BIRZEIT UNIVERSITY

Faculty of Engineering & Technology
Electrical & Computer Engineering Department

ENEE2312: Signals & System
First Semester, 2023/2024

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Section.no : 1

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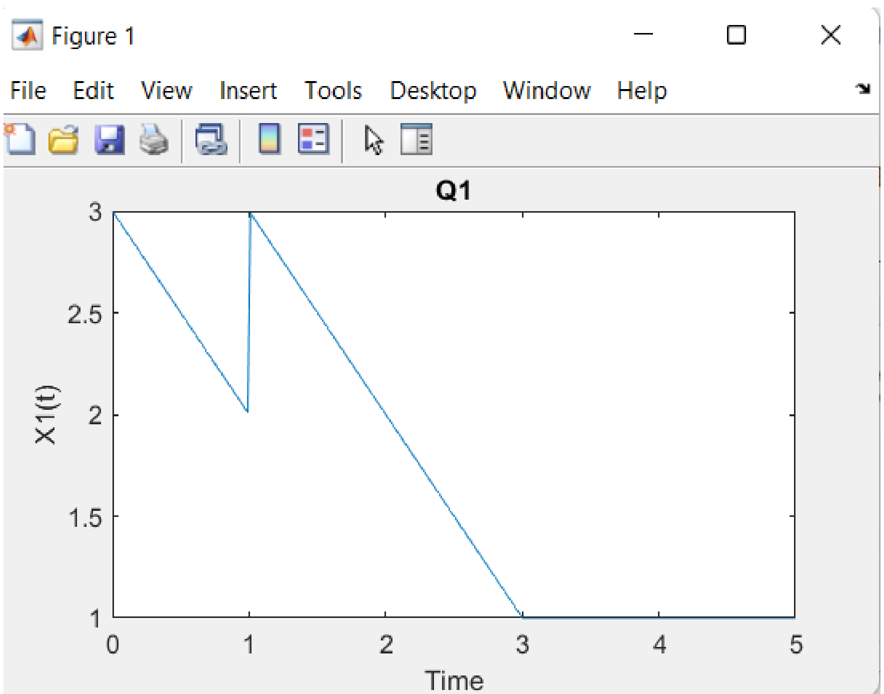
Question I: Generate and plot the following signals using MATLAB:

1. $(t) = (t - 1) - (t - 7) + (-t + 3)$

Q1.m

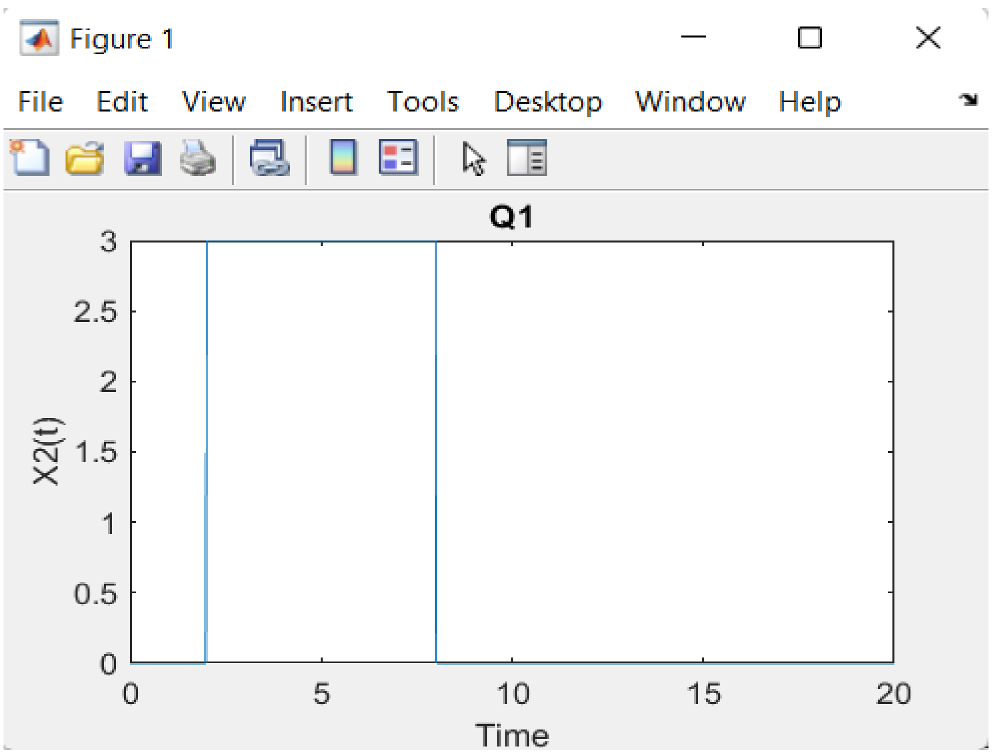
```
t=0:0.01:5;
u1=heaviside(t-1);
r1=(t-7).*heaviside(t-7);
r2=(3-t).*heaviside((-1*t)+3);
x1=u1-r1+r2;
plot(t,x1);
title('Q1');
xlabel('Time');
ylabel('X1(t)');
```



2. A finite pulse (t /6) with value = 3 centered at t=5

Q1.m *

```
t=0:0.01:20;
x2=3*rectangularPulse(2,8,t);
plot(t,x2);
title('Q1');
xlabel('Time');
ylabel('X2(t)');
```

