DESIGN OF ANALOG FILTER FOR RADIO FREQUENCY APPLICATIONS

Project report submitted

In partial fulfilment for the degree of

Bachelor of Technology in Electrical and Electronics Engineering

By

Simran Harichandan, 1641014160
G Shubham Sree, 1641014038

Priyanka Ghosal, 1641014132

Debansh Ray, 1641014035

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Institute of Technical Education and Research

SIKSHA 'O' ANUSANDHAN (Deemed to be) UNIVERSITY
Bhubaneswar,

Odisha, India

(May 2020)

CERTIFICATE

This is to certify that the project titled "**DESIGN OF ANALOG FILTER FOR RADIO FREQUENCY APPLICATIONS**" submitted by Simran Harichandan, G Shubham Sree, Priyanka Goshal, Debansh Ray to the **Institute of Technical Education and Research, SIKSHA 'O' ANUSANDHAN (Deemed to be) University**, Bhubaneswar for the partial fulfilment for the degree of Bachelor of Technology in **Electrical and Electronics Engineering** is a record of original bonafide work carried out by them under my / our supervision and guidance. The project work, in my / our opinion, has reached the requisite standard, fulfilling the requirements for the degree of Bachelor of Technology.

The results contained in this thesis have not been submitted in part or full to any other university or institute for the award of any degree or diploma.

Dr. Niranjan Nayak
Dept. of EEE
ITER

Dr. Taraprasanna Dash
Dept. of EEE
ITER

ACKNOWLEDGEMENT

We have taken efforts in this project. However, it would not have been possible without the kind support and help of many individuals of our institution. Through this project work we have learnt a lot about designing processes and considerations, which will help us in future.

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We are grateful to **Dr. N.Nayak**, HOD Department of Electrical & Electronics Engineering for allowing us to use all the facilities available in the college laboratories and library along with other facilities, without which the completion of the project is impossible.

DECLARATION

We hereby declare that this written submission report represents our ideas in our own words and where other's ideas and words have been included. We have adequately cited and referenced the original sources. We also declare that we have adhered to all the principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea / source / fact in our submission.

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Simran Harichandan

1641014160

Date:

Priyanka Ghosal

1641014132

Date:

G Shubham Sree

1641014038

Date:

Debansh Ray

1641014035

Date:

REPORT APPROVAL

This project report entitled “DESIGN OF ANALOG FILTER FOR RADIO FREQUENCY APPLICATIONS” by Simran Harichandan, G Shubham Sree, Priyanka Ghosal, Debansh Ray is approved for the degree of Bachelor of Technology in Electrical and Electronics Engineering.

Examiners

_____

_____

_____

_____

Supervisors

_____

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H.O.D.

_____

Date: _____

Place: _____

ABSTRACT

Analog filters are the key and the basic component of various applications . Op Amps, resistors, transconductance and capacitors acts as the main components of Active filter. In this project the design of the analog filter is ranging from 100krad/sec to 140krad/sec with a gain of 0.25dB to 18dB has been presented .The filter is composed by 5^{th} order Chebyshev type-II filter usually known as inverse Chebyshev filter designed using the Ackerberg-Moserberg biquads . This has been carried out using a MATLAB and multisim modelling ,taking account into the resistance parasitic effect and the op-amp impact on the transfer function.

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Chapter 1

INTRODUCTION

Analog Filters

Analog filter is the basic building block of signal processing and are typically used in electronics. To combine and also to separate different telephonic channels involves the use of these filters. A particular radio station is considered as reference and rest other channels are not allowed to pass through the filter.

Using passive linear electronics that constitutes of components such as capacitors, resistors, inductors , Analog signal that the property to vary continuously can be build.

Types of Analog Filters

Basically, the filters are classified into two types linear analog filter and digital filter. The Analog is further classified as simple filters , image impedance filters. One more type of Analog filter is network Synthesis filter which can be further sorted as Chebyshev, Butterworth, Elliptical filters. On the other hand simple filters constitutes of RC , LC and RLC type filters.

Analog Filter Design

In order to determine the output response the analog filters makes use of location of poles & zeros and transfer function during its design. Through the output response we ultimately find the Frequency response.

Simple Analog Filters

RC-Filter

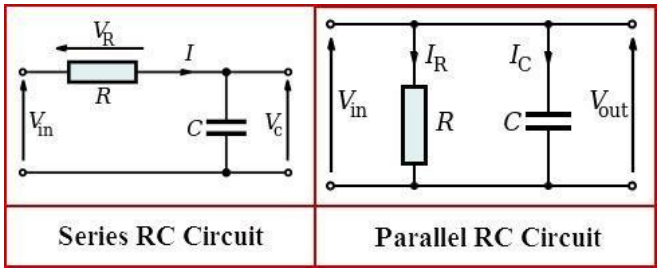


Fig No.1.1 RC Filter Circuit

As the name suggests the RC filter comprises of a Resistor and a Capacitor that is fed by a voltage source . The RC filter circuits helps in filtering a signal by blocking doesn't allow a particular range of frequency while the other frequencies are allowed to pass, as per their specification. As per their use the RC i.e. the Resistor and Capacitor can be connected either in series or in parallel

LC-Filter

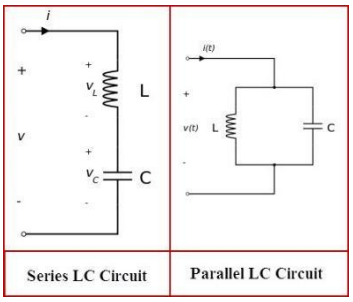


Fig No.1.2 LC Filter Circuit

In a similar configuration as the previous one, the LC circuit can be designed just by replacing the resistor by a Inductor . This circuit can also be termed as a Resonant circuit. The LC circuits help in picking up signals or generating signals at a specific frequency. As per their use the LC i.e. the Inductor and Capacitor can be connected either in series or in parallel as shown in fig 1.2.

RL-Filter

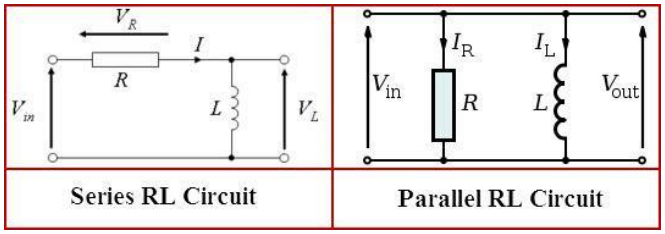


Fig No.1.3 RL Filter Circuit

The RL filter circuit is made of the resistor and inductor and is driven using current or voltage source.

RLC-Filter

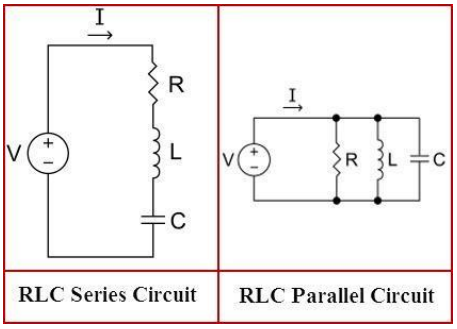


Fig No. 1.4 RLC Filter Circuit

The RLC filter circuit makes use of all the three elements namely resistor, capacitor, and inductor, which can be either connected in parallel or series. The RLC filter circuit can resonate like an LC circuit and can behave as a harmonic oscillator for current. Damping is the factor that can delay the oscillations, and this can be done by the involvement of a resitors of specific values.

TYPES OF FILTER DESIGN:

Butterworth Filter Design

These filters are used in communication system or control systems for shaping the signal's frequency.

The filter has flat frequency response so it is also called as a maximally flat magnitude filter (from 0Hz to -3dB excluding any ripples). In the stop band, all high frequencies above the cut-off point band rolls down to zero at 20dB per decade or 6dB per octave. The main disadvantage of Butterworth filter is the transition of pass band to stop band happens at very slow rate , allowing the transition band to be even more wide. Due to its regular estimation for orders and the frequency response, it is termed as "Brick wall"

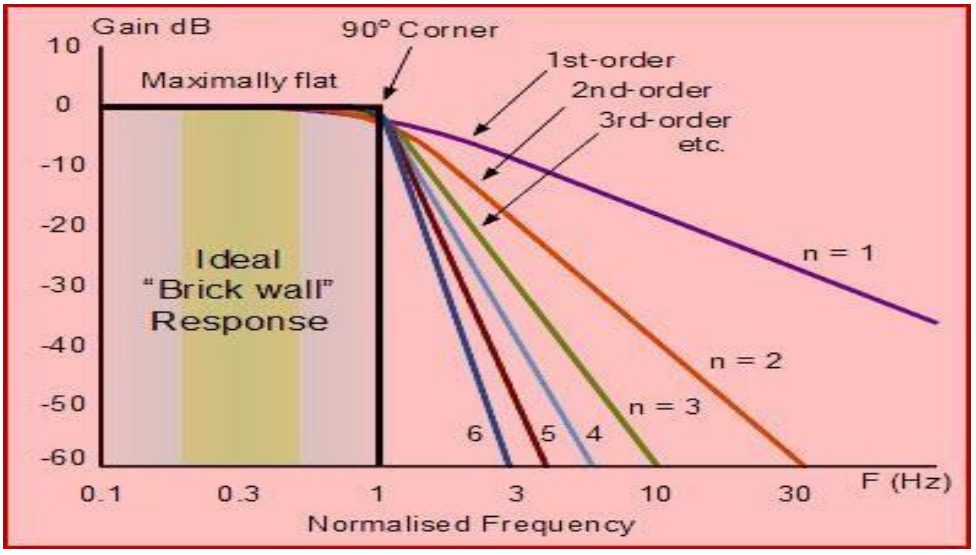


Fig No.1.5 Butterworth filter graph

On increasing the filter order the cascaded stages in design increases and also it comes close to achieve the ideal brick wall scenario.

The nth order frequency response of Butterworth filter is given as

$$H_{(jw)} = \frac{1}{\sqrt{1 + \varepsilon^2 \left(\frac{}{\omega_p}\right)^{2n}}}$$

Where,

'n' is defined as the order of filter,

'ω' = $2\pi f$ is the angular frequency,

ε is maximum pass band gain, $(Amax)$.

Application of Butterworth Filter

- the radar target track display.
- Used for high quality audio applications.
- As an anti-aliasing filter for Data converter applications.
- Digital Butterworth filters are used in the motion analysis.

Chebyshev's filter

The Chebyshev filters are also known as "Pafnufy Chebyshev" because of its mathematical characteristics . Chebyshev filters are the analog or digital filters. These filters have a fast roll off as compared to that of Butterworth filter & type-1 filter which has more pass band ripple or type-2 filter which ha ripples in stop band . Due to its pass band ripple it has an advantage above all as it reduces the error between ideal and actual case.

The key features of the Chebyshev filter can be summarised as below:

- ***Roll-off:*** This filter has a steeper roll-off and it reaches its ultimate roll-off faster than any other filter. Therefore it is used in radio frequency to remove unwanted harmonics.
- **Ripple**: The only disadvantage is its ripple which is due to its steeper roll -off for which the performances gets affected.
- ***Cut-off frequency:***. When the gain falls to the exact same avalue as that of a ripple that point is considered as cut-off frequency.

TYPE-1:-

Here the pass-band displays equi-ripple performance. As the gain varies between two points that is at G = 1 and at G =1/√(1+ε2) , the filter interchanges between -1 & 1.

The no. of reactive components used is similar to the order of this filter required. The ripple in dB is 20log10 √(1+ε2). So that an even steeper roll-off can be found by permitting 0's on the jw-axis which will permit repel in the stop band. stop band. The effect is called a Cauer or elliptic filter.

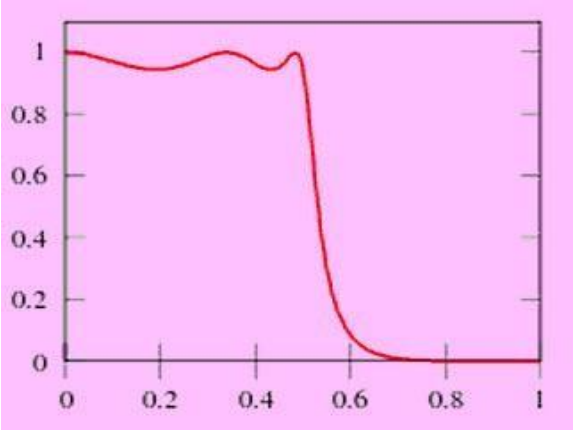


Fig No. 1.6 chebyshev's type-1 graph

The no. of reactive components used is similar to the order of this filter required.The ripple in dB is 20log10 √(1+ε2). So that an even steeper roll-off can be found by permitting 0's on the jw-axis which will permit repel in the stop band. stop band.

