Lab Report 2

EE23BTECH11049 - Praful Kesavadas

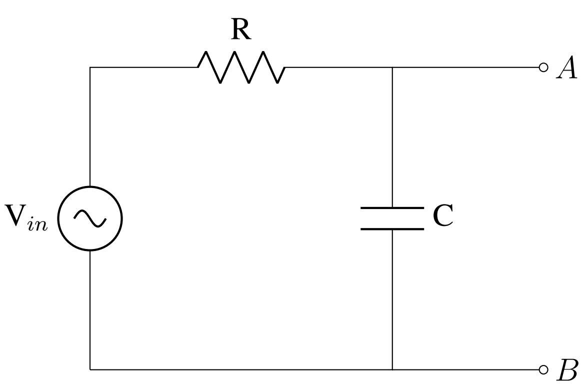
AIM

To plot the frequency response, obtain the cutoff frequency and compare it with the theoretical value.

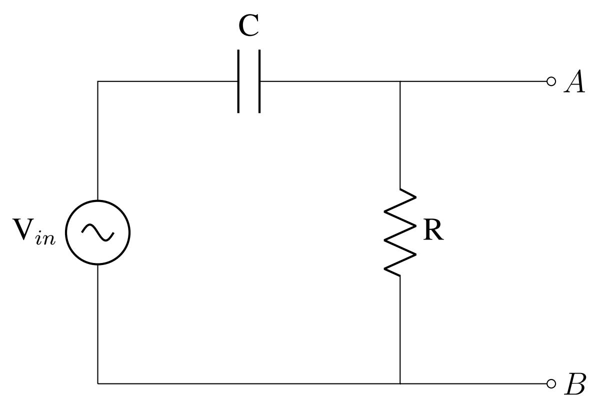
MATERIALS USED

- Resistor $10k\Omega$
- Capacitor $100nF$
- Function Generator
- Oscilloscope
- Breadboard, wires
- Multimeter

CIRCUIT DIAGRAM



(a) Low Pass Filter



(b) High Pass Filter

V_{in} : Sinusoidal Input Voltage
V_{AB} : Output Voltage
R = $10k\Omega$
C = $100nF$

THEORY

1) Low Pass Filter : The filter lets signals with frequencies below a certain cutoff frequency pass unchanged, but attenuates (reduces) the amplitudes of signals with frequencies above the cutoff.

2) High Pass Filter : The filter lets signals with frequencies above a certain cutoff frequency pass unchanged, but attenuates signals with frequencies below the cutoff.

Cut-off Frequency = $\frac{1}{2\pi RC}$

$$f_c = \frac{1}{2.(\pi)10k.100n}$$

$$\mathbf{f_c \approx 159\ Hz} \qquad \text{- - - - - - (1)}$$

Generally cut-off frequency is calculated practically by plotting graph between Voltage gain and a range of frequencies.

Voltage gain (A) = 20 $\log$ (V_{out} / V_{in}) dB - - - - - - (2)

On a rough scale, cut-off is the frequency corresponding to gain,
A = A_{max} - 3 dB : For low and high pass filters - - - - - - (3)

