



Faculty of Engineering & Technology
Electrical & Computer Engineering Department

Signals & Systems Assignment Report

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1201139

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Section: 3

Date: 23/8/2022

My university ID is 1201139 so A=1, B=3 & C=9.

1) Generate & plot the following signals:

a. $x(t) = \Pi[(t-3)/A] + \Pi[(t-C)/B]$
 $x(t) = \Pi[(t-3)/1] + \Pi[(t-9)/3]$

Code using MATLAB online:

```
t=0:.001:15;  
x=heaviside(t-2.5)-heaviside(t-3.5)+heaviside(t-7.5)-heaviside(t-10.5);  
plot(t,x);  
title('x(t)=\Pi [(t-3)/1]+\Pi [(t-9)/3]');  
xlabel('(t)'),ylabel('x(t)');  
set(gca,'xtick', 0:1:15);
```

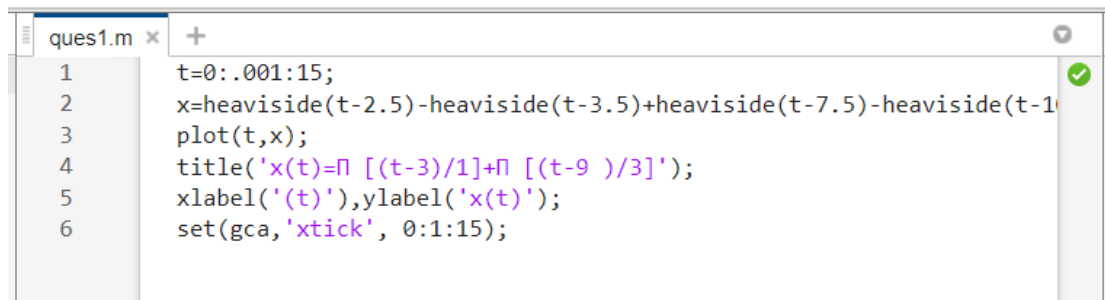
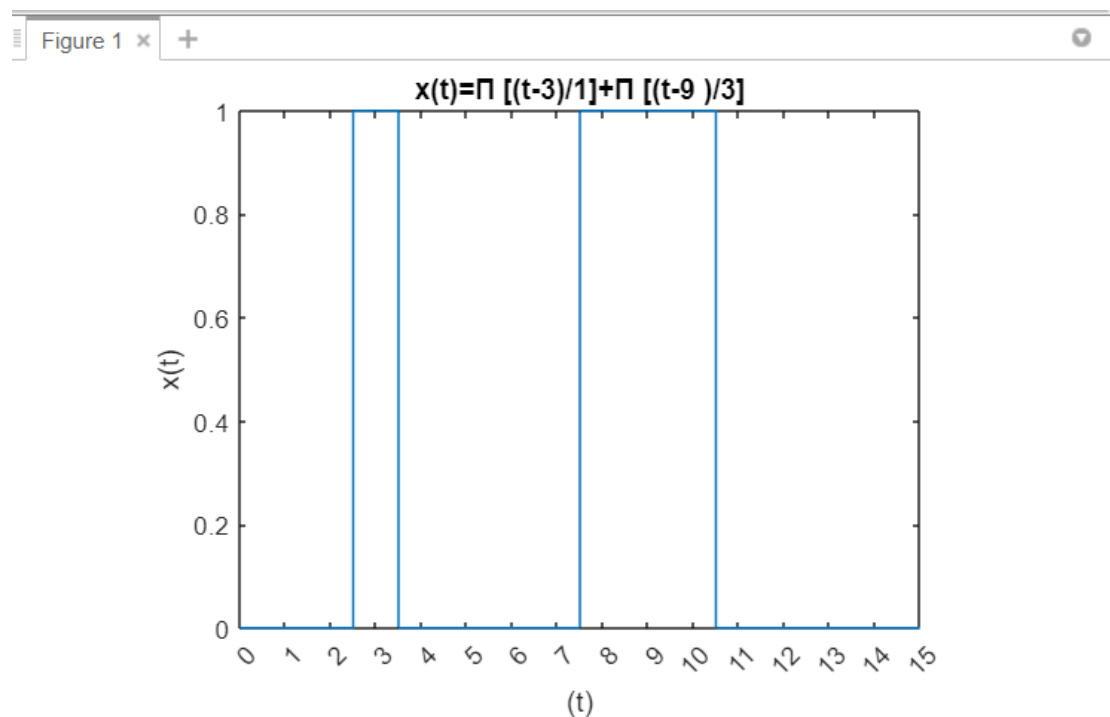



Figure:

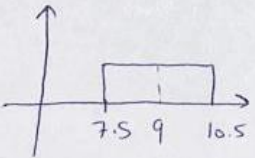


My solution to make sure that everything is correct:

1) a) $x(t) = \pi \left[\frac{(t-3)}{1} \right] + \pi \left[\frac{(t-9)}{3} \right]$

