EE387 – SIGNAL PROCESSING

LAB 03 – SYSTEM FUNCTIONS AND FREQUENCY RESPONSE

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SEMESTER 06

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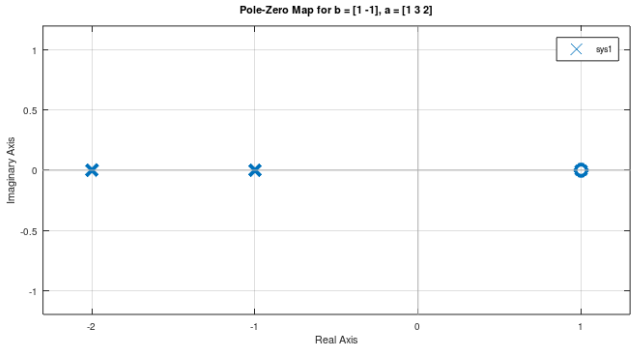
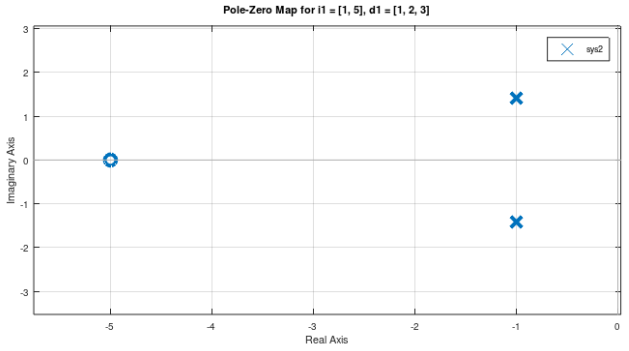
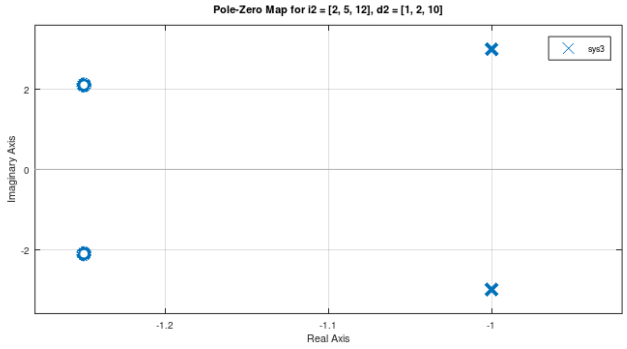
Part 1

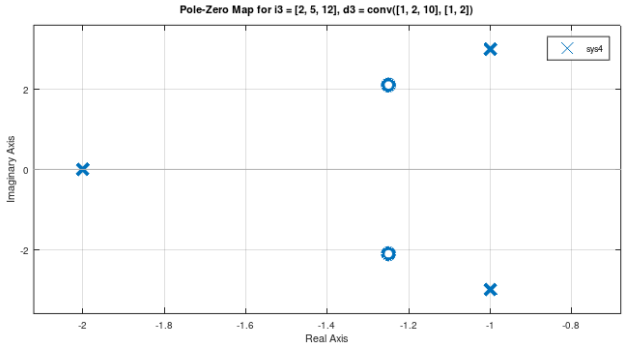
Exercise

```
% Clear workspace and close all figures
clear all;
close all;

% Load the control package
pkg load control;

% Plot 1: Create LTI model and Pole-zero map for the given b and a
subplot(2,2,1)
b = [1 -1]; % Numerator coefficients
a = [1 3 2]; % Denominator coefficients
sys1 = tf(b, a); % Create LTI model
pzmap(sys1); % Generates pole-zero diagram using LTI model
title('Pole-Zero Map for b = [1 -1], a = [1 3 2]');

% Plot 2: Create LTI model and Pole-zero map for i1 and d1
i1 = [1, 5];
d1 = [1, 2, 3];
sys2 = tf(i1, d1); % Create LTI model
subplot(2,2,2);
pzmap(sys2);
title('Pole-Zero Map for i1 = [1, 5], d1 = [1, 2, 3]');

% Plot 3: Create LTI model and Pole-zero map for i2 and d2
i2 = [2, 5, 12];
d2 = [1, 2, 10];
sys3 = tf(i2, d2); % Create LTI model
subplot(2,2,3);
pzmap(sys3);
title('Pole-Zero Map for i2 = [2, 5, 12], d2 = [1, 2, 10]');

% Plot 4: Create LTI model and Pole-zero map for i3 and d3
i3 = [2, 5, 12];
d3 = conv([1, 2, 10], [1, 2]);
sys4 = tf(i3, d3); % Create LTI model
subplot(2,2,4);
pzmap(sys4);
title('Pole-Zero Map for i3 = [2, 5, 12], d3 = conv([1, 2, 10], [1, 2])');
```







