Faculty of Engineering & Technology
Electrical & Computer Engineering Department

Signals & Systems Assignment Report

Prepared by:

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Instructor: Dr. Ashraf Al-Rimawi

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

$x(t) = \Pi\,[(t-3)/1] + \Pi[(t-9)/3]$

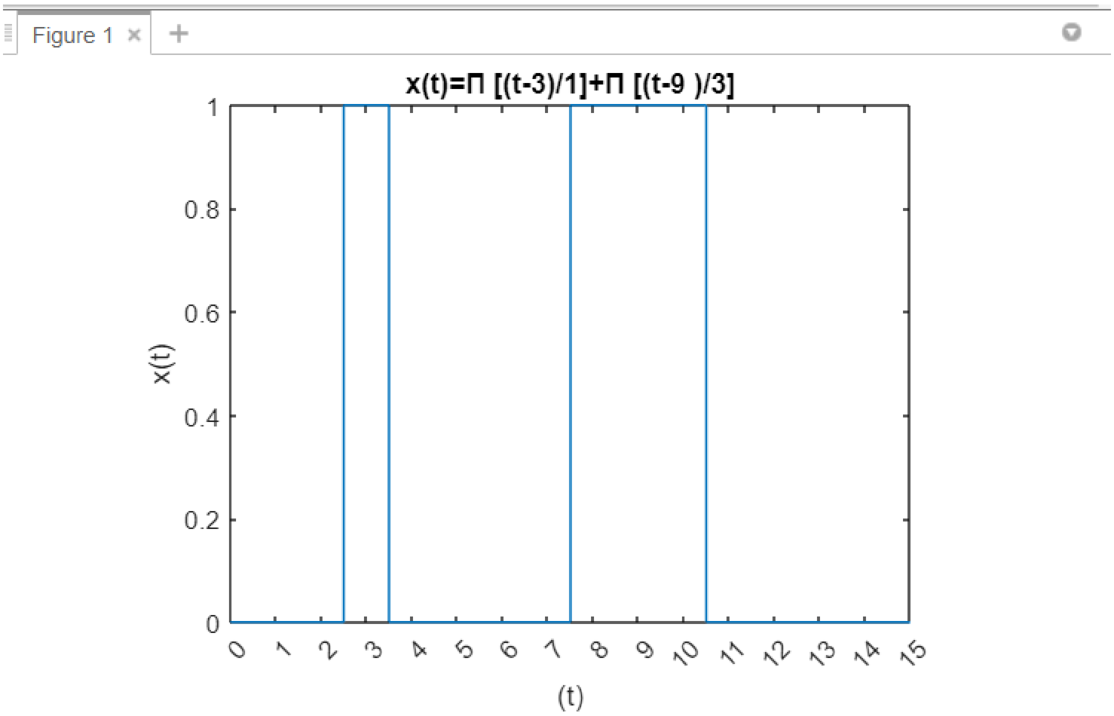
Code using MATLAB online:

```
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)=Π [(t-3)/1]+Π [(t-9 )/3]');
xlabel('(t)'),ylabel('x(t)');
set(gca,'xtick', 0:1:15);
```

ques1.m


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


Figure:



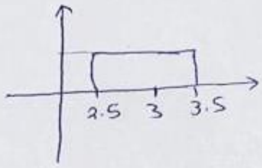
My solution to make sure that everything is correct:

1) a) $x(t) = \Pi\left[(t-3)/\underset{A}{1}\right] + \Pi\left[(t-\underset{C}{9})/\underset{B}{3}\right]$