Type-II Chebyshev Filter

The type II chebyshev's filter is also called as an inverse filter, this type of filter has no ripple in the pass band but has equiripple in the stopband stopband. The gain is

$$G_n(\omega, \omega_0) = \frac{1}{\sqrt{1 + \frac{1}{\varepsilon^2 T_n^2(\omega_0/\omega)}}}.$$

The Chebyshev polynomial interchanges between -1& and 1 in the stop band so the gain 'G' will interchange between zero and $\frac{1}{\sqrt{1+\frac{1}{\varepsilon^2}}}$.

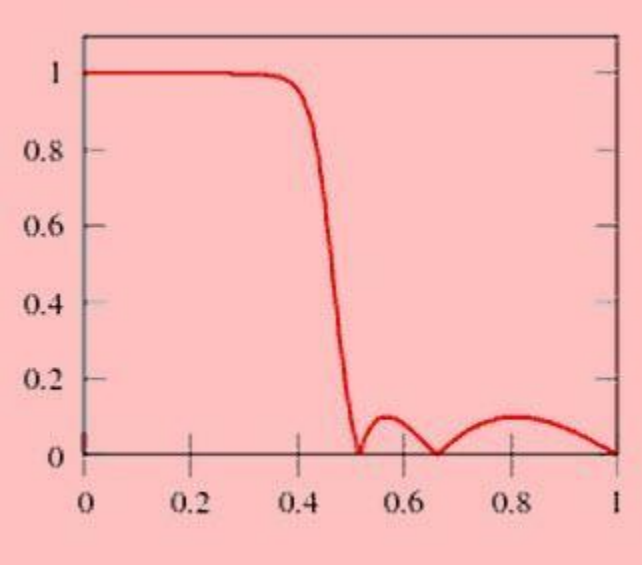


Fig No1.7 Chebyshev's filter type-II

Low pass filter

A low pass filter (LPF) passes lower frequency signals and removes high frequency signals than the cut off frequency. The frequency response depends on the filter design.

DESIGN OF A LOW PASS FILTER

A RC low pass filter, can be designed by simply connecting a resistor and a capacitor together in series a series RC circuit is fed with a voltage supply , and since it is a low pass filter the O/P voltage is measured across the capacitor.

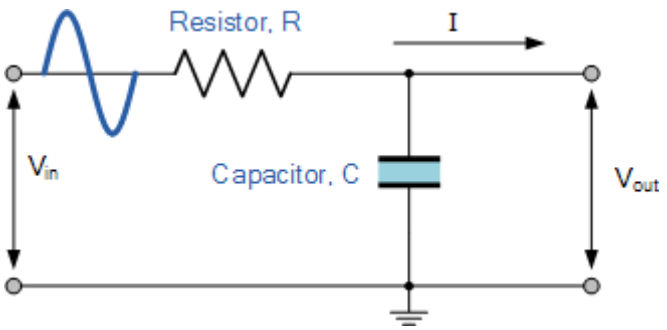


Fig No.1.8 RC circuit

Applications of Active Low Pass Filters:

- These filters are used to reduce the high frequency hiss produced in the hiss filter system .
- Audio amplifiers and equalizers.
- An anti-aliasing filters to control signals.
- Smoothing sets of data signals, blurring of images in digital filters .
- In radio transmitters to block harmonic emissions.

Radio frequency

Radio frequency ranges from 300 GHZ to as low as 9 KHZ . It represents the oscillation rate of electromagnetic spectrum or Electromagnetic radio waves. It uses antennas and transmitters for accomplishing it purpose. An RF field can be used for various types of communication and wireless broadcasting.

Radio Frequency technology

We can find the application of RF in many types of wireless devices. Satellite communications system,radio and television broadcast stations ,Cordless and cell phones , Wi-Fi and Bluetooth. Apart from communication RF are also applied in microwave ovens garage-door openers and Some wireless devices,

like TV remote controls, some cordless computer keyboards

Student Outcomes and Bloom's taxonomy

To facilitate the process of evaluation of the progress of the project, there are eleven student outcomes (student outcome A – student outcome K) for the Electrical and Electronics Engineering program. Each outcome is unique in its approach to inspect the ability of the student or the team in understanding and overcoming various issues faced during the course of the project. The table containing the description of each of these eleven student outcomes used to examine the quality of progress of the group is shown below.

Table 1.1: Student Outcomes

Outcome	**Description**
a	An ability to apply knowledge of mathematics, science and engineering.
b	An ability to design and conduct experiments, as well as to analyze and interpret data.
c	An ability to design a system , component or process to meet desired needs within realistic constraints such as economic , environmental , social , political, safety and sustainability.
d	An ability to function on multidisciplinary teams.
e	Ability to identify, A formulate and solve engineering problems.
f	An understanding of professional and ethical responsibility.
g	An ability to communicate effectively.
h	The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context.

i	A recognition of the need for and an ability to engage in life-long learning.
j	A knowledge of contemporary issues.
k	An ability to use the techniques, skills and modern engineering tools necessary for engineering practice.

Bloom's taxonomy is a three-tier hierarchical model used to promote higher forms of thinking in the educational system. It promotes understanding, processing, analyzing, etc. instead of just memorizing things, the old way. The three domains under the Bloom's taxonomy are: cognitive, affective and psychomotor domains. For the purpose of structuring and evaluating the project in the educational realm, only the cognitive domain is considered. There are six levels of learning as defined in the cognitive domain of Bloom's taxonomy: knowledge, comprehension, application, analysis, evaluation and creation. The levels are classified on the basis of complexity and specificity. The figure 1.1 graphically shows the cognitive learning levels of the Bloom's taxonomy while the table 1.2 lists the descriptions of each learning level

Fig No 1.10 - Cognitive domain of bloom's taxonomy

LEVEL	NAME	DESCRIPTION
L-1	Knowledge	Retrieving, recognizing and recalling relevant knowledge from long term memory.
L-2	Comprehension	Constructing meaning from oral, written and graphic messages through interpreting, exemplifying, classifying, summarizing, inferring, comparing and explaining.
L-3	Application	Carrying out or using a procedure through executing or implementing.
L-4	Analysis	Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure or purpose through differentiating, organizing and attributing.
L-5	Synthesis	Making judgments based on criteria and standards through checking and critiquing.
L-6	Evaluation	Putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure through generating, planning or producing.

Table 1.2: learning levels

Course Outcomes

In this project, the course outcomes can be verified in terms of the knowledge of the students in the field of power system which mainly focus on voltage and frequency regulation to achieve the desired results. During the course of the project, we understood the need of time management for the successful completion of the project. Below table 1.3 shows the 11 course outcomes that plays a vital role in the progress of this thesis.

Student Outcomes	Students will be able to
SO1	Follow the proper design process
SO2	Understand the global issues.
SO3	Work effectively in teams.
SO4	Use appropriate prototyping techniques.
SO5	Understand concepts of professionalism and ethics.
SO6	Include issues of standards and certification in project design.
SO7	Include issues of intellectual property in project design.

SO8	Include issues of product liability and social responsibility in project design.
SO9	Use design resources such as professional, journals, trade journals, catalogs, and the internet in project design.
SO10	Communicate the project design effectively.
SO11	Test, debug, and verify that the design meets the desired specifications.

Table 1.3: Course Outcomes

1.1 Design Checkpoints

The product design passes through several phases. Each phase in turn is separated into various steps. For the purpose of proper execution and evaluation of these steps, checkpoints are used. These checkpoints proved to be apt points of evaluation to ensure systematic and strategic progress of the project. Table 1.4 shows the checkpoints for each chapter to be fulfilled by the design team members.

	Checkpoints	A	B	C	D	E	F	G	H	I	J	K
1	Engineering specification			√	√							
2	Concept generation			√	√							
3	Concept selection	√		√	√	√				√	√	
4	Product metric model	√		√	√	√						
5	Analytical and numerical solution			√	√	√	√					√
6	Testing and improvement		√	√	√							
7	Final product and Final Report				√			√				

Table1.4: Design Checkpoints

Chapter 2

CUSTOMER NEEDS RECOGNITION

Client's requirement is essential to create or enhance another item for future. By taking client needs we can to increment or change the office in the item on the grounds that a client has confronting which issue when it utilizes their item.

Task Distribution and Monitoring

The work assigned for this project has been divided among the following individuals. The Team chief has allocating various assignments to various individuals and set the timetable for fruition of this errand as appeared in Table 2.1:

Table 3.1: Work Distribution

Work done by each Team member			
Team leader: Simran Harichandan			
Team members	Task(s) to be performed	Task assigned date	Task completed on
Simran Harichandan	Taking the serve.	02.12.2019	09.12.2019
G Shubham Sree	Analysing the serve	02.12.2019	09.12.2019
Priyanka Ghosal	Report	02.12.2019	09.12.2019
Debansh Ray	PPT	02.12.2019	09.12.2019

Customer Needs Data

a. Direct Needs: These prerequisites apply to every person in the customer people.

b. Latent Needs: These prerequisites apply to every person in the customer people.

c. Constant Needs: These prerequisites apply to every person in the customer people.

d. Variable Needs: These prerequisites apply to every person in the customer people.

e. General Needs: These prerequisites apply to every person in the customer people.

f. Niche Needs: These necessities apply just to a more diminutive market area inside the entire buying masses. The pace of progress of these limits in the client need space is totally subject to the condition of innovation and its pace of progress. The main classification considers unmistakable and the second considers innovation change.

Gathering Customer Need

We have gathered client prerequisites utilizing different strategies, similar to, Questionnaire, Conducting Interview, Focus Group Discussion, and Be a Customer. They will put comparative prerequisites into gatherings to get quantities of remarkable necessities. They will likewise recognize necessities and imperatives. There are a couple of procedures available for a structure gathering to grasp the customer needs.

Unmistakable strategies are applying for customer needs are

a. **Questionnaires:** The group builds up a rundown of standards where it believes is applicable to the client's interests. It at that point positions the item on these standards.

b. **Interviews:** The arrangement partners talk about the necessities with a lone client, every one thus. such gatherings are commonly held in the client condition, where the

customer uses the thing. The arrangement partner records the customer responses. This technique capacity splendidly for things that have a strategy related with their customer use**.**

c. **Focus Groups:** An authority energizes a meeting with a social occasion of customers. This meeting is generally held in the item designer's condition.

Questionnaire Method -

In this technique a lot of inquiries are readied and the clients are approached to offer their input on our item. Here we arranged a lot of 15 inquiries. 20 clients gave their perspectives relying on their decision. The inquiries are appeared in figure 3.2

Table 3.2: Questionnaire for the Product

Title	
Customer name: Rakesh Yadav Occupation: Engineer Address : Patna, bihar	
Q. 1	What are your views on this product?
Q. 2	What are the aspects that we can improve on for better outcomes?
Q. 3	If you were in charge of this product what change would you bring for enhacement?
Q. 4	How did this product make your daily life any better?
Q. 5	Does this product play an indispensable?
Q. 6	Which society of people do you believe would benefit most from this product?
Q. 7	What is the major benefit you receive from this product?
Q. 8	What should we stop doing before using this project?
Q. 9	What are the steps should be taken care before using this project?

Q.10	What other solutions have you consider? a. If they have found solution, how recently? b. If they have failed to find a solution, why so?

Interview Method

There is fundamental information related to the endeavor and the gathering subjects. The structure itself has three portions. The primary fragment is used to record a particular request that streak a customer response, the middle portion is the veritable customer clarification and the last area is the change of this genuine customer verbalization into a compact thing, activity word, action word modifier structure, using unclear words from the subject communicated as recorded in the subsequent section.

The Like/Dislike procedure has general line characterization to save customer decrees. If the customer cherishes the path wherein a need is completed, it is recorded in Likes lines. If the customer couldn't care less for how a need is realized, it is saved in the Dislike sections. The structure licenses snappy cognizance of what ought to be based on while upgrading a thing. The portion number four measures phonetic explanations of criticalness that the customers may have used.

Organizing and Prioritizing of Customer Need

Afterwards collection of the data from all the 20 costumers, the weightage has been calculated for redesigning of product. In Table 3.3., these datas are shown. In this table 4 ratings are given.

Evaluation shows the best to worst (5-1). Following these weightage, we have to modify our design.