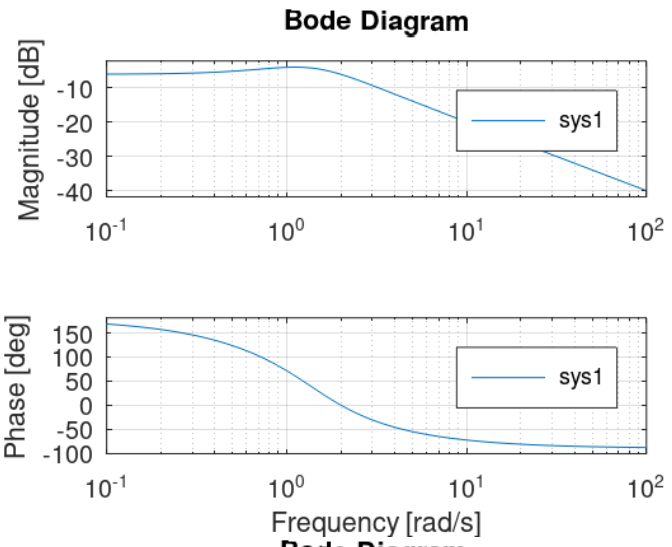


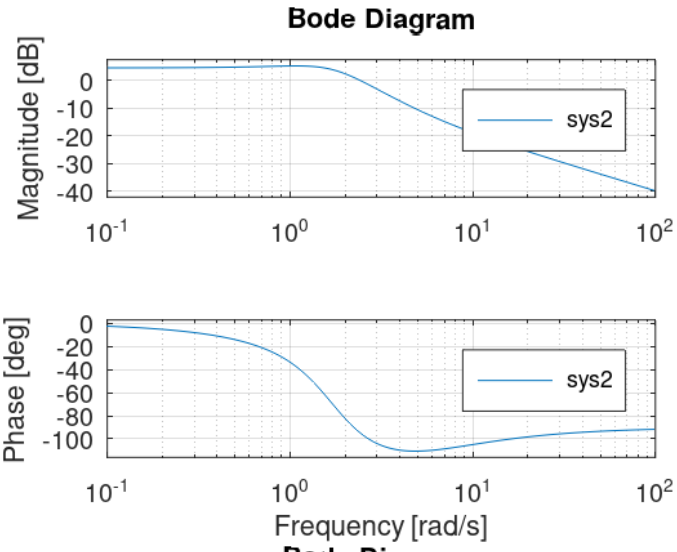
Part 2

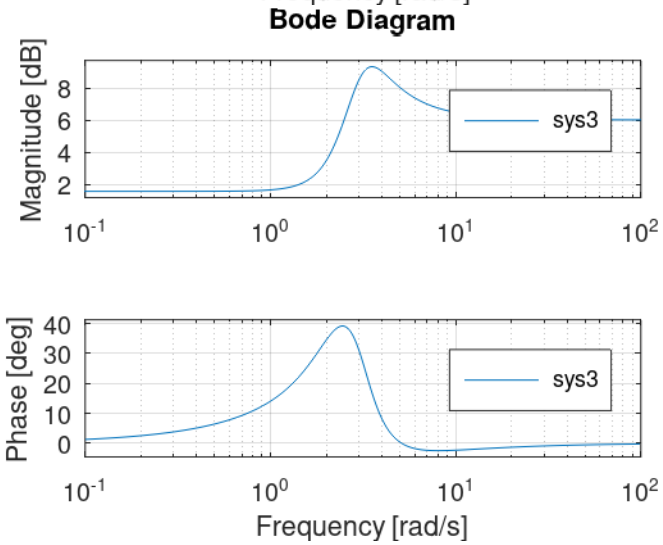
Exercise

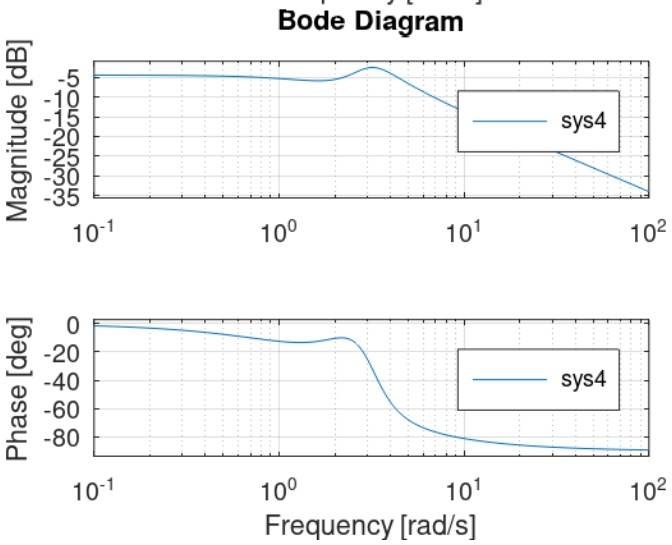
1.

```
close all;
clear all;

pkg load control;

% Bode plot for sys1

subplot(2,2,1);
i1 = [1, -1];
d1 = [1, 2, 2];
sys1 = tf(i1, d1);
bode(sys1);

% Bode plot for sys2
subplot(2,2,2);
i2 = [1, 5];
d2 = [1, 2, 3];
sys2 = tf(i2, d2);
bode(sys2);
##
% Bode plot for sys3
subplot(2,2,3);
i3 = [2, 5, 12];
d3 = [1, 2, 10];
sys3 = tf(i3, d3);
bode(sys3);
##
% Bode plot for sys4
subplot(2,2,4);
i4 = [2, 5, 12];
d4 = conv([1, 2, 10], [1, 2]);
sys4 = tf(i4, d4);
bode(sys4);
```

