Department of
Electrical & Electronics Engineering

Abdullah Gül University

EE1200 ELECTRONIC SYSTEM DESIGN CAPSULE

PROJECT-2 A 3-Channel Audio Equalizer Circuit

Submitted on: 11.08.2020

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Grade: / 100

1. INTRODUCTION

A. Project Description

The objective of this project is to design a 3 channel audio equalizer circuit in accordance with the specified specifications. A typical equalizer is used for increasing or decreasing the gain of some specific frequency bands. This system used in studios, music devices, instrumental systems.

B. Project Motivation

Filters are in most important areas in electrical and electronics engineering. Almost every electronic devices, electronic systems, and even digital systems include filters. The equalizer that was developed in this project also occurred by filters. That's why, developing an equalizer circuit is as important as filters, and it is a fairly good example of understanding theoretical information and applying it in the real world.

2. MATERIALS AND METHODS

A. Required Components and Info About Components

Component Name	Value	Pieces	Cost	Info About Component
LM741	-	5	5,25 TL	Lm741 is used for active filtering and amplification of signals.
Capacitor	4.7nF	8	0,48 TL	Capacitors are used for active and passive filtering circuits in this project.
Capacitor	2.2nF	24	1,44 TL	
Capacitor	1nF	16	0,96 TL	
Capacitor	10nF	8	0,48 TL	
Capacitor	6,8nF	16	0,96 TL	
Resistor	10k Ohm	18	0,48 TL	Resistors are used for filtering and amplification Opamp circuit.
Resistor	4.7k Ohm	3	0,09 TL	
Resistor	1k Ohm	6	0,18 TL	
Resistor	300 Ohm	3	0,09 TL	
Resistor	6,8k Ohm	2	0,06 TL	
Resistor	220 Ohm	2	0,06 TL	
Potentiometer	5k Ohm	6	7,80 TL	Potentiometer is used for vary resistor value at the output of resistors.

Speaker	0,25 Watt	1	2,44 TL	Speaker is used for converting electrical signals to sound signals.
Total Cost:	20,77 TL			

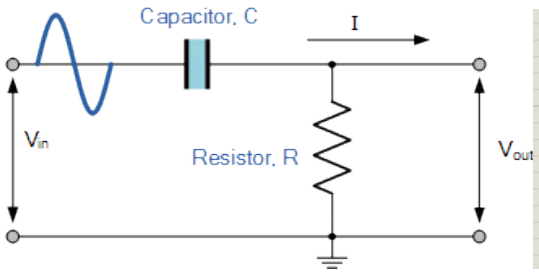
B. Parts and Steps of Project

The equalizer circuit is occurred by 3 passive and 3 active filters with an input and output.

B.1 Passive Filters

- **Passive High Pass Filter**

A high pass filter is used in eliminating and suppressing below a certain frequency (cut-off). A basic high pass filter design is shown in figure1. The passive high pass filter using in this project is shown in figure 2. The cut-off frequency is 2.5 kHz.



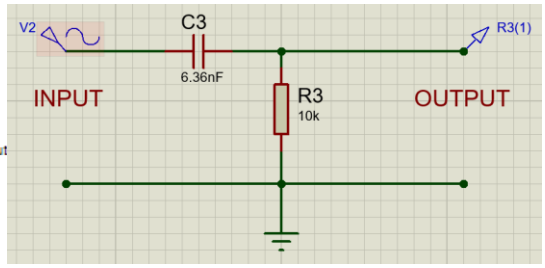
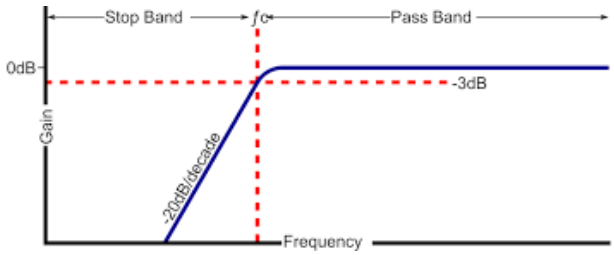


Figure 1 *Figure 2*

In this diagram, a first order filter is shown. If the same filter is added at the end of the filter, it is called 2nd order, and order is depending on the number of filters. The graph of high pass filter is shown in figure 3.



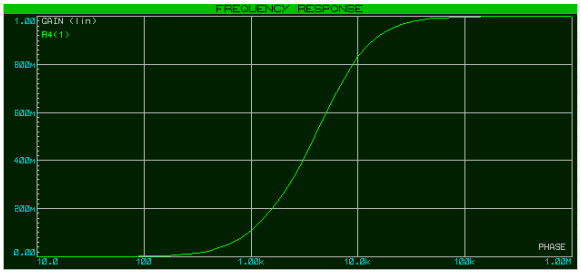


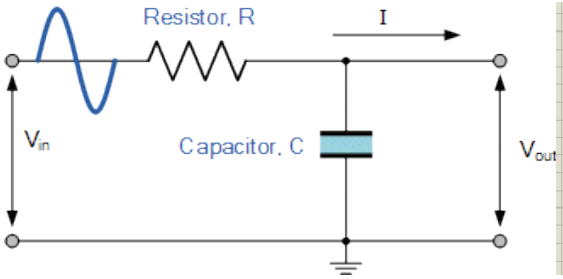
Figure 3 *Figure 4*

At the cut-off point on frequency domain, the voltage or volume is decreased to 0.707 times input voltage. The equation of cut off frequency is:

$$f_{cutoff} = \frac{1}{2\pi RC}$$

- **Passive Low Pass Filter**

A low pass filter is used in eliminating and suppressing under a certain frequency (cut-off). A basic low pass filter design is shown in figure 5. The pass low pass filter using in this project is shown in figure 6. The cut-off frequency is 1 kHz.



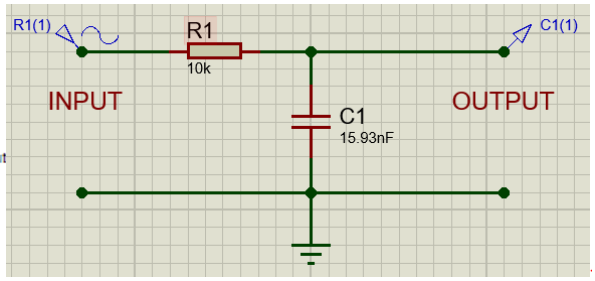
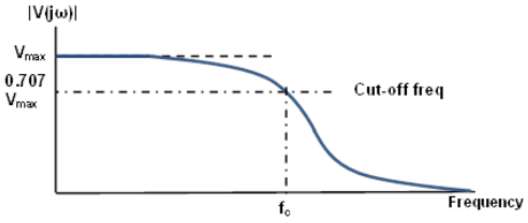


Figure 5 *Figure 6*

In this diagram, a first order filter is shown. Just like passive high pass filter, If the same filter is added at right of this filter, then the order of filter increases. The graph of low pass filter is shown in figure 7.



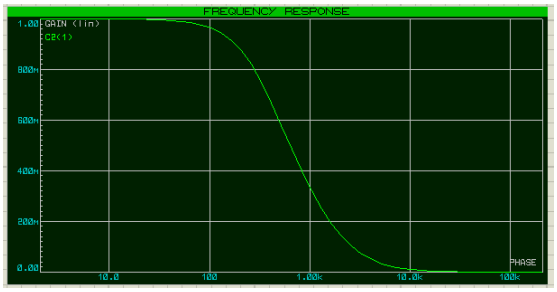


Figure 7 *Figure 8*

Also, in this graph, at the cut-off point on frequency domain, the voltage or volume is decreased to 0.707 times input voltage. The equation of cut off frequency is as same as high pass.

