Low Pass Filter Example

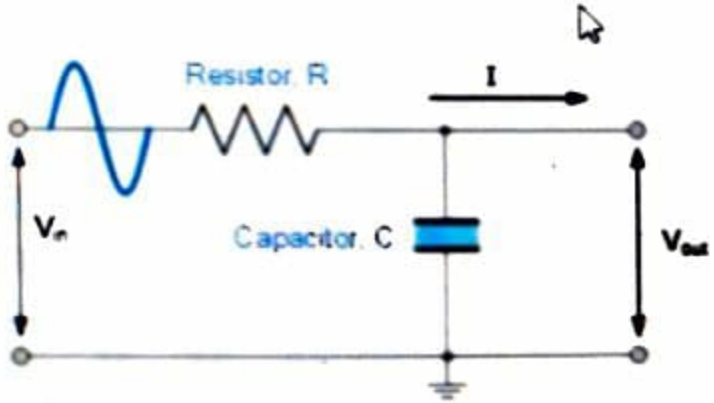
A Low Pass Filter circuit consisting of a resistor of 4.7 kΩ in series with a capacitor of 47 nF is connected across a 10 V sinusoidal supply. Calculate the output voltage (V_{out}) at a frequency of 100 Hz, 200 Hz and again at frequency of 10kHz, 11 kHz.

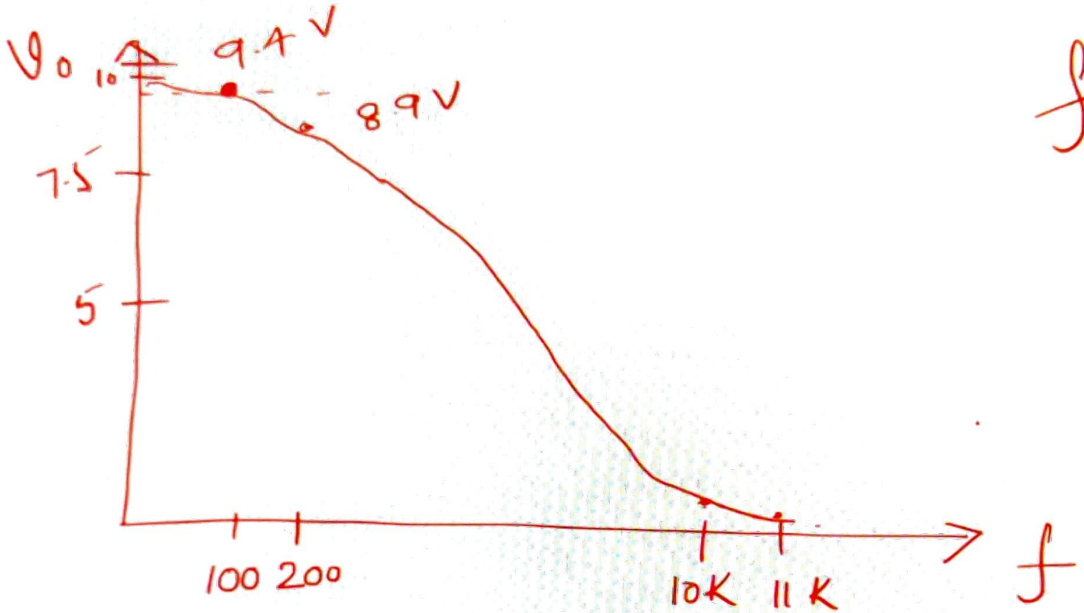
$$X_c = \frac{1}{2\pi fC}$$

$$Z = R - jX_c$$

$$|Z| = \sqrt{R^2 + X_c^2}$$

$$V_{out} = V_{in} \frac{X_c}{\sqrt{R^2 + X_c^2}} = V_{in} \frac{X_c}{Z}$$





frequency response (V_o, f)

