جامعة بيرزيت
BIRZEIT UNIVERSITY

**Faculty of Engineering & Technology**
**Electrical & Computer Engineering Department**

# Signal and system EE2312

# MATLAB-Assignment

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Section:2

**Question I:**

Generate and plot the following signals using MATLAB:

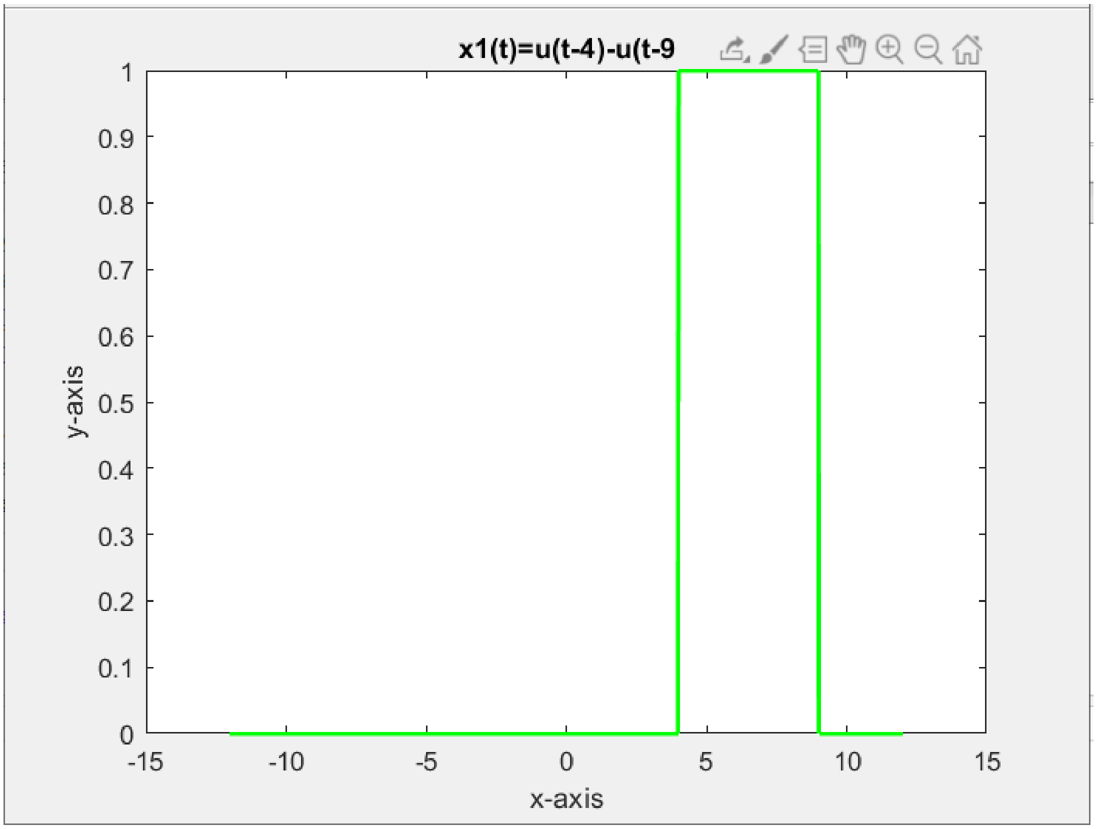
1. $X_1(t) = u(t-4) - u(t-9)$
2. A finite pulse (π(t) ) with value = 4 and extension between 3 and 8
3. $X_2(t) = u(t-4) + r(t-6) - 2r(t-9) + r(t-11)$ in the time interval [0 22]

# 1.

Code:

```
% Maha Mali
%1200746
clear all
close all
clc
t=-12:0.01:12;
x=heaviside(t-4)-heaviside(t-9);
plot(t,x,'g','lineWidth',2);
xlabel('x-axis');
ylabel('y-axis');
title('x1(t)=u(t-4)-u(t-9');
```

Plot:


x1(t)=u(t-4)-u(t-9
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
y-axis
-15
-10
-5
0
5
10
15
x-axis

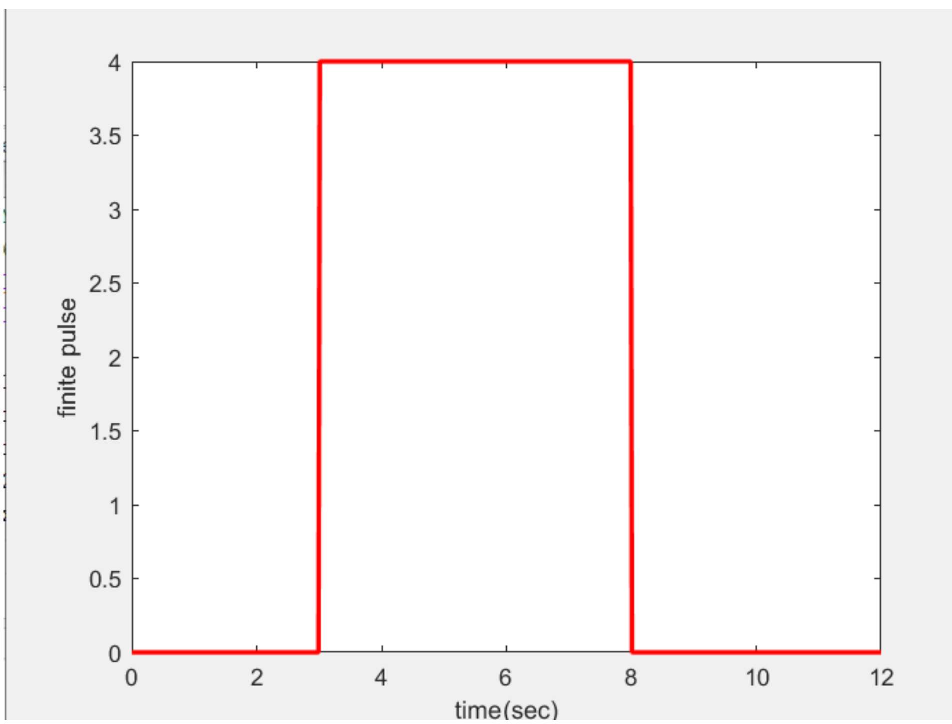
--------------------------------------------------------------

# 2.

Code:

```
% Maha Mali
%1200746
clear all
close all
clc
t=0:0.01:12;
x1=heaviside(t-3);
x2=heaviside(t-8);
x=(x1-x2)*4;
plot(t,x,'r','lineWidth',2);
xlabel('time(sec)');
ylabel('finite pulse');
```

Plot:

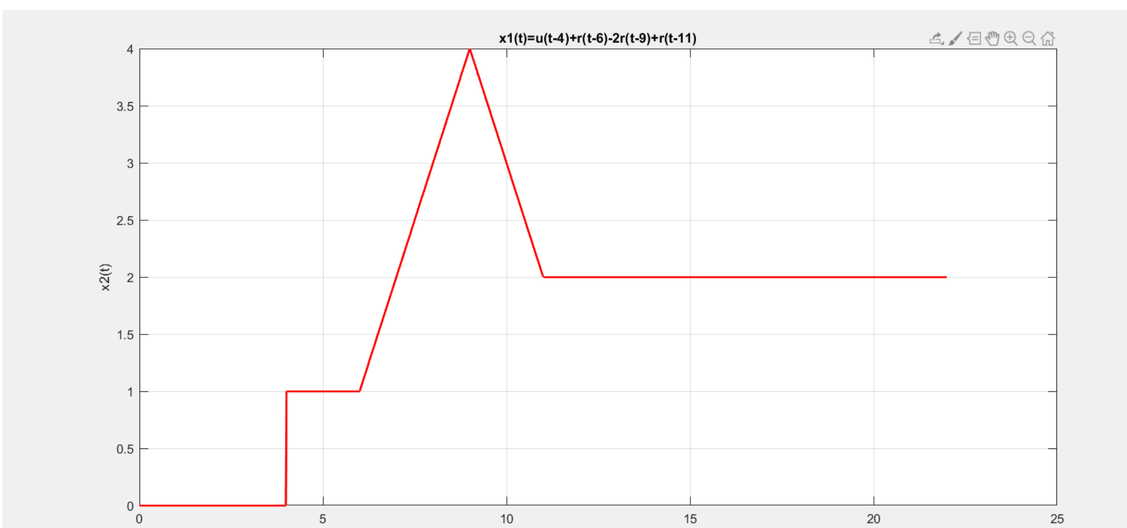


# 3.

Code

```
% Maha Mali
%1200746
clear all
close all
clc
t=0:0.01:22;
x1=heaviside(t-4);
x2=heaviside(t-6).*(t-6);
x3=heaviside(t-9).*(t-9);
x4=heaviside(t-11).*(t-11)
x=x1+x2-2*x3+x4;
plot(t,x,'r','lineWidth',2);
xlabel('Time(sec)');
ylabel('x2(t)');
title('x1(t)=u(t-4)+r(t-6)-2r(t-9)+r(t-11)');
grid on
```

