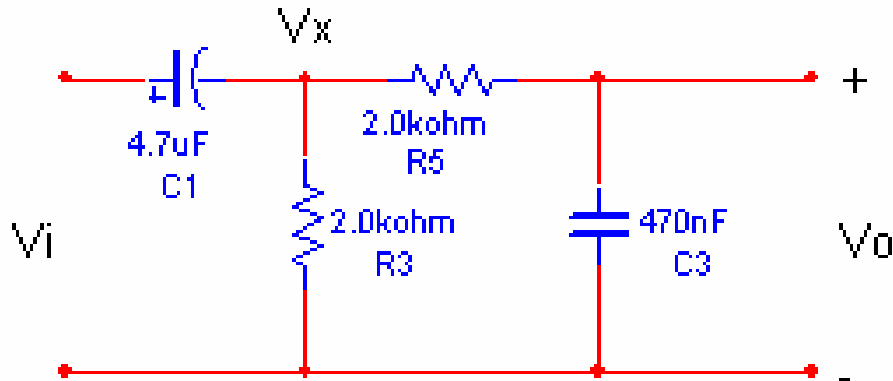


FILTRO PASABANDA: BANDA ANCHA



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

$$V_x = \frac{R_3}{R_3 + Z_{C_1}} V_i \rightarrow V_x = \frac{R_3}{R_3 + \frac{1}{j\omega C_1}} V_i \rightarrow \boxed{V_x = \frac{j\omega R_3 C_1}{1 + j\omega R_3 C_1} V_i} \quad (1)$$

$$V_o = \frac{Z_{C_3}}{Z_{C_3} + R_5} V_x \rightarrow V_o = \frac{\frac{1}{j\omega C_3}}{\frac{1}{j\omega C_3} + R_5} V_x \rightarrow \boxed{V_o = \frac{1}{1 + j\omega R_5 C_3} V_x} \quad (2)$$

Reemplazando 1 en 2

$$V_o = \frac{1}{1 + j\omega R_5 C_3} * \frac{j\omega R_3 C_1}{1 + j\omega R_3 C_1} V_i \quad V_o = \frac{j\omega R_3 C_1}{(1 + j\omega R_5 C_3)(1 + j\omega R_3 C_1)} V_i$$

$$\frac{V_o}{V_i} = \frac{j\omega R_3 C_1}{- \omega^2 R_5 R_3 C_3 C_1 + j\omega R_3 C_1 + j\omega R_5 C_3 + 1}$$

Dado que  $\frac{V_o}{V_i}$  forma la ganancia del filtro en función de la frecuencia en forma fasorial su módulo se halla hallando la raíz cuadrada de la suma de su parte real e imaginaria al cuadrado:

$$\boxed{|A_v(\omega)| = \frac{\omega R_3 C_1}{\sqrt{(1 - \omega^2 R_5 R_3 C_3 C_1)^2 + (\omega R_3 C_1 + \omega R_5 C_3)^2}}$$

b. Hallar  $\omega_c$  y  $f_c$

$$\frac{1}{\sqrt{2}} = \frac{\omega R_3 C_1}{\sqrt{(1 - \omega^2 R_5 R_3 C_3 C_1)^2 + (\omega R_3 C_1 + \omega R_5 C_3)^2}}$$



$$\begin{aligned} \sqrt{(1 - w^2 R_5 R_3 C_3 C_1)^2 + (w R_3 C_1 + w R_5 C_3)^2} &= \sqrt{2 w R_3 C_1} \\ \left( \sqrt{(1 - w^2 R_5 R_3 C_3 C_1)^2 + (w R_3 C_1 + w R_5 C_3)^2} \right)^2 &= \left( \sqrt{2 w R_3 C_1} \right)^2 \\ (1 - w^2 R_5 R_3 C_3 C_1)^2 + (w R_3 C_1 + w R_5 C_3)^2 &= 2 w^2 R_3^2 C_1^2 \\ 1 - 2 w^2 R_5 R_3 C_3 C_1 + w^4 R_5^2 R_3^2 C_3^2 C_1^2 + w^2 R_3^2 C_1^2 + 2 w^2 R_3 R_5 C_1 C_3 + w^2 R_5^2 C_3^2 &= 2 w^2 R_3^2 C_1^2 \\ 1 + w^4 R_5^2 R_3^2 C_3^2 C_1^2 - w^2 R_3^2 C_1^2 + w^2 R_5^2 C_3^2 &= 0 \end{aligned}$$