- **Passive Band Pass Filter**

A band pass filter is used in eliminating and suppressing outside a certain frequency range and allow to pass inside the same certain frequency borders. With this aspect, it consists of a combination of two filters these are high pass and low pass filters. A basic band pass filter design is shown in figure 9. The passive band pass filter using in this project is shown in figure 10. The band frequency is 1 kHz<f <2.5kHz

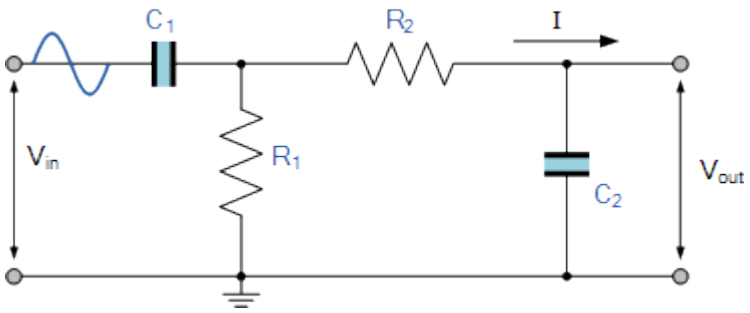


Figure 9

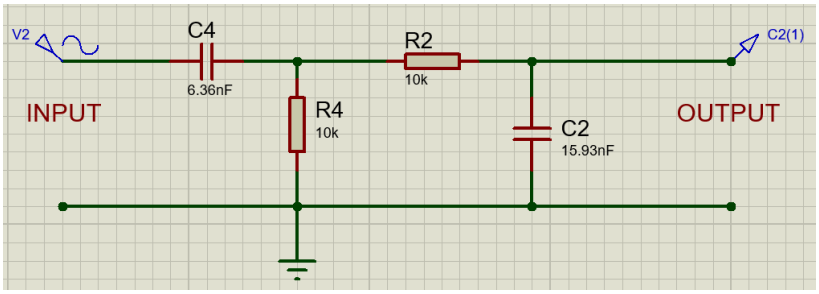


Figure 10

The graph of low pass filter is shown in figure 11.

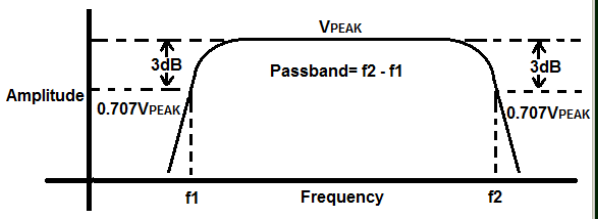


Figure 11

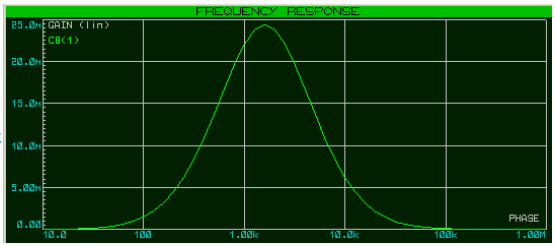


Figure 12

In this graph above, f1 value is the cut-off frequency of high pass filter and f2 value is the cut off frequency of low pass filter.

- **Whole Passive Filters Circuitry**

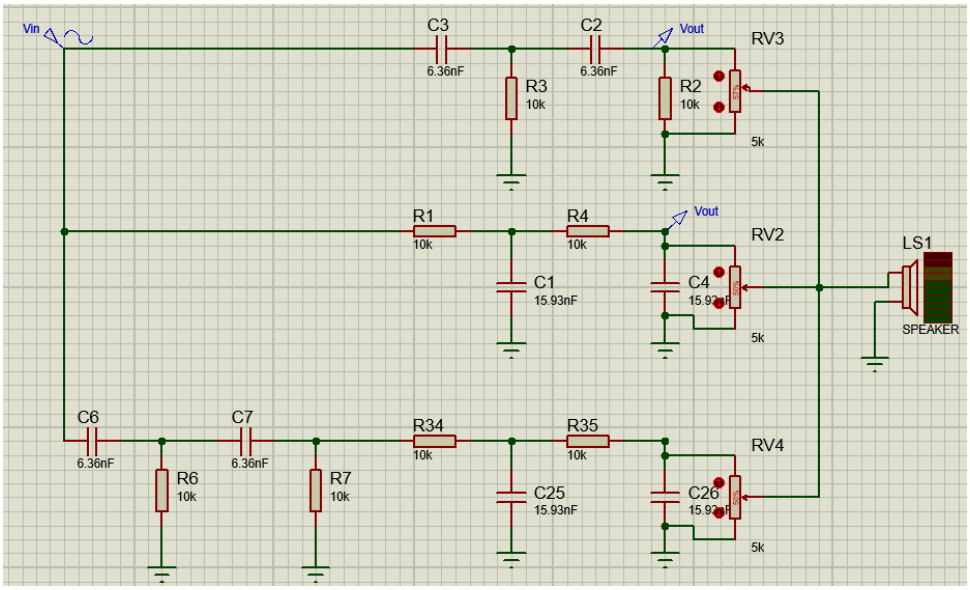


Figure 13

B.2 Active Filters

- **Active High Pass Filter**

Active high pass filter, like all of three filters, is occurred by adding an Opamp. In this way, the graph line between passing and suppressing frequency is closer to perpendicular. Also, all of active filters are designed as 2nd order in this project and LM741 is used as Opamp and a gain is given by using LM741. A basic active high pass filter design and its formulas are shown in figure 14. The active high pass filter using in this project is shown in figure 15. The cut-off frequency is 2.5 kHz.

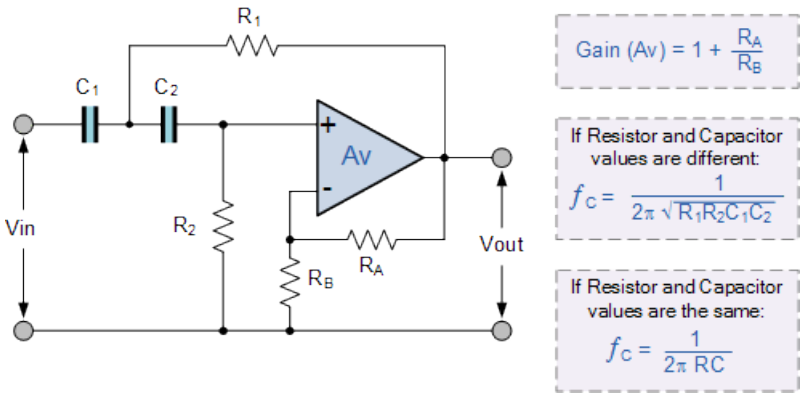
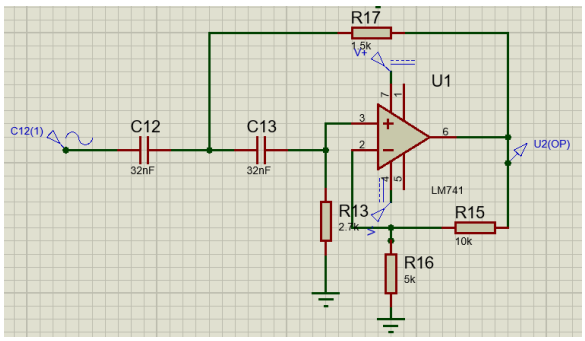


Figure 14



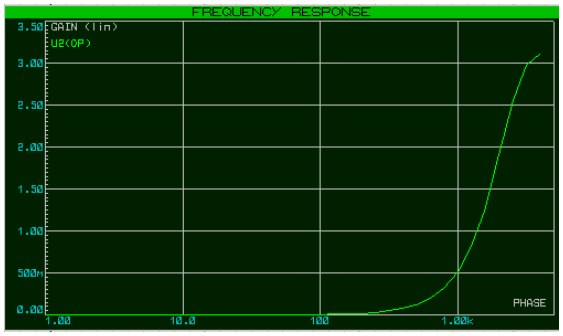


Figure 15

Figure 16

- **Active Low Pass Filter**

The usage aim of active low pass filter is as same as passive low pass filter. A basic active low pass filter design is shown in figure 17. The active pass low pass filter using in this project is shown in figure 18. The cut-off frequency is 1 kHz.