Plot

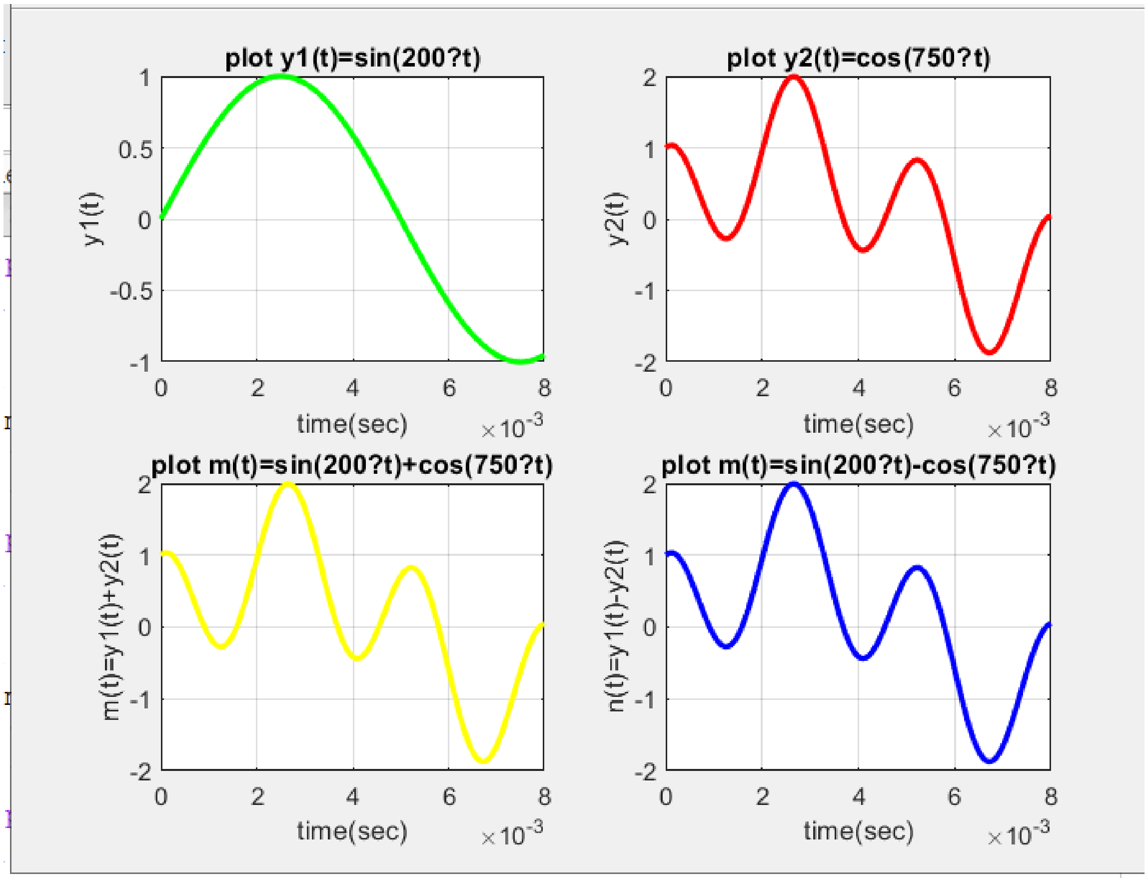


**Question II:**

1. Generate and plot the signals $y_1(t)\,\sin(200\pi t)$, and $y_2(t) = \cos(750\pi t)$, then determine y1 and plot the signals $m(t) = +y2$ and $n(t) = y_1 - y_2$.
2. Determine, using the MATLAB plots, if the sum and/or difference signals are periodic. In case a signal is periodic, determine its fundamental frequency.)

# 1-

```
% Maha Mali
%1200746
clear all
close all
clc
t=-0:0.00005:0.008;
y1=sin(200*pi*t);
y2=cos(750*pi*t);
m=y1+y2;
n=y1-y2;
subplot(2,2,1);
plot(t,y1,'g','lineWidth',2);
xlabel('time(sec)');
ylabel('y1(t)');
title('plot y1(t)=sin(200?t)');
grid on
subplot(2,2,2);
plot(t,m,'r','lineWidth',2);
xlabel('time(sec)');
ylabel('y2(t)');
title('plot y2(t)=cos(750?t)');
grid on
subplot(2,2,3);
plot(t,m,'y','lineWidth',2);
xlabel('time(sec)');
ylabel('m(t)=y1(t)+y2(t)');
title('plot m(t)=sin(200?t)+cos(750?t)');
grid on
subplot(2,2,4);
plot(t,m,'b','lineWidth',2);
xlabel('time(sec)');
ylabel('n(t)=y1(t)-y2(t)');
title('plot m(t)=sin(200?t)-cos(750?t)');
grid on
```




## 2-

Fregancy equal(1/T)

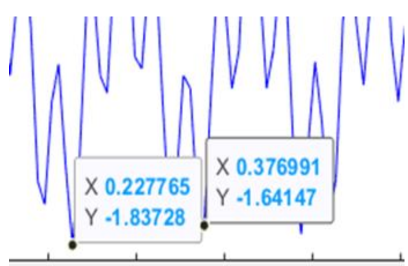
F1=1/X2-X1=1/(0.376991-0.227765)

=6.7Hz

F2=1/X2-X1=1/(0.298451-0.15708)

=7.1Hz

From the graph we notice the signal is periodic



**Question III:**

Write the programs that solve the following differential equations using zero initial conditions.

1. $10\frac{dy(t)}{dt} + 20y(t) = 10$
2. $\frac{d^2y(t)}{dt^2} + 2\frac{dy}{dt} + 4y(t) = 5\cos 1000t$

## 1- Code

```
% Maha Mali
%1200746
clear all
close all
clc

syms y(t)
Dy=diff(y,t);
fun=((Dy.*10)+(20.*y))==10;
con1=y(0)==0;
cond=[con1];
solution=dsolve(fun,cond)
simple_sol=simplify(solution)
```

2-solution

```
solution =

1/2 - exp(-2*t)/2


simple_sol =

1/2 - exp(-2*t)/2

>>
```

## 2-

Code

```
clear all
close all
clc
syms y(t)
Dy1=diff(y,t);
Dy2=diff(y,t,2);
fun=(Dy2+(Dy1.*2)+(y.*4))==5.*cos(1000.*t);
con1=y(0)==0;
cond=[con1];
solution=dsolve(fun,cond)
simple_sol=simplify(solution)
```

**solution =**

sin(3^(1/2)*t)*((625*cos(1000*t - 3^(1/2)*t))/124999500002 - (625*cos(1000*t + 3^(1/2)*t))/124999500002 - (1249995*sin(1000*t + 3^(1/2)*t))/499998000008 + (1249995*sin(1000*t - 3^(1/2)*t))/499998000008 + (1250005*3^(1/2)*cos(1000*t + 3^(1/2)*t))/1499994000024 + (1250005*3^(1/2)*cos(1000*t - 3^(1/2)*t))/1499994000024 + (312499375*3^(1/2)*sin(1000*t + 3^(1/2)*t))/374998500006 + (312499375*3^(1/2)*sin(1000*t - 3^(1/2)*t))/374998500006) - (5*3^(1/2)*cos(3^(1/2)*t)*((sin(t*(3^(1/2) - 1000)) - cos(t*(3^(1/2) - 1000))*(3^(1/2) - 1000))/((3^(1/2) - 1000)^2 + 1) + (sin(t*(3^(1/2) + 1000)) - cos(t*(3^(1/2) + 1000))*(3^(1/2) + 1000))/((3^(1/2) + 1000)^2 + 1)))/6 - (1250005*3^(1/2)*exp(-t)*sin(3^(1/2)*t))/749997000012 - (1249995*exp(-t)*cos(3^(1/2)*t))/(4*(500*3^(1/2) - 250001)*(500*3^(1/2) + 250001))

**simple_sol =**

(625*sin(1000*t))/62499750001 - (1249995*cos(1000*t))/249999000004 + (1249995*exp(-t)*cos(3^(1/2)*t))/249999000004 - (1250005*3^(1/2)*exp(-t)*sin(3^(1/2)*t))/749997000012

**Question IV:**

Write the programs that determine the response of the linear time invariant system to the given input and the given initial conditions:

1. $\frac{dy(t)}{dt} + 5y(t) = 10u(t)$ $\quad y(0) = 3$;

2. $\frac{d^2y(t)}{dt^2} + 2\frac{dy}{dt} + 2y(t) = 5\cos 2500t$ $\quad$ (y(0) =1, y'(0)=2);

**1-**code

```
% Maha Mali
%1200746
clear all
close all
clc
syms y(t)
Dy1=diff(y,t);
fun=(Dy1+(5.*y))==10.*heaviside(t);
con1=y(0)==3;
cond=[con1];
solution=dsolve(fun,cond)
simple_sol=simplify(solution)
```

Solution:

```
solution =

2*exp(-5*t) - exp(-5*t)*(sign(t) - exp(5*t)*(sign(t) + 1))


simple_sol =

2*exp(-5*t) + sign(t) - exp(-5*t)*sign(t) + 1

fx >>
```

**2-**code

```
% Maha Mali
%1200746
clear all
close all
clc
syms y(t)
Dy1=diff(y,t);
Dy2=diff(y,t,2);
fun=(Dy2+(2.*Dy1)+(2.*y))==5.*cos(2500.*t);
con1=y(0)==1;
con2=Dy1(0)==2;
cond=[con1,con2];
solution=dsolve(fun,cond)
simple_sol=simplify(solution)
```

**solution =**

sin(t)*((5*cos(2499*t))/12490004 + (5*cos(2501*t))/12510004 + (12495*sin(2499*t))/12490004 + (12505*sin(2501*t))/12510004) - cos(t)*((12495*cos(2499*t))/12490004 - (12505*cos(2501*t))/12510004 - (5*sin(2499*t))/12490004 + (5*sin(2501*t))/12510004) + (19531265624997*exp(-t)*cos(t))/19531250000002 + (58593734375001*exp(-t)*sin(t))/19531250000002

**simple_sol =**

sin(t)*((5*cos(2499*t))/12490004 + (5*cos(2501*t))/12510004 + (12495*sin(2499*t))/12490004 + (12505*sin(2501*t))/12510004) - cos(t)*((12495*cos(2499*t))/12490004 - (12505*cos(2501*t))/12510004 - (5*sin(2499*t))/12490004 + (5*sin(2501*t))/12510004) + (19531265624997*exp(-t)*cos(t))/19531250000002 + (58593734375001*exp(-t)*sin(t))/19531250000002

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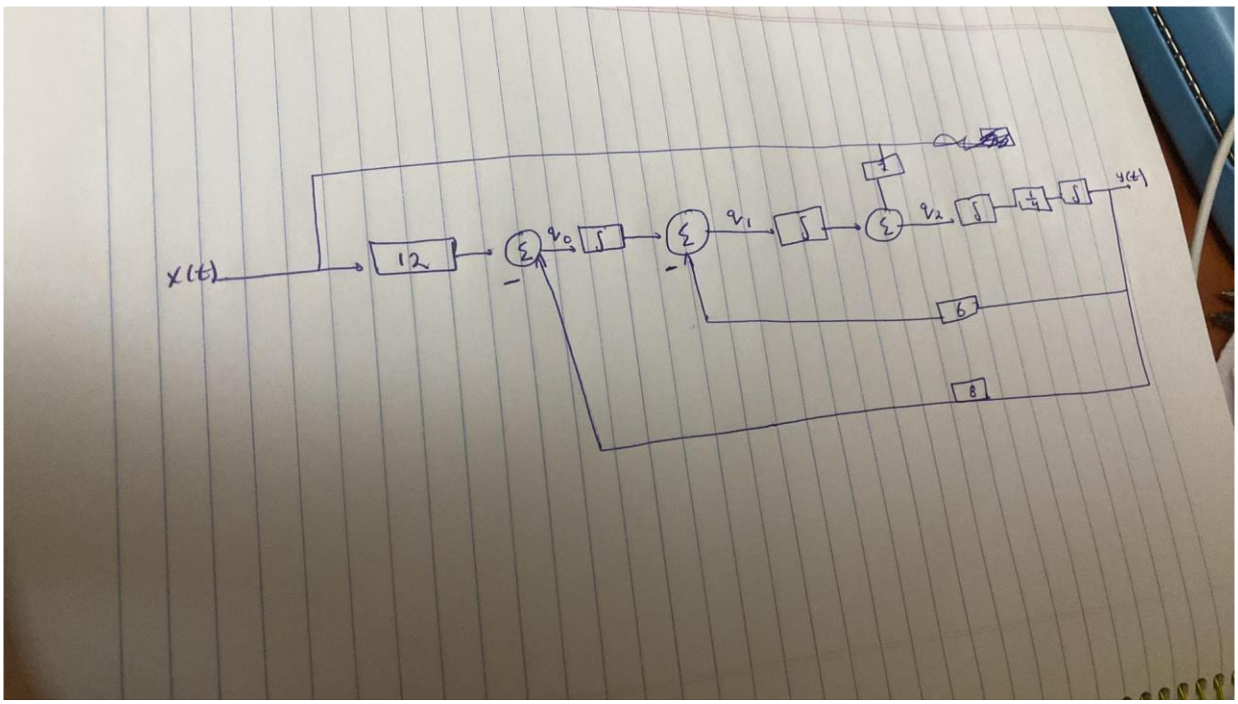
**Question V:**

Use Simulink (MATLAB) to simulate the following systems then show and plot the step response of the system.

1. $4\frac{d^4y(t)}{dt^4}+6\frac{dy(t)}{dt}+8y(t)=7\frac{d^2x(t)}{dt^2}+12x(t)$
2. $H(s)=\frac{100(s+3)}{(s+1)*(s+4)}+\frac{10}{(s+10)}$ (Hint: transform to differential equation form)

# 1-



$$4\frac{d^4y(t)}{dt^4}+6\frac{dy(t)}{dt}+8y(t)=7\frac{d^2x(t)}{dt^2}+12x(t)$$

$$\int 4\frac{d^4y(t)}{dt^4}+\int 6\frac{dy(t)}{dt}+\int 7\frac{d^2x(t)}{dt^2}=\int \underbrace{12x(t)-8y(t)}_{q_0}$$

$$4\frac{d^3y(t)}{dt^3}+6y(t)-7\frac{dx(t)}{dt}=\int q_0$$

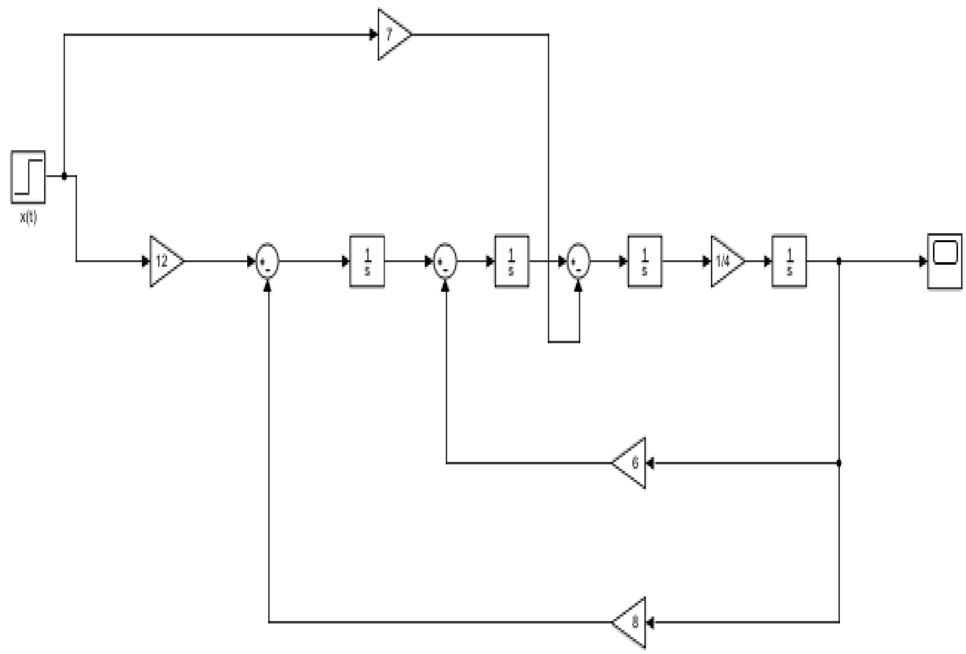
$$4\frac{d^3y(t)}{dt^3}\cancel{+6y(t)}-7\frac{dx(t)}{dt}=\underbrace{\int q_0-6y(t)}_{q_1}$$

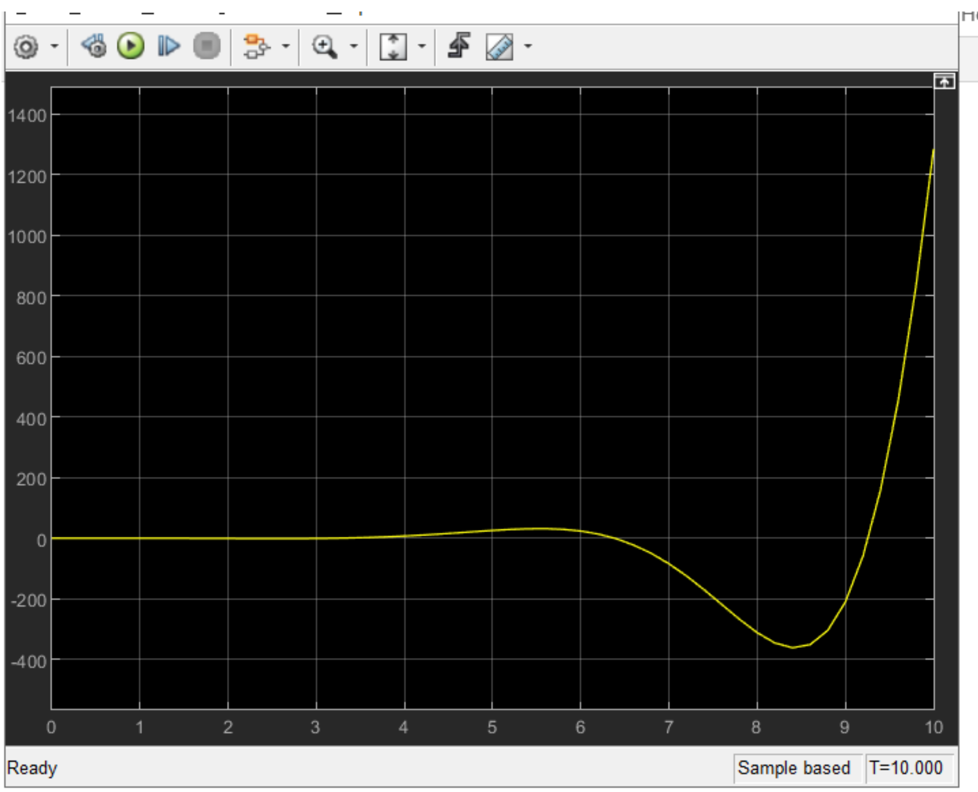
$$4\frac{d^2y(t)}{dt^2}=\underbrace{\int q_1+7x(t)}_{q_2}$$

$$\frac{1}{4}\cdot\frac{\overset{4\cancel{y(t)}}{4dy(t)}}{dt}=\underbrace{\int q_2\cdot\frac{1}{4}}_{q_3}$$

$$q_3=\frac{1}{4}$$

$$\boxed{y(t)=\int q_3}$$


7
x(t)
12
1/4
6
8


1400
1200
1000
800
600
400
200
0
-200
-400
0
1
2
3
4
5
6
7
8
9
10
Ready
Sample based
T=10.000

**2-**

$\boxed{2}$ $$H(s) = \frac{100(s+3)}{(s+1)(s+4)} + \frac{10}{(s+10)}$$

$$= \frac{(s+10)\,100(s+3)}{(s+10)\,s^2+5s+4} + \frac{10\,(s^2+5s+4)}{(s+10)(s^2+5s+4)}$$

$$H(s) = \frac{110s^2 + 1350s + 3040}{s^3 + 15s^2 + 54s + 40} = \frac{Y(s)}{X(s)}$$

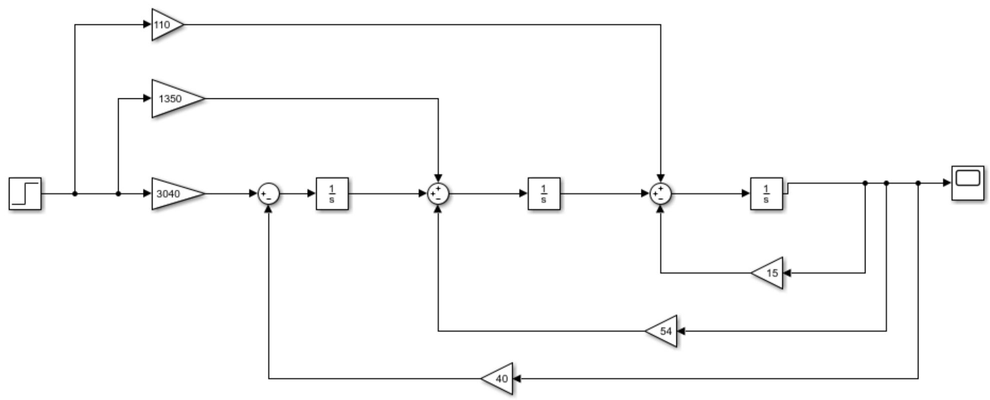
$$\frac{dy^3}{dt^3} + 15\frac{dy^2}{dt^2} + 54\frac{dy}{dt} + 40y = 110\frac{dx^2}{dt} + 1350\frac{dx}{dt} + 3040x$$

