RC LOW PASS FILTER

Aim To design and set up a low pass filter circuit for a 3-dB frequency of 1 kHz and study the frequency response.

Components and equipments required Capacitor, resistor, signal generator, bread board and CRO.

Theory Filters are the networks designed to pass only certain desired frequency band. It can be broadly classified as passive or active filters according to the devices used to implement them. Filters can also be classified according to the frequency spectrum it passes, such as low pass, high pass, band pass and band reject filters.

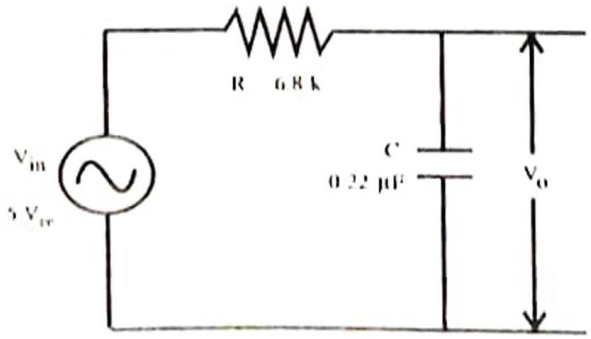
A passive low pass filter is shown in the figure. Since the reactance of the capacitor C decreases with increasing frequency, it passes low frequency readily and attenuates high frequencies. At high frequencies the capacitor acts as a virtual short and output falls to zero.

For a sinusoidal input V_{in}, the output signal V_O decreases with increasing frequency. The magnitude of the ratio of output voltage to input voltage of the circuit is given by

$$A = \frac{1}{\sqrt{1 + (f/f_H)^2}} \quad \text{where } f_H = \frac{1}{2\pi RC} \text{ and } f = \text{input signal frequency.}$$

At the frequency f_H, the gain falls to 0.707 of its value at low frequency. Hence f_H is called upper 3-dB frequency.

Circuit diagram



Procedure

1. Set up the circuit after testing all components and probes.
2. Set the input sine wave voltage at 5 V peak to peak and observe the input and output on the two channels of the CRO.
4. Vary the input frequency from 10 Hz to 100 kHz or more and note down the output voltage in tabular column.
5. Plot the graph on semilog graph sheet with f (or log f) on x-axis and gain in dB on y-axis.
6. Mark a point on graph at 3-dB less than the maximum gain. Extend the point to x-axis and mark the upper 3-dB frequency.

Design Let the upper cut off frequency f_L be 1 KHz.

We have $f_L = 1/2\pi RC$.

To avoid loading, as a thumb rule, select R = ten times the output impedance of the function generator. i.e., R = 6000 Ω. Use 6.8 k std.

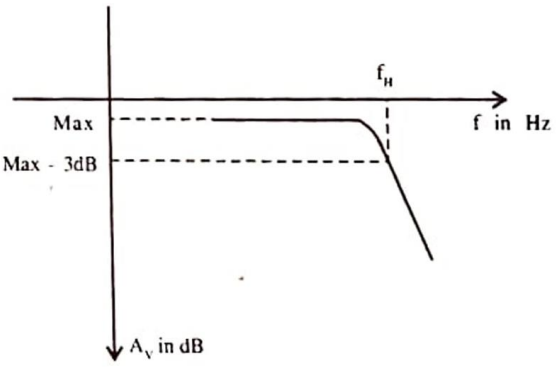
Substituting this in the above expression we get, C = 0.023 µF. Use 0.022 µF.

Observation

Vin = 5 V_{PP}

f in Hz	V_O in volts	A_V in dB

Graph



Result

Theoretical 3-dB frequency = ...Hz

Observed 3-dB frequency = ...Hz

Reference

Electronics Lab Manual Volume I, K.A. Navas, **Rajath Publishers**