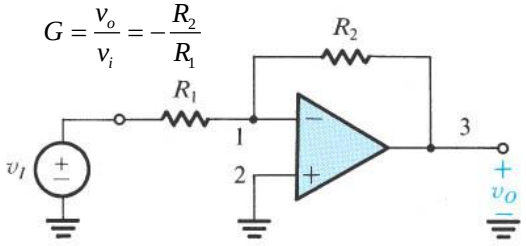
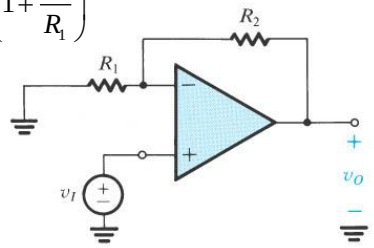
Formulário de Electrónica Geral

2. Amplificadores Operacionais

$$G = \frac{v_o}{v_i} = -\frac{R_2}{R_1}$$



$$G = \frac{v_o}{v_i} = \left(1 + \frac{R_2}{R_1}\right)$$



$$\omega V_{om} \leq SR \qquad SR = \left.\frac{dv_o}{dt}\right|_{\max}$$

3. Filtros Activos

Butterworth

n	$\hat{H}(\hat{S})$
1	$\hat{S}+1$
2	$\hat{S}^2+1{,}414\,\hat{S}+1$
3	$(\hat{S}+1)(\hat{S}^2+\hat{S}+1)$

$$A(\Omega) = 10\log(1+\varepsilon^2\Omega^{2n})$$

$$\hat{S} = \sqrt[n]{\varepsilon}\,\frac{s^2+\omega_0^2}{Bs};\quad \hat{S} = \sqrt[n]{\varepsilon}\,\frac{s}{\omega_p};\quad \hat{S} = \sqrt[n]{\varepsilon}\,\frac{\omega_p}{s};\quad \hat{S} = \sqrt[n]{\varepsilon}\,\frac{Bs}{s^2+\omega_0^2}$$

Chebyshev

$A_{Cheby}(\Omega)=10\log[1+\varepsilon^2 C_n^2(\Omega)]$

$$S = \frac{s^2+\omega_0^2}{Bs};\quad S = \frac{s}{\omega_p};\quad S = \frac{\omega_p}{s};\quad S = \frac{Bs}{s^2+\omega_0^2}$$

$C_n(\Omega)$	
Ω	$S = s/\omega_p$
$2\Omega^2-1$	$S = \omega_p/s$
$4\Omega^3-3\Omega$	$S = (s^2+\omega_0^2)/Bs$
	$S = Bs/(s^2+\omega_0)$

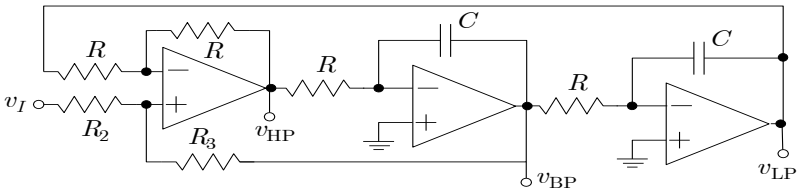
Ap=0,5 dB $T(S) = K / D(S)$

n	K	D(S)
1	2,863	S+2,863
2	1,431	S^2+1,425S+1,516
3	0,716	(S+0,626) (S^2+0,626S+1,142)

Ap=1 dB $T(S) = K / D(S)$

n	K	D(S)
1	1,965	S+1,965
2	0,983	S^2+1,098S+1,103
3	0,491	(S+0,494) (S^2+0,490S+0,994)

KHN (Two Integrator in Loop - TIL)