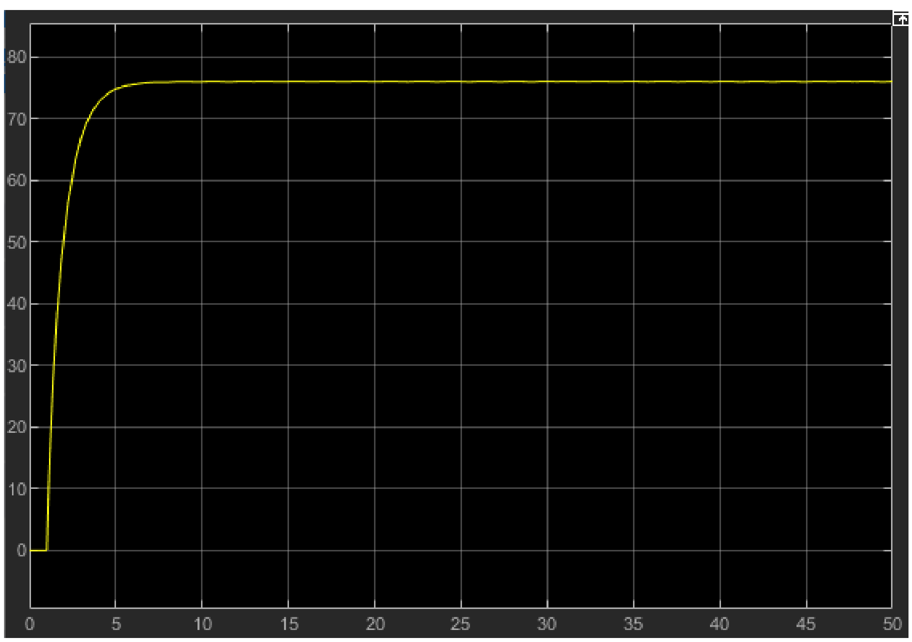
$$\frac{dy^3}{dt^3} + 15\frac{dy^2}{dt^2} + \frac{54}{\cancel{45}}\frac{dy}{dt}\ \cancel{-}\ 110\frac{dt^2}{dt} - 1350\frac{dx}{dt} = \int \underbrace{3040x - 40y}_{q_0}$$

$$\frac{d^2y}{dt^2} + \frac{15\,dy}{dt} - 110\frac{dy}{dt} = \int \underbrace{q_0 + 1350x - 54y}_{q_1}$$

$$\frac{dy}{dx} = \underbrace{\int q_1 + 110x - 15y}_{q_2}$$

$$\underbrace{y(t) = \int q_2}_{q_3}$$


110
1350
3040
1
s
1
s
1
s
15
54
40


80
70
60
50
40
30
20
10
0
0
5
10
15
20
25
30
35
40
45
50

**Question VI:**

Write a program that computes and plots the spectral representation of the function
1. $y(t) = (10e^{-10t})u(t)$
2. $y(t) = (10e^{-10t}\cos 100t)u(t)$

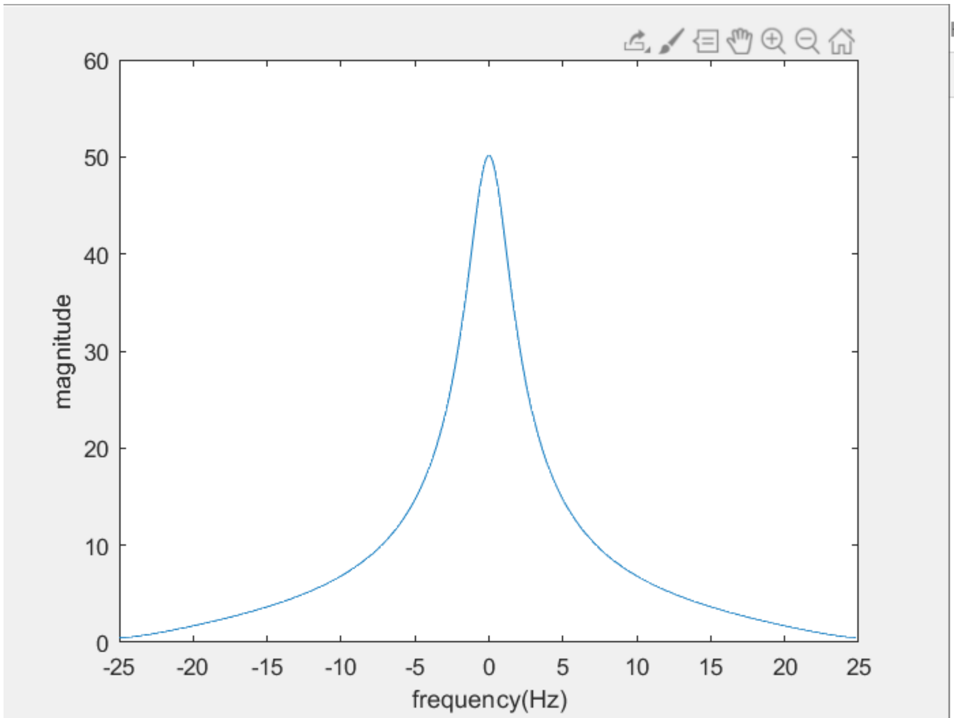
# 1-

Code

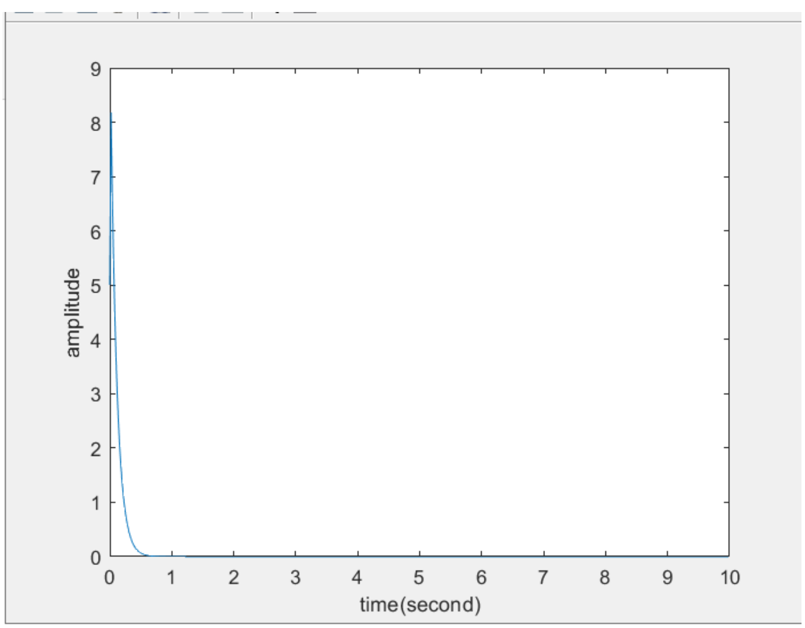
```
% Maha Mali
%1200746
clear all
close all
clc
Ts=1/50;
t=0:Ts:10;
x=(10*exp(-10.*t)).*heaviside(t);
plot(x,t,'r','lineWidth',2);
xlabel('time(sec)');
ylabel('Ampltude');
y=fft(x);
fs=1/Ts;
f=(0:length(y)-1)*fs/length(y);%definr freqancy axis
ymag=abs(y);
yphase=phase(y);
figure
plot(f,ymag,'b','lineWidth',2);
xlabel('Freqancy(Hz)');
ylabel('Magnitude');
title('Magnitude');
```

```
fs=1/Ts;
f= (0:length(y)-1) * fs/length(y);
figure
plot (f,abs(y));
xlabel ('frequency');
ylabel('magnitude');
title('Magnitude');
n= length(x);
fshift = (-n/2:n/2-1)*(fs/n);
yshift = fftshift (y);
figure
plot (fshift,abs(yshift));
xlabel('frequency(Hz)');
ylabel('magnitude');
```

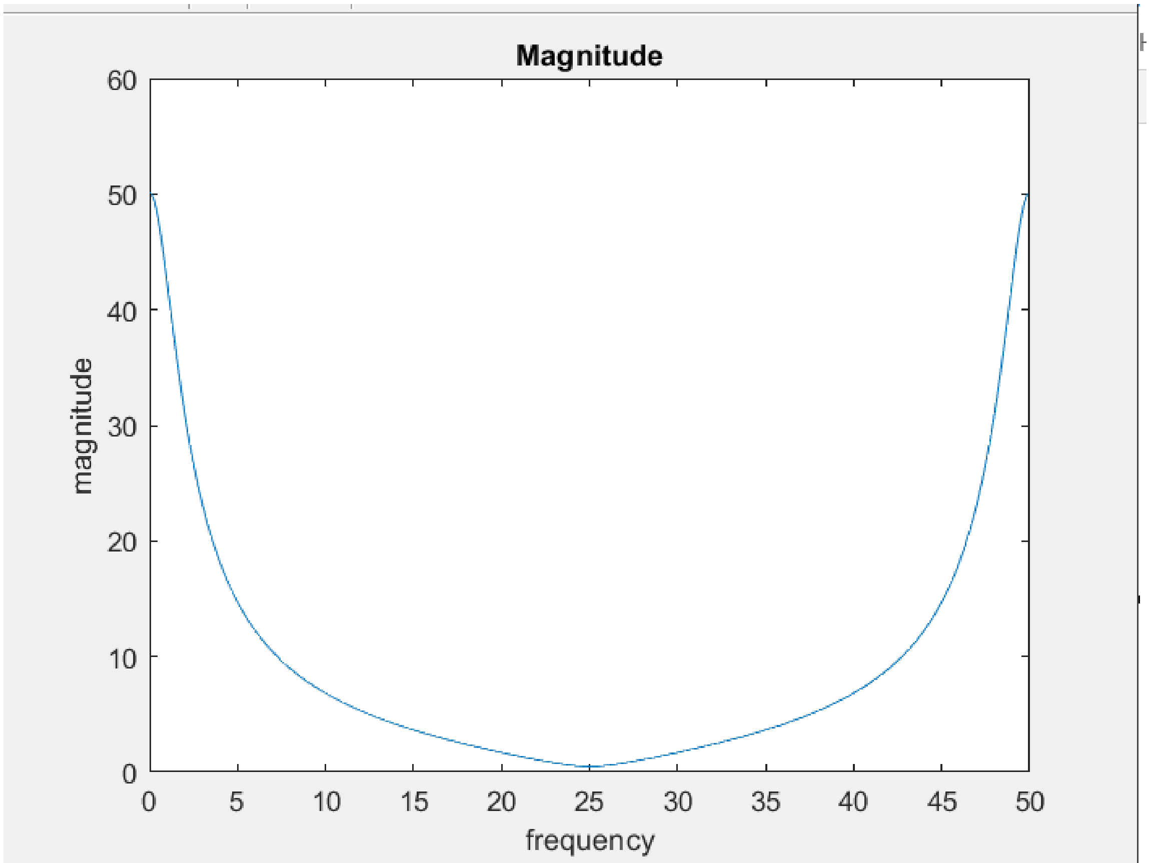
Plot



magnitude
60
50
40
30
20
10
0
-25
-20
-15
-10
-5
0
5
10
15
20
25
frequency(Hz)

amplitude
9
8
7
6
5
4
3
2
1
0
0
1
2
3
4
5
6
7
8
9
10
time(second)