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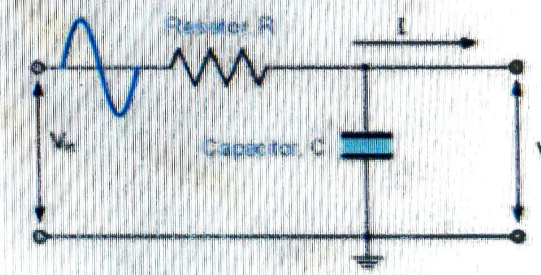
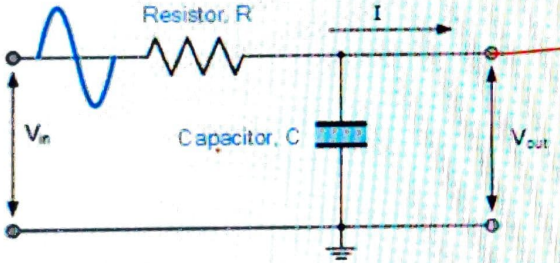


Active filter



non-inverting HPAF

Inverting HPAF

non-Inverting LP Active filter

Inverting LP Active filter

High-pass RC filter

$$H(j\omega) = \frac{V_o}{V_i} = \frac{R}{R + 1/(j\omega C)} = \frac{1}{1 - j(1/\omega RC)}$$

gain

frequency response

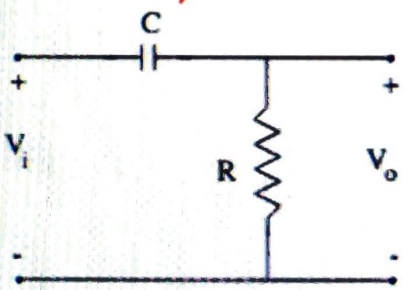
when

f = 100 Hz

200 Hz

10 KHz

20 KHz



→ from previous problem

Start a **business:** $999 - too much
Buy a new **iPhone:** $999 - no problem

Healthy **groceries:** $100 - too much
Dinner & **drinks:** $100 - no problem

Watch **Netflix:** 2 hrs - 1 more episode
Learn a new **skill:** 2 hrs - no time

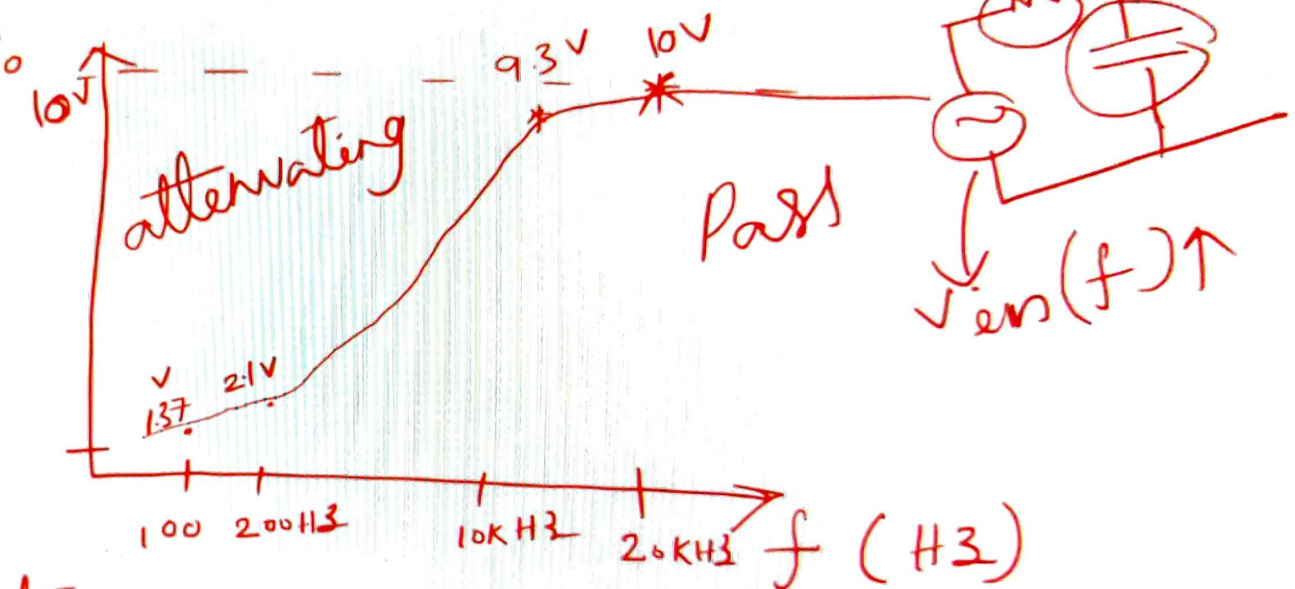
Life is about choices. stop blaming the "LACK OF OPPORTUNITY."