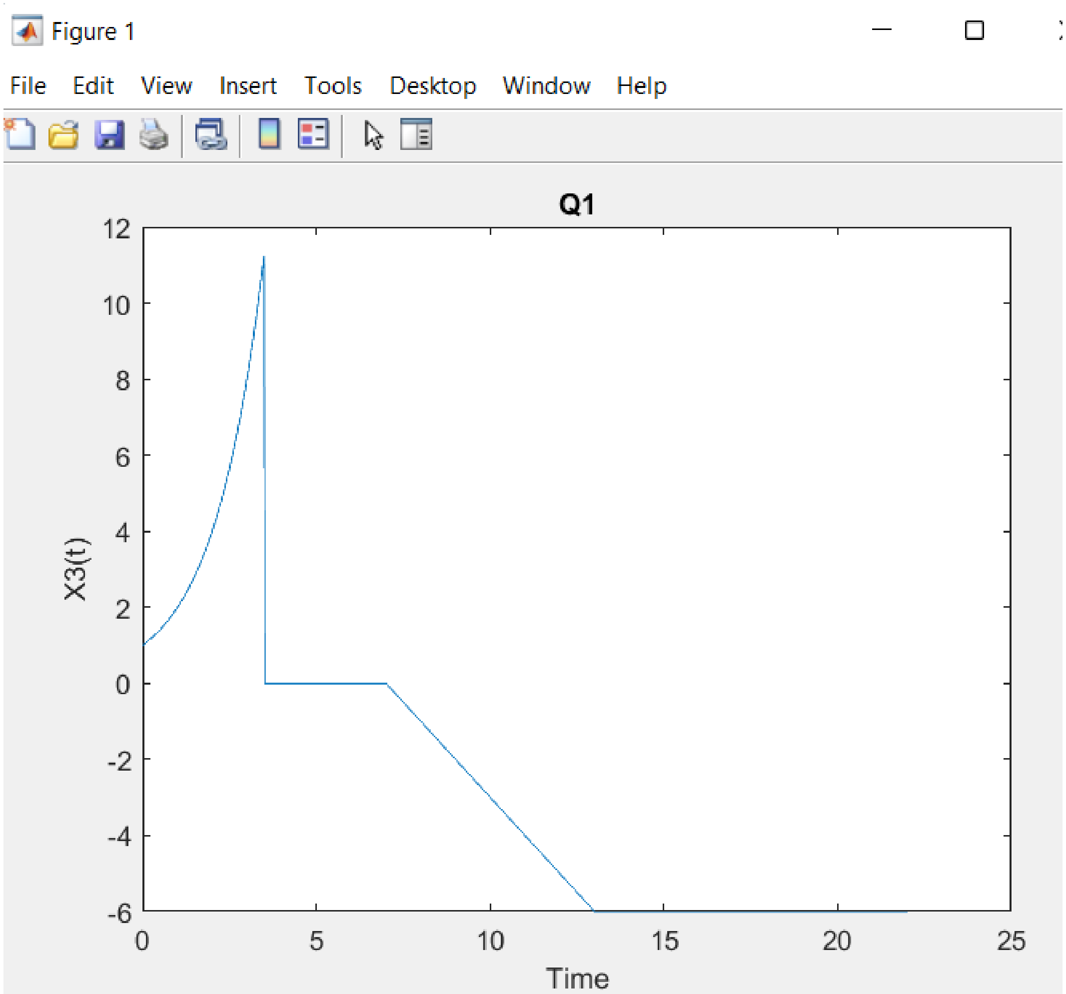


3. X(t) = $u(-t-4) + p(t)\pi((t-3)/6) - r(t-7) + r(t-13)$ in the time interval [0 22]

Editor - C:\Users\fares\Downloads\n.m *

n.m *

```
t=0:0.01:22;
u1=heaviside(-t-4);
f1=pow2(t);
f2=rectangularPulse(-2.5,3.5,t);
rec=f1.*f2;
r1=(t-7).*heaviside(t-7);
r2=(t-13).*heaviside(t-13);
x3=u1+rec-r1+r2;
plot(t,x3);
title('Q1');
xlabel('Time');
ylabel('X3(t)');
```

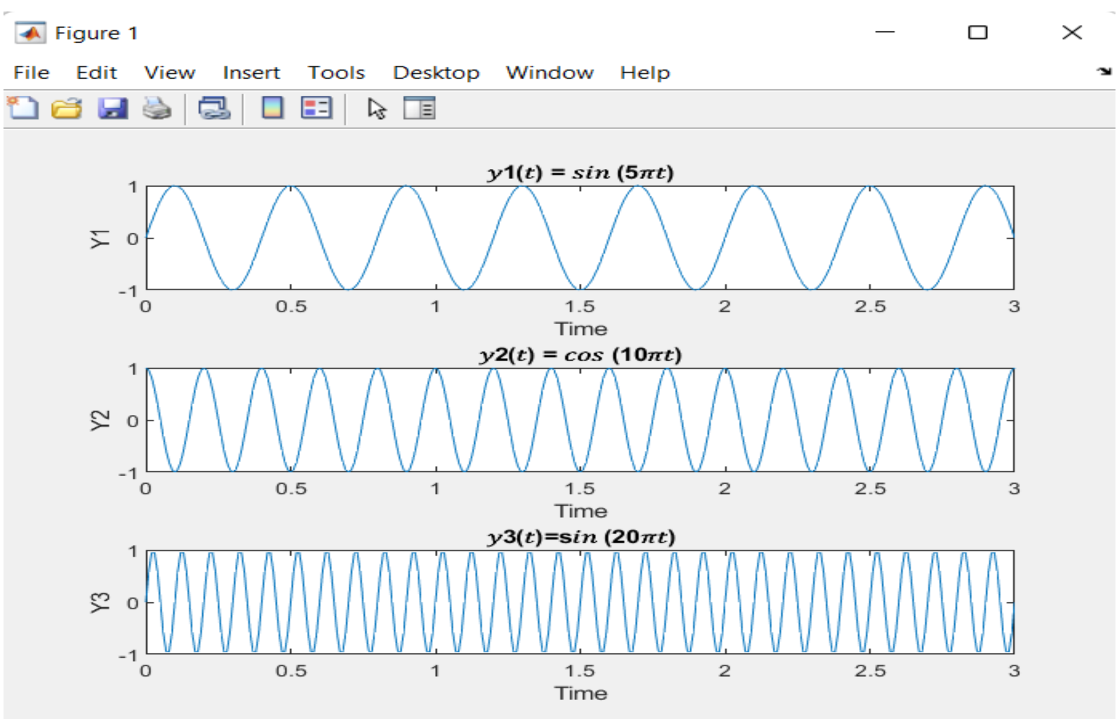


Question II:

1. Generate and plot the signals $y1(t) = sin\ (5\pi t)$, $y2(t) = cos\ (10\pi t)$, $y3(t) = sin\ (20\pi t)$ in the interval [0 3] seconds.