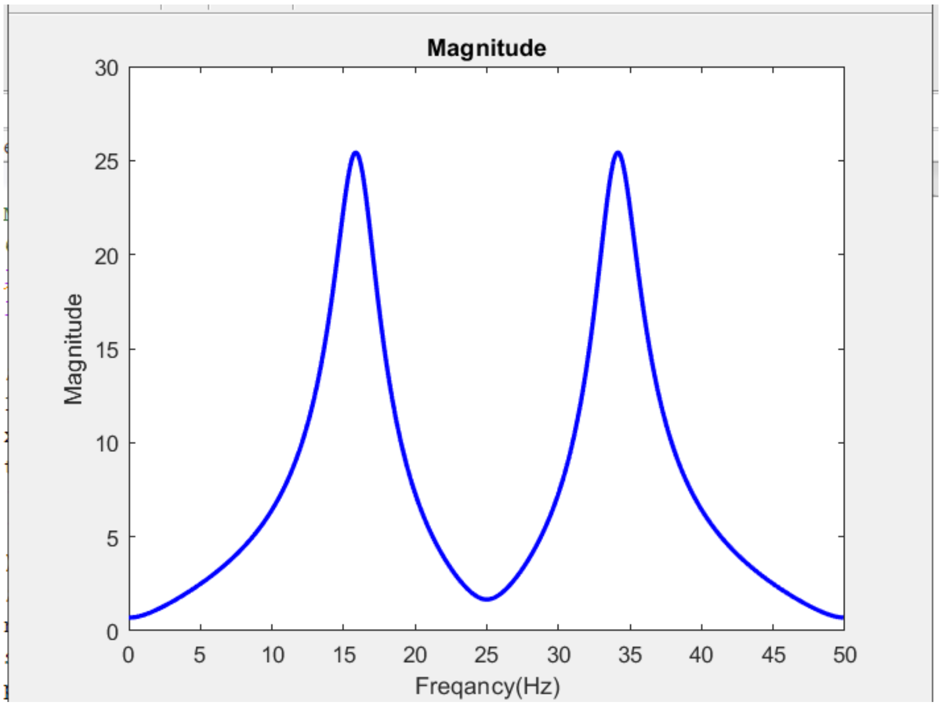


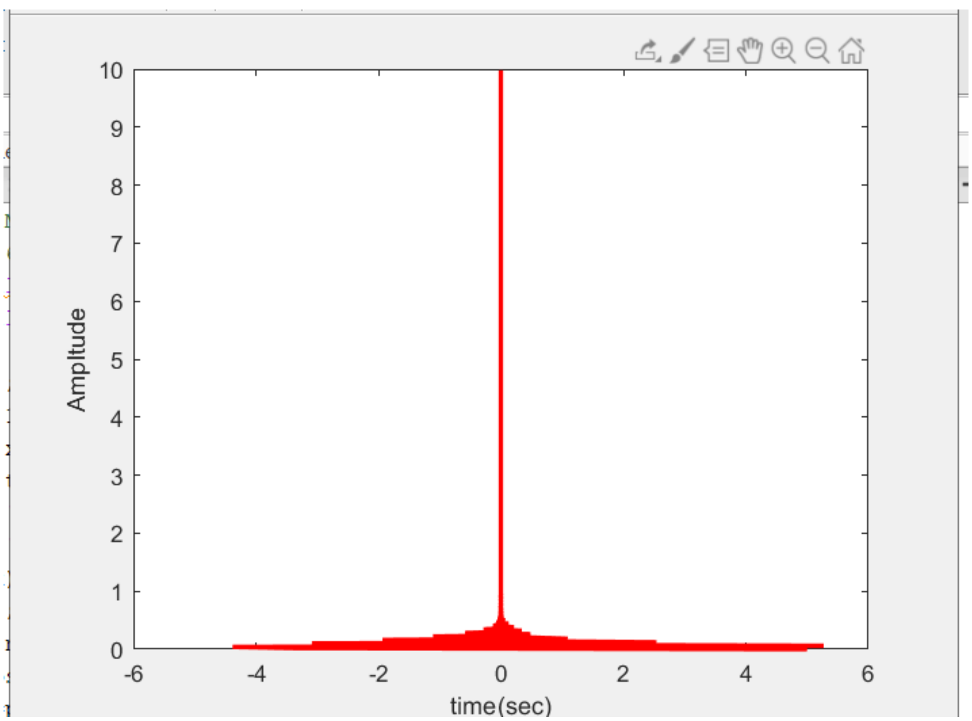

## 2-

Code

```
% Maha Mali
%1200746
clear all
close all
clc
Ts=1/50;
t=0:Ts:10-Ts;
x=(10*exp(-10.*t).*(cos(100*t))).*heaviside(t);
plot(x,t,'r','lineWidth',2);
xlabel('time(sec)');
ylabel('Ampltude');
y=fft(x);
fs=1/Ts;
f=(0:length(y)-1)*fs/length(y);%define freqancy axis
ymag=abs(y);
yphase=phase(y);
figure
plot(f,ymag,'b','lineWidth',2);
xlabel('Freqancy(Hz)');
ylabel('Magnitude');
title('Magnitude');
```

Plot :


Magnitude
30
25
20
15
10
5
0
Magnitude
0
5
10
15
20
25
30
35
40
45
50
Freqancy(Hz)


10
9
8
7
6
5
4
3
2
1
0
Amplitude
-6
-4
-2
0
2
4
6
time(sec)

**Question VII:**

Write a program that computes the Laplace and Fourier transforms of the function and plot the phase and amplitude spectra.

3. $y(t) = (10 - 10e^{-5t})u(t)$
4. $y(t) = (30 - 10e^{-8t}\cos 100t)u(t)$

# 3-

Code:

```
% Maha Mali
%1200746
clear all
close all
clc
syms t;
yt= (10-(10*exp(-5*t))).*heaviside(t);
syms f;
yf=fourier(yt,f);
ys=laplace(yt);
```

Solution:

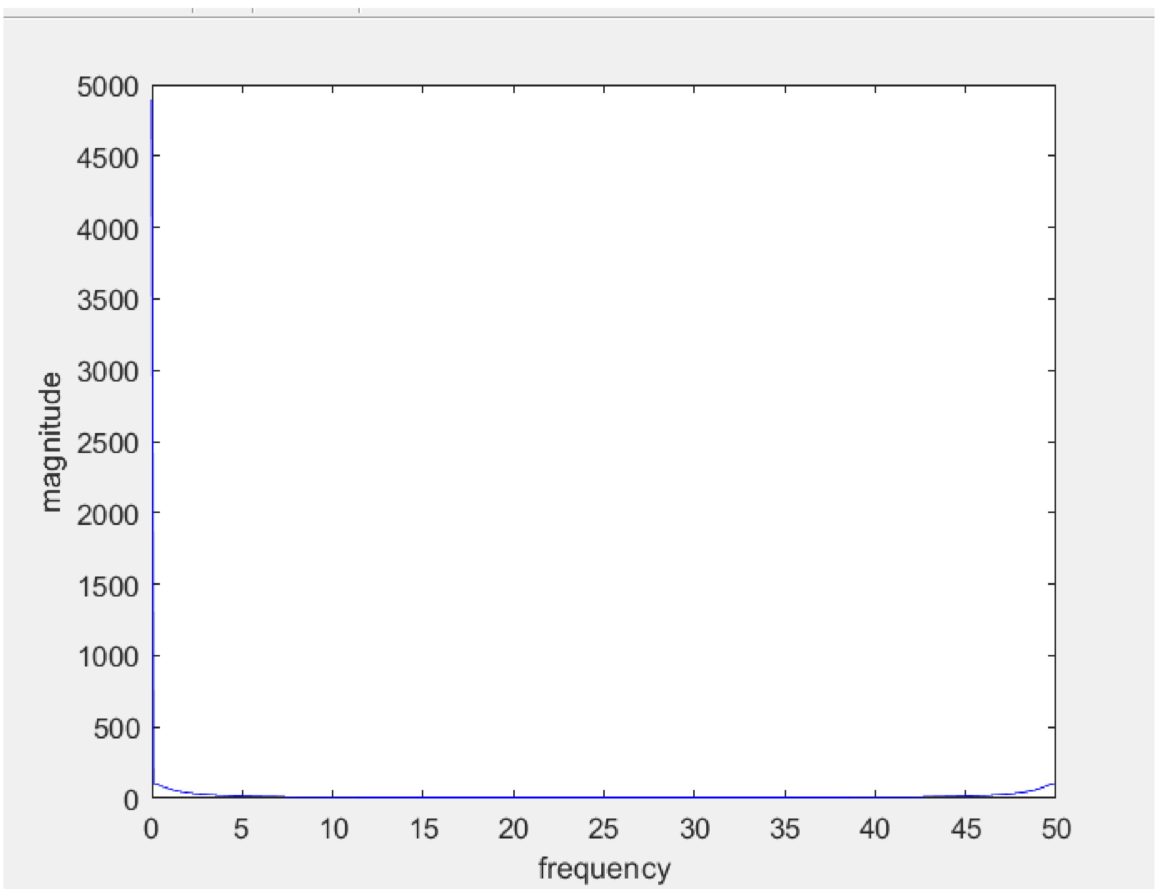
```
>> yf

yf =

10*pi*dirac(f) - 10/(5 + f*1i) - 10i/f

>> ys

ys =

10/s - 10/(s + 5)
```

