BIRZEIT UNIVERSITY

Birzeit University-Faculty Of Engineering

Electrical Engineering Department

Signals and Systems –EE2312

MATLAB _Assignment I

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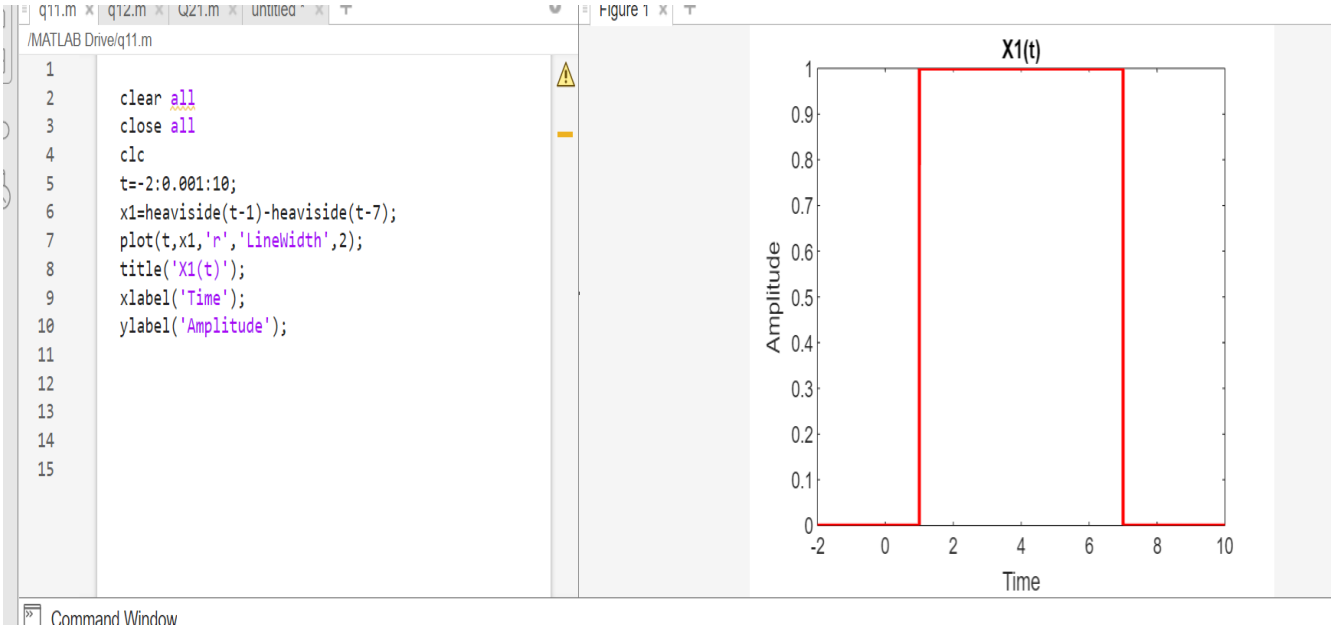
Question I >> Generate and plot the following signals using MATLAB:

1- X1(t) = u(t-1)- u(t-7)

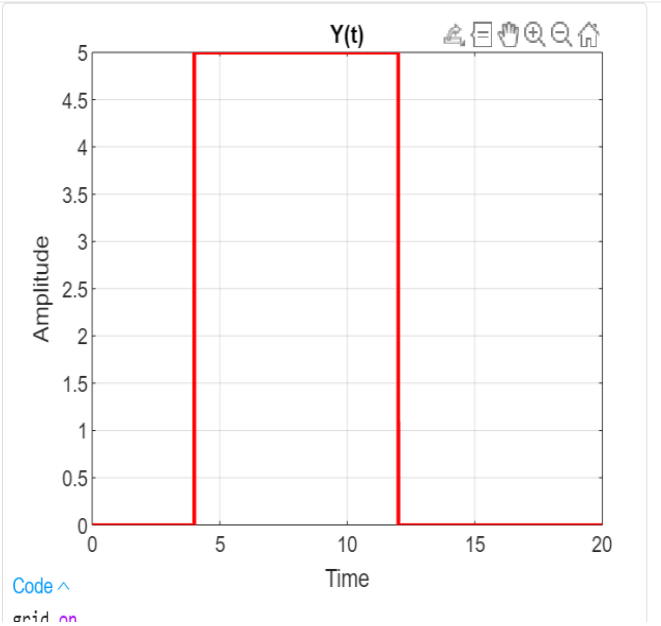
>> Code and Graph:



2- A finite pulse (π(t)) with value = 5 and extension between and center=8

>> Code and Graph:

```
clear all
close all
clc
t=0:0.001:20;
y=5*rectangularPulse(4,12,t);
plot(t,y,'r','LineWidth',2);
title('Y(t)');
xlabel('Time');
ylabel('Amplitude');
```

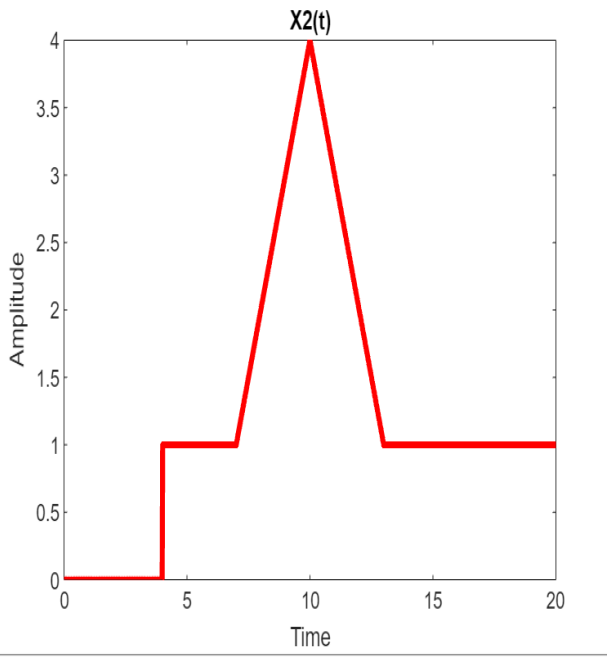


3- X2(t)= u(t-4) +r(t-7)-2r(t-10) +r(t-13) in the time interval [0 20]

>>Code and Graph:

/MATLAB Drive/q12.m

```
1   clear all
2   close all
3   clc
4   t=0:0.01:20;
5   u=heaviside(t-4);
6   r1=(t-7).*heaviside(t-7);
7   r2=(t-10).*heaviside(t-10);
8   r3=(t-13).*heaviside(t-13);
9   x2=u+r1-2*r2+r3;
10  plot(t,x2,'r','LineWidth',3);
11  title('X2(t)');
12  xlabel('Time');
13  ylabel('Amplitude');
14
```



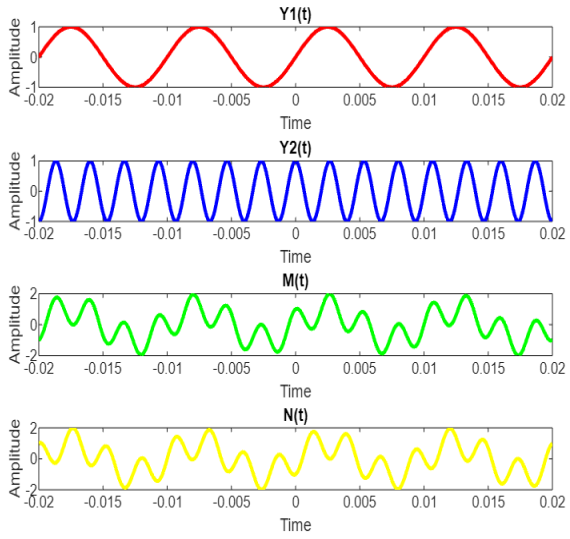
Question II :

1- Generate and plot the signals y1(t)= sin 200π(t), y2(t)= cos750πt, then determine y1 and plot the signals m(t)= y1+y2 and n(t)= y1-y2.

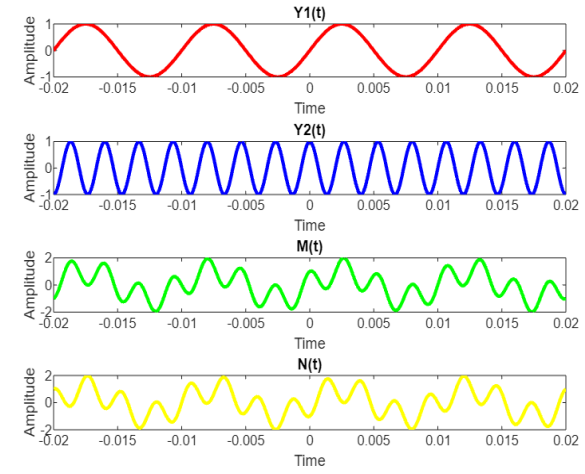
>>Code and Graph:

/MATLAB Drive/Q21.m

```
1   clear all
2   close all
3   clc
4   t=-0.02:0.0001:0.02;
5   Y1=sin(200.*pi.*t);
6   Y2=cos(750.*pi.*t);
7   M=Y1+Y2;
8   N=Y1-Y2;
9
10  subplot(4,1,1);
11  plot(t,Y1,'r','LineWidth',2);
12  title('Y1(t)');
13  xlabel('Time');
14  ylabel('Amplitude');
15
16  subplot(4,1,2);
17  plot(t,Y2,'b','LineWidth',2);
18  title('Y2(t)');
19  xlabel('Time');
20  ylabel('Amplitude');
21
22
23  subplot(4,1,3);
```

