DESIGN OF ANALOG FILTER FOR RADIO FREQUENCY APPLICATIONS.

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OUTLINE

1. Introduction
2. Literature survey
3. Customer need
4. Concept generation and selection
5. Project modelling and simulation
6. Results
7. Conclusion
8. Reference

INTRODUCTION

Analog Filters:-

- Analog filter is typically used in electronics and is considered as a basic building block of signal processing. These analog filters are used to separate audio signals before applying to loudspeakers.
- It can be operated as passive filter composed of passive elements such as resistors, capacitors and inductors.
- Active filters utilizes active components such as op-amps.
- These filters has wide range of applications in the field of chemistry, optics, engineering, turbulence modelling, engineering, computing, philosophy, and signal processing

TYPES OF FILTERS

There are mainly three main stages of filters

1. Simple filters
2. Image filters
3. Network synthesis filters

- Simple filters are RC filter, RL filter, LC filter and RLC filter.
- Image filters are Constant k filter, General image filter, Lattice filter and Composite image filter.
- Now from a long list of network synthesis filters some of the general filters used in this project are Butterworth filter, Chebyshev filter, Elliptic filter also known as Cauer filter.

Butterworth Filter:-

- A great advantage of using a butterworth filter is that it is maximally flat(i.e has no ripples) in the passband and rolls off towards zero in the stopband.
- Compared to other filters, it has a slower roll-off, and thus will require a higher order to implement a particular stopband specification.

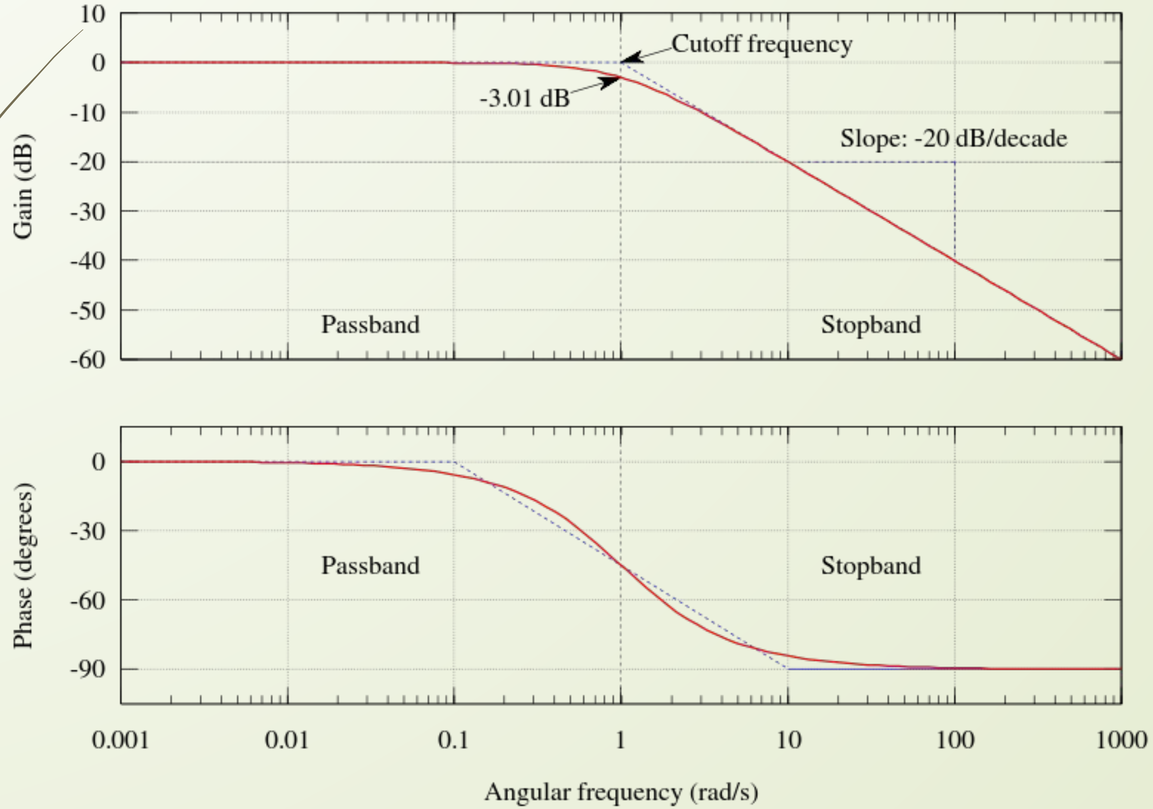

Fig – 1st order butterworth filter bode plot.

Type-I Chebyshev Filter

The pass-band shows equiripple performance. In this band, the filter interchanges between -1 & 1 so the gain of the filter interchanges between max at G = 1 and min at G =1/√(1+ε2) . At the cutoff frequency, the gain has the value of 1/√(1+ε2) and remains to fail into the stop band as the frequency increases

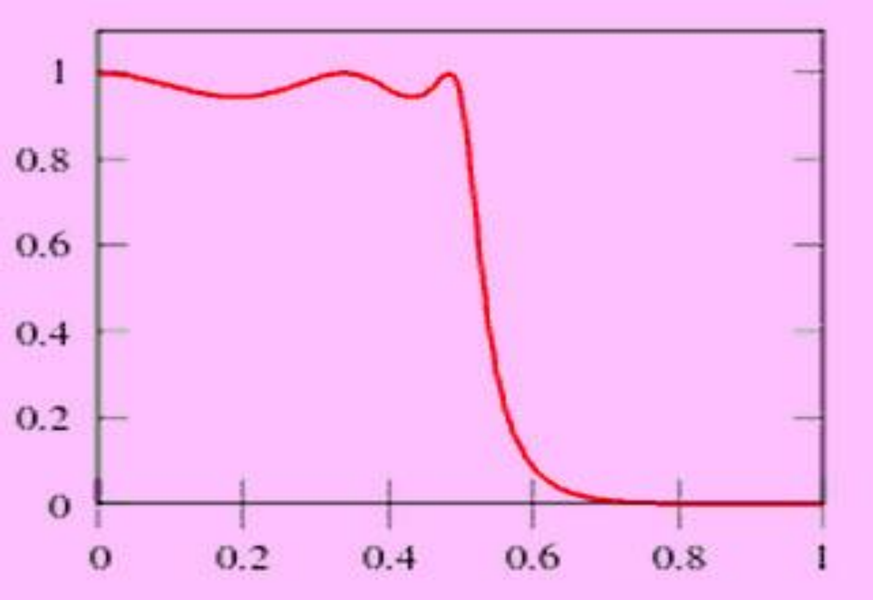

Fig 1:- plot of type 1 Chebyshev's filter

Type-II Chebyshev Filter

The type II chebyshev's filter is also known as an inverse filter, this type of filter is less common. Because, it doesn't roll off and needs various component. It has no ripple in the passband, but it has equiripple in the stopband.