$\pi[t-3] =$ 

$\pi(t-3) = u(t-2.5) - u(t-3.5)$

$\pi \left[\frac{1}{3}(t-9) \right] =$ 

$\pi \left[\frac{1}{3}(t-9) \right] = u(t-7.5) - u(t-10.5)$

$x(t) = u(t-2.5) - u(t-3.5) + u(t-7.5) - u(t-10.5)$

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A B C

b. $x_b(t) = r(t) - r(t-A) - r(t-B) + r(t-C)$

$x_b(t) = r(t) - r(t-1) - r(t-3) + r(t-9)$

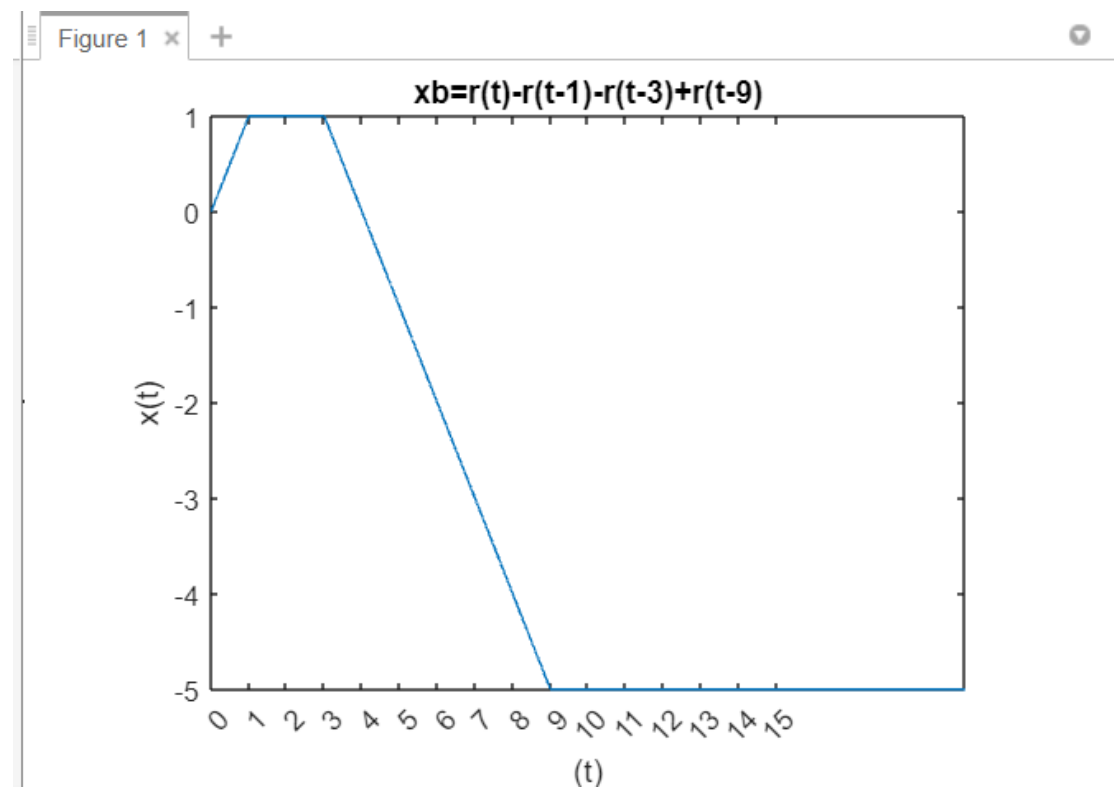
Code using MATLAB online:

```
t=0:0.001:20;
xb=(t).*heaviside(t)-(t-1).*heaviside(t-1)-(t-3).*heaviside(t-3)+(t-9).*heaviside(t-9);
plot(t,xb);

set(gca,'xtick', 0:1:15)
title('xb=r(t)-r(t-1)-r(t-3)+r(t-9)')
xlabel('(t)'),ylabel('x(t)')
```

```
MATLAB Drive >
ques1.m ques2.m
1 t=0:0.001:20;
2 xb=(t).*heaviside(t)-(t-1).*heaviside(t-1)-(t-3).*heaviside(t-3)+(t-9).*heaviside(t-9);
3 plot(t,xb);
4
5 set(gca,'xtick', 0:1:15)
6 title('xb=r(t)-r(t-1)-r(t-3)+r(t-9)')
7 xlabel('(t)'),ylabel('x(t)')
```

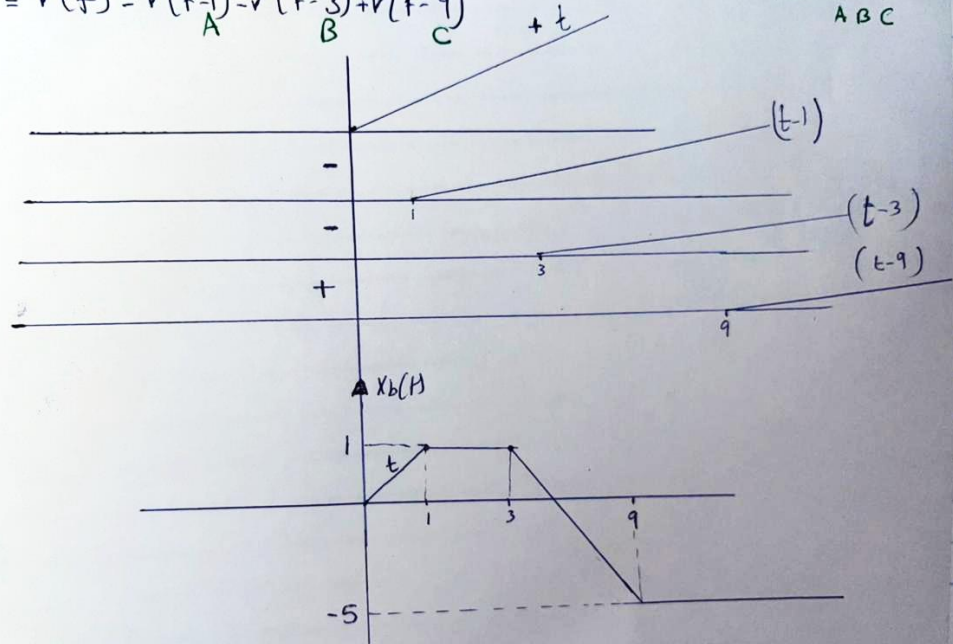
Figure:



My solution to make sure that everything is correct:

$$X_b(t) = r(t) - \underset{A}{r(t-1)} - \underset{B}{r(t-3)} + \underset{C}{r(t-9)}$$

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2) Consider the following signals:

$$x_1(t) = A \sin(10\pi t), \quad x_2(t) = \frac{1}{3} A \sin(30\pi t), \quad x_3(t) = \frac{1}{5} A \sin(50\pi t).$$

Since my ID is 1201139 $A=1$ so the following signals will be:

$$x_1(t) = A \sin(10\pi t) = \sin(10\pi t)$$

$$x_2(t) = \frac{1}{3} A \sin(30\pi t) = \frac{1}{3} \sin(30\pi t)$$

$$x_3(t) = \frac{1}{5} A \sin(50\pi t) = \frac{1}{5} \sin(50\pi t)$$

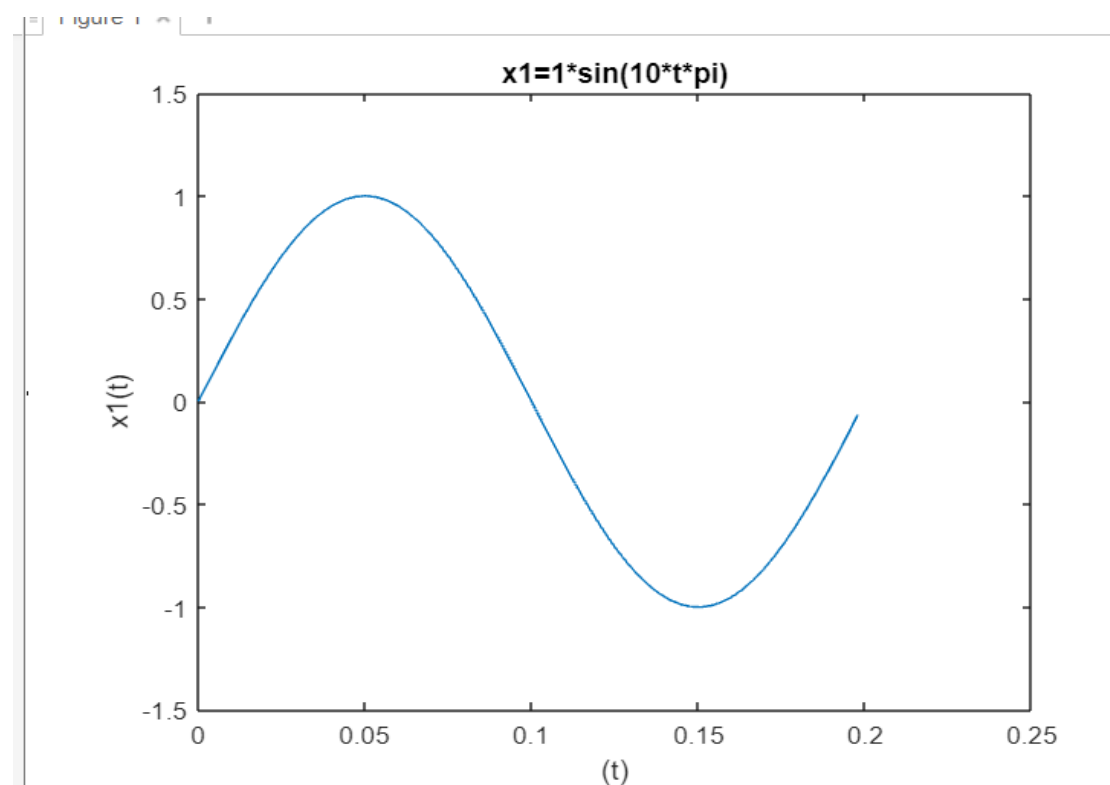
A. Generate and plot $x_1(t)$ for one period.

Code using MATLAB online:

```
t=0:pi/1000:(1/5); %since the period is 2pi/10pi
x1= sin(10*pi*t); %A=1
plot(t,x1) %to plpt x1 according to t
title('x1=1*sin(10*t*pi)') %to give a title to the drawing
axis ([0 0.25 -1.5 1.5]) %so that only one period is drawn
xlabel('(t)'),ylabel('x1(t)');
```

ques1.m	A.m	+
1	t=0:pi/1000:(1/5); %since the period is 2pi/10pi	✓
2	x1= sin(10*pi*t); %A=1	
3	plot(t,x1) %to plpt x1 according to t	
4	title('x1=1*sin(10*t*pi)') %to give a title to the drawing	
5	axis ([0 0.25 -1.5 1.5]) %so that only one period is drawn	
6	xlabel('(t)'),ylabel('x1(t)');	

Figure:



B. Generate and plot $x_b(t)=x_1(t)+x_2(t)$ for one period.

Code using MATLAB online:

```
t=0:pi/1000:(1/5); %the period for the sum signal xb is
%equal to the larger period between the two signals x1 & x2 which is equal
%to 1/5 by using the GCD and then finding f0
x1=sin(10*pi*t);
plot(t,x1)
hold on; % to complete the plot
x2=(1/3)*sin(30*pi*t);
plot(t,x2)
hold on; % to complete the plot
xb=x1+x2;
plot(t,xb)
legend('x1','x2','xb=x1+x2') %This is used to determine to each plot with a
%different color.
title('xb (t) = x1(t)+ x2(t) for one period') %title of the plot
axis ([0 0.25 -1.5 1.5])
```

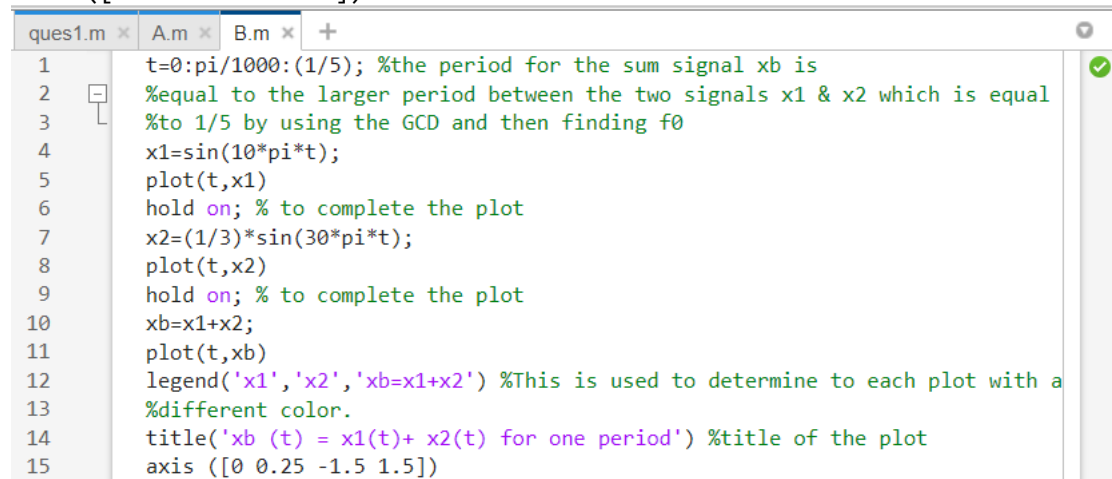
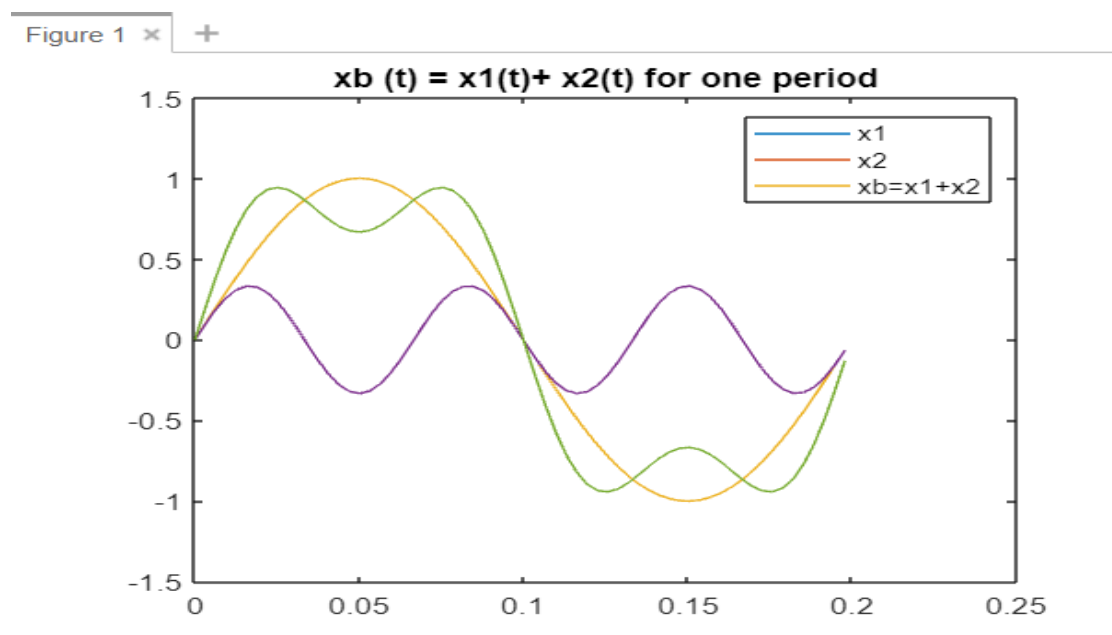