clean

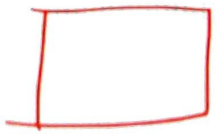
Gain

creative minds

frequency response of HPF

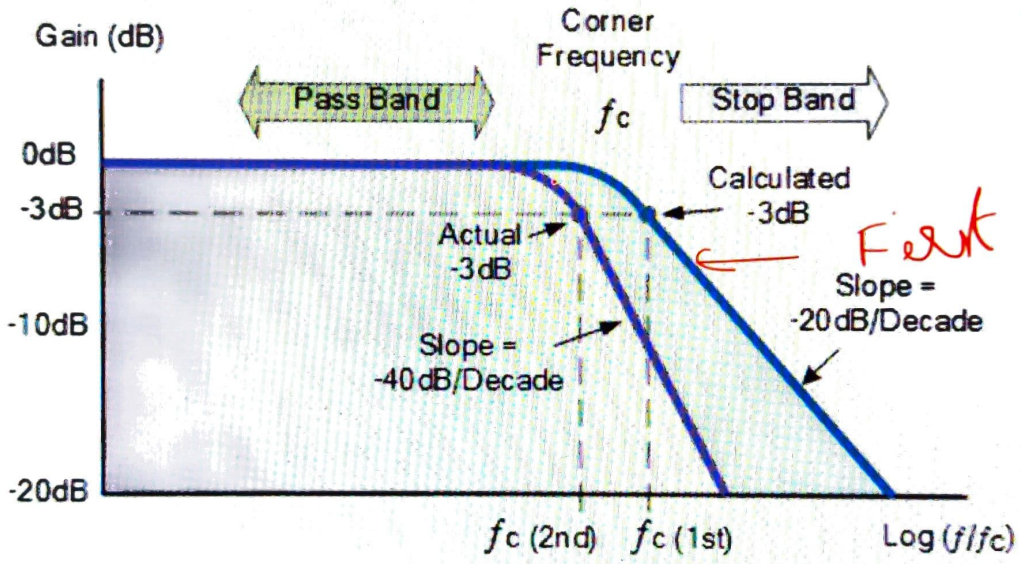


charging fast



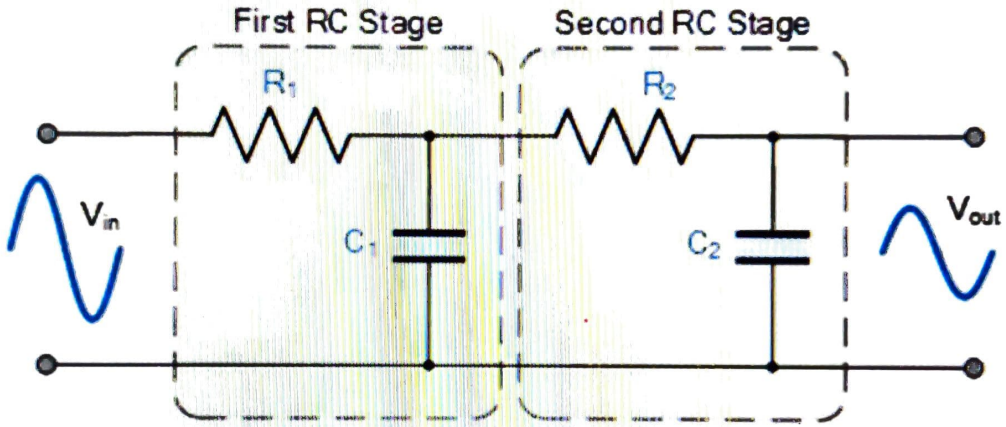
charging wire

Frequency Response of a 2nd-order Low Pass Filter



First

Second-order Low Pass Filter

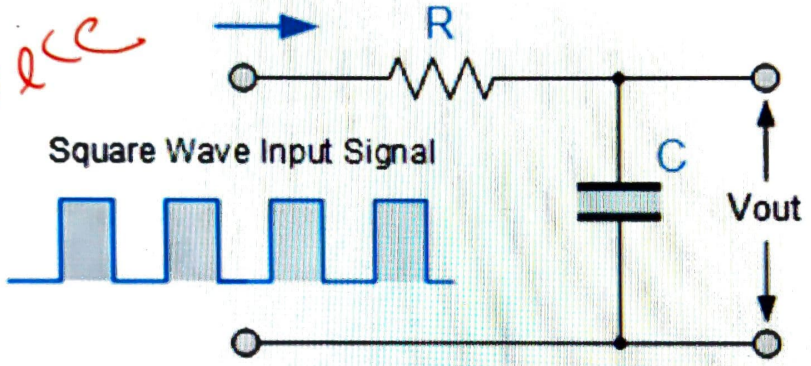


If -20dB/decade angle of the slope is not enough to remove an unwanted signal, then two stages of filtering can be used