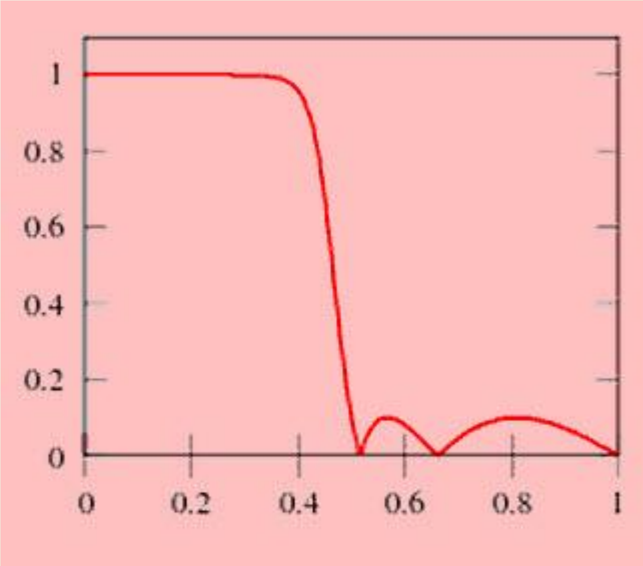

Fig 2:- Chebyshev's filter type-II

LOWPASS FILTER

- A Low Pass Filter is a circuit that can be designed to modify, reshape or reject all unwanted high frequencies of an electrical signal and accept or pass only those signals wanted by the circuits designer.
- The Low Pass Filter – the low pass filter only allows low frequency signals from 0 *Hz* to its cut-off frequency, *fc* point to pass while blocking those any higher.

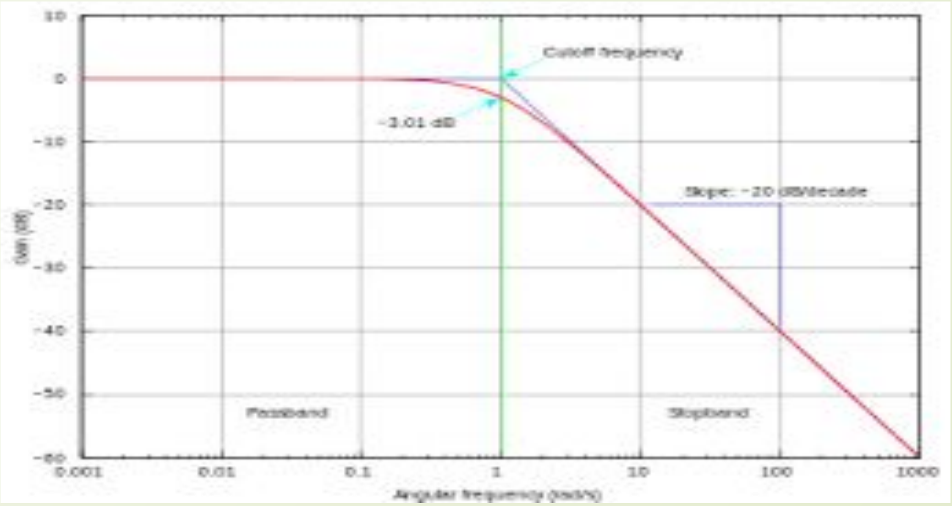

Fig 3:- low pass filter

LITERATURE REVIEW

Sl. No.	Author	Journal	Points Taken	Year of publish
1.	Yuting Yao, Jipeng wei, Manxin Li	A 256MHz Analog Baseband Chain with tunable Bandwidth and Gain for UWB Receivers	An analog baseband chain including LPF and VGA has been presented which helps in realization of UWB systems.	2019
2.	DariaYu.Denisenka , Nikolay N. Prokopenko	Multi-Functional Active RC-Filter(LPF,HPF, BPF) For Designing Specialized Gate-Array Master Chip and Frequency Selection Devices	An advance ARCF's architecture has been proposed which does not alter transfer ratio's and pole frequency after Q-factor adjustment.	2019

3.	Sheikh Shanawaz Mostafa, Nuno Horta, Antonio G. Ravelo-Garcia	Analog active filter design using a multi objective genetic algorithm.	Use of multi-objective optimization method(NSGA-II) for calculation of exact values of passive elements	2018
4.	Rolf schaumann, Mac E. Van Valkenburg	Design of analog filters	Example 7.1, pg-365	2001
5.	R.A.Barapate,J.S.Katre	Digital Signal Processing	Comparision of different filters.	2008
6.	Wazir Muhammad Laghari, Muhammad Abid	Performance Analysis of Analog Butterworth low pass filter as compared to Chebyshev Type-1 Chebyshev Type-11 filter and elliptical filer.	A detailed comparision citing the advantage and disadvantages and uses	2014

CUSTOMER NEEDS RECOGNITION

The process of identifying customer needs is an integral part of the larger product development process and is most closely related to concept generation, concept selection, competitive benchmarking and the establishment of product specifications

1) If you were in charge of this product what would you change?

2) Now that you have this product, what's the thing you're able to do that you weren't before?

3) How would you feel if you could no longer uses this product?

4) How can we improve this product?

5) What are the steps should be taken care before using this project?

6) What type of people do you believe can benefit most from this product?

CONCEPT GENERATION AND SELECTION

- As per the customer needs the low frequency signal are used in the radio frequency domain in the range of 3-30 kHz, corresponding to the wavelength of 100m to 10km.
- So, initially we started with a test signal that is easy to track upon which was sine wave of a frequency of 10kHz. We added a white Gaussian noise in the sine wave so that the analog filter would deduce the white Gaussian and we were able to study the process of filtering in our simulation model.
- So we modified the signal range to a lower frequency that was perfect to the model and it can be implemented in the lab also. From the wide spectrum of lower frequency range we choose the range of 100krad/sec to 140krad/sec and proceeded our work from MATLAB simulation to the MULTISIM circuit simulation. Then we got the desired results.
- After going through the research papers and comparing the filters we could find out

The Butterworth filter has slower roll off, and thus require higher order to implement a particular stopband specification. So, we implemented it using the inverse chebyshev filter which is also known as type II chebyshev filter. This has the fast roll off than the Butterworth filter thus require lower order to implement in a filter specification.

- Ackerberg – Mossberg circuit proved to be the best choice to design bi-quad circuits, due to its stability. The response of the circuit in the bode plotter of Multisim was found to be approximately same as the Bode plot for MATLAB

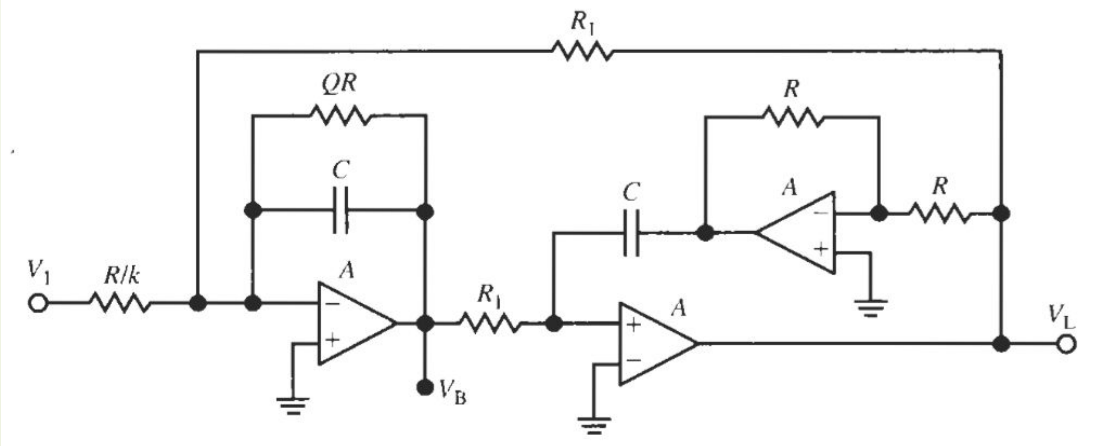

Fig 4:- Ackerberg Mosseberg circuit

Our Approach

- Taken a test signal(sine wave).
- Taking a real signal(Audio signal) from reference [4].