1201139

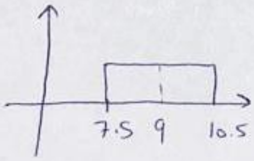
A B C

$\Pi[t-3] =$



$\Pi(t-3) = u(t-2.5) - u(t-3.5).$

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



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

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

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

xb(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)')
```

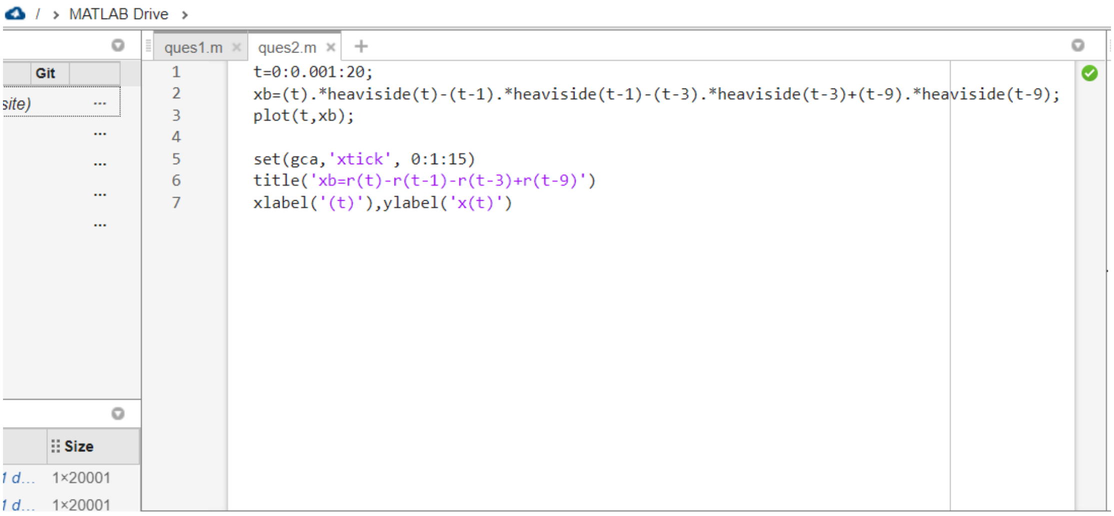
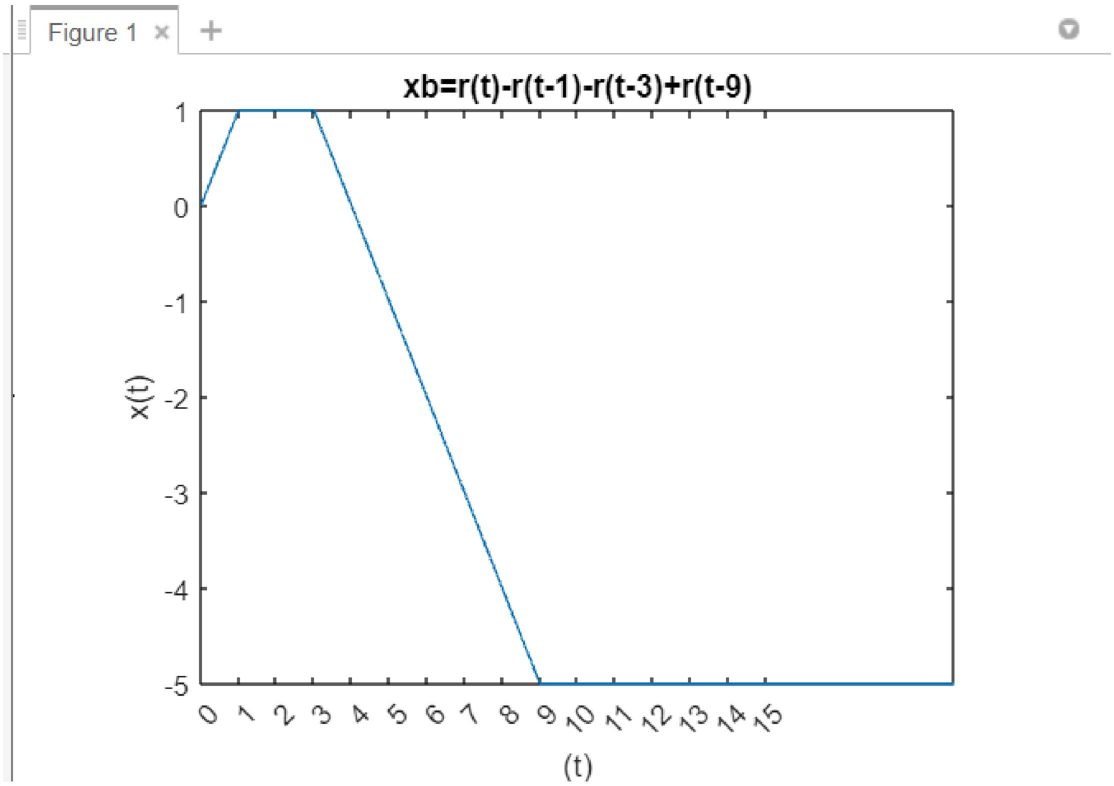
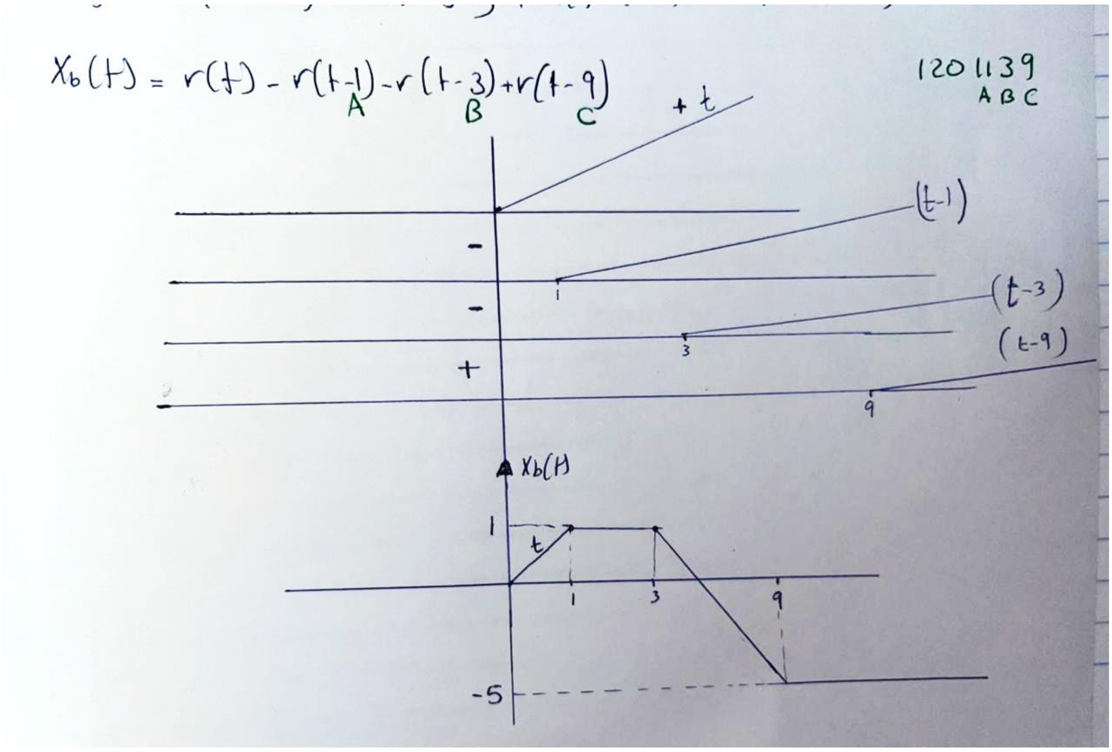


