CHAPTER : VI

STUDY OF RESPONSE OF THE CIRCUIT WITH VARIATION OF TAPPING POINT (A)

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6.1 INTRODUCTION :-

In this section the effect of variation of tapping point parameter (A) is studied.

With the help of equation (4.1) and tapping parameter (A), the voltage transfer function becomes as follows.

1. Voltage transfer function for low pass filter-

$$T_{(L.P.)} = \frac{V_3}{V_1} = \frac{-\left(\frac{1}{R_1}\right)\left[(1-A)\ GB_2.S + GB_1.GB_2\right]}{S^2\left(\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}\right) + GB_2.S\left(\frac{A}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}\right) + GB_1+GB_2\left(\frac{1}{R_2}+\frac{1}{R_3}\right)} \quad \ldots(6.1)$$

2. Voltage Transfer Function for High Pass Filter

$$T_{HP} = \frac{V_A}{V_1} =$$

$$\frac{\frac{1}{R_1}\left[s^2 + AGB_2 \cdot s\right]}{s^2\left(\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}\right) + S.GB_2\left(\frac{A}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}\right) \div GB_1.GB_2\left(\frac{1}{R_2}+\frac{1}{R_3}\right)} \quad \ldots.(6.2)$$

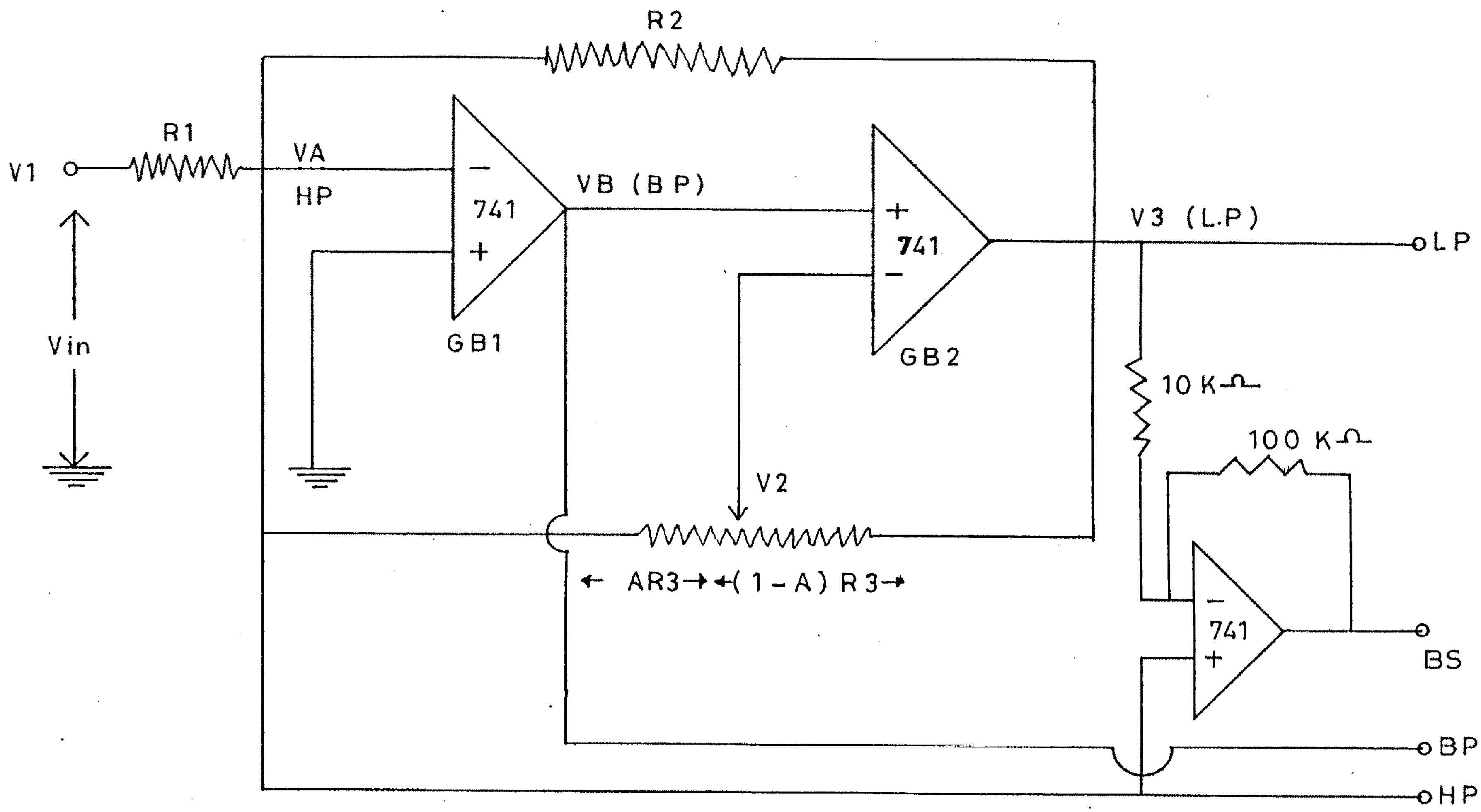
3. Voltage Transfer Function for Band Pass Filter :-