Methodology

- Software implementation using MATLAB 2018a.
- Testing the circuit derived from the transfer function in NI Multisim 14.1.
- Implementation of the circuit in a hardware setup.
- Comparison of error in output signal

PROJECT MODELLING AND SIMULATION

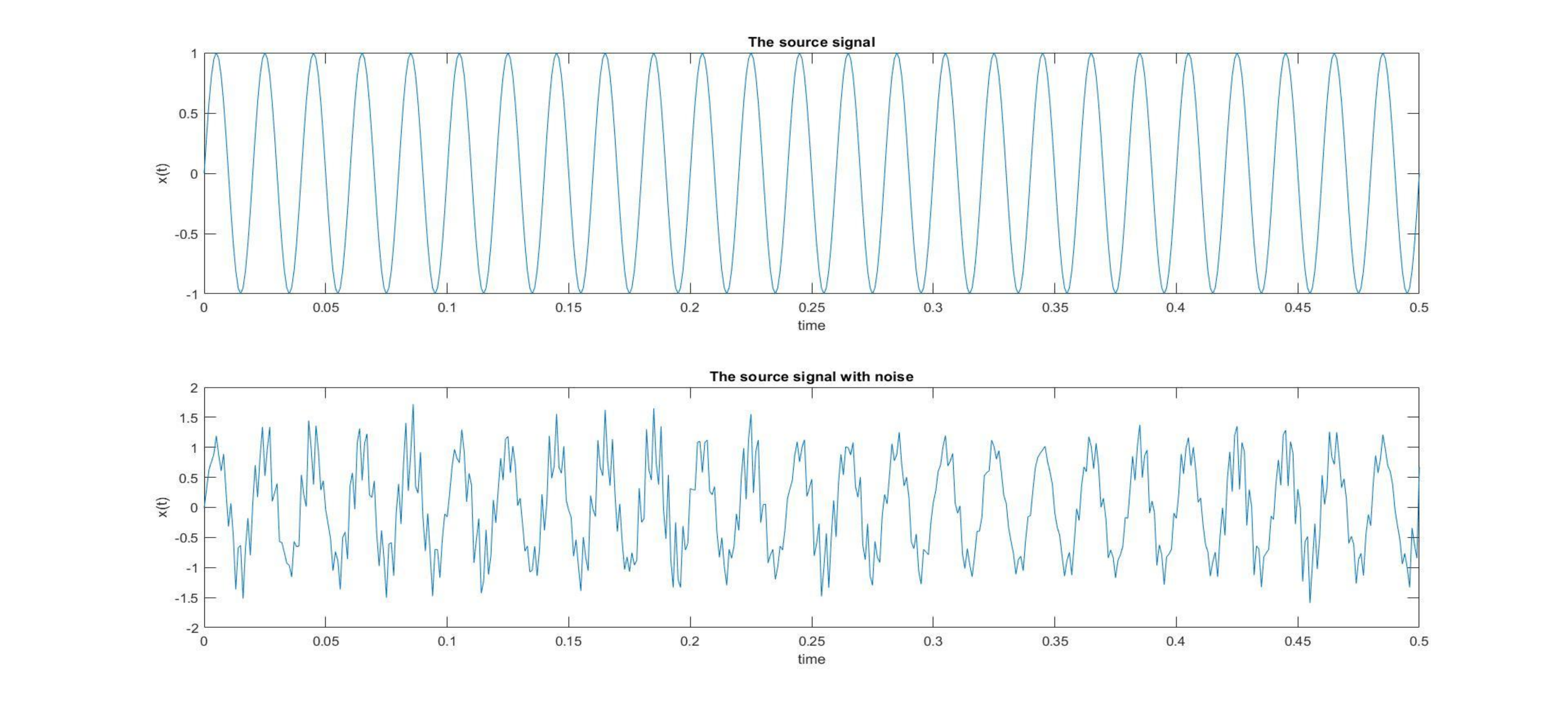

Fig 5:- the input source and noisy signal

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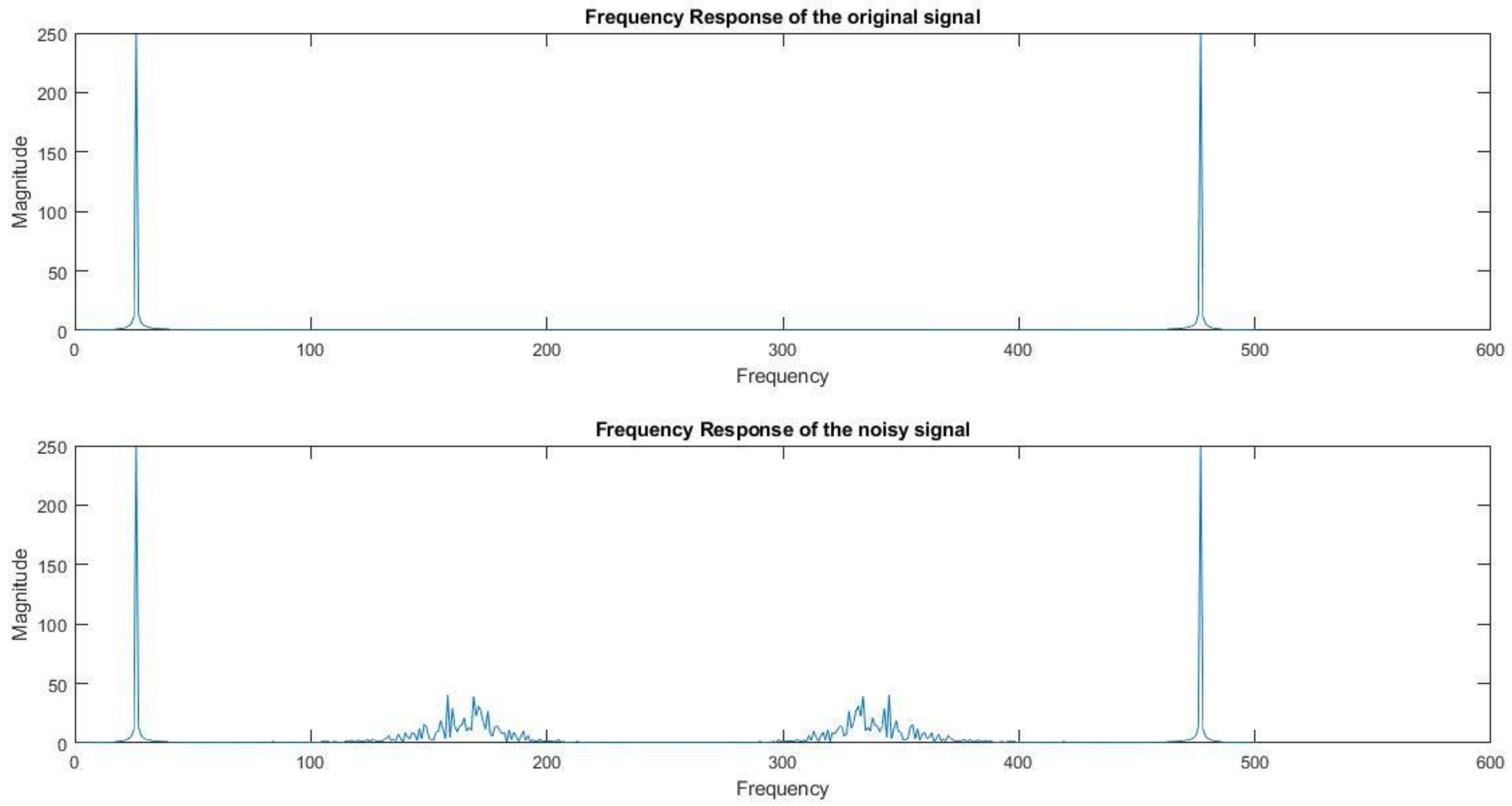


Fig 6:- Frequency plot of the source and noisy signal.