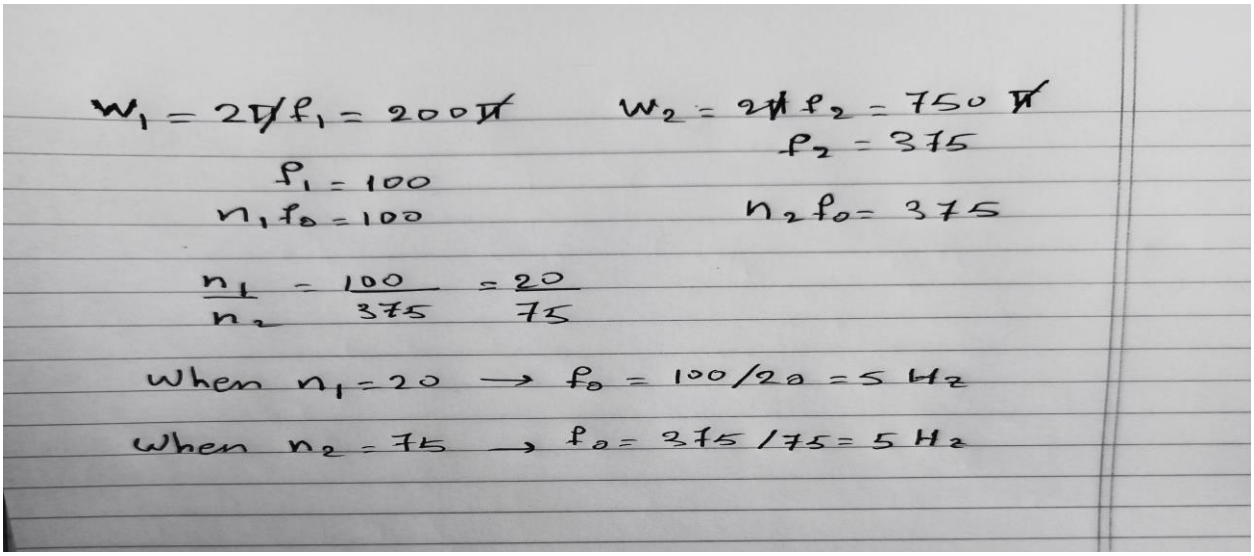


```
ylabel('Amplitude');

subplot(4,1,2);
plot(t,Y2,'b','LineWidth',2);
title('Y2(t)');
xlabel('Time');
ylabel('Amplitude');


subplot(4,1,3);
plot(t,M,'g','LineWidth',2);
title('M(t)');
xlabel('Time');
ylabel('Amplitude');
subplot(4,1,4);
plot(t,N,'y','LineWidth',2);
title('N(t)');
xlabel('Time');
ylabel('Amplitude');
```



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.)

The sum and difference of the signals are periodic and the fundamental frequency is 5HZ



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

1- 5 dy(t)/dt + 20y(t) = 15

>>Code and soluation:

/MATLAB Drive/q31.m

```
1   clear all
2   close all
3   clc
4   syms y(t);
5   dy(t)=diff(y(t),t);
6   initial_condition2=y(0)==0;
7   cond=[initial_condition2];
8   equation=5*dy(t)+20*y(t)==15;
9   solution=dsolve(equation,cond)
10  simple_solution=simplify(solution);
```

Command Window

New to MATLAB? See resources for Getting Started.

```
solution =

3/4 - (3*exp(-4*t))/4

>>
```

2-d 2y(t) /dt 2 + 2 dy dt + 4y(t) = 5 cos1000t.

>>Code and soluation:

AB Drive

q122.m | Q21.m | q12.m | q11.m | q31.m

/MATLAB Drive/q31.m

```
1   clear all
2   close all
3   clc
4   syms y(t);
5   dy(t)=diff(y,t);
6   dy2(t)=diff(y,t,2);
7   initial_condition1=y(0)==0;
8   initial_condition2=dy(0)==0;
9   equation= dy2(t)+2*dy(t)+4*y(t)==5*cos(1000*t);
10  solution=dsolve(equation,initial_condition1,initial_condition2)
11  simple_solution=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))
```

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-dy(t) /dt + 2y(t) = 7u(t) $y(0) = 2$;

>>Code and soluation:

```
1  clear all
2  close all
3  clc
4  syms y(t);
5  dy(t)=diff(y(t),t);
6  initial_condition1=y(0)==2;
7  equation=dy(t)+2*y(t)==7*heaviside(t);
8  solution=dsolve(equation,initial_condition1)
9  simple_solution=simplify(solution);
```

Command Window

New to MATLAB? See resources for Getting Started.

```
solution =

exp(-2*t)/4 - exp(-2*t)*((7*sign(t))/4 - (7*exp(2*t)*(sign(t) + 1))/4)

>>
```

2-d 2y(t)/ dt2 + 4 dy /dt + 5y(t) = 5 cos2000t (y (0) =1, y' (0) =2);

>>Code and soluation:

```
clear all
close all
clc
syms y(t);
dy(t)=diff(y,t);
dy2(t)=diff(y,t,2);
initial_condition1=y(0)==1;
initial_condition2=dy(0)==2;
equation=dy2(t)+4*dy(t)+5*y(t)==5*cos(2000*t);
solution=dsolve(equation,initial_condition1,initial_condition2)
simple_solution=simplify(solution);
```

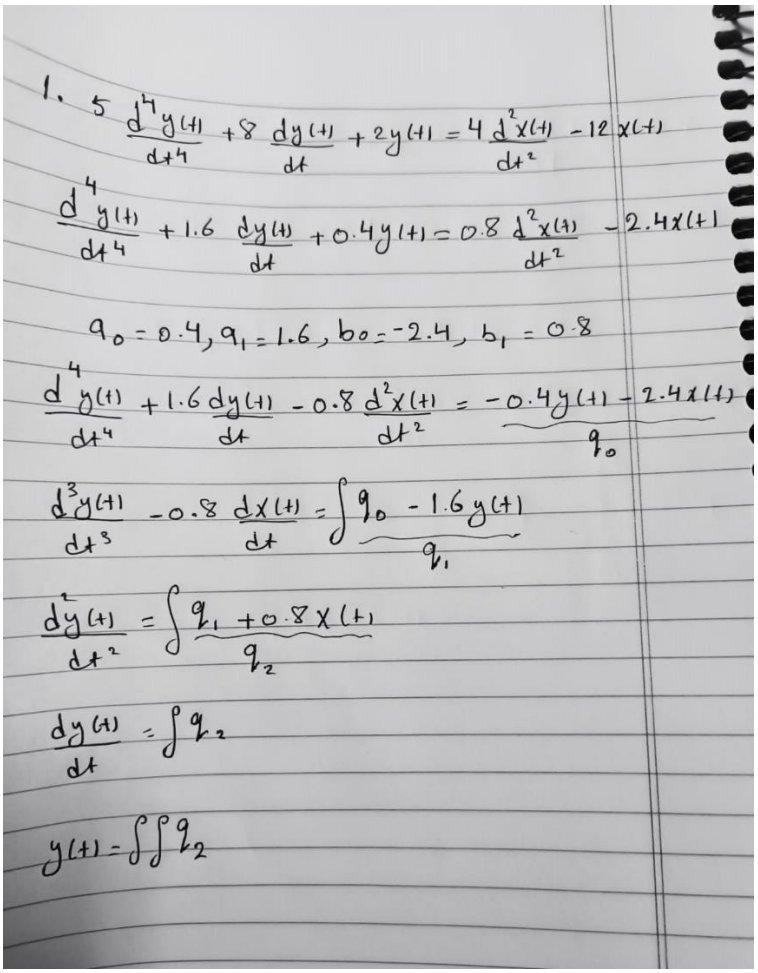
Solution=

sin(t)*(cos(1999*t)/799201 + cos(2001*t)/800801 + (1999 sin(1999*t))/1598402 + (2001*sin(2001*t))/1601602) - cos(t) ((1999*cos(1999*t))/1598402 - (2001*cos(2001*t))/1601602- sin(1999*t)/799201 + sin(2001*t)/800801) + (640001760000*exp(-2*t)*cos(t))/640000960001 + (2560002240002*exp(-2*t)*sin(t))/640000960001

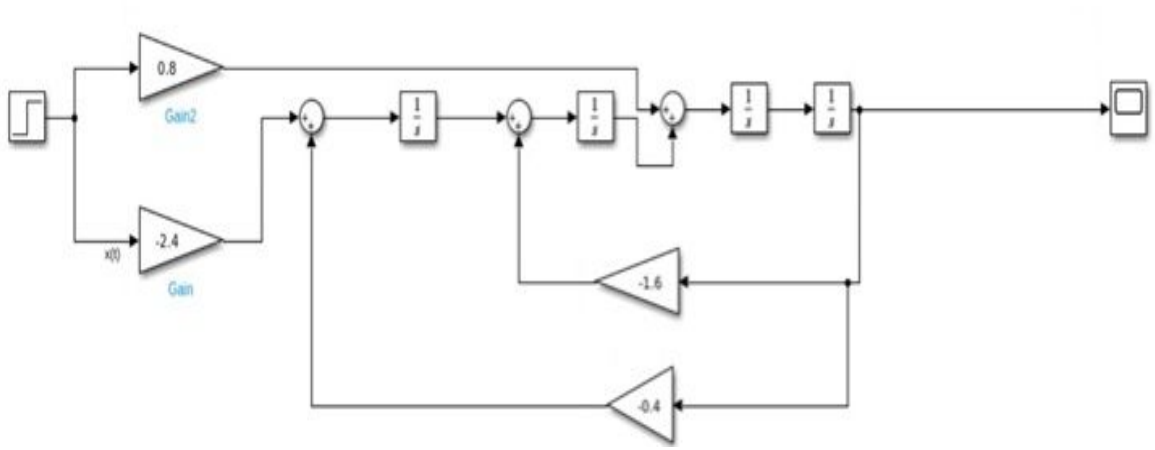
Question V: Use Simulink (MATLAB) to simulate the following systems then show and plot the step response of the system.

