EE230: Lab 7 (Offline)
Special Opamp Linear Circuits - Active Filters

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1 Overview of the experiment

1.1 Aim of the experiment

To assemble sallen key active high pass and active low pass filters and also active bandpass filter. To also study their frequency response and determine their parameters.
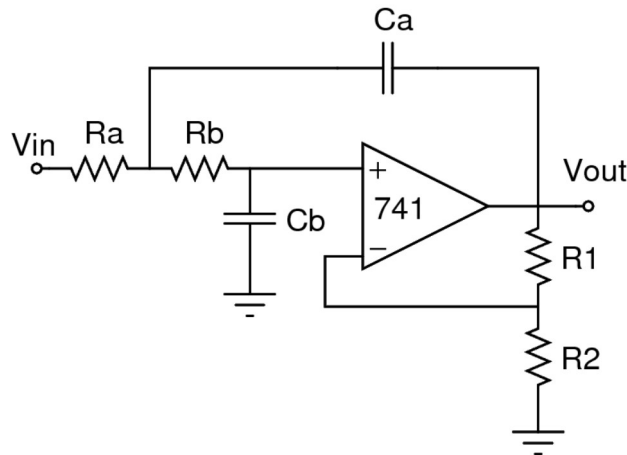
1.2 Circuit Diagrams
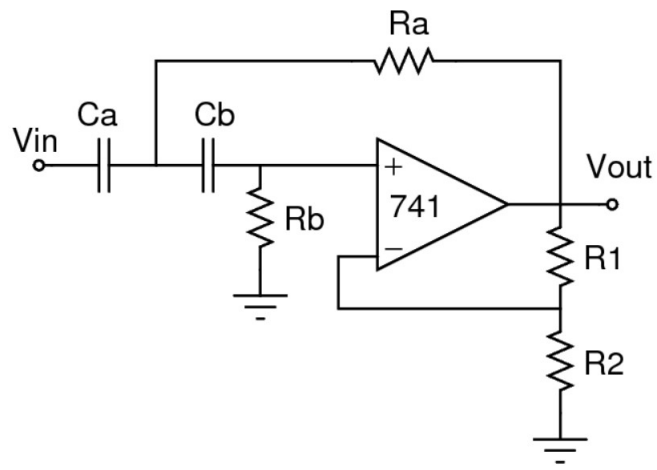

Fig 1: Active Lowpass Filter
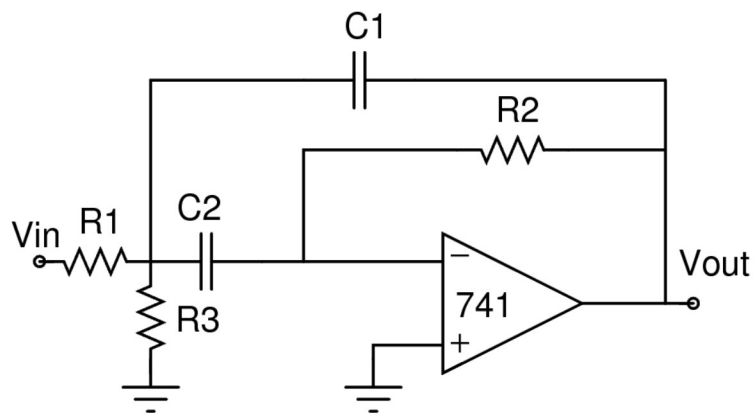
Fig 2: Active Highpass Filter

Fig 3: Multiple Feedback Active Bandpass Filter

2 Experimental Results

2.1 Readings Obtained

2.1.1 Active Lowpass Filter

Frequency(Hz)	O/P Maximum(mV)	O/P Minimum(mV)	O/P Peak to Peak(mV)
50	504	-504	1008
100	520	-520	1040
150	536	-528	1064
200	544	-544	1088
250	552	-544	1096
300	544	-536	1080
310	544	-536	1080
320	536	-528	1064
330	528	-528	1056
335	528	-520	1048
340	528	-520	1048
350	520	-520	1040
360	512	-512	1024
370	512	-504	1016
380	504	-496	1000
390	496	-496	992
400	488	-488	976
500	416	-408	824
600	352	-344	696
700	304	-296	600
900	224	-224	448
1000	200	-200	400
1250	160	-160	320
1500	132	-132	264
1750	112	-112	224
2000	100	-100	200
3000	68	-64	132
5000	44	-40	84
10000	24	-24	48