$$T_{HP} = \frac{V_B}{V_1}$$

$$= \frac{(s^2 + AGB_2.S)\left[\frac{-S}{GB_1R_1}\right]}{s^2\left(\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}\right) + GB_2.S\left(\frac{A}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}\right) + GB_1.GB_2.\left(\frac{1}{R_2}+\frac{1}{R_3}\right)} \quad \ldots\ldots(6.3)$$

6.2 **DESIGN CONSIDERATION :-**

As discussed in earlier chapters, the design equations were obtained by comparing the transfer functions with general second order transfer function.



(FIG.6.1) NEW ACTIVE R FILTER CIRCUIT

(CIRCUIT DIAGRAM)

The transfer function is

$$T(S) = \frac{\alpha_2 s^2 + \alpha_1 . s + \alpha_o}{s^2 + (\frac{\omega_o}{Q}) s + \omega_o^2} \quad ......(6.4)$$

The result of comparision yields,

$$\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = 1 \quad ....(6.5)$$

$$GB_2 \left(\frac{A}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right) = \frac{\omega_o}{Q} \quad ....(6.6)$$

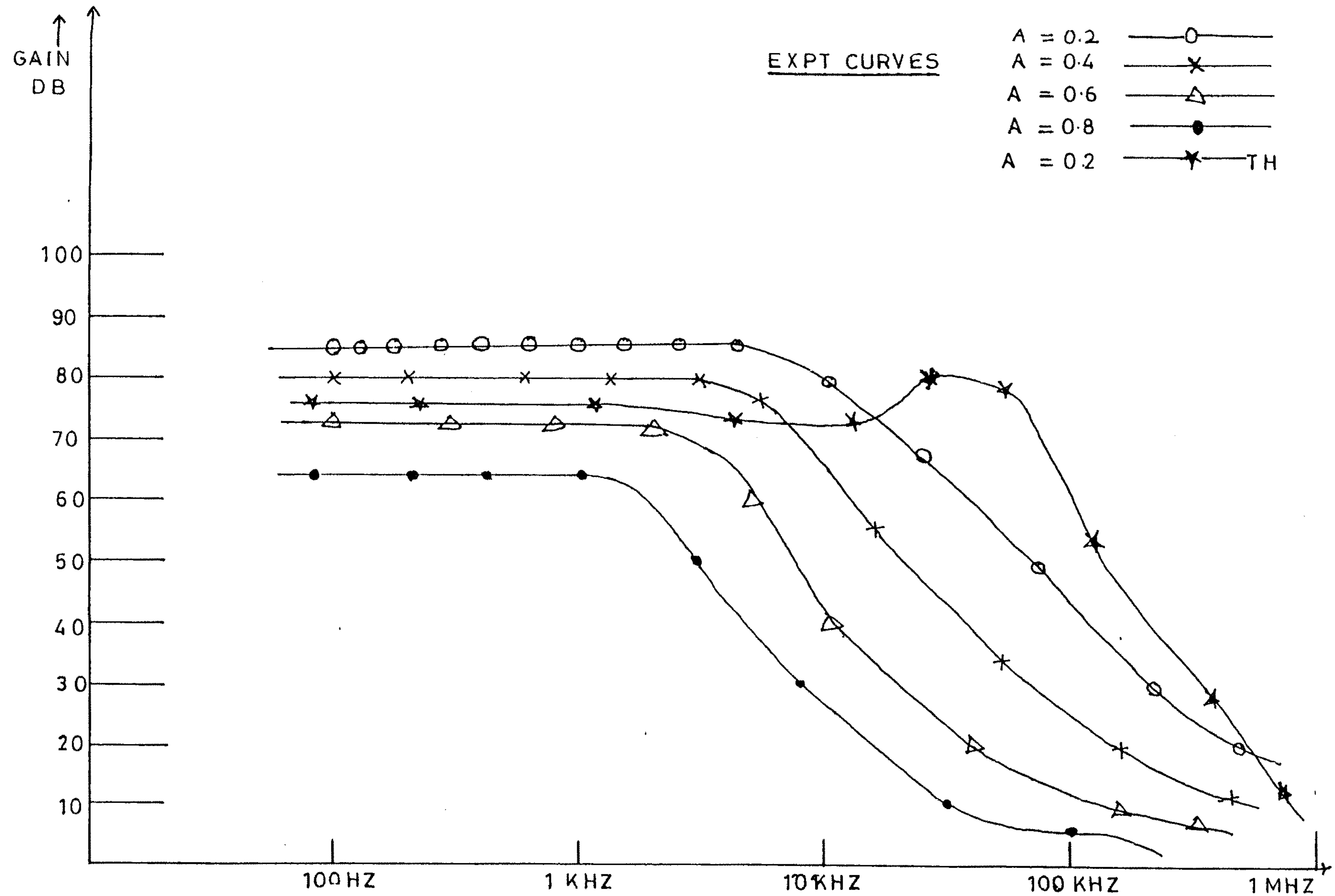
$$GB_1 . GB_2 \left(\frac{1}{R_2} + \frac{1}{R_3}\right) = \omega_o^2 \quad ....(6.7)$$