Figure:



My solution to make sure that everything is correct:



2) Consider the following signals:
$x1(t)$ =A $sin(10\pi t)$, $x2$ (t) = 1/3 A $sin(30\pi t)$, $x3$ (t) = 1/5 A $sin(50\pi t)$.

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

$x1(t)$ =A $sin(10\pi t)$ = sin (10 πt)

$x2$ (t) = 1/3 A $sin(30\pi t)$ = 1/3 sin $(30\pi t)$

$x3$ (t) = 1/5 A $sin(50\pi t)$ = 1/5 $sin(50\pi t)$

A. Generate and plot x1(t) for one period.

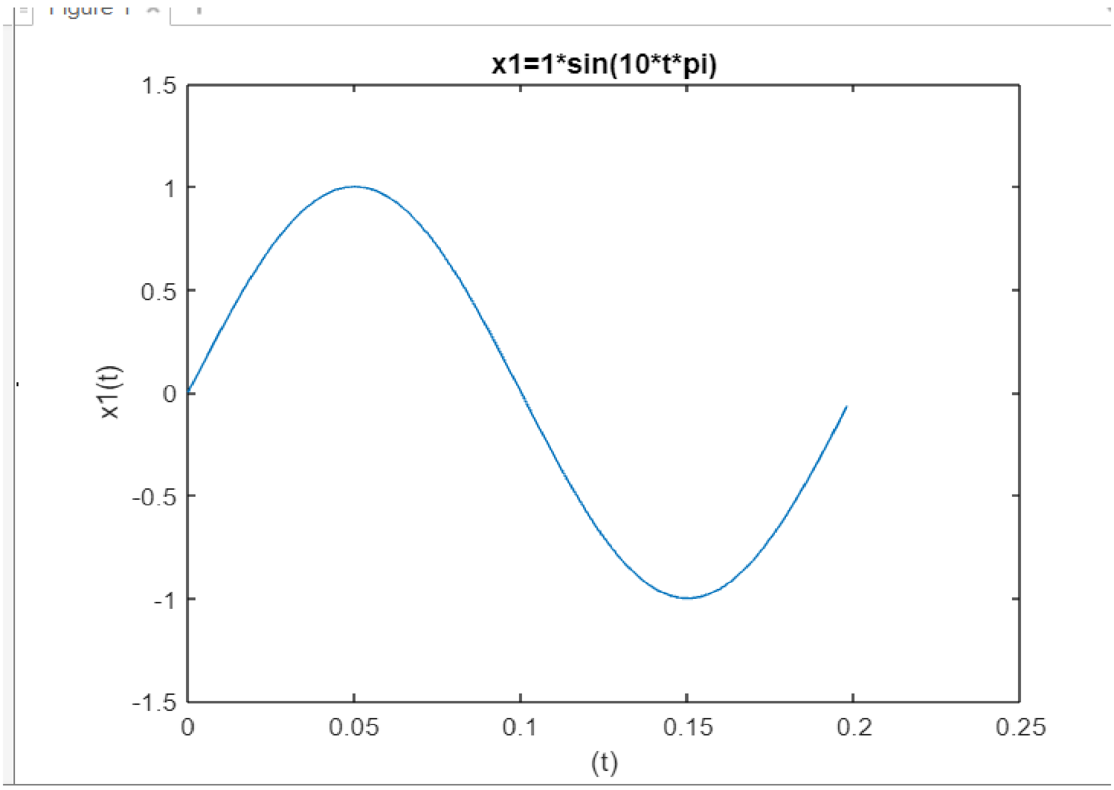
Code using MATLAB online:

```
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 ×


```
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)');
```

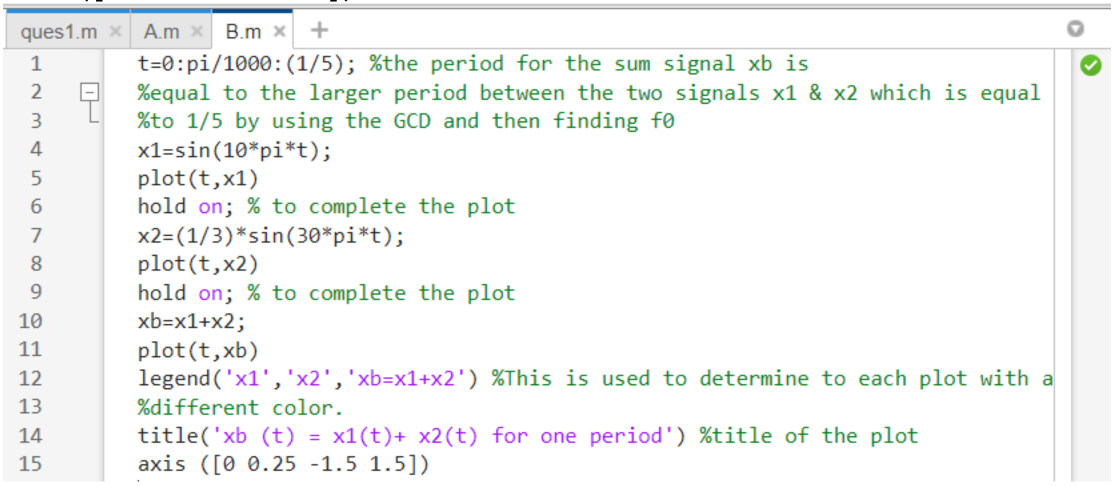

Figure:



B. Generate and plot xb(t)=x1(t)+x2(t) for one period.

Code using MATLAB online:

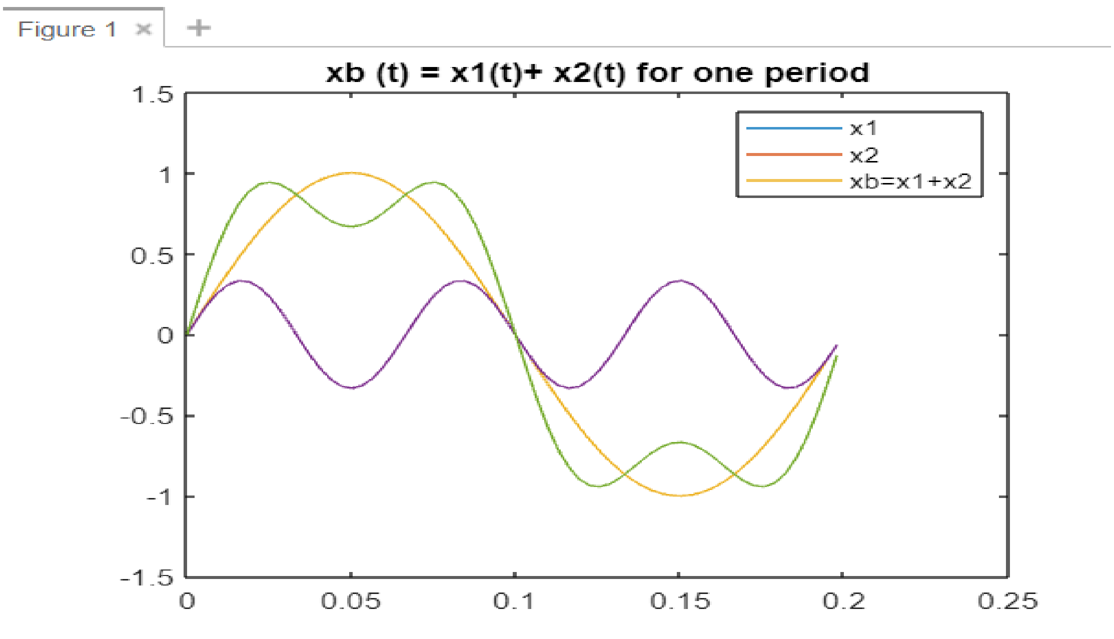
```
t=0:pi/1000:(1/5); %the period for the sum signal xb is
%equal to the larger period between the two signals x1 & x2 which is equal
%to 1/5 by using the GCD and then finding f0
x1=sin(10*pi*t);
plot(t,x1)
hold on; % to complete the plot
x2=(1/3)*sin(30*pi*t);
plot(t,x2)
hold on; % to complete the 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])
```



ques1.m A.m B.m

```
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])
```

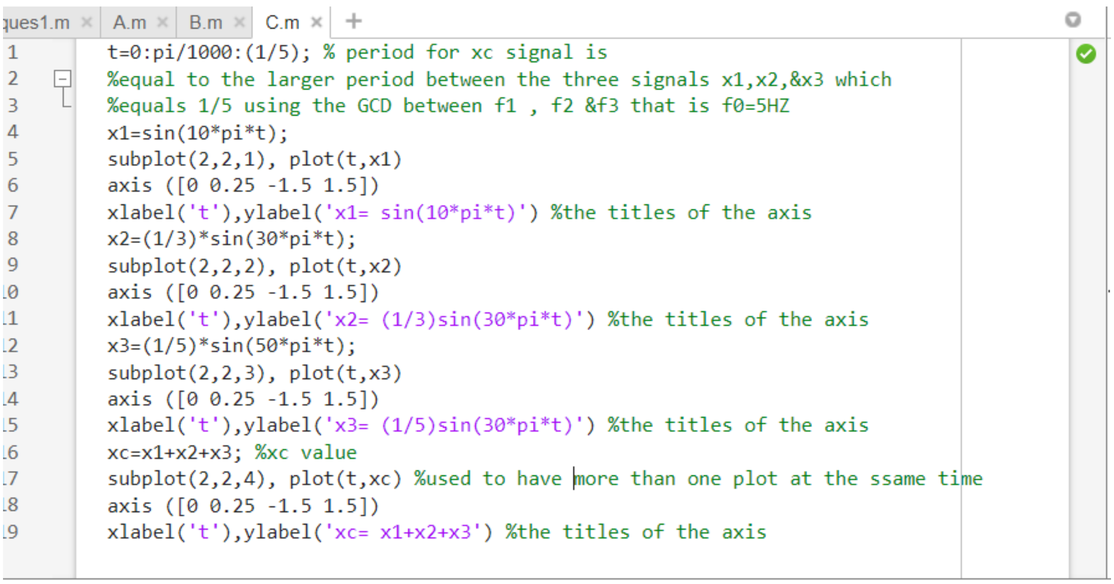
Figure:



C. Generate and plot xc(t)=x1(t)+x2(t) +x3(t) for one period. Show all the results on one figure using subplot

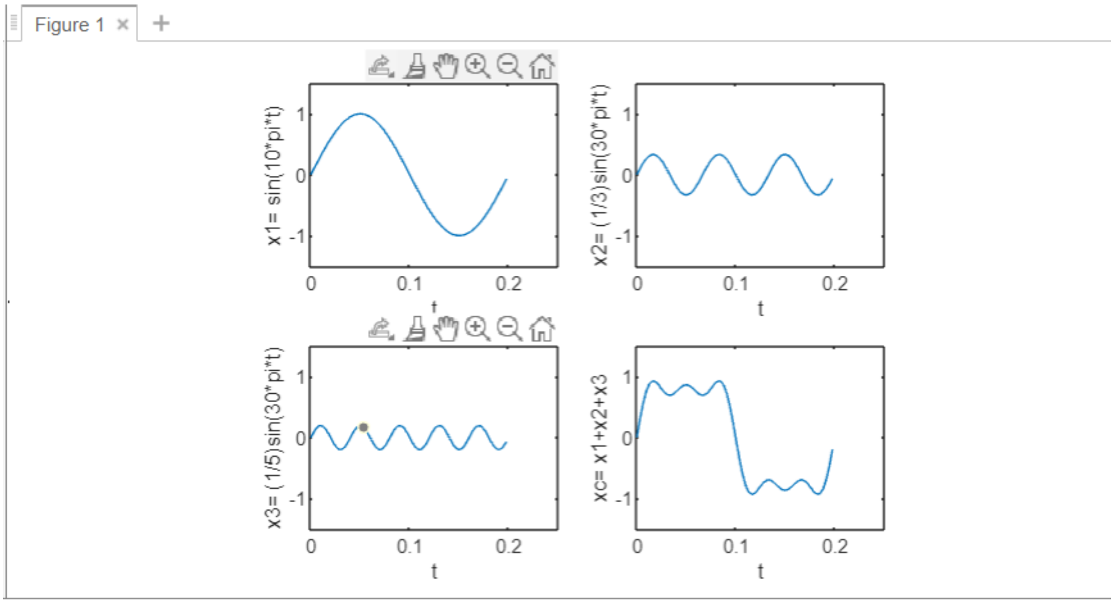
Code using MATLAB online:

```
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
```




```
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
```

Figure:



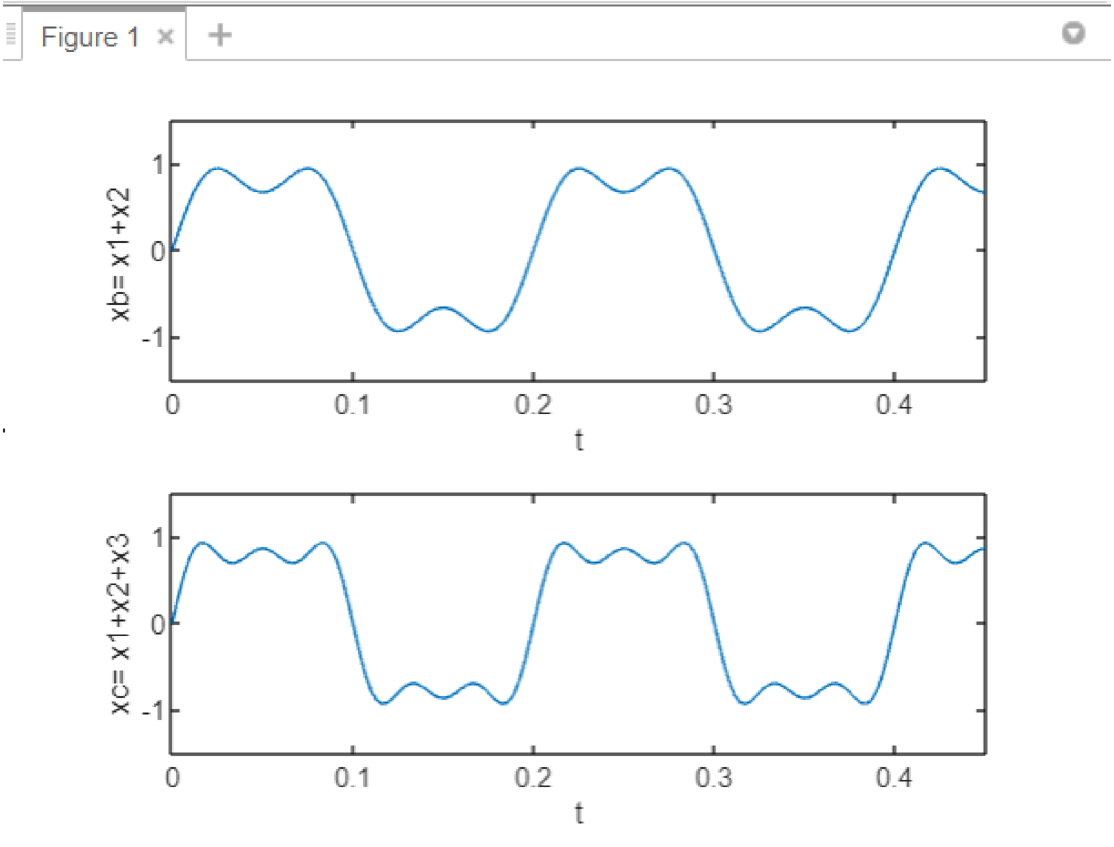
D. Determine, using MATLAB plots, if the generated signals are periodic or not.

