CHAPTER – VI

SUMMARY AND CONCLUSION

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6.1 SUMMARY :-

This chapter is devoted to the general discussions of present work.

Chapter one represents a discussion on basic filters, classification of filters, simulation, need and requirements of simulation. The filters are classified in a number of ways such as analog or digital filters. Passive or active filters depending on the type of elements used in their realization. According to their performance filters are also classified as low pass, high pass, band pass, band stop and all pass. There are some limitations in passive filters. The active filters consist of active device like Op. Amp. along with RC network in feedback configuration. The active filters provide high Q networks. These inductorless filters provide very shaper filtering action. They are light in weight, compact, economical and free from loading effect. The departure of active device from ideality at high frequencies restricts active filter application below MHz range. Simulation is a powerful supplement to traditional design techniques. How the development of simulation software is carried out is discussed along with its advantages and limitations. Simulation allows the designer to test a circuit quickly over a variety of conditions. Multiple simulation is possible using circuit simulator. It offers user a fast efficient means to test a circuit performance characteristics. Due to simulation one can investigate the circuit behaviour before building a working prototype. With simulation designer can effectively predict the performance of a circuit by changing one or more circuit parameter.

Chapter second explains the theoretical aspects of active filters. In this first order, second order and higher order filters are discussed. The standard form of transfer function of first order and second order are compared. The designing of higher order filter using first and second order filter is discussed. In order to obtain the ideal response, some approximations are also used in the filter designing. They are Butterworth, Chebyshev, Elliptic and Bessel. The comparison between their performance is done with graphical representation. Practically the filter performance is affected by the component tolerance, drift, aging and nonlinearities of Op. Amp. Sensitivities constitute important factor in weighing different realizations of filter functions. Sensitivities helps the designer to specify the component tolerance required to meet the design objectives.

Chapter three deals with the theoretical aspects of computer based circuit simulation using DC linear model. A circuit is described to a computer by using circuit file. The format of circuit file is discussed along with the syntax used for it. The result of simulation by PSpice are stored in an output file. It is possible to control the type and output performance by various commands. PSpice allows various types of analysis like DC analysis, Transient analysis, AC analysis, Fourier analysis, Sensitivity analysis, Parametric analysis and Multiple analysis. The general form of each analysis is discussed. In DC analysis four types of dependent sources are studied using its symbol and the general form of statements used in PSpice. PROBE is the graphical post processor and waveform analyzer of PSpice. The waveform analysis using PROBE is studied with graphical representation. How modeling of pulse, exponential, piecewise linear, sinusoidal and single frequency modulation of sources are done is also discussed. In the dissertation the effect of parameters like resistance ratio m, capacitance ratio n and the gain (k), on the frequency response of the filter circuit is studied. For this study the parametric analysis is used. The frequency response of the filter circuits is studied using AC analysis. In active filters the operational amplifier is used for amplification. For accurate response of filter circuit, the simulation of actual behaviour of Op. Amp. is required. DC linear model, AC linear model and Non linear macro model are also discussed for comparison.

In chapter four a KRC low pass and high pass filters are presented. In active filter circuit high value of quality factor requires a larger capacitance spread to remove this drawback operational amplifier is used with gain k greater than 1. Such type of filter with gain $k > 1$ is called KRC filter. The design procedure of second order KRC low pass filter is discussed using the equations for transfer function H, quality factor Q and cutoff frequency fo. The parameters m (resistance ratio) and n (capacitance ratio) control the quality factor Q and cutoff frequency of filter circuit. To study the effect of variation of resistance ratio m, the frequency response of low pass and high pass KRC filters are studied practically and using simulation software PSpice. The low pass response are studied for different values of m (0.2, 0.4, 0.6... etc) at fo = 1000 Hz, n = 1, and k = 2. For m > 0.707 gain peaking is observed exactly at frequency fo. The quality factor Q of the circuit depends on the m. It shows that the performance of the filter is marked dependent on the tolerense of the resistors. Practically at fo the maximum gain observed is 20 at m = 5.73. Using PSpice software the maximum gain observed is 11.5 at m = 5.73. For high pass response the maximum gain (k) practically observed is 2.5 for m = 1 at fo. The high pass filter response using simulation programme shows that the maximum gain observed is 2.5 for m = 1 at cutoff frequency fo. The effect of capacitance ratio n is studied practically and using PSpice for low pass and high pass KRC filter with changing n. The gain peaking is observed at fo. In low pass response the flat portion is observed upto n =1.5, for higher n, peaked response is observed. The study of response of the KRC low pass and high pass circuit with changing gain (k) is also discussed in this chapter. The response of the circuits are studied for constant m and n and different k. In low pass filter with increase in gain (k) the peaked response is observed exactly at fo. But in high pass filter circuit the flat response is observed with increase in the gain (k). The gain peaking is not observed in high pass filter.

In chapter five the study of response of multiple feedback band pass and band reject filter with changing Q, Req, gain and R_3 is discussed. The multiple feedback, band pass filter is studied for fo = 5 KHz with different Q (Q = 0.8, 1, 1.5, 2, 3). From the response curve it is found that there is satisfactory agreement between practical and simulated program observations. With increase of Q the band becomes more narrower i.e. sensitivity increases with Q. The response of the band reject filter was studied for different Q (Q = 1 2, 3, 4 5, 6, 7) with keeping notch depth constant. With increase of Q circuit becomes more selective. The notch depth of band reject filter is determined by the resistor R_3. The frequency response of notch filter was studied for fo = 1 KHz, Q= constant and the effect of variation of resistance R_3 is studied for R_3 = 2.7 k, 5.6 k, 10 k, 13.9 k, 15.6 k. It is observed that the notch depth is maximum for R_3 = 10 k. For other resistance the notch depth is minimum than for R_3 = 10 k.

The behaviour of all circuits is satisfactory. Practically it is found that variation of m and n has effect on quality factor Q of the low pas and high pass circuit. Due to variation of m and n peaked response are observed exactly at cutoff frequency fo. There is satisfactory agreement between practically observed frequency response and frequency response observed using simulation program. For equal component KRC high pass and low pass filters (i.e. m = n = 1) the quality factor of the circuit is only determined by the gain k. if gain k of the circuit is 3 then quality factor Q becomes infinite and circuit works as an oscillator. In band reject filter its order, notch frequency fo and quality factor Q is determined by the used band pass filter. The gain of the original signal is substracted from the output of the band pass filter using summing amplifier.

6.2 CONCLUSIONS :-

In this dissertation work a designing approach of active filter is proposed. The departure of actual Op. Amp. from ideality at high frequencies restricts active filter application below MHz. range. In active filter filtering is done by the RC network. In the active filter circuit the quality factor Q is more sensitive to component tolerances. Very small change in component value due to drift or aging leads to large variation in Q in active filters. To study the effect of small variation of component value, two parameters m (resistance ratio) and n (capacitance ratio) are taken into consideration and its effect on frequency response of filter circuits is studied. Due to increase in the value of m and n, the gain peaking is observed exactly at fo. For low Qs the transition from one asymptote to the other is very gradual, while for high Qs, there is a range of frequencies in the neighbourhood of fo where filter provides gain. This phenomenon referred to as peaking. Such peaked responses are useful in the synthesis of formant filters for the simulation of the human vocal tract.

Frequency responses for different values of m and n are studied. For higher values of m and n the gain peaking is observed i.e. Q increases, indicating a high degree of selectivity.

In band reject filter it is noticed that the notch depth is maximum for $R_3 = R_6/Av$. The notch depth of band reject filter depends on the resistance R_3 which is used in the input of summing amplifier. The frequency response of band pass filter shows that the gain bandwidth product remains constant. For higher Q, the response becomes narrower i.e. more selective the filter.