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MOCCCII BASED CURRENT MODE FRACTIONAL ORDER UNIVERSAL FILTER

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Abstract: In this project fractional order universal filter are using three MO-CCCII symbols and two resistors and capacitors using BJTS also used. this paper work is using tanner software and matlab .schematic are desiging the tanner sedit and the matlab program for the filter verify the show the performance of it. also used .the study on non-inverting filter based CFOA.

***Index Terms* - fractional order universal filters, MO-CCCII, non-inverting filters.**

I. Introduction

A filter, often referred to as a frequency selective circuit, is a specialized type of circuit designed for the purpose of selecting or filtering specific input signals based on their respective frequencies.
Filter circuits operate by allowing certain frequency signals to pass through without any significant reduction in amplitude. In some cases, they may even amplify these frequencies. Simultaneously, these circuits attenuate or decrease the amplitude of other frequencies, depending on the specific type of filter in use. Filters play a vital role in various electronic systems, enabling the isolation and manipulation of signals according to their frequency components, making them an essential component in signal processing and communications. Advantages:1.Straightforward and streamlined design methodologies. Quick and easy to implement. Disadvantages1. Relatively low stability and sensitivity to temperature variations. Costly to implement on a large scale**.** There are many types of filters: low pass filters, highpass filter, band pass filter, bandstpop filter.all pass filter is it passes all the frequencies change the phase response. A bandpass filter is a type of electronic circuit that selectively permits a particular range of frequencies, referred to as the passband, to pass through while suppressing frequencies that falloutsidethis range. These filters are employed to isolate and work with specific frequencycomponents within a signal. The Butterworth filter is a category of analog or digital filter known for delivering a maximally flat frequency response within the passband. It is frequently utilized when there is a need for a relatively smooth and flat frequency response in a filter. Chebyshev filters are known for their steeper roll-off characteristics between the passband and stopband when compared to Butterworth filters. They are available in two primary variants: Type I, which exhibits equal ripple in the passband, and Type II, which features equal ripple in the stopband**.** Elliptic filters, alternatively referred to as Cauer filters, are distinguished by their ability to deliver the steepest roll-off and the sharpest transition between the passband and stopband among commonly used filter types. These filters find their utility when stringent demands for stopband attenuation are a prerequisite.

Fractional order calculations in interdisciplinary projects has rise to several applications. caputo'sdefinition given by Eq.(1)

$$\propto^{D_t^{\propto}} f(t) = \frac{1}{\tau(n-\alpha)} \int_{\alpha}^{t} (t\tau)^{n-\alpha-1} f^{(n)(\tau)d\tau, n-1<\propto<n}$$

T is time a is starting time α fractional order

$$\text{L } \{\propto_t^{D\propto} f(t)\} = s^{\propto} F(s)$$

Several advantages are a wide bandwidth, wide dynamic range, high exchange rate, high linearity ,lower consumption, and simple construction .MOCCCII is used as the 4 topologies low-pass (LP),high-pass(HP),band-pass,(BP) band stop(bs) filters .

CFOA(Current feedback operational amplifier):

CFOA is a active device there are four ports vx,vy,vz,vo,Ix,Iy,Iz,Io CFOAs have found extensive applications in various fields, including bioengineering, control theory, and fractional-order electrical circuits and oscillators. Notably, fractional calculus has opened up a wide array of research opportunities and applications in these areas

Some applications of the filters are:

1.Signal Conditioning: Non-inverting CFOA-based filters are used for signal conditioning tasks, such as amplification and filtering, to prepare sensor signals for further processing in measurement and instrumentation systems.

2. Audio Processing: CFOA-based non-inverting filters can be used in audio systems for equalization, tone control, and audio effects. Their high bandwidth and low distortion make them suitable for high-quality audio processing.

3. Communication Systems: In communication systems, CFOA-based filters can be used for filtering and frequency response shaping in applications like modulation and demodulation.