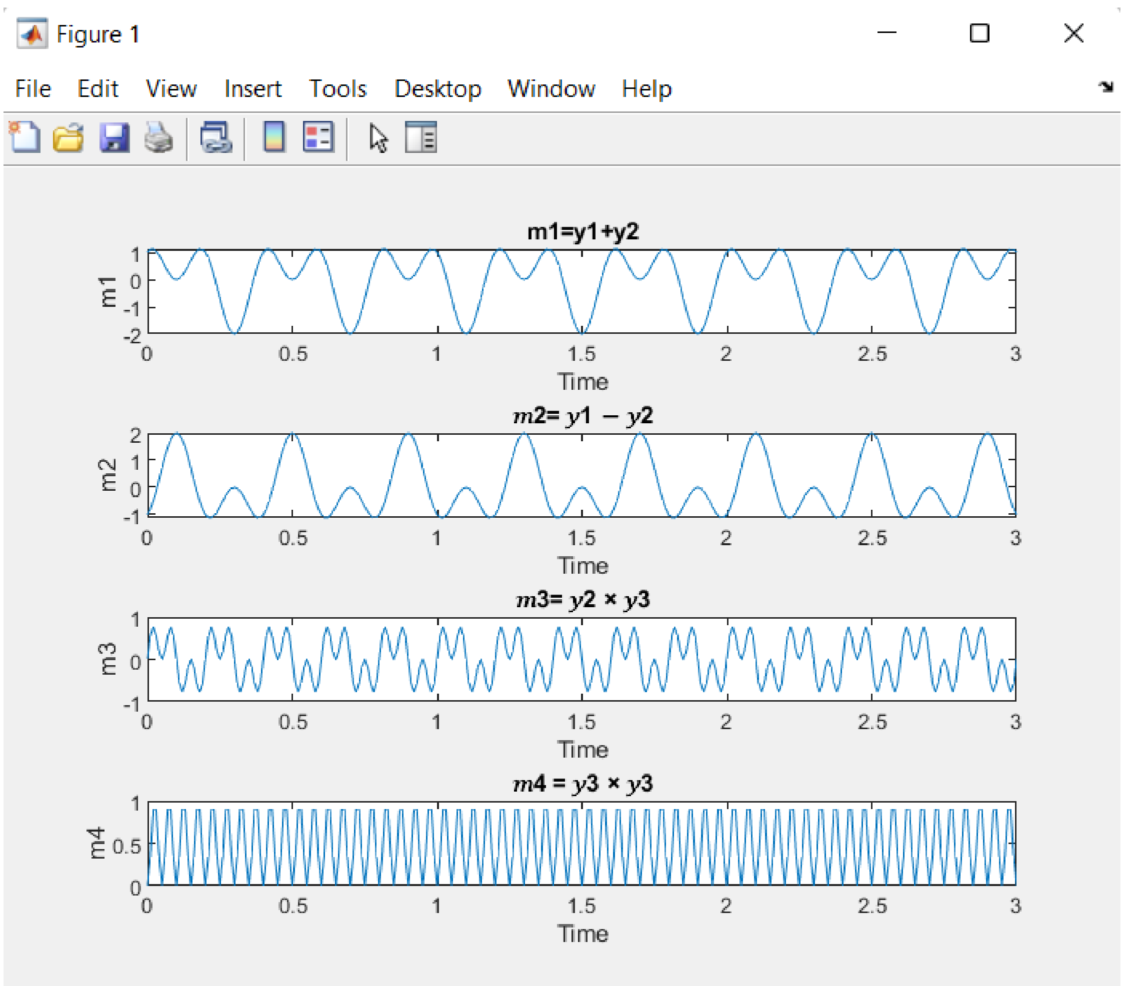
Q2.m *

```
t = 0:0.01:3;
y1 =sin(5*pi*t);
y2 =cos(10*pi*t);
y3 =sin(20*pi*t);

subplot(3,1,1);
plot(t,y1);
title('$y1(t)$ = $sin$ $(5\pi t)$');
ylabel('Y1');
xlabel('Time');

subplot(3,1,2);
plot(t,y2);
title('$y2(t)$ = $cos$ $(10\pi t)$');
ylabel('Y2');
xlabel('Time');
subplot(3,1,3);

plot(t,y3);
title('$y3(t)$=$sin$ $(20\pi t)$');
ylabel('Y3');
xlabel('Time');

```



2. Plot the signals $m1\ (t) = y1 + y2$, $m2\ (t) = y1 - y2$, and $m3\ (t) = y2 \times y3$, and $m4\ (t) = y3 \times y3$

```
m1=y1+y2;
m2=y1-y2;
m3=y2.*y3;
m4=y3.*y3;

subplot(4,1,1);
plot(t,m1);
title('m1=y1+y2');
ylabel('m1');
xlabel('Time');

subplot(4,1,2);
plot(t,m2);
title('m2= y1 - y2');
ylabel('m2');
xlabel('Time');

subplot(4,1,3);
plot(t,m3);
title('m3= y2 × y3');
ylabel('m3');
xlabel('Time');

subplot(4,1,4);
plot(t,m4);
title('m4 = y3 × y3');
ylabel('m4');
xlabel('Time');
```



3. Determine, using the MATLAB plots, which of these signals is periodic (in case it is the case, determine the fundamental period), alternating, and has half-wave odd symmetry.

Q2.m

```matlab
freq1=(5.*pi)/(2.*pi);
freq1=round(freq1);

freq2=(10.*pi)/(2.*pi);
freq2=round(freq2);

freq3=(20.*pi)/(2.*pi);
freq3=round(freq3);

freqi = gcd(freq1,freq2);
freqii= gcd(freq2,freq3);
freqiii=gcd(freq3,freq3);

disp("the freq of y1 is :");
disp(freq1);

disp("the freq of y2 is :");
disp(freq2);

disp("the freq of y3 is :");
disp(freq3);

disp("the fundemental frequency for m1 and m2 is :");
disp(freqi);

disp("the fundemental frequency for m3 is :");
disp(freqii);

disp("the fundemental frequency for m4 is :");
disp(freqiii);
```

Command Window

```
>> Q2
the freq of y1 is :
     3

the freq of y2 is :
     5

the freq of y3 is :
    10
```

Command Window

```
the fundemental frequency for m1 and m2 is :
     1

the fundemental frequency for m3 is :
     5

the fundemental frequency for m4 is :
    10

>>
```

m1 = y1 + y2:

Periodicity: Appears to be periodic.

Fundamental Period: 1

Alternation: Appears to be alternating.

m2 = y1 - y2:

Periodicity: Appears to be periodic.

Fundamental Period: 1

Alternation: Appears to be alternating.

m3 = y2 * y3:

Periodicity: Appears to be periodic.

Fundamental Period: 5

Alternation: Appears to be alternating.

m4 = y3 * y3:

Periodicity: Appears to be periodic.

