An Industrial Training Report on

TO DESIGN OF FRACTIONAL ORDER LOW PASS FILTER

submitted by

Vikas Agarwal (1804331056)

BACHELOR OF TECHNOLOGY

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

BUNDELKHAND INSTITUTE OF ENGINEERING & TECHNOLOGY, JHANSI, INDIA

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Attach Training certificate here

Training Outcomes(Ps)

S. N.	After completing this training, I am able to	Bloom's knowledge level
T1	1 To design fractional order butter-worth low pass filter.	KL6
T2	2 To verify the design of filter proteus software is used for simulation .	KL5
T3	3 To obtain fractional order capacitor use of fourth order integer approximation.	KL6
T4	4 To optimize the result using Genetic Algorithm (GA).	KL3
T5	5 To improve the overall performance and stability of Tow Thomas Bi-quad Filter	KL4

KL: Bloom's knowledge level, KL1: remember, KL2: Understand, KL3: Apply,
KL4: Analyse, KL5: Evaluate, KL6: Create/Design

Mapping of outcomes with Program Outcomes (POs)

Ps	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
T1	_	3	_	_	2	3	1	3	2	3	3	3
T2	3	_	3	3	3	3	3	3	3	3	3	_
T3	3	3	3	2	3	3	3	3	3	3	3	3
T4	3	3	3	3	3	3	3	3	3	3	3	_
T5	3	3	3	3	_	3	3	3	3	3	3	3

Mapping rules (Rubrics)

1: poor 2: medium 3: best

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Vikas Agarwal
Roll No. 1804331056

Abhay Kushwaha
Roll No. 1904331901

ABSTRACT

Keywords - Butterworth; continued fraction expansion; fractional order; RC ladder; simulated annealing; Tow-Thomas bi-quad topology.

In this paper, simulated annealing and suitable scaling optimization techniques are used to design the fractional order low pass filters with Butterworth approximation. The frequency responses of the obtained optimal designs are closer to the ideal one as compared to the other existing designs. The designed filters are further realized using Tow-Thomas bi-quad topology by replacing traditional capacitors with the fractional capacitors, which are approximated by continued fraction expansion and then realized with the RC ladder network. The effectiveness of the proposed circuit realizations is also shown by Proteus simulated results.

TABLE OF CONTENTS

Table of Contents (continued) **Page**

LIST OF TABLES

LIST OF FIGURES

Major Contributions

The main objective of this training was to design fractional order butter-worth low pass filter. The main contributions of the work done are

1 To design fractional order butter-worth low pass filter.

2 To verify the design of filter proteus software is used for simulation .

3 To obtain fractional order capacitor use of fourth order integer approximation.

4 To optimize the result using Genetic Algorithm (GA).

5 To improve the overall performance and stability of Tow Thomas Bi-quad Filter.

6 To implement the design filter in hardware.

ABBREVIATIONS

GA	Genetic Algorithm
LPF	Low Pass Filter
FIR	Finite Impulse Response
RB	Resistance Bridge
TT	Tow Thomas

NOTATION

English Symbols

R resistance

C capacitance

Greek Symbols

α order of filter in decimal

Ω unit of resistance

Miscellaneous

$|x|$ Absolute value of x

% Per-cent

1. Introduction

1.1 Filter Definition

In electronics, a **filter** (signal processing) is a kind of devices or process that removes some unwanted components or features from a signal. Filtering is a class of signal processing, the defining feature of filters being the complete or partial suppression of some aspect of the signal. Most often, this means removing some frequencies or frequency bands. However, filters do not exclusively act in the frequency domain; especially in the field of image processing many other targets for filtering exist. As is known to all, electronic filters remove unwanted frequency components from the applied signal, enhance wanted ones, or both.

1.2 Type of Filters

Filters have different effects on signals of different frequencies. According to this fact, the basic filter types can be classified into four categories: low-pass, high-pass, band-pass, and band-stop. Each of them has a specific application in DSP. One of the objectives may involve digital filters design in applications. Generally, the filter is designed based on the specifications primarily for the passband, stopband, and transition band of the filter frequency response. The filter passband is the frequency range with the amplitude gain of the filter response being approximately unity. The filter stopband refers to the frequency range over which the filter magnitude response is attenuated to eliminate the input signal whose frequency components are within that range. The transition band means the frequency range between the passband and the stopband.

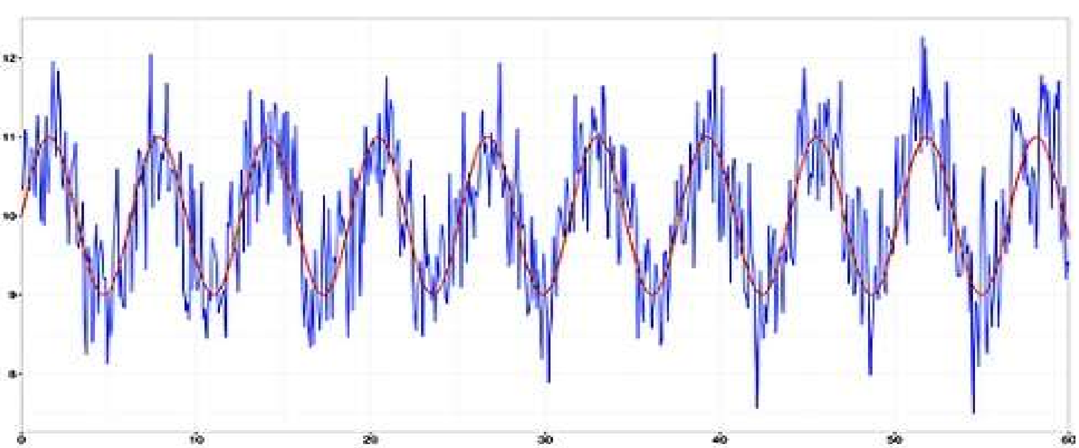

Figure 1.1 Filtering Out the Noise (signal processing)

