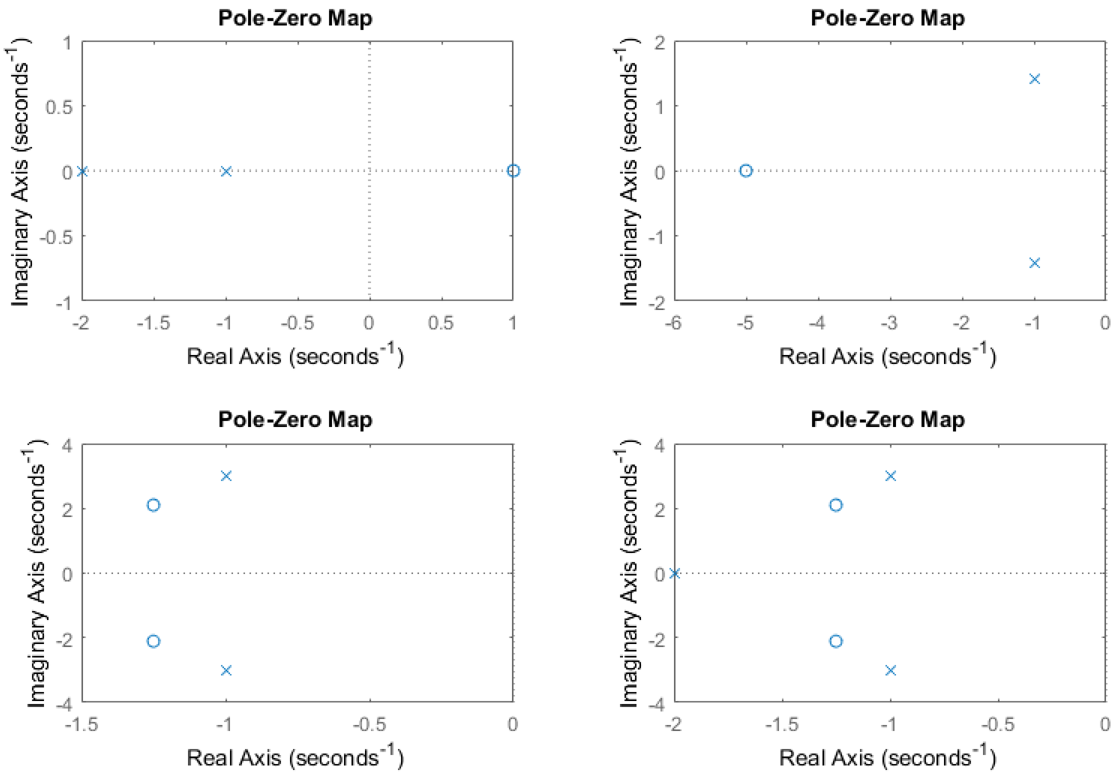
# EE 387 – Signal Processing

**Lab 3: System Functions and Frequency Response**

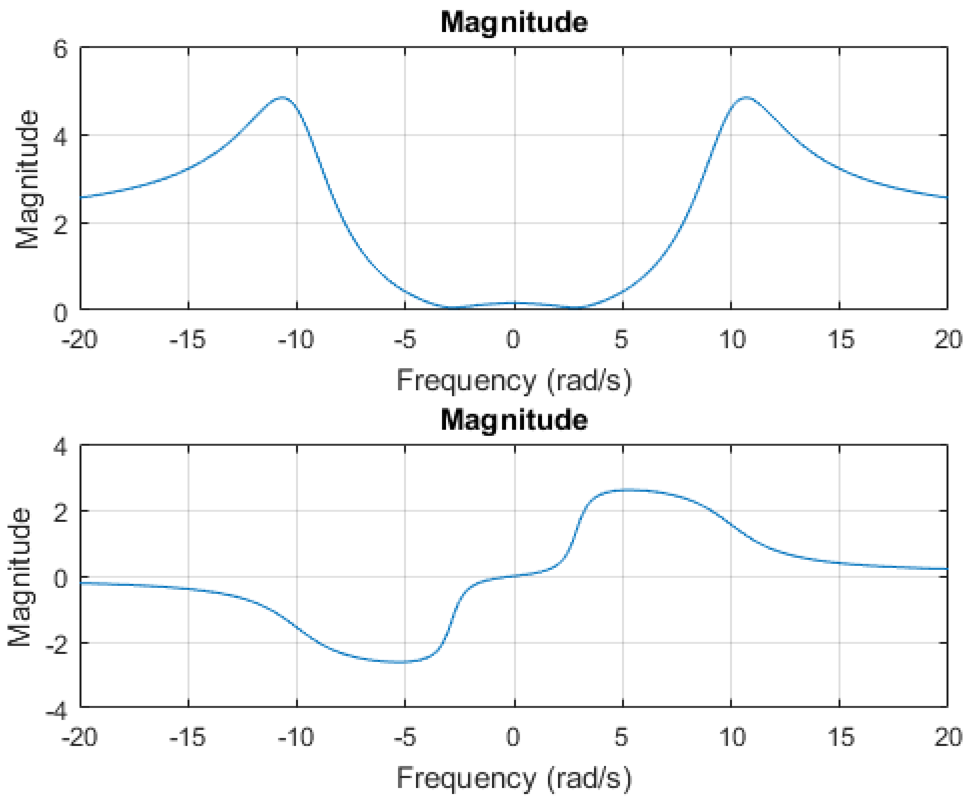
**PART 1: Pole-Zero Diagrams in MATLAB.**

```
clear all;
close all;


example
subplot(2,2,1);
b = [1 -1]; % Numerator coefficients
a = [1 3 2]; % Demoninator coefficients
zs = roots(b); % Generetes Zeros
ps = roots(a); % Generetes poles
pzmap(ps,zs); % generates pole-zero diagram

%1
subplot(2,2,2);
b = [1 5]; % Numerator coefficients
a = [1 2 3]; % Demoninator coefficients
zs = roots(b); % Generetes Zeros
ps = roots(a); % Generetes poles
pzmap(ps,zs); % generates pole-zero diagram



%3
subplot(2,2,3);
b = [2 5 12]; % Numerator coefficients
a = [1 2 10]; % Demoninator coefficients
zs = roots(b); % Generetes Zeros
ps = roots(a); % Generetes poles
pzmap(ps,zs); % generates pole-zero diagram

%4
subplot(2,2,4);
b = [2 5 12]; % Numerator coefficients
a = [1 4 14 20]; % Demoninator coefficients
zs = roots(b); % Generetes Zeros
ps = roots(a); % Generetes poles
pzmap(ps,zs); % generates pole-zero diagram
```