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 previos 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')
```

```
t=0:pi/1000:(5); % the period of the generated signals are both 1/5
%after calculating it via GCD method.
%the previos 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')
```

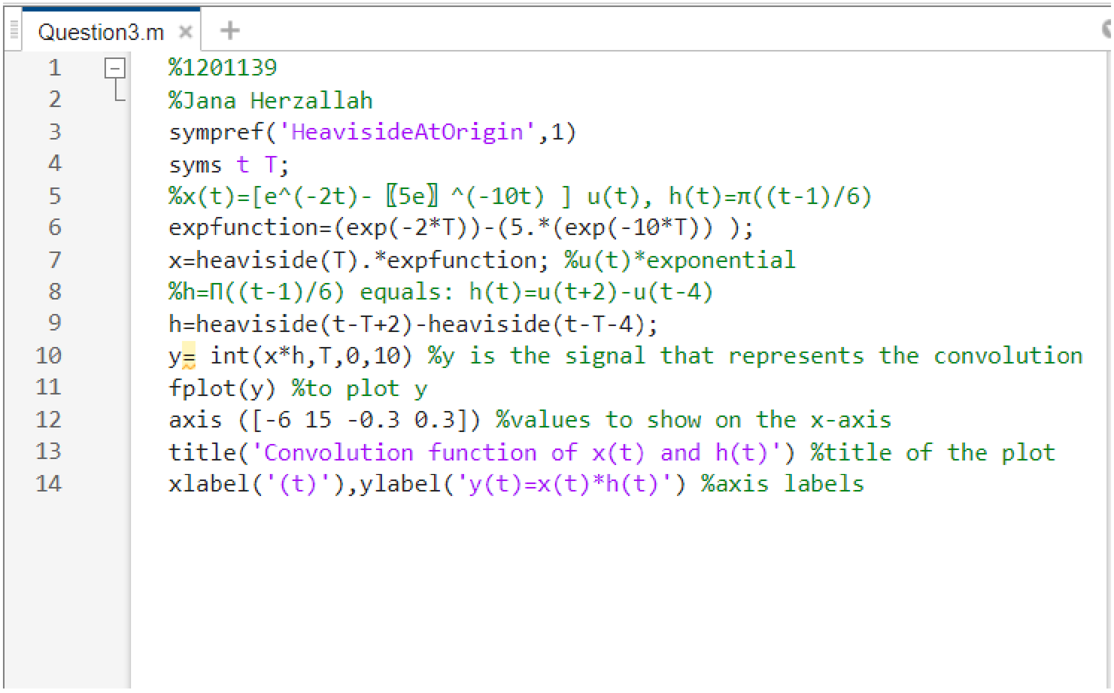
Figure:



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

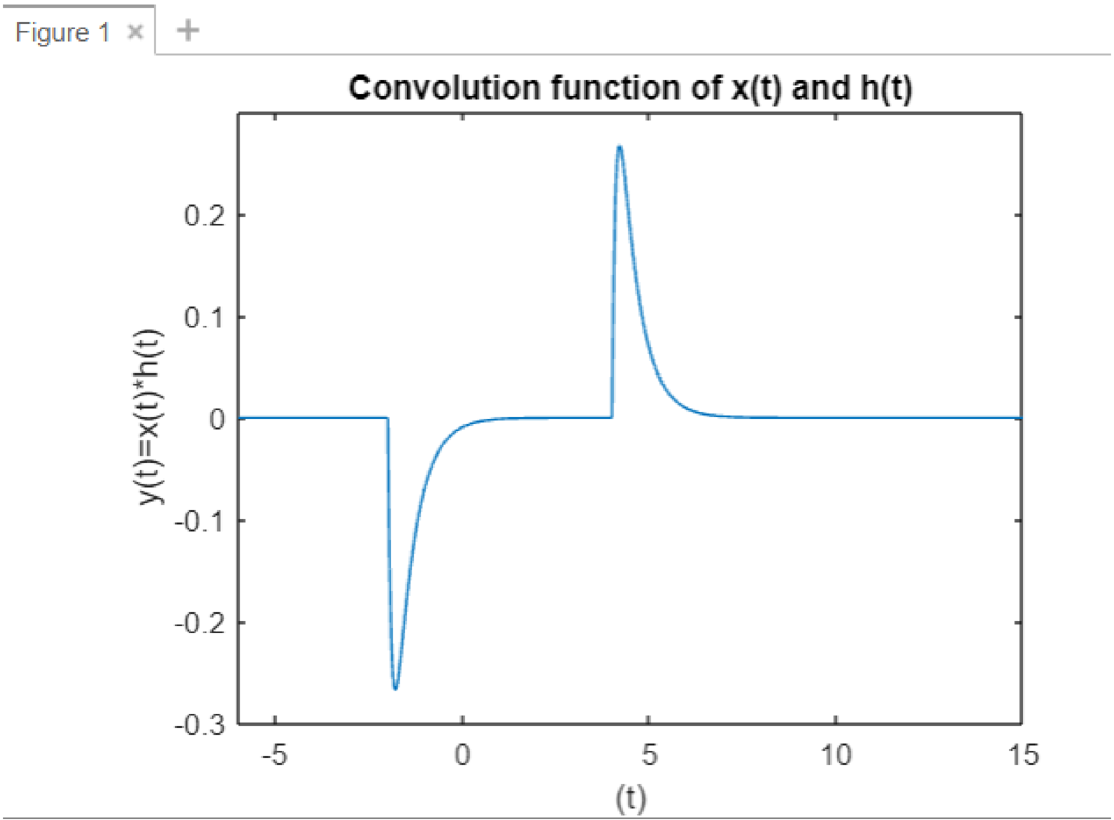
Code using MATLAB online:

```
%1201139
%Jana Herzallah
sympref('HeavisideAtOrigin',1)
syms t T;
%x(t)=[e^(-2t)- ⟦5e⟧ ^(-10t) ] u(t), h(t)=π((t-1)/6)
expfunction=(exp(-2*T))-(5.*(exp(-10*T)) );
x=heaviside(T).*expfunction; %u(t)*exponential
%h=Π((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

```
%1201139
%Jana Herzallah
sympref('HeavisideAtOrigin',1)
syms t T;
%x(t)=[e^(-2t)- ⟦5e⟧ ^(-10t) ] u(t), h(t)=π((t-1)/6)
expfunction=(exp(-2*T))-(5.*(exp(-10*T)) );
x=heaviside(T).*expfunction; %u(t)*exponential
%h=Π((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
```

Figure:



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

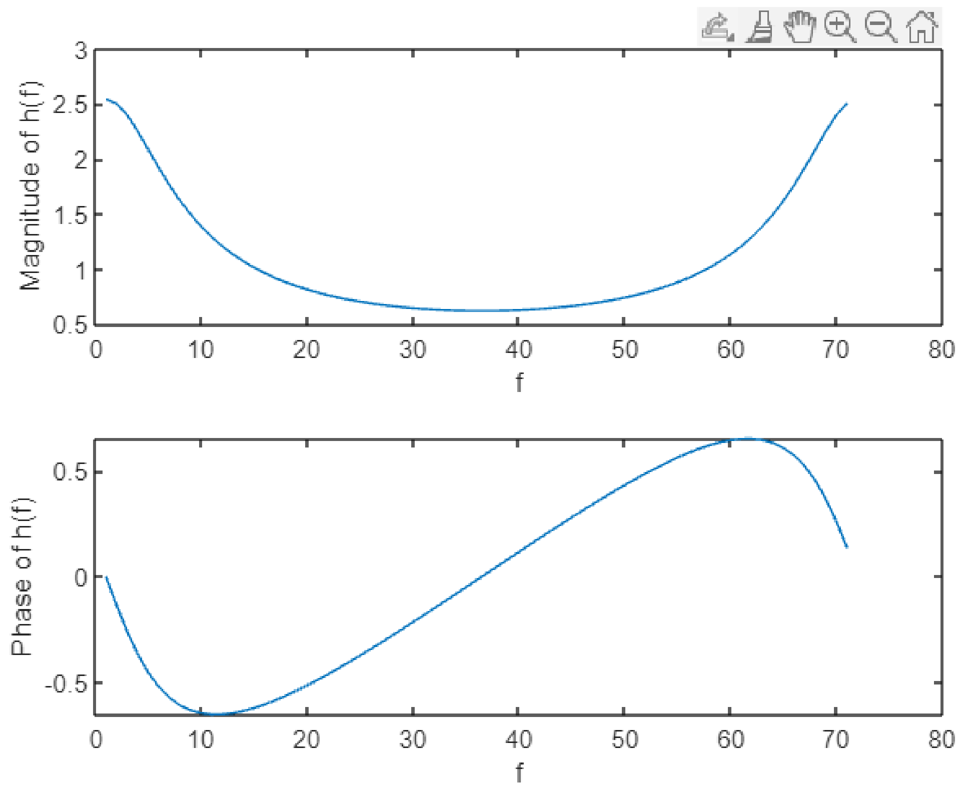
$$x(t) = A + \sum_{\substack{k=-\infty \\ k\ odd}}^{\infty} \frac{B}{\pi k} e^{-j\pi/2} e^{jkt}$$