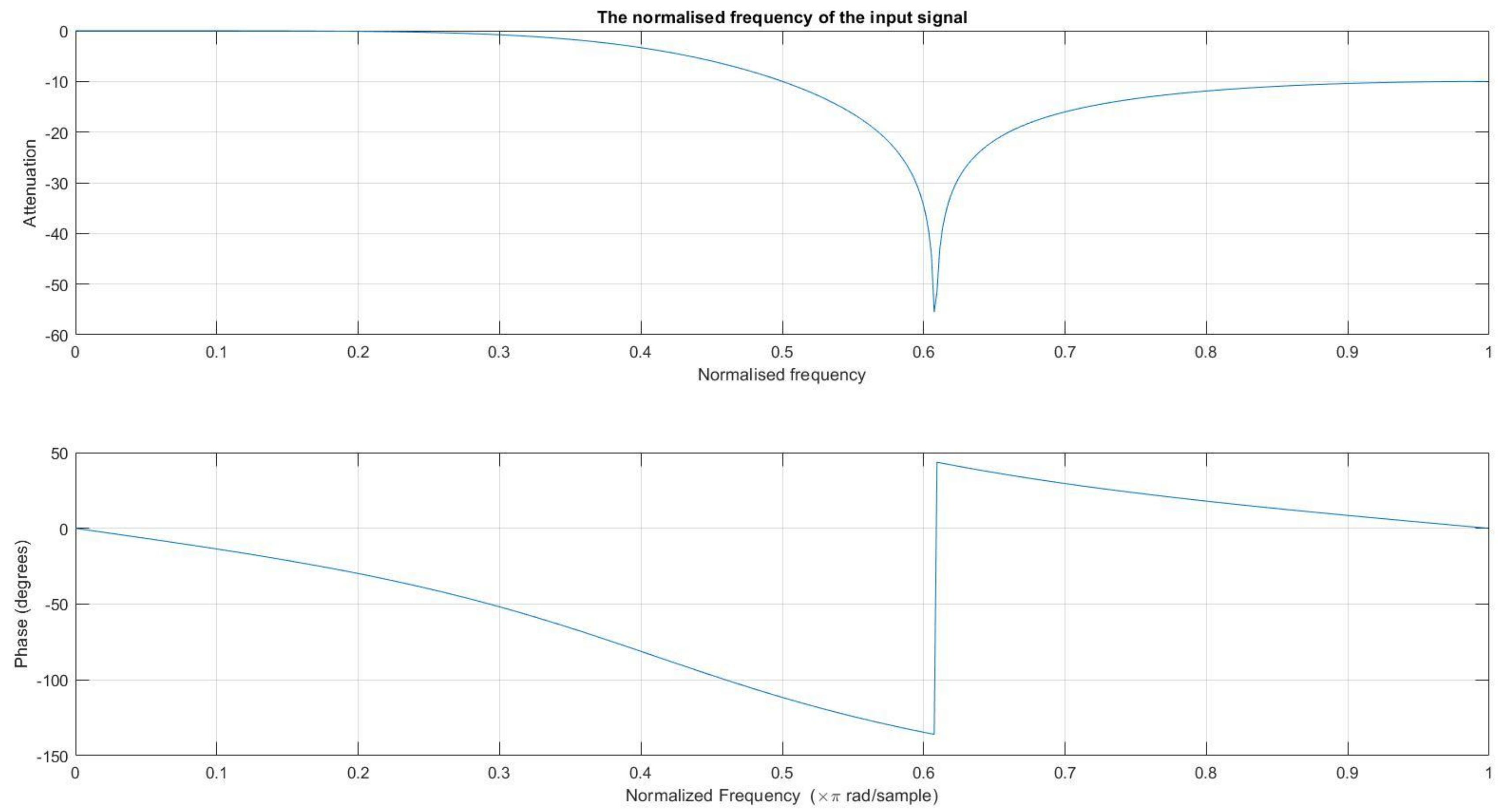


Fig 7:- Frequency response.

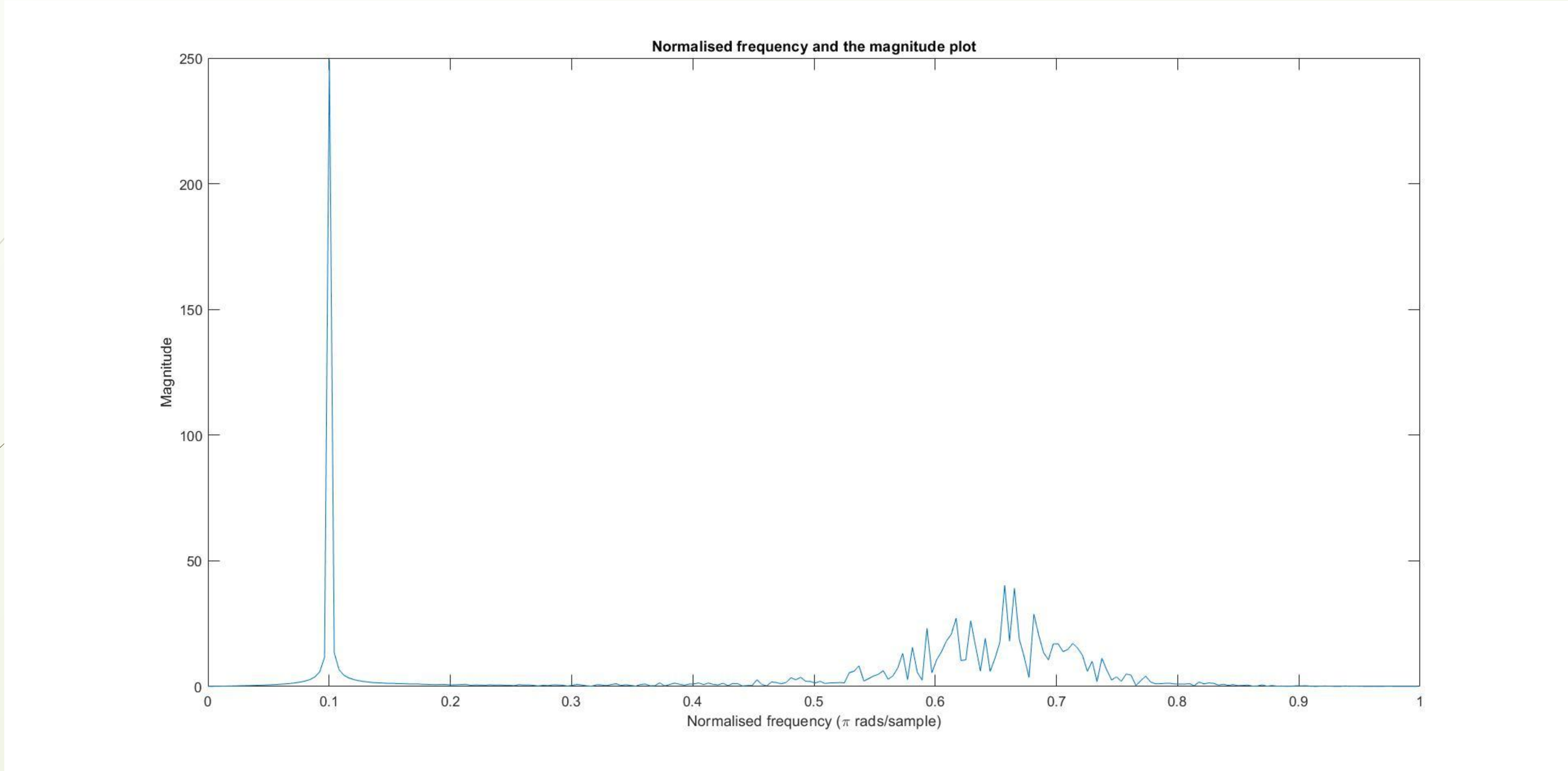


Fig 8:- normalised frequency.

