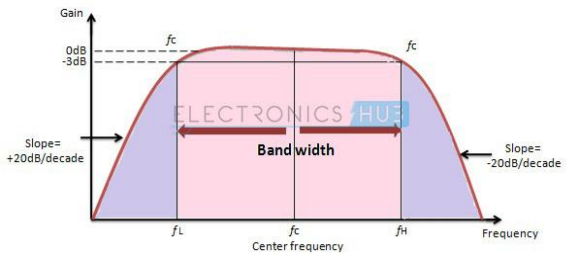
Circuit Simulation Project

Name of the participant : Kartik S Patil.

Title of the circuit : Wide Band Pass Filter using Op-Amp 741.

Theory / Description : A Band Pass Filter is a circuit which allows only particular band of frequencies to pass through it. This Pass band is mainly between the cut-off frequencies and they are f_L and f_H, where f_L is the lower cut-off frequency and f_H is higher cut-off frequency. The centre frequency is denoted by 'f_C' and it is also called as resonant frequency or peak frequency. By cascading High Pass Filter and Low Pass Filter with an amplifying component we obtain band pass filter. Depending on the quality factor the band pass filter is classified into Wide band pass filter and Narrow band pass filter. The quality factor is also referred as 'figure of merit'. If the value of quality factor is less than ten, then the pass band is wide, which gives us the larger bandwidth. This band pass filter is called Wide Band Pass Filter. First the signal will pass through the high pass filter, the output signal of this high pass filter will tends to infinity and thus the signal which tends to infinity is given to the low pass filter at the end. This low pass filter will low pass the high frequency signal. When the High Pass Filter is cascaded with Low pass filter the simple Band Pass Filter is obtained. In order to realise this filter the order of the low pass and high pass circuits must be same. Due to this cascading the circuit produces a low value quality factor. The capacitor in the first order high pass filter will block any DC biasing from the input signal. The response of the wide band filter is shown below.



These are used in wireless communication medium at transmitter and receiver circuits. In transmitter section this filter will pass the only required signals and

reduces the interfering of signals with other stations. In receiver section, it will help from unwanted signal penetration in to the channels.

These are also used to optimize the signal to noise ratio of the receiver.

And in optical communication area like LIDARS.etc

Design : The simulation circuit was designed based on the consideration of the below parameters. The lower cutoff frequency off of 3 KHz, upper cutoff frequency of 15 KHz and a pass band gain of 4, and the subsequent resistance values were calculated by formula.

Capacitance value was chosen to be <1uF for better performance. The resistance values were rounded off to its nearest standard values.

Upper cut-off frequency	15 kHz
lower cut-off frequency	3 kHz
Pass band gain (Af)	4
R3 = R6	1KΩ
R2 = R5	(Af-1)R3 =3KΩ
R1	1/2πfhC=5.1KΩ
R4	1/2πflC=1KΩ
Af in dB	40log(Af) = 36.12

Circuit Diagram(s) :

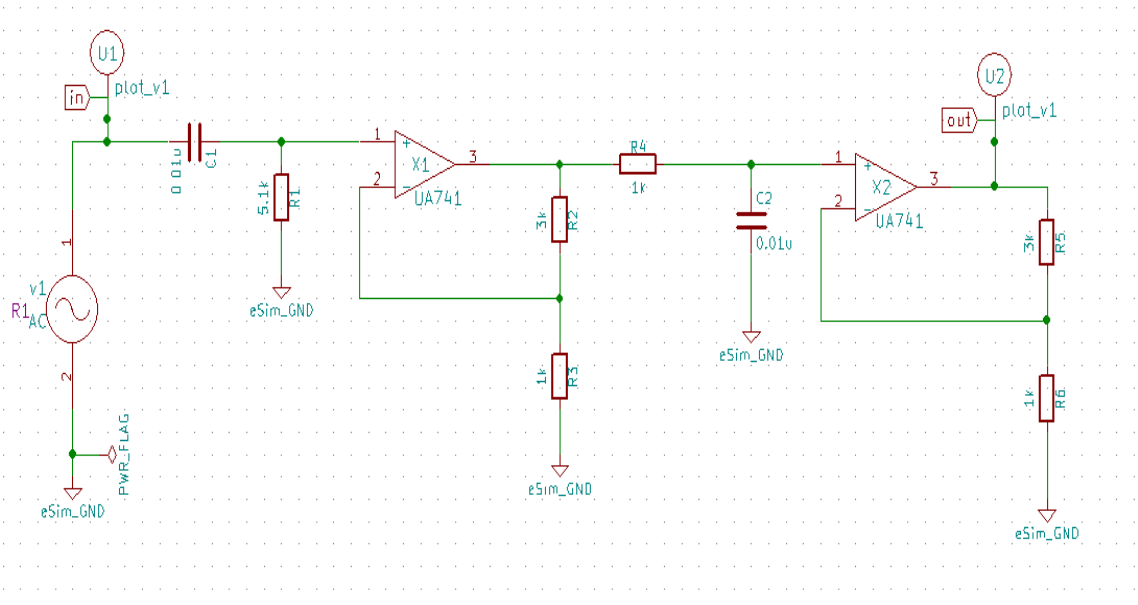


Fig.1 Wide Band Pass Filter Using Op-Amp 741

Results (Input, Output waveforms) :