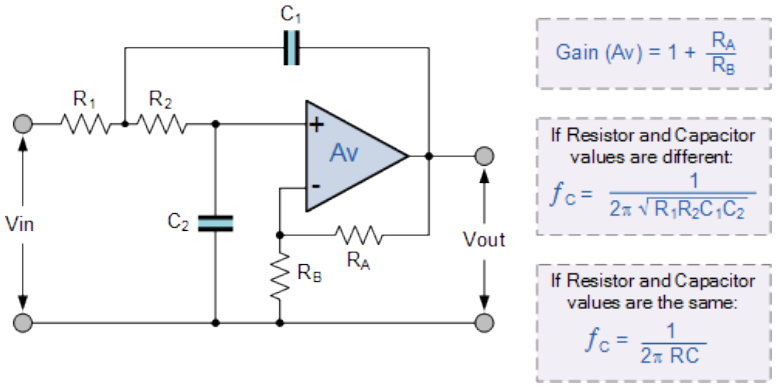
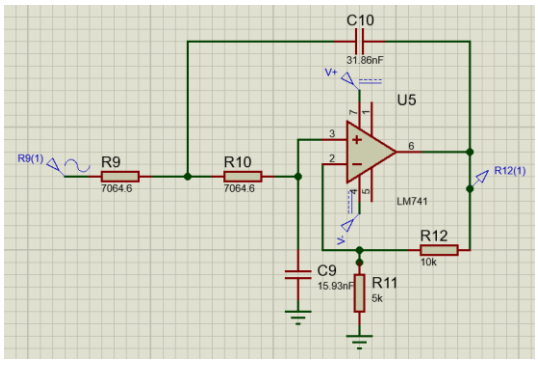


Figure 17



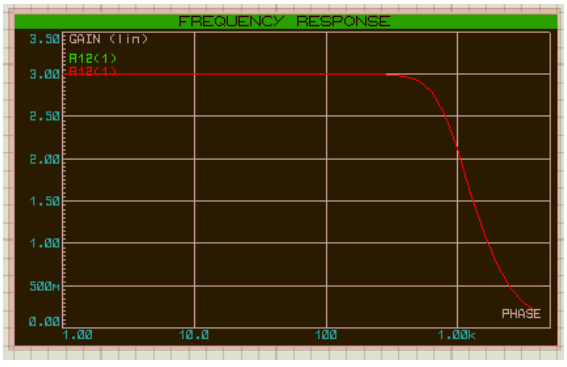


Figure 18

Figure 19

- **Active Bandpass Filter**

The usage aim of active bandpass filter is as same as passive band pass filter. An active bandpass filter is occurred by two active high pass and low pass filters. The active bandpass filter using in this project is shown in figure 20. The band frequency is 1 kHz< f <2.5 kHz

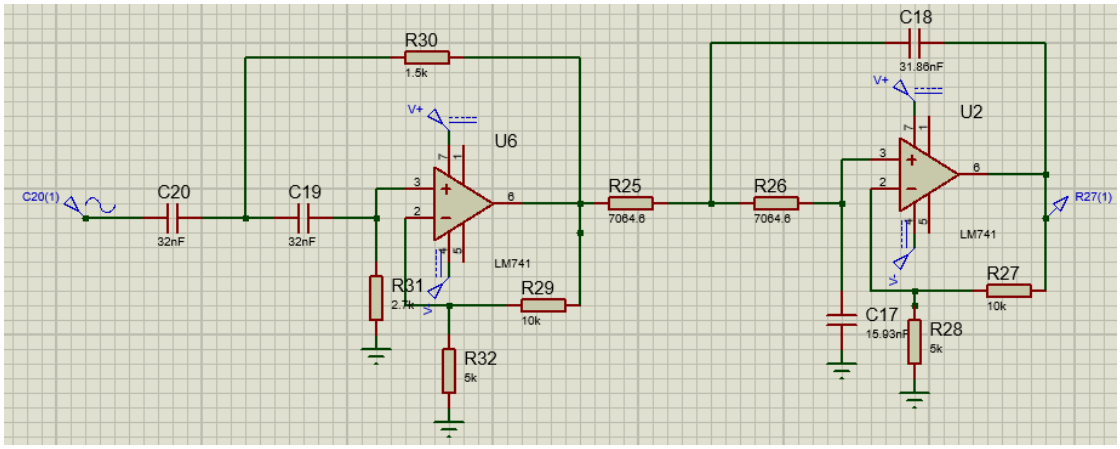


Figure 20

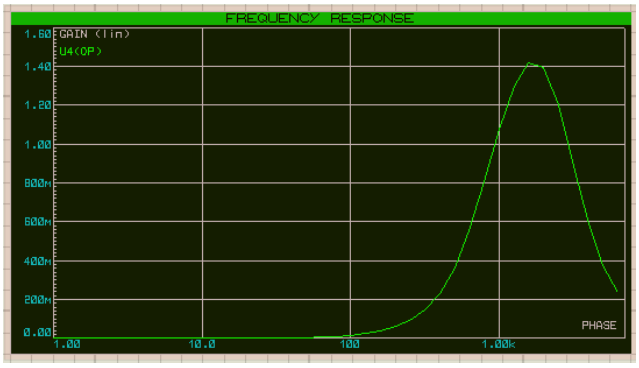
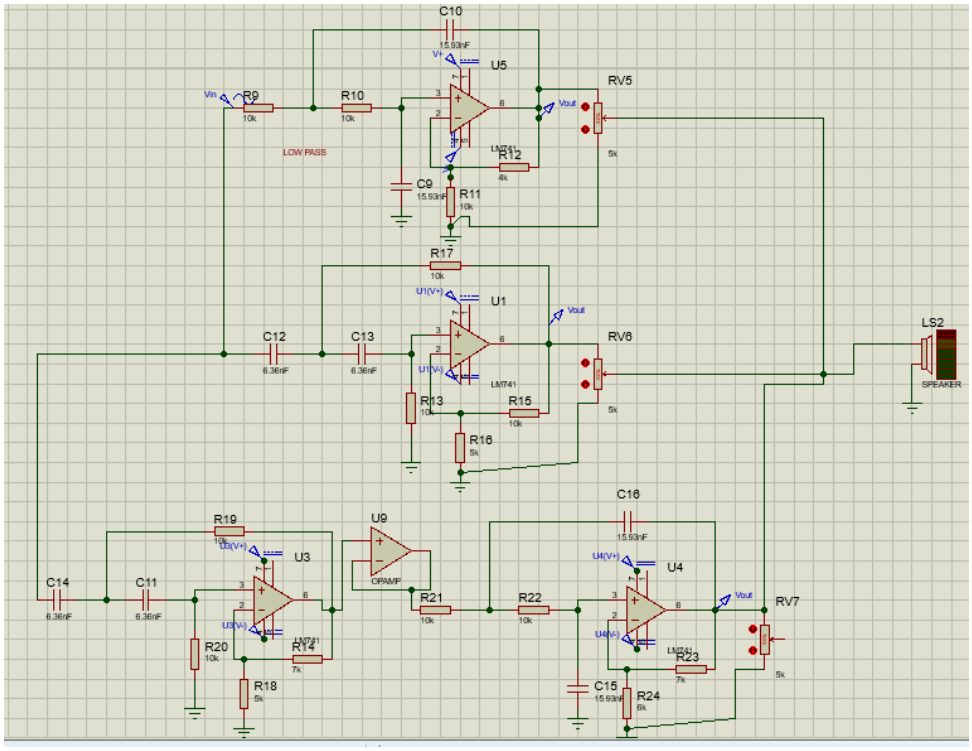


Figure 21

- **Whole Active Filters Circuitry**



3. RESULTS

Three active filters audio equalizer and three passive filter equalizer circuits are developed in this project. These six filters are tested 5 times with different frequencies. Because the oscilloscope component is working very slowly, the simulations results are shown by analogue graph in Proteus 8. Also, these filters are compared with the same frequency and differences are shown in a good perspective in this way.

