Electronics 236 → L21, Part2, Opamb Active filters

Bode' plot

$$|A(jw)| = \frac{K}{\sqrt{1+\left(\frac{w}{wc}\right)^2}}$$, when $w=wc$ & $K=1$

$$|A(jw)| = \frac{1}{\sqrt{1+\left(\frac{wc}{wc}\right)^2}} = \frac{1}{\sqrt{2}} = 0.707$$

$$20\log 0.707 = -3dB$$

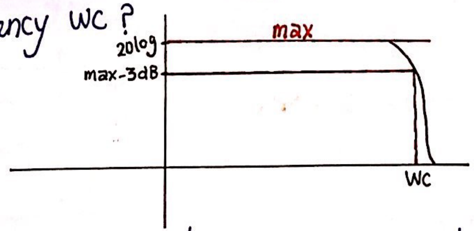
When $k=10$

$$20\log\frac{10}{\sqrt{2}} = \overbrace{20\log 10}^{20} - 20\log\sqrt{2}$$
$$= \boxed{+17\,dB}$$

Note : when $W=Wc$ always value in decibels equal the maximum $-3dB$

$w=\frac{1}{RC}$ "Called cutoff frequancy"

Cutoff frequency wc ?



$$@\ w=0.1\,wc \Rightarrow 20\log\frac{1}{\sqrt{1+\left(\frac{0.1wc}{wc}\right)^2}} = 20\log\frac{1}{\sqrt{1+0.01}} = \frac{1}{\sqrt{1.01}} \approx \boxed{0dB}$$

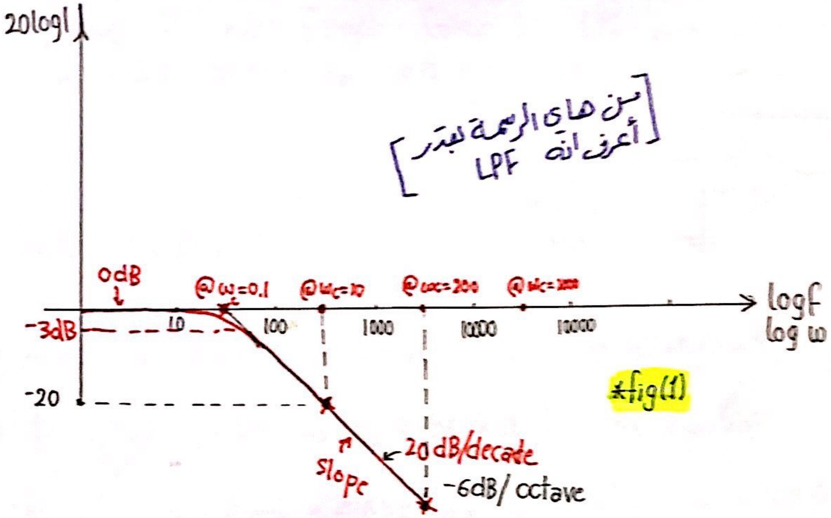
$$@\ w=10\,wc \Rightarrow 20\log\frac{1}{\sqrt{1+\left(\frac{10wc}{wc}\right)^2}} = 20\log\frac{1}{\sqrt{101}} \cong \boxed{-20dB}$$

$$@\ w=100\,W_c \Rightarrow 20\log\frac{1}{\sqrt{1+(100)^2}} \cong 20\log\frac{1}{100} \cong \boxed{-40\,dB}$$

$$@\ w=1000\,W_c \Rightarrow 20\log\frac{1}{\sqrt{1+(1000)^2}} \cong \boxed{-60\,dB}$$

Note: كل ما ضربنا wc x 10 كل ما تنقص المقدار بمقدار 20 dB

L21, Part 2, Opamp Active filter

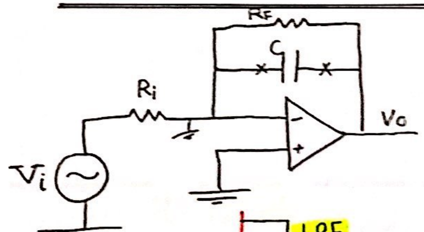


[من هاي الرسمة بقدر أعرف انه LPF]