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 seconed graph
plot(yAngle);
xlabel('f'),ylabel('Phase of Y(f)'); %the titles of the axis
```

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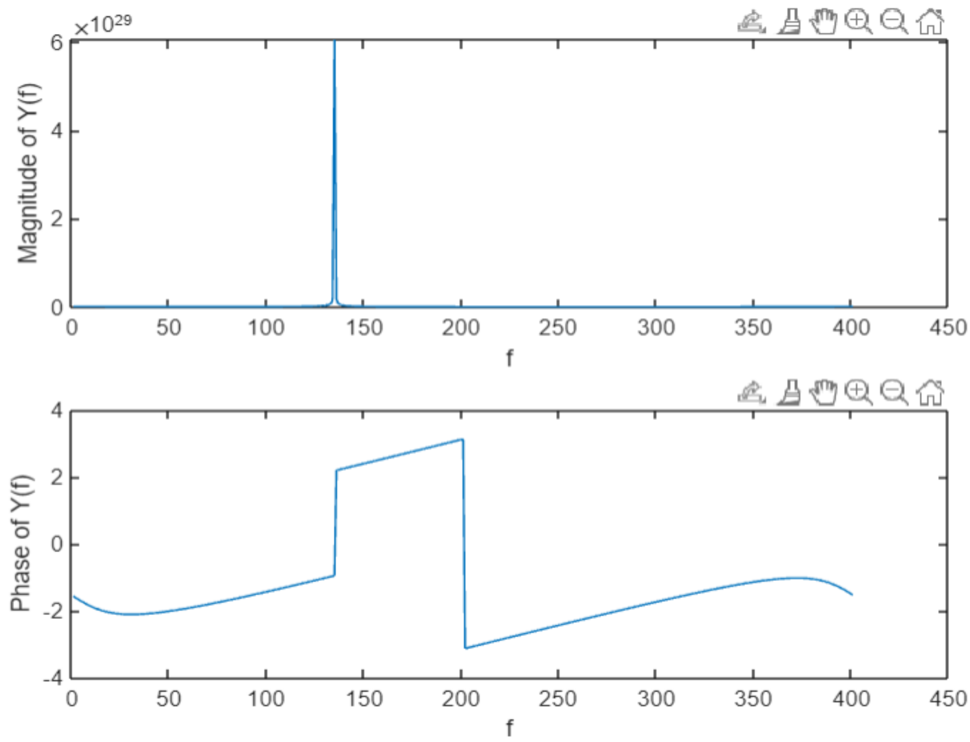
```
%1201139
%A =1 , B=3
%x(t)=(3/pi.*k).*exp((-1i.*pi/2).*exp(1i.*k.*t);
%h(t) = exp(-3.*t);
%frequency reponse means that we need the fourier transform of each signal
%then we find the magnitude & phase of the muliplication of x,h.

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 seconed graph
plot(yAngle);
xlabel('f'),ylabel('Phase of Y(f)'); %the titles of the axis
```

Figure:

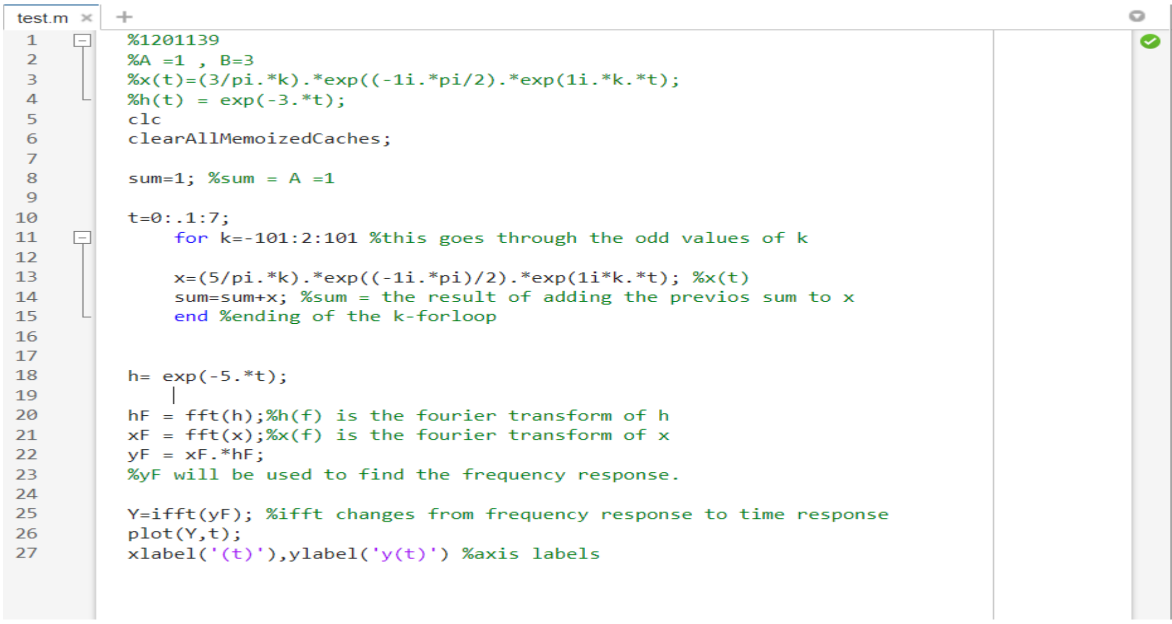


b) Plot the system time response for the square wave input (consider the time interval [0:0.1:7])

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
```



```
%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
```

Figure: