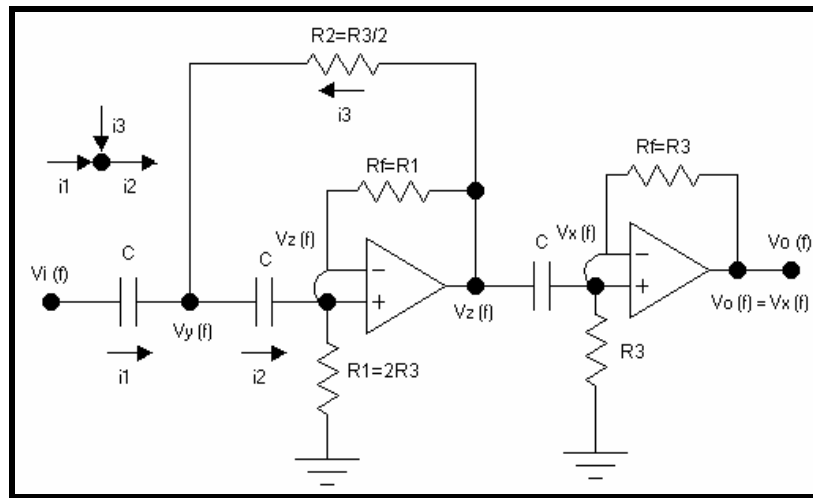


FILTRO PASA ALTAS -60 db/dec



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

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

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

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

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

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

$$i_2 = i_1 + i_3$$

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



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

$$V_y = \frac{\frac{R_3 V_i + 2Z_c V_z + R_3 V_z}{R_3 Z_c}}{\frac{2R_3 + 2Z_c}{R_3 Z_c}} \quad \rightarrow \quad V_y = \frac{R_3 V_i + \frac{2}{j\omega C} V_z + R_3 V_z}{2R_3 + \frac{2}{j\omega C}}$$

$$V_y = \frac{\frac{j\omega R_3 C V_i + 2V_z + j\omega R_3 C V_z}{j\omega C}}{2j\omega R_3 C + 2} \quad \rightarrow \quad \boxed{V_y = \frac{j\omega R_3 C V_i + 2V_z + j\omega R_3 C V_z}{2j\omega R_3 C + 2}} \quad (3)$$

Reemplazo 3 en 2

$$V_z(w) = \frac{2j\omega R_3 C}{2j\omega R_3 C + 1} \left[ \frac{j\omega R_3 C V_i + 2V_z + j\omega R_3 C V_z}{2j\omega R_3 C + 2} \right]$$

$$(2j\omega R_3 C + 1)(2j\omega R_3 C + 2)V_z(w) - 4j\omega R_3 C V_z - 2(j\omega R_3 C)^2 V_z = 2(j\omega R_3 C)^2 V_i$$

$$V_z(w) \left[ (2j\omega R_3 C + 1)(2j\omega R_3 C + 2) - 4j\omega R_3 C - 2(j\omega R_3 C)^2 \right] = 2(j\omega R_3 C)^2 V_i$$

$$V_z(w) = \frac{2(j\omega R_3 C)^2}{(2j\omega R_3 C + 1)(2j\omega R_3 C + 2) - 4j\omega R_3 C - 2(j\omega R_3 C)^2} V_i$$

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

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

Reemplazo 4 en 1

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

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



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

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

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

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

**b. Hallar  $w_c$  y  $f_c$**

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

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

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

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

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

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

$$w_c = \frac{1}{R_3 C}$$

$$\rightarrow \quad 2\pi f_c = \frac{1}{R_3 C}$$

$$f_c = \frac{1}{2\pi R_3 C}$$

**c. Hallar  $|A_v(f)| = f(f, f_c)$**

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



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

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

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

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

$$A_v = 20 \log \left( \frac{V_o}{V_i} \right)$$

<b>f</b>	<b><math> A_v(f) </math></b>	<b><math> A_v(f) </math> db</b>
<b>0</b>	0	0
<b>0.1fc</b>	0	-60
<b>0.5fc</b>	0.1	-18
<b>0.8 fc</b>	0.5	-7
<b>Fc</b>	0.7	-3
<b>2 fc</b>	1	0
<b>4 fc</b>	1	0
<b>6 fc</b>	1	0
<b>8 fc</b>	1	0
<b>10 fc</b>	1	0