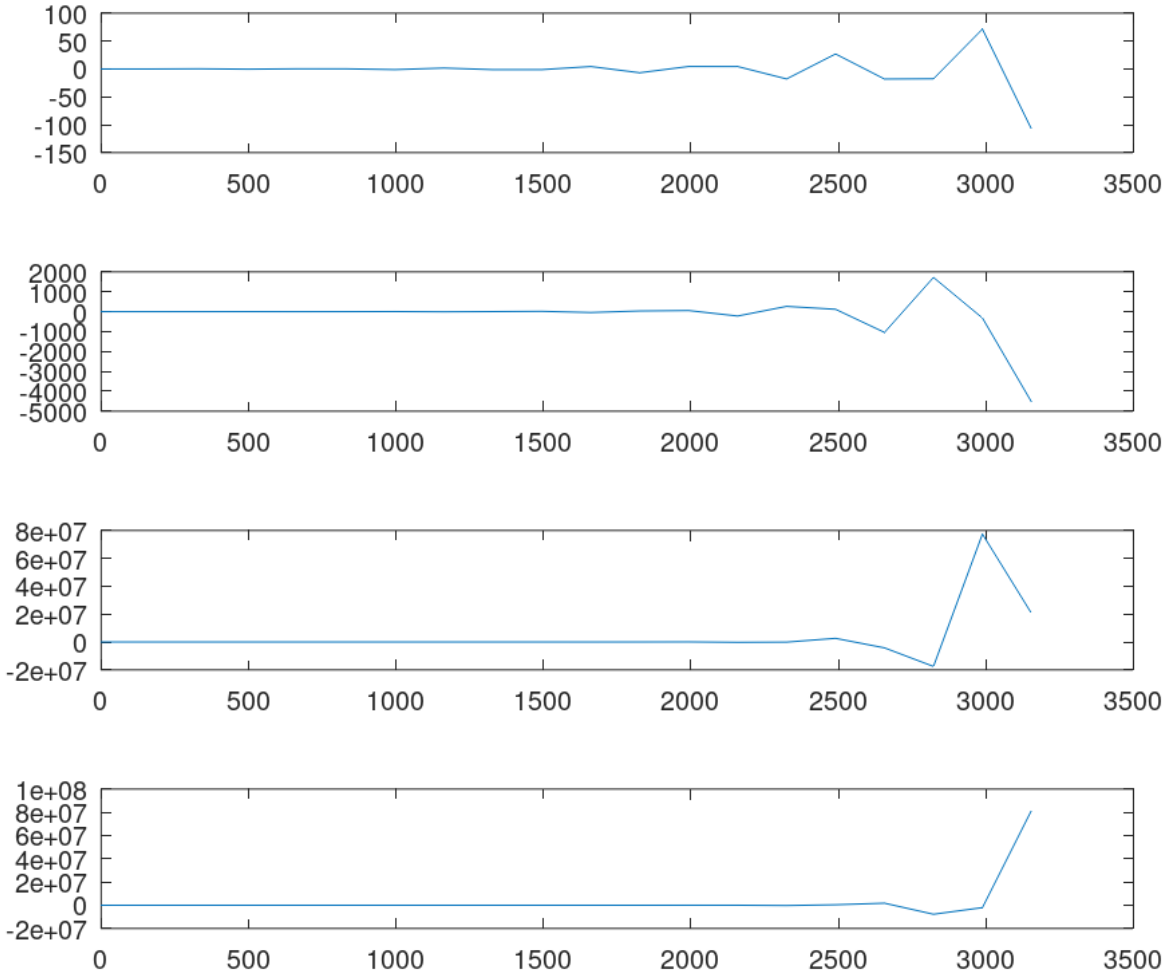

Bode Diagram
Magnitude [dB]
-10
-20
-30
-40
sys1
Phase [deg]
150
100
50
0
-50
-100
sys1
10^{-1}
10^{0}
10^{1}
10^{2}
Frequency [rad/s]


Bode Diagram
Magnitude [dB]
0
-10
-20
-30
-40
sys2
Phase [deg]
0
-20
-40
-60
-80
-100
sys2
10^{-1}
10^{0}
10^{1}
10^{2}
Frequency [rad/s]

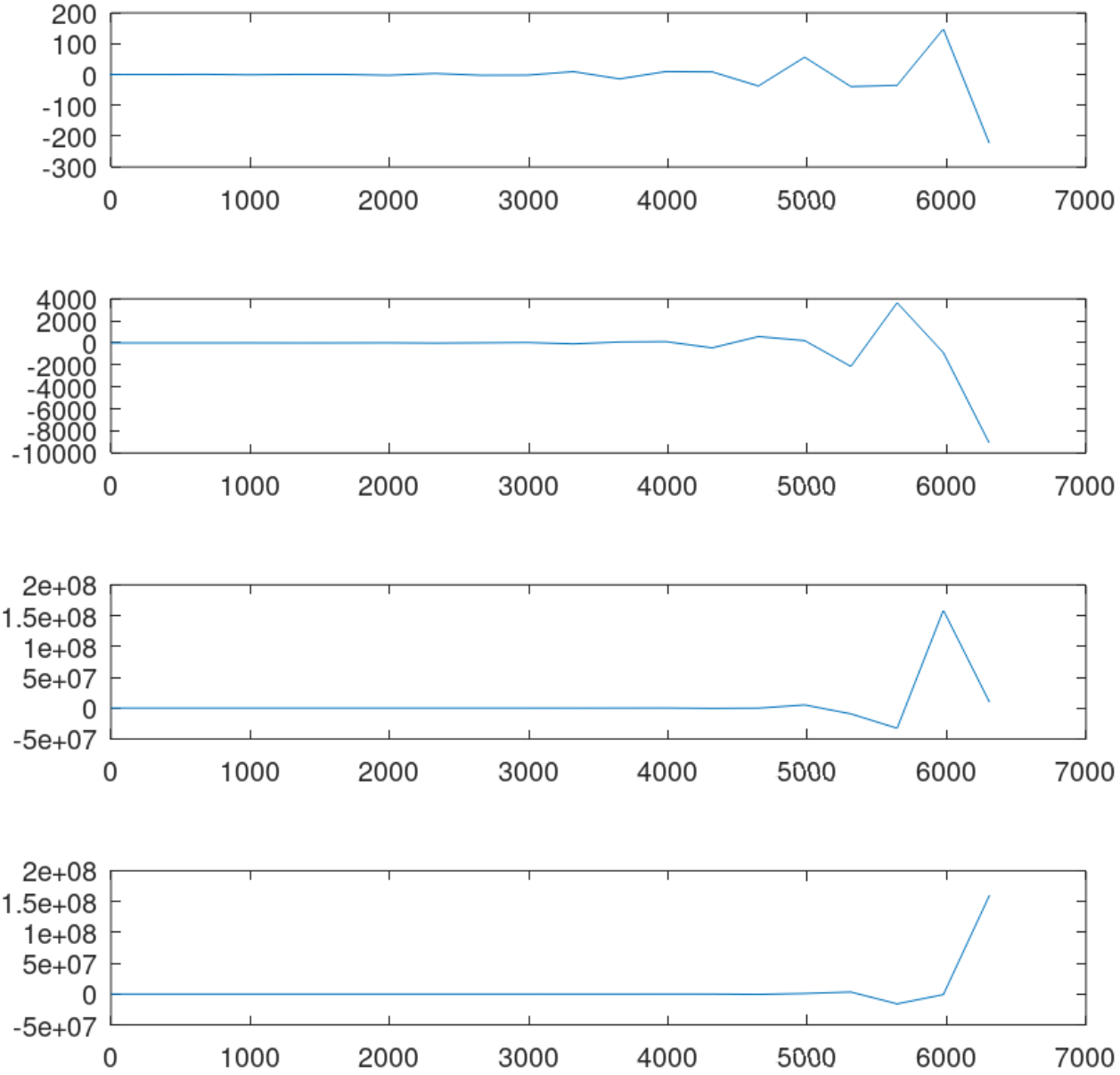

Bode Diagram
Magnitude [dB]
8
6
4
2
sys3
Phase [deg]
40
30
20
10
0
sys3
10^{-1}
10^{0}
10^{1}
10^{2}
Frequency [rad/s]


Bode Diagram
Magnitude [dB]
-5
-10
-15
-20
-25
-30
-35
sys4
Phase [deg]
0
-20
-40
-60
-80
sys4
10^{-1}
10^{0}
10^{1}
10^{2}
Frequency [rad/s]

