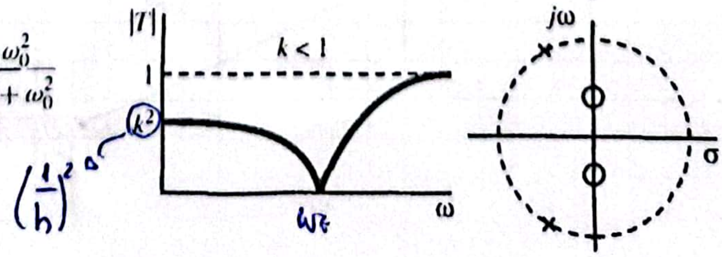
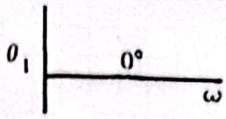
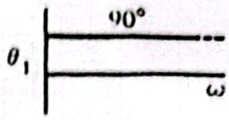
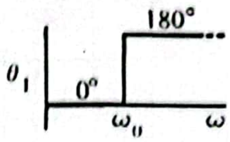
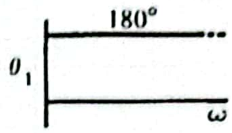
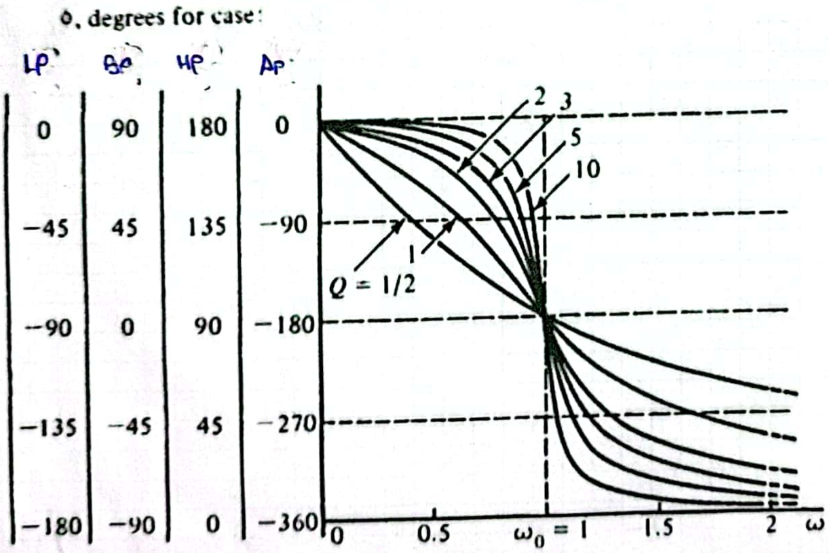
	Frequency Response / Poles/Zeros	Name
$T_{LP} = \dfrac{\omega_0^2}{s^2 + \frac{\omega_0}{Q}s + \omega_0^2}$		Lowpass
$T_{BP} = \dfrac{\frac{\omega_0}{Q}s}{s^2 + \frac{\omega_0}{Q}s + \omega_0^2}$		Bandpass
$T_{BE} = \dfrac{s^2 + \omega_0^2}{s^2 + \frac{\omega_0}{Q}s + \omega_0^2}$		Bandstop "notch"
$T_{HP} = \dfrac{s^2}{s^2 + \frac{\omega_0}{Q}s + \omega_0^2}$		Highpass
$T_{AP} = \dfrac{s^2 - \frac{\omega_0}{Q}s + \omega_0^2}{s^2 + \frac{\omega_0}{Q}s + \omega_0^2}$		Allpass
$T_{LPN} = \dfrac{s^2 + k^2\omega_0^2}{s^2 + s\frac{\omega_0}{Q} + \omega_0^2}$		Lowpass notch
$T_{HPN} = \dfrac{s^2 + h^2\omega_0^2}{s^2 + s\frac{\omega_0}{Q} + \omega_0^2}$		Highpass notch