- **1 Hz Frequency, All Six Filters**

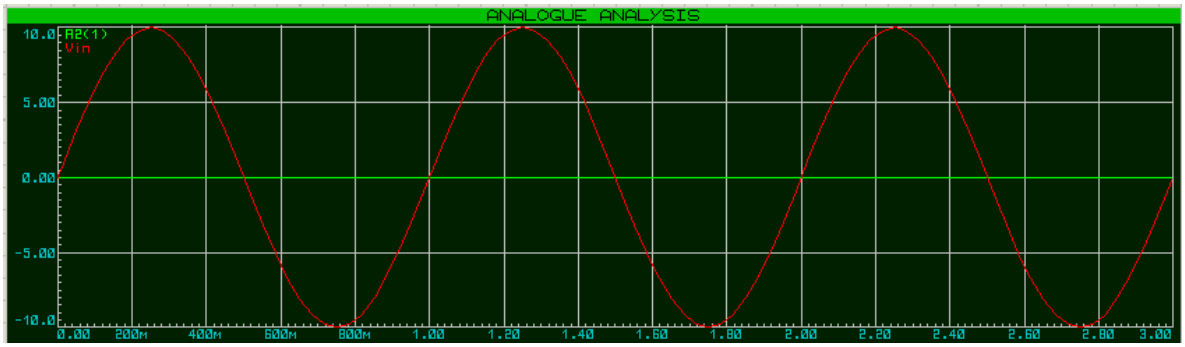


Figure 22 Passive High Pass

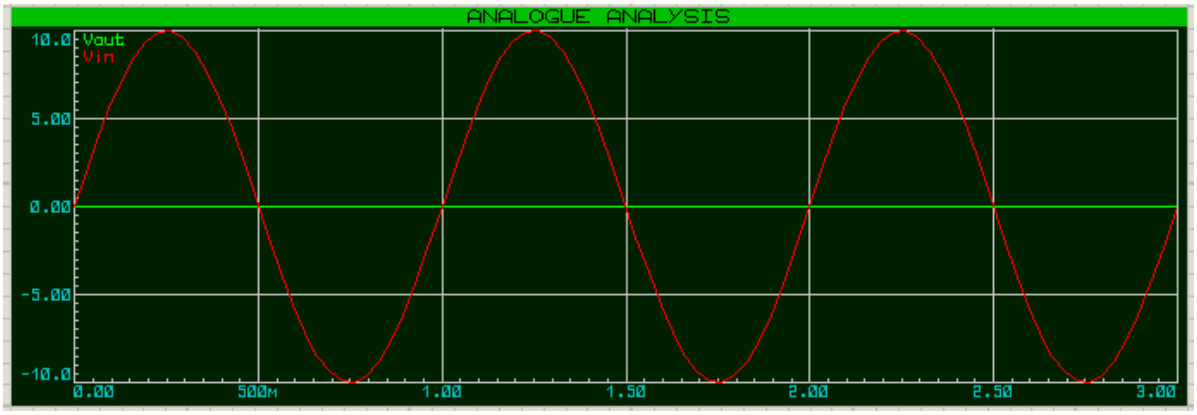


Figure 23 Active High Pass

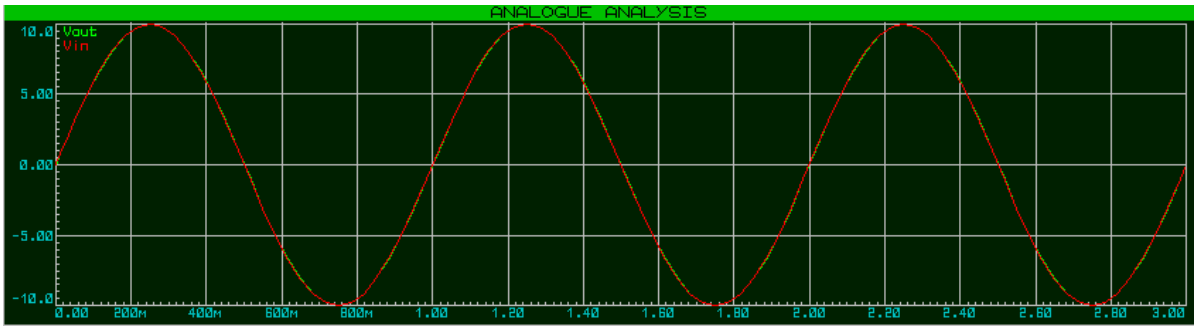


Figure 24 Passive Low Pass

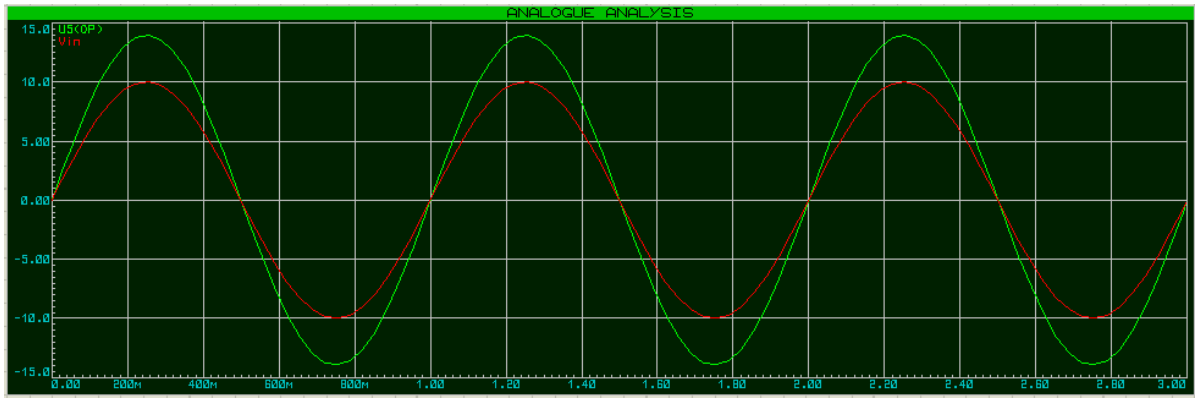


Figure 25 Active Low Pass

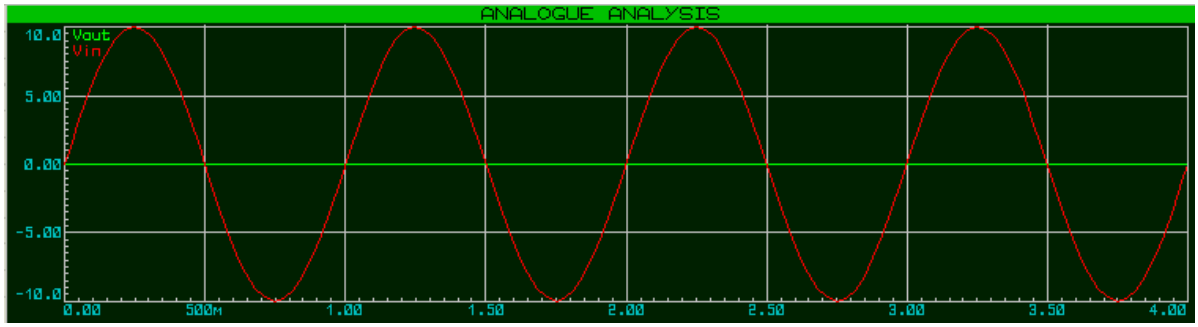


Figure 26 Passive Band Pass

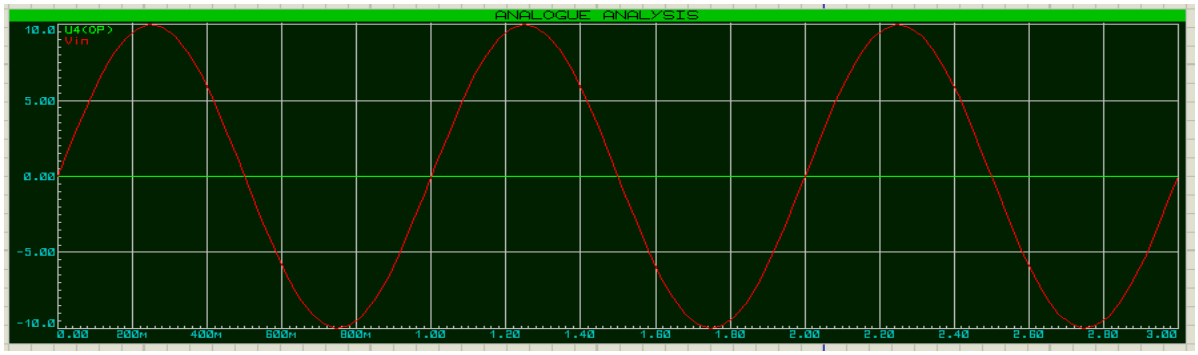


Figure 27 Active Band Pass

- **100 Hz Frequency, All Six Filters**

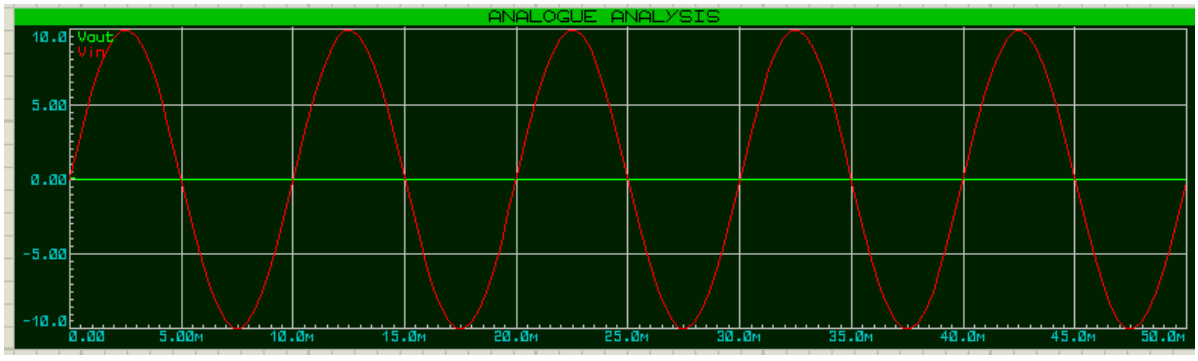


Figure 28 Passive High Pass

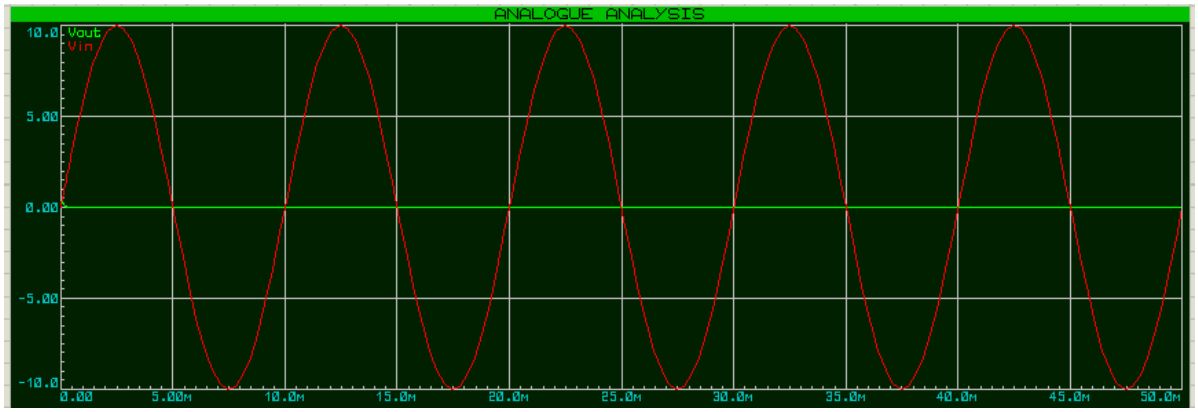


Figure 29 Active High Pass

