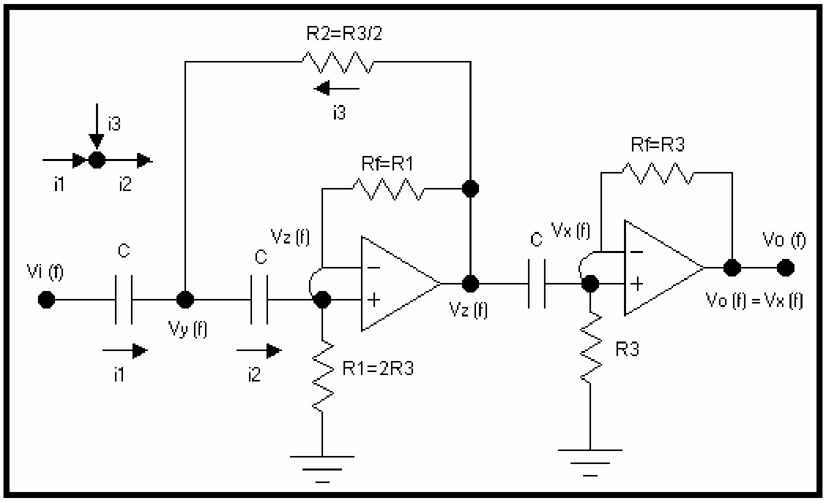
FILTRO PASA ALTAS –60 db / dec



a. Hallar $A_v(w) = f(R, C, w)$

$$V_x(w) = \frac{R_3}{R_3 + Z_c} V_z(w) \quad \rightarrow \quad V_x(w) = \frac{R_3}{R_3 + \frac{1}{jwC}} V_z(w) \quad \rightarrow$$

$$V_x(w) = \frac{R_3}{\frac{jwR_3C + 1}{jwC}} V_z(w)$$

$$V_x(w) = V_o(w) \quad \rightarrow \quad \boxed{V_o(w) = \frac{jwR_3C}{jwR_3C + 1} V_z(w) \quad (1)}$$

$$V_z(w) = \frac{2R_3}{2R_3 + Z_c} V_y(w) \quad \rightarrow \quad V_z(w) = \frac{2R_3}{2R_3 + \frac{1}{jwC}} V_y(w)$$

$$\boxed{V_z(w) = \frac{2\,jwR_3C}{2\,jwR_3C + 1} V_y(w) \quad (2)}$$

$$i_2 = i_1 + i_3$$

$$\frac{V_y}{Z_c} - \frac{V_z}{Z_c} = \frac{V_i}{Z_c} - \frac{V_y}{Z_c} + \frac{V_z}{\frac{R_3}{2}} - \frac{V_y}{\frac{R_3}{2}} \quad \rightarrow \quad \frac{V_y}{Z_c} - \frac{V_z}{Z_c} = \frac{V_i}{Z_c} - \frac{V_y}{Z_c} + \frac{2V_z}{R_3} - \frac{2V_y}{R_3}$$

$$\frac{V_y}{Z_c}+\frac{V_y}{Z_c}+\frac{2V_y}{R_3}=\frac{V_i}{Z_c}+\frac{2V_z}{R_3}+\frac{V_z}{Z_c} \quad\rightarrow\quad V_y\left(\frac{2}{Z_c}+\frac{2}{R_3}\right)=\frac{R_3V_i+2Z_cV_z+R_3V_z}{R_3Z_c}$$

$$V_y=\frac{\dfrac{R_3V_i+2Z_cV_z+R_3V_z}{R_3Z_c}}{\dfrac{2R_3+2Z_c}{R_3Z_c}} \quad\rightarrow\quad V_y=\frac{R_3V_i+\dfrac{2}{jwC}V_z+R_3V_z}{2R_3+\dfrac{2}{jwC}}$$

$$V_y=\frac{\dfrac{jwR_3CV_i+2V_z+jwR_3CV_z}{jwC}}{\dfrac{2jwR_3C+2}{jwC}} \quad\rightarrow\quad \boxed{V_y=\frac{jwR_3CV_i+2V_z+jwR_3CV_z}{2jwR_3C+2} \quad (3)}$$

Reemplazo 3 en 2

$$V_z(w)=\frac{2jwR_3C}{2jwR_3C+1}\left[\frac{jwR_3CV_i+2V_z+jwR_3CV_z}{2jwR_3C+2}\right]$$

$$(2jwR_3C+1)(2jwR_3C+2)V_z(w)-4jwR_3CV_z-2(jwR_3C)^2V_z=2(jwR_3C)^2V_i$$

$$V_z(w)\left[(2jwR_3C+1)(2jwR_3C+2)-4jwR_3C-2(jwR_3C)^2\right]=2(jwR_3C)^2V_i$$

$$V_z(w)=\frac{2(jwR_3C)^2}{(2jwR_3C+1)(2jwR_3C+2)-4jwR_3C-2(jwR_3C)^2}V_i$$

$$V_z(w)=\frac{-2w^2R_3{}^2C^2}{-4w^2R_3{}^2C^2+2jwR_3C+4jwR_3C+2-4jwR_3C+2w^2R_3{}^2C^2}V_i$$

$$\boxed{V_z(w)=\frac{-2w^2R_3{}^2C^2}{-2w^2R_3{}^2C^2+2jwR_3C+2}V_i \quad (4)}$$

