APPENDIX

APPENDIX - I

CALCULATION OF Q

The experimental value of quality factor Q can be obtained by using the observed values of gain for low pass, high pass and band pass response[1].

The second order tranfer function for low pass ,band pass and high pass filter are given by

$$H_{LP}(S)=\frac{G_{LP}.W_0^2}{S^2+(W_0/Q)S+W_0^2} \quad ....(1.A)$$

$$H_{BP}(S)=\frac{G_{BP}(W_0/Q).S}{S^2+(W_0/Q)S+W_0^2} \quad ....(1.B)$$

$$H_{HP}(S)=\frac{G_{HP}.S^2}{S^2+(W_0/Q)S+W_0^2} \quad ....(1.C)$$

Analysis of a new active -R biquadratic filter circuit given in section (3.3) of fig.(3.1) yields.

$$H_{LP}(S)=\frac{-(1/R_3)GB_1GB_2}{S^2[1/R_A+1/R_2+1/R_3]+S[GB_1(1/R_2+2/(4R+R_1))-GB_2(2/R_1-1/R_A)]+GB_1GB_2(2/R_1-1/R_A)}$$

........(2.A)

$$H_{HP}(S)=\frac{(1/R_3)S^2}{S^2[1/R_A+1/R_2+1/R_3]+S[GB_1(1/R_2+2/(4R+R_1))-GB_2(2/R_1-1/R_A)]+GB_1GB_2(2/R_1-1/R_A)}$$

.......(2.B)

$$H_{BP}(S)=\frac{-(1/R_3)S}{S^2[1/R_A+1/R_2+1/R_3)+S[GB_1(1/R_2+2/(4R+R_1)-GB_2(2/R_1-1/R_A)]+GB_1GB_2(2/R_1-1/R_A)}$$

......(2.C)

Comparing numerator equancy (1) & (2),we have

$$G_{LP}.W_o^2 = (1/R_3).GB_1GB_2 \quad \text{........(3.A)}$$

$$G_{HP} = (1/R_3) \quad \text{........(3.B)}$$

$$G_{BP}(W_o/Q) = (1/R_3).GB_1 \quad \text{........(3.C)}$$

By comparing denominator of equancy (2) with equancy (1)

$$(W_o/Q) = GB_1[1/R_2+2/(4R+R_1)]-GB_2(2/R_1-1/R_A)$$

..........(4)

$$W_o^2 = GB_1.GB_2(2/R_2-1/R_A) \quad \text{..........(5)}$$

$$1 = 1/R_A + 1/R_2 + 1/R_3 \quad \text{..........(6)}$$

where $$\frac{1}{R_A} = \frac{2}{R_1} - \frac{4R}{4R\,R_1 + R_1^2}$$

Putting values of (4),(5),(6) in (3.A),(3.B),(3.C)

$$G_{BP} = \frac{1}{R_3[1/R_2+2/(4R+R_1) - 4R/(4RR_1^2+R_1)]} \qquad \text{..........(7)}$$

$$G_{LP} = \frac{4RR_1+R_1^2}{4RR_3} \qquad \text{.........(8)}$$

$$G_{HP} = (1/R_3) \qquad \text{........(9)}$$

From equation (5)

$$W_o^2 = GB_1.GB_2\left(\frac{4R}{4RR_1+R_1^2}\right)$$

Putting the vaule of W_o from equation (4) in this equation

we get

$$Q_{TH}^2 = \left(\frac{4R}{4RR_1+R_1}\right)\left[\frac{1}{\left(\frac{1}{R_2} + \frac{2}{4RR_1} - \frac{4R}{4RR_1+R_1^2}\right)^2}\right] \qquad \text{..........(10)}$$

Putting vatues from equation (7),(8),(9) in equation (10)

$$Q^2_{EXP.} = \frac{G^2_{BP}}{G_{HP}.G_{LP}} \qquad ....(11)$$

Where TH for theoretical and EXP. for experimental.This equation is used to calculate the value of Q for the bandpass response ;where R_1 is at center tapped.

For the variation of the center tap ,

$$Q^2_{DE} =$$

$$= \frac{R}{R_1[(1-A)AR_1+R]} \cdot \frac{1}{[\frac{1}{R_2} + \frac{A}{(1-A)AR_1+R} - \frac{R}{R_1[(1-A)AR_1+R]^2}]^2}$$

$$...... \quad (12)$$

$$Q^2_{EXP.} = \frac{G^2_{BP}}{G_{LP}\ G_{HP}} \qquad .... (13)$$

REFERENCE

1. **MOHAN** N. and **PATIL** R.L. " An analytical method for determining the Q - Values of an tate - variable active-R filter", Journal of instrumentation society of India, VOL. - 176, (1987) 306 - 312.