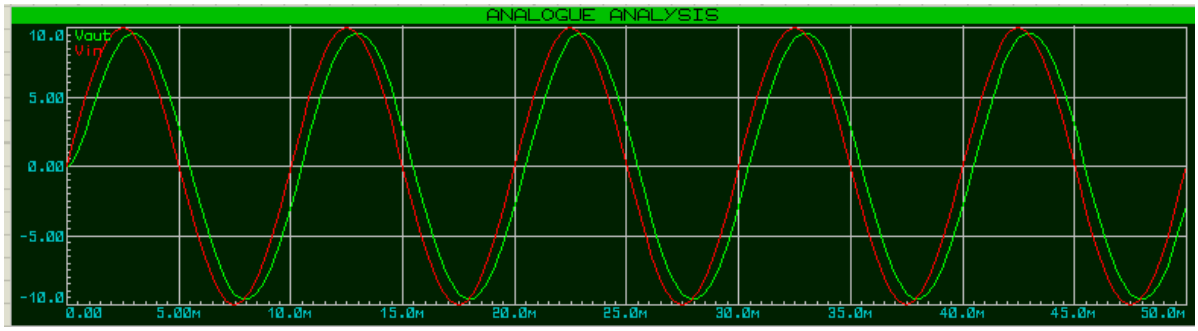


Figure 30 Passive Low Pass

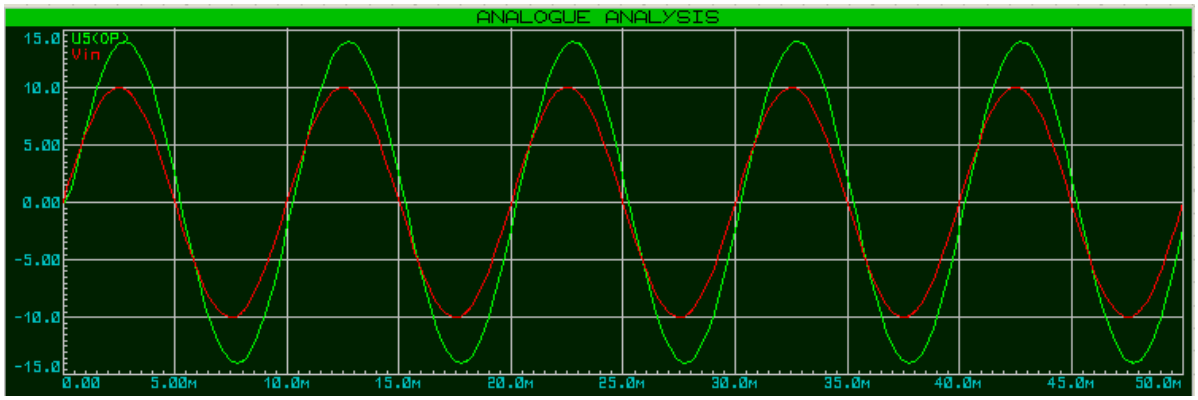


Figure 31 Active Low Pass

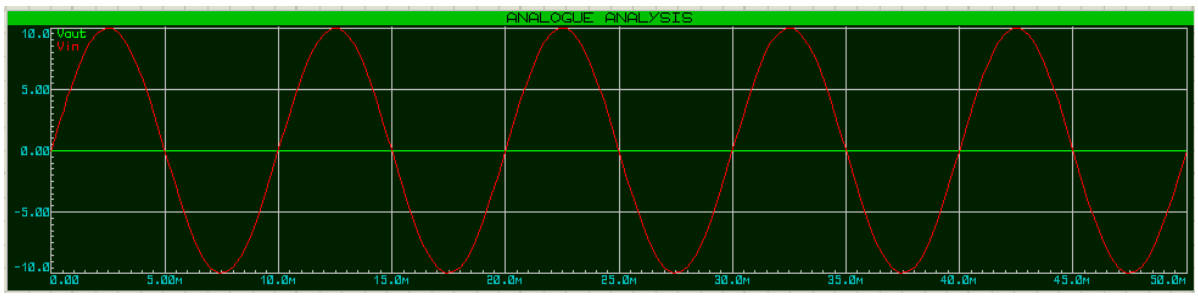


Figure 32 Passive Band Pass

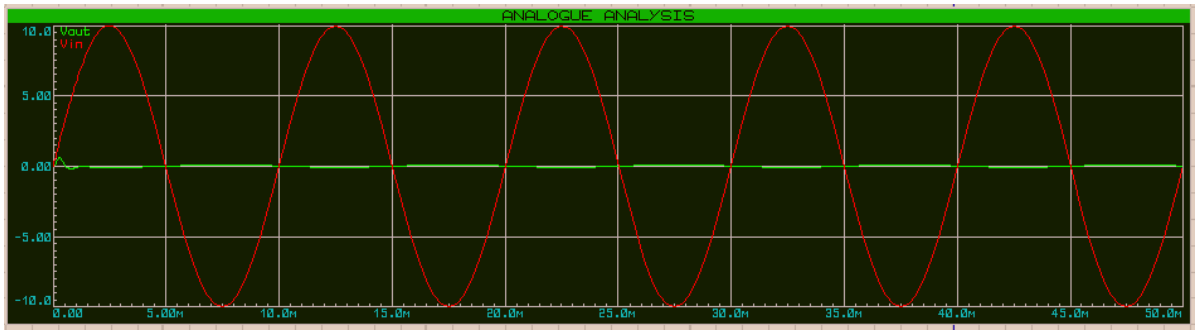


Figure 33 Active Band Pass

- **1600 Hz Frequency, All Six Filters**

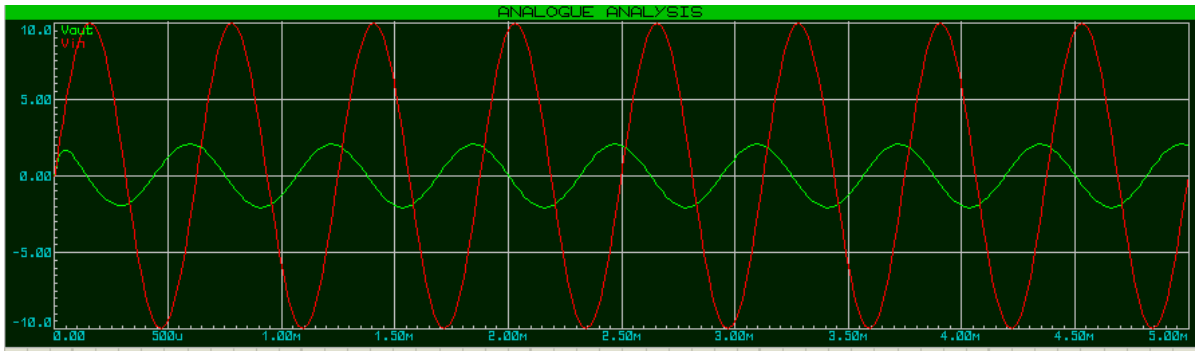


Figure 34 Passive High Pass

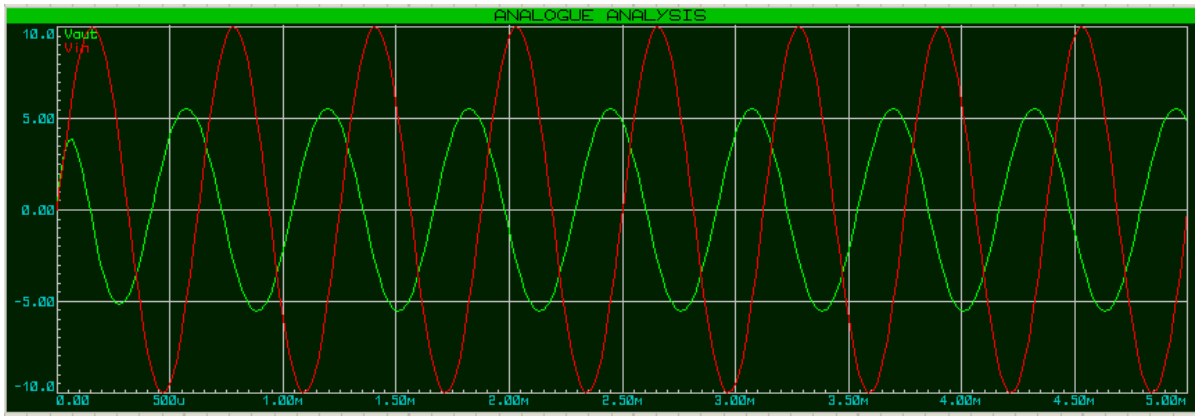


Figure 35 Active High Pass

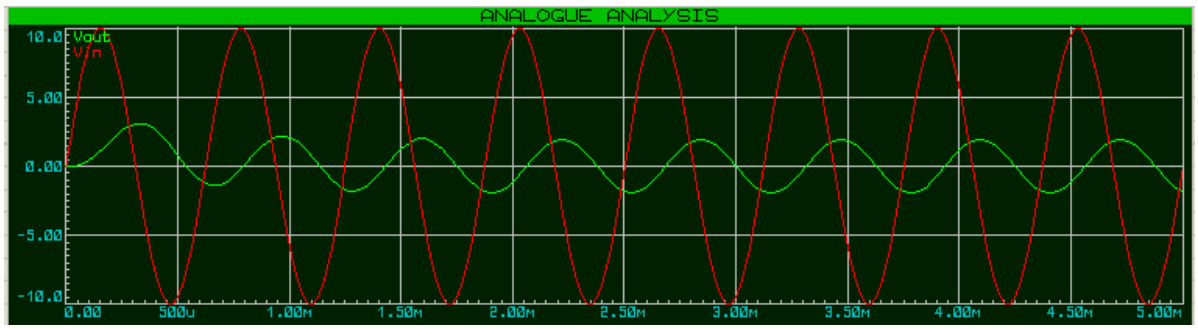


Figure 36 Passive Low Pass

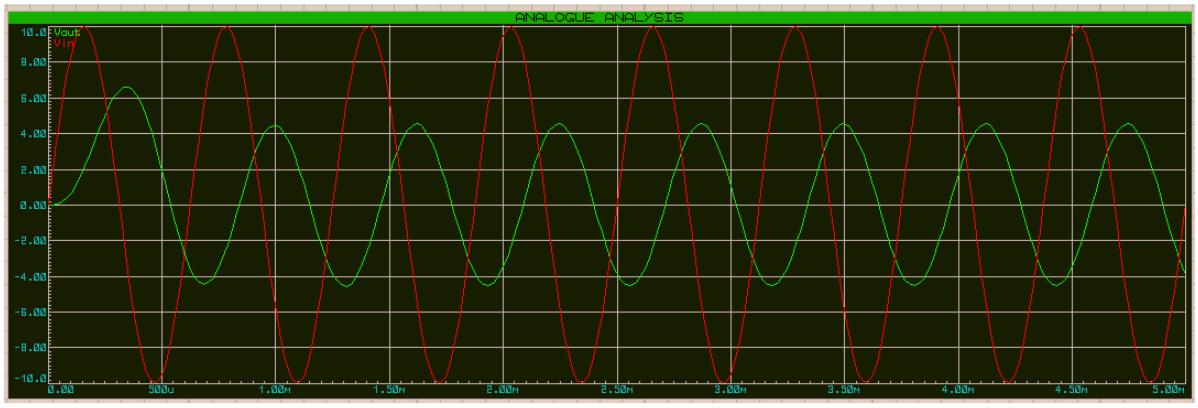


Figure 37 Active Low Pass

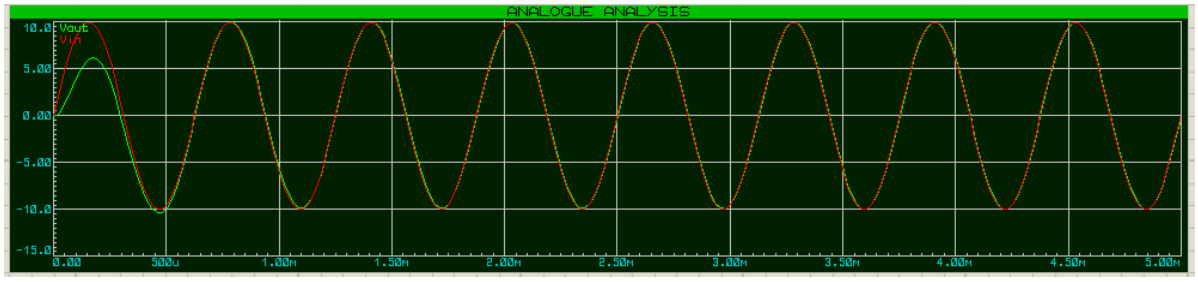


Figure 38 Passive Band Pass

