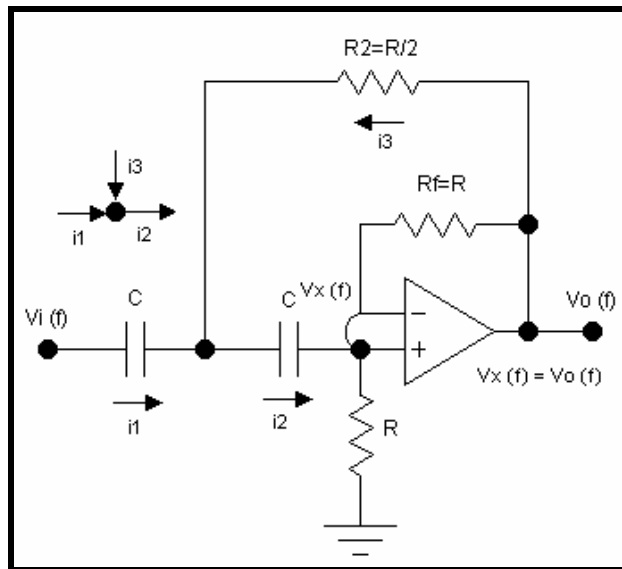


FILTRO PASA ALTAS DE  $-40$  db/dec



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

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

$$V_x(w) = \frac{R}{\frac{jwRC + 1}{jwC}} V_y(w)$$

$$V_x(w) = \frac{jwRC}{jwRC + 1} V_y(w) \quad \rightarrow \quad V_x(w) = V_o(w) \quad \rightarrow$$

$$\boxed{V_o(w) = \frac{jwRC}{jwRC + 1} V_y(w)} \quad (1)$$

$$i_2 = i_1 + i_3$$

$$\frac{V_y}{Z_c} - \frac{V_x}{Z_c} = \frac{V_i}{Z_c} - \frac{V_y}{Z_c} + \frac{V_x}{\frac{R}{2}} - \frac{V_y}{\frac{R}{2}} \quad \rightarrow \quad \frac{V_y}{Z_c} - \frac{V_x}{Z_c} = \frac{V_i}{Z_c} - \frac{V_y}{Z_c} + \frac{2V_x}{R} - \frac{2V_y}{R}$$

$$\frac{V_y}{Z_c} + \frac{V_y}{Z_c} + \frac{2V_y}{R} = \frac{V_i}{Z_c} + \frac{2V_x}{R} + \frac{V_x}{Z_c} \quad \rightarrow \quad V_y \left( \frac{2}{Z_c} + \frac{2}{R} \right) = \frac{RV_i + 2Z_c V_x + RV_x}{RZ_c}$$



$$V_y(w) = \frac{\frac{RV_i + 2Z_c V_x + RV_x}{RZ_c}}{\frac{2R + 2Z_c}{RZ_c}} \rightarrow V_y(w) = \frac{RV_i + 2Z_c V_x + RV_x}{2R + 2Z_c}$$

$$V_y(w) = \frac{RV_i + \frac{2V_x}{j\omega C} + RV_x}{2R + \frac{2}{j\omega C}} \rightarrow V_y(w) = \frac{\frac{j\omega RC V_i + 2V_x + j\omega RC V_x}{j\omega C}}{\frac{2j\omega RC + 2}{j\omega C}}$$

$$V_y(w) = \frac{j\omega RC V_i + 2V_x + j\omega RC V_x}{2j\omega RC + 2} \rightarrow V_x(w) = V_o(w)$$

$$V_y(w) = \frac{j\omega RC V_i + 2V_o + j\omega RC V_o}{2j\omega RC + 2} \quad (2)$$