Table3.3: Prioritized Customer Need (Weightage Calculation)

Serial .No.	Questions	W (5-1)	5	4	3	2	1	0
1	Labor and time saving model	4	7	5	6	2	0	0
2	Time saving	3	4	3	6	3	3	1
3	Easy transportation.	4	5	8	6	1	0	0
4	Highly Durable product	3	5	4	3	3	4	1
5	Environment friendly	4	8	6	5	1	0	0
6	Less maintenance cost of the system	4	8	4	5	2	1	0
7	Motor operated	4	8	5	5	2	0	0
8	Chain and sprocket system is cheaper	3	2	5	3	4	3	3
9	Easy to clean your system .	4	7	6	4	3	0	0
10	High and efficient performance of the system	4	6	7	3	2	1	1
11	Operator friendly	4	9	6	5	0	0	0

Interview method for giving weightage to the needs:

- The Customers have given ratings according to their requirements.
- Then the average importance of need is calculated by the following method.
- The weightage scale ranges from 0 to 5.
- 5 is the maximum and 1 is the minimum weightage that a customer can rate.
- If customer does not mention any thing, then the rating is considered as 0.
- Then the average importance of need is calculated in the following manner,

$$\frac{(n1 * 5 + n2 * 4 + n3 + 3 + n4 * 2 + n5 * 1 + n6 * 0)}{n1 + n2 + n3 + n4 + n5 + n6}$$

Here n1, n2, n3, n4, n5, n6 = number of customers who gives the corresponding ratings to the product that is 5, 4, 3, 2, 1, 0 respectively.

This helps us to identify the needs of the customers which is required to be given prioritization. In the above method weightage(WT) is given by referring customers about each part of the product and ask them to rate each function according to their need from 1 to 5 and then the average importance of need is calculated as follows Example: Weightage calculation of Sl. No. 11 is

$$WT = \frac{3 * 4 + 4 * 3 + 1 * 2 + 2 * 1}{20}$$

Chapter 3

FUNCTION DECOMPOSITION

After we understand what the customer needs from a thing, we will develop a model of how a thing should function. It is required to clarify and design the thing building. For all intents and purposes all things achieve something. Things recognize data sources and work to convey yields. The yield is the perfect execution. We can show anything, get together, sub-assembling, or fragment as a structure, with wellsprings of information and yields that explore a system limit. The substance of such a model is the need-work structure significance of building plan, where our consideration is on deciphering the customer prerequisites for a thing to the thing limits.

Task Distribution and Monitoring

The work for this project has been divided among the group members. The Group leader has allocated various tasks to various individuals and set the course of events for finishing of this errand as appeared in table mentioned below.

Table 4.1: Work Distribution

Work Done by individual member			
Team Leader : Simran Harichandan			
Team Members	Task(s) to be performed	Assigned Date	Completion Date
1: Simran Harichandan	PPT	20.02.2020	25.02.2020
2: G Shubham Sree	Research and Mathematical calculations	20.02.2020	25.02.2020
3: Priyanka Ghosal	Report	20.02.2020	25.02.2020
4: Debansh Ray	Report	20.02.2020	25.02.2020

Function Modelling Basics

a. Function

A segment of a thing is a declaration of a sensible, duplicable association betwixt the available data and the perfect yield of the thing, liberated from a particular structure.

b. Sub work

Sub work is a portion of a thing work. A general limit can and as often as possible ought to be isolated into conspicuous sub limits contrasting with sub-tasks. The association between some sub limits and the general limit is habitually directed by a prerequisite or information – yield relationship.

c. Abstraction

Reflection is the route toward ignoring what is explicit or incidental and underlining what is general and essential. Such hypothesis prompts the quintessence of the issue. In case a thing is found in principle, one is better prepared to describe commonly utilitarian necessities.

d. Constraints

A Constraint is a proclamation of a reasonable paradigm that must be fulfilled by an item and requires thought of the whole item to decide the foundation esteem.

Function Trees

Capacity trees are fast and simple to fabricate anyway this straightforwardness of improvement is gotten to the hindrance of understanding associations between the all-inclusive sub limits. Interconnecting joins among the sub work mystery components are not thought of. Making capacity trees can be moved nearer in different manners, two of which are presented in the subsections underneath. The first is a top down methodology,

utilizing the orderly FAST technique.

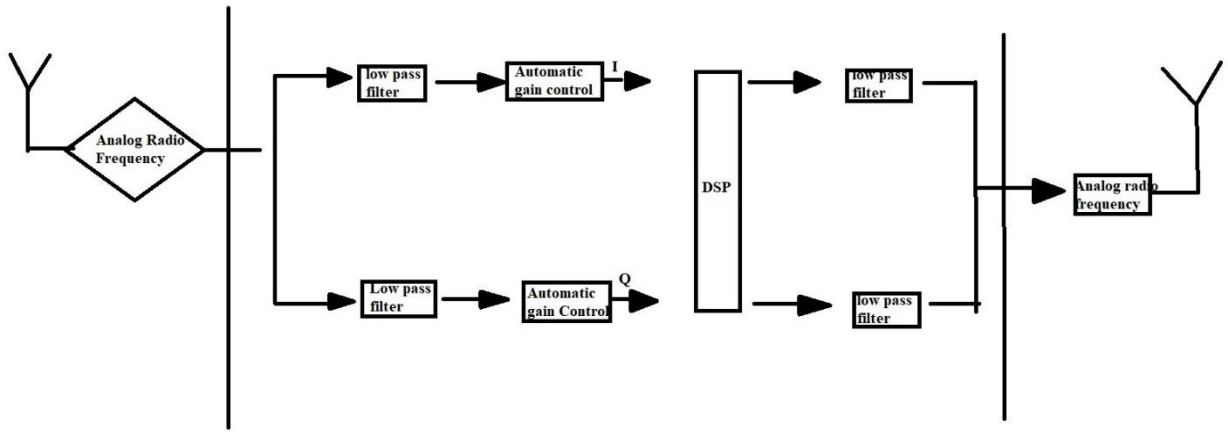


Fig No 4.1: Fast Diagram

Signals from the antenna enters the receiver and later on are applied to the Radio Frequency amplifier where they are tuned reduce the unwanted frequencies that are not required and remove the image signal.

The wanted signal is converted down to intermediate frequency and the along with the local oscillator are applied to the mixer. The signals are filtered by applying significant levels of amplification. This filtering selects signals on one channel against those on the next.

The one employed in the front end is much smaller. The advantage of the IF filter over RF filtering is that we can consider a fixed frequency to design a filter which helps in better tuning.

After filtration the next block in the receiver is the demodulator. According the mode being received we can possibly switch to different demodulators.

An audio amplifier is shown as the final element in the receiver block diagram but any form of circuit block can be used to process or amplify the demodulated signal.

Black Box Modeling

It is a simple relationship between the Input and Output components of a particular System. It can process any data . Since it can implement any algorithm to generate the Output , hence, its implementation is Black. Almost anything can be placed inside it which gives the Desired Output. They can be of Linear and non-linear type. One drawback of Black Box still persists i.e. its unaffected by the criterias such as Temperature, heat ,kinetics, which plays a crucial part in deciding the Output.

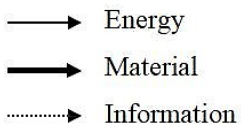
Certain definitions to describe black box and other functions are:-

Boundary Interactions(flows)

For systems that manipulate matter inputs and outputs are found to be categorized into three types: - Energy, Material and Information. In each flow instance, both the quantity and quality of the inputs and outputs has been defined in different types of arrows.

- Information

Data is the thing that we term the gave inside basic leadership capacity of a gadget or tactile information gave to or by a gadget or procedure.



- Material

Matter is normally alluded to as material with properties of structure, mass, shading, condition, etc. Materials can be blended, isolated, synthetically changed, dried, cooked, colored, and so on.

- Energy

Vitality is the capacity to get something going. It must stream in or out of the framework for something to occur. It must be moderated.

Fig No 4.2 – Black box of the Analog Filter.

Chapter 4

PRODUCT TEAR-DOWN

To benchmark an item against the opposition, item tear-down is required. The present rendition must be dissected and this investigation must be changed into data that can be utilized as a piece of the new update. After tear-down is finished, building determination is made for the item.

Task Distribution and Monitoring

The work has been distributed among the group members. The Team leader has allocated different tasks to the group members as shown in Table 5.1 :

Table 5.1: Work done by each member

Work done by each member of Team			
Team leader: Simran Harichandan			
Team member	Task(s) to be performed	Task assigned date	Task completed on
1:Simran Harichandan	Bench Marking ,House of Quality	27.02.2020	04.03.2020
2:G Shubham Sree	Disassembly plan,Specification Sheet	27.02.2020	04.03.2020
3:Priyanka Ghosal	Product Tear Down, Teardown Reporting	27.02.2020	04.03.2020
4.Debansh Ray	Bill of Material	27.02.2020	04.03.2020
Signature of Team Members:			
Member 1:Simran Harichandan		Member 2:G Shubham Sree	
Member 3:Priyanka Ghosal		Member 4:Debansh Ray	

Product Tear-down

Product tear down means disassembling the product in order to gain knowledge about the components used and know about the product better. The three core needs of a product tear-down are:

1. Product inspection and analysis and figuring out in between.
2. Acquiring knowledge of a person's home database.
3. Cut-throat standard.

Subtract & Operate Procedure (SOP)

It is another strategy for item tear-down. SOP is a consistent apparatus in item teardown. It decides segment

usefulness and additionally redundancies (or potential redundancies) in a get together. SOP decides overplus by uncovering the usefulness that is deducted from the framework coming about because of expulsion of a segment. On the off chance that this usefulness is repetitive, the plan is over

compelled and the segment can be evacuated if the degrees of opportunity stay unaltered while taking away a piece, yet other usefulness is influenced, there may exist.

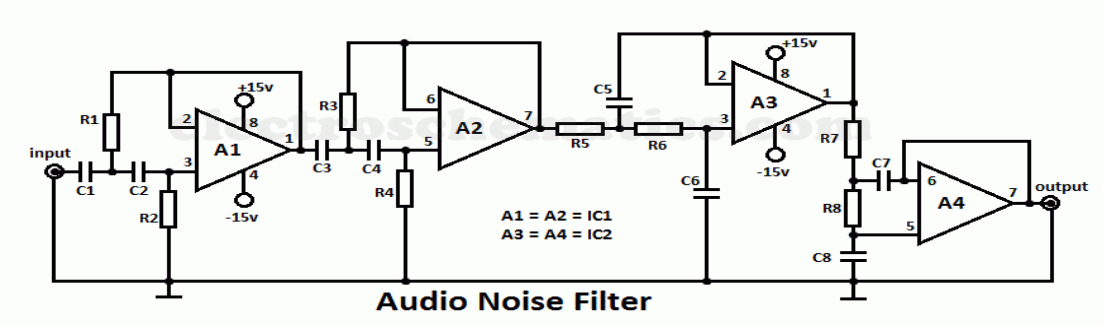
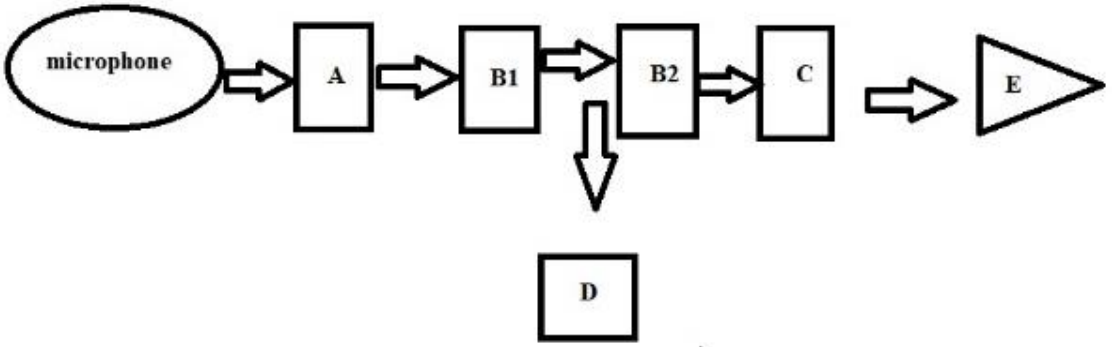


Fig No 5.1 – Audio Noise Filter

From the power control unit (DC-DC converters/inverters) and other power electronics devices it can be seen that the electromagnetic interference in audio modulator radio receivers along with noise generation has become a serious threat. To account this problem, most noise suppression methods use noise filters.



A-The power microphone preamplifier circuit
B1-The low pass Chebyshev 's filter
B2-The low pass chebyshev's filter
C-The signal detection circuit
D-The missing circuit
E-The audio-amplifier circuit

POST TEARDOWN REPORTING

Capacitors:-

The capacitor is just like a rechargeable battery which stores energy in the form of electrical energy thereby giving rise to potential difference across its plates .

The main purpose of capacitor is to store charge . The range of capacitor varies as per its application from small to in Resonant circuits to Large ones in industrial areas as a power factor correction capacitor.

