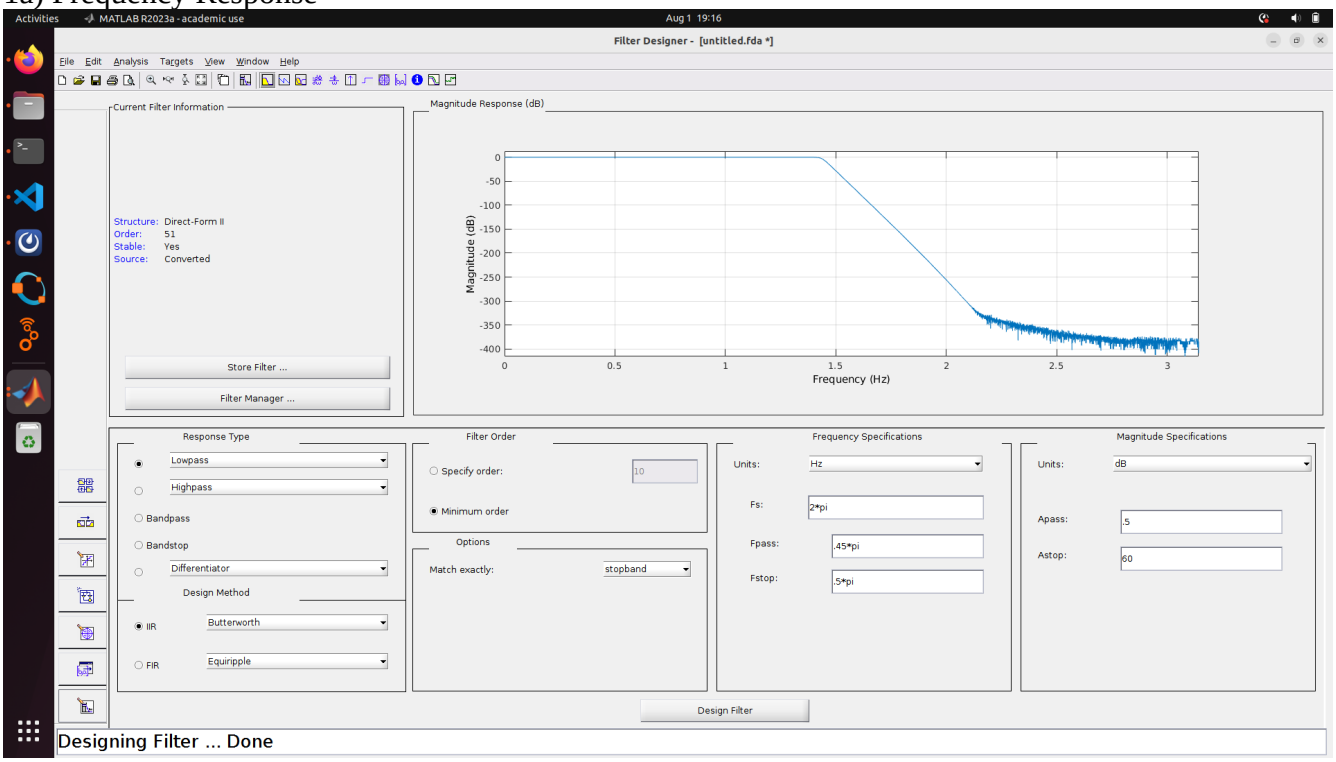
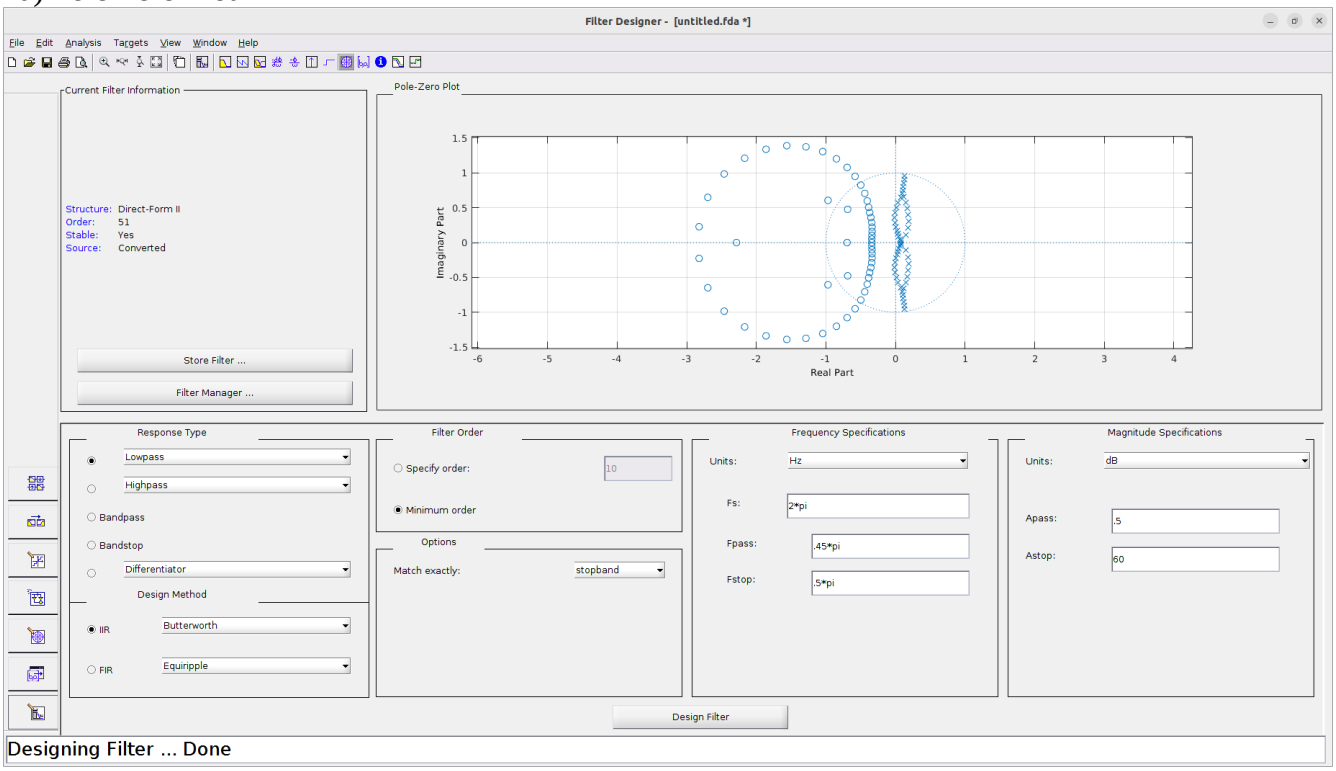
HW9

