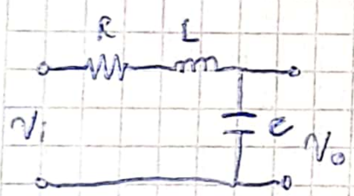
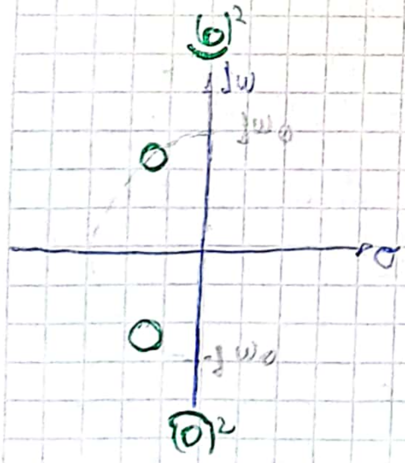
Análisis de un pasabajos: $T(s) = V_o / V_i$



$$V_i = V_o \cdot \frac{1/sC}{R + sL + 1/sC} \Rightarrow T(s) = \frac{1}{LC\left(s^2 + sR/L + 1/LC\right)}$$

$$T(s) = \frac{1/LC}{s^2 + s\,R/L + 1/LC} = \frac{\omega_0^2}{s^2 + s\frac{\omega_0}{Q} + \omega_0^2}$$

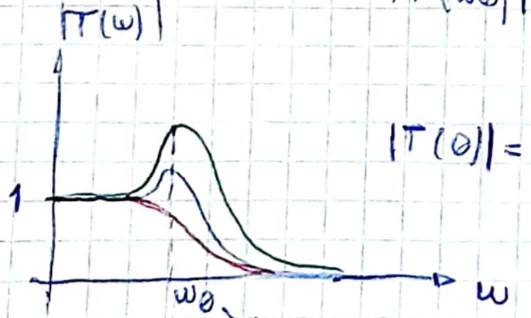


$$T(s)\big|_{s=j\omega} = \frac{\omega_0^2}{-\omega^2 + j\omega\frac{\omega_0}{Q} + \omega_0^2}$$

$$|T(s)|_{s=j\omega} = \frac{\omega_0^2}{\sqrt{\left(\omega_0^2 - \omega^2\right)^2 + \frac{\omega^2 \omega_0^2}{Q^2}}}$$

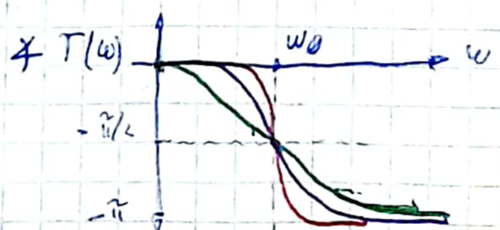
$$|T(\omega_0)| = \frac{\omega_0^2}{\sqrt{\frac{\omega_0^4}{Q^2}}} = Q \rightarrow \text{si } Q > 1 \text{ tengo amplif}$$

con elementos pasivos



$\omega_0 \rightarrow$ No está el máximo acá

$$|T(0)| = \frac{\omega_0^2}{\sqrt{(\omega_0^2 - 0)^2}} = 1$$

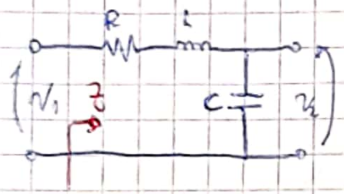


NOTA

Normalización de Redes: → Escalar para manejar valores mas accesibles

- Frecuencia
- Impedancia

$\Omega_w = w_0$



$T(s) = \frac{V_2(s)}{V_1(s)} = \frac{w_0^2}{s^2 + s\frac{w_0}{Q} + w_0^2}$

$\$ = \frac{s}{w_0} = \frac{s}{\Omega_w}$

$T(\$) = \frac{w_0^2}{(\$ w_0)^2 + \$ w_0 \frac{w_0}{Q} + w_0^2} = \frac{1}{\$^2 + \$ \cdot \frac{1}{Q} + 1}$

$Z_1 = sL + R = \$ \underbrace{w_0 L}_{L'} + R$

$Z_2 = \frac{1}{sC} = \frac{1}{\$ \underbrace{w_0 C}_{C'}}$

$L' = w_0 L \longrightarrow L = \frac{L'}{w_0}$

$C' = w_0 C \longrightarrow C = \frac{C'}{w_0}$

$Z = R + sL + \frac{1}{sC}$

$Z = \frac{Z}{\Omega_z} = \underbrace{\frac{R}{\Omega_z}}_{R''} + \underbrace{\frac{sL}{\Omega_z}}_{L''} + \underbrace{\frac{1}{sC\Omega_z}}_{C''}$