Fundamental Period: 10

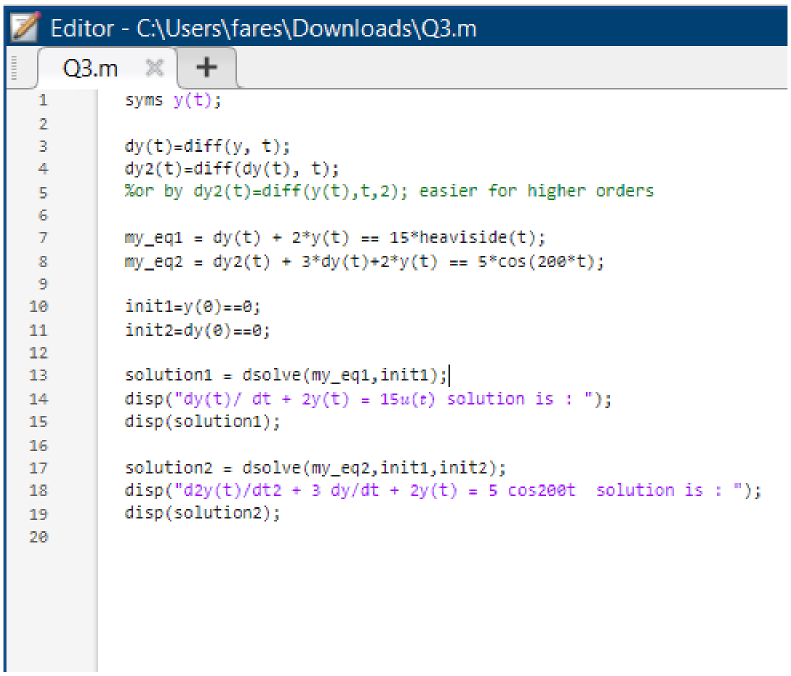
Alternation: Appears to be non-alternating.

In summary, none of the combinations m1, m2 , m3 , or m4 are expected to exhibit half-wave symmetry .

Question III: Write Matlab scripts that determine the zero-state responses of the following systems by solving differential equations in the time domain.

1. dy(t)/ dt + 2y(t) = 15$u(t)$

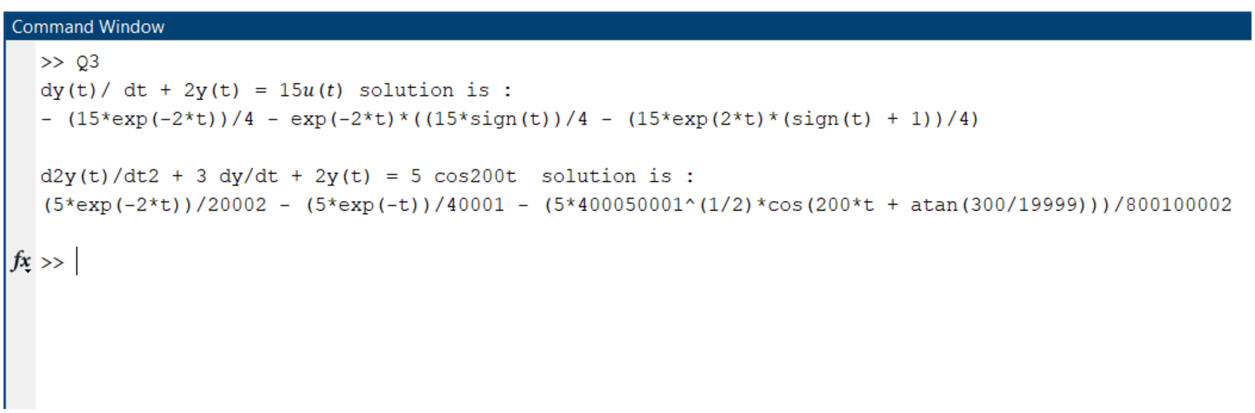
2. d2y(t) /dt 2 + 3 dy /dt + 2y(t) = 5 cos200t



Editor - C:\Users\fares\Downloads\Q3.m

Q3.m

```
syms y(t);

dy(t)=diff(y, t);
dy2(t)=diff(dy(t), t);
%or by dy2(t)=diff(y(t),t,2); easier for higher orders

my_eq1 = dy(t) + 2*y(t) == 15*heaviside(t);
my_eq2 = dy2(t) + 3*dy(t)+2*y(t) == 5*cos(200*t);

init1=y(0)==0;
init2=dy(0)==0;

solution1 = dsolve(my_eq1,init1);
disp("dy(t)/ dt + 2y(t) = 15u(t) solution is : ");
disp(solution1);

solution2 = dsolve(my_eq2,init1,init2);
disp("d2y(t)/dt2 + 3 dy/dt + 2y(t) = 5 cos200t  solution is : ");
disp(solution2);
```



Command Window

```
>> Q3
dy(t)/ dt + 2y(t) = 15u(t) solution is :
- (15*exp(-2*t))/4 - exp(-2*t)*((15*sign(t))/4 - (15*exp(2*t)*(sign(t) + 1))/4)

d2y(t)/dt2 + 3 dy/dt + 2y(t) = 5 cos200t  solution is :
(5*exp(-2*t))/20002 - (5*exp(-t))/40001 - (5*400050001^(1/2)*cos(200*t + atan(300/19999)))/800100002

>>
```

Question IV: Write Matlab scripts that determine the responses of the following systems by solving differential equations in the time domain. and the given initial conditions:

1. dy(t)/dt + 2y(t) = 7u(t) , *y*(0) = 2

2. d2y(t)/dt 2 + 2 dy/dt + 4y(t) = 5 cos200t , (y (0) =1, y’ (0) =2);

Q3.m

```matlab
syms y(t);
% 1. dy(t)/dt + 2y(t) = 7u(t) , y(0) = 2
% 2. d2y(t)/dt2 + 2 dy/dt + 4y(t) = 5cos200t , (y (0) =1, y'(0)=2);

dy(t)=diff(y, t);
dy2(t)=diff(dy(t), t);
%or by dy2(t)=diff(y(t),t,2); easier for higher orders

my_eq1 = dy(t) + 2*y(t) == 7*heaviside(t);
my_eq2 = dy2(t) + 2*dy(t)+4*y(t) == 5*cos(200*t);

init1=y(0)==0;
init2=dy(0)==2;

solution1 = dsolve(my_eq1,init1);
disp("dy(t)/dt + 2y(t) = 7u(t) solution is : ");
disp(solution1);

init=y(0)==2;
solution2 = dsolve(my_eq2,init,init2);
disp("d2y(t)/dt2 + 2 dy/dt + 4y(t) = 5cos200t  solution is : ");
disp(solution2);
```