Figure:



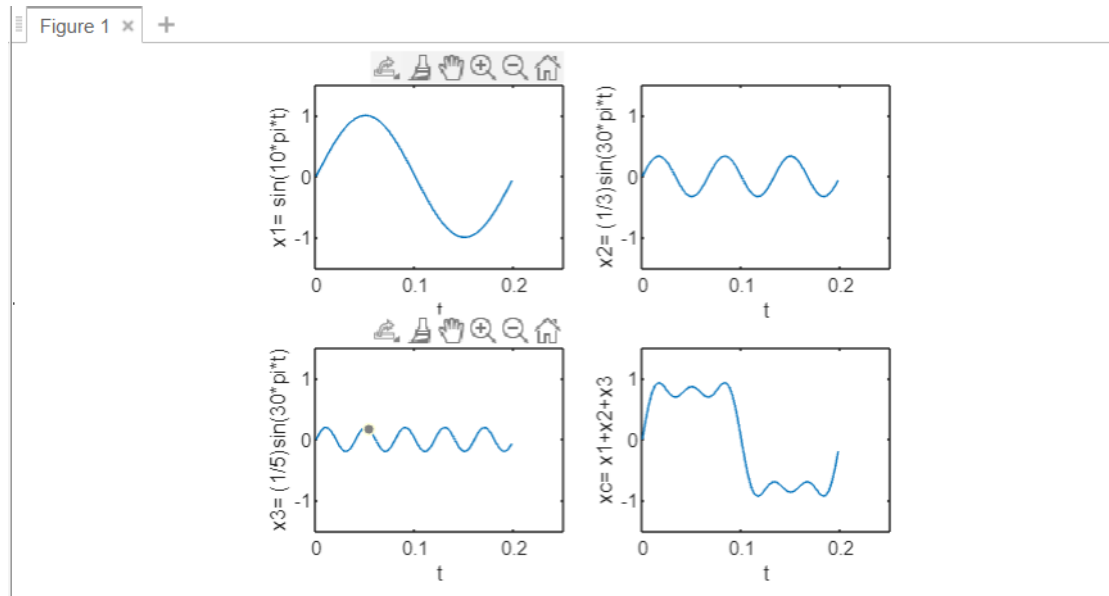
C. Generate and plot $x_c(t)=x_1(t)+x_2(t)+x_3(t)$ for one period. Show all the results on one figure using subplot

Code using MATLAB online:

```
t=0:pi/1000:(1/5); % period for xc signal is
%equal to the larger period between the three signals x1,x2,&x3
which
%equals 1/5 using the GCD between f1 , f2 &f3 that is f0=5HZ
x1=sin(10*pi*t);
subplot(2,2,1), plot(t,x1)
axis ([0 0.25 -1.5 1.5])
xlabel('t'),ylabel('x1= sin(10*pi*t)') %the titles of the axis
x2=(1/3)*sin(30*pi*t);
subplot(2,2,2), plot(t,x2)
axis ([0 0.25 -1.5 1.5])
xlabel('t'),ylabel('x2= (1/3)sin(30*pi*t)') %the titles of the axis
x3=(1/5)*sin(50*pi*t);
subplot(2,2,3), plot(t,x3)
axis ([0 0.25 -1.5 1.5])
xlabel('t'),ylabel('x3= (1/5)sin(30*pi*t)') %the titles of the axis
xc=x1+x2+x3; %xc value
subplot(2,2,4), plot(t,xc) %used to have more than one plot at the
ssame time
axis ([0 0.25 -1.5 1.5])
xlabel('t'),ylabel('xc= x1+x2+x3') %the titles of the axis
```

```
ques1.m x Am x B.m x C.m x +
1 t=0:pi/1000:(1/5); % period for xc signal is
2 %equal to the larger period between the three signals x1,x2,&x3 which
3 %equals 1/5 using the GCD between f1 , f2 &f3 that is f0=5HZ
4 x1=sin(10*pi*t);
5 subplot(2,2,1), plot(t,x1)
6 axis ([0 0.25 -1.5 1.5])
7 xlabel('t'),ylabel('x1= sin(10*pi*t)') %the titles of the axis
8 x2=(1/3)*sin(30*pi*t);
9 subplot(2,2,2), plot(t,x2)
10 axis ([0 0.25 -1.5 1.5])
11 xlabel('t'),ylabel('x2= (1/3)sin(30*pi*t)') %the titles of the axis
12 x3=(1/5)*sin(50*pi*t);
13 subplot(2,2,3), plot(t,x3)
14 axis ([0 0.25 -1.5 1.5])
15 xlabel('t'),ylabel('x3= (1/5)sin(30*pi*t)') %the titles of the axis
16 xc=x1+x2+x3; %xc value
17 subplot(2,2,4), plot(t,xc) %used to have more than one plot at the ssame time
18 axis ([0 0.25 -1.5 1.5])
19 xlabel('t'),ylabel('xc= x1+x2+x3') %the titles of the axis
```


Figure:



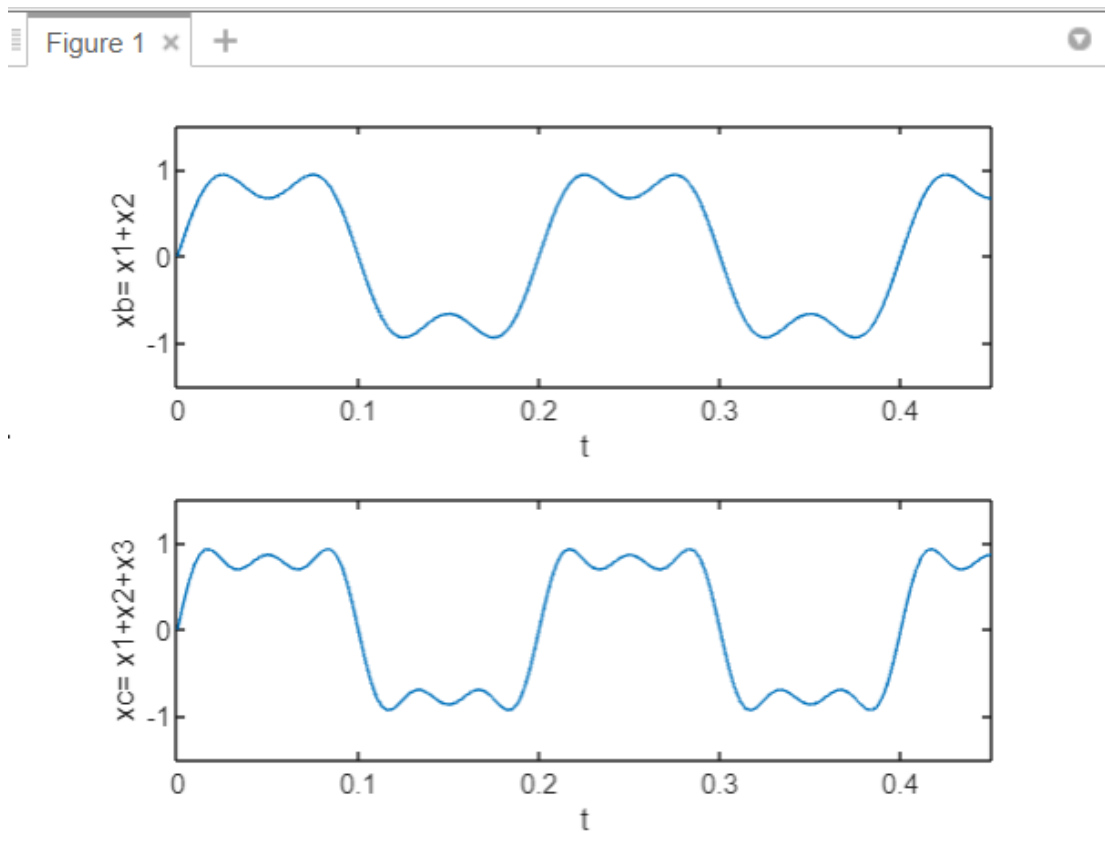
D. Determine, using MATLAB plots, if the generated signals are periodic or not.

Code using MATLAB online:

```
t=0:pi/1000:(5); % the period of the generated signals are both 1/5
%after calculating it via GCD method.
%the previous questions we determined t to be 1/5(period) so now we need to
% put the t to a bigger scale to check if the signal repeat itself or not
%that way its determined if the signal is periodic or not.
x1=sin(10*pi*t);
x2=(1/3)*sin(30*pi*t);
x3=(1/5)*sin(50*pi*t);
xb=x1+x2;
subplot(2,1,1),plot(t,xb) %to plot them together
axis ([0 0.45 -1.5 1.5])
xlabel('t'),ylabel('xb= x1+x2 ') %the axis titles
xc=x1+x2+x3;
subplot(2,1,2), plot(t,xc)
axis ([0 0.45 -1.5 1.5])
xlabel('t'),ylabel('xc= x1+x2+x3')
```

```
D.m x +
1 t=0:pi/1000:(5); % the period of the generated signals are both 1/5
2 %after calculating it via GCD method.
3 %the previos questions we determined t to be 1/5(period) so now we need to
4 % put the t to a bigger scale to check if the signal repeat itself or not
5 %that way its determined if the signal is periodic or not.
6 x1=sin(10*pi*t);
7 x2=(1/3)*sin(30*pi*t);
8 x3=(1/5)*sin(50*pi*t);
9 xb=x1+x2;
10 subplot(2,1,1),plot(t,xb) %to plot them together
11 axis ([0 0.45 -1.5 1.5])
12 xlabel('t'),ylabel('xb= x1+x2 ') %the axis titles
13 xc=x1+x2+x3;
14 subplot(2,1,2), plot(t,xc)
15 axis ([0 0.45 -1.5 1.5])
16 xlabel('t'),ylabel('xc= x1+x2+x3')
```

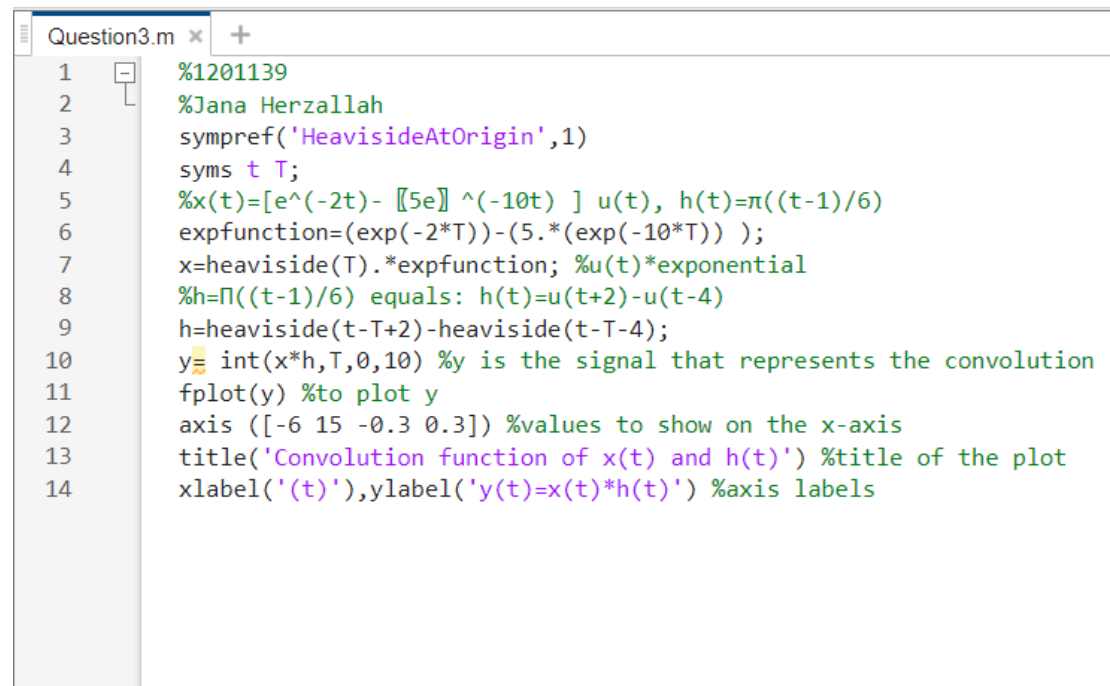
Figure:



- 3) Find & sketch the signal $y(t)$ which is the convolution of the two pairs of signals. $x(t) = [e^{-2t} - 5e^{-10t}] u(t)$, $h(t) = \pi(t - 1/6)$.