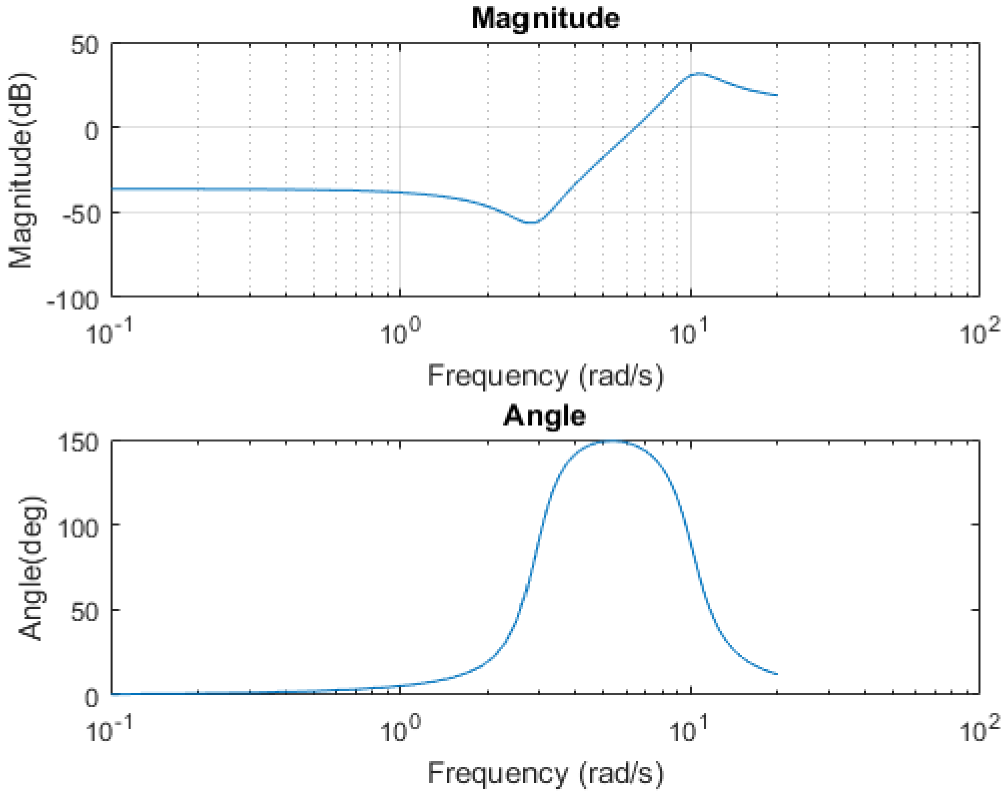



**PART 2: Frequency Response and Bode Plots in MATLAB**

```
b=[2 2 17]; % Numerator coefficients
a=[1 4 104]; % Demoninator coefficients
w=linspace(-20,20,200);

H = freqs(b,a,w);%frequency response of Laplace transform

figure;
%plot the maginutde
subplot(2,1,1);
plot(w,abs(H));
grid on
xlabel('Frequency (rad/s)');
ylabel('Magnitude');
title('Magnitude');

%plot the phase
subplot(2,1,2);
plot(w,angle(H));
grid on
xlabel('Frequency (rad/s)');
ylabel('Magnitude');
title('Magnitude');
```



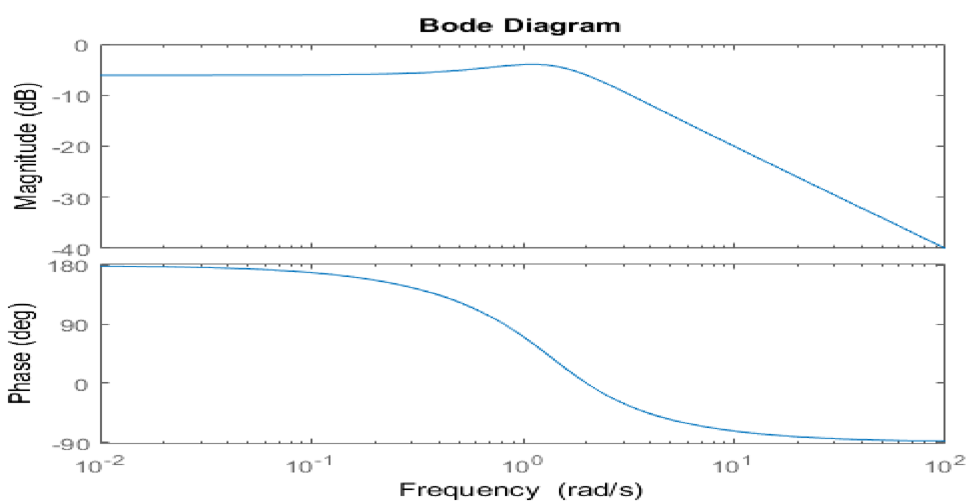

```
figure;
%plot the magnitude  bode plot
subplot(2,1,1);
semilogx(w,20*log(abs(H)));
grid on
xlabel('Frequency (rad/s)');
ylabel('Magnitude(dB)');
title('Magnitude');


%plot the phase bode plot
subplot(2,1,2);
grid on
semilogx(w,angle(H)*180/pi);
xlabel('Frequency (rad/s)');
ylabel('Angle(deg)');
title('Angle');
```




