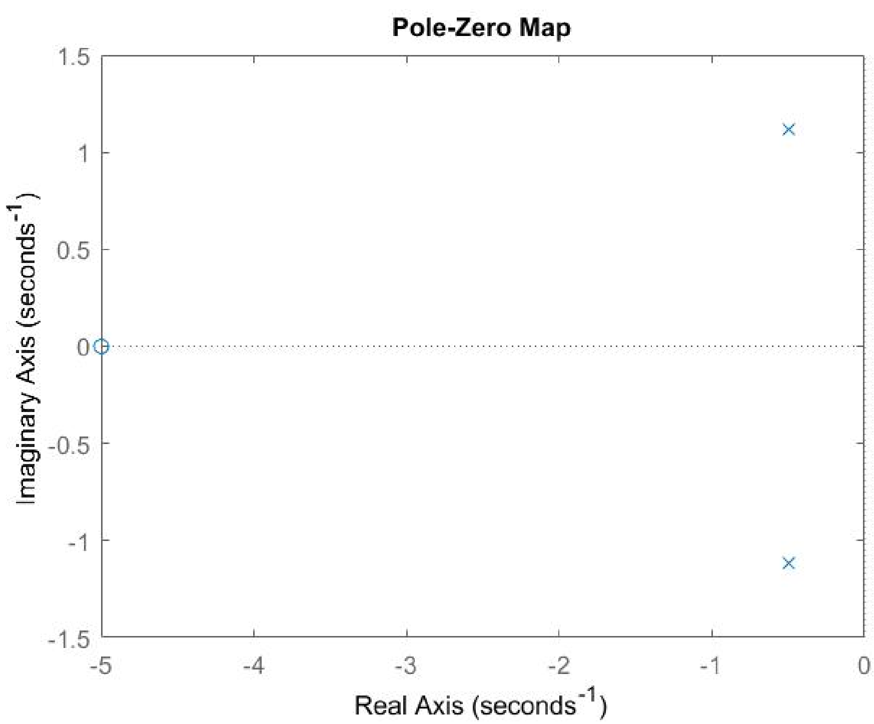
Lab 3: System Functions and Frequency Response

PART 1: Pole-Zero Diagrams in MATLAB.