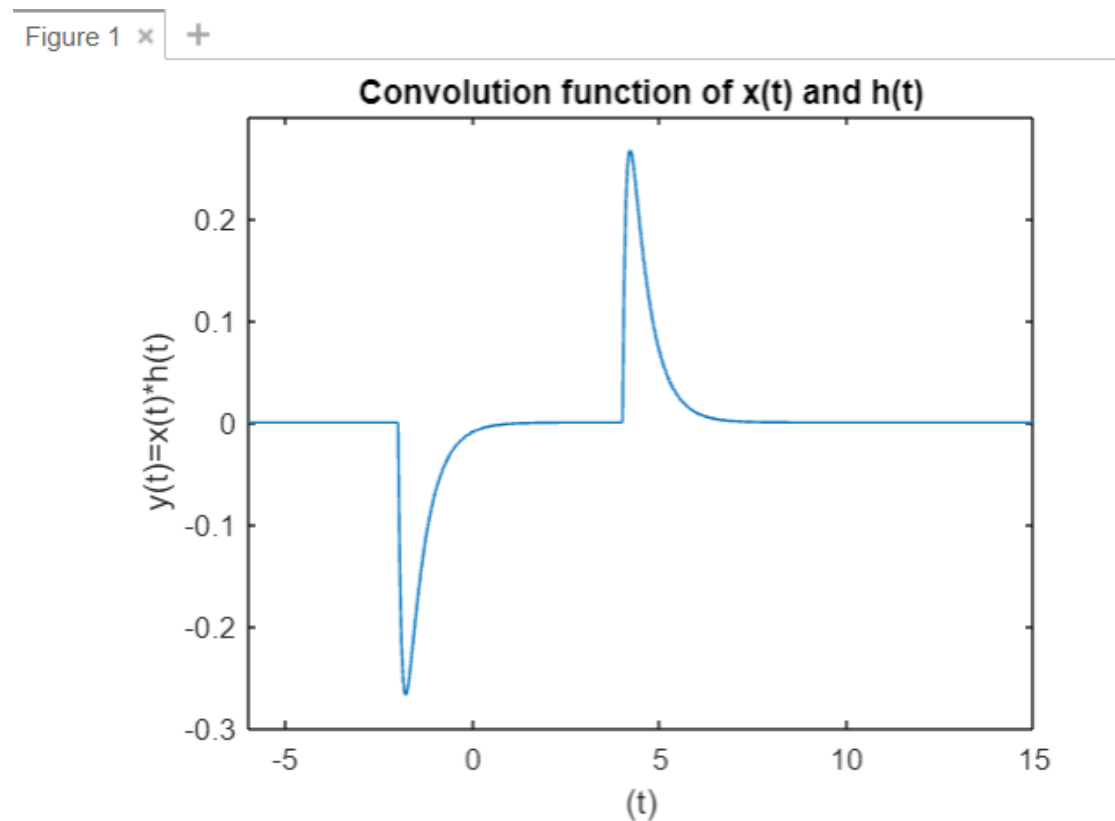
Code using MATLAB online:

```
%1201139
%Jana Herzallah
sympref('HeavisideAtOrigin',1)
syms t T;
%x(t)=[e^(-2t)- [5e] ^(-10t) ] u(t), h(t)=pi((t-1)/6)
expfunction=(exp(-2*T))-(5.*(exp(-10*T)) );
x=heaviside(T).*expfunction; %u(t)*exponential
%h=pi((t-1)/6) equals: h(t)=u(t+2)-u(t-4)
h=heaviside(t-T+2)-heaviside(t-T-4);
y= int(x*h,T,0,10) %y is the signal that represents the convolution
fplot(y) %to plot y
axis ([-6 15 -0.3 0.3]) %values to show on the x-axis
title('Convolution function of x(t) and h(t)') %title of the plot
xlabel('(t)'),ylabel('y(t)=x(t)*h(t)') %axis labels
```



```
Question3.m x +
1 %1201139
2 %Jana Herzallah
3 sympref('HeavisideAtOrigin',1)
4 syms t T;
5 %x(t)=[e^(-2t)- [5e] ^(-10t) ] u(t), h(t)=pi((t-1)/6)
6 expfunction=(exp(-2*T))-(5.*(exp(-10*T)) );
7 x=heaviside(T).*expfunction; %u(t)*exponential
8 %h=pi((t-1)/6) equals: h(t)=u(t+2)-u(t-4)
9 h=heaviside(t-T+2)-heaviside(t-T-4);
10 y= int(x*h,T,0,10) %y is the signal that represents the convolution
11 fplot(y) %to plot y
12 axis ([-6 15 -0.3 0.3]) %values to show on the x-axis
13 title('Convolution function of x(t) and h(t)') %title of the plot
14 xlabel('(t)'),ylabel('y(t)=x(t)*h(t)') %axis labels
```

Figure:



4) For LTI system $h(t) = Ae^{-Bt}$ consider the input square wave be:

$$x(t) = A + \sum_{\substack{k=-\infty \\ k \text{ odd}}}^{\infty} \frac{B}{\pi k} e^{-j\pi/2} e^{jkt}$$

a) Plot the system frequency response (Amplitude and Phase)

Code using MATLAB online:

Fourier transform of $h(t)$ alone:

```
%1201139
%A =1 , B=3
%x(t)=(3/pi.*k).*exp((-1i.*pi/2).*exp(1i.*k.*t));
%h(t) = exp(-3.*t);
clc
clearAllMemoizedCaches;

sum=1; %sum = A =1

t=0:.1:7;
    for k=-101:2:101 %this goes through the odd values of k

        x=(5/pi.*k).*exp((-1i.*pi)/2).*exp(1i*k.*t); %x(t)
        sum=sum+x; %sum = the result of adding the previos sum to x
    end %ending of the k-forloop

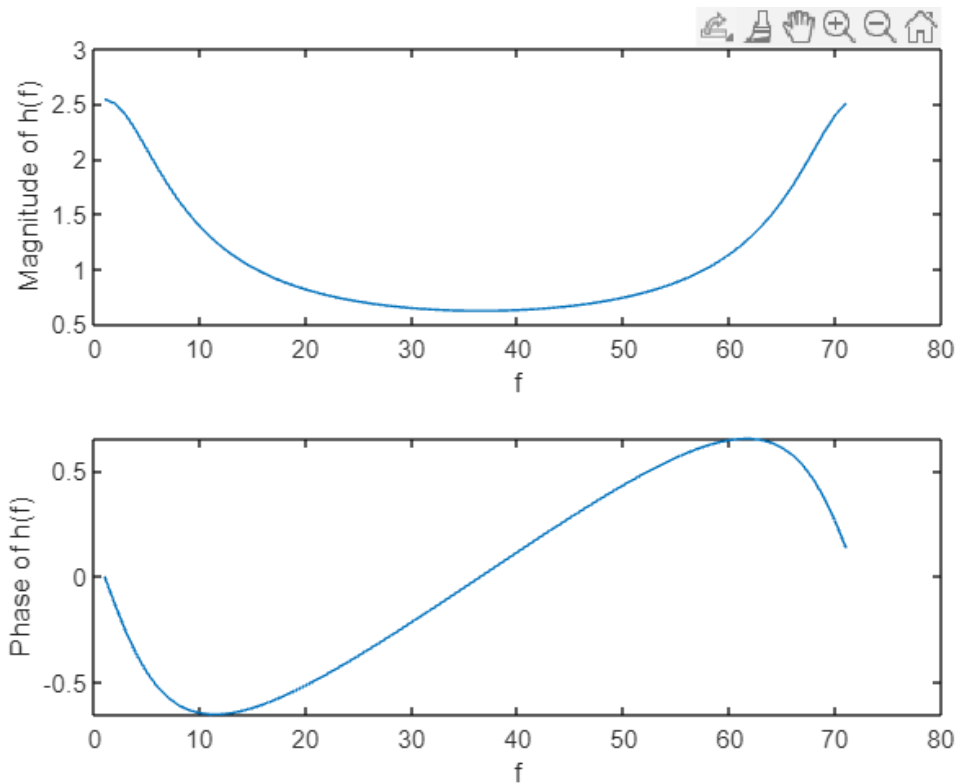
h= exp(-5.*t);

hF = fft(h);%h(f) is the fourier transform of h

xF = fft(x);%x(f) is the fourier transform of x

hMagnitude = abs(hF); %magnitude of y
hAngle = angle (hF); %angle of y

subplot (2,1,1); %subplotting the first graph
plot(hMagnitude);
xlabel('f'),ylabel('Magnitude of h(f)') %the titles of the axis
subplot (2,1,2); %subplotting the seconed graph
plot(hAngle);
xlabel('f'),ylabel('Phase of h(f)'); %the titles of the axis
```



Fourier transform of the system $y(t) = h(t)*x(t)$:

```
%1201139
%A =1 , B=3
```

```
%x(t)=(3/pi.*k).*exp((-1i.*pi/2).*exp(1i.*k.*t));
%h(t) = exp(-3.*t);
```

%frequency reponse means that we need the fourier transform of each signal
 %then we find the magnitude & phase of the muliplication of x,h.

```
h= exp(-3.*t);
sum=1; %sum = A =1
```

```
t=-20:.1:20
for k=-21:2:21 %this goes through the odd values of k
```

```
    x=(3/pi.*k).*exp((-1i.*pi)/2).*exp(1i*k.*t); %x(t)
    sum=sum+x; %sum = the result of adding the previos sum to x
end %ending of the k-forloop
```

```
hF = fft(h);%h(f) is the fourier transform of h
xF = fft(x);%x(f) is the fourier transform of x
```

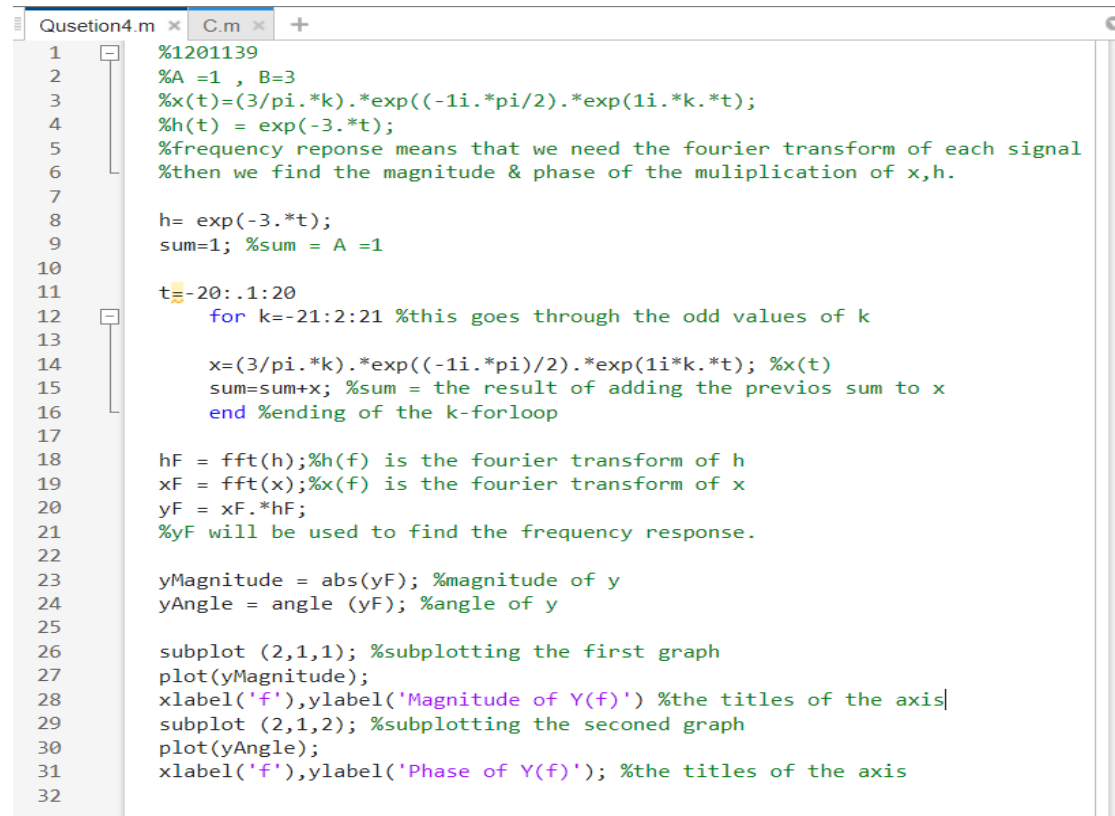
```
yF = xF.*hF;
%yF will be used to find the frequency response.
```

```

yMagnitude = abs(yF); %magnitude of y
yAngle = angle (yF); %angle of y

subplot (2,1,1); %subplotting the first graph
plot(yMagnitude);
xlabel('f'),ylabel('Magnitude of Y(f)') %the titles of the axis
subplot (2,1,2); %subplotting the second graph
plot(yAngle);
xlabel('f'),ylabel('Phase of Y(f)'); %the titles of the axis

