Resum de Teoria de Circuits

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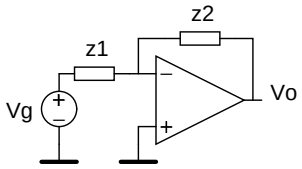
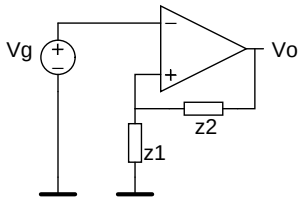
1 Amplificadors operacionals

1.1 Amplificador inversor



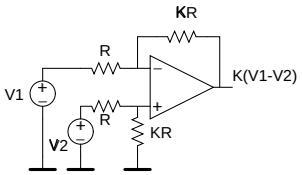
$$V_o = -\frac{z_2}{z_1} V_g$$

1.2 Amplificador no inversor



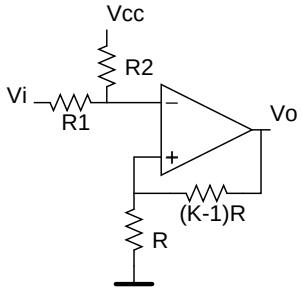
$$V_o = (1 + \frac{z_2}{z_1}) V_g$$

1.3 Amplificador diferencial



$$Vo = K(V_2 - V_1)$$

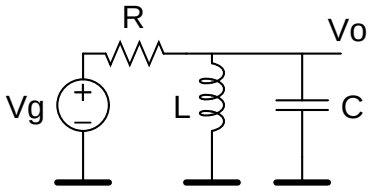
1.4 Amplificador amb offset DC



$$Vo = KV_+ = K\frac{R_2}{R_1+R_2}V1 + K\frac{R_1}{R_1+R_2}Vcc$$

2 Filtres

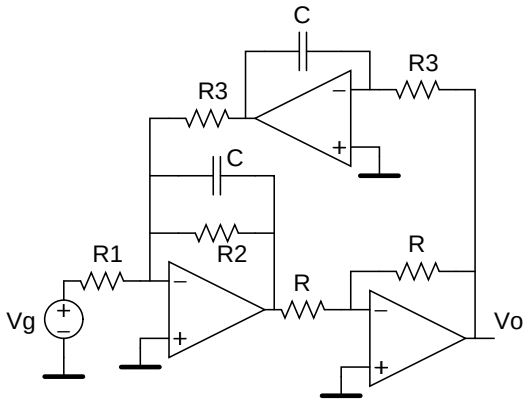
2.1 Filtre passa banda de 2on ordre



$$H(s) = K\frac{\frac{1}{RC}s}{s^2+\frac{1}{RC}s+\frac{1}{LC}} = K\frac{BWs}{s^2+BWs+\omega_r^2} = K\frac{\frac{\omega_r}{Q}s}{s^2+\frac{\omega_r}{Q}s+\omega_r^2}$$

$f_r = \frac{1}{2\pi\sqrt{LC}}$
$f_{c1} = \frac{1}{2\pi}\left[\sqrt{\frac{1}{LC}+\left(\frac{1}{2RC}\right)^2} - \frac{1}{2RC}\right]$
$f_{c2} = \frac{1}{2\pi}\left[\sqrt{\frac{1}{LC}+\left(\frac{1}{2RC}\right)^2} + \frac{1}{2RC}\right]$
$Q = R\sqrt{\frac{C}{L}}$
$BW = \frac{f_r}{Q} = \frac{1}{RC}$
$|H(2\pi fj)| = \frac{|K|}{\sqrt{1+\left[\left(\frac{f}{f_r}-\frac{f_r}{f}\right)Q\right]^2}}$
$\varphi(H(2\pi fj)) = \varphi(k) - \arctan\left(\left(\frac{f}{f_r}-\frac{f_r}{f}\right)Q\right)$

2.2 Filtre passa banda de 2on ordre sense bobina



$$H(s) = \frac{R_2}{R_1} \frac{\frac{1}{R_2 C} s}{s^2 + \frac{1}{R_2 C} s + \frac{1}{(R_3 C)^2}}$$

$A_{vmax} = \frac{R_2}{R_1}$
$BW = \frac{1}{2\pi R_2 C}$
$f_r = \frac{1}{2\pi R_3 C}$

2.3 Filtre pas baix de 2on ordre

$$H(s) = \frac{\frac{1}{LC}}{s^2 + \frac{R}{L} s + \frac{1}{LC}}$$

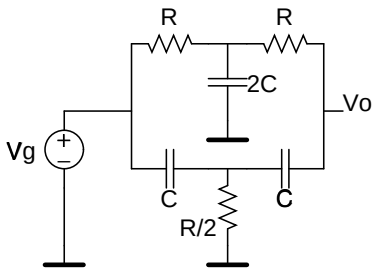
$$H(s) = K \frac{\omega_0^2}{s^2 + \sqrt{2}\omega_0 s + \omega_0^2}$$

$$H(j\omega) = \frac{\omega_0^2 - \omega^2 \omega_0^2 - \sqrt{2}\omega\omega_0 j}{\omega^4 + \omega_0^4}$$

$$|H(j\omega)| = \frac{\omega_0^2}{\sqrt{\omega_0^4 + \omega^4}} = \frac{\left(\frac{f_c}{f}\right)^2}{\sqrt{1 + \left(\frac{f_c}{f}\right)^4}}$$