II. **MO-CCCII based Fractional order universal filter**

In this project we are using MO-CCCII symbol the symbol has two inputs and four outputs inputs are x and y outputs are iz+, ,iz+iz

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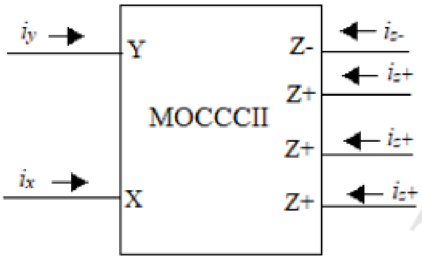

FIG 1:MO-CCCII SYMBOL

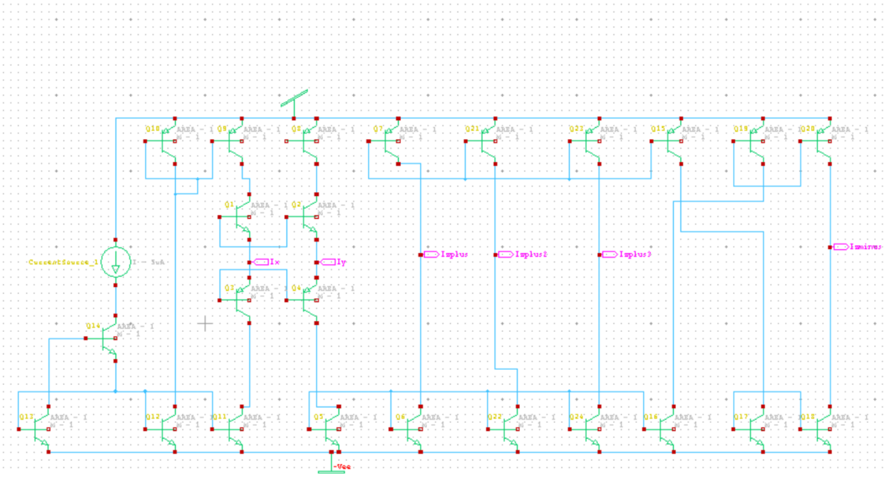

FIG2: Internal Diagram of the MO-CCCII

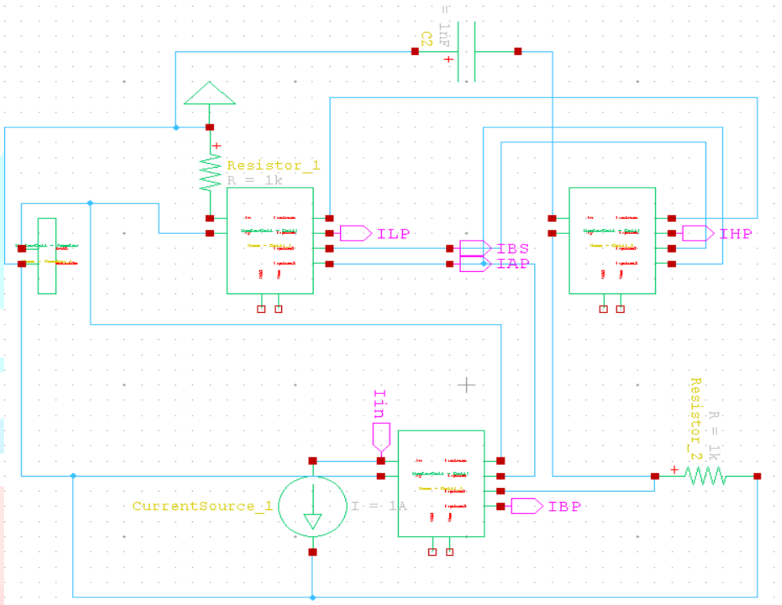

FIG3: the Main block diagram of fractional order universal filter

The fractional order universal filter using 3 MO-CCCII symbols and two resistors and grounded capacitors Using BJT NPN, PNP.

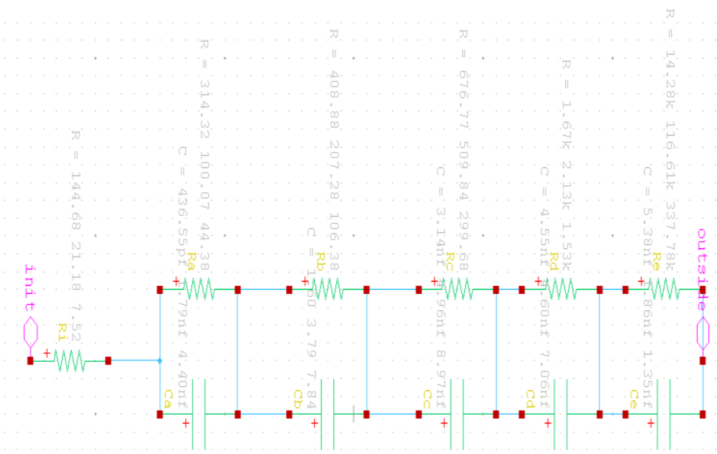

Fig4: foster-I RC network

Components	Fractional order (α)		
	0.5	0.8	0.9
R_i (Ω)	144.68	21.18	7.52
R_a (Ω)	314.32	100.07	44.38
R_b (Ω)	408.88	207.28	106.38
R_c (Ω)	676.77	509.84	299.68
R_d (Ω)	1.67k	2.13k	1.53k
R_e (Ω)	14.28k	116.61k	337.78k
C_a (nF)	436.55pF	1.79	4.40
C_b (nF)	1.60	3.79	7.84
C_c (nF)	3.14	4.96	8.97
C_d (nF)	4.55	4.60	7.06
C_e (nF)	5.38	1.86	1.35

The FOSTER-I RC network circuit component values of (α=0.5,0.8,0.9)

$$T(s) = \frac{ds^{1+\alpha} + es^{\alpha} + f}{s^{1+\alpha} + bs^{\alpha} + c} = \frac{N(s)}{s^{1+\alpha} + bs^{\alpha} + c} \quad (1)$$

$$H_{1+\propto}^{FLPF} = -= -\frac{\frac{1}{C1R1C2R2}}{S^{1+\propto} + \frac{1}{C2R2}S\propto + \frac{1}{C1R1C2R2}} \quad (2)$$

$$H_{1+\propto}^{FHPF} = -= -\frac{S^{1+\propto}}{S^{1+\propto} + \frac{1}{C2R2}S^{\propto} + \frac{1}{C1R1C2R2}} \quad (3)$$

$$H_{1+\propto}^{FBPF} = -= -\frac{\frac{1}{C2R2}}{S^{1+\propto} + \frac{1}{C2R2} + S^{\propto}\frac{1}{C1R1C2R2}} \quad (4)$$

$$H_{1+\propto}^{FAPF} = \frac{I_{AP}}{I_{in}} = -\frac{\frac{C1R1C2R2s^{1+\propto - C1R1+1}}{C1R1C2R2}}{S^{1+\propto} + \frac{1}{C2R2}s^{\propto} + \frac{1}{C1R1C2R2}} \quad (5)$$

III. Fractional order non-inverting filter (CFOA)

A (CFOA) is an active electronic device used in analog circuit design. Unlike traditional voltage feedback operational amplifiers (VFAs or op-amps), CFOAs primarily operate in the current domain. They are designed to handle current signals at their inputs and provide current signals at their outputs. Key characteristics of a CFOA include its high bandwidth, high slew rate, and excellent linearity in the current domain. CFOAs are particularly useful in applications where high-speed current amplification, current-mode signal processing, or current-controlled circuits are required. They are often employed in various electronic systems, including filters, oscillators, amplifiers, and instrumentation amplifiers. In summary, (CFOA) is an electronic device optimized for handling and manipulating current signals, offering advantages in terms of bandwidth and linearity in current-based applications.