1-5 d 4 $y(t)/\ dt$ 4 + 8 $dy(t)\ /dt$ + 2$y(t)$ = 4 d 2 $x(t)\ /dt$ 2 – 12$x(t)$

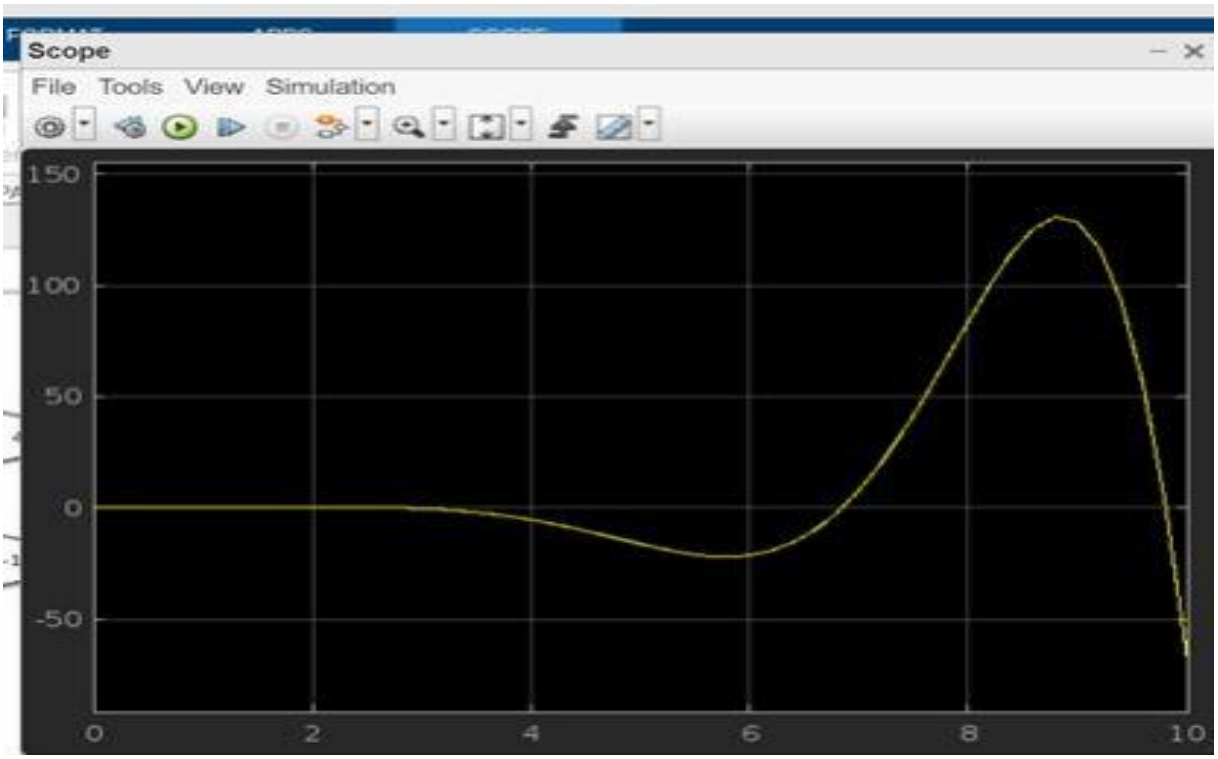
Solution:



Simulation:

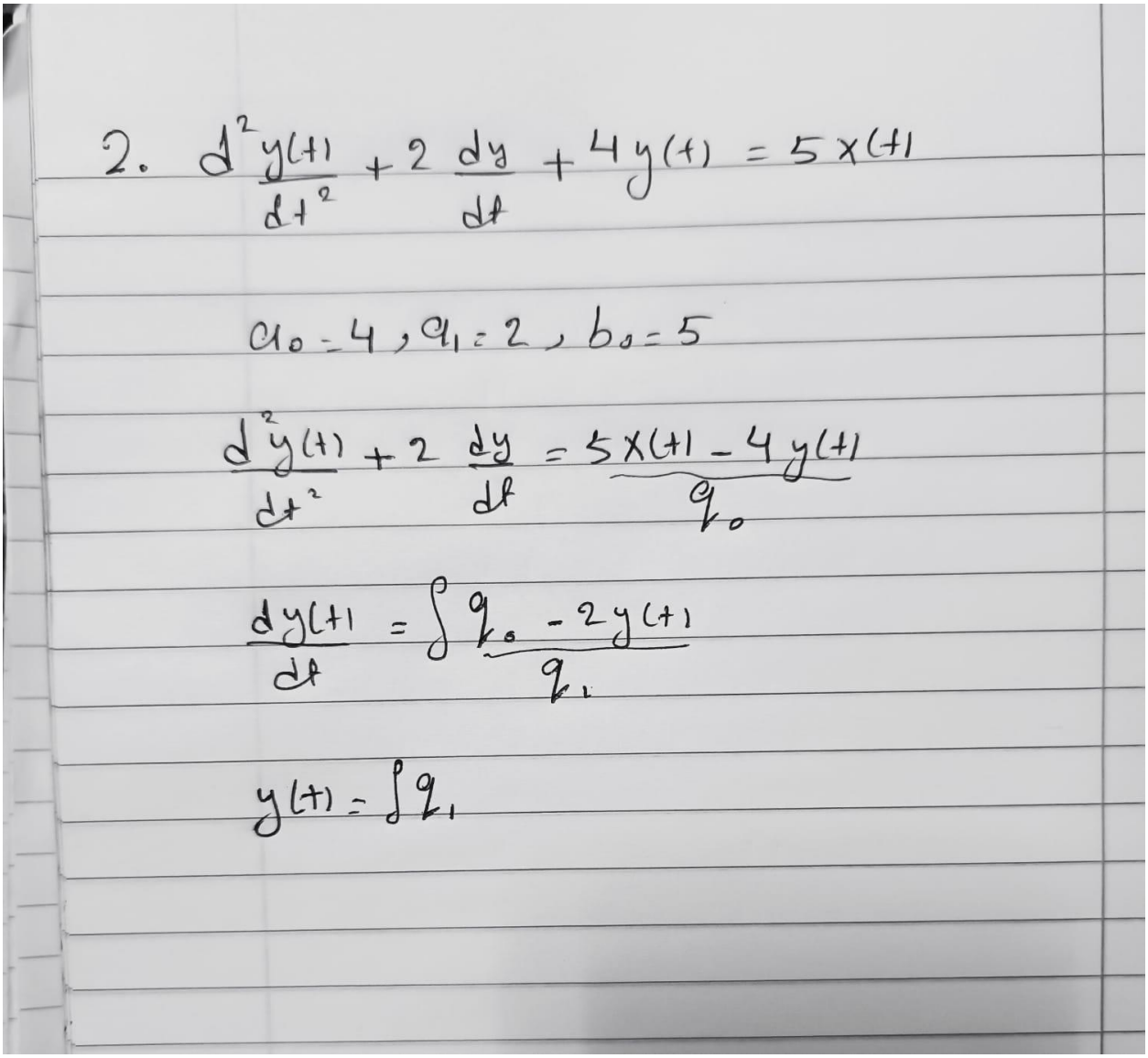


Graph:

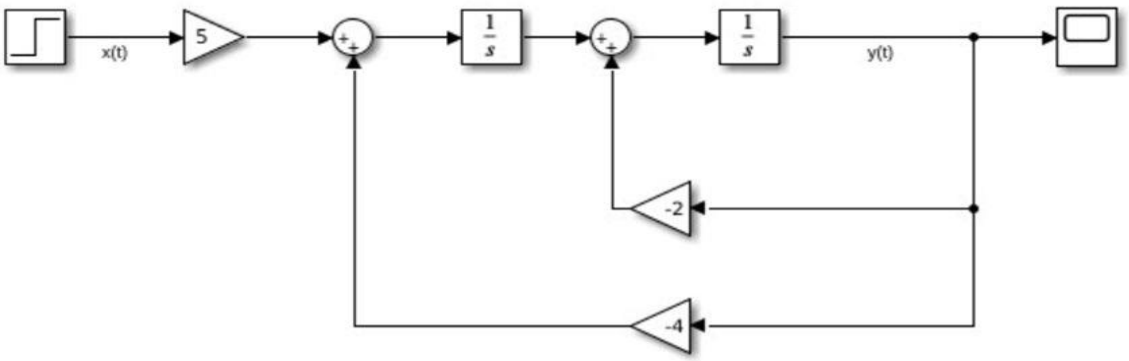


2-d 2y(t) /dt 2 + 2 dy /dt + 4y(t) = 5 $x(t)$

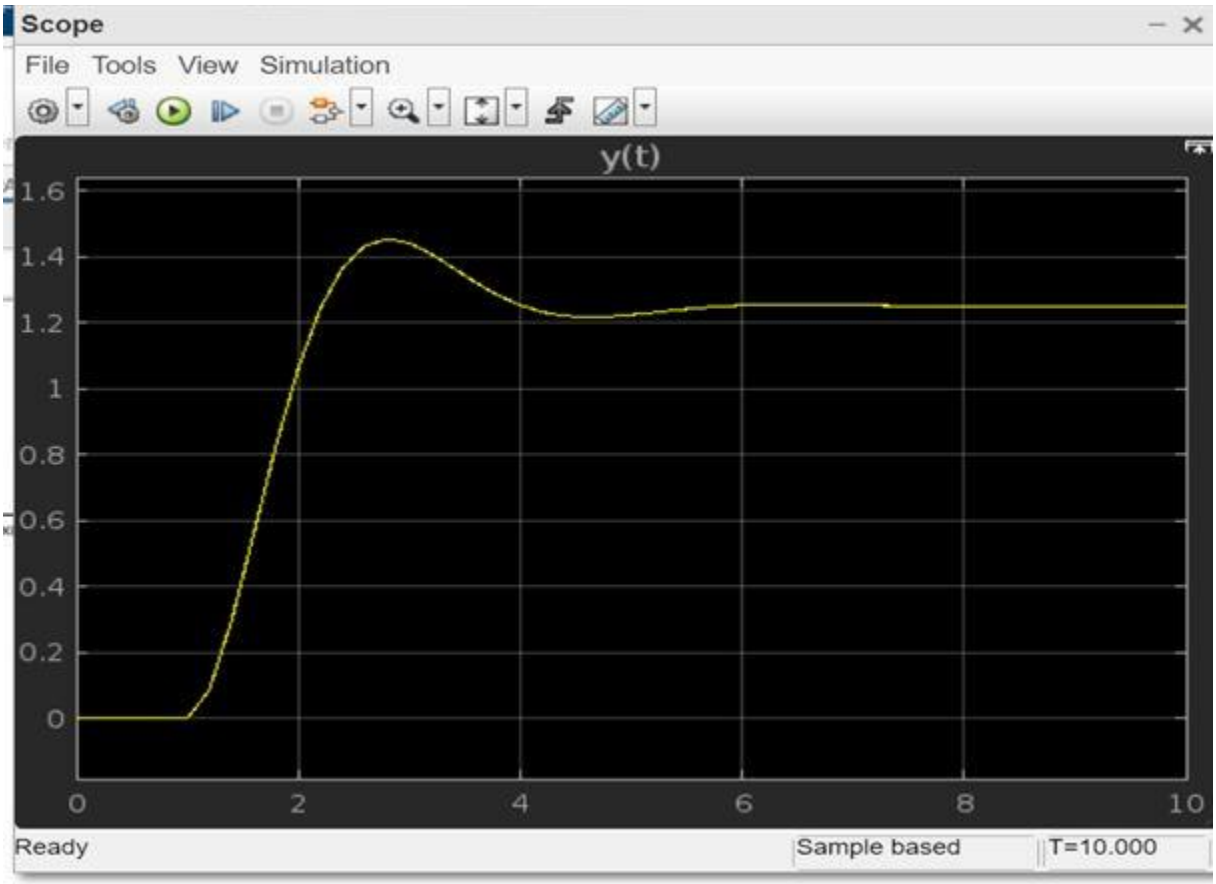
Solution:


2. $\frac{d^2y(t)}{dt^2} + 2\frac{dy}{dt} + 4y(t) = 5x(t)$
$a_0 = 4, a_1 = 2, b_0 = 5$
$\frac{d^2y(t)}{dt^2} + 2\frac{dy}{dt} = \underbrace{5x(t) - 4y(t)}_{q_0}$
$\frac{dy(t)}{dt} = \int \underbrace{q_0 - 2y(t)}_{q_1}$
$y(t) = \int q_1$

Simulation:


x(t)
5
1
s
1
s
y(t)
-2
-4

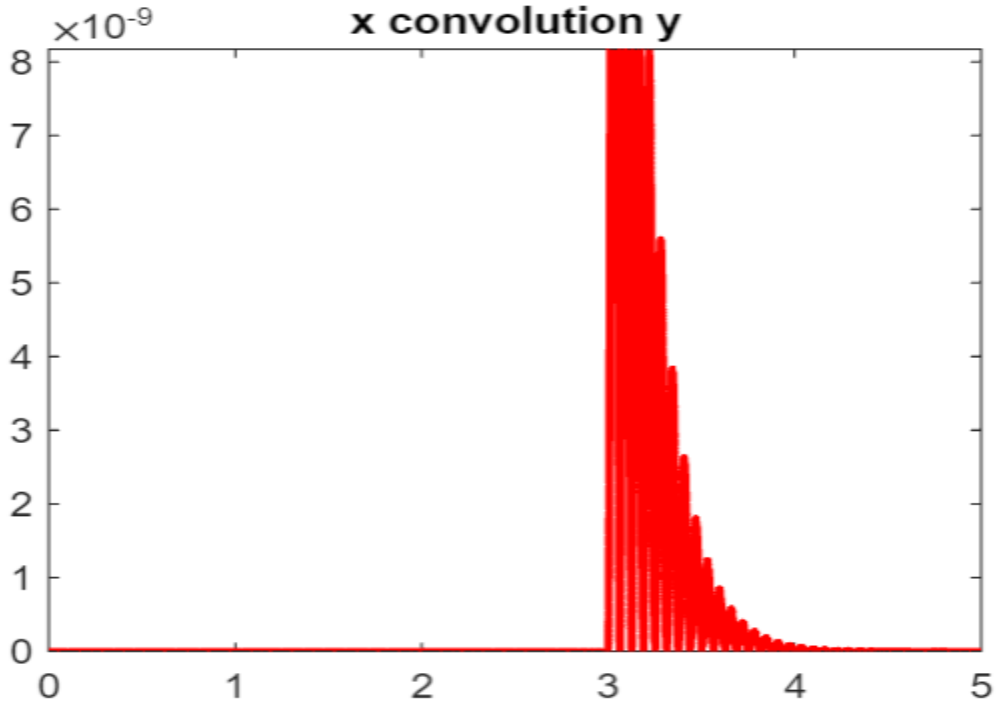
Graph:


Scope
File Tools View Simulation
y(t)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
2
4
6
8
10
Ready
Sample based
T=10.000

Question VI: Write a program that computes and plots the convolution of the functions $x(t)$ = (10e −6t)π((t-2)/4), $y(t)$ = (10e −6t cos 100t) π((t-6)/6

>>Code and Graph:

```
clear all
close all
clc
syms toe t
x=10.*exp(-6*toe).*rectangularPulse(0,4,toe);
y=10.*exp(-6*(t-toe)).*cos(100*(t-toe)).*rectangularPulse(3,9,t-toe);
conv_ans=int(x*y,toe,-inf,inf)
fplot(conv_ans,[0 5],'r','LineWidth',2);
title('x convolution y');
```



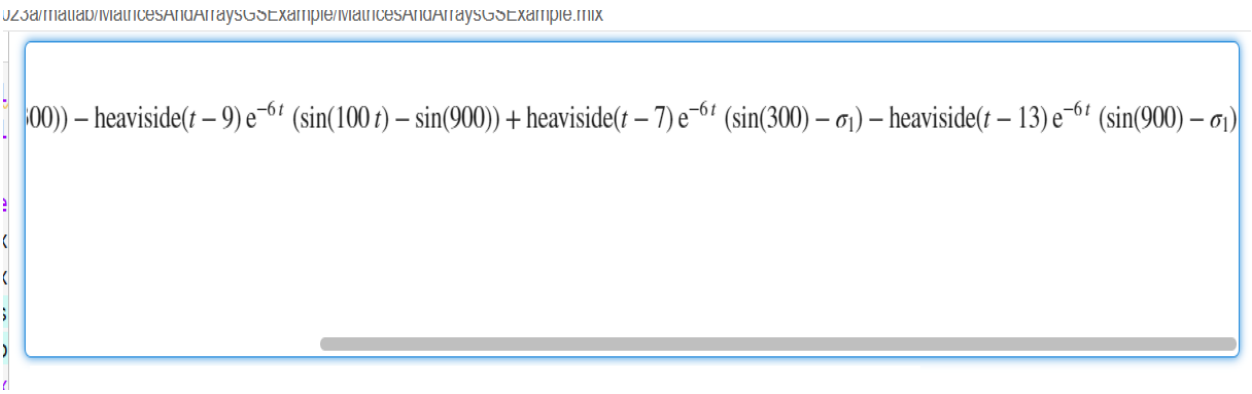
>> Solution:

```
conv_ans =
```

$$\text{heaviside}(t-3)\,e^{-6t}\,(\sin(100\,t)-\sin(300))-\text{heaviside}(t-9)\,e^{-6t}\,(\sin(100\,t)-\sin(900))+\text{heaviside}(t-7)\,e^{-6t}\,(\sin(300)-\sigma_1)$$

where

$$\sigma_1 = \sin(100\,t-400)$$



Question VII: Write a program that computes and plots the spectral representation of the function

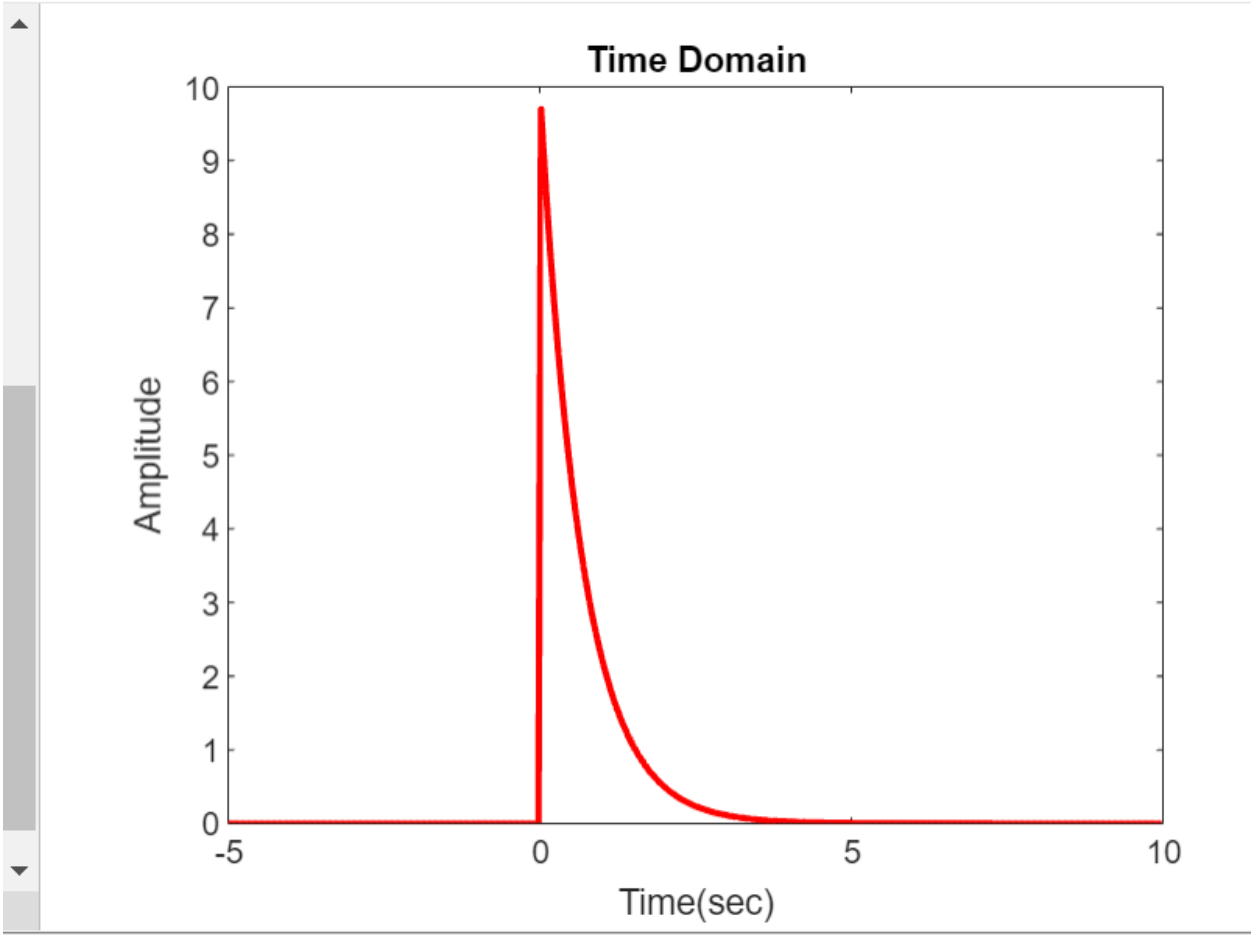
1-$y(t)$ = (10e –(3/2)t)u(t)