TABLE 5.2 Common Forms of $N(s)$ and Phases of $N(j\omega)$ → Aporte de Fase de Cada Término

Name	$N(s)$	$N(j\omega)$	Plot of $\theta_1(\omega)$
Lowpass	ω_0^2	ω_0^2	
Bandpass	$\frac{\omega_0}{Q}s$	$j\frac{\omega_0\omega}{Q}$	
Bandstop	$s^2+\omega_0^2$	$-\omega^2+\omega_0^2$	
Highpass	s^2	$-\omega^2$	

Si analizar la Fase de cada filtro Tienen mismas formas Todas menos el BE. De los que son iguales solo le cambian los limites (está desplazado)



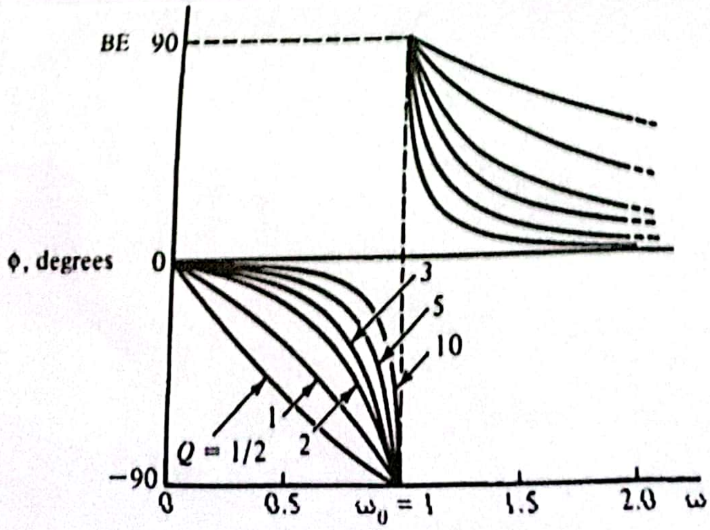


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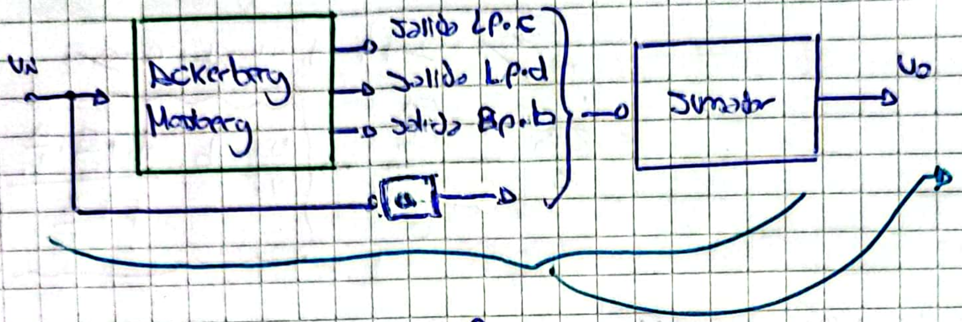
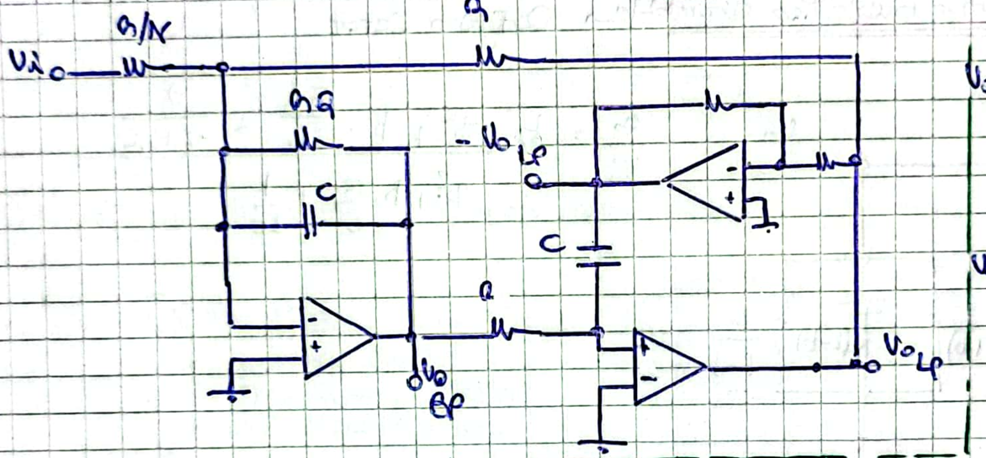
Figure 5.10 The phases of the most common second-order filters.