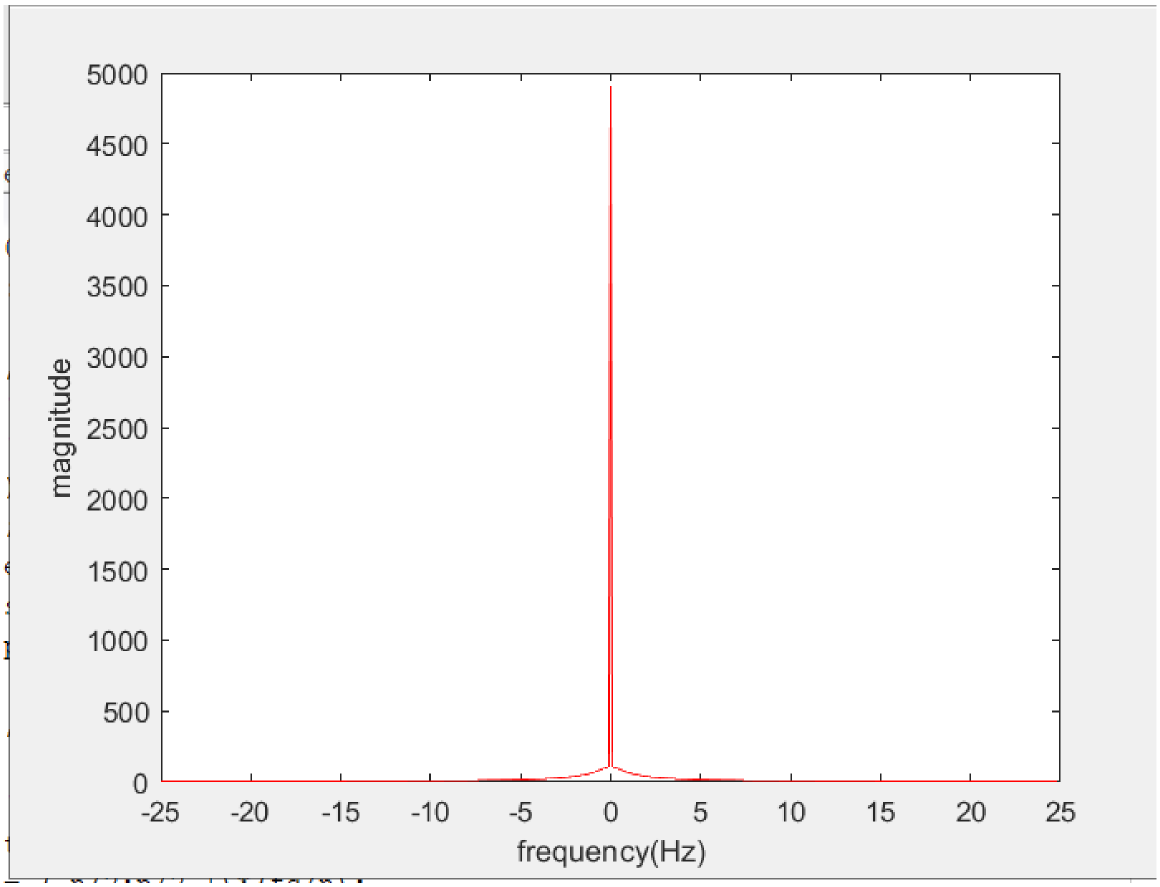
Plot:

+14 tray.m qustion7part1.m qustionsevenpart2.m qustion8.m q8part2.m qustion9pa

```
% Maha Mali
%1200746
clear all
close all
clc
syms t1
y= (10-(10*exp(-5*t1))).*heaviside(t1);
syms f1
yf=fourier(y,f1);
syms s1
ys=laplace(y,s1);
Ts = 0.02 ;
t= 0:Ts:10-Ts;
y= (10-(10*exp(-5*t))).*heaviside(t);
plot (t,y);
xlabel('time(second)');
ylabel('amplitude');
y=fft(y);
fs=1/Ts;
f= (0:length(y)-1) * fs/length(y);
ymag=abs(y);
yphase=phase(y);
```

```
yphase=phase(y);
figure
plot (f,ymag,'b');
xlabel ('frequency');
ylabel('magnitude');
n= length(y);
fshift = (-n/2:n/2-1)*(fs/n);
yshift = fftshift (y);
figure
plot (fshift,abs(yshift),'r');
xlabel('frequency(Hz)');
ylabel('magnitude');
```





5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
magnitude
-25
-20
-15
-10
-5
0
5
10
15
20
25
frequency(Hz)

## 4-

Code:

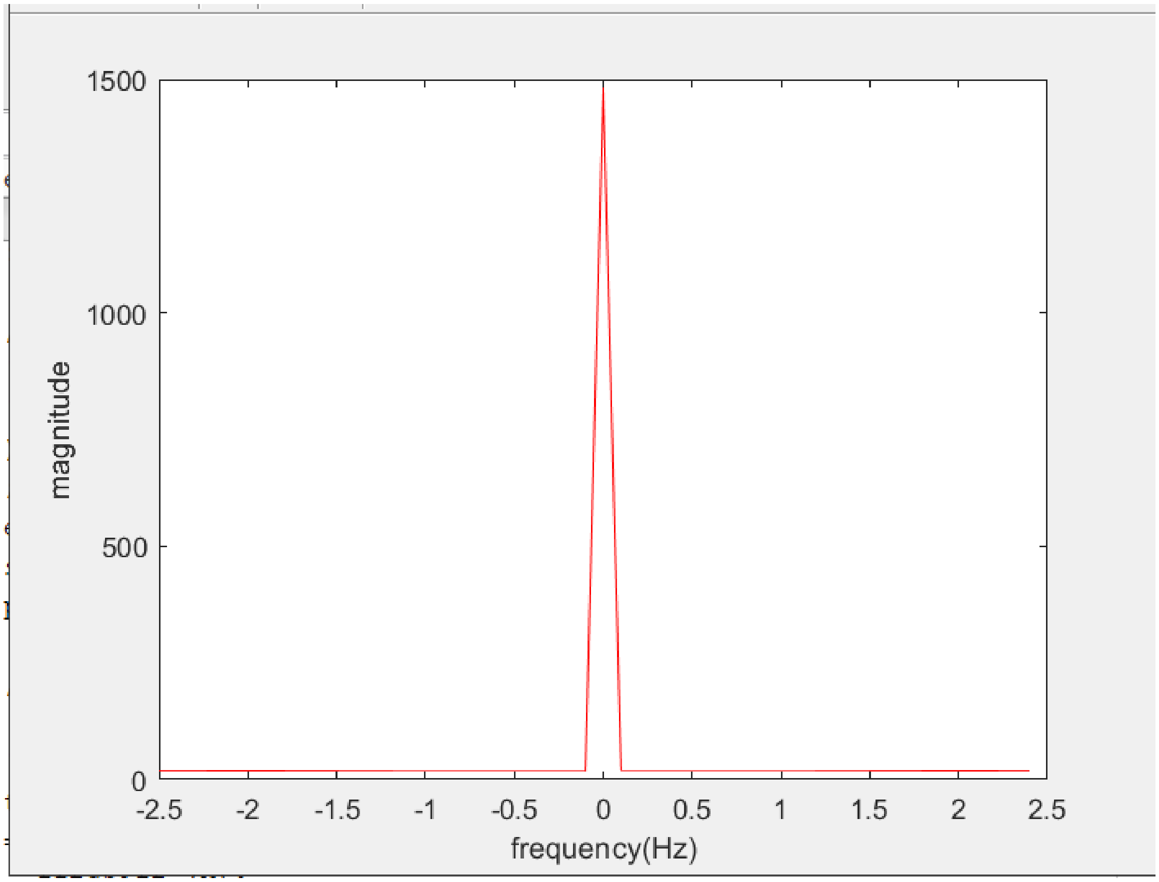
```
% Maha Mali
%1200746
clear all
close all
clc
syms t;
yt= (30-(10*exp(-8*t).*(cos(100*t)))).*heaviside(t);

syms f;
yf=fourier(yt,f);
ys=laplace(yt);
```

Solution:

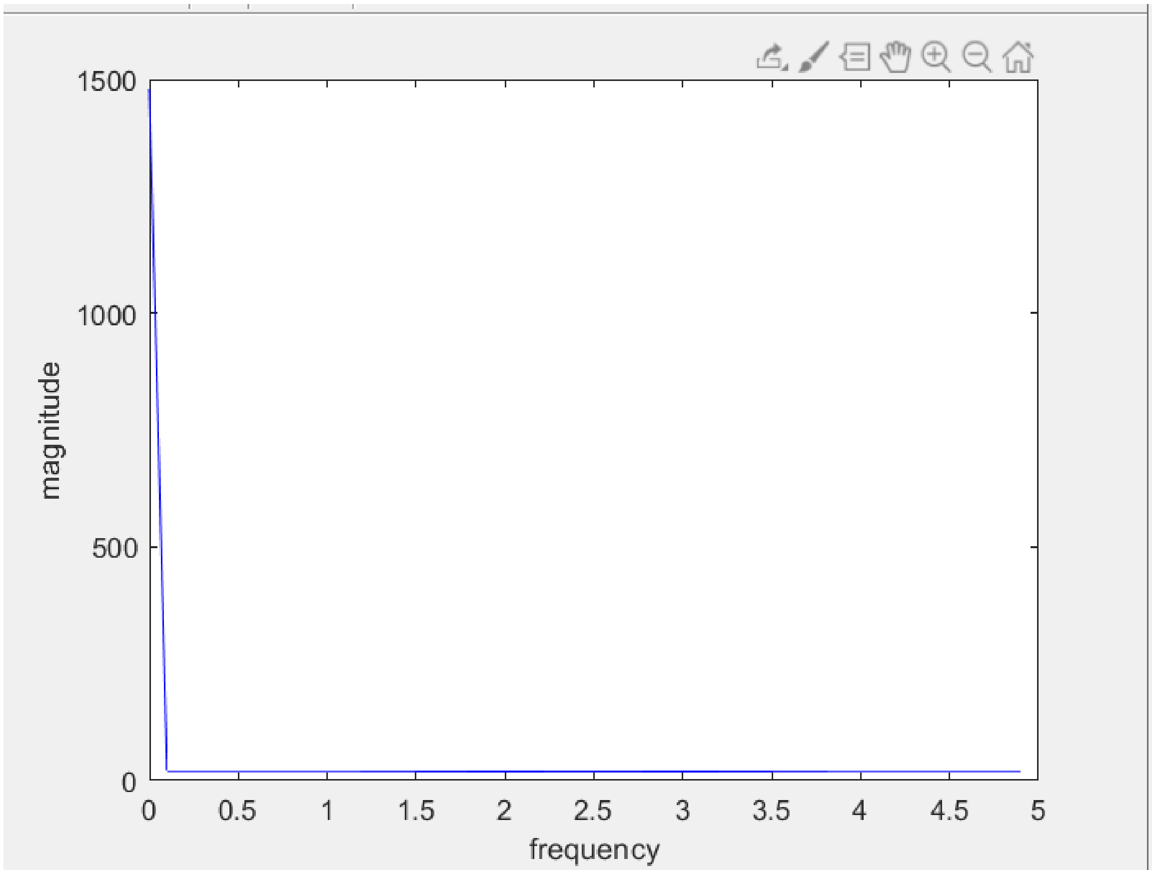
```
>> yf

yf =

30*pi*dirac(f) - 5/(f*1i + 8 - 100i) - 5/(f*1i + 8 + 100i) - 30i/f

>> ys

ys =

30/s - (10*(s + 8))/((s + 8)^2 + 10000)
```

Plot:

```
% Maha Mali
%1200746
clear all
close all
clc
syms t1
y= (30-(10*exp(-8*t1).*(cos(100*t1)))).*heaviside(t1);
syms f1
yf=fourier(y,f1);
syms s1
ys=laplace(y,s1);
Ts = 0.2 ;
t= 0:Ts:10-Ts;
y= (30-(10*exp(-8*t).*(cos(100*t)))).*heaviside(t);
plot (t,y);
xlabel('time(second)');
ylabel('amplitude');
y=fft(y);
fs=1/Ts;
f= (0:length(y)-1) * fs/length(y);
ymag=abs(y);
yphase=phase(y);
figure
plot (f,ymag,'b');
xlabel ('frequency');
ylabel('magnitude');
n= length(y);
fshift = (-n/2:n/2-1)*(fs/n);
yshift = fftshift (y);
figure
plot (fshift,abs(yshift),'r');
xlabel('frequency(Hz)');
ylabel('magnitude');
```



1500
1000
500
0
magnitude
-2.5
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
2.5
frequency(Hz)



1500
1000
500
0
magnitude
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
frequency

**Question VIII:**

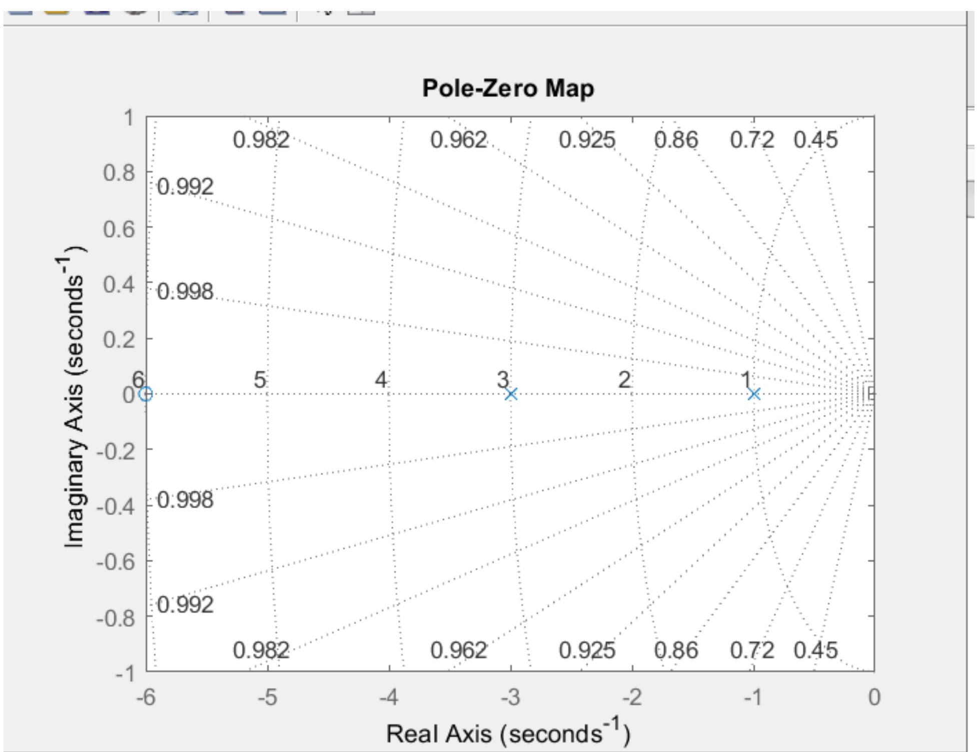
Write a program that define the transfer functions and plots the zero-pole map of the systems

1. with poles (-1,-3) and zero (-6)
2. with poles (-1, 1+2j and 1-2j) and zero at (-3)

**1-**code:

```
% Maha Mali
%1200746
clear all
close all
clc
system=tf([0 1 6],[1 4 3 ])
pzplot(system);
grid on
```

Plot:

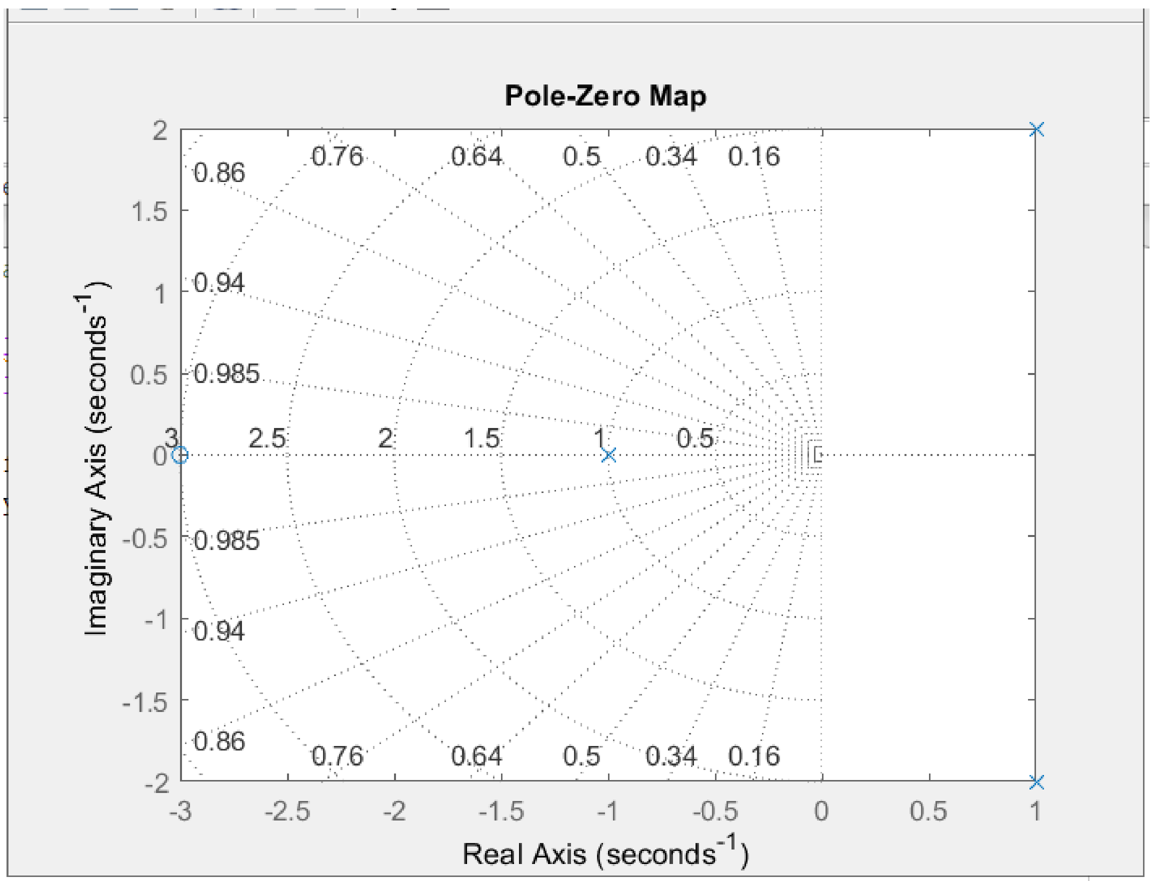


**2-**

Code:

```
% Maha Mali
%1200746
clear all
close all
clc
system=tf([0 1 3],[1 -1 3 5 ])
pzplot(system);
grid on
```

Plot:



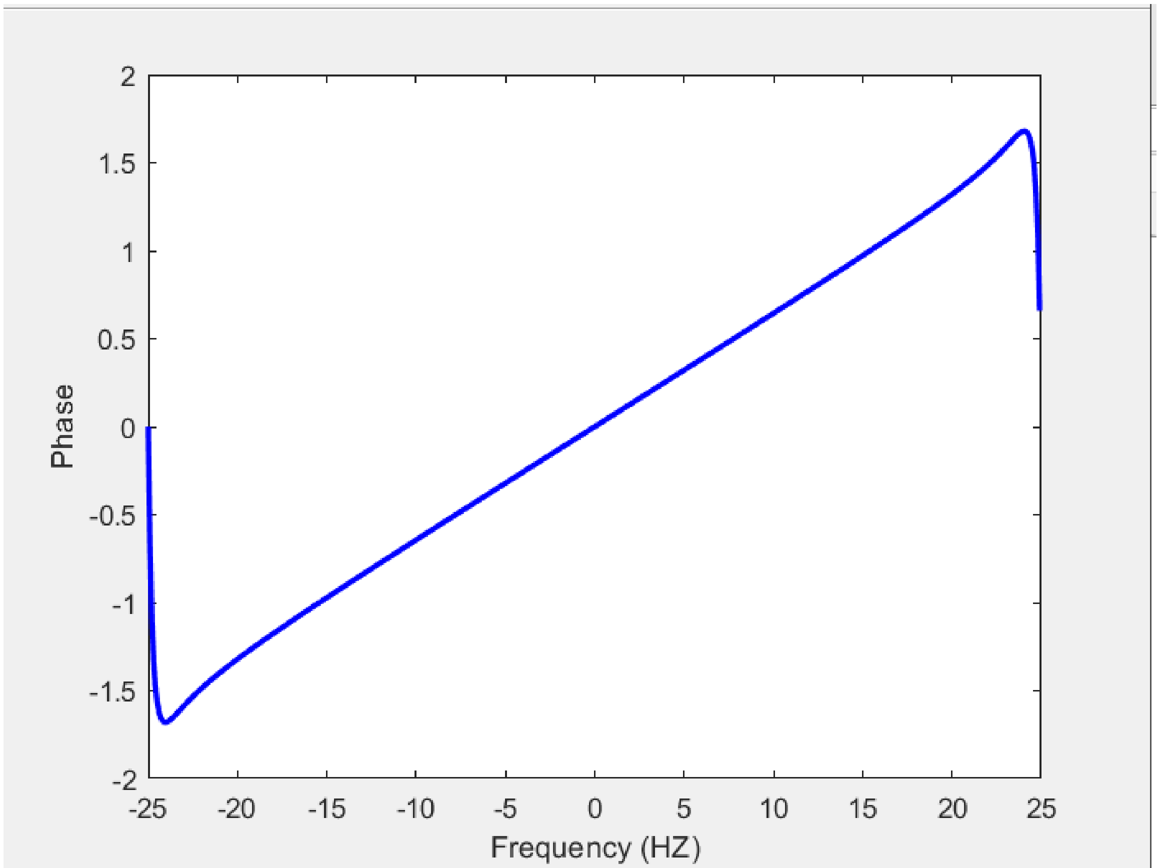
## Question IX:

Write a program that determine the inverse Laplace and Fourier transforms of the transfer functions in VIII and plot their phase and magnitude spectra.