Command Window

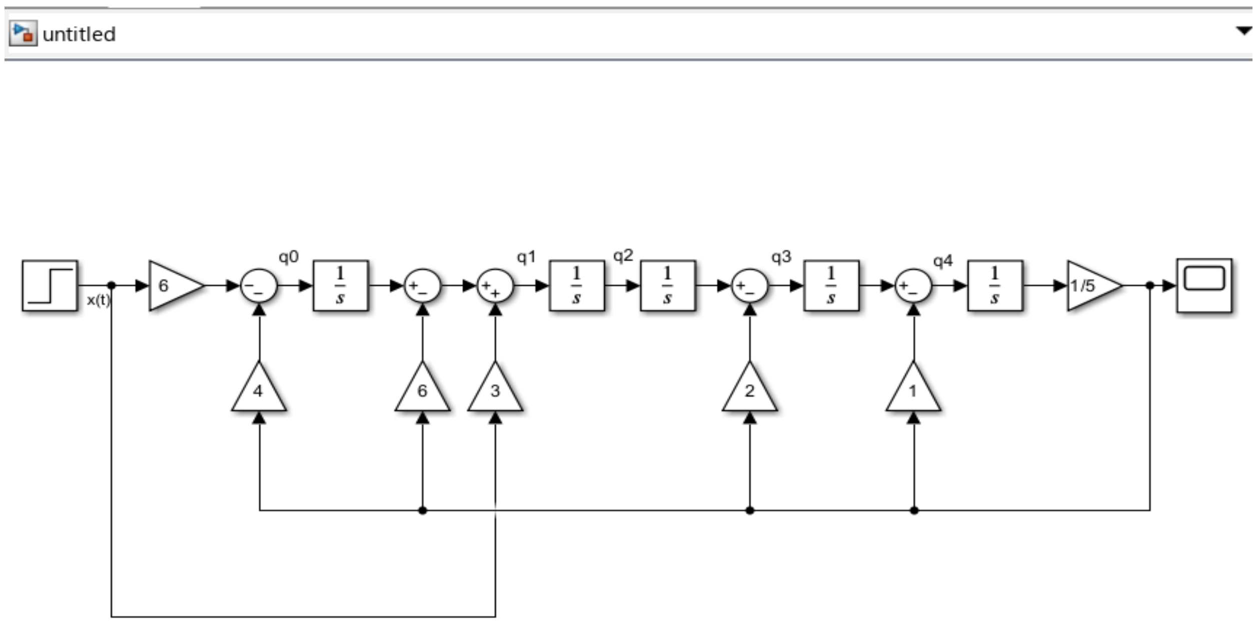
```
>> Q3
dy(t)/dt + 2y(t) = 7u(t) solution is :
- (7*exp(-2*t))/4 - exp(-2*t)*((7*sign(t))/4 - (7*exp(2*t)*(sign(t) + 1))/4)
```

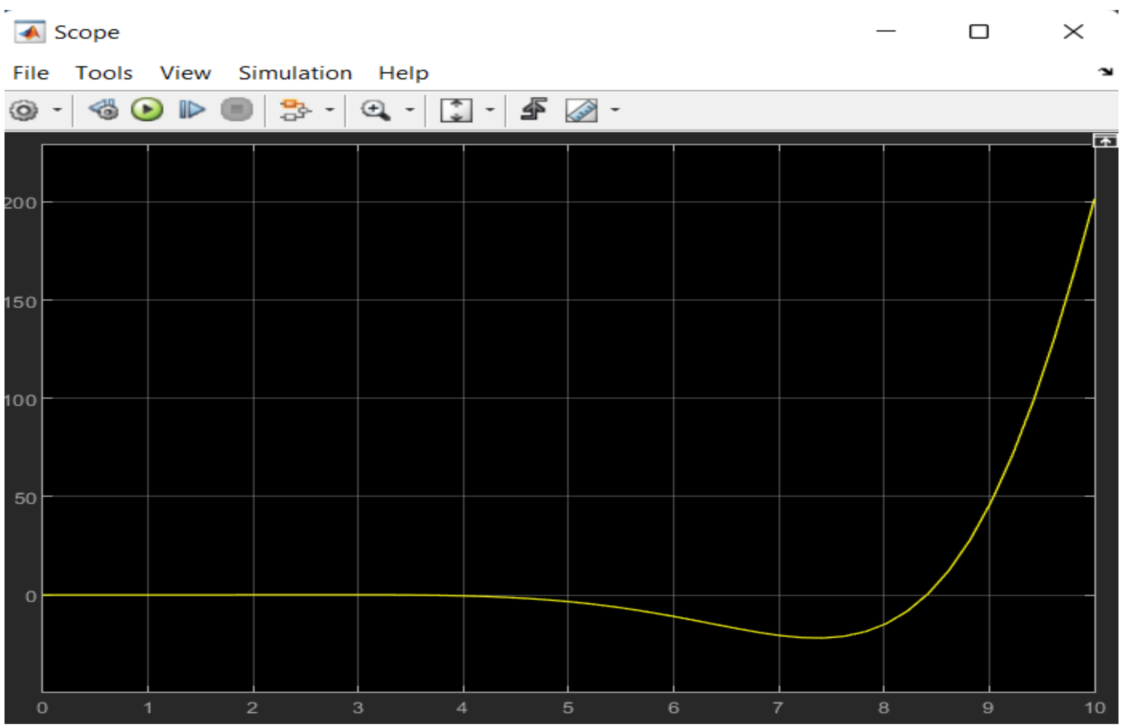
d2y(t)/dt2 + 2 dy/dt + 4y(t) = 5cos200t solution is :

sin(3^(1/2)*t)*((125*cos(200*t - 3^(1/2)*t))/199980002 - (125*cos(200*t + 3^(1/2)*t))/199980002 - (49995*sin(200*t + 3^(1/2)*t))/799920008 + (49995*sin(200*t - 3^(1/2)*t))/799920008 + (50005*3^(1/2)*cos(200*t + 3^(1/2)*t))/2399760024 + (50005*3^(1/2)*cos(200*t - 3^(1/2)*t))/2399760024 + (2499875*3^(1/2)*sin(200*t + 3^(1/2)*t))/599940006 + (2499875*3^(1/2)*sin(200*t - 3^(1/2)*t))/599940006) - (5*3^(1/2)*cos(3^(1/2)*t)*((sin(t*(3^(1/2) - 200)) - cos(t*(3^(1/2) - 200))*(3^(1/2) - 200))/((3^(1/2) - 200)^2 + 1) + (sin(t*(3^(1/2) + 200)) - cos(t*(3^(1/2) + 200))*(3^(1/2) + 200))/((3^(1/2) + 200)^2 + 1)))/6 + (533263337*3^(1/2)*exp(-t)*sin(3^(1/2)*t))/399960004 - (799970003*exp(-t)*cos(3^(1/2)*t))/(4*(100*3^(1/2) - 10001)*(100*3^(1/2) + 10001))