Implementación de Funciones Bicuadráticas por suma de Transferencias

Para poder implementar una transferencia ajustable podemos hacer lo siguiente

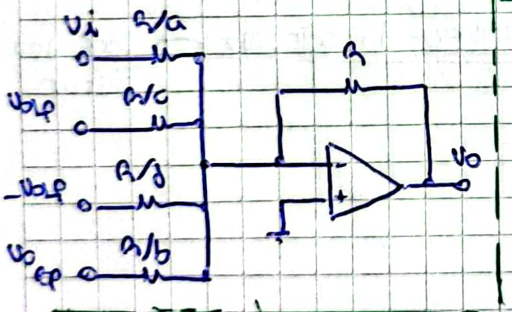


$$\frac{c_1\, s^2 + s\cdot\frac{\omega_0}{Q}\cdot c_2 + c_3\,\omega_0^2}{s^2 + \frac{\omega_0}{Q}\cdot s + \omega_0^2}$$



$$V_{o_{Bp}} = \frac{-s\cdot K\cdot Q\left(\frac{\omega_0}{Q}\right)}{s^2 + s\frac{\omega_0}{Q} + \omega_0^2}$$

$$V_{o_{Lp}} = \frac{-K\,\omega_0^2}{s^2 + s\cdot\frac{\omega_0}{Q} + \omega_0^2}$$



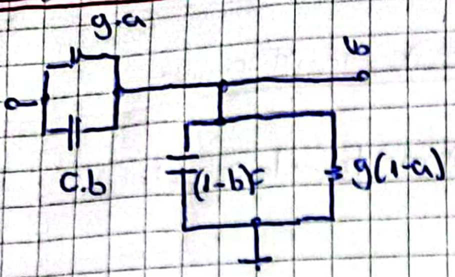
$$V_o = a\cdot V_i + b\cdot V_{Bp} + \overbrace{c V_L + d\cdot(-V_L)}^{V_L(c-d)}$$

$$V_o = V_i\cdot\left\{a + b\cdot\frac{-s K Q\frac{\omega_0}{Q}}{s^2 + s\frac{\omega_0}{Q} + \omega_0^2} + \frac{-K\cdot\omega_0^2}{s^2 + s\frac{\omega_0}{Q} + \omega_0^2}(c-d)\right\}$$

$$\frac{V_o}{V_i} = \frac{a\left(s^2 + s\cdot\frac{\omega_0}{Q} + \omega_0^2\right) - b\left(s K Q\frac{\omega_0}{Q}\right) + (d-c)\,K\cdot\omega_0^2}{s^2 + s\frac{\omega_0}{Q} + \omega_0^2}$$

$$\frac{V_o}{V_i} = \frac{a\cdot s^2 + s\cdot\frac{\omega_0}{Q}\left(a - bKQ\right) + \omega_0^2\left[a + K(d-c)\right]}{s^2 + s\cdot\frac{\omega_0}{Q} + \omega_0^2}$$