The circuit is again assembled with the operational amplifiers used for earlier studies and the values of resistances are calculated using above equations. The calculated and actually used component values are given in Table (6.1).

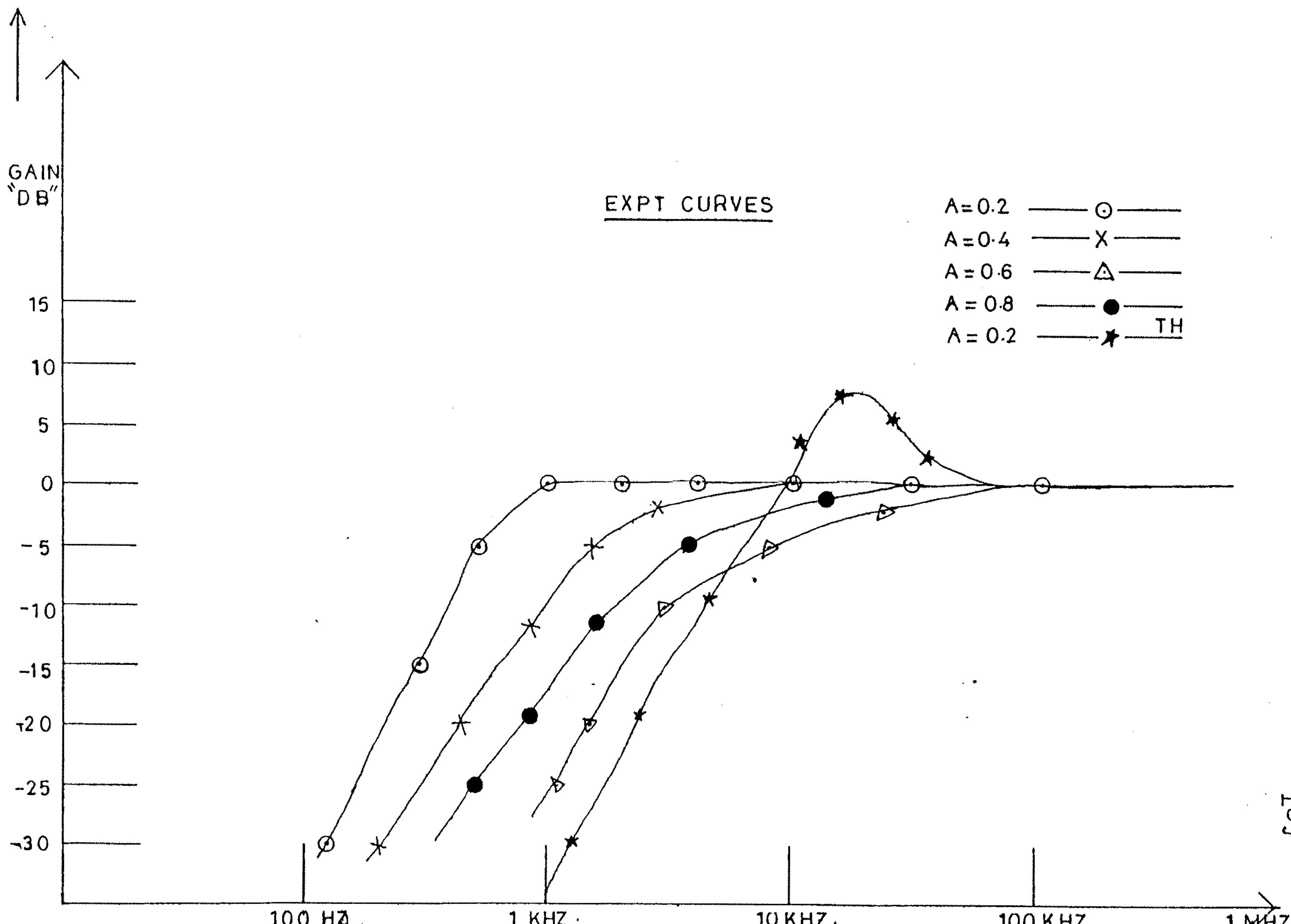