*fig(1)

20 → -6dB/octave
40 → -12dB/octave
60 → -18dB/octave

للعلم

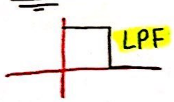


Filter type ? LPF/HPF ? **Inverting**

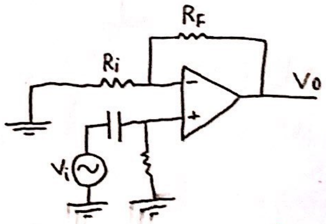
Qualative analysis

$\omega C = 0 \rightarrow C \rightarrow$ open // $V_o = \frac{-R_F}{R_i} . V_i \neq 0$

$\boxed{\omega = \omega_C}$



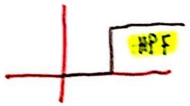
$W = \infty \rightarrow C \rightarrow$ short // $V_o = 0$ "Virtually Ground"



$\omega C = 0 \rightarrow C \rightarrow$ open // $V_o = 0$

$W = \infty \rightarrow C \rightarrow$ Short // $V_o \neq 0$ $\left(1 + \frac{R_F}{R_i}\right) V_i$

Non Inverting



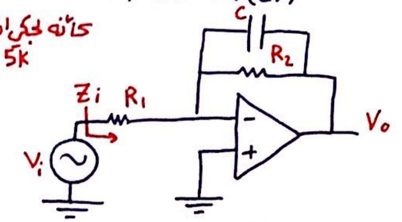
$f_{oH} = \frac{1}{2\pi R C}$

Active filter

يعني بالجزء الثابت من fig(1)

Active LPF filter Example : Given 1-st LPF, with $A_{v(dB)} = 40dB$

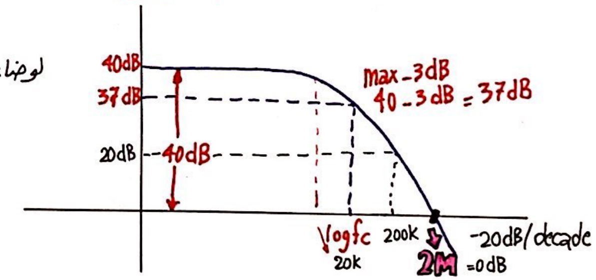
$\omega_c = 2\pi(20kHz)$, $Z_{in} = 5K\Omega$ كأنه حكى انه قيمة $R_1 = 5k$



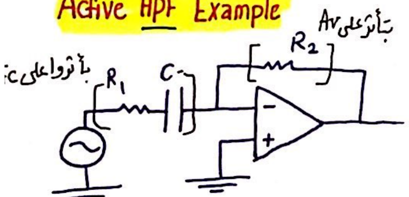
Solution :• $A_v = \dfrac{-K}{(1+\frac{j\omega}{\omega_c})}$;

- $20\log A_v = 40\,dB \Rightarrow A_v = (10)^{40/20}$ @ $\omega = 0 \Rightarrow A_v = 100 = K$] لحساب قيمة K أو الـ Gain
- $K = \dfrac{R_2}{R_1}$, $R_1 = 5K \Rightarrow R_2 = 500k\Omega$] لايجاد قيمة R_2
- $f_c = \dfrac{\omega_c}{2\pi} = \dfrac{1}{2\pi R_2 C} = 20KHz \Rightarrow \therefore C = \dfrac{1}{2\pi(500k)(20k)} = 159\,pf$

لوضاعفنا fc عشرة ← 200K "كم الـ decade in dB"



Active HPF Example



let $\dfrac{1}{R_1 C} = \omega_c$, $-R_2/R_1 = -K$

$$A_v = \frac{-R_2}{R_1 + \frac{1}{j\omega C}} = \frac{-R_2/R_1}{1 + 1/j\omega C R_1} = \frac{K}{(1+\frac{\omega_c}{j\omega})}$$

$\omega_c = 2\pi f_c \Rightarrow f_{oH} = \dfrac{1}{2\pi R_1 C_1}$

$$\left[\begin{array}{l} \omega_c = \frac{1}{RC} \\ K = \frac{R_2}{R_1} \end{array}\right]$$