>> Code:

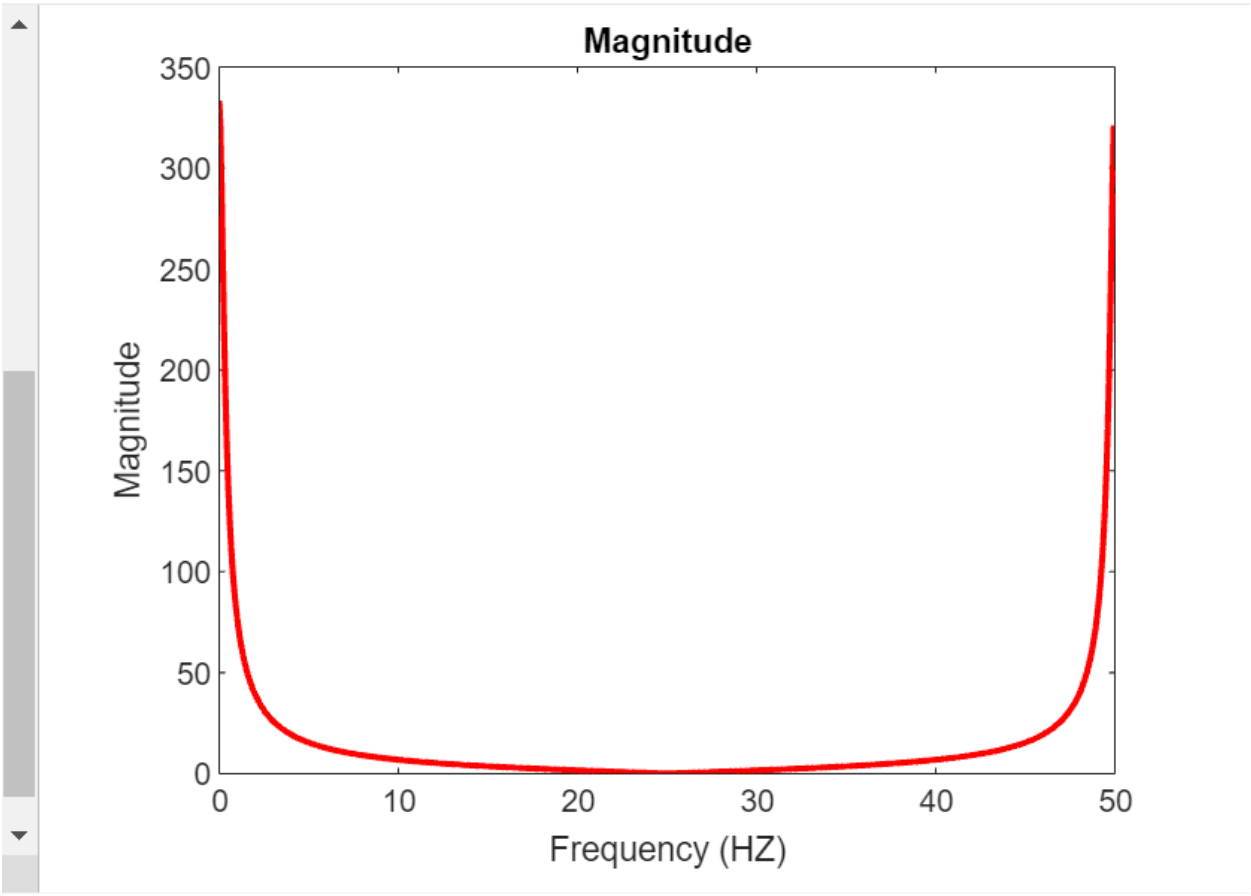
```
clear all
close all
clc
Ts=1/50;
t=-5:Ts:10-Ts;
y=(10*exp(-(3/2)*t).*heaviside(t));
plot(t,y,'r','LineWidth',2);
xlabel('Time(sec)');
ylabel('Amplitude');
title('Time Domain');

y=fft(y);
fs=1/Ts;
f=(0:length(y)-1)*fs/length(y);
ymag=abs(y);
yphase=phasez(y);
```

```
ymag=abs(y);
yphase=phasez(y);


figure
plot(f,ymag,'r','LineWidth',2)
xlabel('Frequency (HZ)')
ylabel('Magnitude')
title('Magnitude')
n=length(y);
fshift=(-n/2:n/2-1)*(fs/n);
yshift=fftshift(y);

figure
plot(fshift,abs(yshift),'r','LineWidth',2);
xlabel('Frequency (HZ)')
ylabel('Phase')
title('Phase spectra')
```

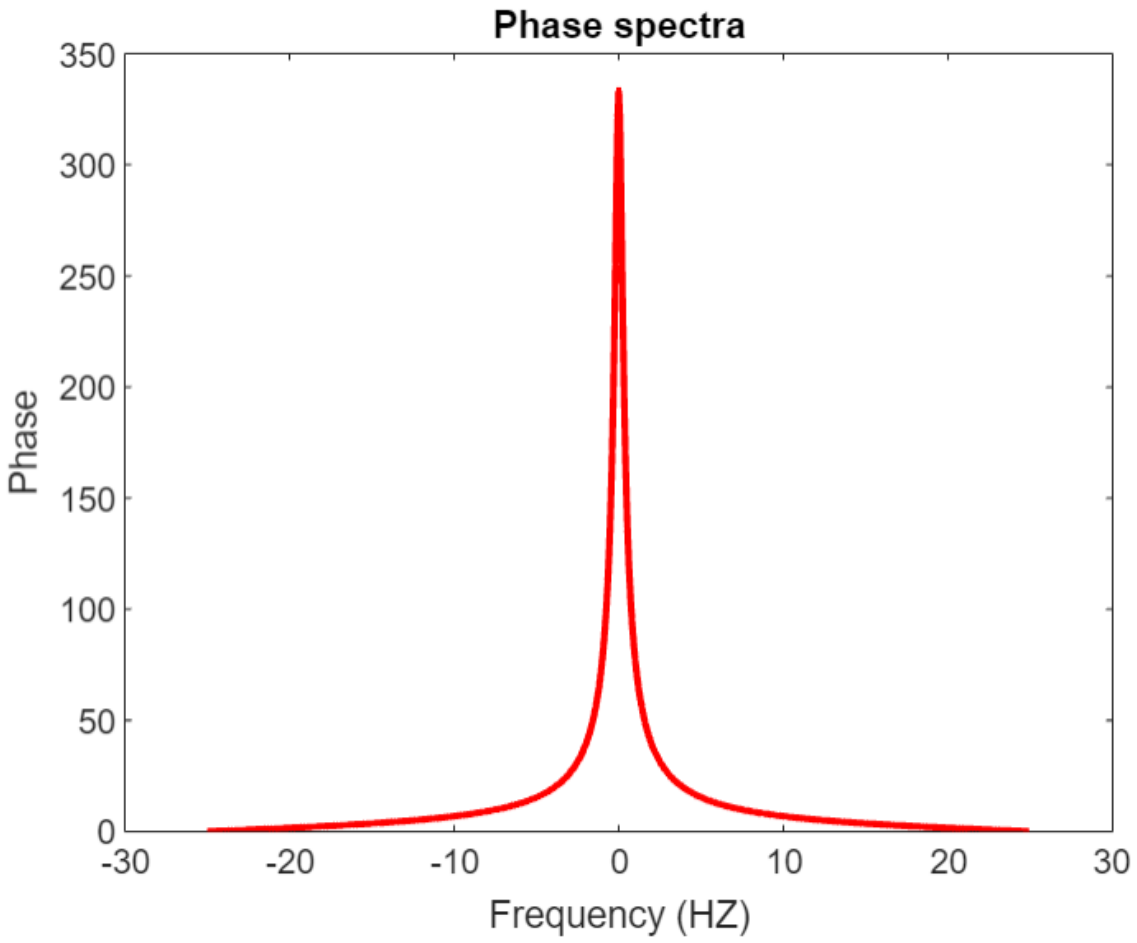
Graph 1:



Graph 2:


Magnitude
350
300
250
200
150
100
50
0
Magnitude
0
10
20
30
40
50
Frequency (HZ)

Graph 3:


Phase spectra
Phase
350
300
250
200
150
100
50
0
-30
-20
-10
0
10
20
30
Frequency (HZ)