1a) Frequency Response



1a) Pole Zero Plot



1a) Coefficients

A)

1
-4.38354402101529
16.2748775393327
-41.8403663588703
93.7912232426107
-174.989163736413
292.334707955330
-431.248194548530
579.722637064334
-707.089513154840
795.122227136974
-823.403591449256
792.371034257115
-708.556178802205
591.989315020949
-462.249083991011
338.486350274588
-232.507342052900
150.139104289026
-91.1551620553554
52.1026417662570
-28.0358014668440
14.2111808774175
-6.78415461824185
3.05057724276259
-1.29140517661688
0.514541172360040
-0.192798557307813
0.0678914787002092
-0.0224419168495347
0.00695586061758425
-0.00201846823370359
0.000547486345998350
-0.000138524234325554
3.26228604560259e-05
-7.13191959861140e-06
1.44307788688431e-06
-2.69302715108016e-07
4.61652692453798e-08
-7.23510367756377e-09
1.03091002339916e-09
-1.32664741739260e-10
1.52966507080209e-11
-1.56496572922098e-12
1.40353181618839e-13
-1.08648778136344e-14
7.11346413699079e-16
-3.83056514367495e-17
1.62912143610840e-18

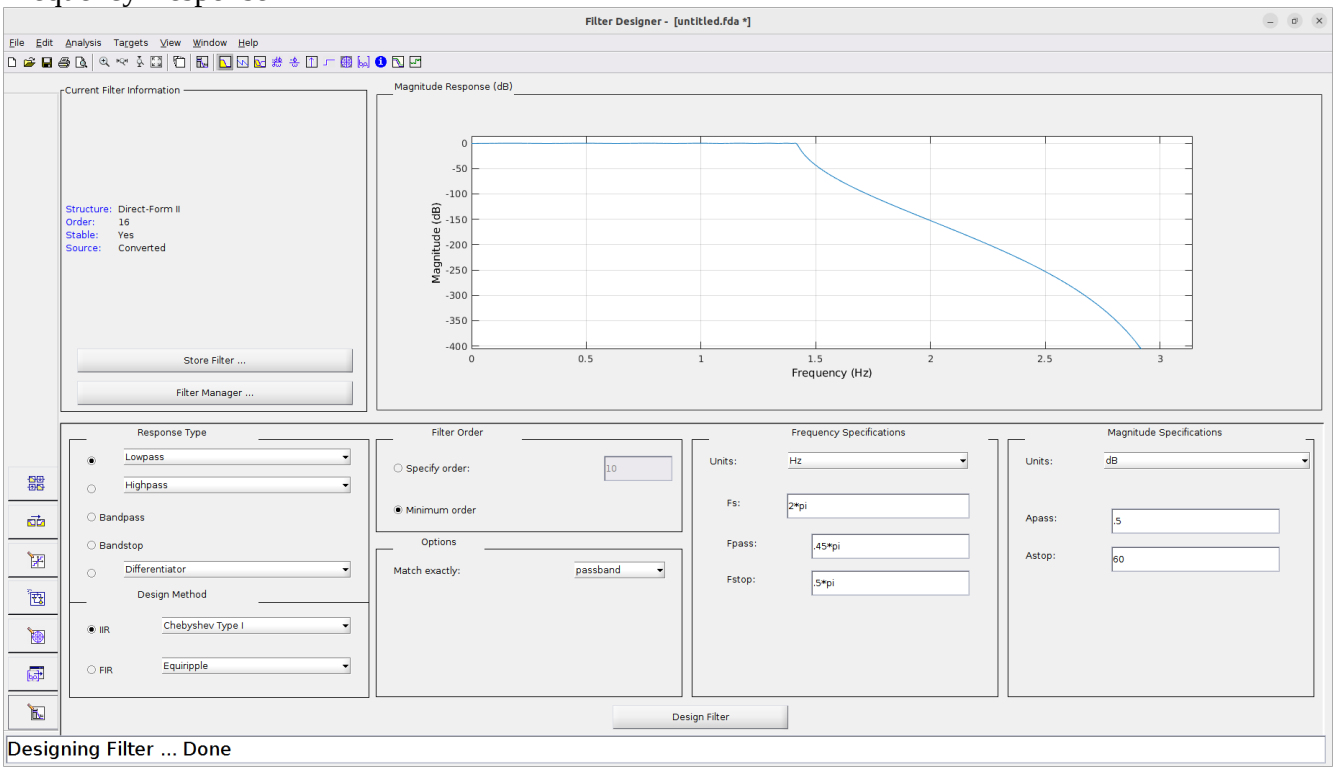
-5.13123598915643e-20
1.06418837087416e-21
-1.09017084901164e-23