**Exercise**

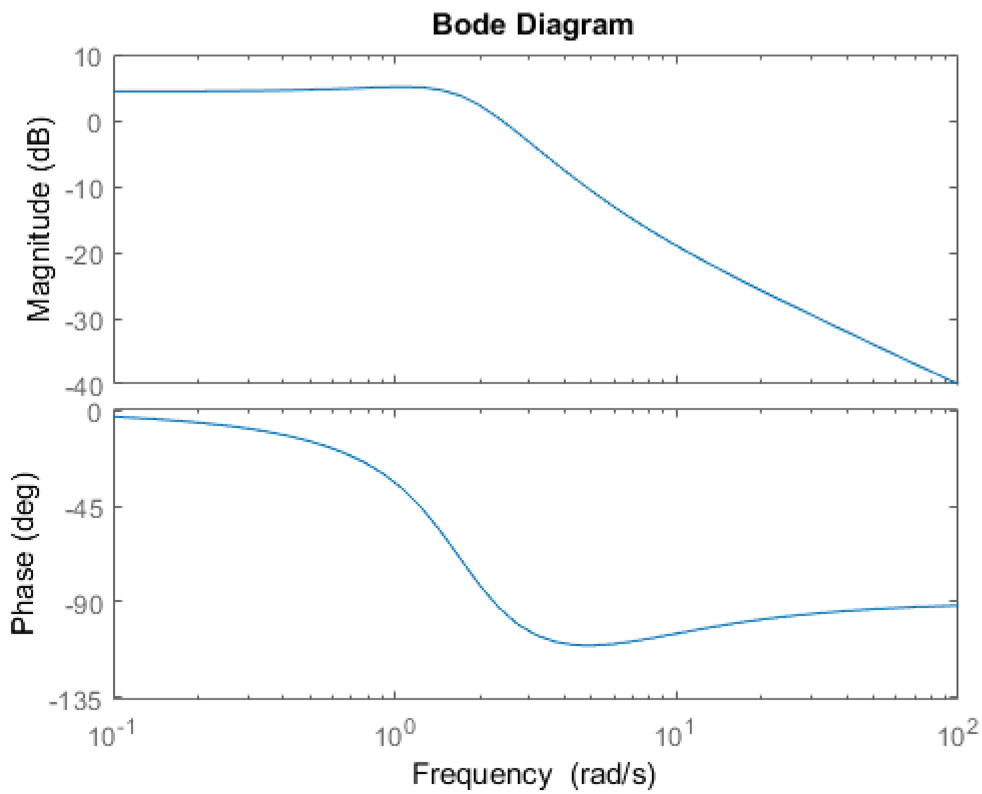
**1) i)**

```
clear all;
b = [1 -1]; % Numerator coefficients
a = [1 3 2]; % Demoninator coefficients
sys=tf(b,a); %transfer function
bode(sys) %bode plot
```



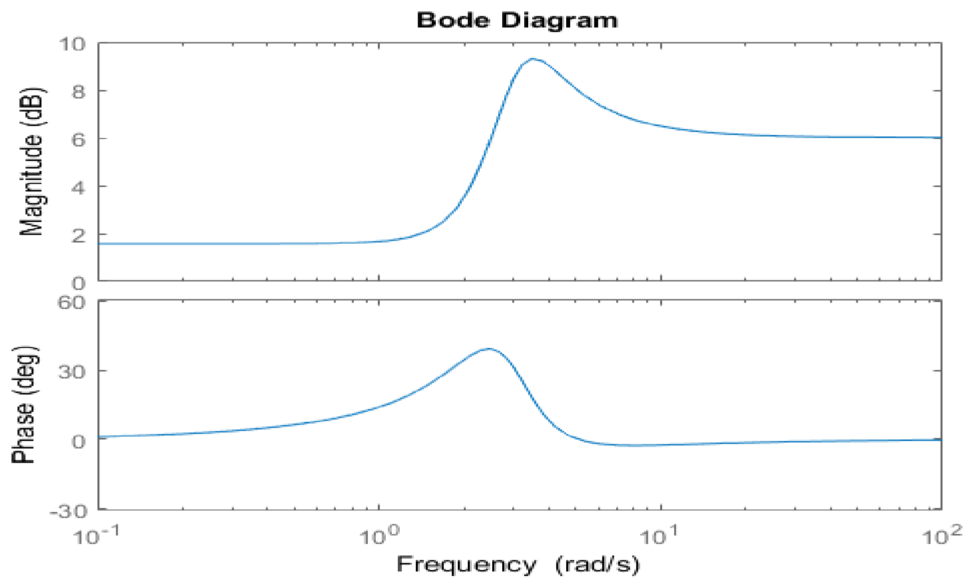
ii)

```
clear all;
b = [1 5]; % Numerator coefficients
a = [1 2 3]; % Demoninator coefficients
sys=tf(b,a);%transfer function
bode(sys) %bode 1
```