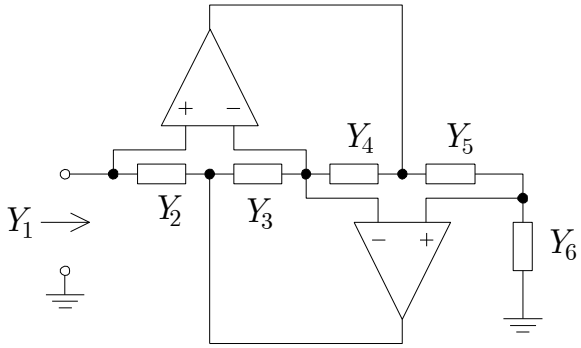


$$T_{LP}(s) = \frac{v_{LP}(s)}{v_i(s)} = \frac{k\,\omega_0^2}{s^2 + \frac{\omega_0}{Q}s + \omega_0^2}$$

$$\omega_0 = \frac{1}{RC} \; ; \; \frac{R_3}{R_2} = 2Q - 1 \; ; \; k = 2 - \frac{1}{Q}$$

GIC

$$Y_1 = \frac{Y_2 Y_4 Y_6}{Y_3 Y_5}$$

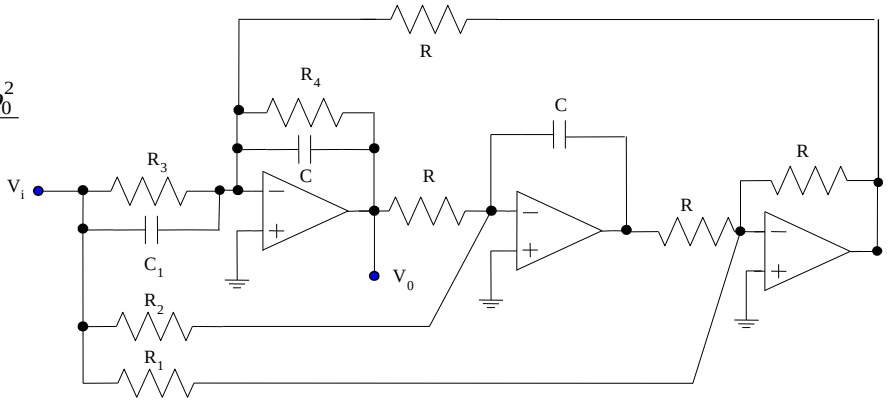


Tow-Thomas

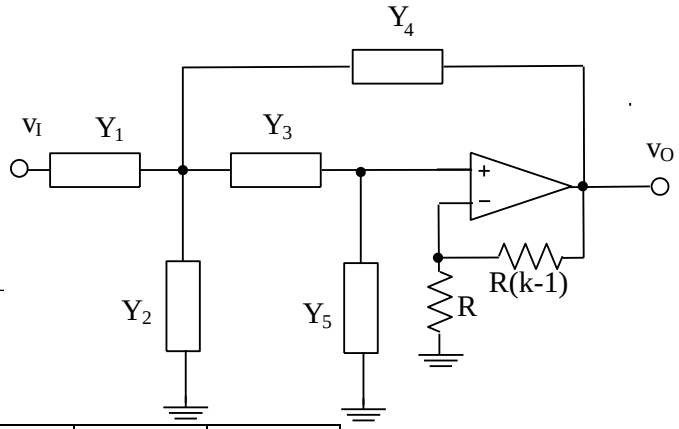
C_1=AC, R_1=R/D, R_2=R/E, R_3=R/B, R_4=Q_0R

$$T(s) = -\frac{As^2 + \omega_0(B-D)s + E\omega_0^2}{s^2 + \frac{\omega_0}{Q_0}s + \omega_0^2}$$

$$\omega_0 = \frac{1}{RC}$$



Sallen & Key

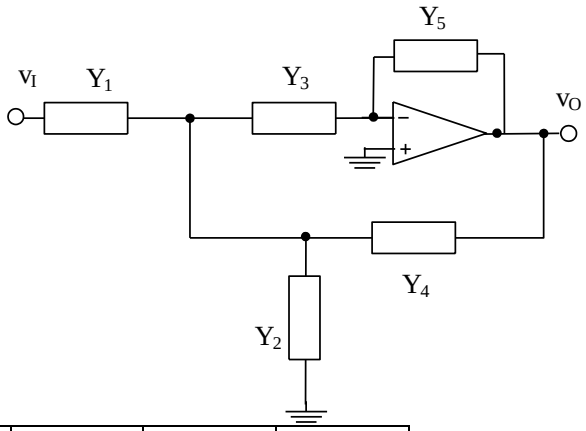


$$\frac{V_o}{V_i} = \frac{kY_1Y_3}{(Y_1+Y_2+Y_3+Y_4).Y_5+(Y_1+Y_2).Y_3+(1-k)Y_3Y_4}$$