B)
3.30177683885160e-15
1.68390618781432e-13
4.20976546953579e-12
6.87595026690845e-11
8.25114032029015e-10
7.75607190107274e-09
5.94632179082243e-08
3.82263543695728e-07
2.10244949032650e-06
1.00450364537822e-05
4.21891531058852e-05
0.000157250479758299
0.000524168265860997
0.00157250479758299
0.00426822730772527
0.0105282940257223
0.0236886615578752
0.0487707737956255
0.0921225727250703
0.160002363154069
0.256003781046511
0.377910343449612
0.515332286522198
0.649766796049728
0.758061262058016
0.818706163022657
0.818706163022657
0.758061262058016
0.649766796049728
0.515332286522198
0.377910343449612
0.256003781046511
0.160002363154069
0.0921225727250703
0.0487707737956255
0.0236886615578752
0.0105282940257223
0.00426822730772527
0.00157250479758299
0.000524168265860998
0.000157250479758299
4.21891531058852e-05
1.00450364537822e-05
2.10244949032650e-06

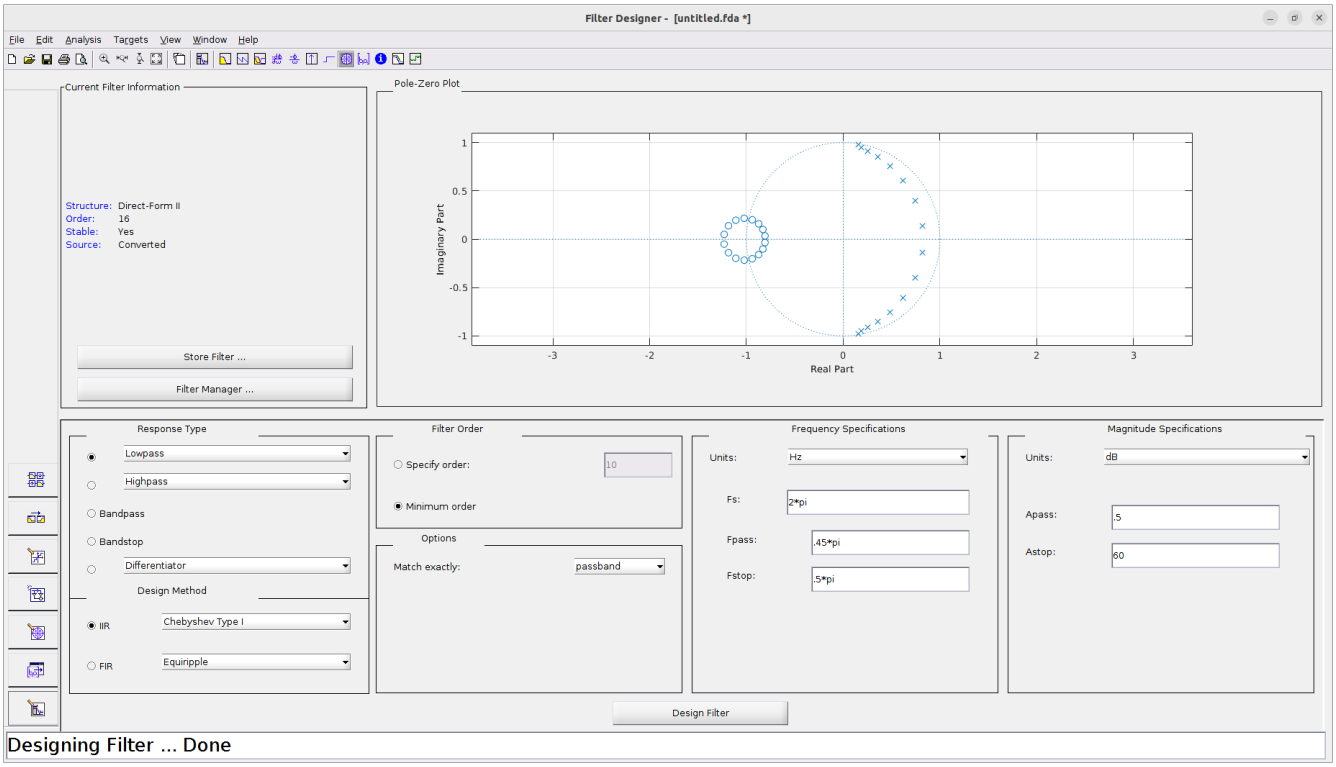
3.82263543695728e-07
5.94632179082243e-08
7.75607190107274e-09
8.25114032029015e-10
6.87595026690846e-11
4.20976546953579e-12
1.68390618781432e-13
3.30177683885160e-15

N = 52
Max atten = about -490dB

1b)
Frequency Response



Pole Zero



Coeffcients)

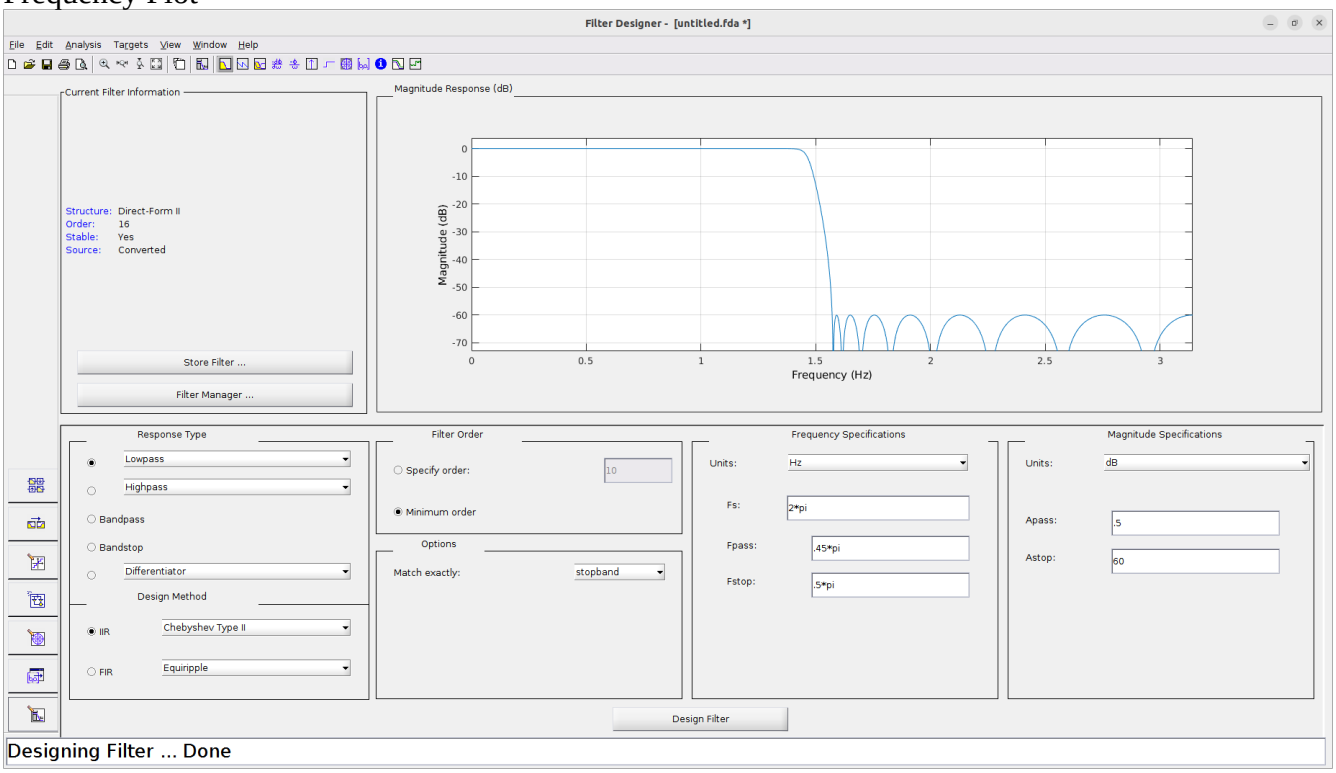
a =
1
-7.21683113670212
28.4751912229379
-78.2983795097531
165.091515606246
-280.055702092561
392.735696694519
-462.398457370582
460.680221921233
-389.117684840792
277.655578122458
-165.757720263415
81.3380306472637
-31.8342941245831
9.42836256384595
-1.90624657919808
0.201737346291808

b =
3.02772020186600e-07
4.84435232298560e-06
3.63326424223920e-05
0.000169552331304496
0.000551045076739612

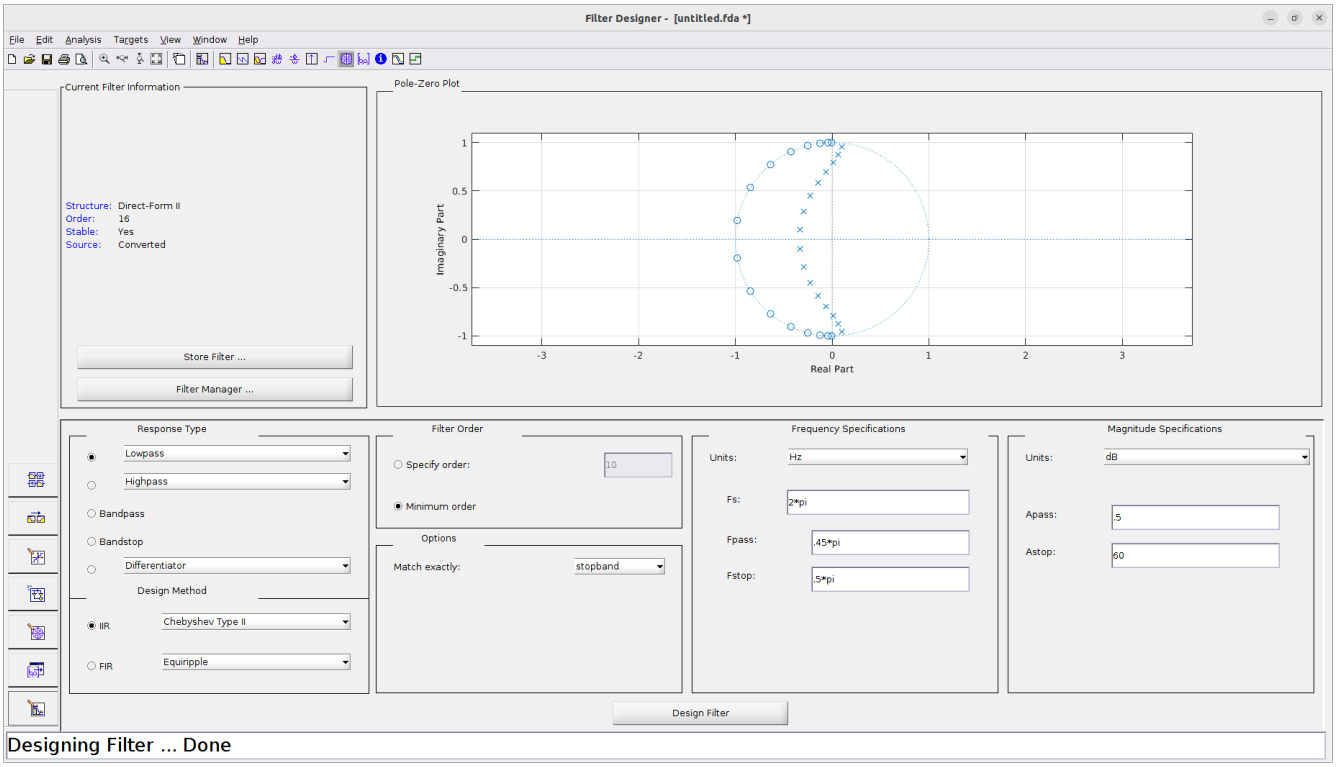
0.00132250818417507
0.00242459833765429
0.00346371191093470
0.00389667589980154
0.00346371191093470
0.00242459833765429
0.00132250818417507
0.000551045076739612
0.000169552331304496
3.63326424223920e-05
4.84435232298560e-06
3.02772020186600e-07