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10  REM                APPENDIX    II
20 PRINT
30 PRINT
40 PRINT
45  CLS:KEY OFF
50 PRINT
70  INPUT "INPUT THE DESIGN VALUE OF FO ";FO
80  INPUT " INPUT THE VALUE OF R ";R
90  INPUT " INPUT THE DESIGN VALUE OF Q ";Q
100   PRINT
110   PRINT  TAB(22); "Q=";Q,: PRINT TAB(46);"Fo=";FO,
120  GB=7.9*44*100000!    /7
130  F1=GB*GB*49*4*R/(44*44*FO*FO)
140 R1= (-2*R+SQR(4*R*R+F1))
150 RA=R1/2+(R1*R)/(R1+2*R)
160 I1=R1*(R1+4*R)  :  I2=2*(R1-2*R)
170 R2= 1/((44*FO)/(GB*7*Q)-I2/I1)
180 'R2=(1/((44*FO)/(GB*7*Q)-R1/(RA*(R1+2*R))))
190 R3=1/(1-1/(RA)-1/(R2))
200 R=R*100
210 R1=INT(100*R1): R2=INT(100*R2) :R3=INT(100*R3):RA=INT(100*RA)
220  PRINT TAB(65);"R=";R
230  PRINT
240  PRINT TAB(22 );"R1=";R1,
250  PRINT TAB(46);"R2=";R2,
260  PRINT TAB(65);"R3=";R3
270  PRINT
280  PRINT
290  PRINT TAB(3);"FREQUENCY",
300  PRINT TAB(22);"LOW PASS",
310  PRINT TAB(46);"HIGH PASS",
320  PRINT  TAB(65);" BAND PASS"
330  PRINT
340 R3=R3/100
350 L=1
360 FOR  M= 1 TO 4
370 FOR  N=1 TO 9
380 F=100*N*L
390  PRINT TAB(1 );F,
400 D1=(44*FO/7)^2 : D2 =(44*F/  )^2
410 D=SQR((D1-D2)^2+(D1*D2)/(Q*Q))
420 'PRINT
430 T1= (GB*GB)/(R3*D) :T1= ((20*LOG(T1))/2.303): PRINT TAB(24);T1,
440 T2=D2/(R3*D):T2=(20*LOG(T2))/2.303 : PRINT TAB(46);T2,
450 T3= (44*F*GB)/(7*D*R3):T3=-((20*LOG(T3))/2.303): PRINT TAB(65);T3,
460 NEXT N
470 L=10*L
480 NEXT M
490 END
```

APPENDIX - 3

TABLE -1

Resistance values of new active -R filter circuits for different value of Q

F_0 kHz	A	Q	Designed value in Ω			Experimental Value in Ω		
			R_1	R_2	R_3	R_1	R_2	R_3
10	0.5	0.2	20 k	1.8k	106	20k	1.6k	99.3
10	0.5	0.5	20 k	6.2k	102.	20k	6.2k	99.3
10	0.5	1.0	20 k	30 k	101	20k	29k	99.3

TABLE-2

Resistance values of new active -R filter circuits with variation of center frequency F_o

F_0 kHz	A	Q	Desined value in Ω			Experimental value in Ω		
			R_1	R_2	R_3	R_1	R_2	R_3
10	0.5	1	20k	30.1k	101.3	20.1k	29.6k	99.3
50	0.5	1	3.7k	4.35k	107.7	3.59k	4.29k	109
100	0.5	1	1.7k	1.62k	119.2	1.67k	1.61k	118

TABLE-3

Resistance value of new active -R filter circuits for variation of tapping point.

A	F_0 KHz	Q	Designed values in Ω				Expt.values in Ω			
			AR_1	$(1-A).R_1$	R_2	R_3	AR_1	$(1-A).R_1$	R_2	R_3
0.1	10	0.2	2K	18K	1.8K	106.8	2.18K	17.7K	1.61K	99.3
0.3	10	0.2	6K	14K	1.8K	106.8	6.2K	14.1K	1.61K	99.3
0.5	10	0.2	10K	10K	1.8K	106.8	9.91K	10.2K	1.61K	99.3
0.7	10	0.2	14K	6K	1.8K	106.8	14.1K	6.2K	1.61K	99.3
0.9	10	0.2	18K	2K	1.8K	106.8	17.7K	2.1K	1.61K	99.3