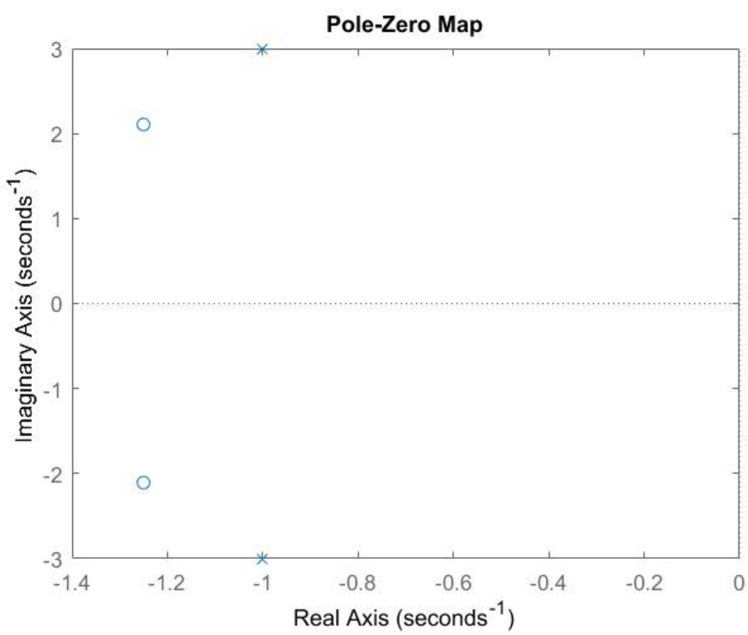
1. $H(s) = \frac{s+5}{s^2+2s+3}$

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



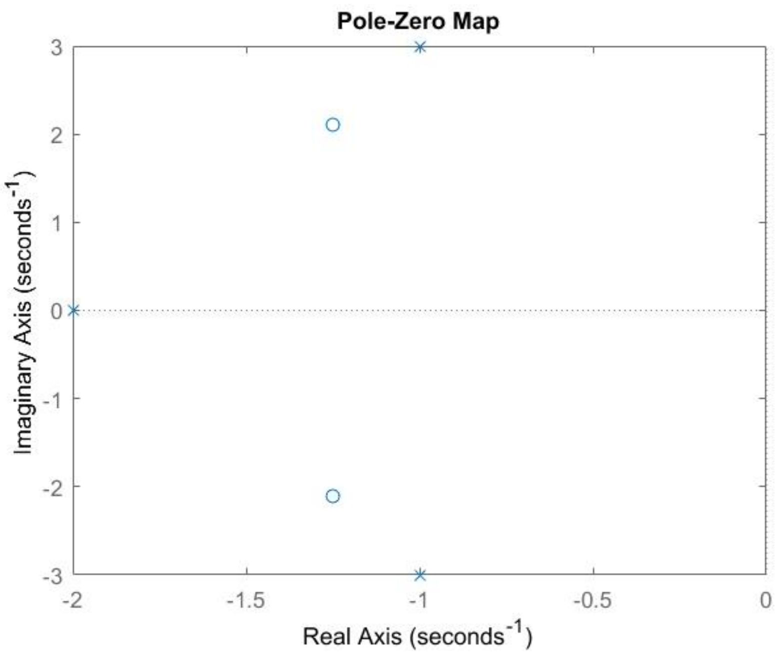
2. $H(s) = \frac{2s^2+5s+12}{s^2+2s+10}$

```
clear all;
close all;
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
```



3. $H(s) = \frac{2s^2+5s+12}{(s^2+2s+10)(s+2)}$

```
clear all;
close all;
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
```

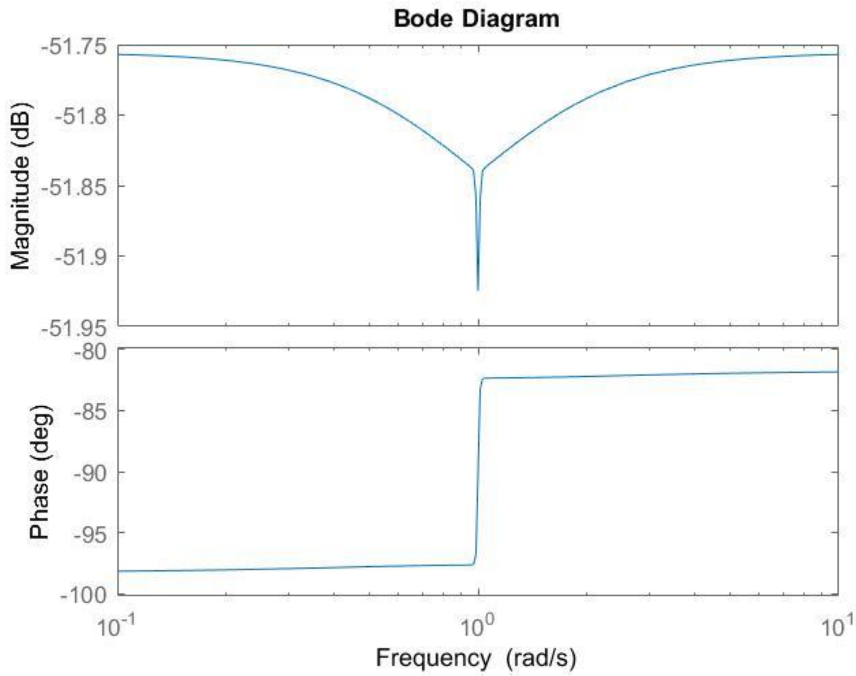


PART 2: Frequency Response and Bode Plots in MATLAB

1. Plot the bode plot of each four system functions given in the part 1

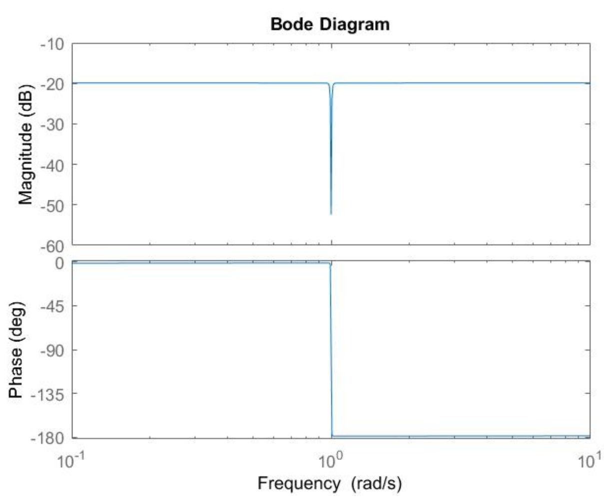
    a. $H(s) = \frac{s+5}{s^2+2s+3}$

```
clear all;
close all;
b = [1 5]; % Numerator coefficients
a = [1 2 3]; % Demoninator coefficients

omega = linspace(-20,20,200);

H = freqs(b,a,omega);

bode(H,omega);
```



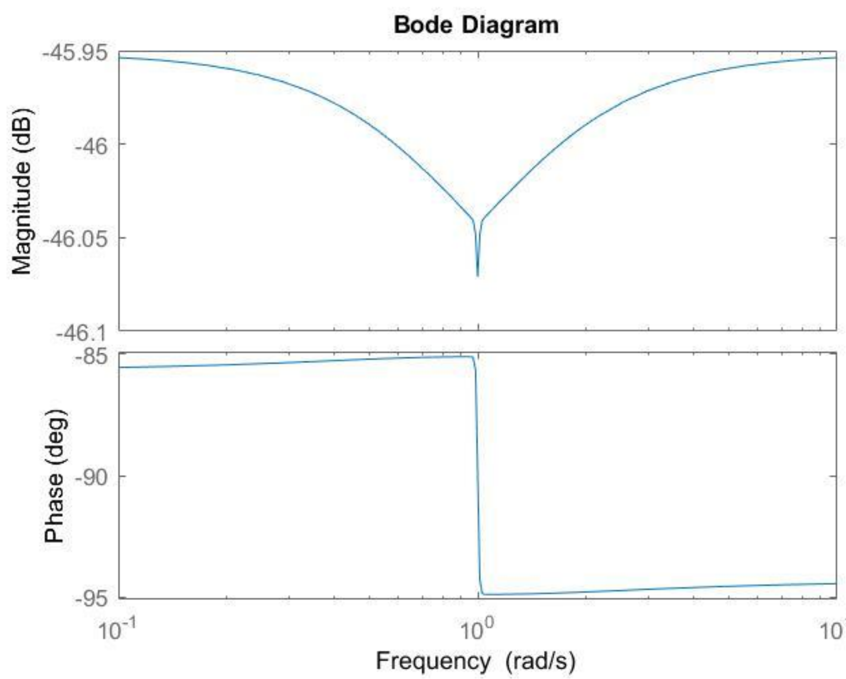
b. $H(s) = \frac{2s^2+5s+12}{s^2+2s+10}$

```
clear all;
close all;
b = [2 5 12]; % Numerator coefficients
a = [1 2 10]; % Demoninator coefficients

omega = linspace(-20,20,200);

H = freqs(b,a,omega);

bode(H,omega);
```



c. $H(s) = \frac{2s^2+5s+12}{(s^2+2s+10)(s+2)}$

```
clear all;
close all;
b = [2 5 12]; % Numerator coefficients
a = [1 4 14 20]; % Demoninator coefficients

omega = linspace(-20,20,200);

H = freqs(b,a,omega);

bode(H,omega);
```

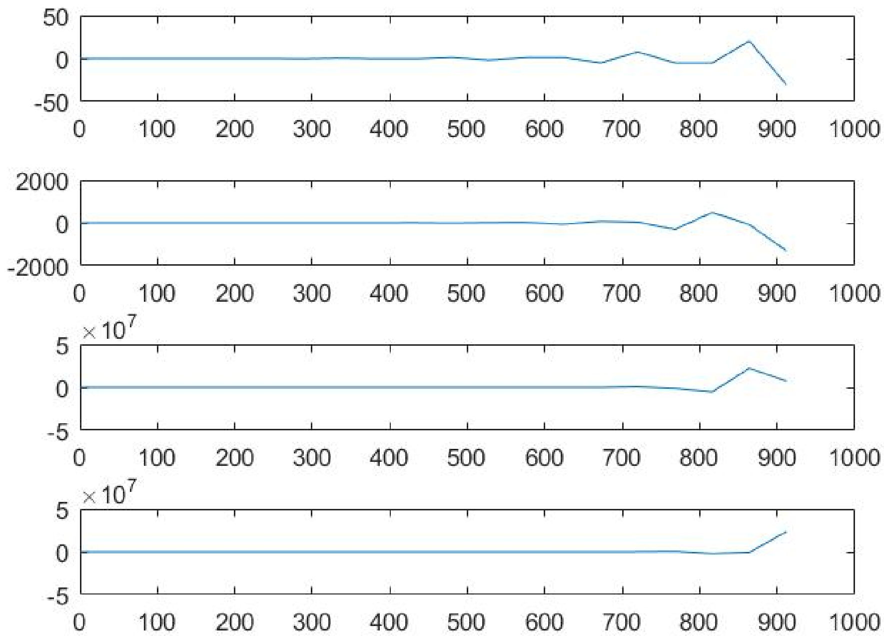


2. Select three sinusoidal signals with unit magnitude, zero phase and three different frequencies (f1, f2, f3 in kHz, here fi = Registration number * i). Assume that they are three inputs for abovementioned four systems. Then find the corresponding three outputs for each system

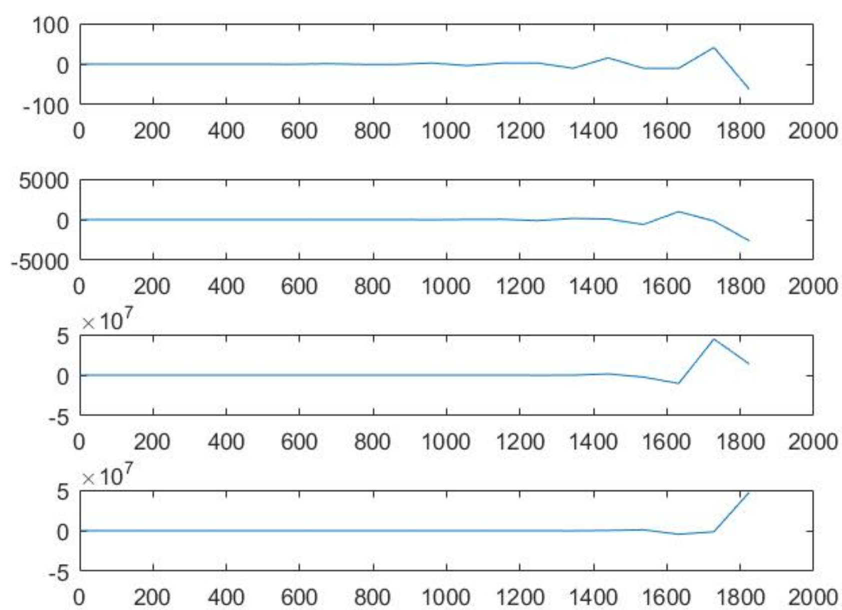
```
close all
clear all

b1=[1,-1];
a1=[1,2,2];

b2=[1,5];
a2=[1,2,3];
```

```
b3=[2,5,12];
a3=[1,2,10];

b4=[2,5,12];
a4=[1 4 14 20];

for i=1:3
   figure
   fi=48*i;
   t=linspace(0,0.002*pi,20);
   x=sin(2*pi*fi*t);

   subplot(4,1,1);
   sys1=tf(b1,a1,fi);
   [y1,t1]=lsim(sys1,x);
   plot(t1,y1);

   subplot(4,1,2);
   sys2=tf(b2,a2,fi);
   [y2,t2]=lsim(sys2,x);
   plot(t2,y2);

   subplot(4,1,3);
   sys3=tf(b3,a3,fi);
   [y3,t3]=lsim(sys3,x);
   plot(t3,y3);

   subplot(4,1,4);
   sys4=tf(b4,a4,fi);
   [y4,t4]=lsim(sys4,x);
   plot(t4,y4);

end
```