6.3 RESULTS AND DISCUSSIION :-

The four filter outputs were observed over the frequency range from 100 Hz to 1 MHz. They are graphically shown in figures (6.1), (6.2), (6.3) and (6.4)

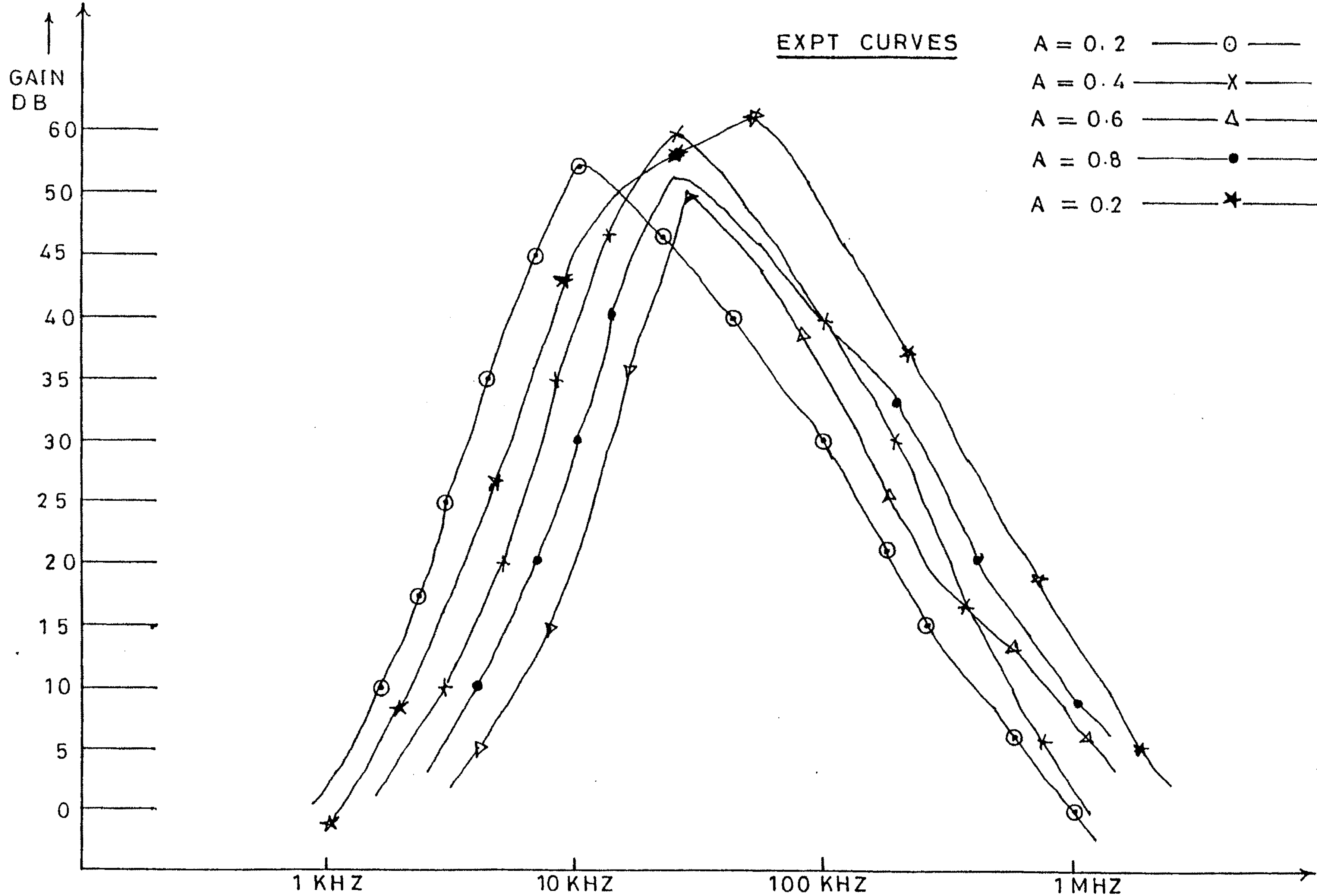
From the observations the following points are noted for various outputs.