2.1.2 Active Highpass Filter

Frequency(Hz)	O/P Maximum(mV)	O/P Minimum(mV)	O/P Peak to Peak(mV)
50	16	-16	32
100	56	-56	112
150	112	-112	224
200	184	-184	368
250	272	-264	536
300	352	-344	696
310	368	-360	728
320	384	-376	760
330	400	-392	792
335	408	-400	808
340	416	-408	824
350	424	-424	848
360	440	-440	880
370	456	-448	904
380	464	-464	928
390	480	-472	952
400	488	-488	976
500	584	-584	1168
600	640	-640	1280
700	672	-672	1344
900	712	-712	1424
1000	720	-712	1432
1250	736	-728	1464
1500	744	-736	1480
1750	744	-744	1488
2000	752	-744	1496
3000	780	-780	1560
5000	780	-780	1560
10000	780	-780	1560

2.1.3   Active Bandpass Filter

Frequency(Hz)	O/P Maximum(mV)	O/P Minimum(mV)	O/P Peak to Peak(mV)
50	40	-40	80
100	40	-60	100
150	60	-60	120
200	80	-80	160
250	90	-90	180
300	120	-120	240
310	128	-128	256
320	136	-136	272
330	140	-140	280
350	160	-160	320
400	212	-212	424
450	296	-296	592
500	424	-424	848
525	504	-504	1008
550	568	-568	1136
575	584	-584	1168
580	576	-576	1152
600	544	-544	1088
610	528	-528	1056
650	424	-424	848
700	336	-336	672
900	172	-168	340
1000	140	-140	280
1250	100	-100	200
1500	76	-76	152
1750	64	-64	128
2000	54	-54	108
3000	36	-36	72
5000	24	-24	48
10000	14	-14	28

2.2 Values of Resistances taken with Tolerances

These were the values taken for the highpass and lowpass filter $R_1 = 1.79\text{k}(1.8\text{k})$, $R_2 = 3.2\text{k}(3.3\text{k})$, $R_A = 4.64\text{k}(4.7\text{k})$, $R_B = 4.59\text{k}(4.7\text{k})$. For the bandpass filter $R_1{=}66.6\text{k}(68\text{k})$, $R_2{=}182\text{k}(180\text{k})$, $R_3 = 2.66\text{k}(2.7\text{k})$

2.3 Theoretical Values

Theoretical Cutoff Frequency - Lowpass Filter $= \frac{1}{2\pi RC} = 338.627$ Hz
Theoretical Cutoff Frequency - Highpass Filter $= \frac{1}{2\pi RC} = 338.627$ Hz

Theoretical Center Frequency - Bandpass $= \frac{1}{2\pi C} \cdot \sqrt{\frac{R_1 + R_3}{R_1 R_2 R_3}} = 736.13$ Hz

Theoretical Bandwidth - Bandpass Filter $= \frac{1}{\pi C R_2} = 176.83$Hz

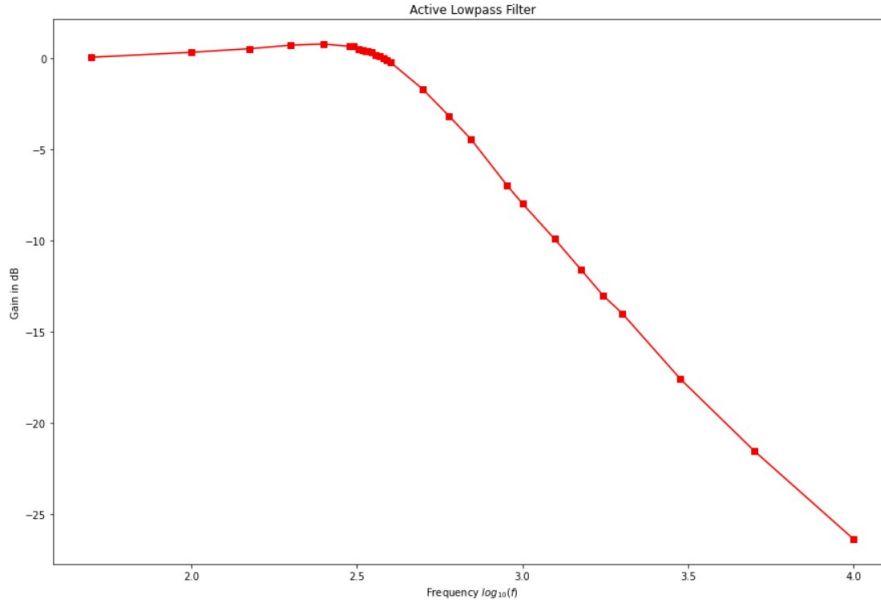## 2.4 Plots obtained for the Readings using Python
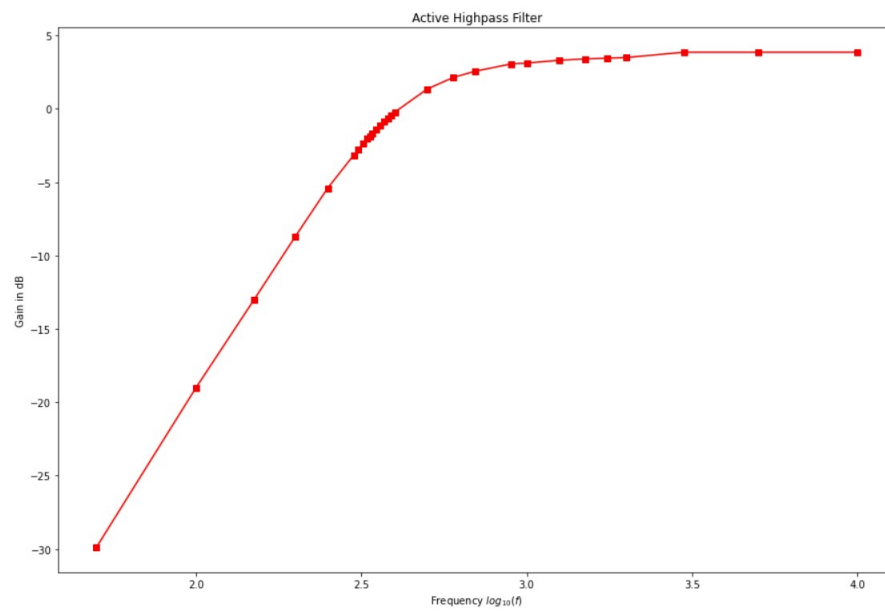