① Estrategia de implementar bilineal configurable → Configuro ceros

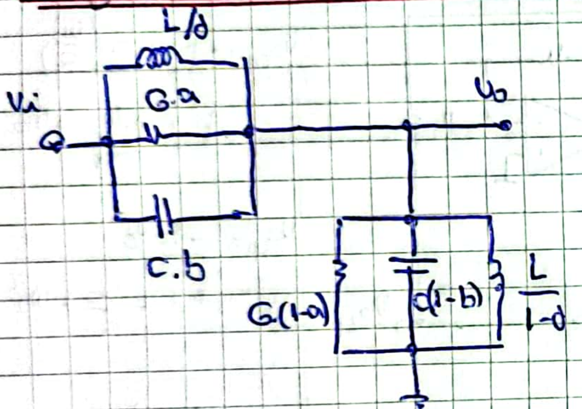


$$\frac{V_o}{V_i} = \frac{(Ga + Cb s)}{(Ga + sCb + (1-b)Cs + (1-a)G)}$$

$$= \frac{Cb\left(\frac{Ga}{Cb} + s\right)}{\cancel{Ga} + \cancel{Cbs} + Cs - \cancel{bCs} + G - \cancel{aG}}$$

$$= \frac{\cancel{C}.b}{\cancel{C}} \cdot \frac{s + \frac{Ga}{Cb}}{s + \frac{G}{C}} \rightarrow \boxed{\frac{V_o}{V_i} = b \cdot \frac{s + \frac{G}{C}\cdot\frac{a}{b}}{s + \frac{G}{C}}}$$

② Estrategia de implementar bicuadrático configurable → Configuro ceros



$$\frac{V_o}{V_i} = b \cdot \frac{s^2 + s\cdot\frac{Ga}{Cb} + \frac{d}{C.b.L}}{s^2 + s\cdot\frac{G}{C} + \frac{1}{LC}}$$

③ Aplicando estos conceptos al Ackerberg Mossberg, puedo modificar la estructura → Configuro ceros

SECOND-ORDER FILTERS WITH ARBITRARY TRANSMISSION ZEROS

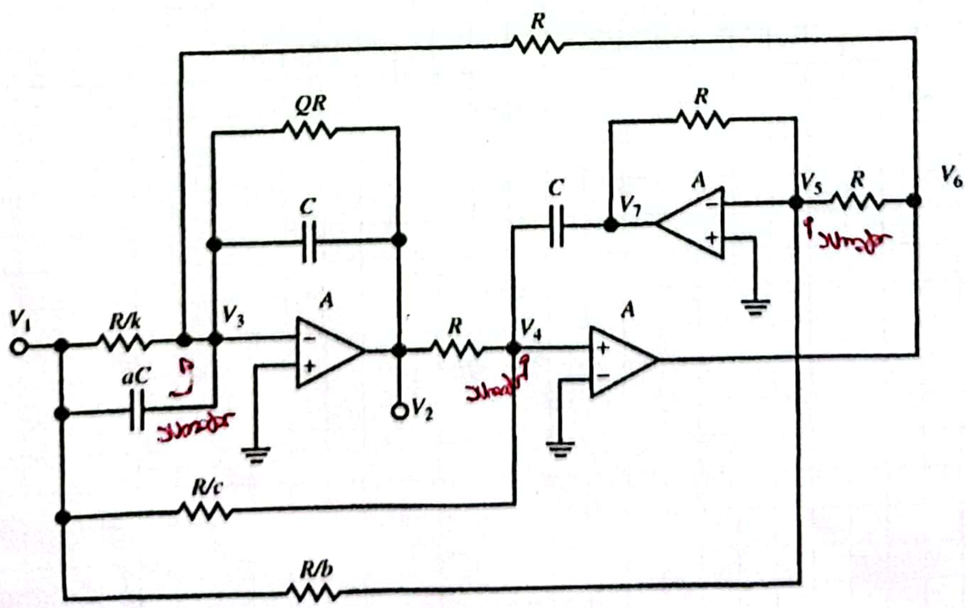


Figure 5.13 The general Åckerberg–Mossberg biquad.

$$T(s) = -\frac{a s^2 + s \cdot \omega_0 (\kappa - b) + c \cdot \omega_0^2}{s^2 + s \cdot \frac{\omega_0}{Q} + \omega_0^2} \qquad \omega_0 = \frac{1}{RC}$$