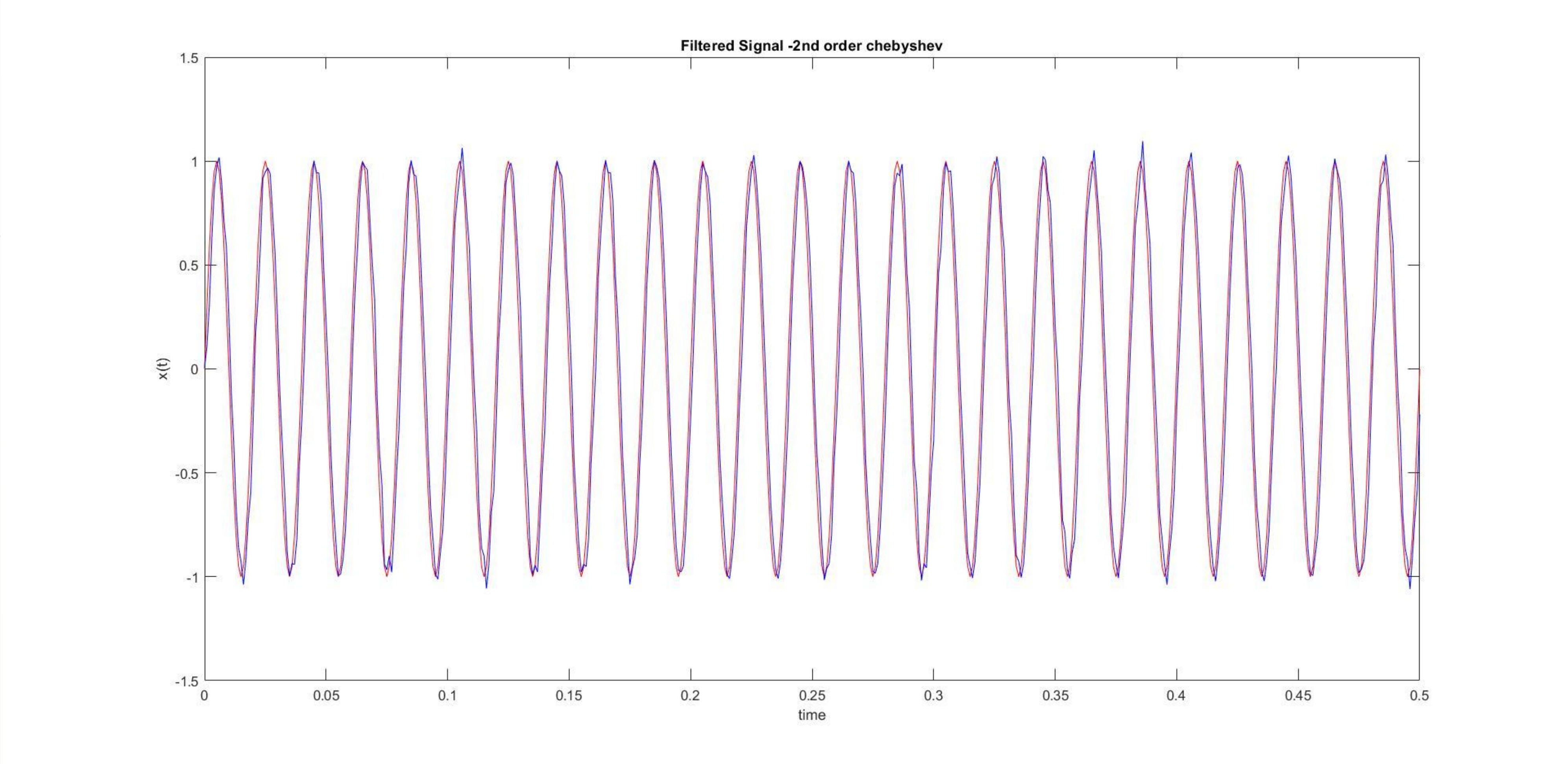


Fig 9:- Filtered output of the signal.

SIMULATION

- Multisim testing:-

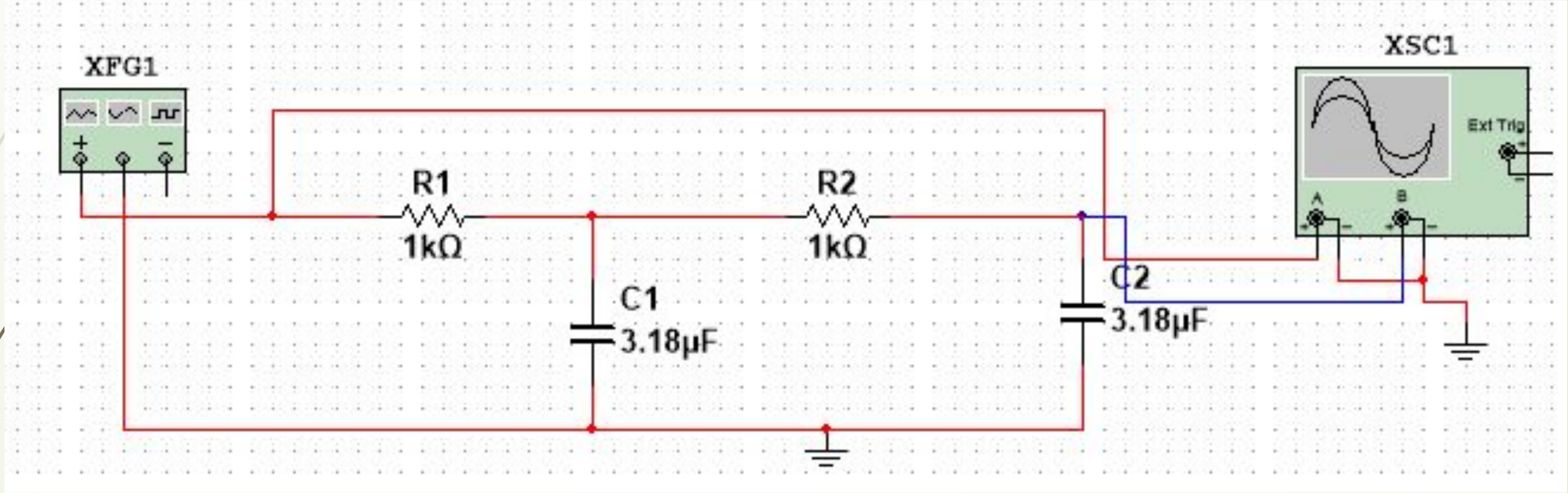
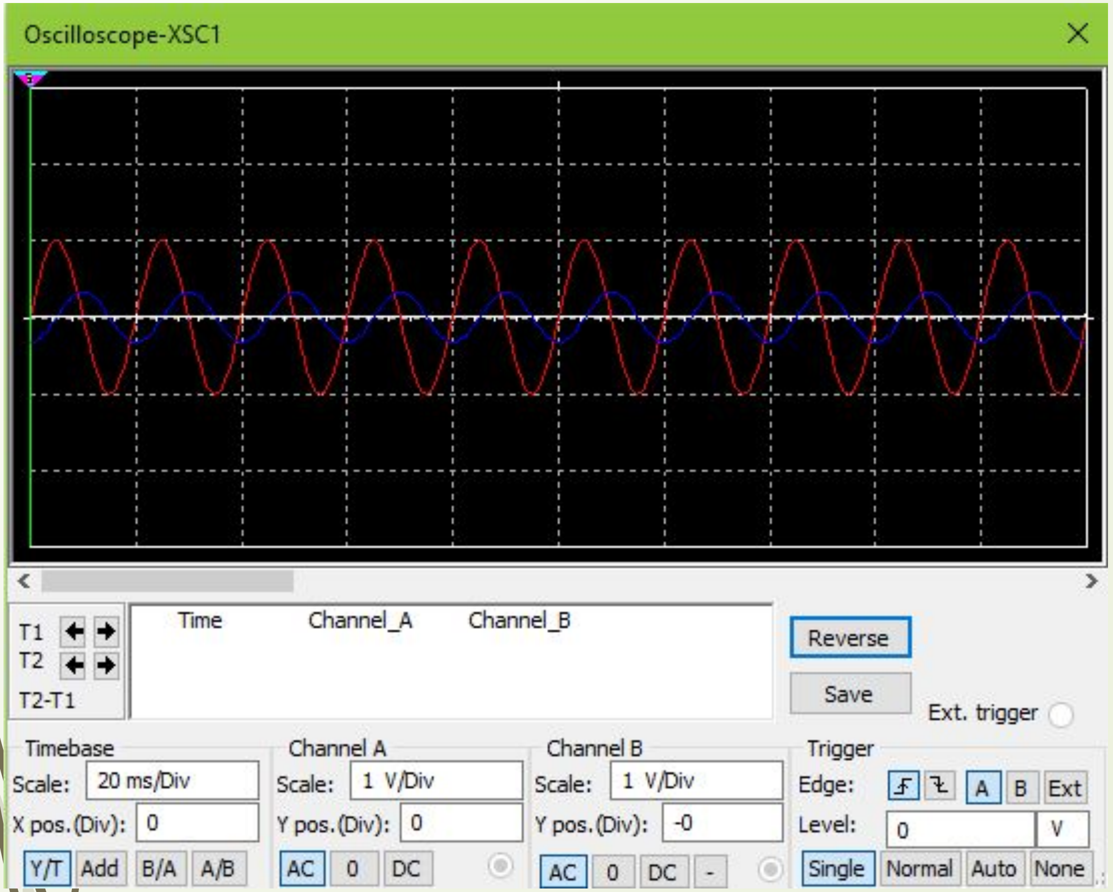