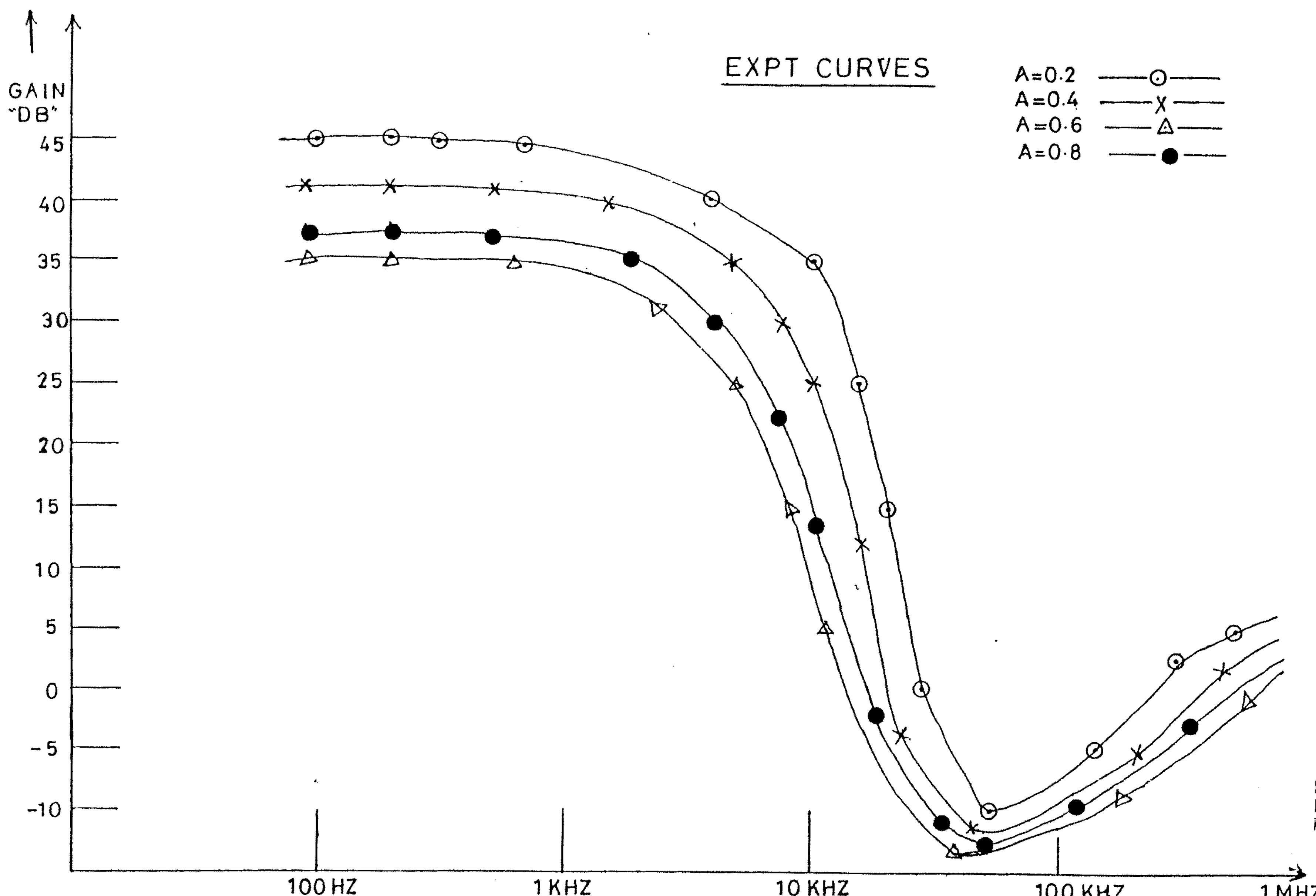
(FIG 6.1) LOW PASS RESPONSE FOR $F_o = 10$ KHZ, $Q = 1$. AND VARIATION OF 'A'