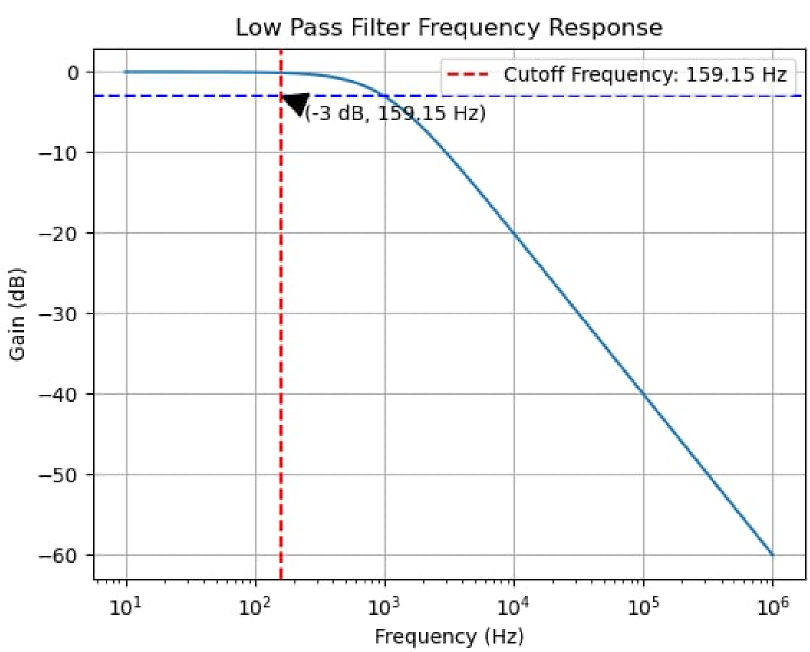
PROCEDURE

- Connect the components in a breadboard as shown in the circuit diagrams
- Use a function generator to produce a sinusoidal input of 5 V (for low pass) and 1 V (for high pass)
- Connect the input voltage ends to the input channel of an oscilloscope
- Connect the output voltage ends to the output channel of the oscilloscope
- Gradually increase the frequency of the input wave from the minimum possible value to as high as 1M Hz.
- Notice the change in the voltages of input and output waves in the oscilloscope and note down the values corresponding to each frequency.
- Calculate the gain (eq. 2) for each frequency noted
- Plot graph between gain and frequency on a graph sheet
- Calculate A for respective low and high pass filters (eq. 3) and check for it's corresponding frequency, which is the cut-off frequency.
- Compare it with our calculated value (eq. 1)

OBSERVATION

(1) For Low Pass Filter :

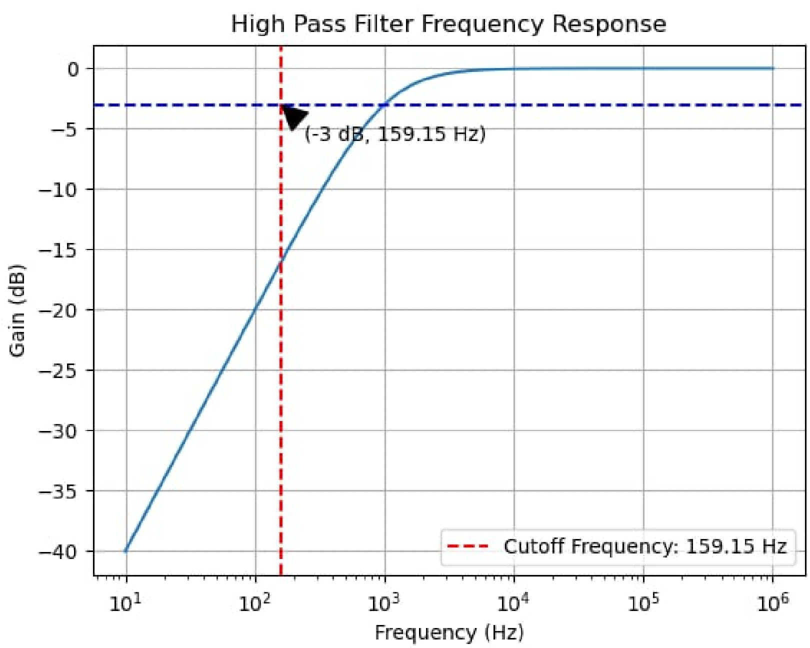
Frequency (Hz)	**V$_{in}$**	**V$_{out}$**	**Gain (dB)**
less than 50	-	-	≈ 0
56	4.3	4.29	-0.087
77	4.3	3.82	-1.01
111	5	3.81	-2.27
130	4.4	3.34	-2.38
148	4.8	3.5	-2.61
159	4.6	3.3	-2.98
170	5.6	4.0	-3.10
205	5.4	3.8	-3.12
250	5.4	3.4	-4.01
700	6.1	1.8	-10.75
900	6.1	1.4	-12.72
1200	6.1	0.9	-14.00
2000	6.3	0.2	-14.10



$\therefore$ The cut-off frequency is **159 Hz** (A$_{max}$ = 0 dB)

(2) For High Pass Filter :

Frequency (Hz)	**V**$_{in}$	**V**$_{out}$	**Gain (dB)**
10	1.0	0.01	-40.00
36	1.0	0.35	-28.89
130	1.0	0.128	-17.85
464	1.0	0.42	-7.51
1668	1.0	0.85	-1.33
5994	1.0	0.89	-0.12
21k	1.0	0.94	-0.08
77k	1.0	0.96	-0.05
278k	1.0	0.99	-0.01
more than 1M	-	-	≈ 0



$\therefore$ The cut-off frequency is **159 Hz** (A$_{max}$ = 0 dB)

Conclusion

Cut-off frequency is 159.15 Hz which is same as our calculated value (eq. 1)
Low pass filter allows signals below frequency of 159 Hz.
High pass filter allows signals above frequency of 159 Hz.