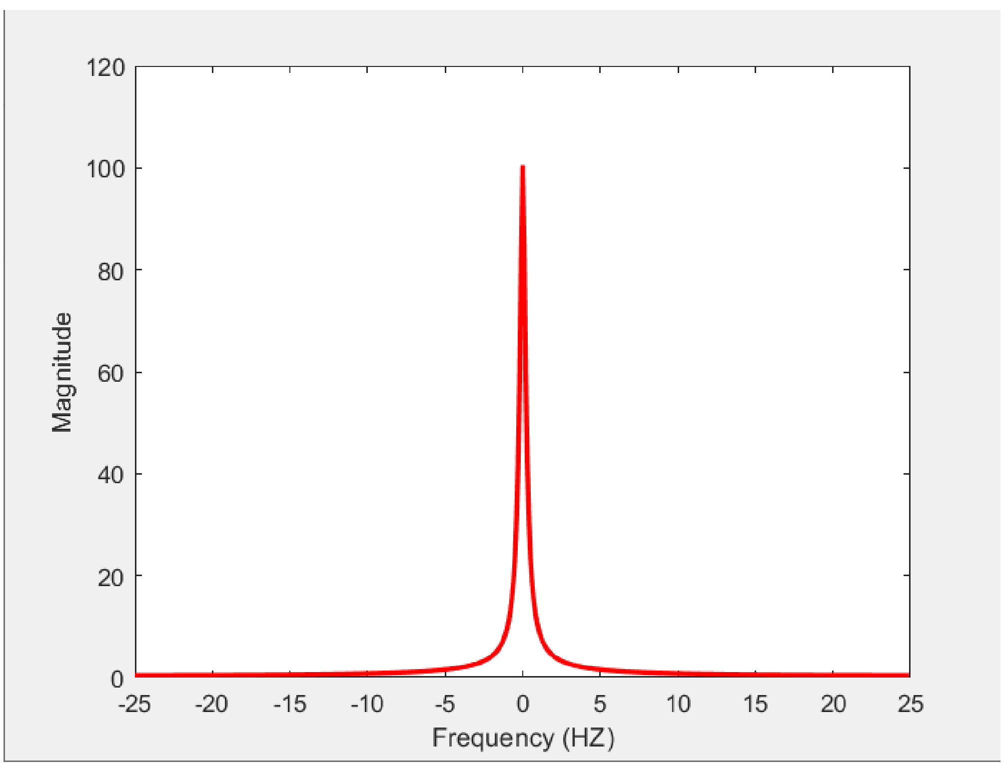
# 1-

```
% Maha Mali
%1200746
clear all
close all
clc
syms  s;
s1 = (s+6)/((s+1)*(s+3));
laplacInv = ilaplace(s1);
fy = fourier(laplacInv);
Ts = 1/50;
t=0:Ts:10-Ts;
y1 = fft((5*exp(-t))/2 - (3*exp(-3*t))/2);
fs = 1/Ts;
f = (0:length(y1)-1)*fs/length(y1);

figure
n= length(y1);
fshift = (-n/2:n/2-1)*(fs/n);
yshift = fftshift(y1);
ymag = abs(yshift);
plot(fshift,ymag)
```

```
xlabel('Frequency (HZ)')
ylabel('Magnitude')

y1phase = phase(y1);
figure
plot(fshift,y1phase)
xlabel('Frequency (HZ)')
ylabel('Phase')
```



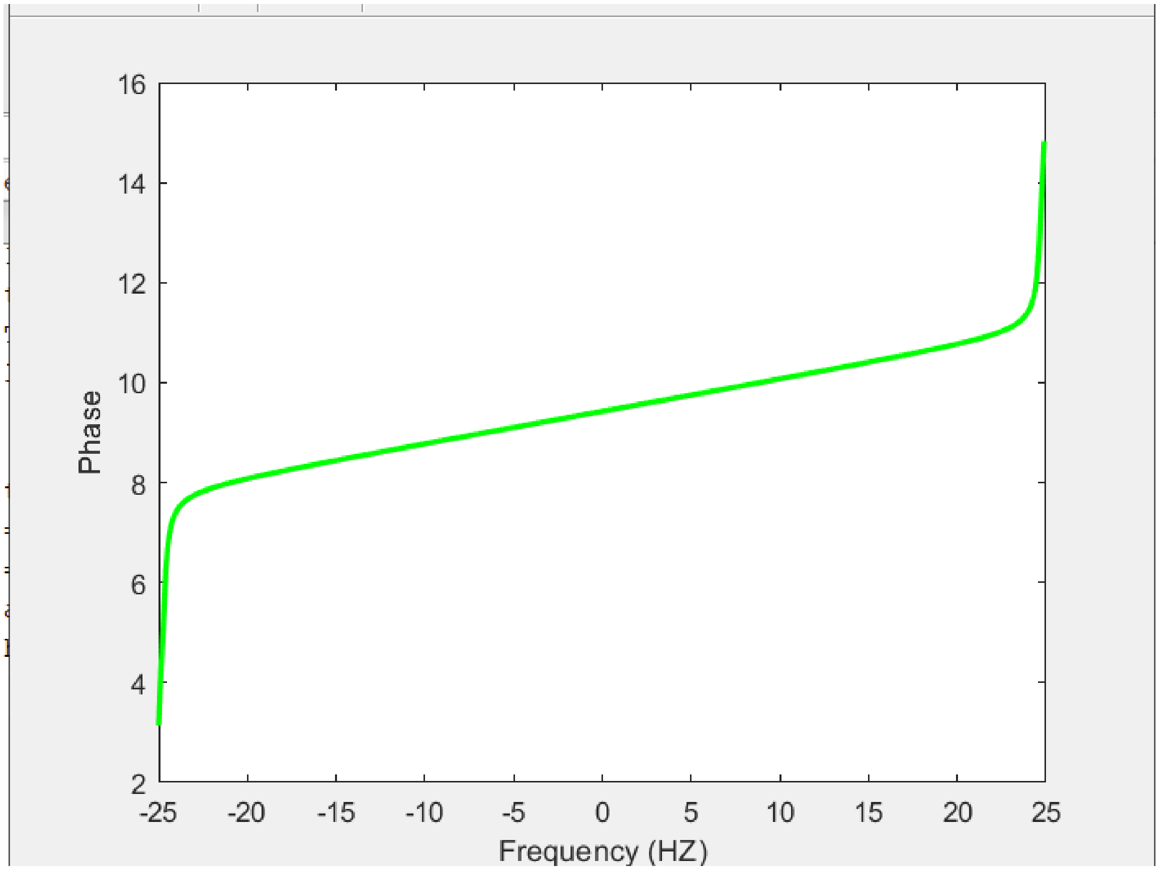
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
Phase
-25
-20
-15
-10
-5
0
5
10
15
20
25
Frequency (HZ)

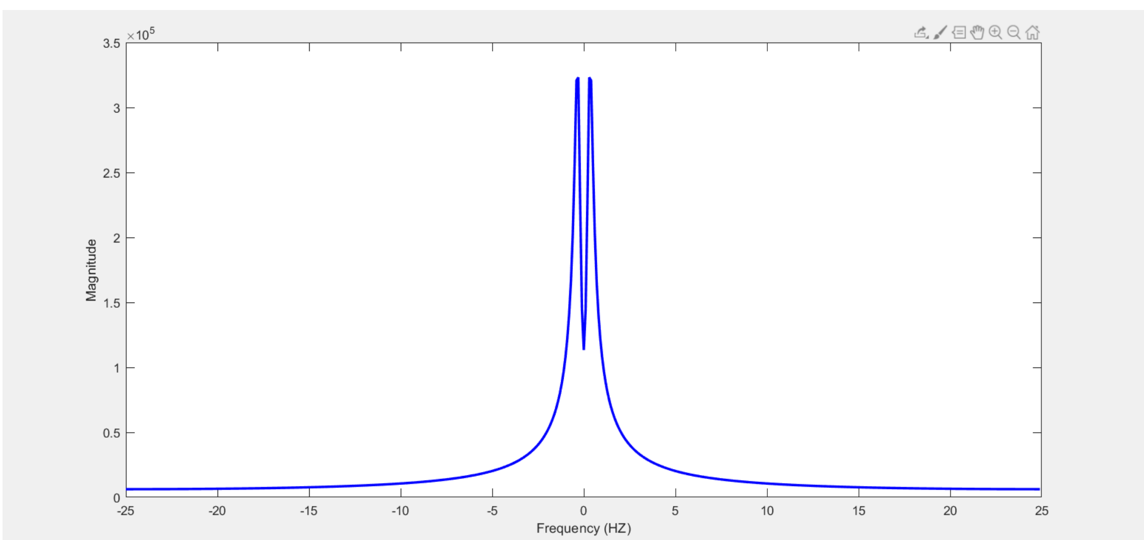
120
100
80
60
40
20
0
Magnitude
-25
-20
-15
-10
-5
0
5
10
15
20
25
Frequency (HZ)

**2-**

```matlab
% Maha Mali
%1200746
clear all
close all
clc
syms  s;
s1 =  (s+3)/(s^3-s^2+3*s+5);
laplacInv = ilaplace(s1);
fy = fourier(laplacInv);
Ts = 1/50;
t=0:Ts:10-Ts;
y1 = fft(exp(-t)/4 - (exp(t).*(cos(2*t) - 3.*sin(2*t)))/4);
fs = 1/Ts;
f = (0:length(y1)-1)*fs/length(y1);

figure
n= length(y1);
fshift = (-n/2:n/2-1)*(fs/n);
yshift = fftshift(y1);
ymag = abs(yshift);
plot(fshift,ymag,'b','lineWidth',2);
xlabel('Frequency (HZ)')
ylabel('Magnitude')

y1phase = phase(y1);
figure
plot(fshift,y1phase,'g','lineWidth',2)
xlabel('Frequency (HZ)')
ylabel('Phase')
```



Phase
Frequency (HZ)

Magnitude
Frequency (HZ)