A capacitor is structurally composed of two parallel plates separated with an insulating medium such as air or a good insulating material such as ceramic, mica, waxed and are not connected with each other The insulating layer between capacitor plates is known as the Dielectric.

Fig No 5.2 - Capacitor

Capacitors in power supplies are used to filter the pulsating DC output so that a smooth constant DC

voltage can be supplied to the load. The capacitors in a filter circuit are used to charge to

the peak of the rectified input voltage in the positive part of the input.

RESISTOR:-

Resistors are basically simple passive electrical component which creates resistance during the flow of

electric current. It is the most popular electronic device as it can be found in most electrical circuits and networks. The unit of resistance is ohms. 1 Ohm resistance can be defined as unit ampere current flows through the resistor, which has a unity voltage drop

Fig No 5.3 - Resistor

Op-Amp:-

An Operational Amplifier or op-amp can be found in electrical circuit combined with other components such as resistor and capacitor. It is a single-ended output. And have a high gain electronic voltage amplifier along with a differential input An amplifier's differential inputs consist of an inverting input with voltage (V−) and a non-inverting input with voltage(V+) .An op-amp called as a differential input voltage because it amplifies the difference in voltage between the two.

Fig No 5.4 Op- Amp

Chapter 5

PRODUCT ARCHITECTURE

It is the phase wherein we begin to take significant choices on how the last item will truly work. It starts the arrangement of powerful frameworks of parts and subsystems.

: Engineering Types

Designs are basically of two kinds: Product and Portfolio. The latter one plans relate to a social event or gathering of things however thing models relate to express thing. Philosophies for thing setup turn around the thing's business sector and execution.

- Integral

Essential thing models are physical structures where most of the sub capacities manual for a single or unobtrusive amount of physical parts.

- Modular

Thing modules are described as essential physical things foundations that have an organized correspondence with a subset of a thing's capacity illustrate.

Task Distribution and Monitoring

The work done for this project has been divided among the group members. The Team head has allocating various errands to various individuals and set the timetable for fulfillment of this undertaking as depicted in the table below: -

Table No 6.1 – Work Distribution

Contribution of each member			
Team leader: Simran Harichandan			
Team member	Task(s) to be performed	Task assigned date	Task completed on
1: Simran Harichandan	Bench Marking	06.03.2020	08.03.2020
2: G Shubham Sree	Disassembly plan	06.03.2020	08.03.2020

3: Priyanka Ghosal	Product Tear Down, Teardown Reporting	06.03.2020	08.03.2020
4. Debansh Ray	Bill of Material	06.03.2020	08.03.2020
Required work completed with alternative arrangement:			
Task name	Originally assigned to	Reason for Non-completion	Member, who completed it
Signature of Team Members:			

Member 1: Simran Harichandan	Member 2: G Shubham Sree
Member 3: Priyanka Ghosal	Member 4: Debansh Ray

Modular Design by Basic Clustering

This zone addresses a central system for setting up specific thing building. The general target is to make a translation of customer needs into cruel plans of a thing. To accomplish this goal, little modules must be recognized in the thing. An item work structure starts the procedure followed by grouping, producing harsh geometry and characterizing communications.

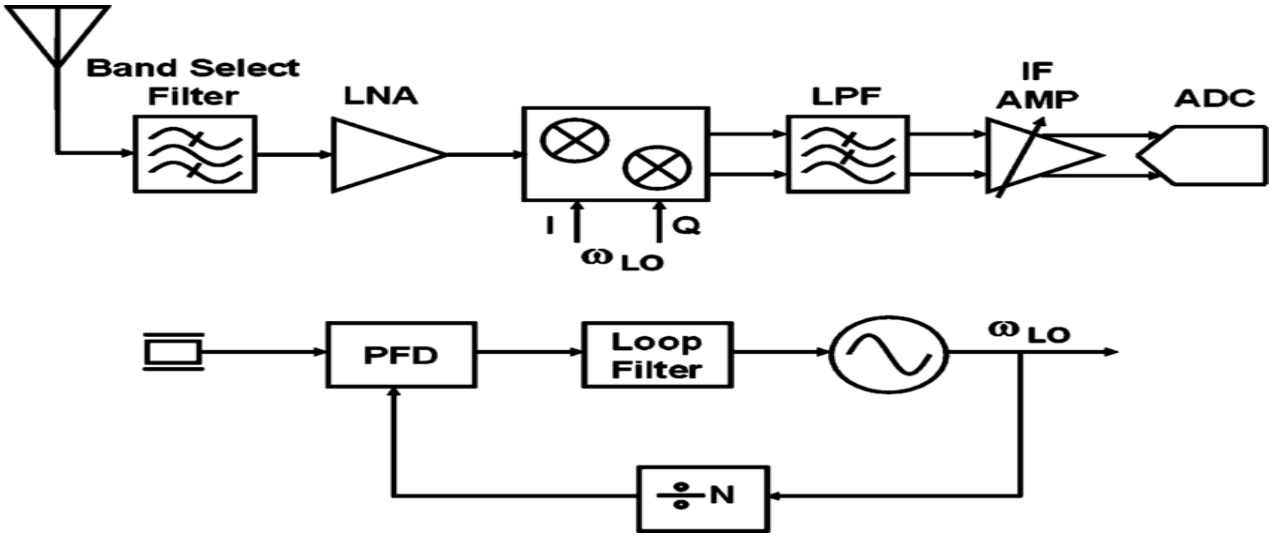


Fig No 6.1 – Modular Design

Amplifiers

- The first stage is the low noise amplifier.
- To cope with different signal levels automatic gain control is used.

Filters

- To separate the desired signal from others ,tunable radio frequency filters cannot be used.

- By using special technologies like surface acoustic wave, mechanical, ceramic, *or* analog filters operating on baseband Sufficient selectivity can be achieved by fixed.

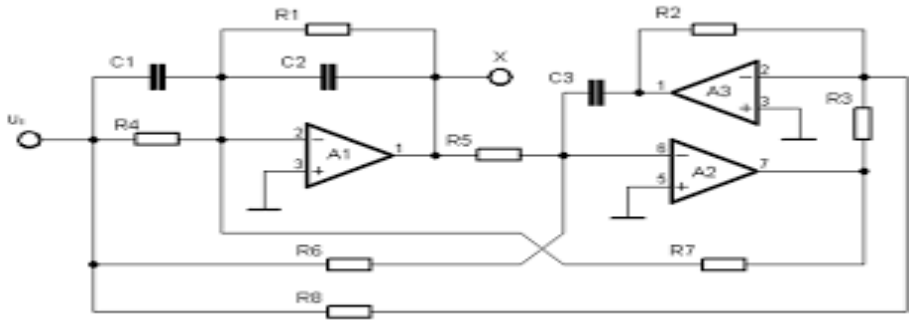


Fig No 6.2 – Analog Filter

Chapter 6
CONCEPT GENERATION

Concept generation enables the team by giving a platform to apply their ideas in order to generate the solution.

- The underlying goal is to gather as much ideas as possible.
- These arrangements standards might be applied to elective formats that are made or elective idea classes characterized by the portfolios.
- The procedure is to consolidate the arrangement thoughts per item work into idea variations that is elective structure. This progression in the process is testing and nonlinear.

Idea age strategies comprehensively are of two sorts

1. Intuitive method

It focuses on the ideas creation of a individual or groups of individuals. The intention behind this method is to remove the barriers between ourselves and better ideas about the product. Ultimately it helps producing innovative ideas and creativity. Examples of those method include brainstorming and morphological chart building.

2. Directed (logical) method

These types of methods use the systematic, step-by-step approach to find the solutions. This method relies on technical information, expertise and various guidelines to find the solution of technical problems.

Task Distribution and Monitoring

The task for above work is distributed among various group members. The team leader has assigning different task to different members of the group and set the timeline for this task as shown in table 7.1

Table 7.1 Work Distribution

Workdone by each member of the team			
Team leader : Simran Harichandan			
Team member	Task(s) to be performed	Task assigned date	Task completed date
1.Simran Harichandan	Memory map, c-sketch, & concept variant	08.03.2020	15.03.2020
2.G Shubham Sree	Idea generation	08.03.2020	15.03.2020
3.Priyanka Ghosal	Morphological chart	08.03.2020	15.03.2020
4. Debansh Ray	Memory map, c-sketch, & concept variant	08.03.2020	15.03.2020
Task completed with alternative arrangements:			
Task name	Originally assigned to	Reason for non-completion	Member, who completed it
Signature of team members:			
Member 1:Simran Harichandan		Member 2:G Shubham Sree	
Member 3:Priyanka Ghosal		Member 4:Debansh Ray	

Brainstorming method

It is an incredible system for creating ideas by natural strategy. The main aim is to communicate thoughts verbally among team members during a given time period. The overall aim of this method is to generate some ideas that might act as solution to a piece of the design problem.

One of the disadvantages of this procedure is that "right idea" won't come at "right time". The team might not get any new ideas. Though these disadvantages exist still it is an effective way to developing concepts.

Chapter 7

CONCEPT SELECTION

Idea choice is one of the most basic dynamic activities in item improvement process. Every idea variation grew before must be assessed, thought about and one last and successful idea must be picked. The request for greatness estimation ought to be utilized to decide the specialized possibility of an item idea. At that point, to choose an idea among the ideas that pass the request for size investigation, a progressively refined dynamic examination must be applied. An essential technique expected for this is known as Pugh outline. In highest level, Product improvement can be thought of as having three fundamental assignments,for example, gathering data, deciding, or scattering data. The dynamic endeavors in the improvement procedure are basic. They decide how accumulated data is changed and executed. They likewise encourage the shaping of group agreement, a basic part of an improvement procedure. The idea determination process introduced here is a way to manage this vulnerability. The selection process are listed below:

1. Formation of a concurrence on the criteria.
2. Formation of a concurrence on the possibilities.
3. Ranking the other possibilities available.
4. Evaluating the other available options.

5.Dealing with the negatives.

Task Distribution and Monitoring

The work has been split up among the group members. The Team leader has assigned different tasks to the group members and has set the timeline for the completion of the work as shown in Table 8.1:

Table 8.1: Work Distribution

Work done by each member			
Team leader: Simran Harichandan			
Team member	Task(s) to be performed	Task assigned date	Task completed on
1: Simran Harichandan	About Concept Selection, PPT & Pugh chart & Report	17.03.2020	27.03.2020
2: G shubham Sree	Involved in making Pugh Chart,REPORT	17.03.2020	27.03.2020
3:Priyanka Ghosal	Involved in making Pugh Chart,PPT,REPORT	17.03.2020	27.03.2020
4:Debansh Ray	Involved in making Pugh Chart	17.03.2020	27.03.2020
Signature of Team Members: Simran Harichandan			
Member 1:Simran Harichandan		Member 2: G Shubham Sree	
Member 3: Priyanka Ghosal		Member 4: Debansh Ray	

Chapter 8

PRODUCT EMBODIMENT

This stage means to change item ideas and structures into acknowledged frameworks. These frameworks must fulfill client needs, be vigorous concerning all natural and client conditions, and be intended to diminish the probability of disappointment.

Task Distribution and Monitoring

The work has been split up among the group members. The Team leader has assigned different tasks to the group members and has set the timeline for the completion of the work as shown in Table 9.1:

Table 9.1: Work Distribution

Work done by each member of Team ID 08 of Section F			
Team leader:			
	Task(s) to be performed	Task assigned date	Task completed on
1:	Material Properties Choosing	29.03.2020	06.04.2020
2:	FEMA Model	29.03.2020	06.04.2020
3:	Geometry & Layout	29.03.2020	06.04.2020
4:	Material Properties Choosing	29.03.2020	06.04.2020
Task completed with alternative arrangement:			
Task name	Originally assigned to	Reason for non-completion	Member, who completed it
Signature of Team Members:			
Member 1:		Member 2:	
Member 3:		Member 4	

Refining Geometry and Layout

With regards to making a vigorous item or group of items, two issues drive idea encapsulation.

1. Refining product geometry and architecture
2. Systems modeling towards detail design.

These two issue relate to four plan situations: unique structure, versatile structure where a huge new innovation is presented, versatile plan where a straightforward subsystem is changed, or invariable plan.

Embodied design includes:-

- Layout of the geometry.
- Composition of material.
- Manufacturing and quality related issues
- Economics

Systems Modeling

This procedure can be applied while epitomizing an idea. Frameworks models are portrayal of an item that anticipate the item's exhibition under fluctuating input(environmental & boundary) conditions. These models should be stretched out to encourage structure parameter and assembling choice during idea encapsulation.