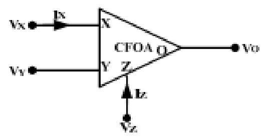

FIG5: Symbol of CFOA

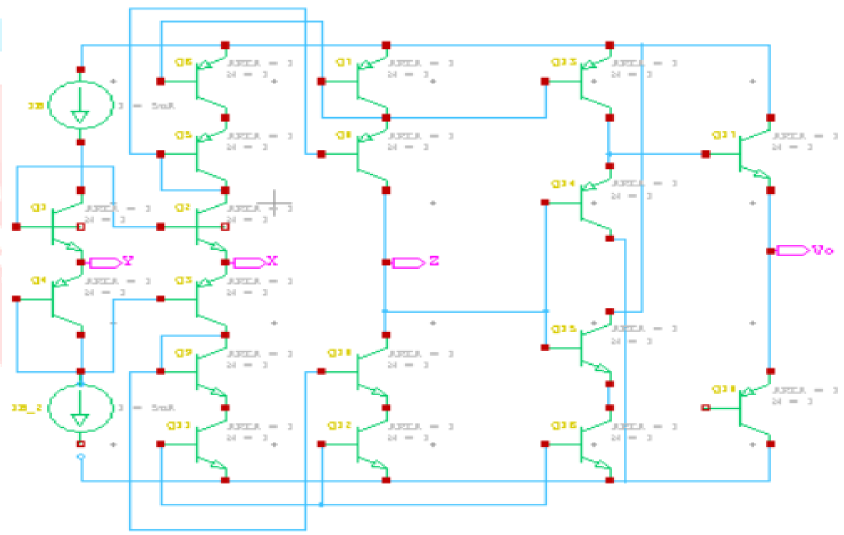

Fig6: internal circuit diagram of CFOA

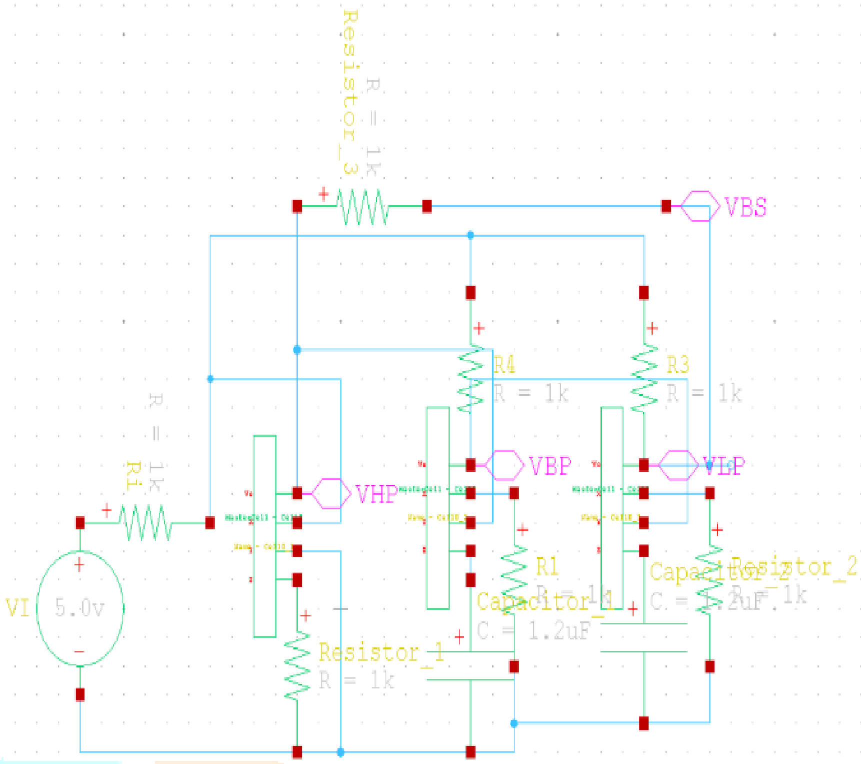

FIG:7 block diagram of non-inverting filter

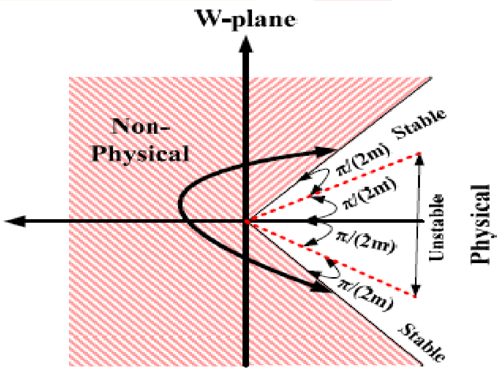

Fig8: Stability regions of fractional order systemsin W-plane

The transfer functions of these three responses are defined as follows: [Include specific equations or transfer functions as needed].

$$T_{LP} = \frac{V_{LP}}{V_i} = \frac{\frac{-R}{C1C2R1R2Ri}}{D(s,\propto,\beta)} \qquad (6)$$

$$T_{BP} = \frac{V_{BP}}{V_i} = \frac{\frac{-R}{C1R1Ri} s^{\beta}}{D(s,\propto,\beta)} \quad (7)$$

$$T_{HP} = \frac{V_{HP}}{V_i} = \frac{\frac{-Rs^{\alpha+\beta}}{Ri}}{D(s,\propto,\beta)} \quad (8)$$

$$D(S,\alpha,\beta) = S^{\propto+\beta} + \frac{R}{C1R1R4} S^{\beta} + \frac{R}{C1C2R1R2R3} \quad (9)$$

An extensive examination of the previous filters was conducted, followed by a thorough stability analysis across various fractional orders. The study utilized standard component values, with C1 = C2 = 1.2x10 and R1 = R2 = R3 = R4 = 1kΩ. The inclusion of fractional orders α and β introduced a higher degree of design flexibility. Of particular importance in filter design is the cutoff frequency, which significantly influences a filter's bandwidth.

The cutoff frequency hinges on the values of α and β, providing designers with additional design freedom. The interplay between the cutoff frequency and fractional order parameters α and β was explored. These parameters can be related through fixed summation, subtraction, or by making them multiples of each other. Two scenarios were considered: one where α + β = 1.8 and another where their difference equals one. Figure illustrates the cutoff frequency when α and β are multiples of each other. It's worth noting that for the chosen circuit components, higher cutoff frequencies are achieved when α is greater than β.