$R = R'' \Omega_z$

$L = L'' \Omega_z$

$C = \frac{C''}{\Omega_z}$

$L = L° \cdot \Omega_z \cdot \Omega_w$

$C = \frac{C° \cdot \Omega_w}{\Omega_z}$

$R = R° \cdot \Omega_z$

Clase 02:

$$T(s) = \frac{\pm H \; w_0^2}{s^2 + s\frac{w_0}{Q} + w_0^2} \xrightarrow{\text{Normalizando frecuencia}} T(s_n) = \frac{\pm H}{s^2 + s\,1/Q + 1}$$

salida

$$\Rightarrow V_L(s^2 + s\,1/Q + 1) = -H\,V_i$$

$$V_L(s^2 + s\,1/Q) = -(HV_I + V_L)$$

$$V_L s\,(s + 1/Q) = -(HV_I + V_L) \Rightarrow V_L s = -(HV_I + V_L)\cdot\frac{1}{s + 1/Q}$$

definiendo

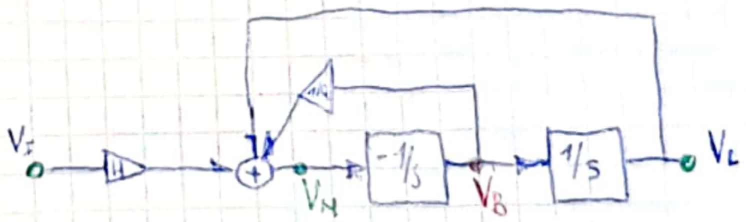
$$V_B = V_L s \Rightarrow V_L = V_B \cdot \frac{1}{s} \quad (1)$$

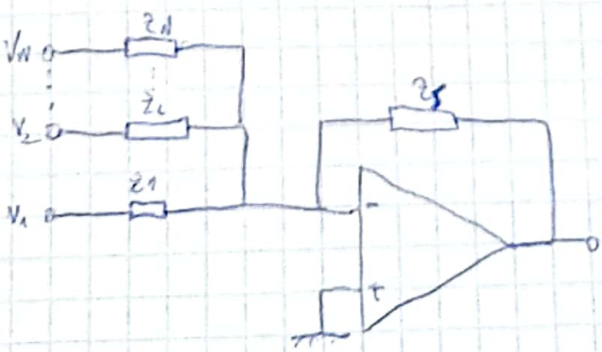
$$V_B = -(HV_I + V_L)\cdot\frac{1}{s + 1/Q}$$

$$V_B s = -(\overbrace{HV_I + V_L + V_B/Q}^{V_H})$$

$$V_B s = -V_H \quad (2)$$

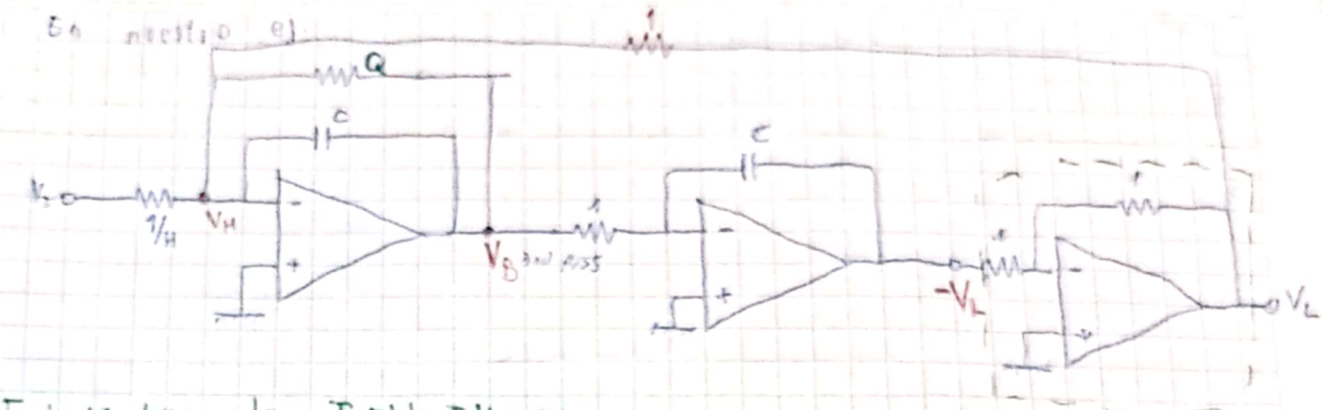
$$\left.\begin{aligned} V_H &= V_I \cdot H + V_L + V_B \cdot \frac{1}{Q} \\ V_B &= V_H\left(-\frac{1}{s}\right) \\ V_L &= V_B \cdot \frac{1}{s} \end{aligned}\right\}$$





$$V_o = \left(V_1\frac{Z_F}{Z_1} + V_2\frac{Z_F}{Z_2} + \dots + V_N\frac{Z_F}{Z_N}\right)$$