N = 16
Max atten = > 400dB

1c)
Frequency Plot



Pole Zero



Coefficients)

a =

1

1.79516200311509

4.74070862936952

6.61306880926972

9.43793601946769

10.1583240267863

10.0521282897678

8.33194722562959

6.12046270063151

3.86358728525964

2.11265838892548

0.981370779824759

0.381016488086449

0.119559888045919

0.0287375089803150

0.00476162604834957

0.000415515248895133

b =

0.0203841681634016

0.135094382575077

0.515210595001715

1.40477203595967

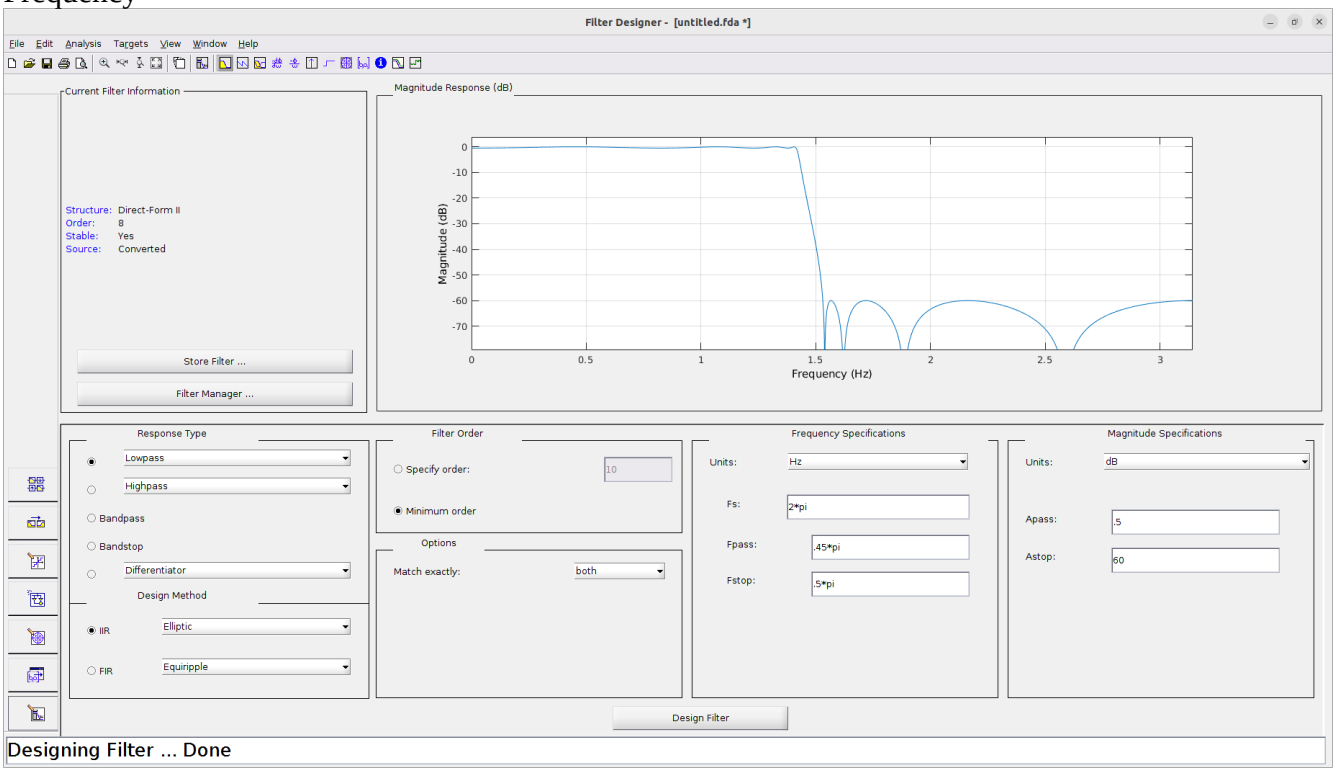
2.99897692939222

5.24308025402115

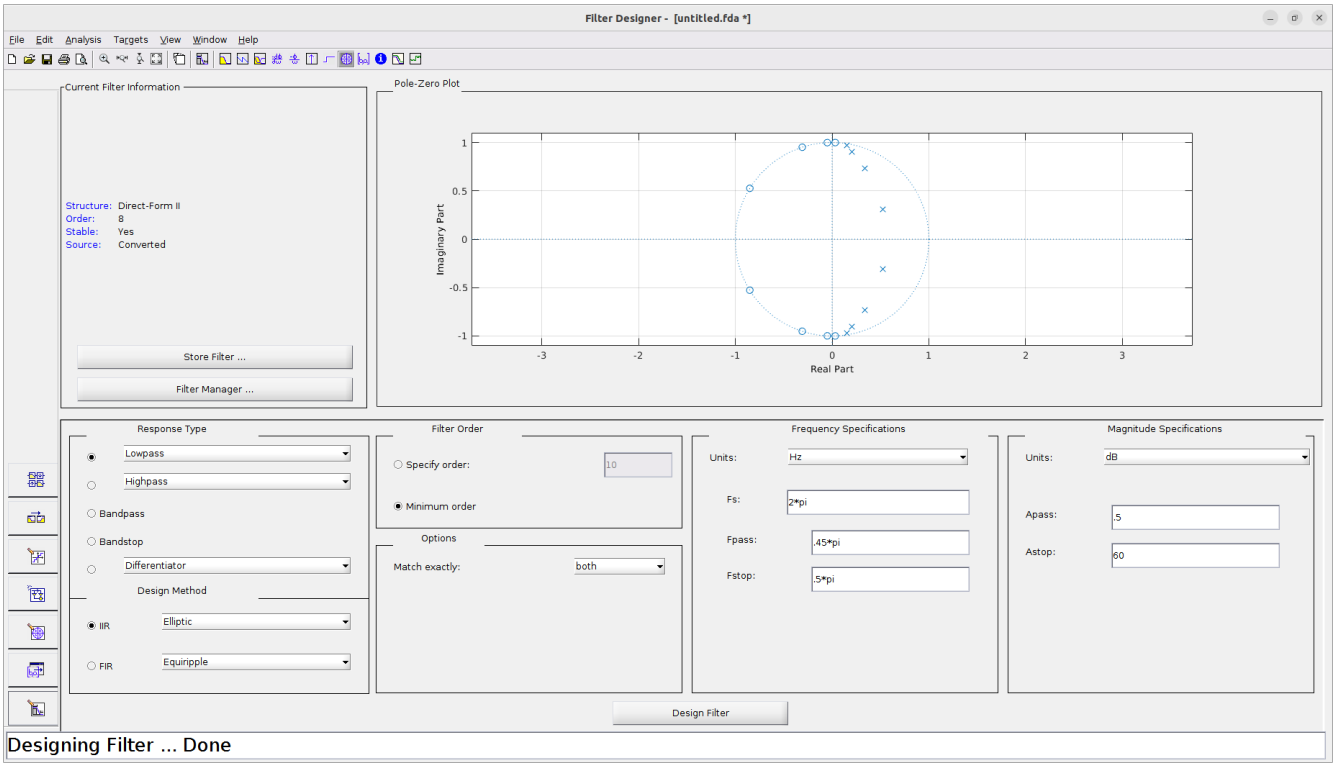
7.70276887903282
9.65201305308425
10.3972445899965
9.65201305308425
7.70276887903282
5.24308025402115
2.99897692939221
1.40477203595967
0.515210595001714
0.135094382575077
0.0203841681634016

N = 16
Max atten = ~125dB

1d)
Frequency



Pole Zero



Coefficients

a =
1
-2.44439331708647
4.91930535394772
-6.20736963487370
6.26349501563445
-4.58002587693542
2.53193851753678
-0.938819790166164
0.201569158298131

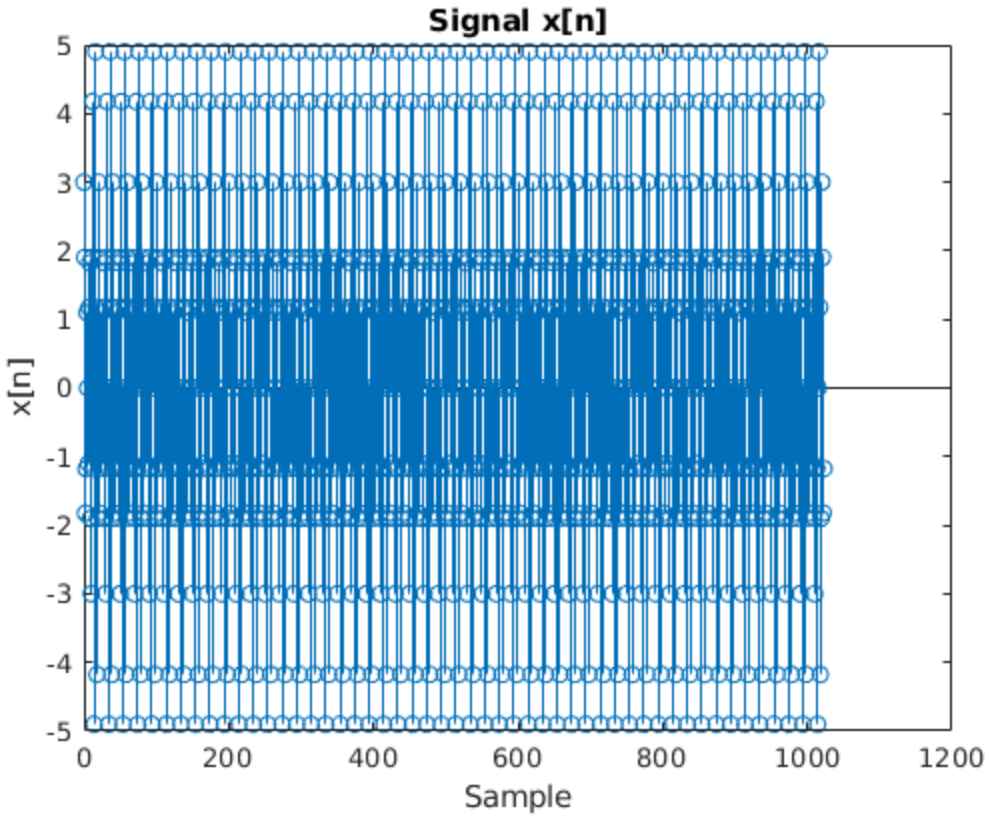
b =
0.0178858975695283
0.0420827878486086
0.0916641973137829
0.126641896456999
0.147436095513069
0.126641896456999
0.0916641973137829
0.0420827878486086
0.0178858975695283