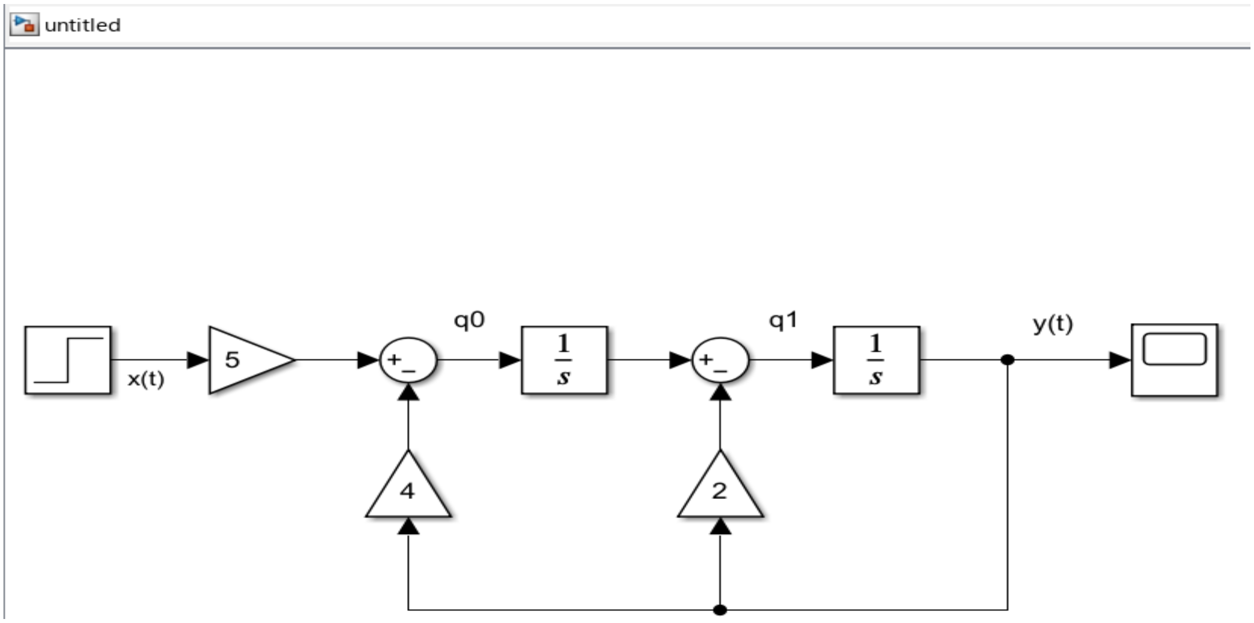
Question V: Use Simulink (MATLAB) to simulate the following systems using the separate and integrate modeling, then show and plot the step response of the system.

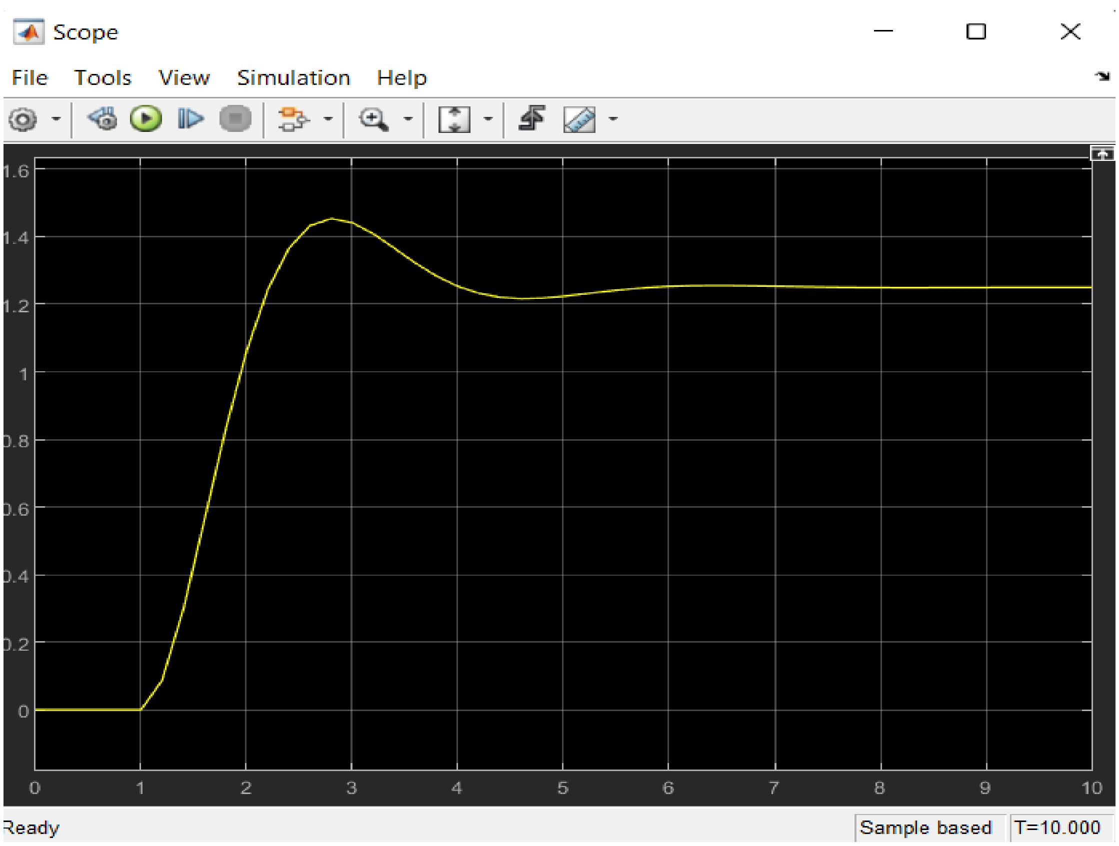
1. $5\ d\ 5\ y(t)\ dt\ 5 + d\ 4\ y(t)\ dt\ 4 + 2\ d\ 3\ y(t)\ dt\ 3 + 6\ dy(t)\ dt + 4y(t) = 3\ dx(t)\ dt - 6x(t)$





