EE 437 HARDWARE PROJECT II

PART 1: 4^{TH} ORDER BUTTERWORTH LOW PASS FILTER

MELTEM DOGANER
ÖMER RAGIP ÖZKAN

4^{th} Order Butterworth Low Pass Filter:

Cascaded Design

The filter asked for to design was a low pass filter with f_c=2 kHz. In the look up table this line below is shown.

F_{01}	Q_1	F_{02}	Q_2
1	0.541	1	1.306

$F_0=f_{0\,(table)}$ x f_c

So F_{01}=1 x 2=2 kHz

F_{02}=1 x 2=2 kHz

It was known that to avoid loss of dynamic range and filter accuracy due to possible signal clipping in the high Q sections, the sections are cascaded in order of ascending Q's. In this design two unity gain Sallen-Key sections are used.

Design Procedures:

i) For Q_1 = 0.541

1) C is chosen **10nF**,

2) $4Q^2 = 4 \times (0.541)^2 = 1.171$ let n=2.2 so nC=**22nF**

3) $k = \frac{n}{2Q^2} - 1 = 2.758$

$m = k + \sqrt{(k^2 - 1)} = 5.328$

4) $R = \frac{1}{\sqrt{(mn)}.2p.f_0.C} = 2324\ \Omega$ for a 1% value it is chosen **2,32 k**W**,**

mR is also chosen as 5.328 x 2324 = 12382 Ω for a 1% value it is chosen mR = **12.4 k**W

ii) For Q_2 = 1.306

1) C is chosen **10nF**,

2) $4Q^2 = 4 \times (1.306)^2 = 6.822$ let n = 10 so nC = **100nF**

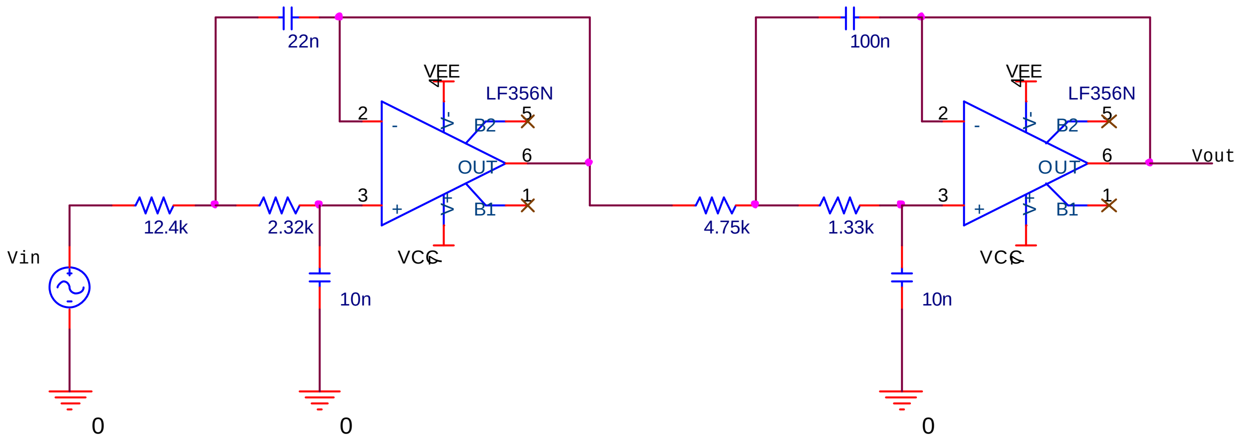
3) k = $\frac{n}{2Q^2}$ -1 = 1.931

m = k+ $\sqrt{(k^2 - 1)}$ = 3.583

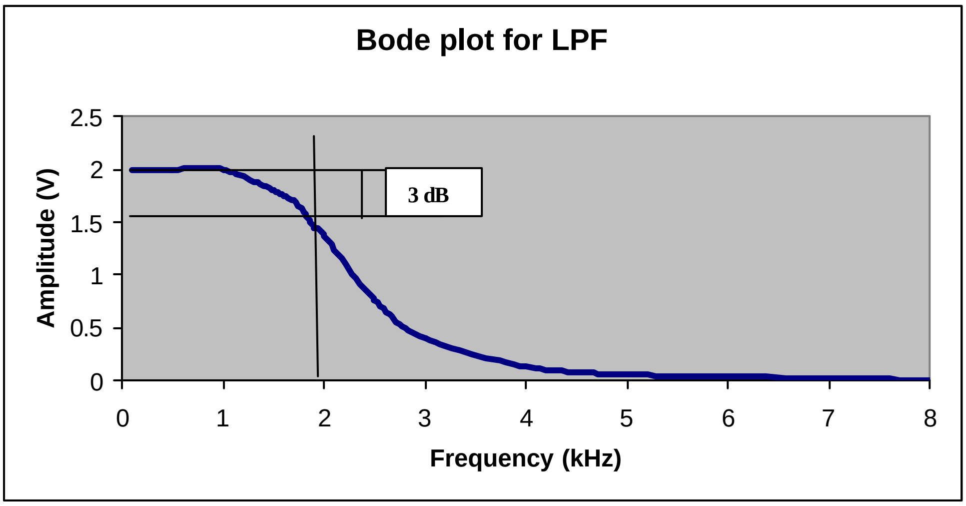
4) R = $\frac{1}{\sqrt{(mn)}.2p.f_0.C}$ = 1329 Ω for a 1% value it is chosen **1.33 k**W

mR is also chosen as 3.583 x 1329 = 4762 Ω for a 1% value it is chosen

mR = **4.75 k**W



According to design values and circuit diagram above the bode plot below is obtained.