The RC Integrator Circuit

Simulate in LT Spice

Lab hour



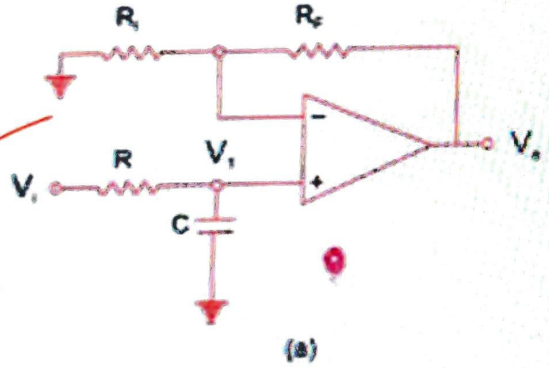
V_{out} at Low Frequencies

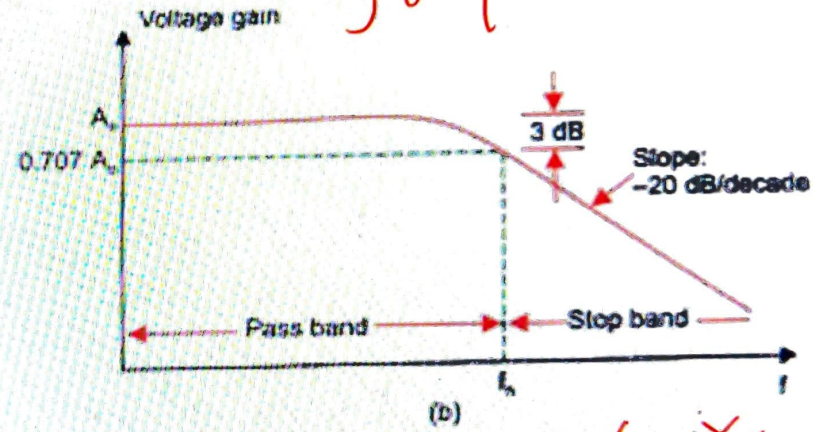
V_{out} at Medium Frequencies

V_{out} at High Frequencies

First order low pass active filter

frequency response





$$v_o = V_1\left(1 + \frac{R_F}{R_1}\right) \quad \therefore \quad v_1 = v_i\left(\frac{-jX_c}{R - jX_c}\right)$$