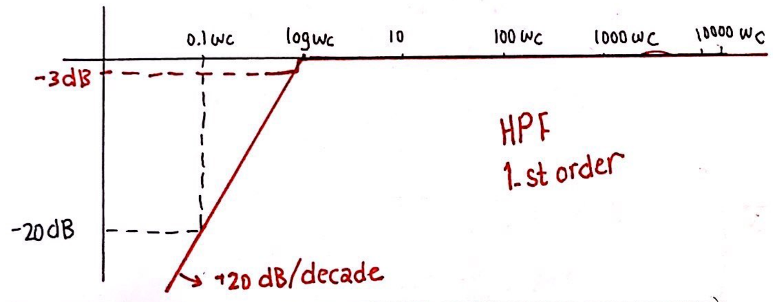
$20\log|A| = 20\log\dfrac{K}{\sqrt{1+(\frac{\omega_c}{\omega})^2}}$ @ $K=1$

for $\omega = \omega_c \Rightarrow 20\log\dfrac{1}{\sqrt{2}} = \boxed{-3\,dB}$

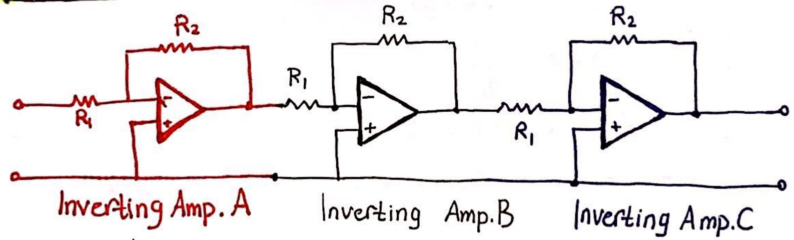
for $\omega = 0.1\omega_c \Rightarrow 20\log\dfrac{1}{\sqrt{101}} = \boxed{-20\,dB}$

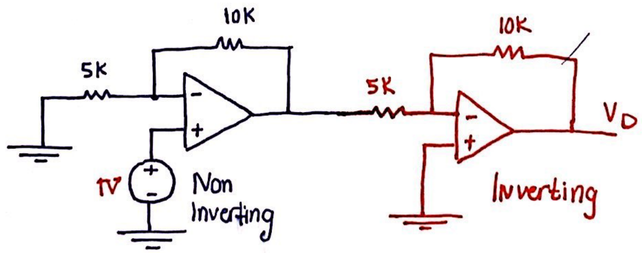
for $\omega = 0.01 \Rightarrow 20\log \Rightarrow \dfrac{1}{\sqrt{10001}} = \boxed{-40\,dB}$

Opamp Active filter



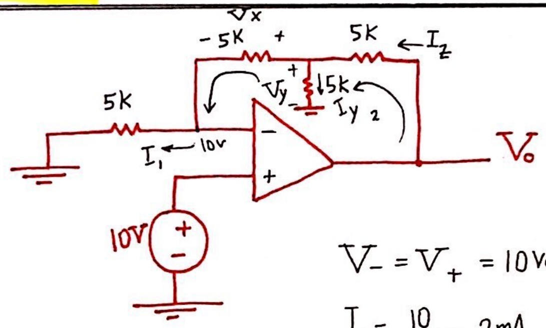
Cascaded Amplifiers





- $V_D = V_B\left(\frac{-10}{5}\right) = -2V_B$
- $V_B = \left(1 + \frac{10K}{5K}\right) \times 1V = 3V$
- $V_D = -2 \times 3 = -6$ Volt

Opamp's



$V_- = V_+ = 10\,\text{Volt}$

$I_1 = \frac{10}{5k} = 2mA$

$V_x = 2mA \times 5k = 10\ \text{volt}$

$V_y = V_x + 10 = 20\ v$

$I_y = \frac{20}{5k} = 4\ mA$

$I_z = 4mA + 2mA = 6mA$

KVL 2

$V_o = V_z + V_y$

$= 6m \times 5k + 20$

$= \underline{\underline{50\ v}}$

Scanned with CamScanner