Failure Modes and Effect Analysis (FMEA) Method

The base of amazing thing arrangement depends on the merged ideas of customer quality and structuring quality. Customer quality is to restrict the execution assortment of a thing for all normal and customer conditions. Structuring quality is to ensure that a thing limits as it is proposed, without coming up short in regards to customer's gotten want. The second kind of

significant worth is relied upon to ensure that a thing has agreeable quality, trustworthiness, and normal impact expectation and incident neutralizing activity measures. A further created and complementary technique is known as disillusionment modes and effect investigation (FMEA). FMEA is a logical procedure used by a thing design bunch as an approach to perceive, portray and take out to the degree possible known as potential dissatisfaction strategies for a thing structure. This technique should be used accommodatingly with structures showing to investigate and choose extraordinary choices for factors portraying a thing.

Table 9.2 : Partial Failure Modes and Effect Analysis

Part & function	Potential failing mode	Potential reaction of failure
Capacitors	Overheating	High Voltage
Resistors	Lost effectiveness , decrease in value	High voltage Excessive ripple
Opamp	Slightest of DC	Entire circuit fails after some hours

Chapter 9

ANALYTICAL AND NUMERICAL MODEL SOLUTIONS

The idea is hypothetically broke down, with the goal that numerous setups might be looked to acknowledge favored arrangements. Various computational arrangement strategies exist to fathom item models.

Task Distribution and Monitoring

The errand for this work has been separated among the gathering individuals. The Team head has doling out various assignments to various individuals and set the timetable for fruition of this undertaking as appeared in Table 10.1:

Table 10.1: Work Distribution

Work done by each member of Team			
Team leader: Simran Harichandan			
Team member	Task(s) to be performed	Task assigned date	Task completed on
1:Simran Harichandan	Theoretical Analysis	10.04.2020	17.04.2020
2:G Shubham Sree	Theoretical Analysis	10.04.2020	17.04.2020
3:Priyanka Ghosal	Theoretical Analysis	10.04.2020	17.04.2020
4:Debansh Ray	Theoretical Analysis	10.04.2020	17.04.2020
Signature of Team Members:			
Member 1:Simran Harichandan		Member 2:G Shubham Sree	
Member 3: Priyanka Ghosal		Member 4: Debansh Ray	

MATHEMATICAL CALCULATIONS: -

1) Derive the expression for the transfer function T(s) using following steps.

a) Normalized Frequency:

$$\omega_{ns} = \frac{\omega_s}{\omega_p} = \frac{14000\ rad/sec}{100000\ rad/sec} = 1.4$$

b)

$$\varepsilon = \frac{1}{\sqrt{10^{0.1*amin}-1}} = \frac{1}{\sqrt{10^{0.1*18}-1}} = 0.127$$

c)

$$\text{N=order of the filter} = \frac{\ln\sqrt{4(10^{0.1amin}-1)/(10^{0.1amin}-1)}}{\ln(1.4+\sqrt{1.4^2-1}} = 4.81 = 5$$

d)

$$a = \frac{1}{n\sin h^{-1}}\left(\frac{1}{\varepsilon}\right) = \frac{1}{s}\sin h^{-1}\left(\frac{1}{0.127}\right) = 0.558$$

e)

Pole location

$$\sin h(0.552) = 0.58 \qquad \sigma_k = \sin h(a)\sin\frac{2k-1}{n}x$$

$$\cos h(0.552) = 1.16 \qquad \omega_k = \cos h(a)\cos(\frac{2k-1}{n}n)$$

$$K = 1,2,3,4,5$$

$\sigma_1 = \sigma_5 = -0.179$ $\omega_{1,5} = \pm 1.108$ $s_{1,5} = -0.174 \pm j1.108$

$\sigma_2 = \sigma_4 = -0.469$ $\omega_{2,4} = \pm 0.680$ $s_{1,4} = -0.469 \pm j0.680$

$\sigma_3 = -0.58$ $\omega_3 = 0$ $s_3 = -0.58$

$$\omega_{0k} = \sqrt{\sigma_k^2 + \omega_k^2} \qquad Q_{0k} = \frac{\omega_{ok}}{2\sigma_k} = Q_{zck} \qquad \omega_{0k}^1 = \frac{1}{\omega_{ok}}$$

$$\omega_{01} = 1.117 \qquad Q_{01} = 3.12 \qquad \omega_{01}^1 = 0.895$$

$$\omega_{02} = 0.827 \qquad Q_{02} = 0.882 \qquad \omega_{02}^1 = 1.209$$

$$\omega_{03} = 0.53 \qquad Q_{03} = 0.5 \qquad \omega_{03}^1 = 1.724$$

f)

Pole positons - $P_K = \sigma_K - JB_K = \frac{\sigma_K}{\omega_{0K}^2} + J(\frac{-\omega_X}{\omega_{0K}^2})$

$$P_1 = -0.223 \pm j1.377$$
$$P_2 = -0.321 \pm J0.466$$
$$P_3 = -0.195$$

g) Zero Location:

$$\omega_{2K} = \sec(\frac{K\pi}{2n}) = K = 1,2,3$$
$$\omega_{1K} = \sec(\frac{\pi}{10}) = 1.05$$
$$\omega_{2K} = \sec(\frac{2\pi}{10}) = 1.70$$

Here the 3rd Pole is located at infinity.

h) By arranging the poles and zeros by numerator and denominator we get the transfer function equation as:

$$\mathrm{T(S)} = \frac{\prod_{k=1}(s - jzk)}{\sigma_{k=1}(s - jpk}$$

$$\frac{0.634(S^2 + 1.1025)(S^2 + 2.898)}{(S + 1.724)(S^2 + 0.287s + 0.801)(s^2 + 1.371s + 1.462)}$$

$$= \frac{0.6345s^4 + 2.538e^2 + 2.03}{s^5 + 3.387s^4 + 5.535s^3 + 6.124s^2 + 3.816s + 2.03}$$

2) The Matlab code and the generation of the pole-zero plot (follows Appendix-A)-

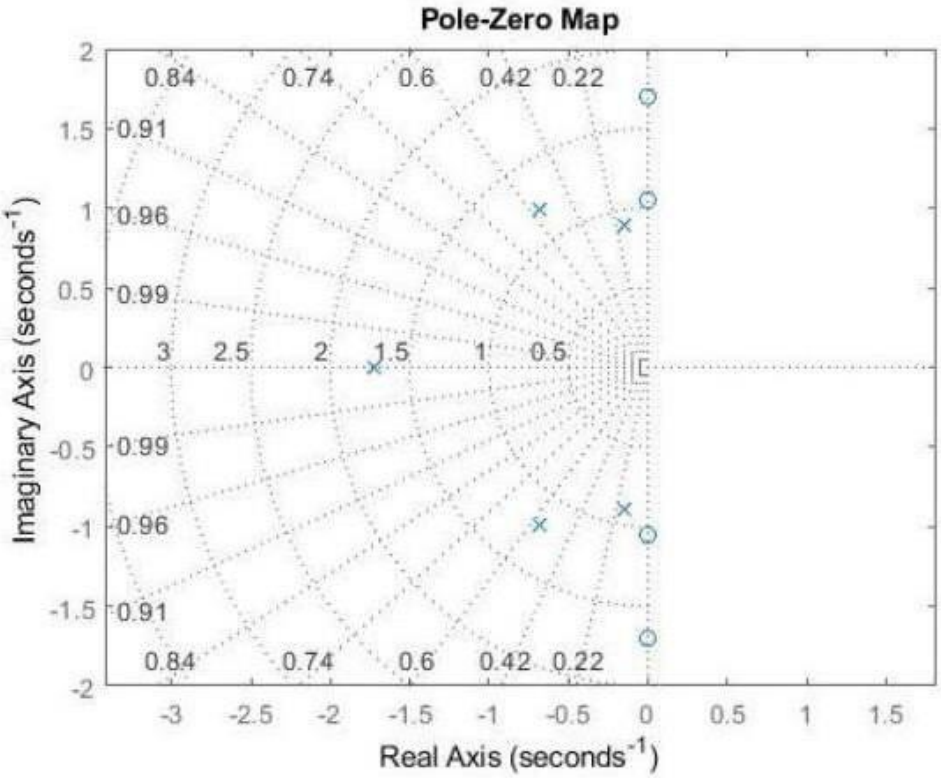


Fig No. 10.1- Pole–Zero plot of MATLAB code.

3) Now we implement the designed filter using the Ackerberg-Mossberg biquad.

H = 0.634

$$K = \frac{1.724 * 0.801 * 1.462}{1.1025 * 2.843} = 0.637$$

Now pairing the poles so that the zeros are associated with the closest poles.

$$T(s) = T_1T_2T_3 = \frac{K_1}{s + 1.724} = \frac{k_2(s^2 + 2.893)}{s^2 + 1.371s + 1.462} * \frac{k_3(s^2 + 1.102s)}{s^{2+0.287s+0.801}}$$

Here , $K = K_1 * K_2 * K_3$

$$M_1 = \frac{1}{1.724} = 0.580$$

$$M_2 = \frac{2.893}{1.461 * 1.724} = 1.1477$$

$$M_3 = \frac{2.893 * 1.1025}{1.462 * 1,724 * 8.801} = \ 1.579$$

Now,

$$k_1 = \frac{KM_3}{M_1} = \frac{4.568}{0.580} = 7.875$$

$$K_2 = \frac{M_1}{M_2} = \frac{0.580}{1.147} = 0.505$$

$$k_3 = \frac{M_1}{M_3} = \frac{1.147}{1.579} = 0.726$$

In this transfer function we will need one bilinear and two biquad circuit equations are being used

The general equation if the bilinear transfer function is:

$$T(s) = \frac{G_1}{sC_2+G_2} \text{ with } C_1 = 0$$

$$T_1(s) = \frac{\frac{G_1}{C_2}}{\frac{S + G_2}{C_2}} = \frac{7.875}{s + 1.724}$$

Comparing it with T_1 we get

If we can choose C_2 = 1μF

$$R_1 = \frac{1}{7.875\omega_s c_2} = \frac{1}{7.875 * 140000 * 10^{-9}} = 926.44\Omega.$$

And,

$$R_2 = \frac{1}{1.724\omega_s c_2} = \frac{1}{1.724*140000*10^{-9}} = 4143.188\Omega.$$

Now for $T_2(s)$ and $T_3(s)$ we which are the biquad equations we have

$$T_2(s) = \frac{as^2 + s(\omega_0[a - b(kQ) + w_0{}^2[a + dk]}{s^2 + \frac{s\omega_0}{Q} + \omega_0^2}$$

This is the general equation for all the biquad circuits Comparing T_2 with $T_2(s)$ we get

$$T_2(s) = -\frac{0.505(s^2 + 2.893)}{s^2 + 1.371s + 1.462}$$

Let $c = 1\mu F$ and $Q = 0.881$

$$R = \frac{1}{\sqrt{1.462}\omega_s c} = \frac{1}{\sqrt{1.462} * 140000 * 10^{-4}} = 5907.42\Omega$$

$$R = 0.881 * 5907.42 = 5204.43\Omega.$$

Also comparing

$$a = 0.505, a * d = 0.505 * \frac{2.893}{1.462} = 0.999$$

and we get, 0.505 + d = 0.999 d = 0.491

$$b = \frac{a}{Q_2} = \frac{0.505}{0.881} = 0.573$$

Now, let the value of G_0 = 1kΩ.

Then we get

$$aG_0 = 0.505 * 1 * 10^{-3} = 1980.19\Omega.$$
$$bG_0 = 0.573 * 1 * 10^{-3} = 1745.20\Omega.$$
$$dG_0 = 0.491 * 1 * 10^{-3} = 2036.65\Omega.$$

Since the coefficient of the s is 0 therefore:

c = 0. Similarly, for T_3 comparing with $T_3(s)$ we get:

$$T_3(s) = -\frac{0.726(s^2 + 1.102s)}{(s\hat{}(2 + 0.287s + 0.801)}$$

Let c =1μF and Q = 3.11

$$R = \frac{1}{\sqrt{0.801}\omega_s c} = \frac{1}{\sqrt{0.801} * 140000 * 10^{-9}} = 7980.97\Omega$$

And QR = 3.11 ∗ 7980.97 = 24820.81Ω.

Here by comparing we get, a = 0.726

&

$$b = \frac{a}{Q_3} = \frac{0.726}{3.11} = 0.233$$

And,

a + d = 0.999 d = 0.999 − 0.726 = 0.273
d = 0.999 – 0.726 = 0.273

Now, let the value of G_0 = 1kΩ.
Then we get:

$$aG_0 = 0.726 * 1 * 10^{-3} = 1377.41\Omega.$$
$$bG_0 = 0.233 * 1 * 10^{-3} = 4291.84\Omega.$$
$$dG_0 = 0.273 * 1 * 10^{-3} = 3663\Omega.$$

Since the coefficient of the s is 0 therefore

c = 0.