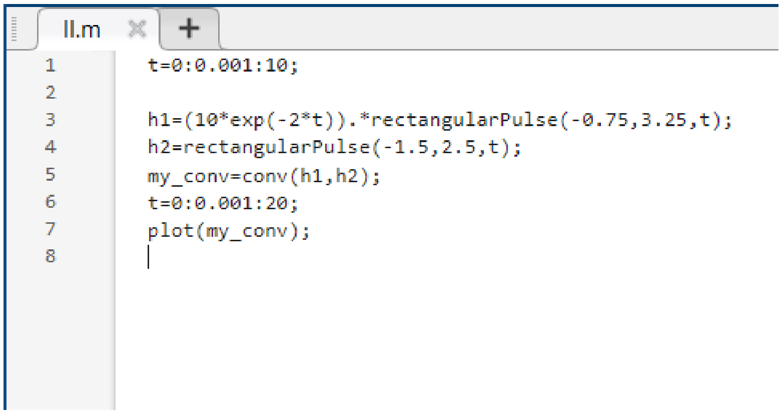
2. d 2y(t) dt 2 + 2 dy dt + 4y(t) = 5 $x(t)$



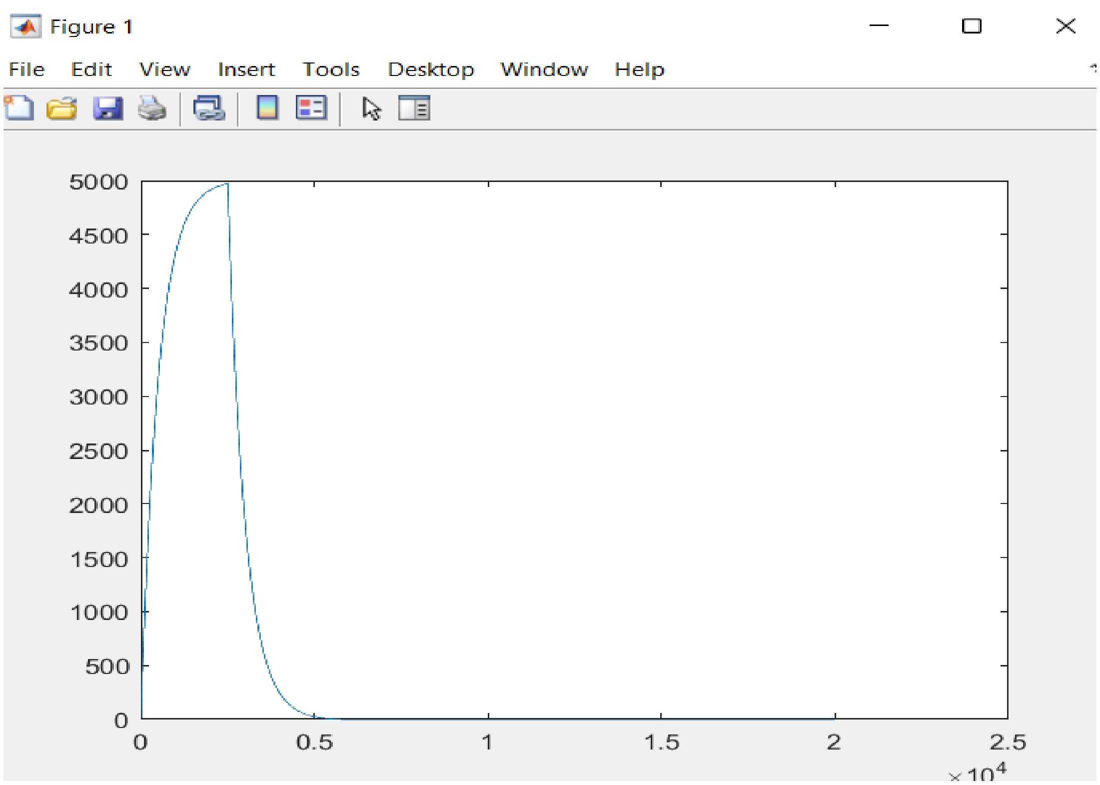


Question VI: Write scripts to compute and plot the response of the following systems using convolution integral

- $h(t) = (10e^{-2t})\pi((t-5)/4)$ and $h(t) = \pi((t-1)/2)$



```
t=0:0.001:10;

h1=(10*exp(-2*t)).*rectangularPulse(-0.75,3.25,t);
h2=rectangularPulse(-1.5,2.5,t);
my_conv=conv(h1,h2);
t=0:0.001:20;
plot(my_conv);
```



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

3. $(t) = (15 - 15e\ {-0.25t}\ )u(t)$

4. $(t) = (20 - 8e\ {-3t} \cos 100t)u(t)$

Editor - C:\Users\fares\Downloads\n.m *

n.m *

```
% 3. y(t) = (15 - 15e -0.25t )u(t)
% 4. y(t) = (20 - 8e -3t cos 100t)u(t)
syms t
y1=(15-(15*exp(-0.25*t))).*heaviside(t);
y2=(20-(8*exp(-3*t)).*cos(100*t)).*heaviside(t);
l1=laplace(y1);
disp("first part sol :");
pretty(l1);

l2=laplace(y2);
disp("second part sol :");
pretty(l2);
```

Command Window

```
>> n
first part sol :
15      15
-- - -----
 s        1
     s + -
          4

second part sol :
20        8 (s + 3)
-- - ----------------
 s            2
     (s + 3)   + 10000
```

Question VIII: Use Simulink (MATLAB) to simulate the following systems in Laplace domain then show and determine the transfer function of the system by using the Simulink model and Matlab commands.