S.NO	Lp	hp	bp	bs
SNR	88.1000	87.4000	87.6000	86.4000
SNR (CFOA)	99.000	98.000	96.0000	96.9000
mse	25.1000	26.8000	25.5000	26.7000
Mse(CFOA)	15.1000	14.8000	13.0000	14.5000
Time	1.272467SECONDS			
Time(CFAO)	1.864102 SECONDS			

Table2: Filter responses of the CFOA

MO-CCCII circuit consists the capacitors and resistors capacitor c2=1nf ,R1=R2=1K, BIAS current I0=13ua and source voltage +VEE=-VCC+2.5V and pnp npn transistors also used .

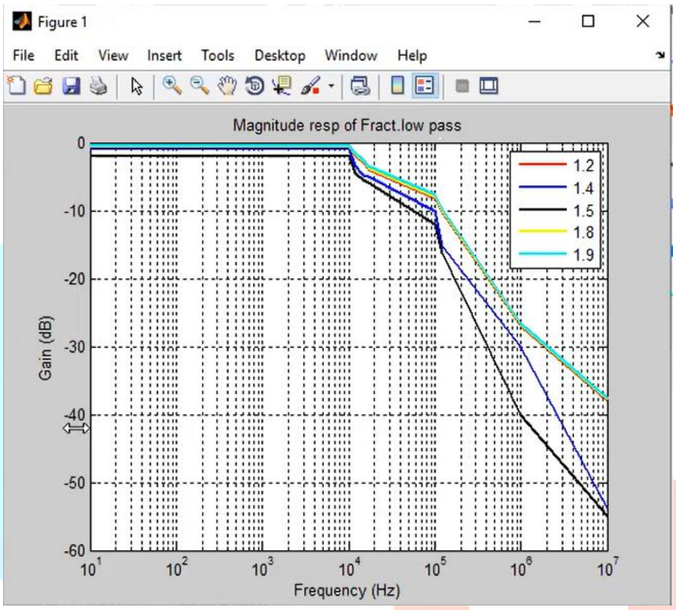

Fig9: Magnitude response of the fractional Low pass filter (1+α) =1.5,1.9,1.8,1.2,1.4