Chapter 10

PROJECT MODELLING AND SIMULATION

MATLAB SIMULATION

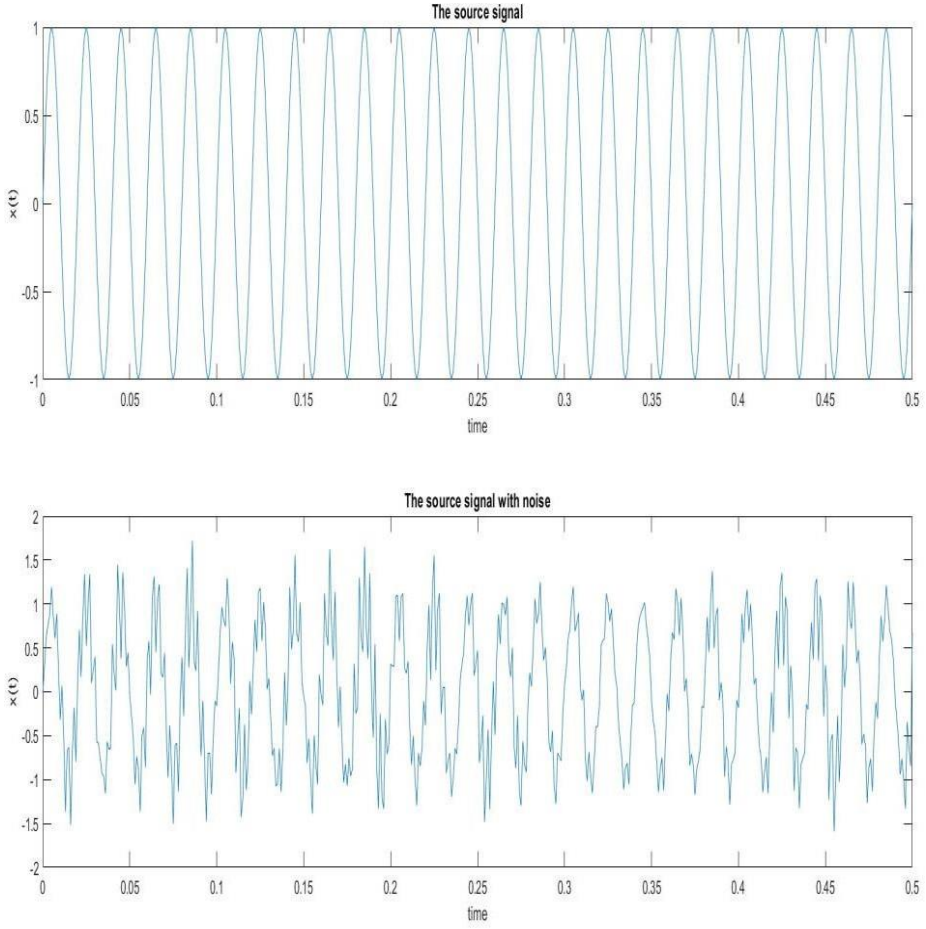


Fig No. 11.1 - The input signal source and noisy signal

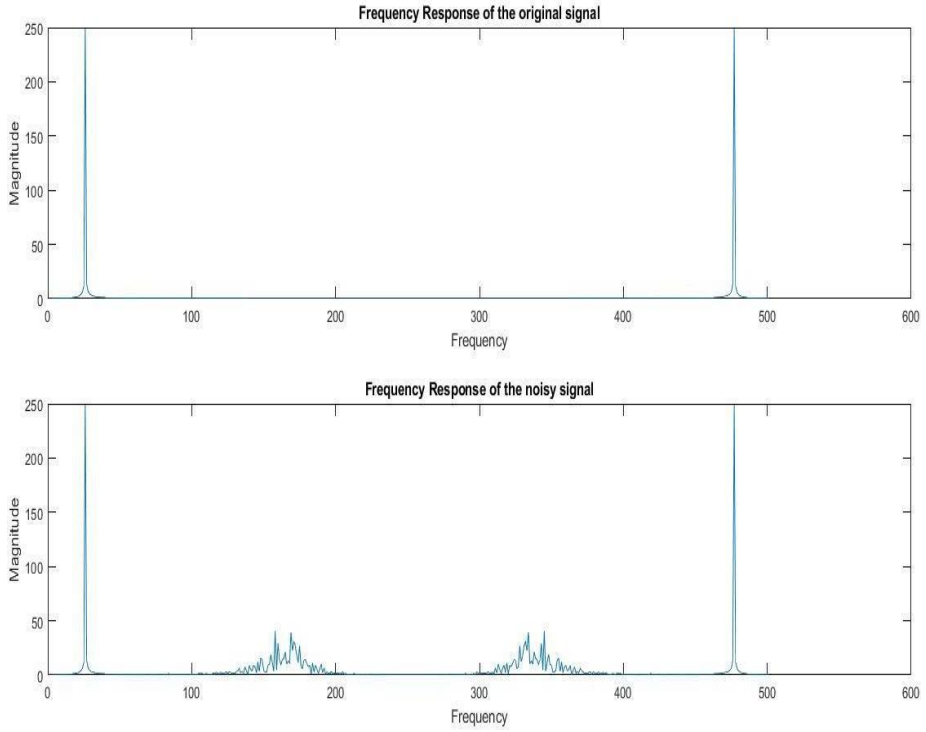


Fig No .11.2 Frequency plot of source and noisy signal

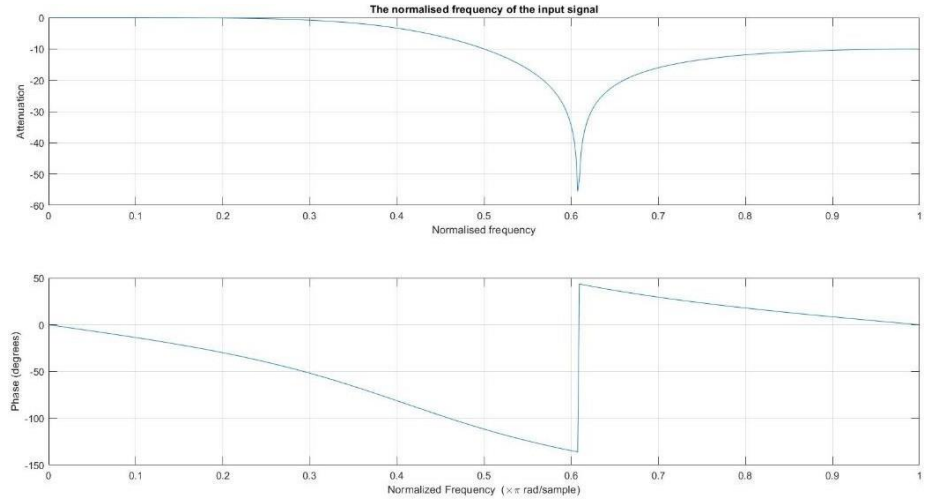


Fig No.11.3 Frequency response

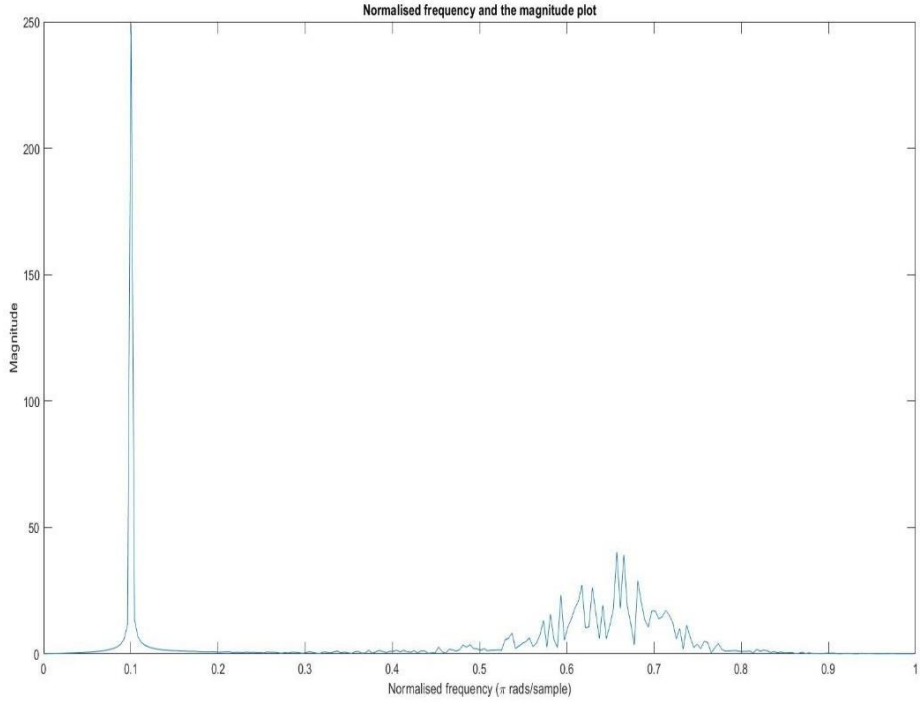


Fig No.11.4 Normalized frequency

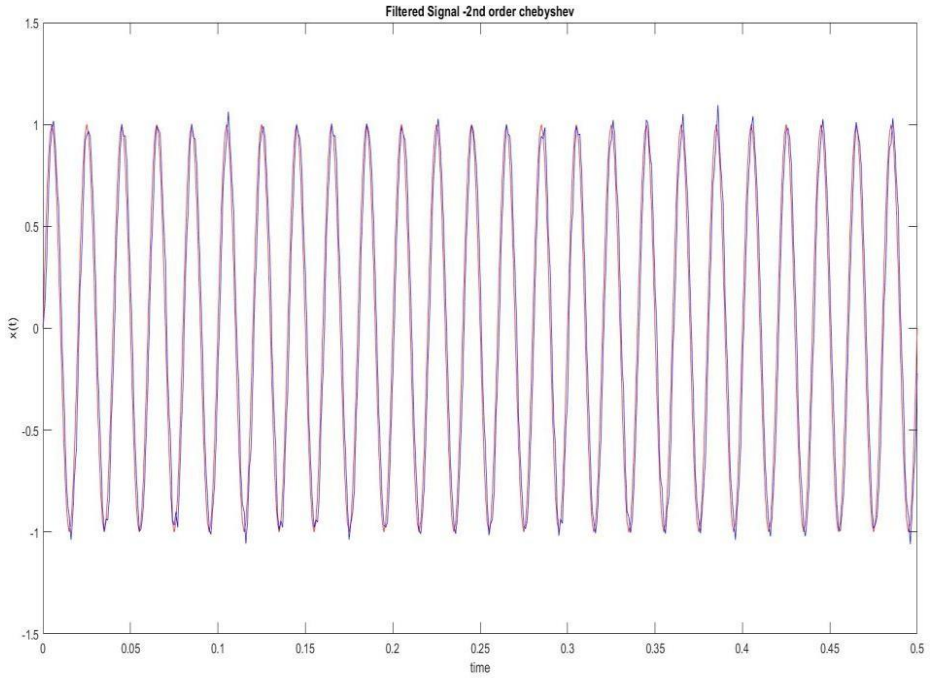


Fig No. 11.5 Filtered output of the signal.

MULTISIM SIMULATION

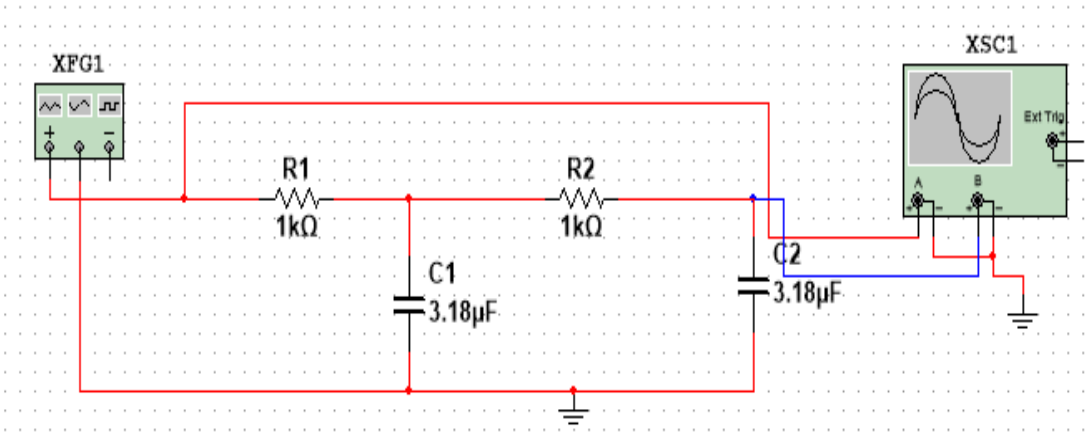


Fig No. 11.6 Simulation of sine wave .