Reemplazo 4 en 1

$$V_o(w)=\frac{jwR_3C}{jwR_3C+1}\left[\frac{-2w^2R_3{}^2C^2}{-2w^2R_3{}^2C^2+2jwR_3C+2}V_i\right]$$

$$V_o(w)=\frac{-2jw^3R_3{}^3C^3}{-2jw^3R_3{}^3C^3-2w^2R_3{}^2C^2+2jwR_3C-2w^2R_3{}^2C^2+2jwR_3C+2}V_i$$

$$\frac{V_o(w)}{V_i\ (w)}=\frac{-2\,jw^3R_3{}^3C^3}{-2\,jw^3R_3{}^3C^3-4w^2R_3{}^2C^2+4\,jwR_3C+2}$$

$$\boxed{\left|A_v(w)\right|=\frac{-2w^3R_3{}^3C^3}{\sqrt{\left(2-4w^2R_3{}^2C^2\right)^2+\left(4wR_3C-2w^3R_3{}^3C^3\right)^2}}}$$

$$\lim_{w\to\infty}A_v(w)=\frac{\infty}{\infty}=1$$ (Las frecuencias altas pasan)

$$\lim_{w\to 0}A_v(w)=\frac{0}{\sqrt{4}}=\frac{0}{2}=0$$ (Las frecuencias bajas no pasan)

b. Hallar $w_c\ \ y\ \ f_c$

$$\frac{1}{\sqrt{2}}=\frac{-2w_c{}^3R_3{}^3C^3}{\sqrt{\left(2-4w_c{}^2R_3{}^2C^2\right)^2+\left(4w_cR_3C-2w_c{}^3R_3{}^3C^3\right)^2}}$$

$$\left(\sqrt{\left(2-4w_c{}^2R_3{}^2C^2\right)^2+\left(4w_cR_3C-2w_c{}^3R_3{}^3C^3\right)^2}=-2w_c{}^3R_3{}^3C^3\sqrt{2}\right)^2$$

$$\left(2-4w_c{}^2R_3{}^2C^2\right)^2+\left(4w_cR_3C-2w_c{}^3R_3{}^3C^3\right)^2=\left(-2w_c{}^3R_3{}^3C^3\sqrt{2}\right)^2$$

$$4-16w_c{}^2R_3{}^2C^2+16w_c{}^4R_3{}^4C^4+16w_c{}^2R_3{}^2C^2-16w_c{}^4R_3{}^4C^4+4w_c{}^6R_3{}^6C^6=8w_c{}^6R_3{}^6C^6$$

$$4+4w_c{}^6R_3{}^6C^6=8w_c{}^6R_3{}^6C^6$$

$$4w_c{}^6R_3{}^6C^6=4\quad\rightarrow\quad w_c{}^6=\frac{4}{4R_3{}^6C^6}\quad\rightarrow\quad\sqrt[6]{w_c{}^6}=\sqrt[6]{\frac{1}{R_3{}^6C^6}}$$

$$\boxed{w_c=\frac{1}{R_3C}}\quad\rightarrow\quad 2\pi f_c=\frac{1}{R_3C}\quad\rightarrow\quad\boxed{f_c=\frac{1}{2\pi R_3C}}$$

c. Hallar $\left|A_v(f)\right|=f(f,f_c)$

$$A_v(w)=\frac{-2\left(\frac{w}{w_c}\right)^3}{\sqrt{\left(2-4\left(\frac{w}{w_c}\right)^2\right)^2+\left(4\left(\frac{w}{w_c}\right)-2\left(\frac{w}{w_c}\right)^3\right)^2}}$$

$$A_v(w) = \frac{-2\left(\frac{2\pi f}{2\pi f_c}\right)^3}{\sqrt{\left(2-4\left(\frac{2\pi f}{2\pi f_c}\right)^2\right)^2 + \left(4\left(\frac{2\pi f}{2\pi f_c}\right) - 2\left(\frac{2\pi f}{2\pi f_c}\right)^3\right)^2}}$$

$$\boxed{A_v(w) = \frac{-2\left(\frac{f}{f_c}\right)^3}{\sqrt{\left(2-4\left(\frac{f}{f_c}\right)^2\right)^2 + \left(4\left(\frac{f}{f_c}\right) - 2\left(\frac{f}{f_c}\right)^3\right)^2}}}$$

d. Dibujar $|A_v(f)|\ \ Vs\ \ f$

$$\boxed{A_v(w) = \frac{-2\left(\frac{f}{f_c}\right)^3}{\sqrt{\left(2-4\left(\frac{f}{f_c}\right)^2\right)^2 + \left(4\left(\frac{f}{f_c}\right) - 2\left(\frac{f}{f_c}\right)^3\right)^2}}} \qquad \boxed{A_v = 20\log\left(\frac{V_0}{V_i}\right)}$$

f	$\lvert A_V(f)\rvert$	$\lvert A_V(f)\rvert\ db$
0	0	0
0.1fc	0	-60
0.5fc	0.1	-18
0.8 fc	0.5	-7
Fc	0.7	-3
2 fc	1	0
4 fc	1	0
6 fc	1	0
8 fc	1	0
10 fc	1	0