```

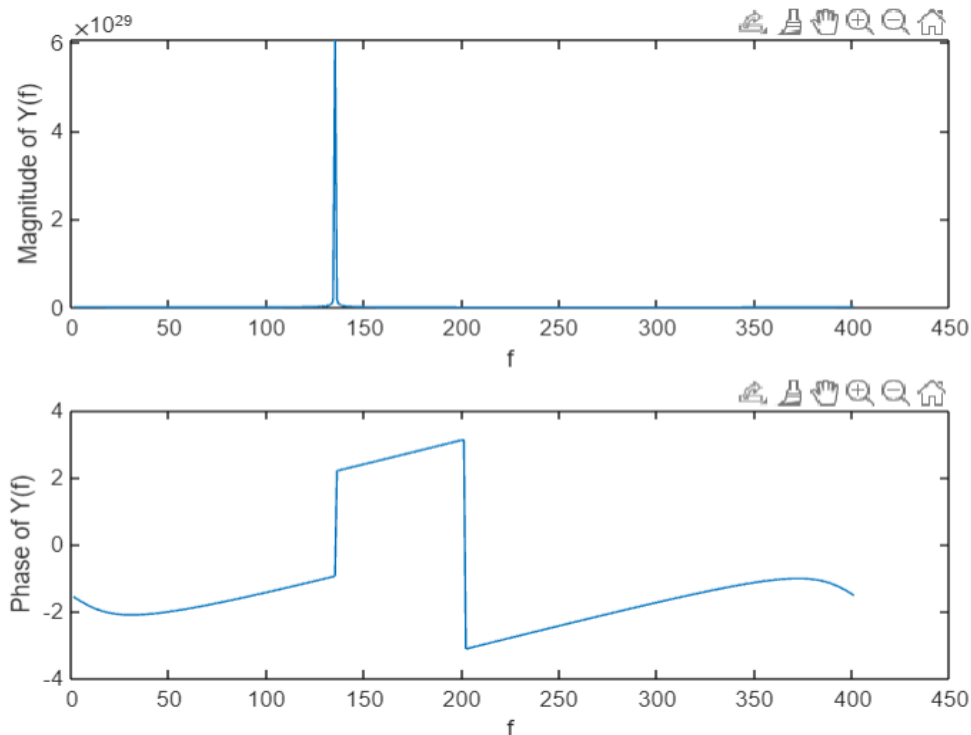


```

1 %1201139
2 %A =1 , B=3
3 %x(t)=(3/pi.*k).*exp((-1i.*pi/2).*exp(1i.*k.*t));
4 %h(t) = exp(-3.*t);
5 %frequency reponse means that we need the fourier transform of each signal
6 %then we find the magnitude & phase of the muliplication of x,h.
7
8 h= exp(-3.*t);
9 sum=1; %sum = A =1
10
11 t=-20:.1:20
12 for k=-21:2:21 %this goes through the odd values of k
13
14 x=(3/pi.*k).*exp((-1i.*pi)/2).*exp(1i*k.*t); %x(t)
15 sum=sum+x; %sum = the result of adding the previos sum to x
16 end %ending of the k-forloop
17
18 hF = fft(h);%h(f) is the fourier transform of h
19 xF = fft(x);%x(f) is the fourier transform of x
20 yF = xF.*hF;
21 %yF will be used to find the frequency response.
22
23 yMagnitude = abs(yF); %magnitude of y
24 yAngle = angle (yF); %angle of y
25
26 subplot (2,1,1); %subplotting the first graph
27 plot(yMagnitude);
28 xlabel('f'),ylabel('Magnitude of Y(f)') %the titles of the axis
29 subplot (2,1,2); %subplotting the second graph
30 plot(yAngle);
31 xlabel('f'),ylabel('Phase of Y(f)'); %the titles of the axis
32

```

Figure:



b) Plot the system time response for the square wave input (consider the time interval [0:0.1:7])

Code using MATLAB online:

```
%1201139
%A =1 , B=3
%x(t)=(3/pi.*k).*exp((-1i.*pi/2).*exp(1i.*k.*t));
%h(t) = exp(-3.*t);
clc
clearAllMemoizedCaches;

sum=1; %sum = A =1

t=0:.1:7;
for k=-101:2:101 %this goes through the odd values of k

    x=(5/pi.*k).*exp((-1i.*pi)/2).*exp(1i*k.*t); %x(t)
    sum=sum+x; %sum = the result of adding the previos sum to x
end %ending of the k-forloop

h= exp(-5.*t);

hF = fft(h);%h(f) is the fourier transform of h
xF = fft(x);%x(f) is the fourier transform of x
yF = xF.*hF;
%yF will be used to find the frequency response.
```



```

Y=ifft(yF); %ifft changes from frequency response to time response
plot(Y,t);
xlabel('(t)'),ylabel('y(t)') %axis labels

```

```

test.m x +
1 %1201139
2 %A =1 , B=3
3 %x(t)=(3/pi.*k).*exp((-1i.*pi/2).*exp(1i.*k.*t));
4 %h(t) = exp(-3.*t);
5 clc
6 clearAllMemoizedCaches;
7
8 sum=1; %sum = A =1
9
10 t=0:.1:7;
11 for k=-101:2:101 %this goes through the odd values of k
12
13 x=(5/pi.*k).*exp((-1i.*pi)/2).*exp(1i*k.*t); %x(t)
14 sum=sum+x; %sum = the result of adding the previos sum to x
15 end %ending of the k-forloop
16
17 h= exp(-5.*t);
18
19 |
20 hF = fft(h);%h(f) is the fourier transform of h
21 xF = fft(x);%x(f) is the fourier transform of x
22 yF = xF.*hF;
23 %yF will be used to find the frequency response.
24
25 Y=ifft(yF); %ifft changes from frequency response to time response
26 plot(Y,t);
27 xlabel('(t)'),ylabel('y(t)') %axis labels

```

Figure:

