First order low pass active filter

The voltage V_1 across the capacitor C in the s-domain is

$$V_1(s) = \frac{\frac{1}{sC}}{R + \frac{1}{sC}} V_i(s)$$

So, $$\frac{V_1(s)}{V_i(s)} = \frac{1}{RCs + 1}$$

where $V(s)$ is the Laplace transform of v in time domain.

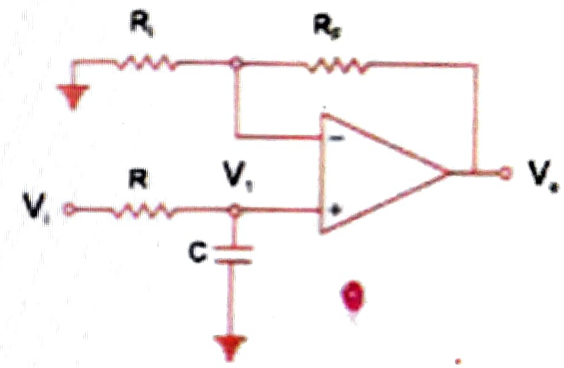
The closed loop gain A_o of the op-amp is,

$$A_o = \frac{V_o(s)}{V_1(s)} = \left(1 + \frac{R_F}{R_1}\right)$$

$$H(s) = \frac{V_o(s)}{V_i(s)} = \frac{V_o(s)}{V_1(s)} \cdot \frac{V_1(s)}{V_i(s)} = \frac{A_o}{RCs + 1}$$

Let $$\omega_h = \frac{1}{RC}$$

Therefore, $$H(s) = \frac{V_o(s)}{V_i(s)} = \frac{A_o}{\frac{s}{\omega_h} + 1} = \frac{A_o \omega_h}{s + \omega_h}$$



(a)

First order low pass active filter

$K = \frac{V_o}{V_i}$ (gain)

gain in dB

$\log_{10}\left(\frac{V_o}{V_i}\right) \rightarrow dB$

impedance ① frequency ($j\omega$) ② S-domain ($s = j\omega$)

The voltage V_1 across the capacitor C in the s-domain is

$$V_1(s) = \frac{\frac{1}{sC}}{R + \frac{1}{sC}} V_i(s)$$

So, $$\frac{V_1(s)}{V_i(s)} = \frac{1}{RCs + 1}$$

where $V(s)$ is the Laplace transform of v in time domain.

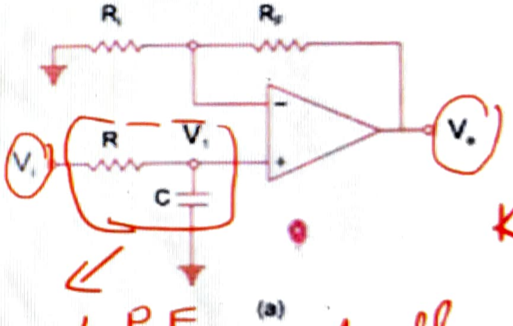
The closed loop gain A_o of the op-amp is,

$$A_o = \frac{V_o(s)}{V_1(s)} = \left(1 + \frac{R_F}{R_1}\right)$$

$$H(s) = \frac{V_o(s)}{V_i(s)} = \frac{V_o(s)}{V_1(s)} \cdot \frac{V_1(s)}{V_i(s)} = \frac{A_o}{RCs + 1}$$

Let $$\omega_h = \frac{1}{RC}$$

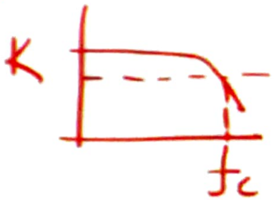
Therefore, $$H(s) = \frac{V_o(s)}{V_i(s)} = \frac{A_o}{\frac{s}{\omega_h} + 1} = \frac{A_o \omega_h}{s + \omega_h}$$



(a)

LPF

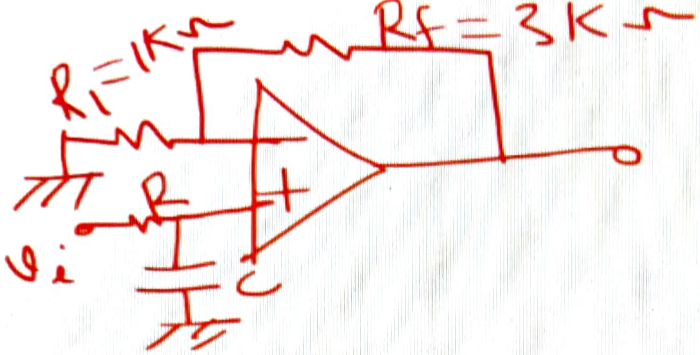
cut off corner



1 KHz /

10 KHz /

100 MHz



$C = 1\mu F$ X large size

let $C = 47\mu F$

R

Design an active lowpass filter with a gain of 4, a corner frequency of 1 kHz

$$1 + \frac{R_f}{R_1} = 4 \Rightarrow \frac{R_f}{R_1} = 3$$

let $R_1 = 1K\Omega$

$R_f = 3K\Omega$

$$\omega_n = \frac{1}{RC}$$

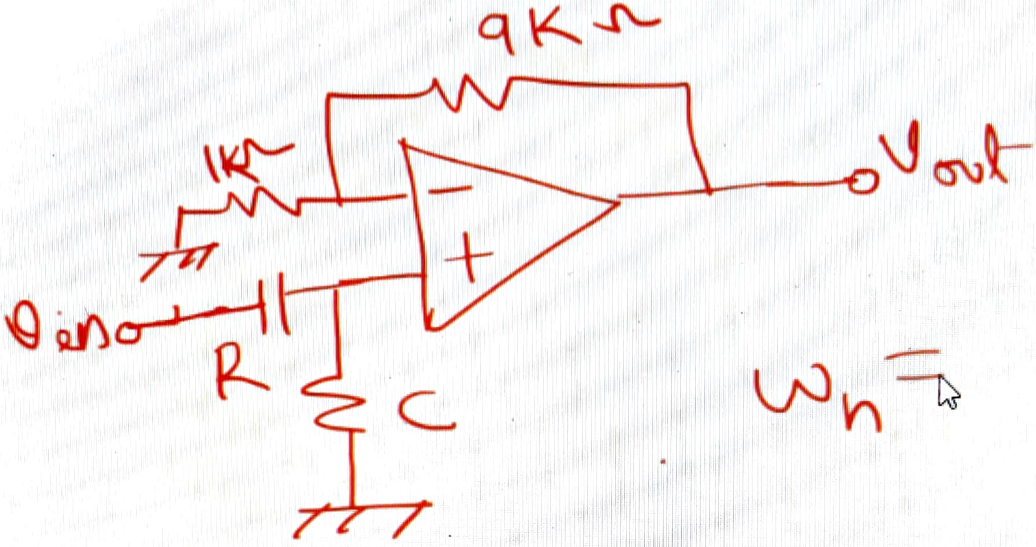
$$f_n = \frac{1}{2\pi RC}$$

let $C = 1\mu F \Rightarrow 10^3 = \frac{1}{2\pi R(10^{-6})} \Rightarrow R = 0.15K\Omega$

$= 159\Omega$

Design an active highpass filter with a gain of 10, a corner frequency of 20 kHz

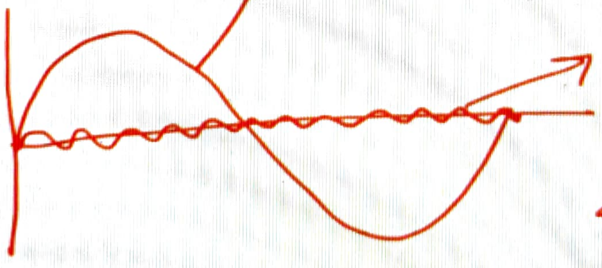
$$1+\frac{R_f}{R_1}=10$$



$\omega_n =$

Filter classification

- Low pass filter (LPF)
- High pass filter (HPF)
- Band pass filter (BPF)
- Band reject filter/Band stop filter (BSF)



noise HF & low magnitude

I were to remove noise