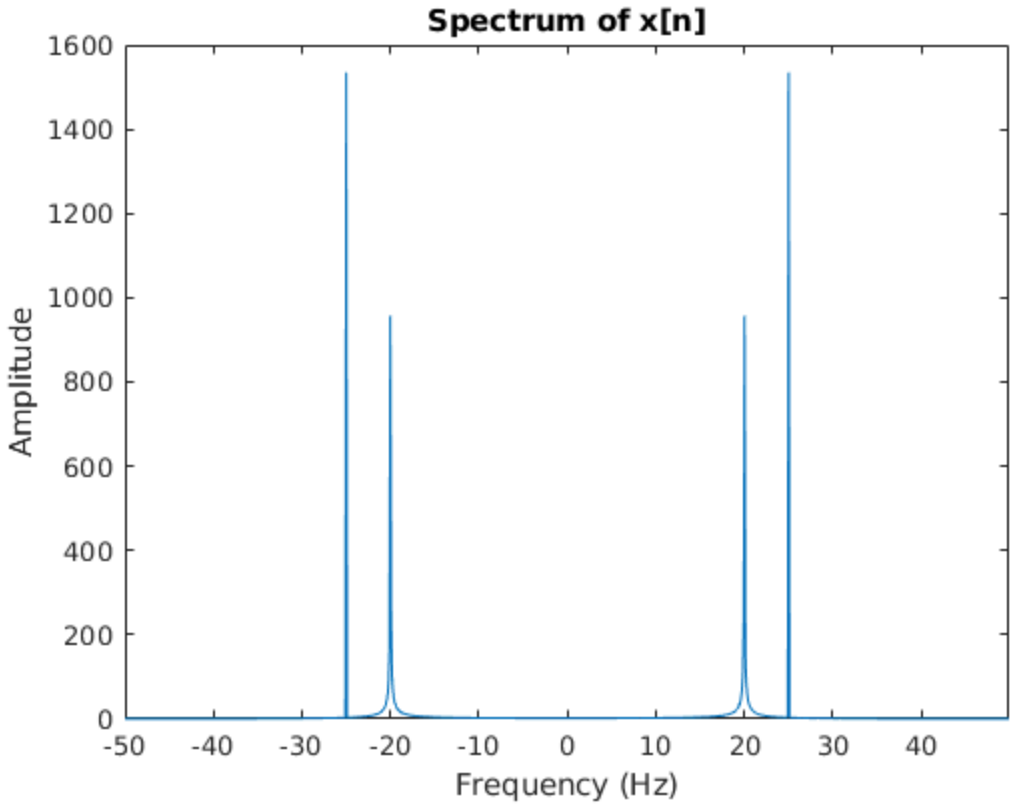
N = 8
Max atten = ~125dB

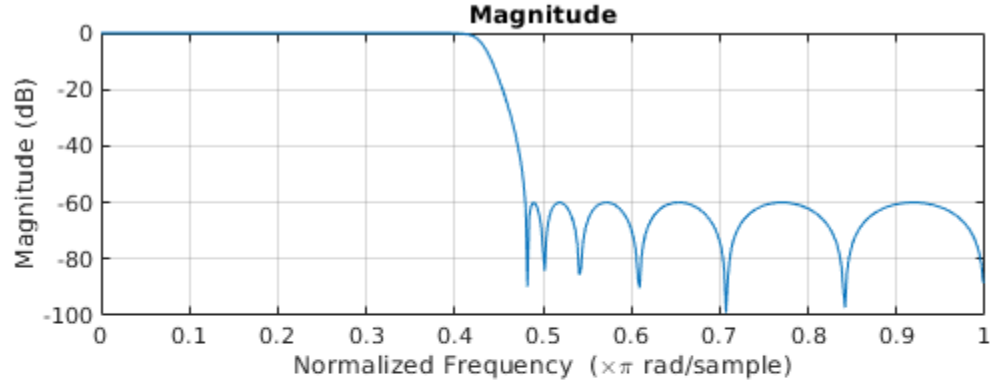
```
%!-------------------------------------------------------------------------
%! DSP HW9 #2
%!  - Create analog signal for x(t) = 2sin(pi20t) + 3cos(pi50t)
%!  - Design Filter with pa < 1dB, ps > 50dB. Filter out higher frequency
%!-------------------------------------------------------------------------

%! Enviorment
clc; clear;
N = 1024;
Fs = 100;
Ts = 1/Fs;
n = (0:N-1)*Ts;
f = ((0:N-1)-N/2)*Fs/N;
filt = load('hw9_2_filtercoef');

%! Signal
xn = 2*sin(40*pi*n) + 3*cos(50*pi*n);

%! Filter
yn = filter(filt.Num, filt.Den, xn);

% Plot
figure()
stem((0:N-1), xn)
title('Signal x[n]')
xlabel('Sample')
ylabel('x[n]')

figure()
plot(f, abs(fftshift(fft(xn))))
xlim([f(1), f(N)])
title('Spectrum of x[n]')
xlabel('Frequency (Hz)')
ylabel('Amplitude')

figure()
freqz(filt.Num, filt.Den)

figure()
stem((0:N/2-1), yn(1:N/2))
title('Signal y[n]')
xlabel('Samples')
ylabel('y[n]')

figure()
plot(f, abs(fftshift(fft(yn))))
xlim([f(1), f(N)])
title('Spectrum of y[n]')
xlabel('Frequency (Hz)')
ylabel('Amplitude')

disp(['The filter was able to reduce the second frequency almost' ...
```

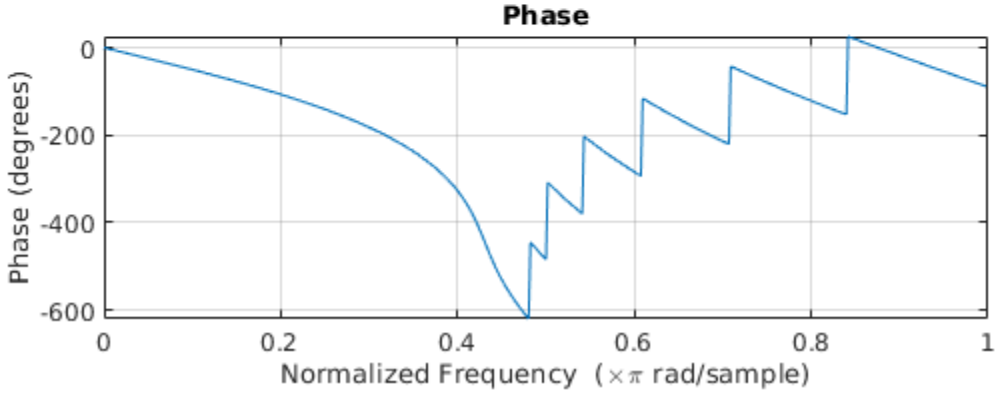
```
    ' completely but the first part of the signal was not perfect while'...
    ' the filter taps filled up'])
```