1.97 kHz was measured as the cut off frequency point for our low pass filter design.

EE 437 HARDWARE PROJECT
II

PART 2: 3^{rd} ORDER CHEBYSHEV HIGH PASS FILTER

MELTEM DOGANER
ÖMER RAGIP ÖZKAN

3rd Order Chebyshev (1.0 dB Ripple) High Pass Filter

Direct Design

The filter asked for to design was a high pass filter with f_c=1 kHz. In the look up table this line below is shown.

L_1	C_2	L_3
2.0236	0.9941	2.0236

In conversion we would like to obtain $C_{1(new)}$ = **10 nF**

$C_{1(new)} = \dfrac{1}{(k_z w_c L_{1(old)})}$ so $k_z = 7865$

$R_{new} = k_z/R_{old}$ for $R_{old} = 1\Omega$, $R_{new} = 7865\,\Omega$ In this design with 1% sensitivity **7.87 k**W is used.

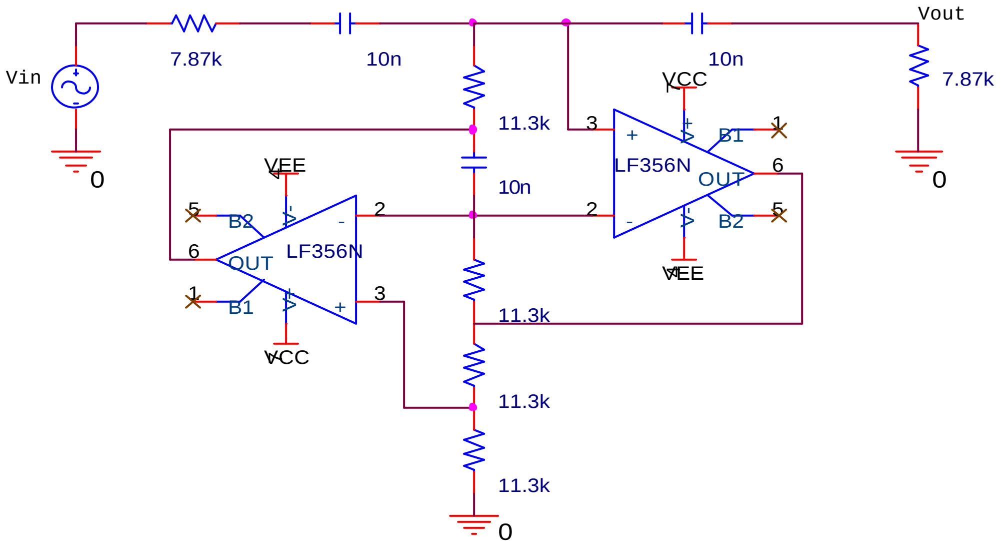
$C_{3(new)} = C_{1(new)}$ = **10 nF**

$L_{2(new)} = \dfrac{k_z}{w_c C_{2(old)}} = \dfrac{7865}{2p.1000.0{,}9941} = 1.2592H$

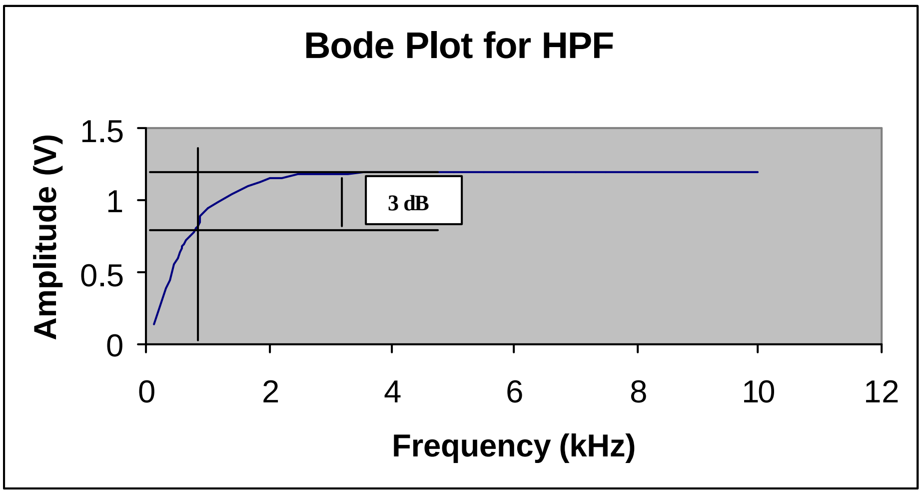
In order to find GIC realization of L;

C_2 = **10 nF** is chosen and all R values are assumed to be equal.

$L = R^2 \times C$ so $1.2592 = R^2 \times 10 \times 10^{-9}$ R is found to be 11221Ω. In this design with 1% sensitivity, it is used as **11.3 k**W



According to design values and circuit diagram above the bode plot below is obtained.



870 Hz was measured as the cut off frequency point for our high pass filter design.