CHAPTER - 6

SUMMARY AND CONCLUSIONS

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6.1) SUMMARY :-

This chapter is devoted to the general discussions of the present work.In the dissertation Chapter-I represents an extensive survey of literature in order to represent entire development of the electrical filters. The deisgns started with passive components and then using active devices with the advent of semiconductor devices. The availability of high performance operational amplifiers led to rapid development of active filters and recent trend is to design the circuit directly in the intergrated circuit form.The survey is followed by the discussion of basic feature of passive and active filter circuits and comparison.

In the Chapter-II, the practical design approach to overcome disadvantages of basic circuit is discussed. In order to obtain ideal response some approximations are used to design the filter circuits. It is noticed that higher order filters are required to achieve this goal. However, all drawbacks cannot be removed Various important approximations and their characeristics are discussed. This is followed by the comparison of various approximations and the frequency transformation for various filter functions from basic low-pass filter.

In any active filter design, it is desired that the response be stable under all conditions. However, the element values as well as parameters of the active devices change with temperature, aging and in some cases with applied voltages also. This is highly undesirable as the response of the circuit can become unstable, as a result of changes in the parameters of the circuit elements.the concept of sensitivity deals exactly with this.

Chapter -III discusses sensitivity considerations in detail. A short note on the choice of components and circuit configuration is also included.

Various design techniques are developed in the design of active filters.State-variable analysis is one such technique.The idea of the state is related to the energy stored in the circuit (reactive components) at any given instant of time from which it is popssible to predict the behaviour of the circuit. The state variable analysis is discussed in Chapter-IV and realization procedure is given for state-variable type active filters.

Chapter-V represents the entire experimental work done by me in the study of active filters. A circuit reported in the literature was studied in detail and modification was introduced to overcome some of the drawbacks. The improvement was attempted by the introduction of positve feedback. The expressions for the transfer function for various outputs for the modified circuits were obtained and the modified circuit is extensively studied to evaluate its performance. The study was done in three different ways viz.

1) Study of response with variation of Q
2) Study of response with variation of R
3) Study of response with variation of tapping parameter "a"

In each case the response of modified circuit was compared with the response of original circuit and conclusions were drawn about the effect of positve feedback.

Finally Chapter-VI concludes the overall status of active filter circuit, the response of modification introduced in the one of the active R filter circuits reported in the literature and summary as well as present developments in brief.

6.2) CONCLUSIONS :-

In this investigation one of the circuits of active R filter, reported in the literature is modified by introducing positive feedback. Experimental details are given in chapter-V. This investigation was basically divided into three parts viz.

1. Variation of 'Q' values.
2. Variation of 'R' values. (which introduces positive feedback).
3. Variation of tapping parameter "a".

In the first part of the experiment i.e. variaiton of 'Q' values ,the circuit was designed for center frequency(f_o) of 10 KHz. using design equations mentioned in chapter-V for R=1.7Ω and a = 0.5. In second part of the experiment the circuit is studied for varionus 'R' values for Q=1, fo= 10 KHz and a=0.5(the values of R=1.7, 4.7, 6.8 and 10 Ω) In the third part of the experiment the circuit is studied by keeping R=1.7 Ω, Q=1 f_o =10 KHz for various 'a' values i.e. for a=0.2, 0.4, 0.6, and 0.8. The salient features are given below.

6.2(a) Low pass response:-

It is seen from the low pass responses from all the three parts of experiments that the response is satisfactory over the entire frequency range. The design value of f_o matches well with observed value of upper cutoff frequency. On comparison with Soderstrand circuit, it is noticed that the two circuits have almost the same gain in pass-band. However, above 100 KHz. the modified circuit gain decreases continously(upto about 25 dB at 1 MHz.) as frequency increases , but in original circuit gain remains constant at about 57 dB at 1 MHz.

6.2(b) Band stop response :-

It is observed from the band stop responses of all the three cases that, in modified circuit, response drops rapidaly from 20 KHz onwards upto 500 KHz and then increases upto 1 MHz. The response of Soderstrand circuit,however, flattens from 100 KHz onwards

The design frequency in this case does not agree with the observed frequency.

6.3(c) Bandpass response:-

It is obserbved from band pass responses of all the three parts of the experiment that the modification gives higher gain than the original circuit and it is also noted that modified and original circuit responses are almost similar in high frequency side. However, modified circuit has poor performance on the low frequiency side i.e. as `R' value increases the bandwidth of the response reduces. The higher the value of `R' the narrower is the bandwidth of the response

6.4(d) <u>High pass response</u> :-

It is noticed that the response of modified circuit is almost similar to that of Soderstrand circuit.

Thus, the overall response of the modified circuit is very satisfactory. It gives better output as compared to Soderstand circuit for low-pass and band-stop actions. For high-pass action the response is almost same but in case of band-pass output there is some degradation at lower frequencies.

Lot of efforts are being made to develop the circuits with response approaching the ideal response.

Now-a-days, in order to fabricate the active filter circuit on a single chip (IC) the reactive (passive) components are not used. Also, special OP-AMPs are developed for the active filters. The research workers and designers are working on switched capacitor filters. One more trend is to use Operational Transconductance amplifiers (OTAs) as an active element in the active filter assembly. The active filters are also available in IC form.

Recently, plug-in card filters are available in various types. Following are the some of the available forms

i) Cauer : The most commonly used filter type on the PC based filter card is, the elliptic Cauer ("Brick- wall")filter. This is a seventh or eigth order low pass switched capacitor filter. Maximuum cutoff frequency is 50 KHz with an input clock frequeny of 100 times of cutoff frequency.

ii) Butterworth : The Butterworth 8^{th}order low pass filter provides a maximally flat pass band is an alternative for the high speed applications and for where ripple in the pass band is unaccpetable.

iii) **Bessal** : The 8th order monolithic low-pass Bessal filter provides a linear phase response over the whole pass- band. Wide band noise level is 60 μV RMS.

iv) **High speed Butterworth** : For high speed applications a sixth order Butterworth has a clock to cutoff frequency ratio of either 25:1 or 50:1 giving maximum cutoff frequency of 250 KHz and 125 KHz respectively.

The study of active filters is very interesting and challanging field both theoretically and practically.