1. NGSPICE plot at Input terminal:

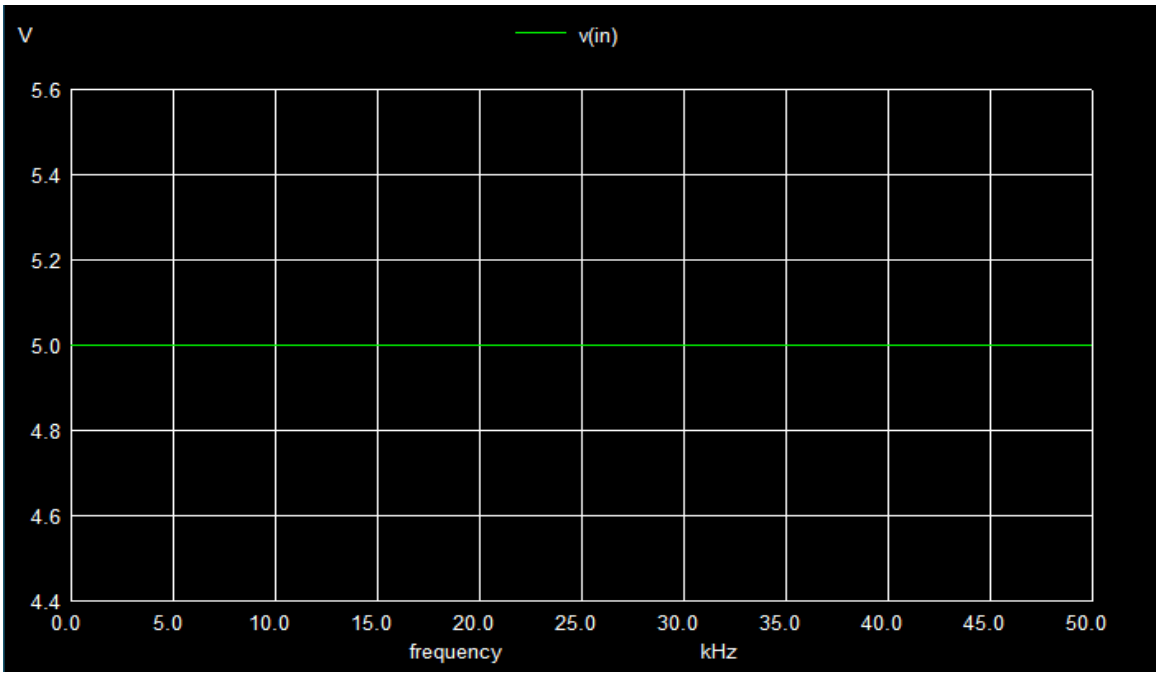


Fig.2 NGSPICE Input Voltage of Wide Band Pass Filter

2. NGSPICE plot at Output terminal:

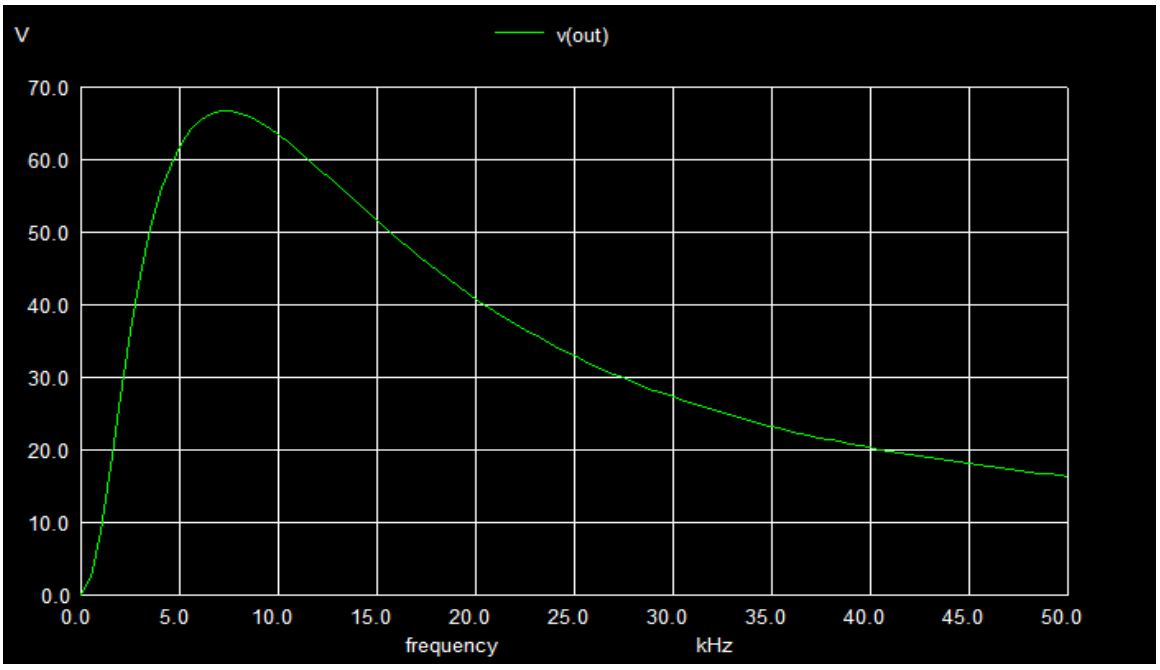


Fig.3 NGSPICE Output Voltage of Wide Band Pass Filter

3. Python plot at Input terminal:

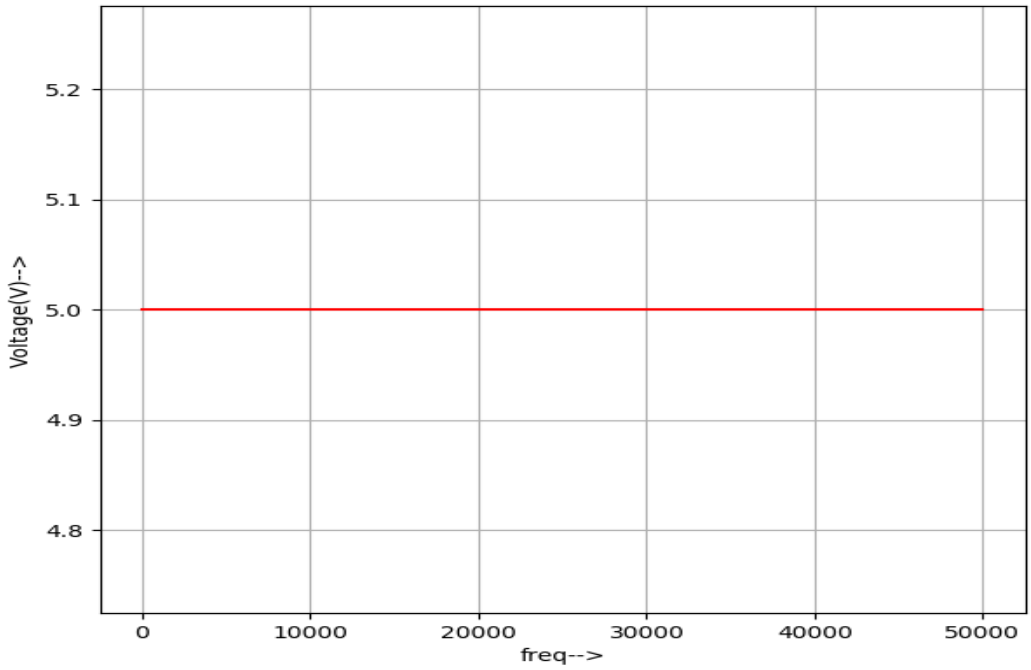


Fig.4 Python Plot Input Voltage of Wide Band Pass Filter

4. Python plot at Output terminal:

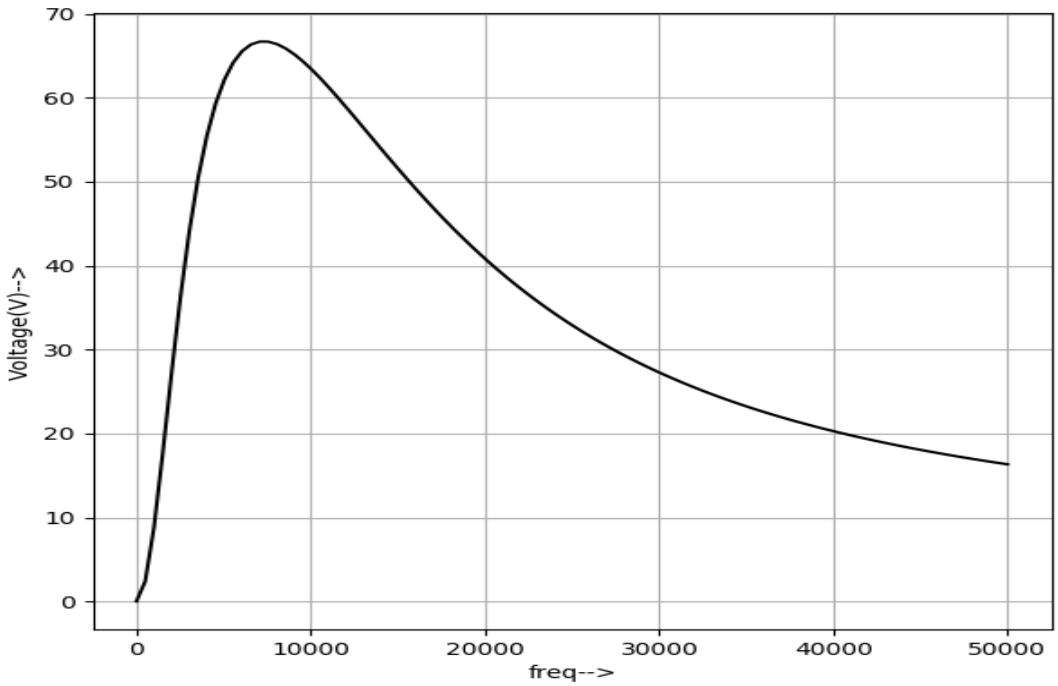


Fig.5 Python Plot Output Voltage of Wide Band Pass Filter

Observation : The calculated gain and simulated gain of the filter are equal. The filter rolls off approximately at 40dB/decade as it is a band pass filter.

Conclusion : The 2nd Order type(it has two reactive components within its circuit design) Wide Band Pass filter was designed and realized successfully using the eSim software and the simulated results were verified.

Source/Reference(s) :

1. Op-amps and Linear Integrated Circuits by Ramakant Gayakwad.

2. https://www.eeeguide.com/band-pass-filter-circuit-diagram/