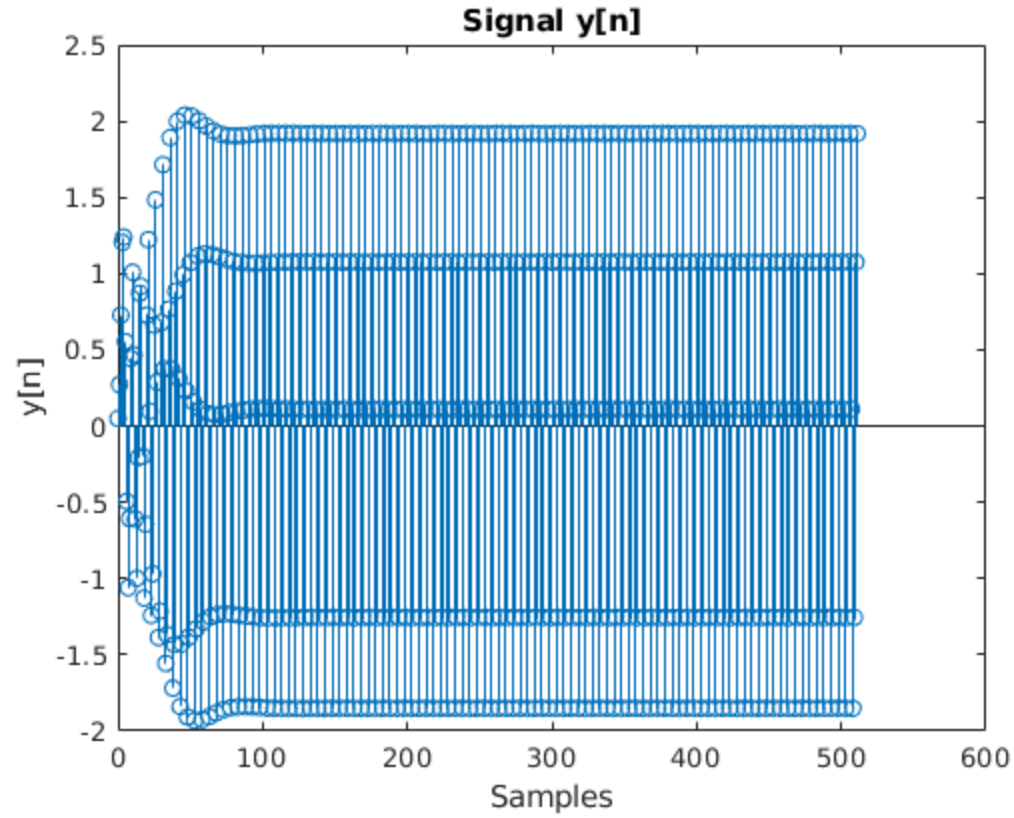
The filter was able to reduce the second frequency almost completely but the first part of the signal was not perfect while the filter taps filled up

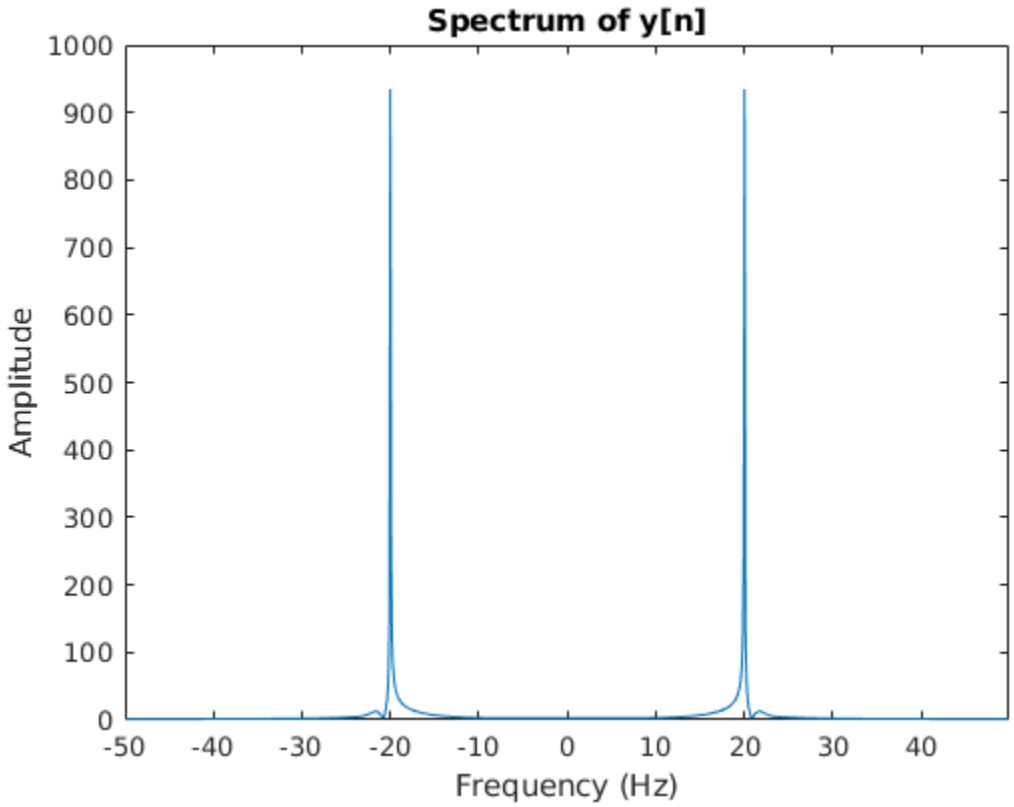



Spectrum of x[n]
Amplitude
Frequency (Hz)


Magnitude
Magnitude (dB)
Normalized Frequency (×π rad/sample)


Phase
Phase (degrees)
Normalized Frequency (×π rad/sample)


Signal y[n]
y[n]
Samples
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
0
100
200
300
400
500
600


Spectrum of y[n]
Amplitude
Frequency (Hz)
1000
900
800
700
600
500
400
300
200
100
0
-50
-40
-30
-20
-10
0
10
20
30
40

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