Fig 10:-simulation of sine wave through a 2nd order low pass RC filter.

Output of the Multisim.



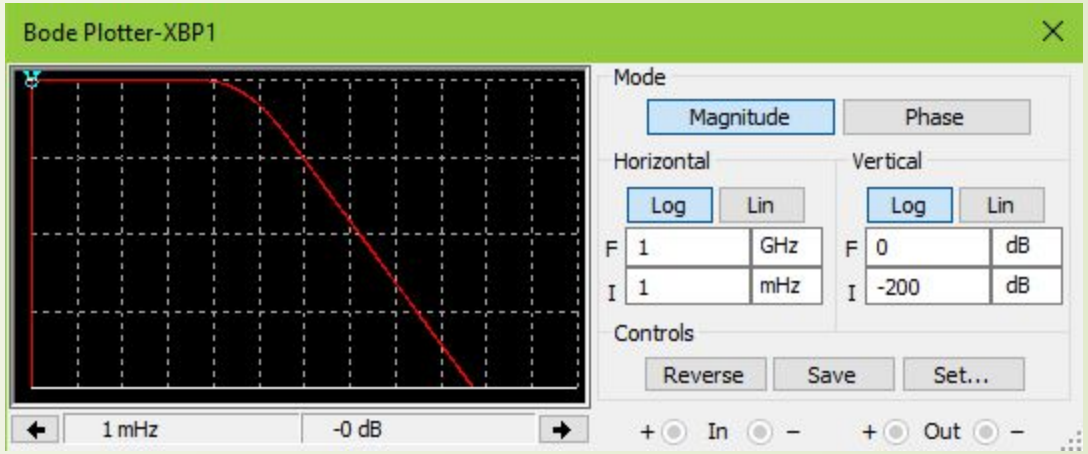


Fig 11:-magnitude plot

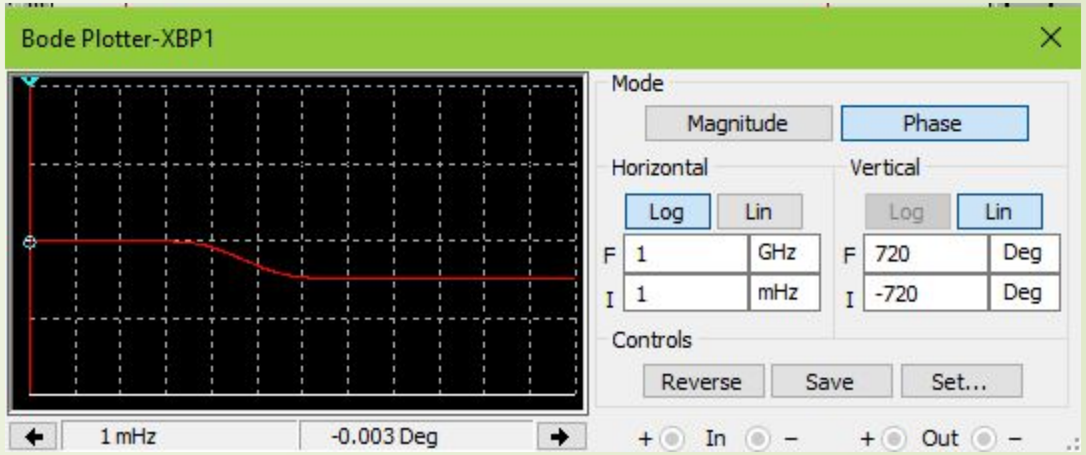
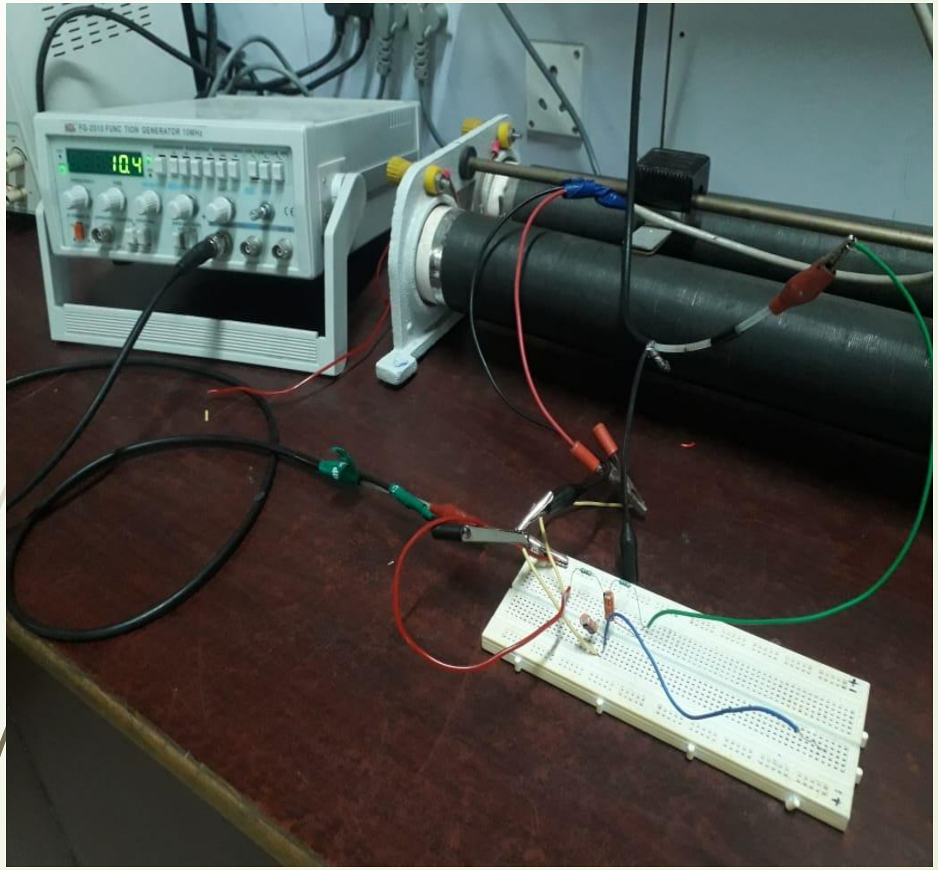