Because there are many different standards of classifying filters and these overlap in many different ways, there is no clearly distinctive classification. Filters may be:

- non-linear or linear
- analog or digital
- time-variant or time-invariant, also known as shift invariance.
- discrete-time (sampled) or continuous-time
- passive or active type of continuous-time filter
- infinite impulse response (IIR) or finite impulse response (FIR) type

1.2.1 Passive Filter & Active Filter

Passive FilterA passive filter is composed of passive components only. It is based on the principle that the reactance of the capacitive and inductive components changes with frequency. The advantages of this type of filter are: simple circuit, causal power supply, and high reliability. Also there are disadvantages: the signal in the pass-band has energy loss, the load effect is relatively obvious, and electromagnetic induction is easy to cause when using inductive components. When the inductance is large, the size and weight of the filter are relatively large, which is not applicable in the low frequency range.

The passive filter circuit has a simple structure and is easy to design, but its pass-band magnification and cut-off frequency change with the load, so it is not suitable for occasions with large signal processing requirements. Passive filter circuits are usually used in power circuits, such as filtering after DC power rectification, or LC (inductance, capacitor) circuit filtering when high current loads are used.

Active Filter Active filters are composed of passive components and active devices. The advantages of this type of filter are that the signal in the pass-band has no energy loss, even be amplified; the load effect is not obvious, and the mutual influence is small when multi-levels are connected. The simple method of cascading is easy to form high-order filter, and the device is small, lightweight, and does not require magnetic shielding.

Their disadvantages are that the pass-band range is limited by the bandwidth of the active device and requires a DC power supply; the reliability is not as high as that of a passive filter, and it is not suitable for high voltage, high frequency, and high power applications.

The load of the active filter circuit does not affect the filtering characteristics, so it is often used in places with superior signal processing requirements. Active filter circuit is generally composed of an RC network and integrated operational amplifier, so it can only be used under the condition of suitable DC power supply, and it can also be amplified. However, the composition and design of the circuit are also more complicated. Active filter circuits are not suitable for high voltage and high current applications.

1.2.2 Digital Filter & Analog Filters

A digital filter is an algorithm or device consisting of a digital multiplier, an adder, and a delay unit. The function of the digital filter is to perform arithmetic processing on the digital code of the input discrete signal to achieve the purpose of changing the signal spectrum. Digital filters can be made by computer software or large-scale integrated digital hardware.

There are active and passive analog filters. Active filters mainly consist of op amps, op amps, resistors, and capacitors. They have problems such as voltage drift, temperature drift, and noise, while digital filters do not get these problems, so they can achieve high stability and accuracy.

Differences between Digital filter & Analog filters

Digital filters are used for discrete systems, analog filters are used in continuous-time systems, and they can also be used in discrete-time systems, such as SC (switched capacitor) filters.

From the point of view of implementation, analog filters are generally built with analog devices such as capacitors and inductors. Digital filters can be implemented by software or digital chips. It is troublesome to replace the capacitor and inductor when the technique parameters of the analog filter are changed. If there is a need for replacement, it is necessary to modify the coefficients (such as when implemented in software).

From the technical view, for example, it is very difficult for analog filters to reach -60dB, and digital filters can easily reach this.

The biggest difference between analog and digital filters is that the digital filter on the $F_s/2$ frequency is flipped, that is, symmetrical, while analog filters are not. Therefore, a large number of interpolation filters are selected in the DAC, and the image frequency is placed at a far frequency point, and then the analog filter regarded as a sound meter is used to filter out the image frequency in the radio frequency band.

The expression of analog filters is different from digital filters: analog filters are represented by H (S), and digital filters are represented by H (Z). Analog filter is based on the approximation of amplitude-frequency characteristics, while digital filters can achieve phase matching.

1.3Characteristics of Filter

1.3.1 Characteristic Frequency

①The pass-band cutoff frequency

$f_p = w_p / (2p)$ --(1.1)

It is the frequency of the boundary point between the passband and the transition band, at

Continue writing other chapters here. At last there will be conclusion and references

5. CONCLUSION

Improved designs of fractional order low pass filters of order 1.1, 1.5 and 1.9 are proposed by using simulated annealing, and suitable scaling optimization techniques.

. The simulated magnitude response obtained using proteus is analyzed and verified at circuit level. The optimized results for the order 1.1, 1.5 and 1.9 are designed and verified

Results show significant improvement near the cut off frequency in the passband and slight improvement in the stopband region of designed filters as compared to the existing ones. The proposed designs are realized using the Tow-Thomas bi-quad topology and continued fraction expansion.

Finally, the Proteus simulated results are also shown to show the effectiveness of the proposed fractional order low pass filter with Butterworth approximation.

Therefore, these maximally flat low pass filter circuits may replace the existing filter circuits for applications in signal processing.

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