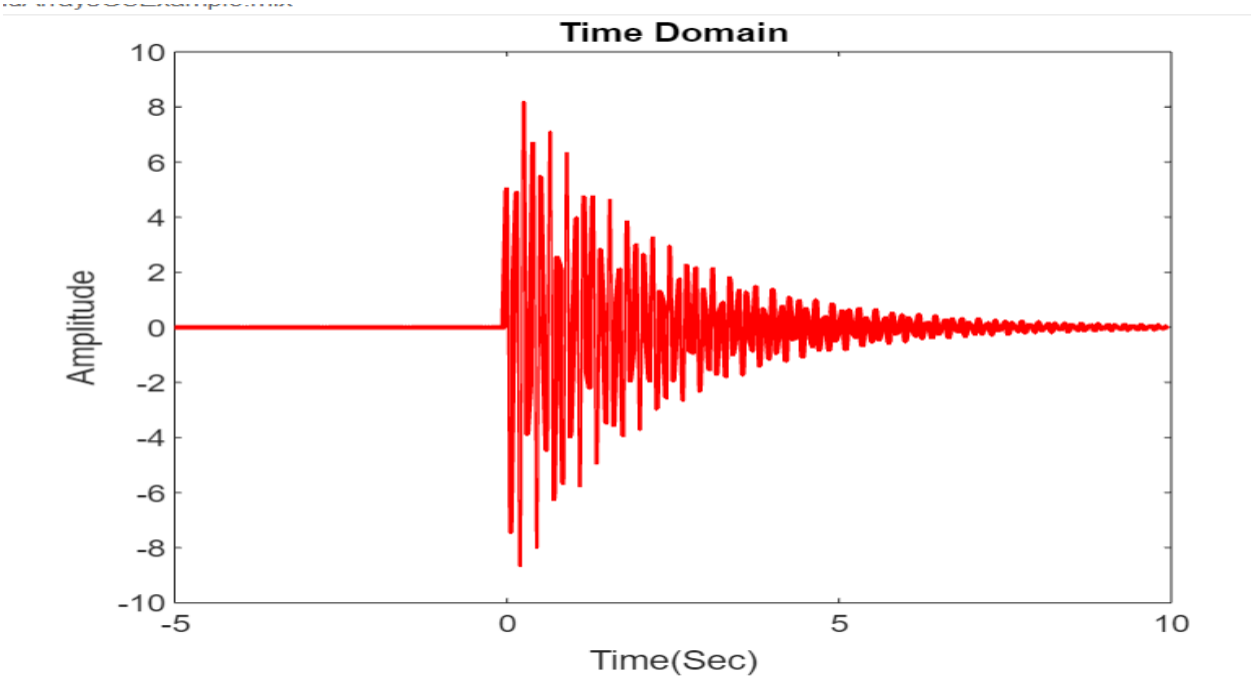
3- $y(t) = (10e^{-0.5t} \cos 300t)u(t)$

>> Code:

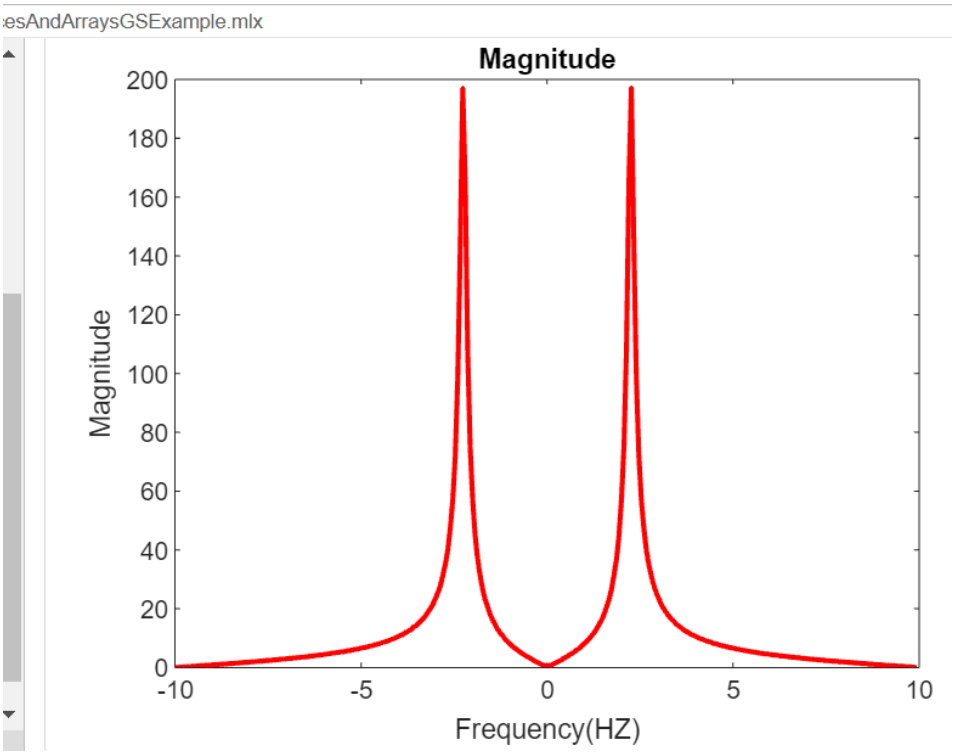
```
clear all
close all
clc
Ts=1/20;
t=-5:Ts:10-Ts;
y=(10*exp((-0.5).*t).*cos(300*t)).*heaviside(t);
plot(t,y,'r','LineWidth',2);
xlabel('Time(Sec)');
ylabel('Amplitude');
title('Time Domain');
y=fft(y);
fs=1/Ts;
f=(0:length(y)-1)*fs/length(y);
ymag=abs(y);
yphase=phasez(y);
figure
n=length(y);
fshift=(-n/2:n/2-1)*(fs/n);
yshift=fftshift(y);
plot(fshift,ymag,'r','LineWidth',2);
xlabel('Frequency(HZ)');
```

```
title('Time Domain');
y=fft(y);
fs=1/Ts;
f=(0:length(y)-1)*fs/length(y);
ymag=abs(y);
yphase=phasez(y);
figure
n=length(y);
fshift=(-n/2:n/2-1)*(fs/n);
yshift=fftshift(y);
plot(fshift,ymag,'r','LineWidth',2);
xlabel('Frequency(HZ)');
ylabel('Magnitude');
title('Magnitude');
figure
plot(fshift,abs(yshift),'r','LineWidth',2);
xlabel('Frequency(HZ)');
ylabel('Phase');
title('Phase spectra');
```

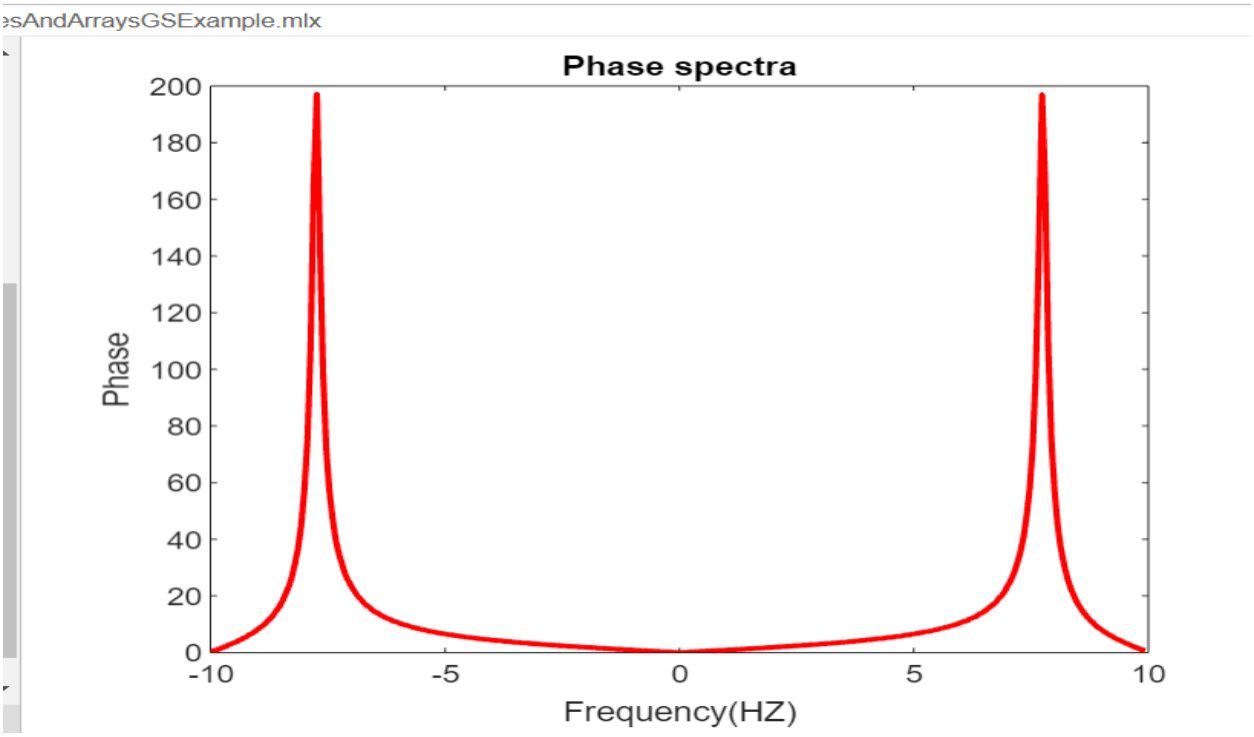
Graph 1:



Graph 2:



Graph 3:


esAndArraysGSExample.mlx
Phase spectra
Phase
200
180
160
140
120
100
80
60
40
20
0
-10
-5
0
5
10
Frequency(HZ)

Question VIII: Write a program that computes the Laplace transform of the function.

3-$y(t)$ = (15 – 15e –0.25t)u(t)

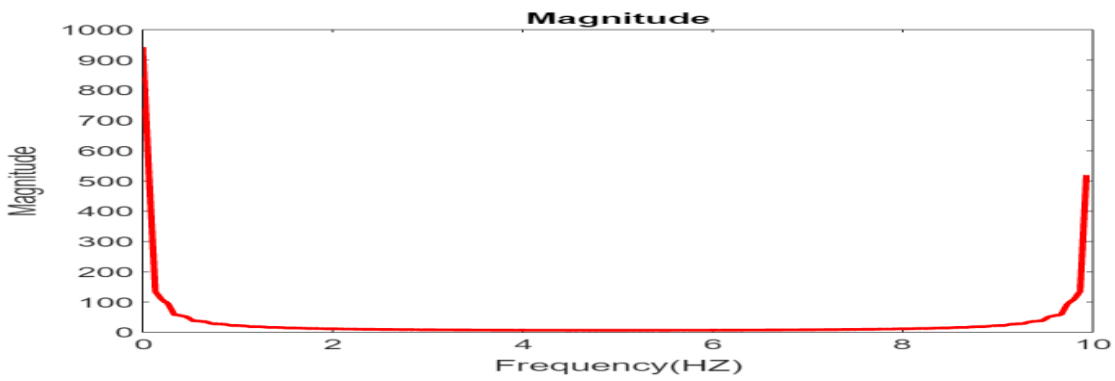
>> Code:

```
clear all
close all
clc
syms t1;
y=(15-15*exp((-0.25).*t1)).*heaviside(t1);
syms f;
yf=fourier(y,f);
syms s;

ys=laplace(y,s)
Ts=1/10;
t=-5:Ts:10-Ts;
y=(15-15*exp((-0.25).*t)).*heaviside(t);
y=fft(y);
fs=1/Ts;
f=(0:length(y)-1)*fs/length(y);
ymag=abs(y);
yphase=phasez(y);

figure
plot(f,ymag,'r','LineWidth',2);
```

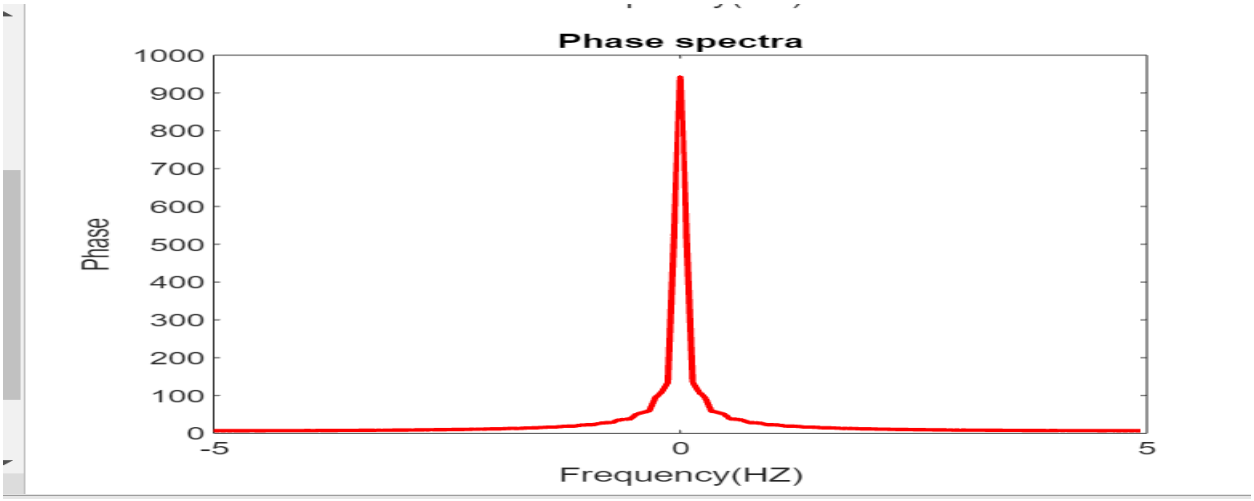
/MATLAB Drive/Examples/R2023a/matlab/MatricesAndArraysGSExample/MatricesAndArraysGSExample.mlx

```
fs=1/Ts;
f=(0:length(y)-1)*fs/length(y);
ymag=abs(y);
yphase=phasez(y);

figure
plot(f,ymag,'r','LineWidth',2);
xlabel('Frequency(HZ)');
ylabel('Magnitude');
title('Magnitude');
n=length(y);
fshift=(-n/2:n/2-1)*(fs/n);
yshift=fftshift(y);

figure
plot(fshift,abs(yshift),'r','LineWidth',2);
xlabel('Frequency(HZ)');
ylabel('Phase');
title('Phase spectra');
```

Graph 1:



Graph 2:



Lablase transform:

ys =

$$\frac{15}{s} - \frac{15}{s+\frac{1}{4}}$$

Fourier transform:

yf =

$$30\,\pi\,\delta(f) - \frac{15}{\frac{1}{4} + f\,\mathrm{i}}$$

4-$y(t)$ = (20 − 8e −3t cos 100t)u(t)

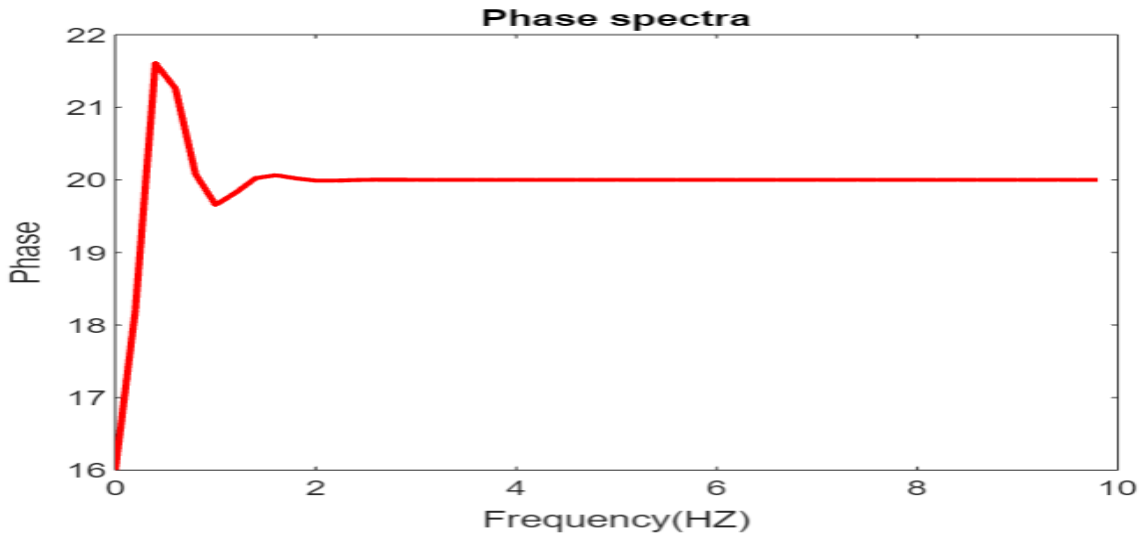
>> Code:

/MATLAB Drive/Examples/R2023a/matlab/MatricesAndArraysGSExample/MatricesAndArraysGSExample.mlx

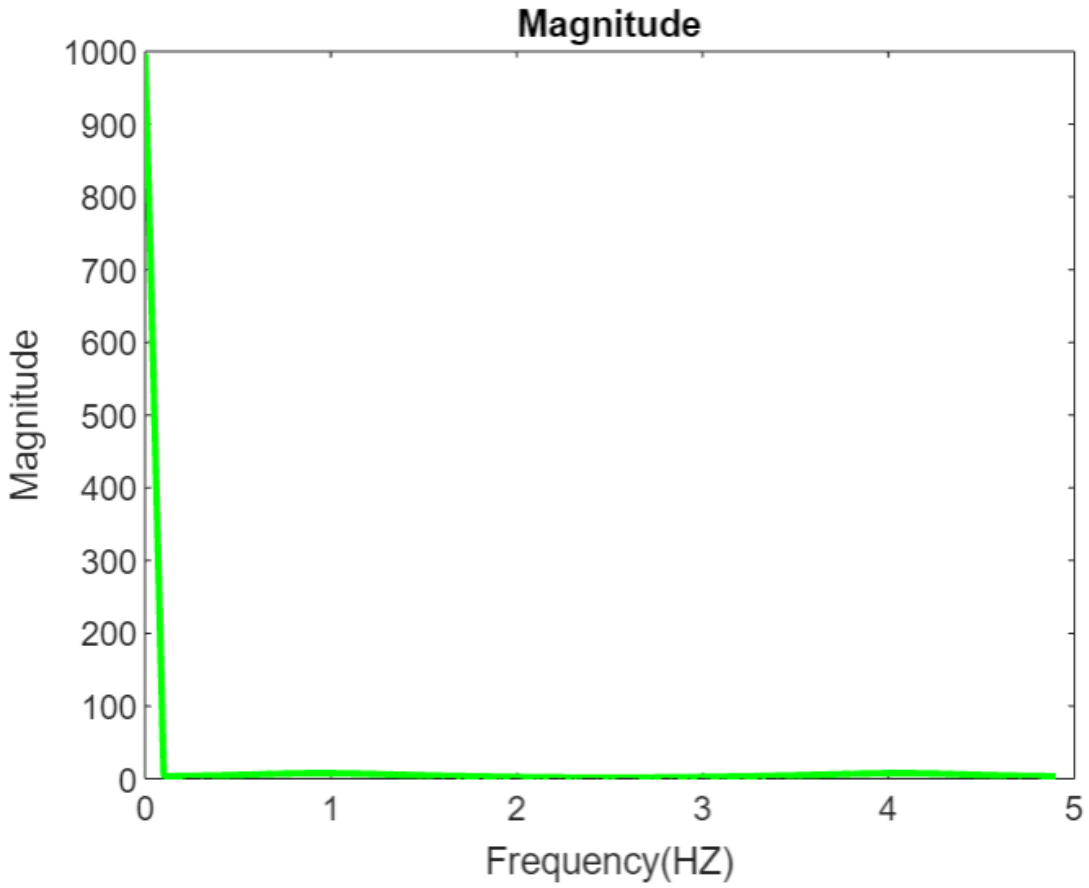
```
1   syms t1;
2   y=(20-(8*exp(-3*t1)).*cos(100*t1)).*heaviside(t1);
3   syms f;
4   yf=fourier(y,f);
5
6   syms s;
7   ys=laplace(y,s);
8
9   Ts=1/5;
10  t=0:Ts:10-Ts;
11  y=(20-(8*exp(-3*t).*cos(100*t)).*heaviside(t));
12  plot(t,y,'r','LineWidth',2);
13  xlabel('Frequency(HZ)');
14  ylabel('Phase');
15  title('Phase spectra')
16
17
18  y=fft(y);
19  fs=1/Ts;
20  f=(0:length(y)-1)*fs/length(y);
21  ymag=abs(y);
```

```
y=fft(y);
fs=1/Ts;
f=(0:length(y)-1)*fs/length(y);
ymag=abs(y);
yphase=phasez(y);


figure
plot(f,ymag,'g','LineWidth',2);
xlabel('Frequency(HZ)');
ylabel('Magnitude');
title('Magnitude');

n=length(y);
fshift=(-n/2:n/2-1)*(fs/n);
yshift=fftshift(y);

figure
plot(fshift,abs(yshift),'r','LineWidth',2);
xlabel('Frequency(HZ)');
ylabel('Magnitude');
title('Magnitude');
```