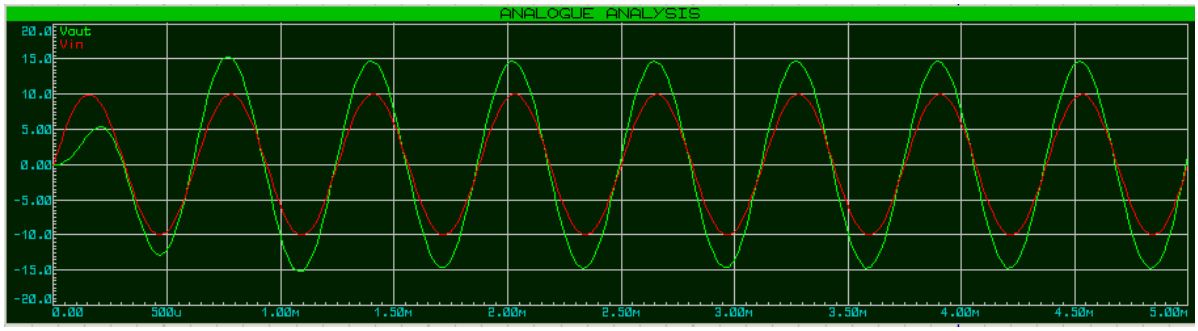


Figure 39 Active Band Pass

- **10 kHz Frequency, All Six Filters**

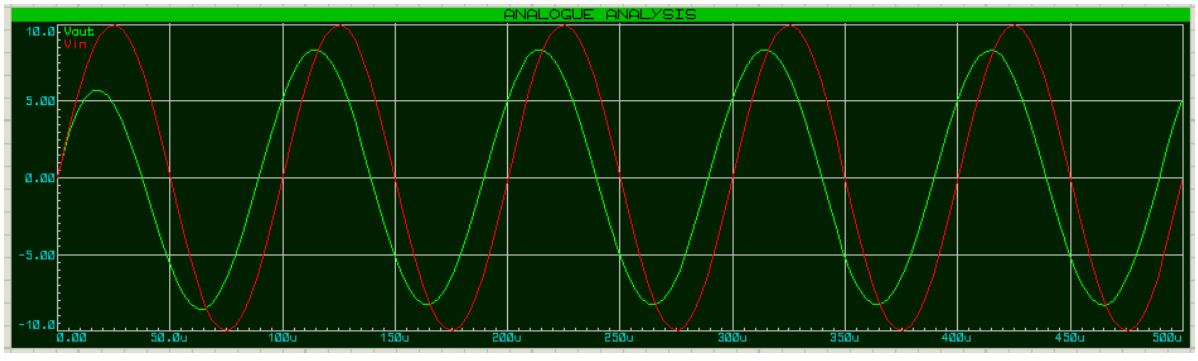


Figure 40 Passive High Pass

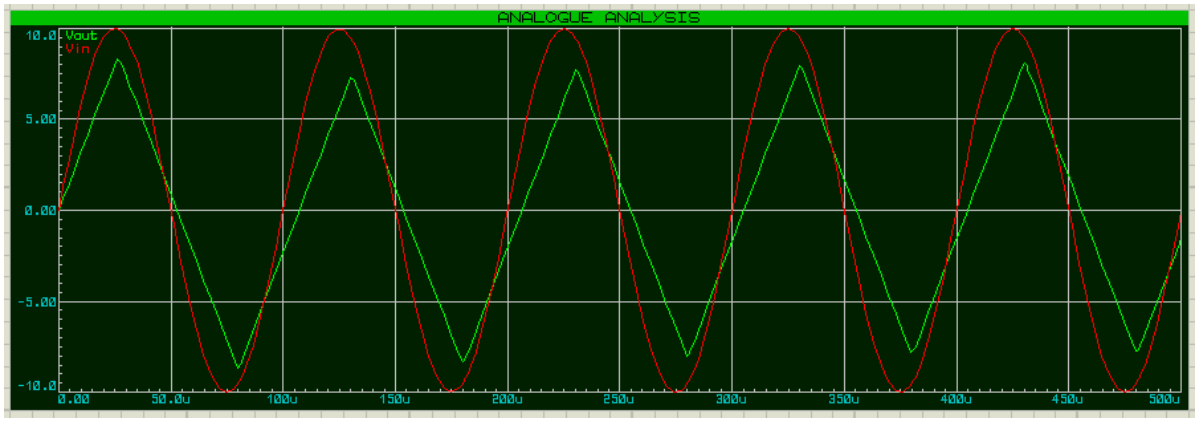


Figure 41 Active High Pass

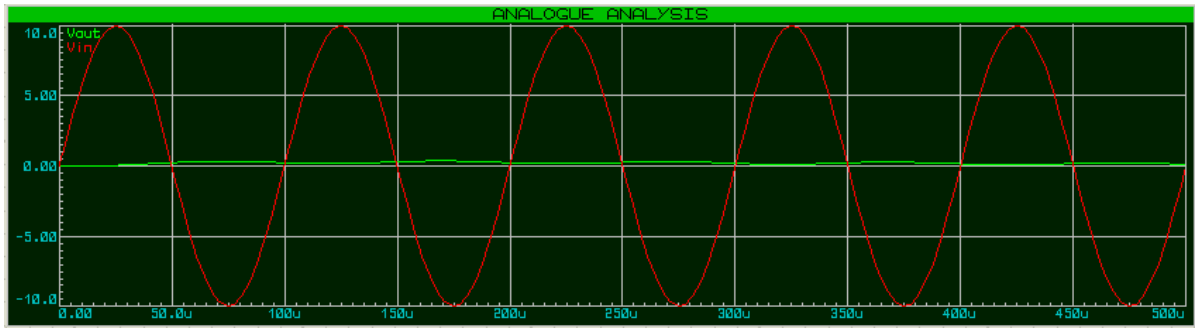


Figure 42 Passive Low Pass

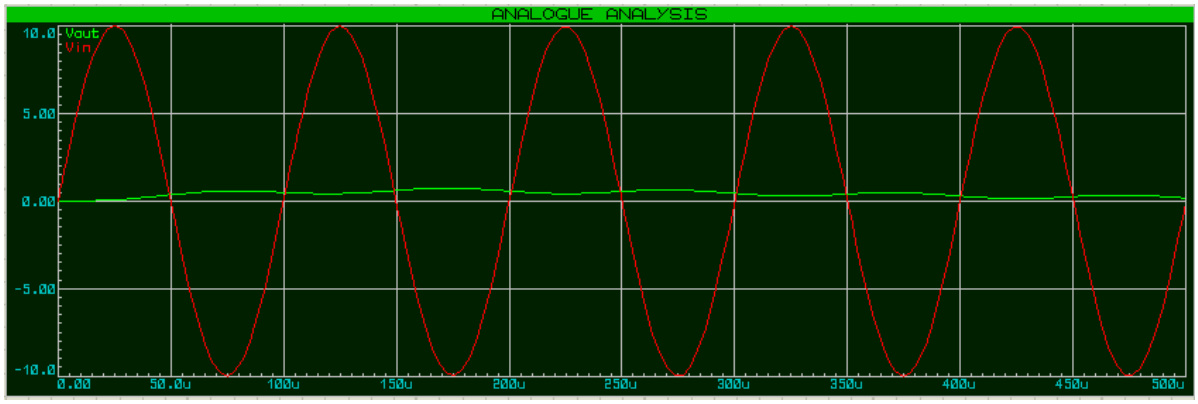


Figure 43 Active Low Pass

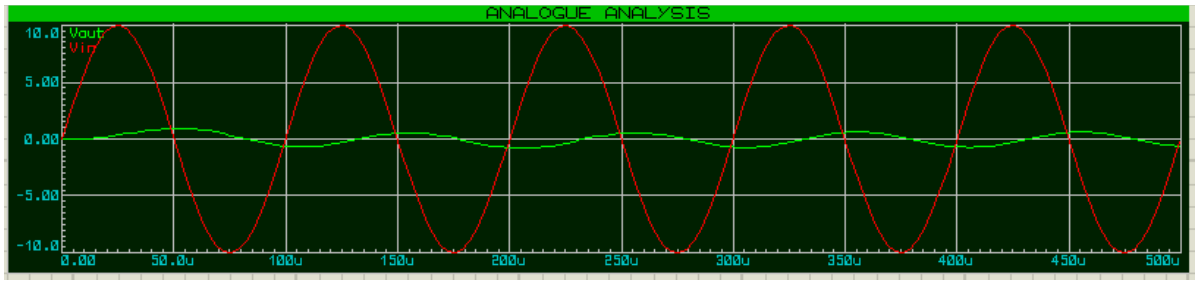


Figure 44 Passive Band Pass

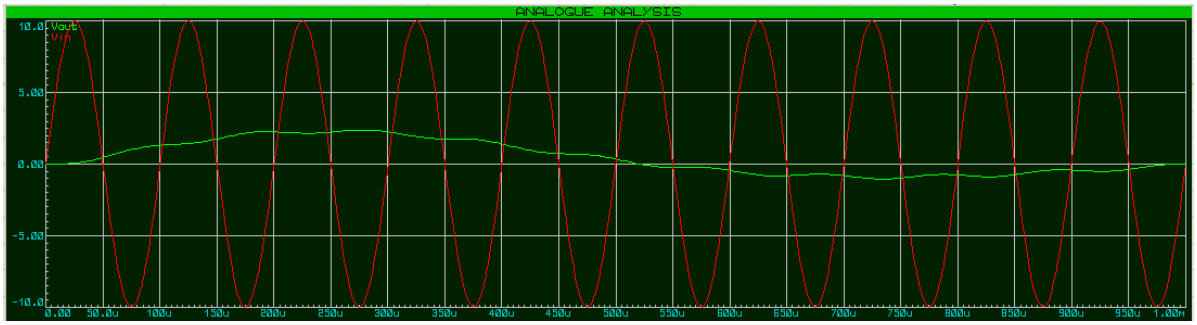


Figure 45 Active Band Pass

- **20 kHz Frequency, All Six Filters**

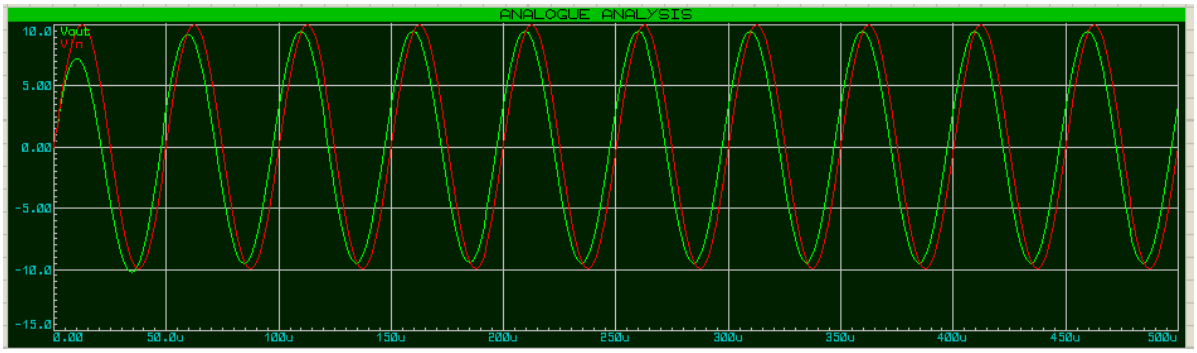


Figure 46 Passive High Pass