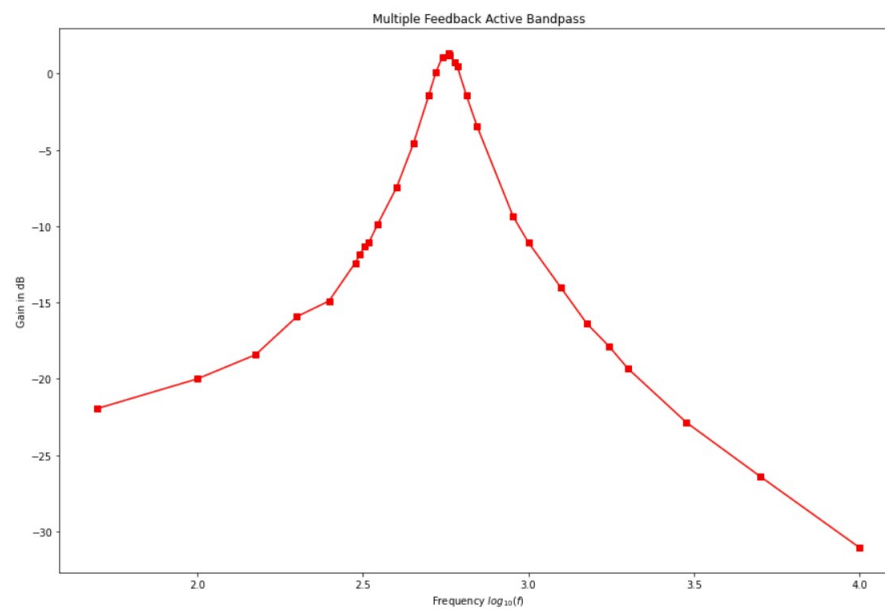
Fig 4: Bode Plot - Lowpass

Fig 5: Bode Plot - Highpass

Fig 6: Bode Plot - Bandpass

2.5   Experimental Values

Obtained by approximate interpolating from above tabular columns and bodeplots

2.5.1   Lowpass Filter

-3dB V_{p-p} = DC gain/1.414 $\approx \frac{1096}{1.414}$ = 775.1 mV which corresponds to an approx frequency of 550Hz from the table
Cutoff Frequency $= \approx$ 550Hz

2.5.2   Highpass Filter

-3dB V_{p-p} = DC gain/1.414 $\approx \frac{1560}{1.414}$ = 1103 mV which corresponds to an approx frequency of 550Hz from the table
Cutoff Frequency $= \approx$ 550Hz

2.5.3   Bandpass Filter

From the table we see maximum V_{p-p} = 1168mV for a frequency of 575Hz
Center Frequency $= \approx$ 575Hz
Bandwidth $= \approx 150 Hz$
[650Hz (upper +3dB freq corresponding to 1168/1.414 $\approx$ 826mV) - 500Hz (lower -3dB freq corresponding to 1168/1.414 $\approx$ 826mV)]

2.6   Comparision of Experimental and Theoretical Values

We observe that the theoretical and experimental values are nearly similar and of the same order, there is discrepancy in the values because of the tolerance values of the actual resistors used and other experimental errors. The experimental plots obtained resemble the behaviour of highpass, lowpass and bandpass filters.