**iii)**

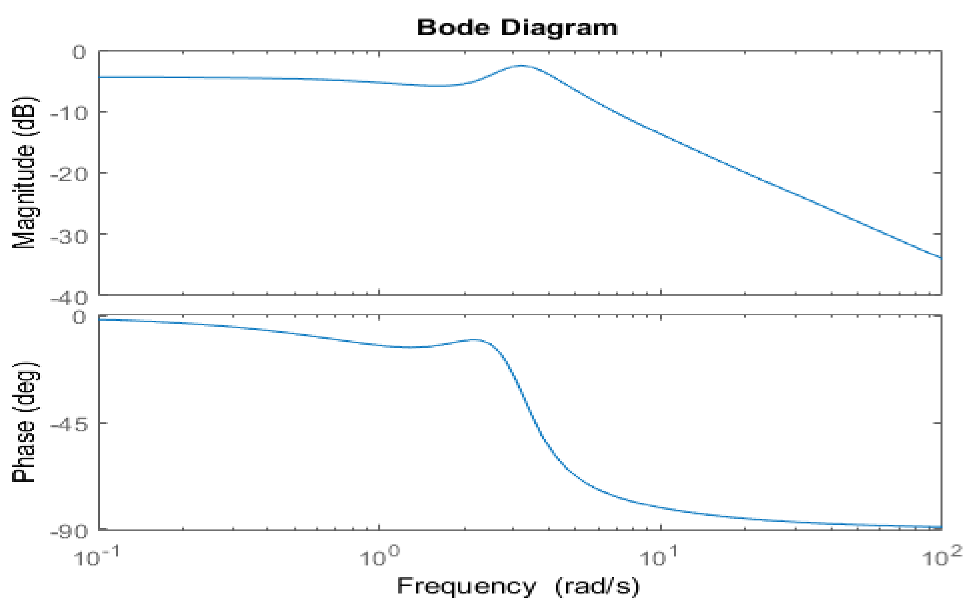
```
clear all;
b = [2 5 12]; % Numerator coefficients
a = [1 2 10]; % Demoninator coefficients
sys=tf(b,a);%transfer function
bode(sys) %bode 1
```




iv)

clear all;

```
b = [2 5 12]; % Numerator coefficients
a = [1 4 14 20]; % Demoninator coefficients
sys=tf(b,a);%transfer function
bode(sys) %bode 1
```