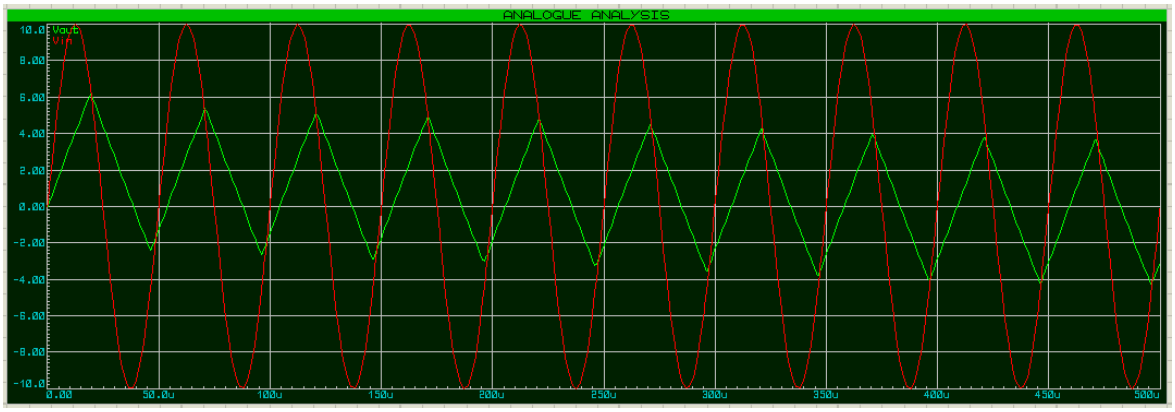


Figure 47 Active High Pass

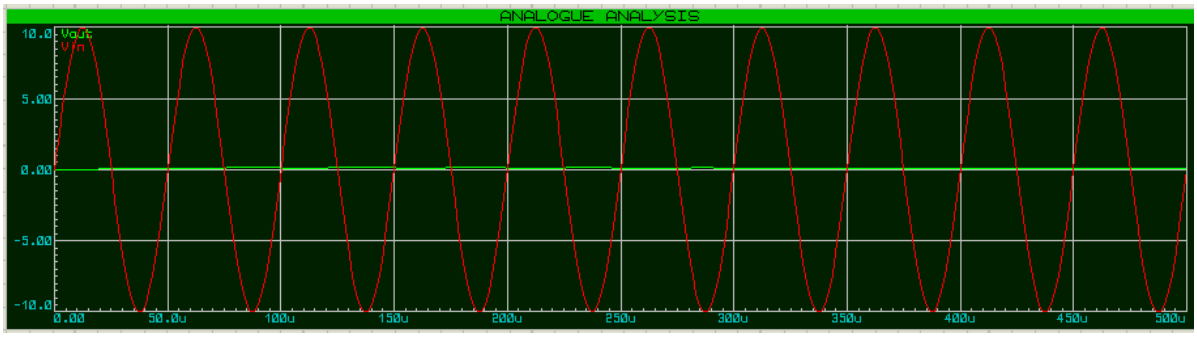


Figure 48 Passive Low Pass

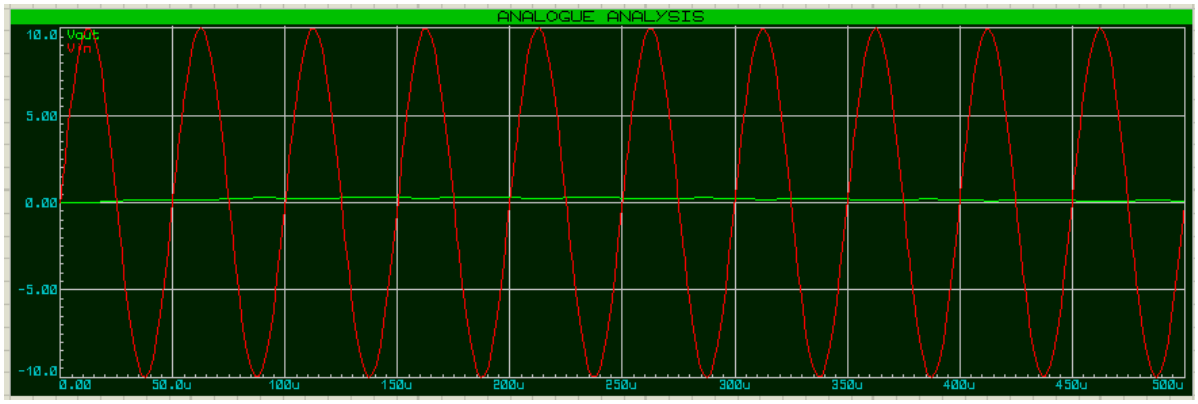


Figure 49 Active Low Pass

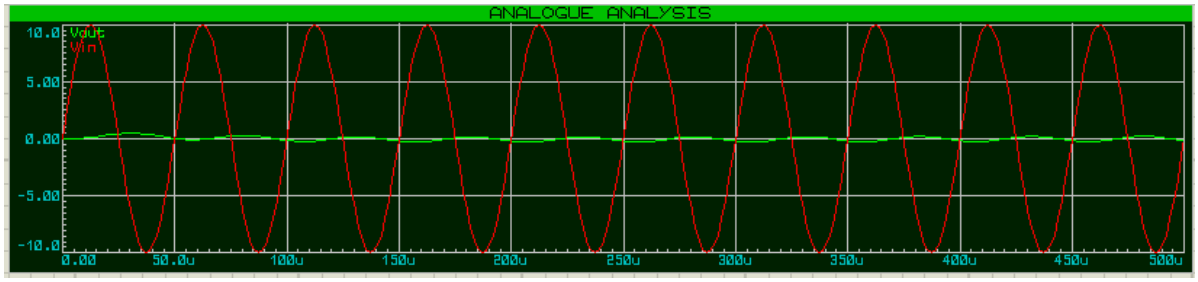


Figure 50 Passive Band Pass

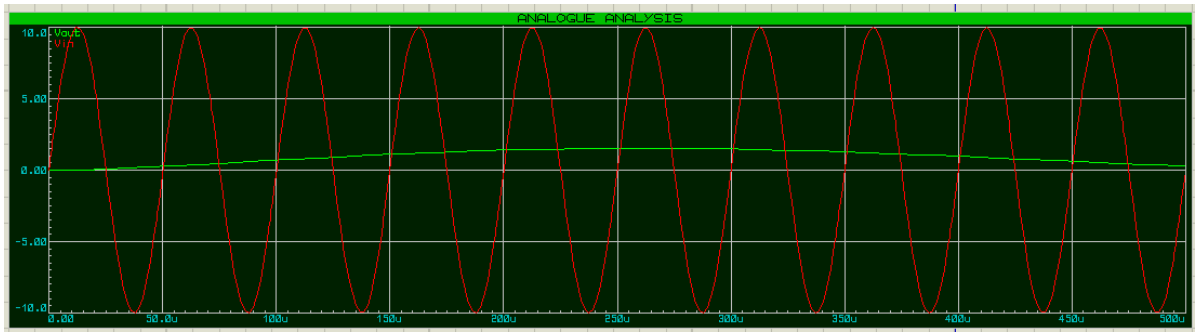


Figure 51 Active Band Pass

4. DISCUSSION AND CONCLUSION

In this project, a 3-channel audio equalizer circuit was developed. This system was designed according to the project sheet as 3 passive 3 active filters. All of the filters are designed as 2nd order because it has sharper change than 1st order filters. If active and passive filters are compared, active filters are better than passives according to frequency domain graph of passing and suppressing frequencies. Although, passive filters are better than actives according to output voltages in the time domain. Also, passives are cheaper and cheaper than actives. Both have advantages and disadvantages, If the user needs to more fast change between passing and suppressing frequencies, an active equalizer circuitry system can be preferable. On the other hand, if the shape of the output signal and cost is more important than sharpness, the passive audio equalizer can be preferable.

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