$\xi = \frac{1}{\sqrt{2}}$
$f_c = \frac{\omega_c}{2\pi}$

2.4 Filtre trampa de 2on ordre



$$H(s) = \frac{s^2 + \left(\frac{1}{RC}\right)^2}{s^2 + \frac{4}{RC}s + \left(\frac{1}{RC}\right)^2}$$

Deduit de:

$$\begin{bmatrix} 2(Cs+G) & 0 & -G \\ 0 & 2(Cs+G) & -Cs \\ -G & -Cs & Cs+G \end{bmatrix} \begin{bmatrix} V_1(s) \\ V_2(s) \\ V_o(s) \end{bmatrix} = \begin{bmatrix} GVg(s) \\ CsVg(s) \\ 0 \end{bmatrix}$$

2.5 Filtre pas alt de 2on ordre

$$H(s) = \frac{s^2}{s^2 + \sqrt{2}\omega_0 s + \omega_0^2}$$

$$H(j\omega) = \frac{\omega^2 - \omega^2\omega_0^2 + \sqrt{2}\omega_0\omega^3 j}{\omega^4 + \omega_0^2}$$

$$|H(j\omega)| = \frac{\omega}{\sqrt{\omega^2 + \omega_0^2}} = \frac{\left(\frac{f}{f_c}\right)^2}{\sqrt{1 + \left(\frac{f}{f_c}\right)^4}} = \frac{1}{\sqrt{1 + \left(\frac{f_c}{f}\right)^4}}$$

2.6 Filtre pas alt de 1er ordre

$$H(s) = \frac{s}{s + \frac{1}{RC}} = \frac{s}{s + \omega_c}$$

$$|H(j\omega)| = \frac{\frac{f}{f_c}}{\sqrt{1 + \left(\frac{f}{f_c}\right)^2}}$$

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

2.7 Filtre pas baix de 1er ordre

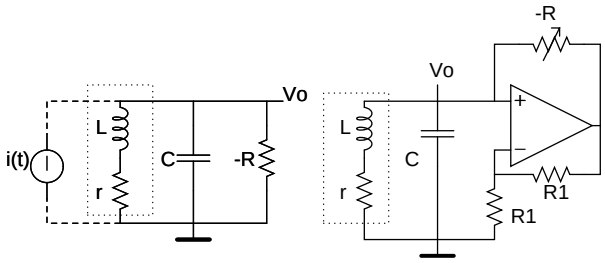
$$H(s) = \frac{\frac{1}{RC}}{s + \frac{1}{RC}} = \frac{\omega_c}{s + \omega_c}$$

$$|H(j\omega)| = \frac{\frac{f_c}{f}}{\sqrt{1 + \left(\frac{f_c}{f}\right)^2}}$$

$\omega_c = \frac{1}{RC} = \frac{1}{\tau}$

$$H(j\omega) = \frac{\omega_c^2 - j\omega\omega_c}{\omega^2 + \omega_c^2}$$

3 Oscil·lador



$f_0 = \frac{1}{2\pi}\frac{1}{\sqrt{LC}}$
Ideal LC:

$$H(s) = \frac{1}{C}\frac{s}{s^2 + \frac{1}{LC}} = \frac{\dots}{s^2 + \omega_0^2}$$

No ideal:

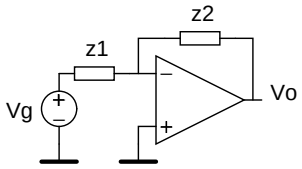
$$H(s) = \frac{1}{C}\frac{s + \frac{r}{L}}{s^2 + \frac{r}{L}s + \frac{1}{LC}}$$

Arreglat amb -R:

$$H(s) = \frac{1}{C}\frac{s + \frac{r}{L}}{s^2 + \left(\frac{r}{L} - \frac{1}{RC}\right)s - \frac{R-r}{R}\frac{1}{LC}}$$

$R = \frac{L}{rC}$

4 Disseny de circuits a partir de Bode (Baixes freqüències)



$z_1(s) = \frac{N_1}{D_1}; z_2(s) = \frac{N_2}{D_2}$
$H(s) = -\frac{z_2(s)}{z_1(s)} = -\frac{N_2 \cdot D_1}{N_1 \cdot D_2} = \frac{Z_2 \cdot P_1}{P_2 \cdot Z_1}$
Per un amplificador no inversor:

$$H(s) = \left(1 + \frac{z_2}{z_1}\right) = 1 + \frac{Z_2 P_1}{P_2 Z_1} = \frac{P_2 Z_1 + Z_2 P_1}{P_2 Z_1}$$

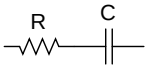
4.1 R

$z(s) = R$
Ni pols ni zeros a $H(s)$

4.2 C

$z(s) = \frac{1}{Cs}$
Pol a l'origen

4.3 RC sèrie



$z(s) = R + \frac{1}{Cs} = \frac{RCs+1}{Cs}$
Zero real a $\frac{-1}{RC}$i Pol a l'origen

4.4 RC paral·lel

$z(s) = \frac{\frac{1}{C}}{s+\frac{1}{RC}} = R\frac{\frac{1}{RC}}{s+\frac{1}{RC}}$
Pol real a $\frac{-1}{RC}$