Fig 12:- phase plot

Hardware setup



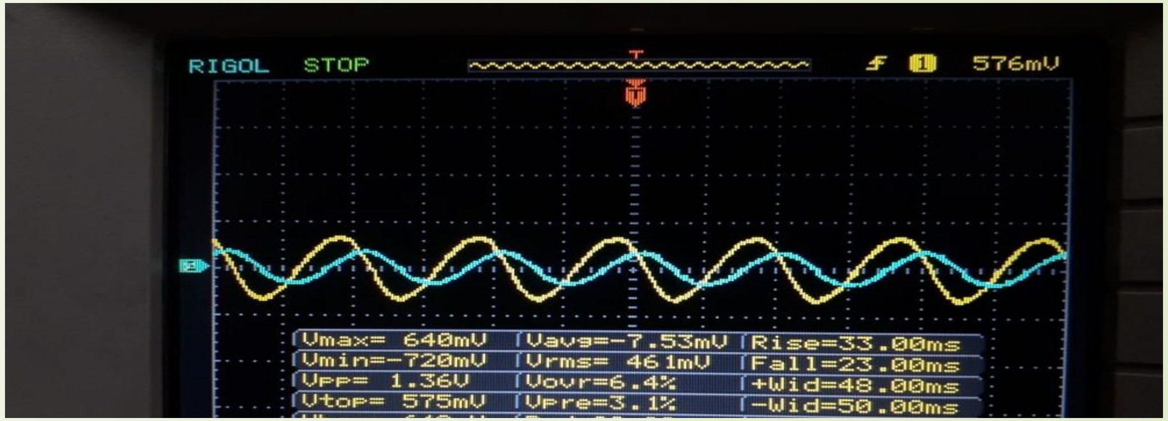


Fig 13:- Input of sine wave

Fig 14:- Filtered wave

Results

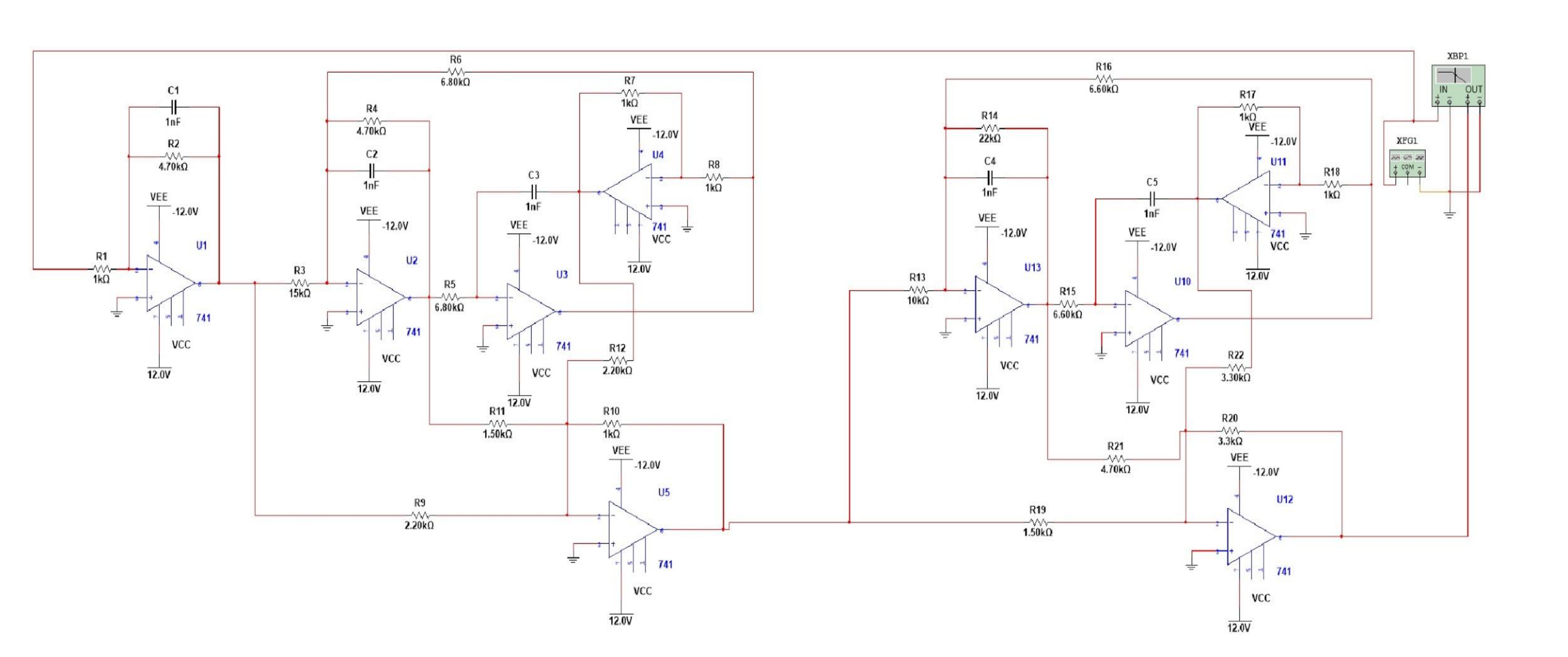


Fig 15:- Multisim circuit diagram

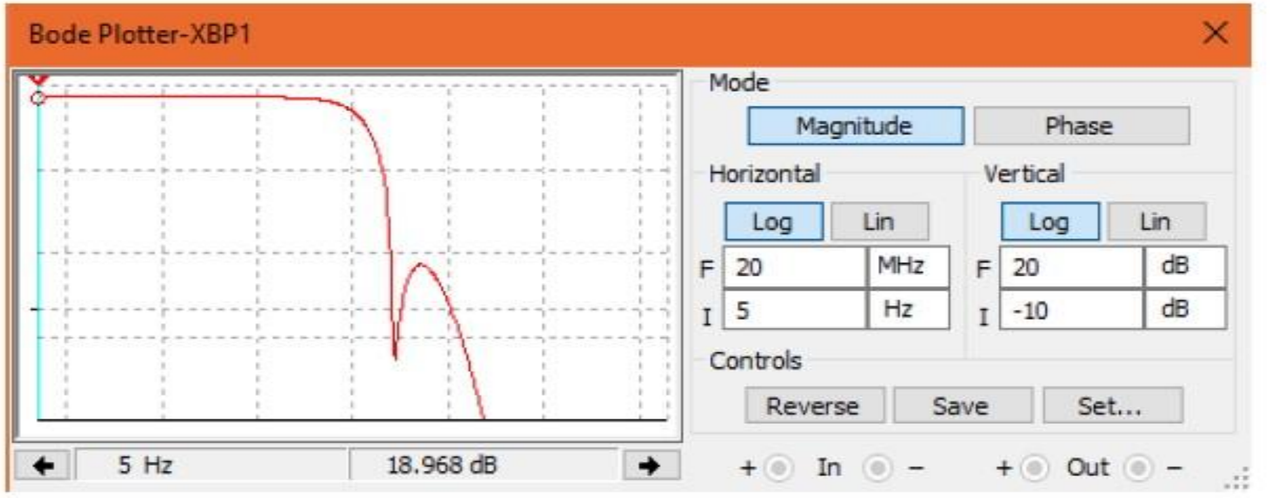


Fig 16:-Magnitude plot in multisim

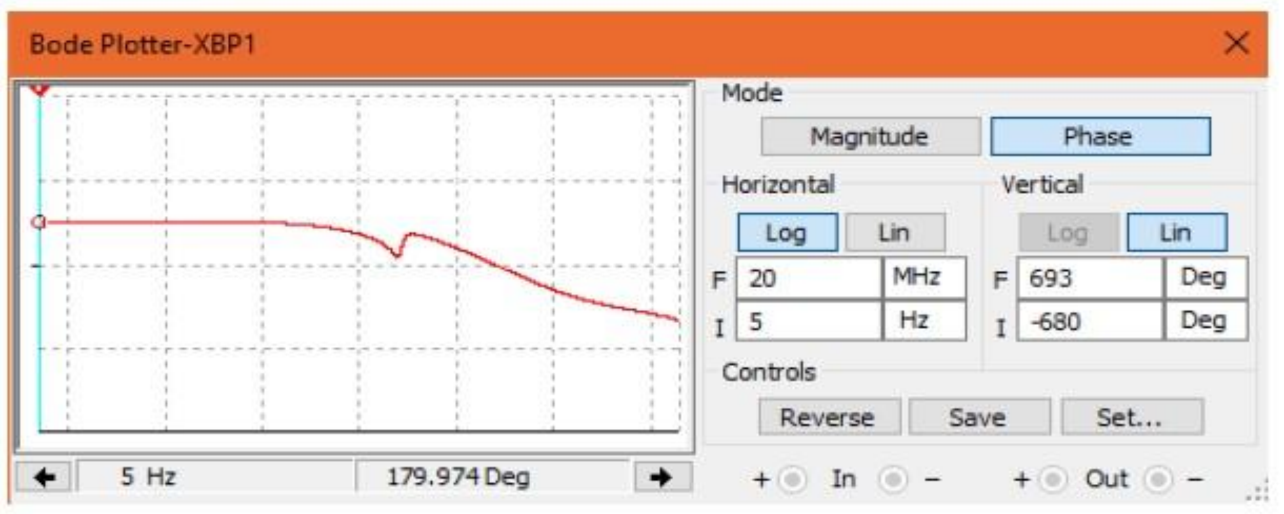


Fig 17:- phase plot in multisim

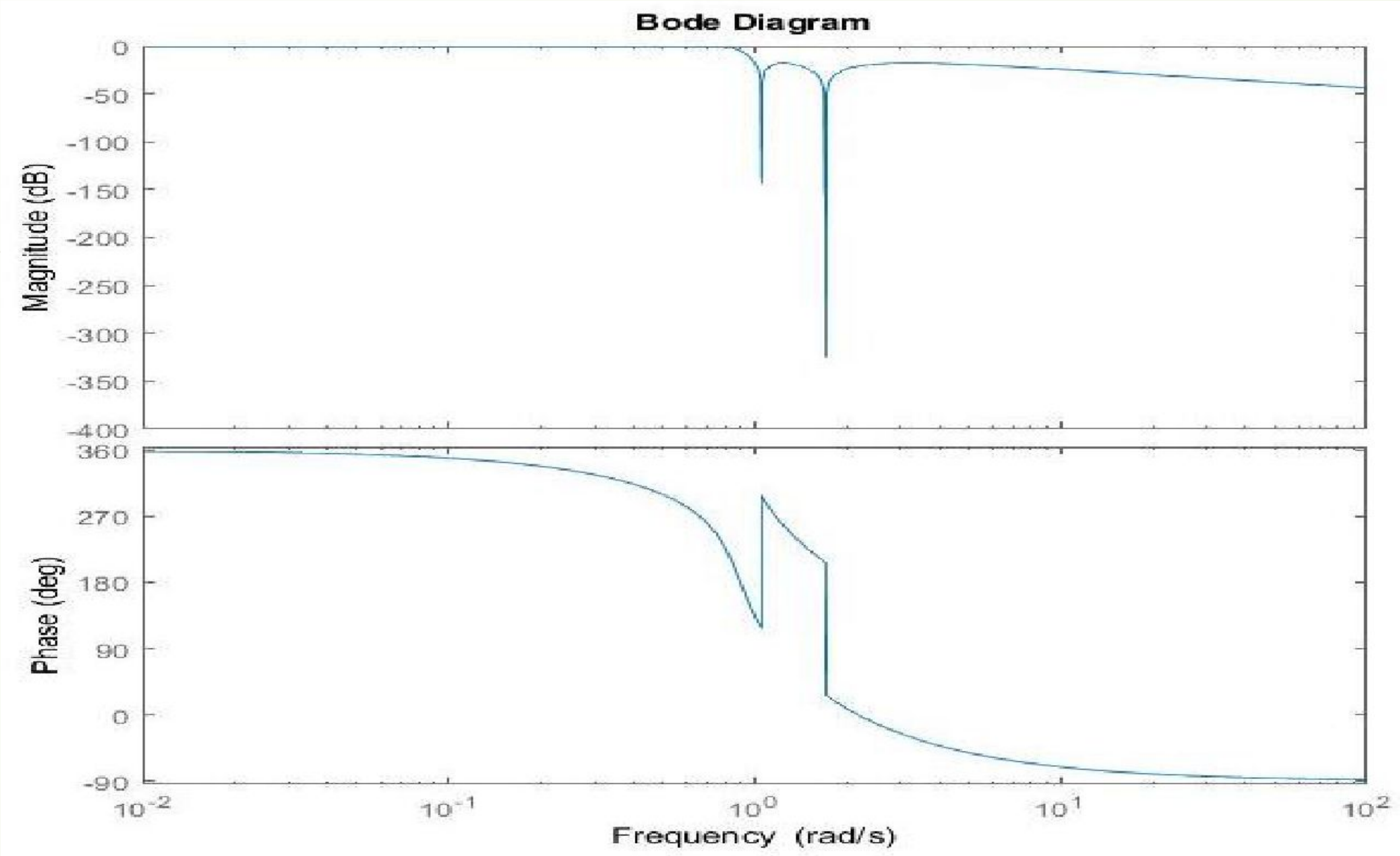


Fig 18:- magnitude and phase plot in MatLab

CONCLUSION

- Designing of low pass filter using inverse Chebyshev filter design technique using ackerberg-mossberg biquad has been successfully implemented.
- The maximum attenuation i.e. αmax is 0.412 dB and minimum attenuation is αmin is 10dB passband frequency 100.835 rad/sec and stop band frequency is 140.835 rad/secs.
- ,Ackerberg – Mossberg circuit proved to be the best choice to design bi-quad circuits, due to its stability. The response of the circuit in the bode plotter of Multisim was found to be approximately same as the Bode plot for MATLAB. The transition zeros pole also be clearly determined at their respective frequencies, within permissible error range
- The exact values could be obtained if we have taken the accurate values of resistor rather than taking ones which are standard resistor values.

REFERNECES

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[5] Oppenheim, A.V., Schafer, R.W. and Buck J.R, " *Discrete-Time Signal Processing. Pearson Education*", New Delhi,2003

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THANK YOU