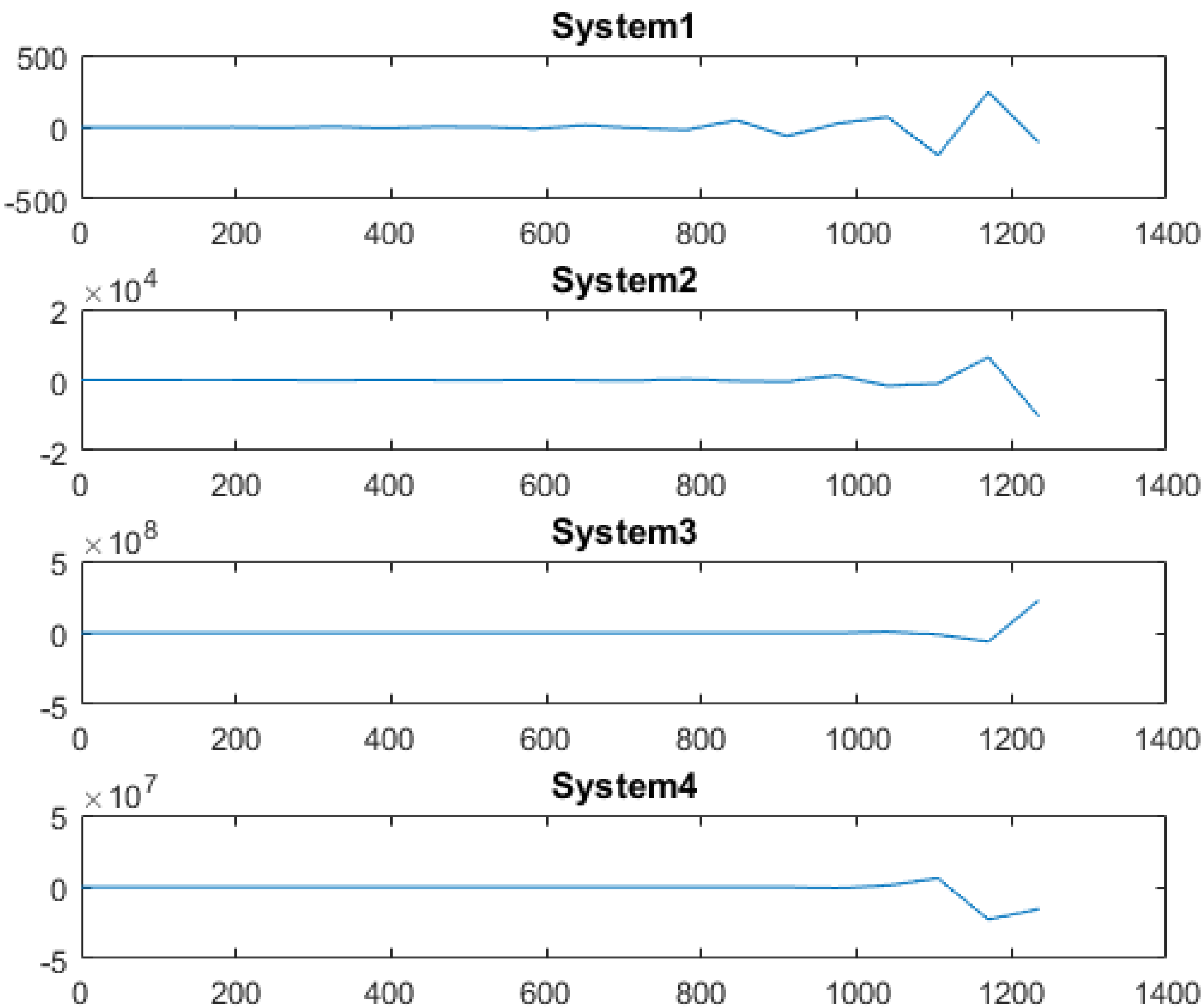


2)

```
reg=65;
for i=1:3
   f=reg*i;
   t=linspace(0,0.05*pi,20);
   x=sin(2*pi*f*t);

   figure;
   subplot(4,1,1);
   sys1=tf([1 -1],[1 2 2],f);
   [y1,t1]=lsim(sys1,x);
   plot(t1,y1);
   title('System1');

   subplot(4,1,2);
   sys2=tf([1 5],[1 2 3],f);
   [y2,t2]=lsim(sys2,x);
   plot(t2,y2);
   title('System2');

   subplot(4,1,3);
   sys3=tf([2 5 12],[1 2 10],f);
   [y3,t3]=lsim(sys3,x);
   plot(t3,y3);
   title('System3');

   subplot(4,1,4);
   sys4=tf([2 5 12],[1 4 14 20],f);
   [y4,t4]=lsim(sys4,x);
   plot(t4,y4);
   title('System4');
end
```