En nuestro el



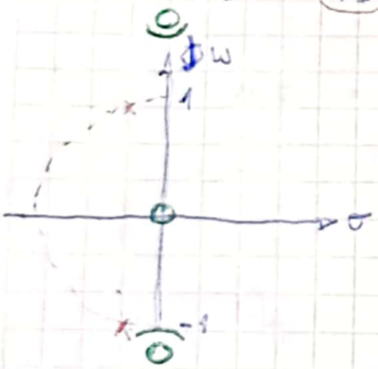
Estructura de TOW-THOMAS

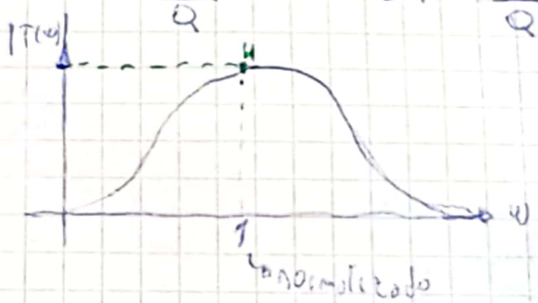
La estructura esta normalizada en frecuencia

$$T_L(s) = \frac{V_L}{V_I} = \frac{-H\,\omega_0^2}{s^2 + s\frac{\omega_0}{Q} + \omega_0^2} \xrightarrow{\Omega_0} = \frac{-H}{s^2 + s\,1/Q + 1}$$

$$T_B(s) = \frac{s V_L}{V_I} = \frac{s V_L}{V_I} = \frac{-sH\omega_0^2}{s^2 + s\frac{\omega_0}{Q} + \omega_0^2} = \frac{-sH}{s^2 + s\cdot\frac{1}{Q} + 1}$$

$T_L(s)$





$$T_B(\omega) = \frac{-j\omega K}{-\omega^2 + j\omega\cdot\frac{1}{Q} + 1} \Rightarrow |T_B(\omega)| = \frac{\omega K}{\left[(1-\omega^2)^2 + \frac{\omega^2}{Q^2}\right]^{1/2}}$$

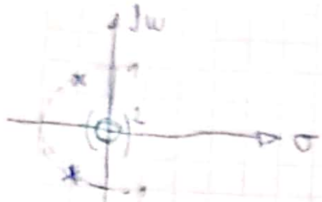
$$|T_B(\omega)|_{\omega_0 1} = \frac{(1)K}{\sqrt{(1-1^2)^2 + \frac{1^2}{Q^2}}} = \frac{K\cdot Q}{\omega_0} = H$$

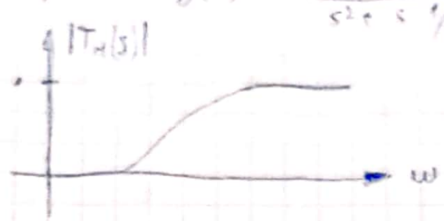
ω_0 → si no esta normalizado

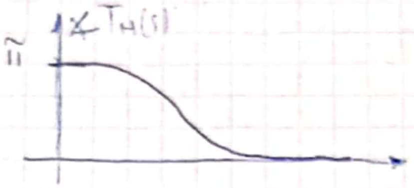
$$k = \frac{H\cdot\omega_0}{Q}$$

NOTA

$$V_H(s) = -s\,V_B(s) = T_H(s) = -s\,T_B(s) = \frac{s^2 H}{s^2 + s\,\frac{1}{Q} + 1}$$