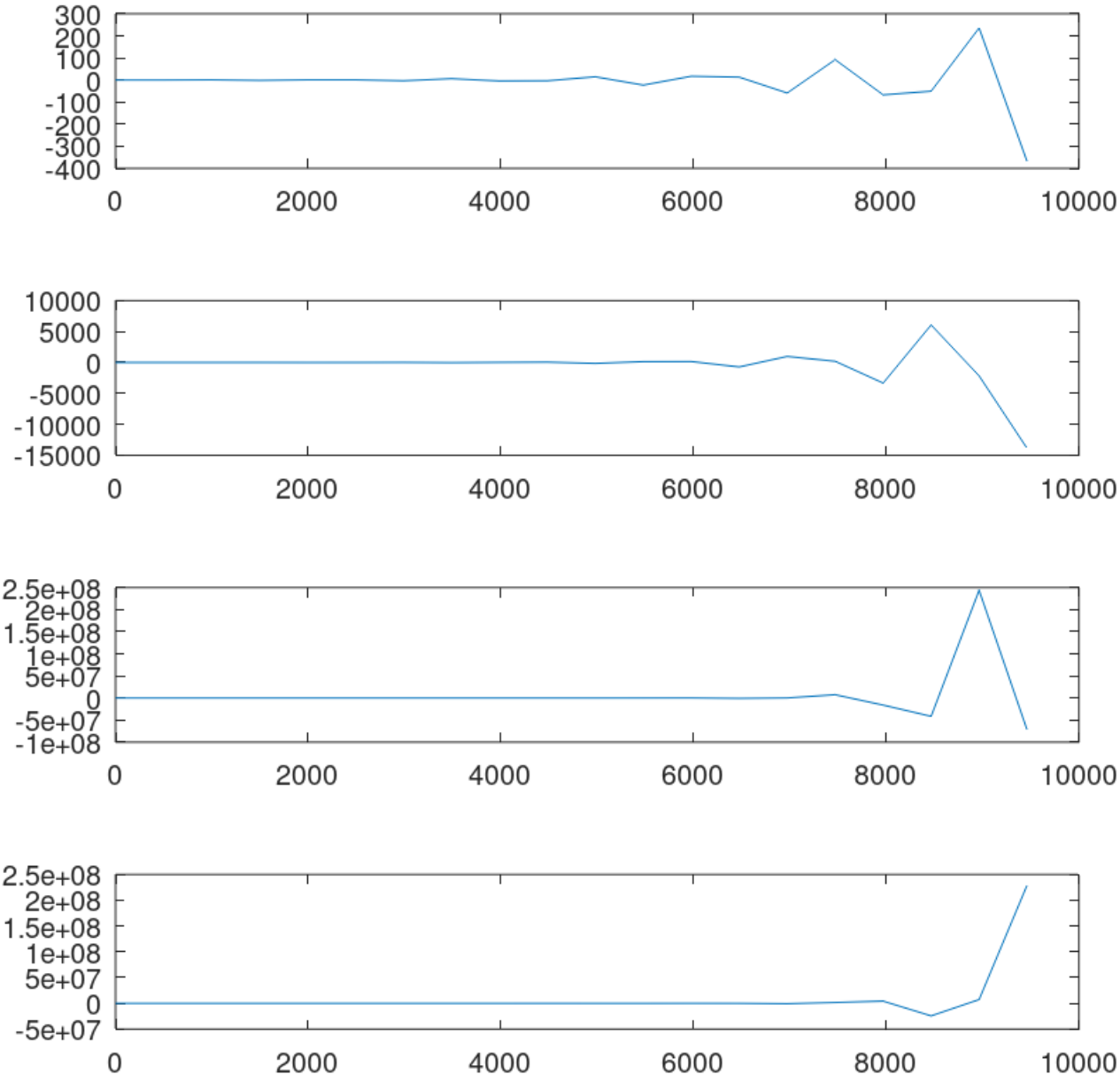
2. f = 166 Hz


100
50
0
-50
-100
-150
0 500 1000 1500 2000 2500 3000 3500
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0 500 1000 1500 2000 2500 3000 3500
8e+07
6e+07
4e+07
2e+07
0
-2e+07
0 500 1000 1500 2000 2500 3000 3500
1e+08
8e+07
6e+07
4e+07
2e+07
0
-2e+07
0 500 1000 1500 2000 2500 3000 3500

f = 332 Hz


200
100
0
-100
-200
-300
0
1000
2000
3000
4000
5000
6000
7000
4000
2000
0
-2000
-4000
-6000
-8000
-10000
0
1000
2000
3000
4000
5000
6000
7000
2e+08
1.5e+08
1e+08
5e+07
0
-5e+07
0
1000
2000
3000
4000
5000
6000
7000
2e+08
1.5e+08
1e+08
5e+07
0
-5e+07
0
1000
2000
3000
4000
5000
6000
7000

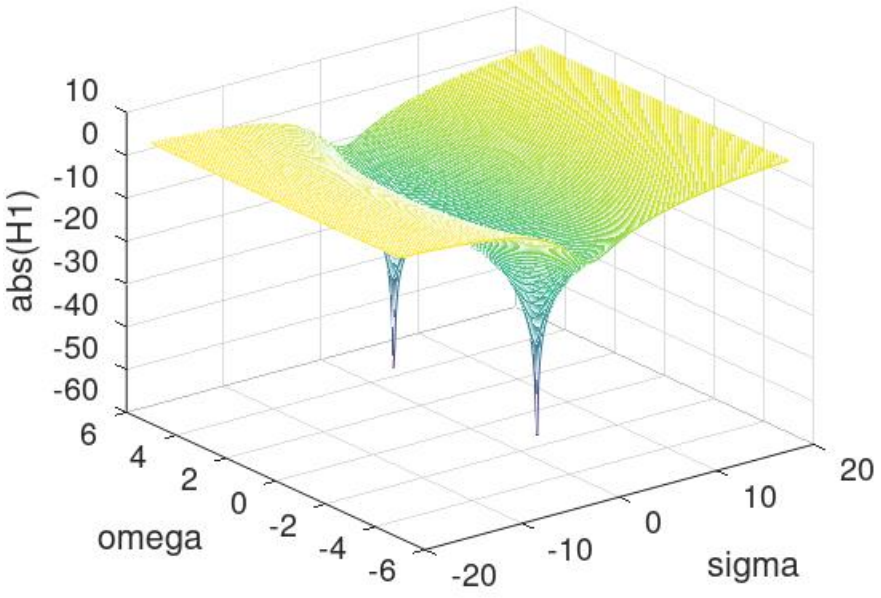
f = 498 Hz


300
200
100
0
-100
-200
-300
-400
0
2000
4000
6000
8000
10000
10000
5000
0
-5000
-10000
-15000
0
2000
4000
6000
8000
10000
2.5e+08
2e+08
1.5e+08
1e+08
5e+07
0
-5e+07
-1e+08
0
2000
4000
6000
8000
10000
2.5e+08
2e+08
1.5e+08
1e+08
5e+07
0
-5e+07
0
2000
4000
6000
8000
10000

Part 3

Exercise

```
clear all;
close all;
sigma = linspace(-20, 20, 200);
omega = linspace(-5, 5, 200);
[sigmagrid, omegagrid] = meshgrid(sigma, omega);
sgrid = sigmagrid + 1i*omegagrid;
b = [2 2 17];
a = [1 4 104];
H1 = polyval(b, sgrid)./polyval(a, sgrid);
mesh(sigma, omega, 20*log10(abs(H1)));
xlabel('sigma');
ylabel('omega');
zlabel('abs(H1)');
```



2.2 is the sigma=0 cross section of this plot. (in logarithmic scale)