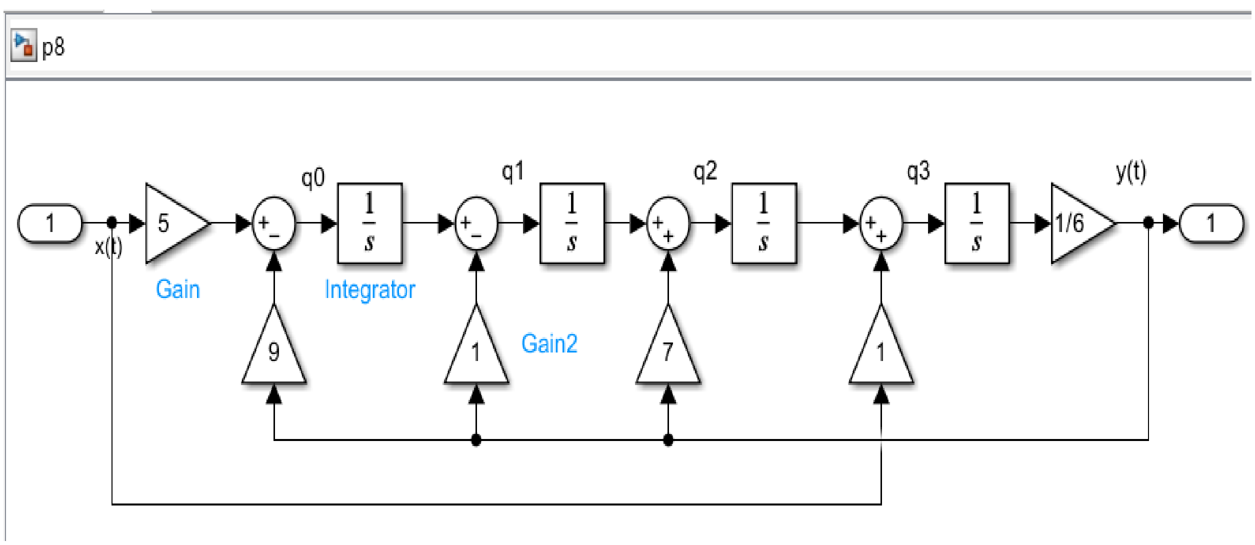
$6\ d\ 4\ (t)/dt\ 4 - 7\ d\ 2\ (t)/dt\ 2 + dy/dt + 9(t) = d\ 3\ (t)/dt\ 3 + 5x(t)$

y.m

```
[a,b,c,d]=linmod('p8');
[num,den]=ss2tf(a ,b ,c ,d );
my_trans_function=tf(num,den);
```

Command Window

```
>> my_trans_function

my_trans_function =

  0.1667 s^3 - 1.11e-16 s^2 - 2.22e-16 s + 0.8333
  ------------------------------------------------
  s^4 - 8.882e-16 s^3 - 1.167 s^2 + 0.1667 s + 1.5
```



Question IX: Using Matlab commands determine the step and ramp responses of the system with the transfer function:

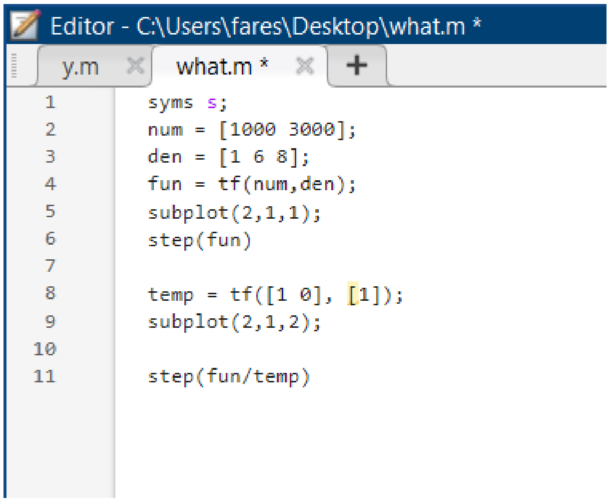
$(s) = 10000\ s + 3/\ s^2 + 6s + 8$

y.m | what.m

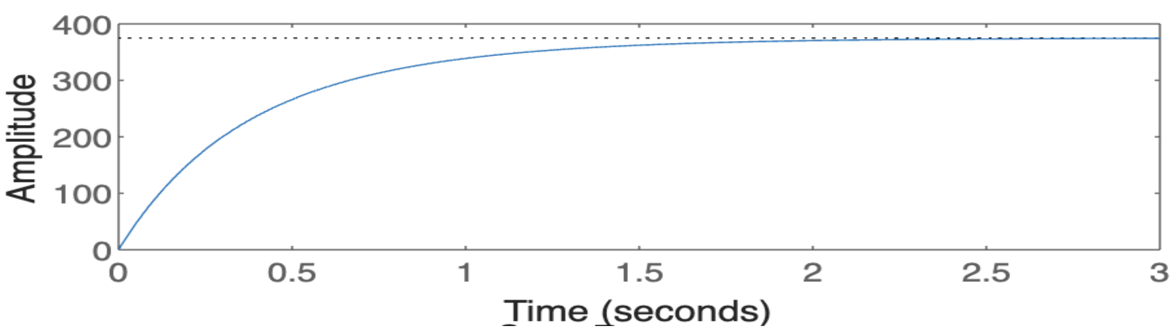
```
% H(s) = 10000 (s + 3/ s^2 + 6s + 8)
syms s;
my_num=[1 3];
my_den=[1 6 8];
my_trans_functionmy=tf(my_num,my_den);
```

Command Window

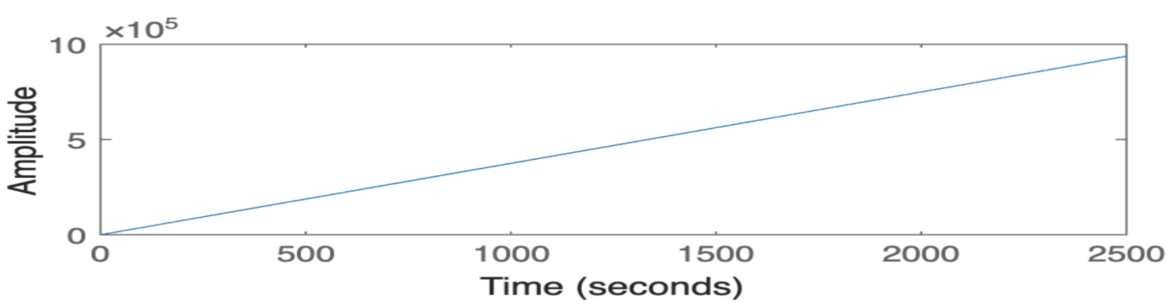
```
>> my_trans_function

my_trans_function =

      s + 3
  -------------
  s^2 + 6 s + 8

Continuous-time transfer function.
Model Properties
>>
```


Editor - C:\Users\fares\Desktop\what.m *
y.m
what.m *
syms s;
num = [1000 3000];
den = [1 6 8];
fun = tf(num,den);
subplot(2,1,1);
step(fun)
temp = tf([1 0], [1]);
subplot(2,1,2);
step(fun/temp)

STEP


400
300
200
100
0
Amplitude
0
0.5
1
1.5
2
2.5
3
Time (seconds)

RAMP


×10^5
10
5
0
Amplitude
0
500
1000
1500
2000
2500
Time (seconds)