CHAPTER - V I

SUMMARY AND CONCLUSIONS

CHAPTER VI

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6.1 SUMMARY

In this dissertation, chapter-I represents brief view on filter and an extensive survey of literature in order to indicate the entire development of electrical filters. A discussion on basic filters and classifications is included in section (1.3). The filters are classified in number of ways such as analog or digital filters. Analog filters are further divided into passive or active filters, depending on the type of elements used in their realization. Filters are also classified according to functions they perform as low pass, high pass, band pass, band reject, amplitude equilizers and delay equilizers. There are some limitations in passive filters which are overcome by active filters. The active filter consists of operational amplifier along with RC network in a feedback configuration providing high 'Q' networks. These inductorless filters provides very sharp filtering action. They are light in weight, compact, economical and free form loading effect.These filters have some drawbacks such as finite bandwidth of the active devices. Recently, there has been a great interest in the design of active-R filters which are based on the single pole intergrator model of the op-Amp. The filter circuits using operational amplifiers and resistor as only external component are commonly known as active-R filter. These circuits have many advantages such as high frequency operation, miniturization, ease of design and tunability.

The chapter-II deals with some theoretical aspects of filters which are very useful in design of filters. The section (2.1) indicates the designing of higher order filter. The cascade structures have higher sensitivity than coupled biquad structure. The various types of sensitivities are discussed in section (2.2). In order to obtain the ideal response, some approximations are used in the design of filter circuits. They are Butterworth (maximally flat response), Chebyshev (equiripple), Elliptic and Bessel (maximally flat delay response). The frequency transformation technique is then applied to design high pass, band pass and band reject filters. A state variable technique, useful for design of higher order filters, is discussed in section (2.4). Also it provides a circuit with less sensitivity as compared to other filter realization. At the end of this chapter, a filter topology is discussed which is important for the selection of filter circuit. Lastly, the impedance and frequency scaling are explained. Scaling is necessary to make the circuit practically realizable.

A new active-R biquadratic filter based on single pole intergrator model is presented in chapter-III. This filter circuit consists of two op-Amps and four resistances. To control the feedback, the resistance 'R' is tapped at the centre as shown in Fig. (3.1). The circuit is multiple feedback circuit which realizes four biquadratic filter functions as low pass, high pass, band pass and band stop. The various sensitivities of this circuit are calculated and found to be less than one. The value of 'R' should be such that all the circuit components are positive. The response of the circuit was studied for R = 33 ohms, Q = 1 and variation of F_o = 10 KHZ, 30 KHZ, 50 KHZ, 70 KHZ and 110 KHZ and R_1 is tapped at the centre. The frequency response was studied upto 1 MHZ. From the response curves, it is found that there is excellent agreement between theoretical and experimental observations. It gives high gain in passband. The circuit is quite satisfactory as far as low pass, high pass and band pass responses are concerned. In theoretical curve, there is slight peaking near the central frequency F_o = 10 KHZ. The performance is not satisfactory in case of band stop response. The transfer functions show that for $R = \infty$, the circuit should oscillate. In practice, such oscillations are observed but the observed frequency does not match with the theoretical results.

Similarly, study of the response of the same circuit with variations of 'Q' is discussed in chapter-IV. The response is studied for R = 33 ohms, F_o = 10 KHZ and various Q = 1, 1.5 and 2.5 for all filter functions. A theoretical curve is also included in each case. In this case also the performance of the circuit is quite satisfactory except for the band stop action. Some degradations are observed at the high frequency end of the response and also below 10 KHZ. It is found that none of the responses show a peak near F_o value but the theoretical curve shows a small peak at F_o = 10 KHZ in each case.

Finally, the study of the response of the new active-R filter circuit with change in tapping point parameter (A) is discussed in chapter-V. The response of the circuit was studied for R = 33 ohms, F_o = 10 KHZ and for different tapping point parameter A = 0.3, 0.5 and 0.8. The behaviour of the circuit is satisfactory for LP, HP and BP actions but band stop response is very poor. Practically, it is found that variation of 'A' has no effect on the response. Further, theoretical curve shows a peak near the design frequency while the observed responses show no peak at all. There is departure at low and high frequencies which might be due to high and low gains of OP-AMPS in these regions. The overall performance of the circuit is very good and satisfactory over the entire frequency range.

6.2 CONCLUSIONS

The proposed, new Active-R biquadratic filter circuit in this dissertation provides a very satisfactory response for all filter functions except for the band stop action. The circuit is studied in detail with variation in F_o, Q and the tapping point parameter. It is observed that the response is quite satisfactory in all cases and design frequency (F_o) matches with observed results. Also, there is very close agreement between the theoretical and observed results. The gain is very high in passband of the low pass response. It is found that for lower value of 'Q', the circuit is not practically realizable. It is noted that a theoretical curve shows a small peak near the design frequency (F_o) while the observed responses do not show a peak at all. However, there are some degradations at low and high frequencies. The performance of a new circuit was studied from 50 HZ to 1 MHZ. It is found that there is departure at low and high frequencies which might be due to high and low gains of operational amplifiers in these regions. The transfer functions show that for $R = \infty$, the circuit should oscillate. In practice, such oscillations are observed but the observed frequency does not match with the theoretical expectations. The circuit utilizes three OP-AMPS and four resistances for providing four filter functions.

Thus, a new active-R filter circuit discussed in this dissertation is quite satisfactory.

6.3 FURTHER INVESTIGATIONS

The new filter circuit discussed in this dissertations, provides some advantages but it also has some degradations.

1. In all filter functions, theoretical curve shows a small peak near the designed frequency.
2. The band stop action is not satisfactory in all cases.
3. There is departure at low and high frequencies which might be due to low and high gain of OP-AMPS in these region.
4. The variation of 'Q' and tapping point parameter (A) have little effect on responses.
5. The transfer functions show that for $R = \infty$, the circuit should oscillate. In practice, such oscillations are observed but the observed frequency does not match with the theoretical expectations.

All these short commings observed in the response curves are being studied so as to find the exact cause of these deviations and to improve the performance of the circuit.