(Fig 6.2) HIGH PASS RESPONSE FOR F_o 10KHZ & VARIOUS 'A'



(Fig 6.3) BAND PASS RESPONSE FOR FO10KHZ AND VARIOUS 'A'



(• Fig 6·4) BAND STOP RESPONSE FOR Fo 10 KHZ & VARIOUS A

A) **LOW PASS RESPONSE :-**

The Low Pass response is shown in fig. (6.1). A theorotical curve is also included for A = 0.2. The agreement between theorotical and observed curve is satisfactory.

The theorotical curve shows slight peaking at 20 KHz. A departure is also observed between theorotical curve and observed results, above 100 KHz. This may be due to the lower gain of the operational amplifier in the high frequency region. It is also noticed that As 'A' increases the gain decreases slightly (from 80 dB to 64 dB). As 'A' increases from 0.2 to 0.8 also cut off frequency decreases with increasing value of 'A'.

For small values the response is quiet satisfactory.

B) **HIGH PASS RESPONSE :-**

The high pass response is shown in fig.(6.2) along with theorotical curve.

It is noticed that the graphs merge together above 50 KHz. A theorotical curve shows a peak at 20 KHz. The cut-off value is slightly lower as compared to design value F_o = 10 KHz. The variation of tapping point (A) has a small effect below the cut-off frequency but almost no effect in the passband. There is a departure between the theorotical curve and observed response below the cut-off frequency. It is noticed that, there is a great departure in cut-off frequency, for small values of 'A'. This may due to the higher gain of operational amplifier in the low frequency region.

C) **BAND PASS RESPONSE :-**

The Band Pass response is shown in fig.(6.3). The band pass response is similar to the response of a resonant circuit with low 'Q' values.

It is noted that the observed curve shown a peak at design value of F_o = 10 KHz.

The general nature of response indicates moderate agreement between theorotical and observed results. On low frequency side there is a slight departure.

Again it is noticed that the variation of 'A' has very little effect on the performance.

D) **BAND STOP RESPONSE :-**

The band stop response is shown in fig.(6.4). From the graph it is found that all the curves are identical showing there is slight variation with respect to the tapping point parameter (A). There is no correlation between design and observed value of F_o. The curves are similar to low pass response except the pronouned deep at about 80 KHz. The performance is not very satisfactory in this case.

6.4 CONCLUSION :-

The circuit response was studied over the entire range for different values of 'A'. It is noticed that the variation of 'A' has small effect on the response. The behaviour of circuit is satisfactory for L.P. H.P. and B.P. actions.

However, the band stop response is poor. The theorotical curve shows a peak at the frequency near about F_o. The departure at low and high frequencies might be due to high and low gains of the operational amplifiers in these regions.

F_o	Q	Tapping Point	Designed Values				Experimental Values			
KHz		A	AR_3	$(1-A) R_3$	R_2	R_1	AR_3	$(1-A) R_3$	R_2	R_1
10	1	0.2	4 K	16 K	16.00 K	100 Ω	4.0K	16.0K	16.00 K	100 Ω
10	1	0.4	8 K	12 K	16.50 K	100 Ω	8 K	12 K	16.50 K	100 Ω
10	1	0.6	12 K	8 K	16.75 K	100 Ω	12.0 K	8.0K	16.75 K	100 Ω
10	1	0.8	16 K	4 K	17K	100 Ω	16 K	4 K	17.00 K	100 Ω

Table (6.1) The Designed and Experimental Values of Resistances of a New bi-quadratic filter.