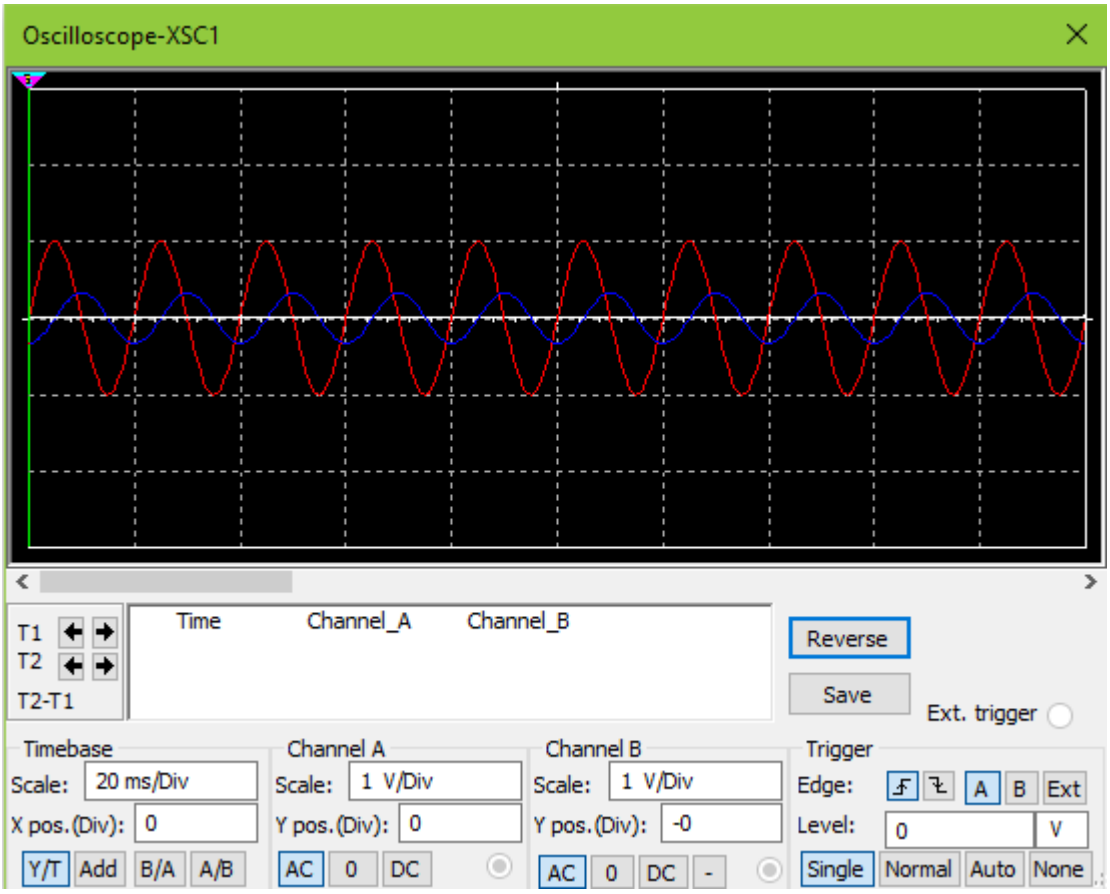


Fig No.11.7 Output of NImultisim.

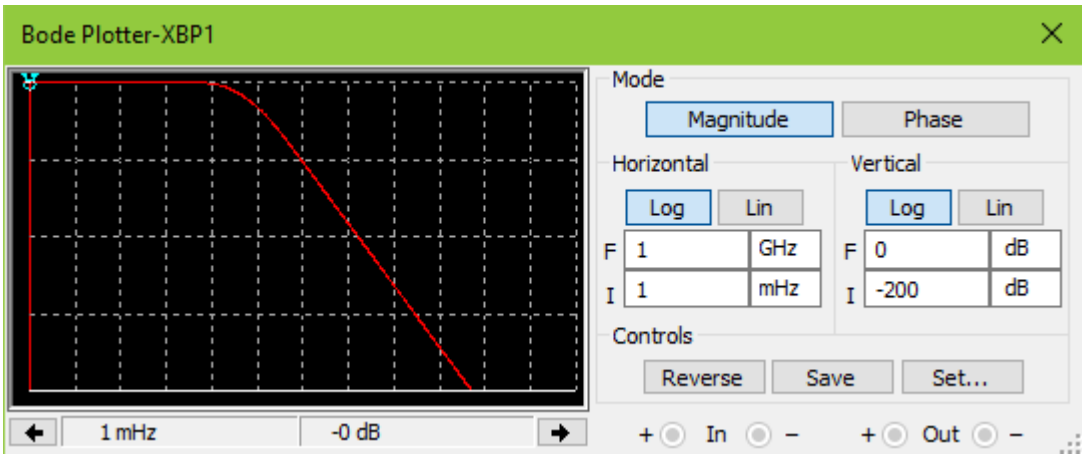


Fig No.11.8 Magnitude plot.