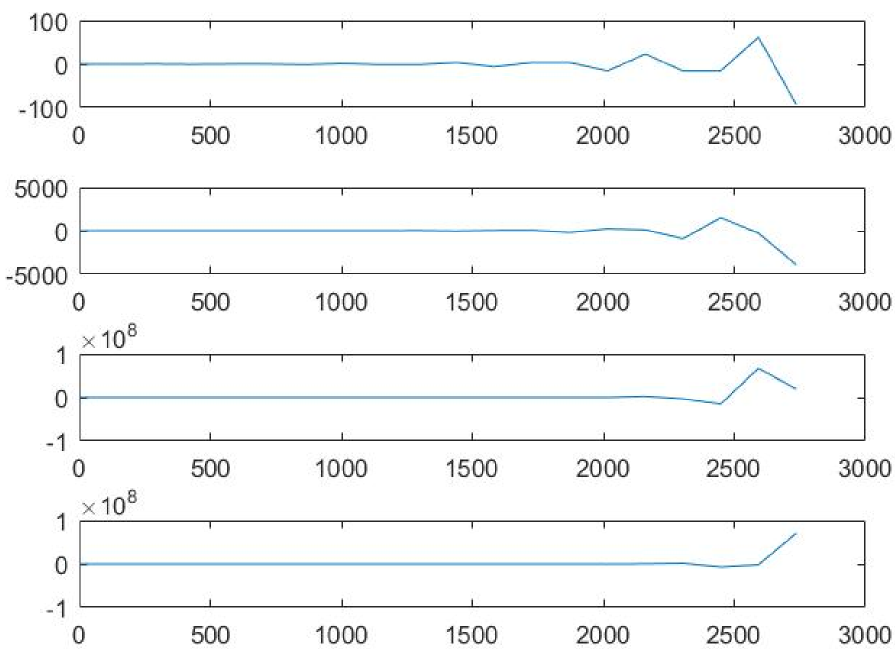
F = 48Hz



F = 48 x 2Hz



F = 48 x 3Hz

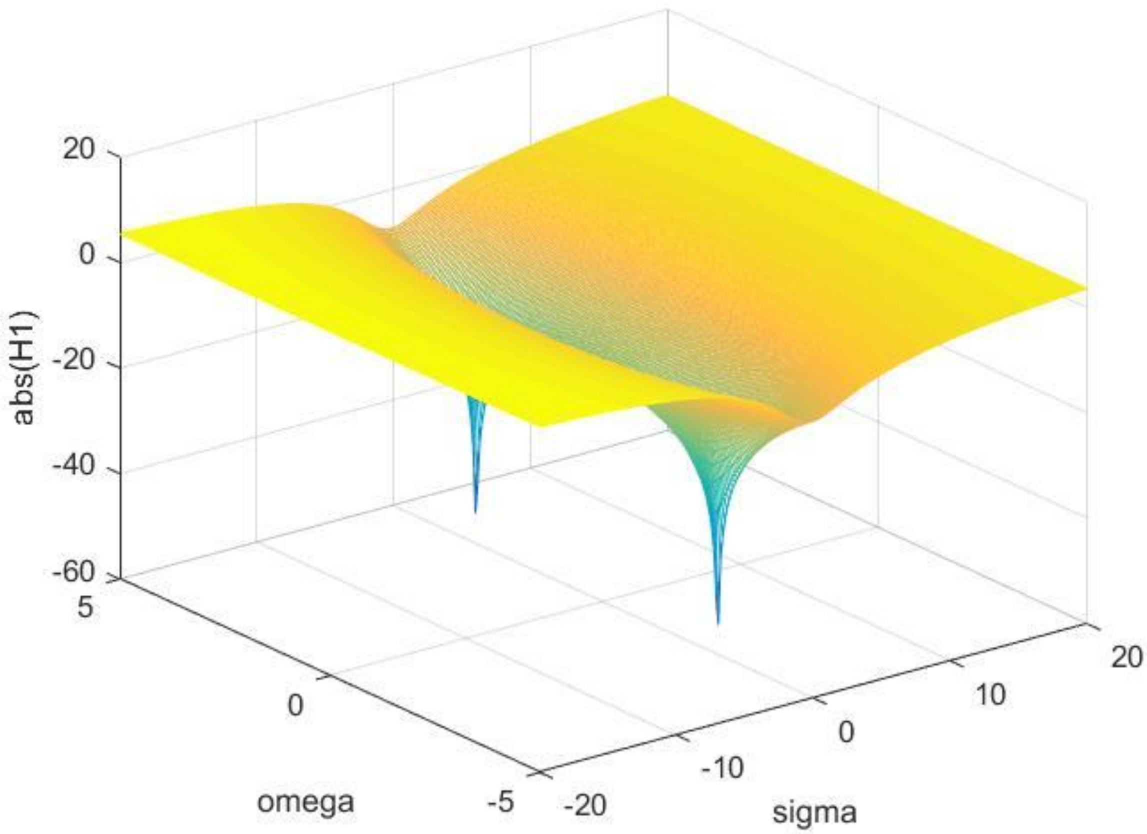


PART 3: Surface Plots of a System Function in MATLAB

Where are the poles and zeros on the surface plot? What's the relationship between the surface plot and the plot in 2.(2) ?

```
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)