Como:  $f_H = 10 f_L$  (5), entonces:

$$f_L = \frac{1}{2\pi R_3 C_1} \rightarrow f_H = \frac{10}{2\pi R_3 C_1} \rightarrow \frac{1}{2\pi R_5 C_3} = \frac{10}{2\pi R_3 C_1} \rightarrow R_3 C_1 = 10 R_5 C_3 \quad (6)$$

Reemplazando (6) en la ecuación (4), se obtiene:

$$\begin{aligned} 1 + w^4 (10 R_5 C_3)^2 R_5^2 C_3^2 - w^2 (10 R_5 C_3)^2 + w^2 R_5^2 C_3^2 &= 0 \\ 1 + 100 w^4 R_5^4 C_3^4 - 100 w^2 R_5^2 C_3^2 + w^2 R_5^2 C_3^2 &= 0 \\ 1 + 100 w^4 R_5^4 C_3^4 - 99 w^2 R_5^2 C_3^2 &= 0 \\ 1 + 100 w^4 R_5^4 C_3^4 - 99 w^2 R_5^2 C_3^2 &= 0 \\ 1 + w^2 (100 w^2 R_5^4 C_3^4 - 99 R_5^2 C_3^2) &= 0 \\ 1 + w^2 &= 0 \\ 100 w^2 R_5^4 C_3^4 - 99 R_5^2 C_3^2 &= 0 \\ w = \sqrt{-1} \\ w^2 = \frac{99 R_5^2 C_3^2}{100 R_5^4 C_3^4} \quad w = \sqrt{\frac{99}{100 R_5^2 C_3^2}} \quad w = \frac{\sqrt{99}}{10 R_5 C_3} &(6) \end{aligned}$$

$$2\pi f_H = \frac{\sqrt{99}}{10 R_5 C_3} \quad f_H = \frac{\sqrt{99}}{20\pi R_5 C_3} \quad f_H = \frac{0.1584}{R_5 C_3} \quad (7)$$

Reemplazando (7) en la ecuación (5), se obtiene:

$$f_L = \frac{f_H}{10} \quad f_L = \frac{0.1584}{10 R_5 C_3} \quad f_L = \frac{0.01584}{10 R_5 C_3} \quad f_L = \frac{0.01584}{R_5 C_3} \quad (8)$$

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

$$f_r = \sqrt{f_H f_L} \quad f = \sqrt{\frac{0.1584}{R_5 C_3} * \frac{0.01584}{R_5 C_3}} \quad f_r = \frac{0.05}{R_5 C_3} \quad (-10)$$



$$f_r = \sqrt{\left(\frac{0.1583}{R_1 C_1}\right)\left(\frac{0.01583}{R_1 C_1}\right)} = \frac{0.05}{R_1 C_1} \rightarrow \boxed{R_1 C_1 = \frac{0.05}{f_r}}$$

$$|A_v(\omega)| = \frac{10\omega\left(\frac{0.05}{f_r}\right)}{\sqrt{\left(1 - 10\omega^2\left(\frac{0.05}{f_r}\right)^2\right)^2 + \left(11\omega\left(\frac{0.05}{f_r}\right)\right)^2}}$$

$$\boxed{|A_v(\omega)| = \frac{3.1415\left(\frac{f}{f_r}\right)}{\sqrt{\left(1 - 0.986\left(\frac{f}{f_r}\right)^2\right)^2 + \left(3.4557\left(\frac{f}{f_r}\right)\right)^2}}}$$

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

$$\boxed{|A_v(\omega)| = \frac{3.1415\left(\frac{f}{f_r}\right)}{\sqrt{\left(1 - 0.986\left(\frac{f}{f_r}\right)^2\right)^2 + \left(3.4557\left(\frac{f}{f_r}\right)\right)^2}}}$$

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

| f      | $ A_v(f) $ | $ A_v(f) $ db |
|--------|------------|---------------|
| 0      | 0          | 0             |
| 0.1fc  | 0.3        | -10           |
| 0.5fc  | 0.8        | -2            |
| 0.8 fc | 0.9        | -1            |
| fc     | 0.9        | -1            |
| 2 fc   | 0.8        | -2            |
| 4 fc   | 0.6        | -4            |
| 6 fc   | 0.5        | -7            |
| 8 fc   | 0.4        | -9            |
| 10 fc  | 0.3        | -10           |