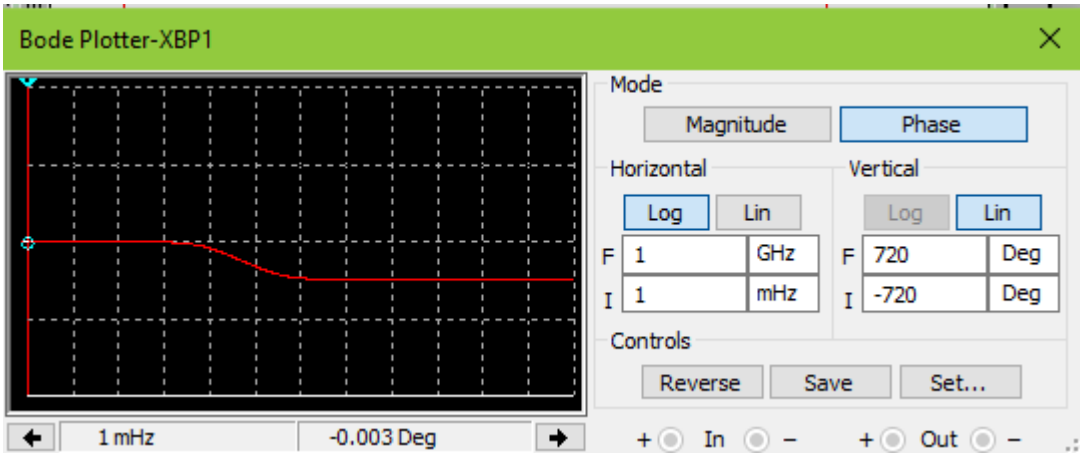


Fig No.11.9 Phase plot

HARDWARE SETUP

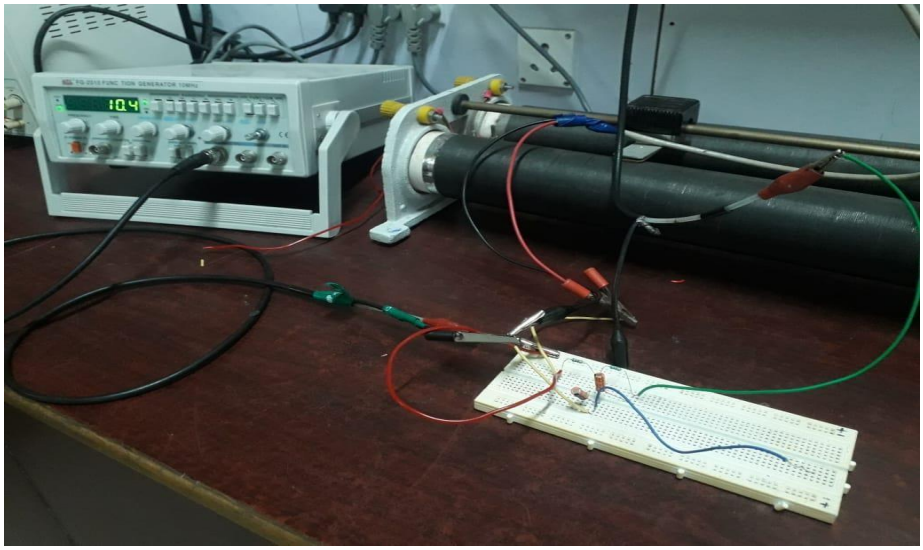


Fig No.11.10 Hardware setup

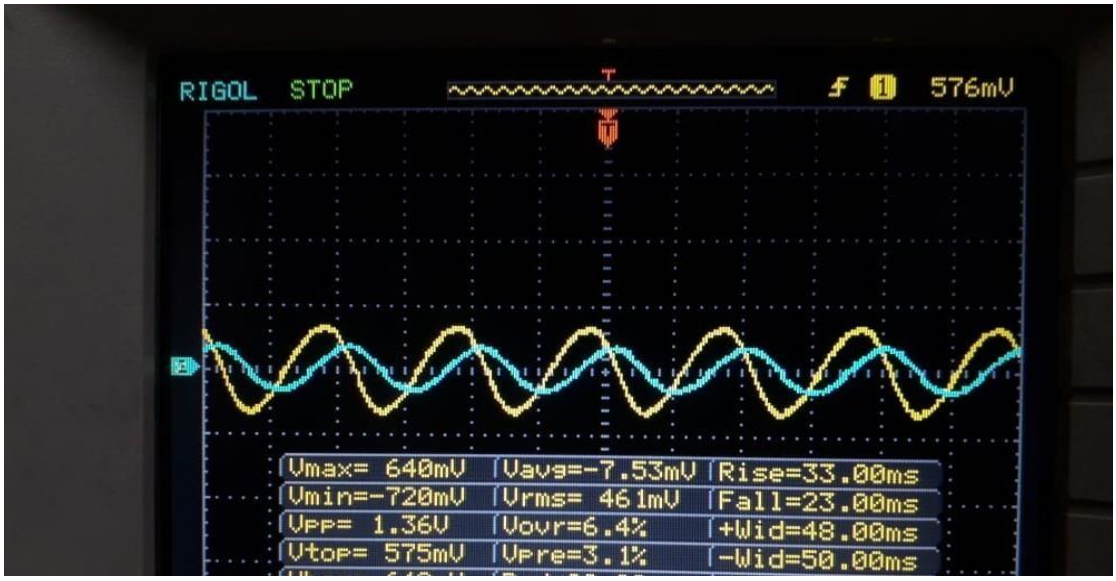


Fig No.11.11 Input sine wave

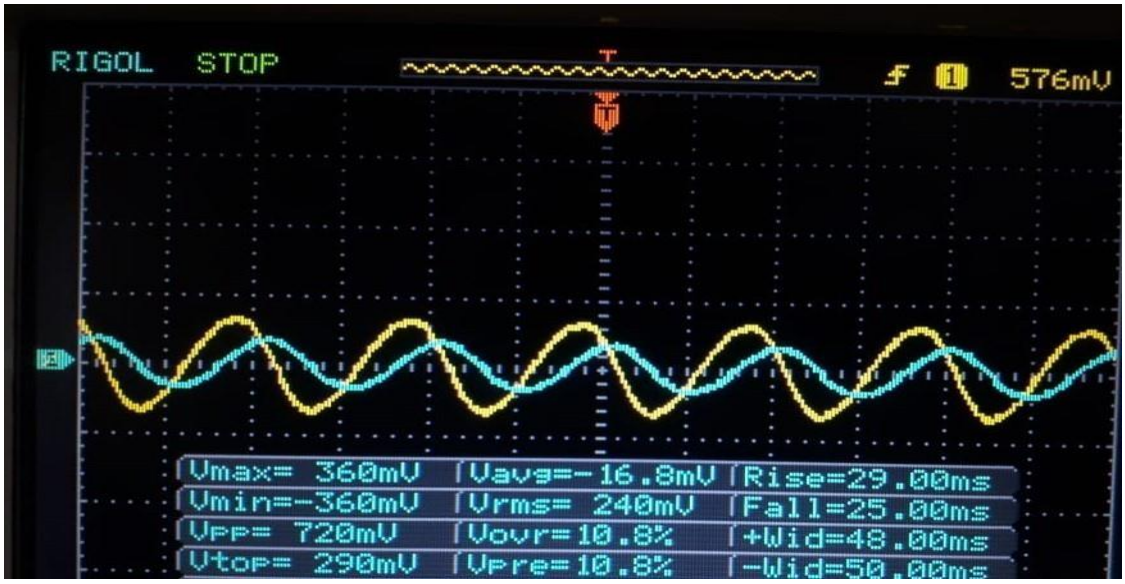


Fig No.11.12 Filtered signal

Chapter 11

RESULTS

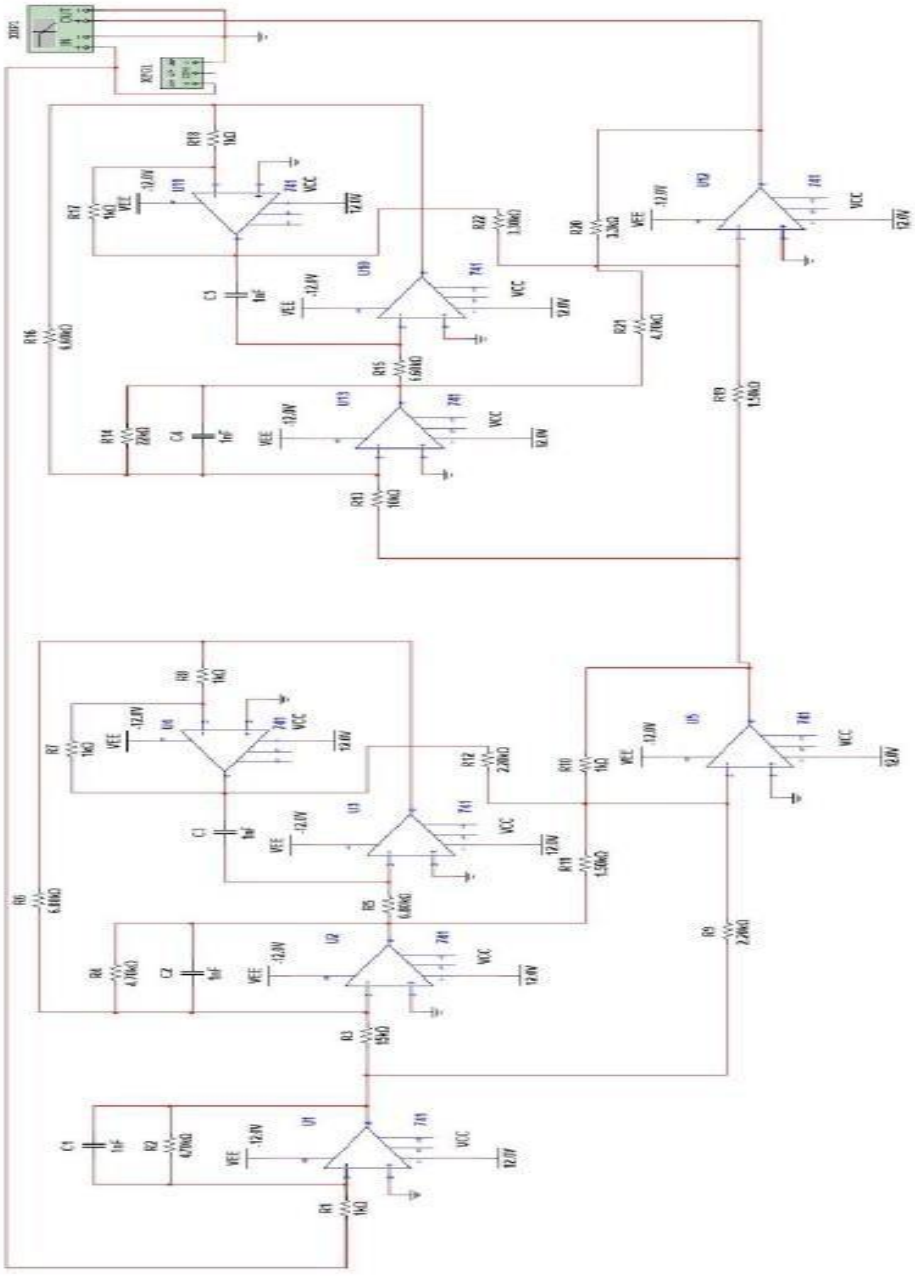


Fig No.12.1 Multisim circuit diagram

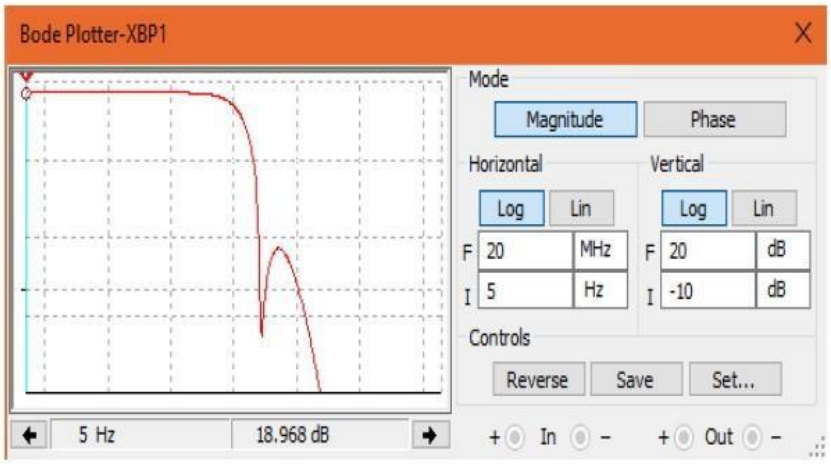


Fig No.12.2 Magnitude plot of Multisim Circuit.

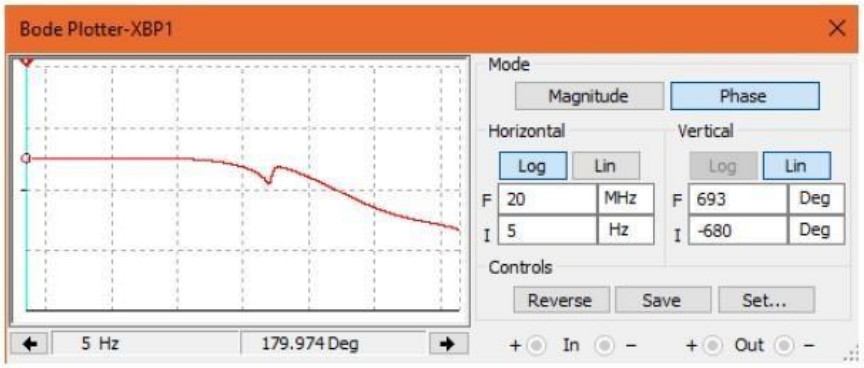


Fig No.12.3 Phase plot of Multisim circuit.

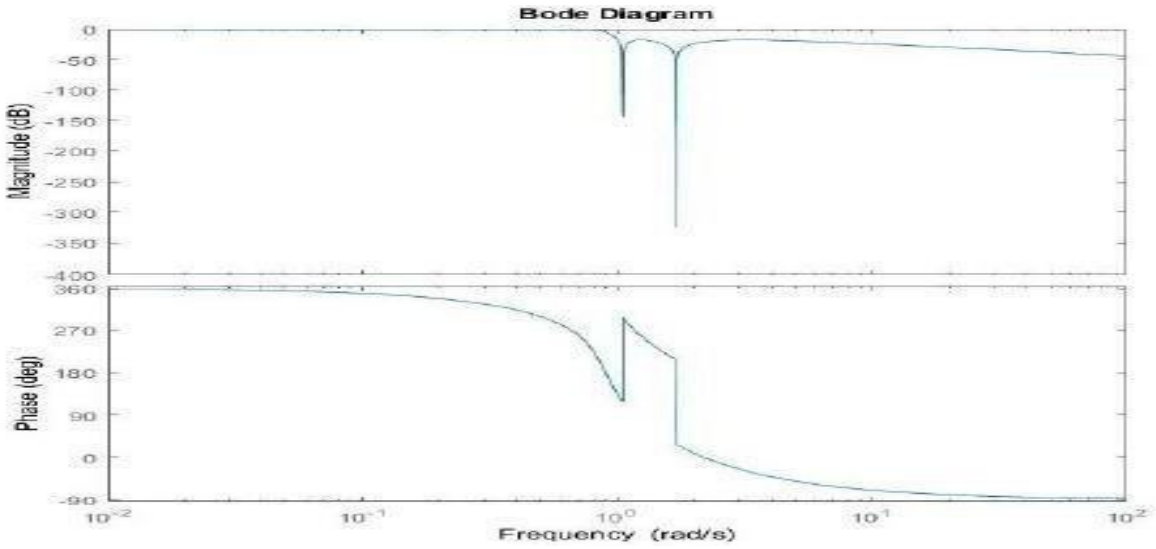


Fig No.12.4 Magnitude and phase plot of the MATLAB code.

Chapter 12

CONCLUSION AND FUTURE SCOPE

It is observed that, the filter was designed with the given specification . and was verified using the results of MATLAB and Multisim. The order of filter was found out to be 5, from the given Stop band (ω_s) and Pass band (ω_p) Frequencies. Then the pole & zero location of the filter was calculated, from where the third zero's location was found at infinity. And from the derived poles and zeros, the final transfer function of the filter was obtained. The result was verified by evaluating and plotting the same in the MATLAB environment. After finding the transfer function we moved to the design steps. As the Transfer function had n=5, we a linear and two bi-quad circuit had to be designed.

As described earlier, 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 . It is also observed that, Ackerberg Mossberg topology of design filters proved to be a better technique above others, as the response was much more improved in it.

Further Improvements can be done to improve the response of the circuit. As cascading of more than two circuit make the circuit bulky, work can be done on how to achieve the required specification with the minimum order of the circuit. Ultra-wideband is a radio technology that uses a low energy level for high-bandwidth ,short-range, communications over a large part of the radio spectrum Nowadays wireless systems are in demand and high data range are increasingly needed so ultra wide band provides a wide range of bandwidth and there a sharp channel filtering is highly desirable.

Chapter 13

INDIVIDUAL AND GROUP LEARNING

Individual Learning

In a group of four members, we learned the skill of effective and efficient learning. prioritizing on the fact of own contribution and sticking to deadlines, every assigned task was completed. we gained proper and valuable information required for our project. We elected a team leader every week and divided our work accordingly. At the end, it can be assured that every member has gained resourceful and abided by the terms of team work,

Group Learning

This is a comparative learning technique which is achieved by team leadership and team spirit. The project was completed by the four members with due co-ordination. Mutual support and reciprocated synchronization. A team leader was appointed for distributing the task among the members which resulted in completion of task harmonically.it took us two months working vigorously and effectively for completing

the project and delivering on time.

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[8] A. Toker, S. Özoguz, "*Novel all-pass filter section using differential difference*

APPENDIX

Appendix A-

```
clc;
clear all;
close all;
amax=0.25;  %maximum attenuation%
amin=18;    %minimum attenuation%
wp=100000;  %passband frequecy%
ws=140000;  %stopband frequency%
wns=ws/wp;  %normalized frequency%
e=1/(sqrt(10^(amin*0.1)-1));
n1=log(sqrt(4*(10^(0.1*amin)-1)/(10^(0.1*amax)-1)))/log(wns+sqrt((wns^2)-1));
%order of the filter%
n=ceil(n1);
a=(1/n)*log((1/e)+sqrt(((1/(e^2)))+1));
b=1;
for i=1:n
theta(i)=-sinh(a)*sin(((2*i-1)/(2*n))*pi);
w(i)=cosh(a)*cos(((2*i-1)/(2*n))*pi);
end
s=tf('s');%transfer function%
if rem(n,2)==1
den=(s-(1/(theta((n+1)/2))));
p((n+1)/2)=(1/(theta(((n+1)/2))));
b=b*(1/(-theta(((n+1)/2))))
else
den=1;
end
for i=1:((n-1)/2)
wo(i)=sqrt((w(i)^2)+((theta(i))^2));
q(i)=wo(i)/(2*(-theta(i)));
wlo(i)=1/(wo(i));
q1(i)=q(i);
b=b*(wlo(i)^2);
alp(i)=theta(i)/(wo(i)^2);
beta(i)=w(i)/(wo(i)^2);
p(i)=complex(alp(i),beta(i));%pole location%
p(i+((n+1)/2))=complex(alp(i),-beta(i));
den=den*(s^2+(wlo(i)/q1(i))*s+wlo(i)^2)
end
num=1;
```

```
c=1;
for i=1:(n-1)
if rem (i,2)==1
wz(i)=1/(cos((i*pi)/(2*n)));%zero location%
num=num*(s^2+wz(i)^2);
c=c*(wz(i)^2);
end
end
k=b/c;
t=k*(num/den)
figure(1)
bode(t) %bode plot of the transfer function%
figure(2)
pzplot(t)%pole-zero plot of the transfer function%
axis equal
grid on
```

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