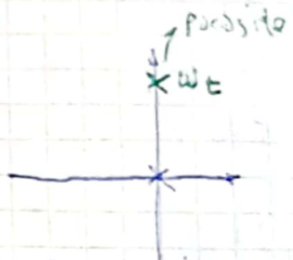




La estructura TOW-THOMAS depende de la calidad de los integradores

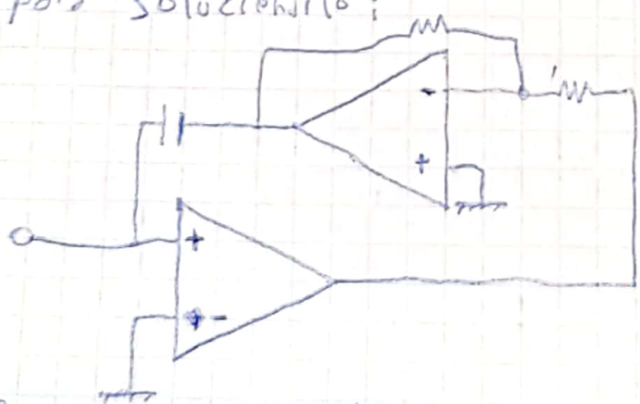
$T_I(s) = \dfrac{1}{s\tau}$ Ideal

$T_I(s) = \dfrac{1}{s\tau + q(s)}$ Realidad → me genera polos parásitos



Este polo se hace muy dominante en altas frecuencias

Para solucionarlo:

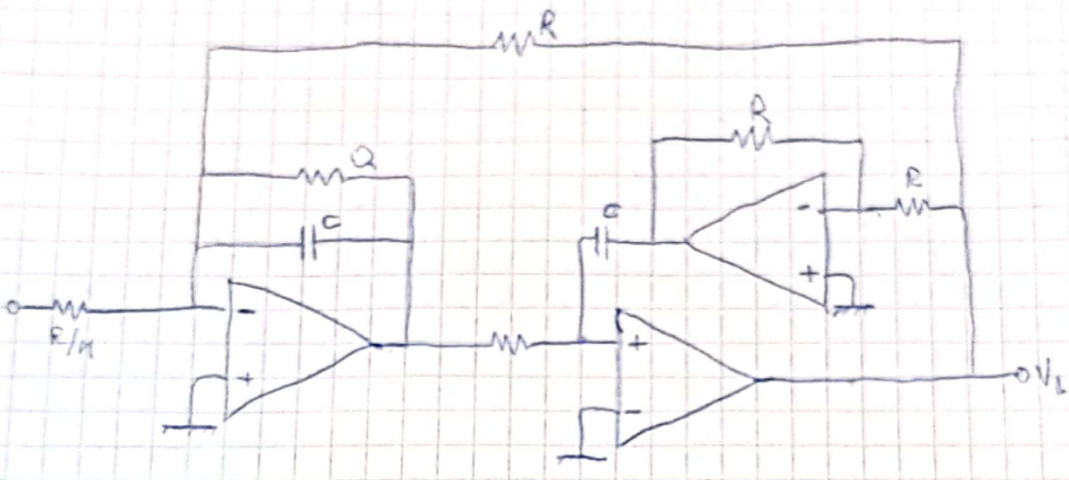


No invierte y mejora la integración

Tow-Thomas Mejorado

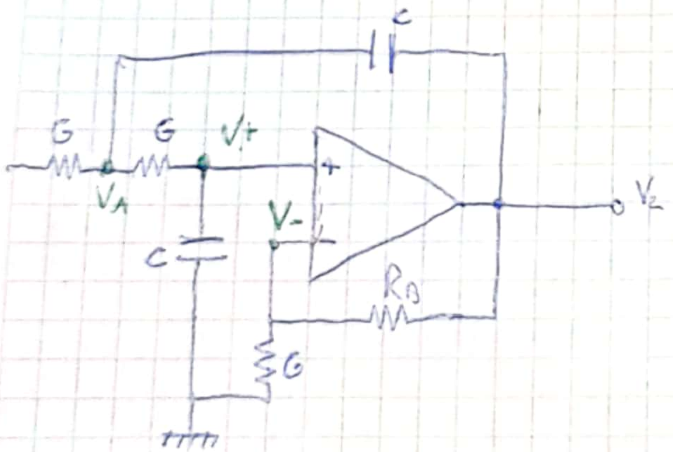
NOTA

Tow - Thomas Mejorado:



Ackerberg - Mosberg

Estructura Sallen - Key



$$V_A(G+G+sC) = V_2(sC) + V_+ G + V_1 G$$

$$V_+(G+sC) = V_A G \qquad \boxed{V_+ = V_-}$$

$$V_-(G + 1/R_B) = V_2 \cdot G_B$$

$$\omega_0 = \frac{1}{RC} \; ; \; k = \frac{R+R_B}{R} \; ; \; Q = \frac{1}{3-k} \qquad T(s) = \frac{k\omega_0^2}{s^2 + s\frac{Q}{\omega_0} + \omega_0^2}$$

Es una estructura poco práctica ya tocar una resistencia implica mover todos los parámetros. Además puede llegar a ser inestable si el G es < 0 y ajustar el Q es difícil