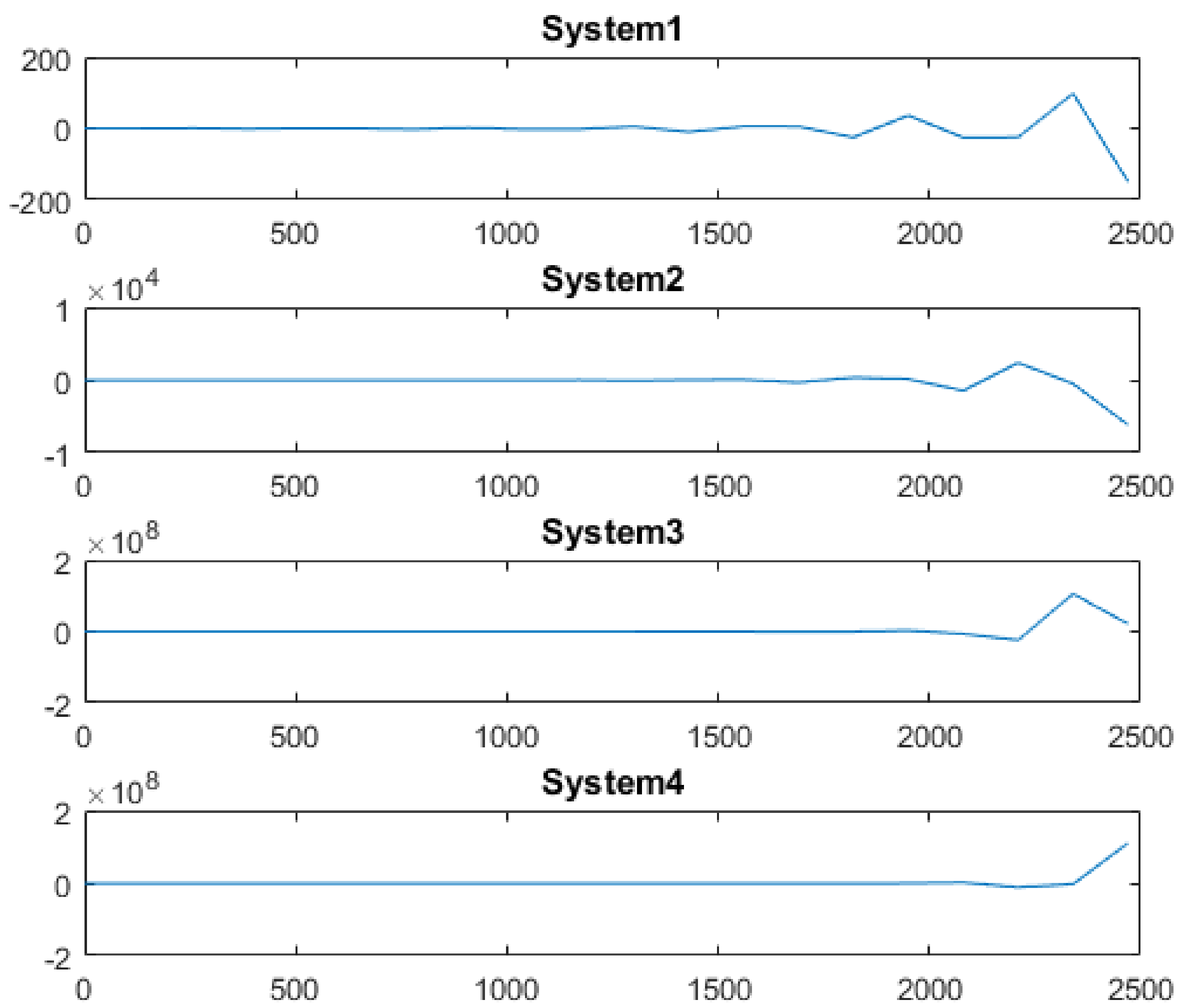
f = 65*1 = 65 hz

x=sin(2*pi*65)



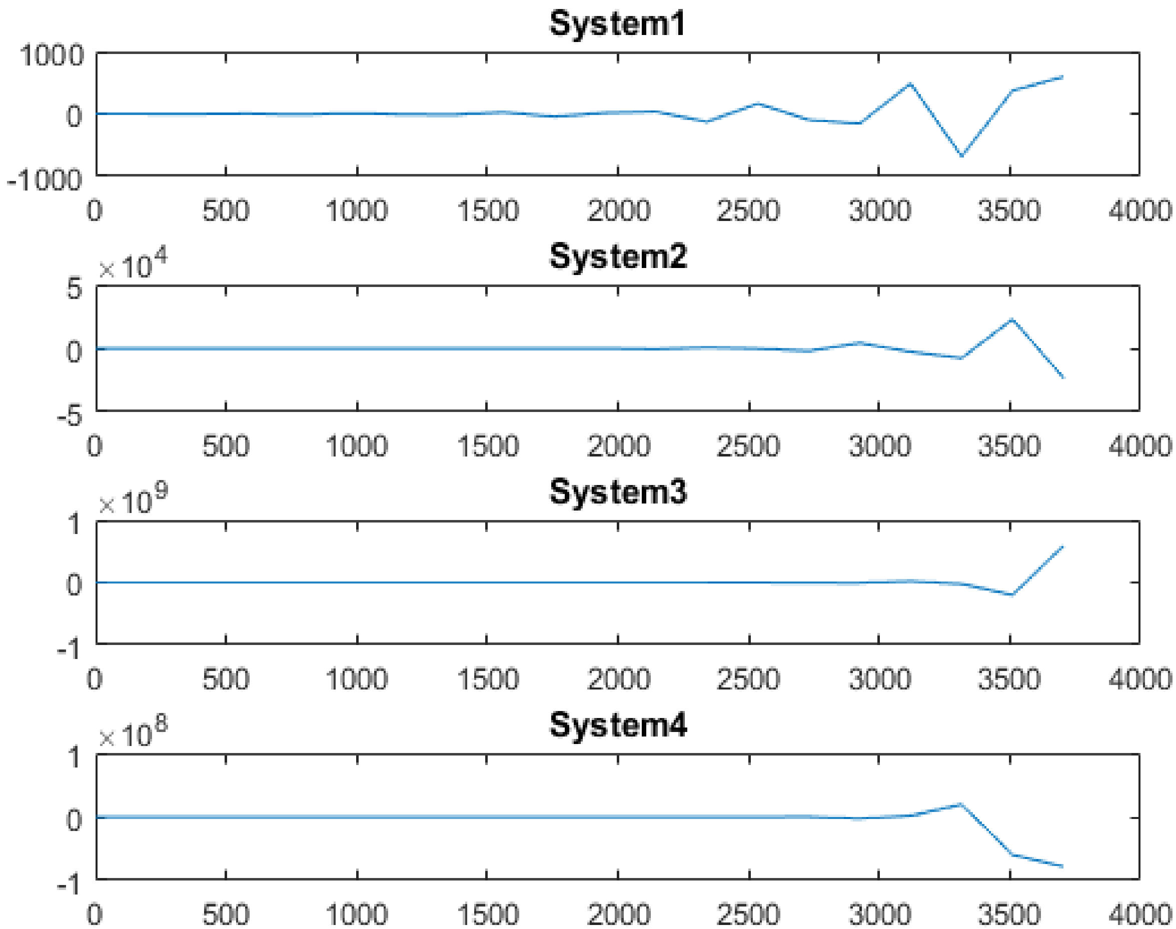
f = 65*2 = 130 hz

x=sin(2*pi*130)



f = 65*3 = 195 hz

x=sin(2*pi*195)



**PART 3: Surface Plots of a System Function in MATLAB**

```
a=[1 7 104];
b=[2 2 17];

sigma=linspace(-5,5,100);
omega=linspace(-20,20,100);

[sigmagrid,omegagrid] = meshgrid(sigma,omega);

sgrid = sigmagrid+j*omegagrid;

H1 = polyval(b,sgrid)./polyval(a,sgrid);

mesh(sigma,omega,20*log10(abs(H1)));
xlabel('sigma');
ylabel('omega');
zlabel('abs(H1)');
```

Here zeros and poles are in the 3d space and they are spread through sigma axis.

The relationship between the surface plot and the plot in 2.(2) is, the plot in 2.(2) is a cross section graph of this surface graph when sigma=0.