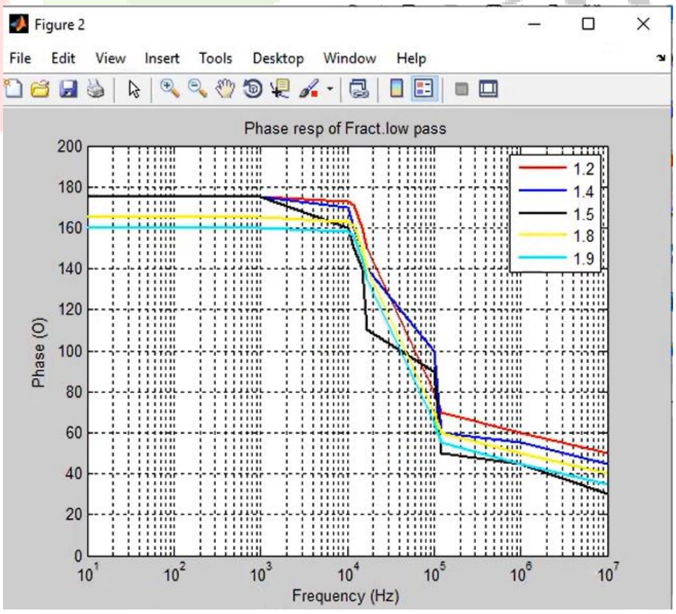

Fig10: phase response of the low pass filter(1+α) =1.5,1.9,1.9,1.2,1.4

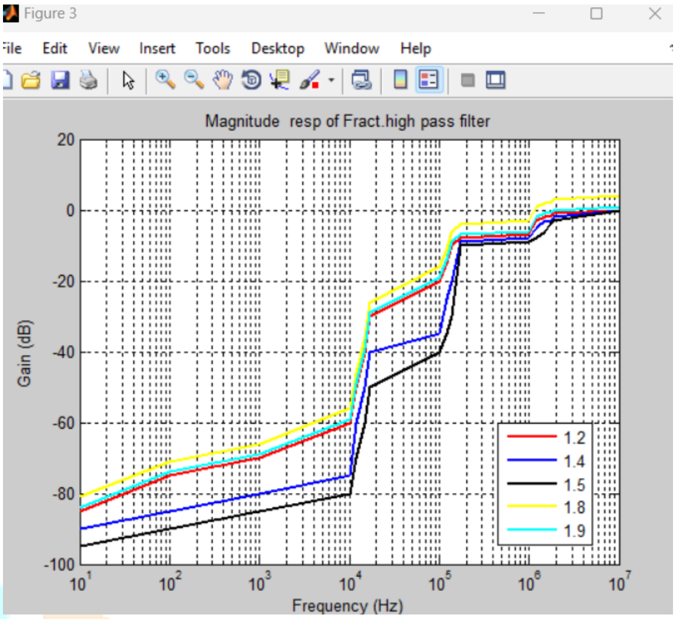

Fig11: Magnitude response of the high pass filter(1+α) = 1.5,1.8,1.9,1.2,1.4

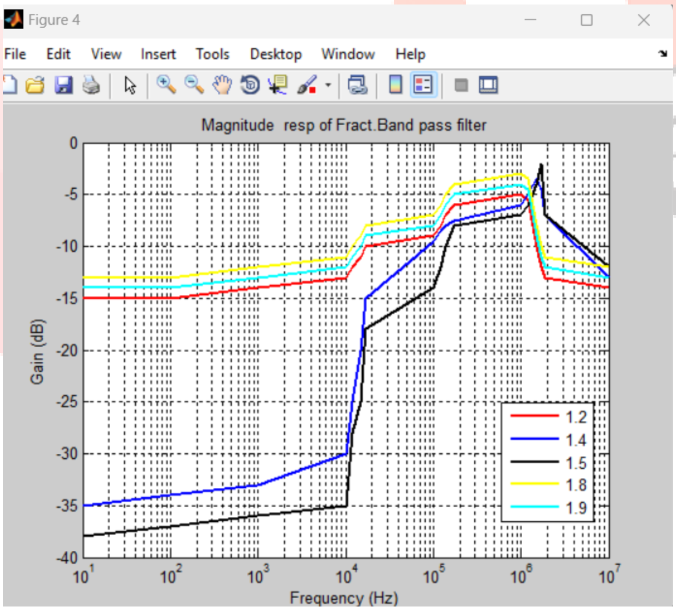

Fig12: magnitude response of the bandpass filter
(1+α) =1.5,1.8,1.9,1.2,1.4

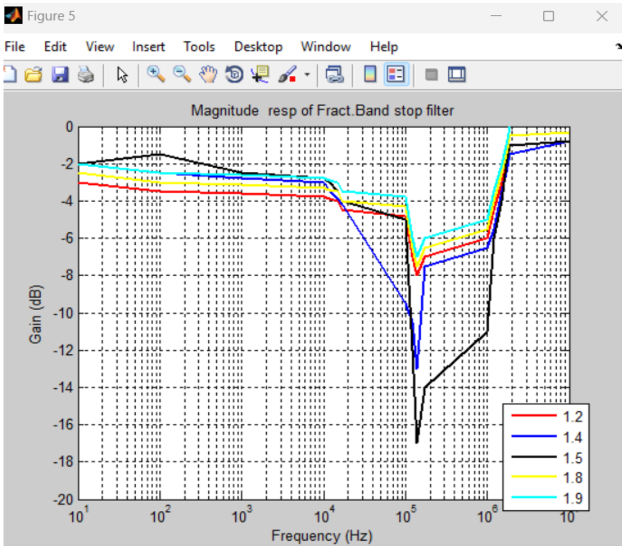

Fig13: Magnitude response of the band stop filter (1+α) =1.5,1.8,1.9,1.2,1.4

IV. conclusion

"A research endeavor was undertaken to extend the design of continuous-time filters into the realm of fractional orders. This study introduced multiple filters based on (CFOA) with (HP), (BP), and (LP) responses. The research delved into both dependent and independent fractional-orders, harnessing the additional degrees of freedom these orders offer to enhance the flexibility and controllability of filter designs.

The study derived the cutoff frequency equation for the LP response in terms of fractional orders, providing insight into the behavior of these filters. Various numerical solutions were explored to address the unique characteristics of the two filter types.

In addition to theoretical analysis, the study examined the stability aspects concerning one of the filter components through pole tracking, contributing to a comprehensive understanding of the filter's performance and reliability.

The results of Spice simulations were subsequently presented, affirming the practicality and effectiveness of the filter designs."

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