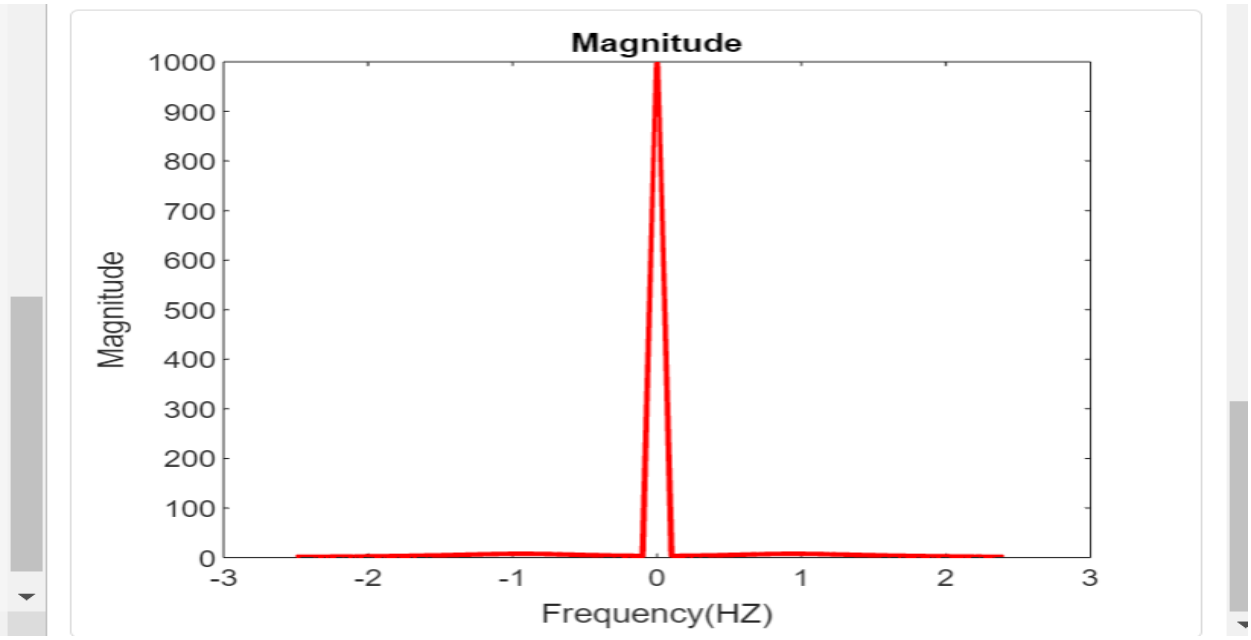
Graph 1:



Graph 2:



Graph 3:



Lablase transform:

ys =

$$\frac{20}{s} - \frac{8\,(s+3)}{(s+3)^2+10000}$$

Fourier transform:

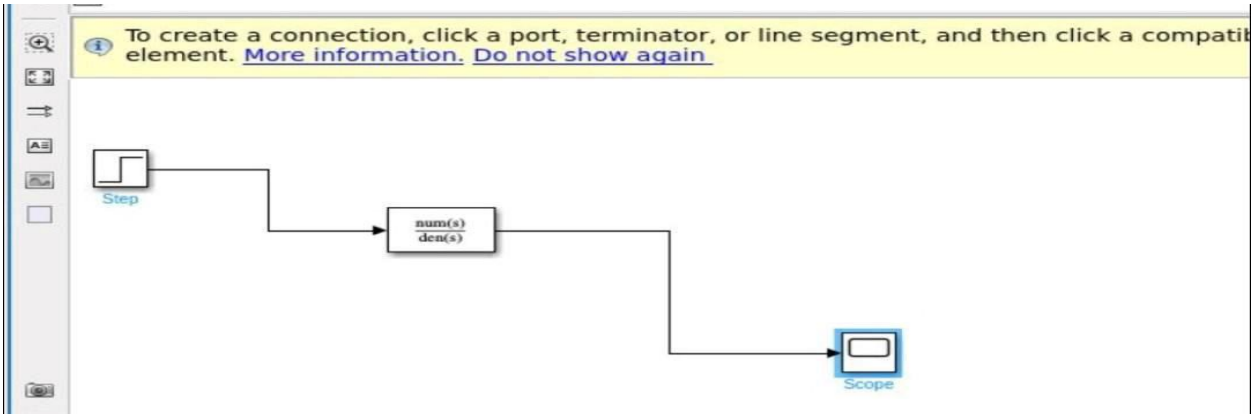
yf =

$$20\,\pi\,\delta(f) - \frac{4}{f\,\mathrm{i}+3-100\,\mathrm{i}} - \frac{4}{f\,\mathrm{i}+3+100\,\mathrm{i}} - \frac{20\,\mathrm{i}}{f}$$

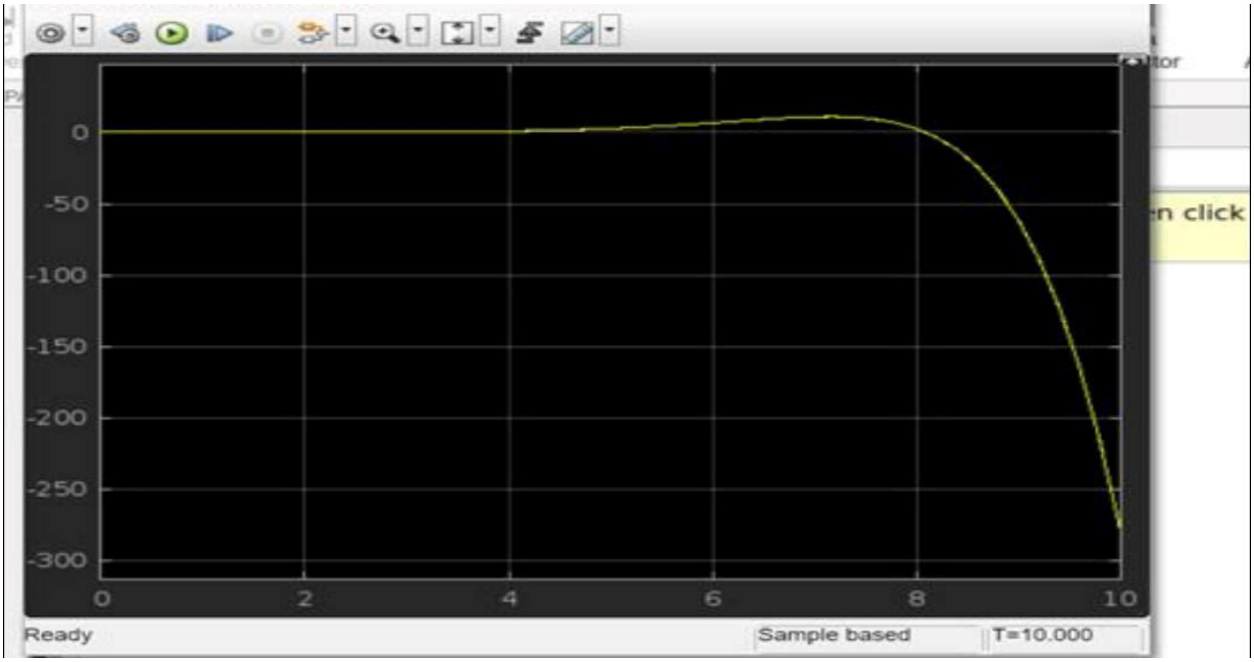
Question IX: Use Simulink (MATLAB) to simulate the following systems in Laplace domain then show and plot the step response of the system.

6 d 4 $y(t)$ /dt 4 – 7 d 2 $y(t)$ /dt 2 + dy/ dt + 9$y(t)$ = d 3 $x(t)$ /dt 3 +

Simulation:



Graph :



Question X: Write a program that determine the inverse Laplace transform of the transfer functions in IV.

>>Code and soluation:

```
syms s t y;
H1=(7/(s+2));
H2=(5/(s^2+(4*s)+5));

h1=ilaplace(H1,s,t);
h2=ilaplace(H2,s,t);

disp('Inverse Laplace Transform of H1:');
disp(h1);

disp('Inverse Laplace Transform of H2:');
disp(h2);
```

```
Inverse Laplace Transform of H1:
```

$$7\,e^{-2t}$$

```
Inverse Laplace Transform of H2:
```

$$5\,e^{-2t}\sin(t)$$

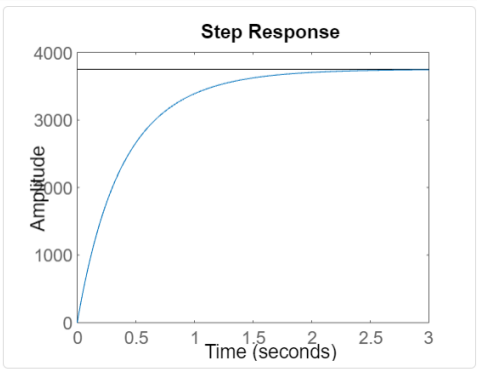
Question XII: Consider the transfer function: $H(s)$ = 10000 s + 3/ s 2 + 6s + 8

- Compute the step response of the system.
- Plot the frequency response (semi-log scale) of the system with transfer function

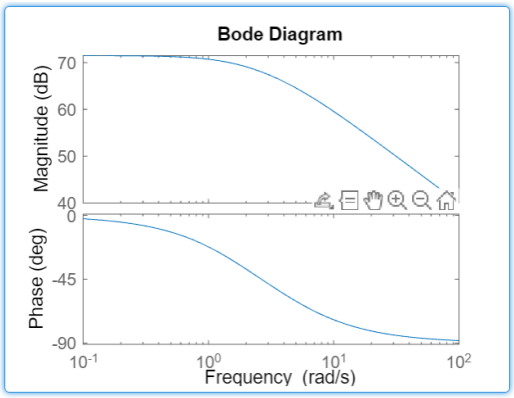
MatricesAndArraysGSExample.mlx *

/MATLAB Drive/Examples/R2023a/matlab/MatricesAndArraysGSExample/MatricesAndArraysGSExample.mlx

```
1  clear all
2  close all
3  clc
4  num1=[10000 30000];
5  den1=[1 6 8];
6  sys=tf(num1,den1);
7  step(sys);
```




```
1  clear all
2  close all
3  clc
4  num=[10000 30000];
5  den=[1 6 8];
6  bode(num,den);
```



UTF-8 LF script Ln 6 Col 1