Tipo de filtro	Y_1	Y_2	Y_3	Y_4	Y_5
Passa-baixo	$1/R_1$	0	$1/R_3$	sC_4	sC_5
Passa-alto	sC_1	0	sC_3	$1/R_4$	$1/R_5$
Passa-banda	$1/R_1$	sC_2	sC_3	$1/R_4$	$1/R_5$

Rauch

$$\frac{V_o}{V_i} = \frac{-Y_1Y_3}{(Y_1+Y_2+Y_3+Y_4).Y_5+Y_3.Y_4}$$



Tipo de filtro	Y_1	Y_2	Y_3	Y_4	Y_5
Passa-baixo	$1/R_1$	sC_2	$1/R_3$	$1/R_4$	sC_5
Passa-alto	sC_1	$1/R_2$	sC_3	sC_4	$1/R_5$
Passa-banda	$1/R_1$	$1/R_2$	sC_3	sC_4	$1/R_5$

4. Osciladores

CRITÉRIO DE BARKHAUSEN

$$A(j\omega_0)\beta(j\omega_0)=1 \quad \Rightarrow \quad \begin{cases} |A(j\omega_0)\beta(j\omega_0)|=1 \\ \arg\{A(j\omega_0)\beta(j\omega_0)\}=0 \end{cases} \quad ou \quad \begin{cases} \mathrm{Re}\{A(j\omega_0)\beta(j\omega_0)\}=1 \\ \mathrm{Im}\{A(j\omega_0)\beta(j\omega_0)\}=0 \end{cases}$$

Tensão aos terminais de um condensador a ser carregado por um sinal em degrau via uma resistência

$$v_C = v_C(\infty) + \left[v_C(0) - v_C(\infty)\right] e^{-\frac{t}{RC}}$$

5. Conversores A/D e D/A

Resposta em frequência de sistemas amostrados:

$$T(s)\big|_{s=j\omega} = T(z)\big|_{z=e^{j\omega T}} = T(z)\big|_{z=e^{j\gamma}}$$

6. Conversores Electrónicos de Potência

$$\eta = \frac{V_0 I_0}{V_I I_I}$$

Redutor	Ampliador	Redutor-Ampliador
$V_0 = V_I D$	$V_0 = \frac{V_I}{1-D}$	$V_0 = -V_I \frac{D}{1-D}$
$\frac{L}{R} > \frac{1-D}{2 f_S}$	$\frac{L}{R} > \frac{D(1-D)^2}{2 f_S}$	$\frac{L}{R} > \frac{(1-D)^2}{2 f_S}$
$V_0 = \frac{D}{D+D_0} V_I$	$V_0 = \frac{D+D_0}{D_0} V_I$	$V_0 = -\frac{D}{D_0} V_I$
$D_0^2 + D D_0 - \frac{2L}{RT} = 0$	$\frac{D+D_0}{D D_0^2} = \frac{RT}{2L}$	$D_0 = \sqrt{\frac{2L}{RT}}$

7. Filtros Digitais

Transformação Bilinear

$$s = \frac{2}{T_s} \frac{1-z^{-1}}{1+z^{-1}}$$

Resposta em Frequência

$s = j\omega$

$z = e^{j\omega T_s} = e^{j\gamma}$, $\gamma = \omega T_s$

$$\tau(\omega) = -\frac{\partial \phi}{\partial \omega}$$

$e^{jx} = \cos(x) + j\sin(x)$, $\cos(x) = ½ (e^{jx} + e^{-jx})$, $\sin(x) = 1/2j (e^{jx} - e^{-jx})$

$1+e^{jx} = e^{jx/2} (e^{jx/2} + e^{-jx/2}) = e^{jx/2} 2\cos(x/2)$