Reemplazando 2 en 1

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

$$V_o(w) = \frac{(j\omega RC)^2 V_i + 2j\omega RC V_o + (j\omega RC)^2 V_o}{2(j\omega RC + 1)^2}$$

$$2(j\omega RC + 1)^2 V_o(w) - 2j\omega RC V_o - (j\omega RC)^2 V_o = (j\omega RC)^2 V_i$$

$$V_o(w) \left[ 2(j\omega RC + 1)^2 - 2j\omega RC - (j\omega RC)^2 \right] = (j\omega RC)^2 V_i$$

$$V_o(w) = \frac{-w^2 R^2 C^2 V_i}{2(-w^2 R^2 C^2 + 2j\omega RC + 1) - 2j\omega RC + w^2 R^2 C^2}$$

$$V_o(w) = \frac{-w^2 R^2 C^2}{-2w^2 R^2 C^2 + 4j\omega RC + 2 - 2j\omega RC + w^2 R^2 C^2} V_i$$

$$\frac{V_o(w)}{V_i(w)} = \frac{-w^2 R^2 C^2}{-w^2 R^2 C^2 + 2j\omega RC + 2} \rightarrow \boxed{|A_v(w)| = \frac{-w^2 R^2 C^2}{\sqrt{(2 - w^2 R^2 C^2)^2 + (2wRC)^2}}}$$

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



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

b. Hallar  $w_c$  y  $f_c$

$$\frac{1}{\sqrt{2}} = \frac{-w_c^2 R^2 C^2}{\sqrt{(2 - w_c^2 R^2 C^2)^2 + (2w_c RC)^2}} \rightarrow$$

$$\left( \sqrt{(2 - w_c^2 R^2 C^2)^2 + (2w_c RC)^2} = -w_c^2 R^2 C^2 \sqrt{2} \right)^2$$

$$(2 - w_c^2 R^2 C^2)^2 + (2w_c RC)^2 = 2w_c^4 R^4 C^4$$

$$4 - 4w_c^2 R^2 C^2 + w_c^4 R^4 C^4 + 4w_c^2 R^2 C^2 = 2w_c^4 R^4 C^4$$

$$4 + w_c^4 R^4 C^4 = 2w_c^4 R^4 C^4 \rightarrow w_c^4 R^4 C^4 = 4 \rightarrow w_c^4 = \frac{4}{R^4 C^4}$$

$$\sqrt[4]{w_c^4} = \sqrt[4]{\frac{4}{R^4 C^4}} \rightarrow \boxed{w_c = \frac{\sqrt[4]{4}}{RC} = \frac{\sqrt{2}}{RC}} \rightarrow 2\pi f_c = \frac{\sqrt{2}}{RC} \rightarrow \boxed{f_c = \frac{\sqrt{2}}{2\pi RC}}$$

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

$$A_v(w) = \frac{-w^2 \left( \frac{\sqrt{2}}{w_c} \right)^2}{\sqrt{\left( 2 - w^2 \left( \frac{\sqrt{2}}{w_c} \right)^2 \right)^2 + \left( 2w \frac{\sqrt{2}}{w_c} \right)^2}} \rightarrow A_v(w) = \frac{-2 \left( \frac{w}{w_c} \right)^2}{\sqrt{\left( 2 - 2 \left( \frac{w}{w_c} \right)^2 \right)^2 + 8 \left( \frac{w}{w_c} \right)^2}}$$

$$A_v(w) = \frac{-2 \left( \frac{2\pi f}{2\pi f_c} \right)^2}{\sqrt{\left( 2 - 2 \left( \frac{2\pi f}{2\pi f_c} \right)^2 \right)^2 + 8 \left( \frac{2\pi f}{2\pi f_c} \right)^2}} \rightarrow \boxed{A_v(w) = \frac{-2 \left( \frac{f}{f_c} \right)^2}{\sqrt{\left( 2 - 2 \left( \frac{f}{f_c} \right)^2 \right)^2 + 8 \left( \frac{f}{f_c} \right)^2}}}$$

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



$$A_v(w) = \frac{-2\left(\frac{f}{f_c}\right)^2}{\sqrt{\left(2 - 2\left(\frac{f}{f_c}\right)^2\right)^2 + 8\left(\frac{f}{f_c}\right)^2}}$$

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

<b>f</b>	<b><math> A_v(f) </math></b>	<b><math> A_v(f) </math> db</b>
<b>0</b>	0	0
<b>0.1 fc</b>	0.01	-40
<b>0.5 fc</b>	0.24	-12
<b>0.8 fc</b>	0.54	-5
<b>fc</b>	0.71	-3
<b>2 fc</b>	0.97	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