Faculty of Engineering & Technology
Electrical & Computer Engineering Department

ENEE2312: Signals & System

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Section.no : 2

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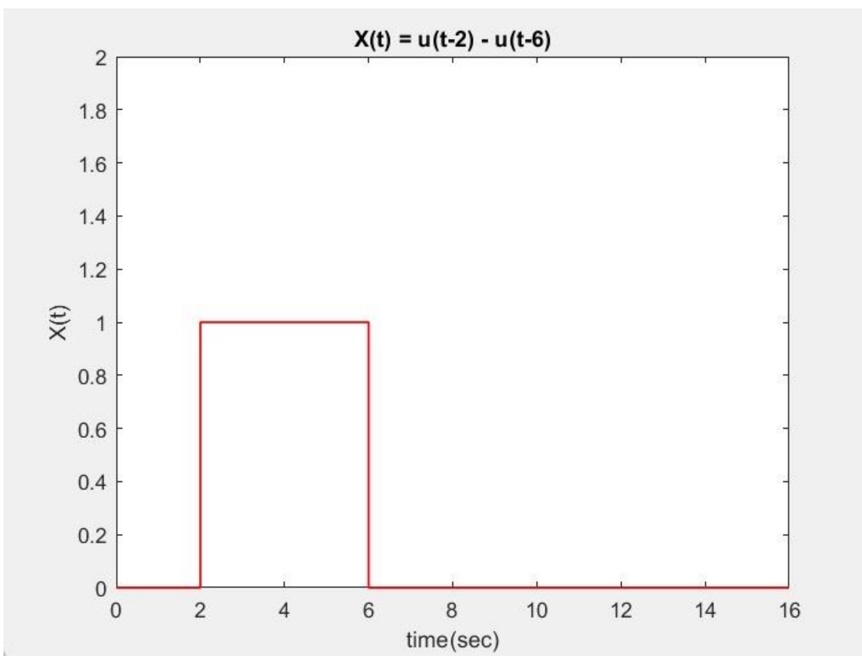
Question I: Generate and plot the following signals using MATLAB:

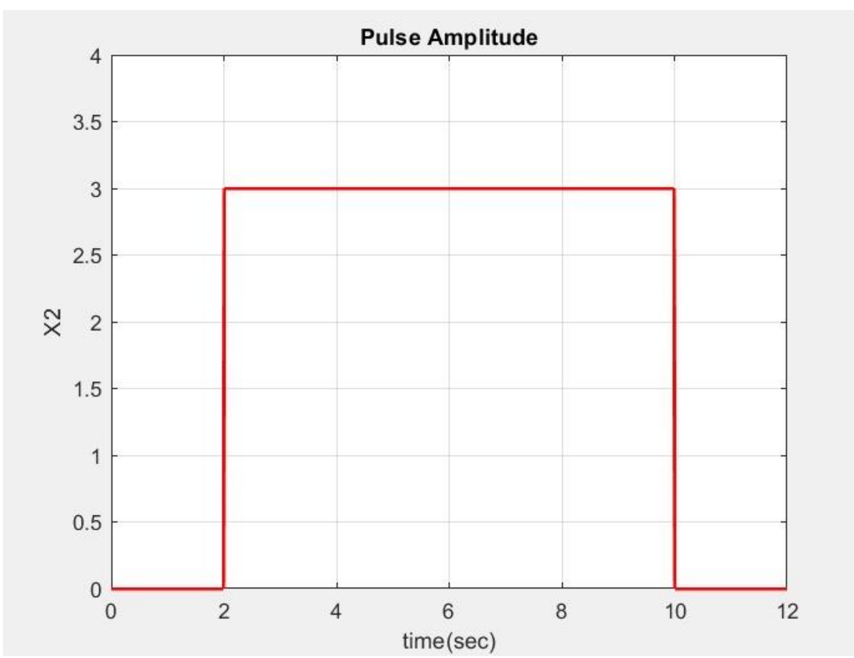
1. **X1(t) = u(t-2)- u(t-6)**

```
%Question 1.1 X1(t) = u(t-2)- u(t-6)

t=0:0.01:5;

syms X1(t);
u1 = heaviside(t-2);
u2 = heaviside(t-6);
X1(t) = u1 - u2;
fplot(X1,'r','LineWidth',1);
title('X(t) = u(t-2) - u(t-6)');
ylabel('X(t)');
xlabel('time(sec)');
axis([0 16 0 2]);
```



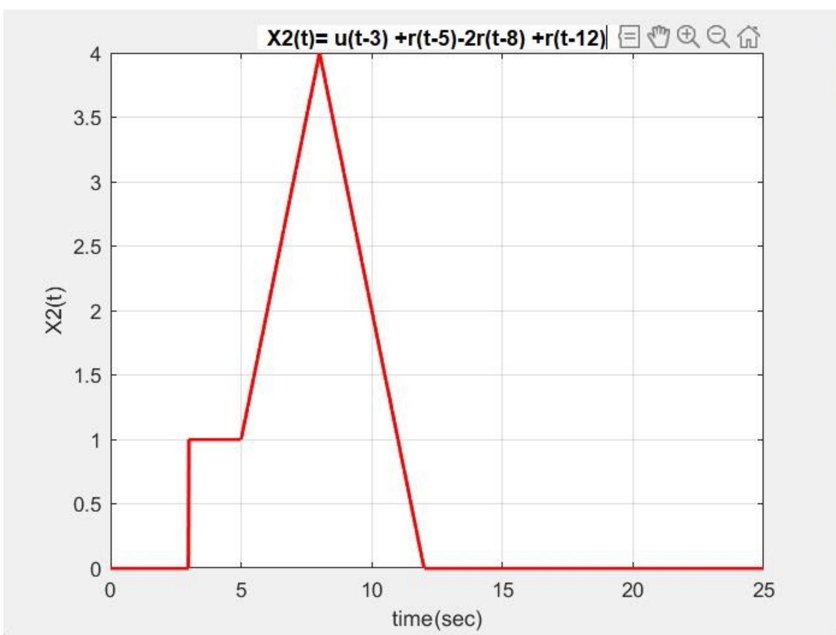
2. A finite pulse ($\pi(t)$) with value = 3 and extension between 2 and 10

```
%Question 1.2. A finite pulse (π(t)) with value = 3 and extension between 2 and 10

t = 0:0.01:12;

X2 = 3 * rectangularPulse(2, 10, t);
plot(t, X2,'r','LineWidth', 1.5);
title('Pulse Amplitude');
xlabel('time(sec)');
ylabel('X2(t)');
grid on;
axis([0 12 0 4]);
```



3. X2(t)= u(t-3) +r(t-5)-2r(t-8) +r(t-12) in the time interval [0 25] :

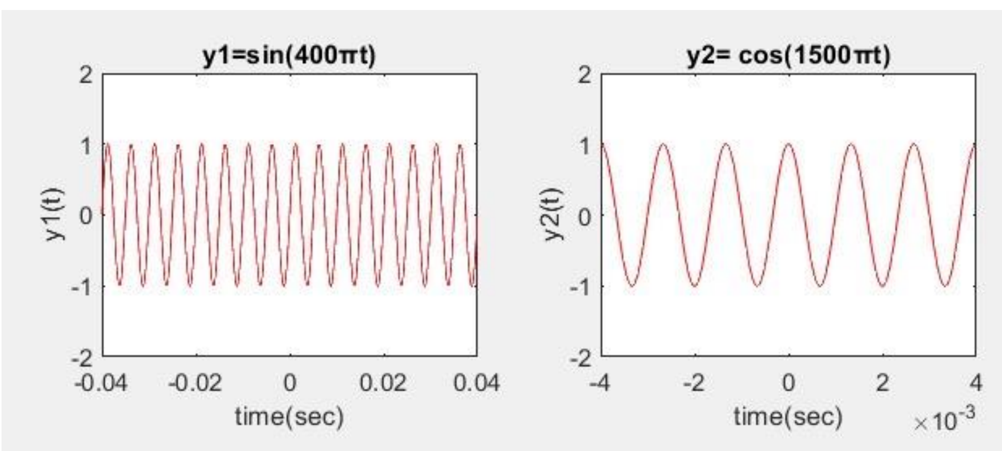
```
%Question 1.3 X2(t)= u(t-3) +r(t-5)-2r(t-8) +r(t-12) in the time interval [0 25]

t=0:0.001:25;

u1 = heaviside(t-3);
r1 = (t-5).*heaviside(t-5);
r2 = 2*(t-8).*heaviside(t-8);
r3 = (t-12).*heaviside(t-12);
X2 = u1 + r1 - r2 + r3;
plot(t, X2,'r','LineWidth', 1.5);
xlabel('time(sec)');
ylabel('X2(t)');
title('X2(t)= u(t-3) +r(t-5)-2r(t-8) +r(t-12)');
grid on;
```



Question II:

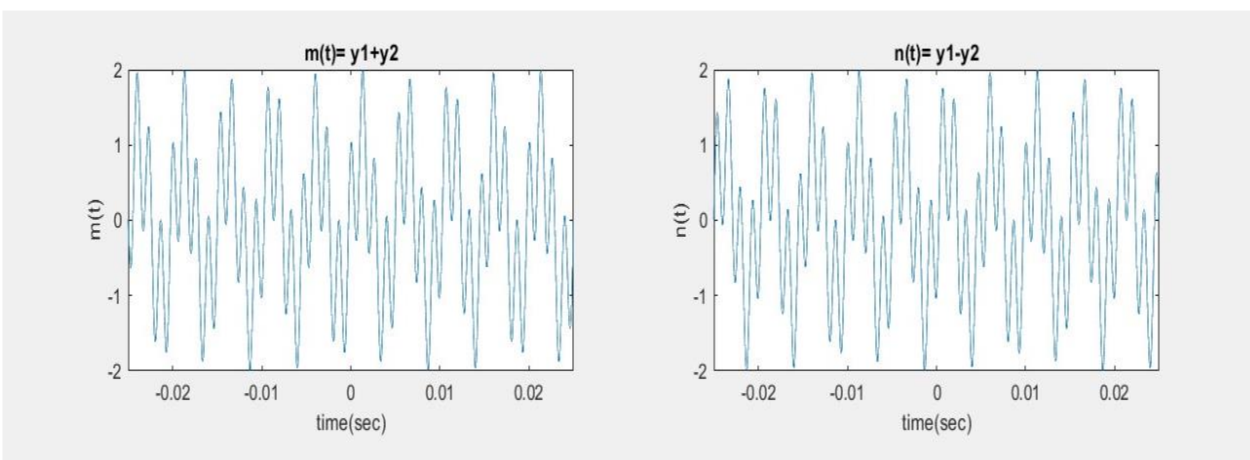
1. Generate and plot the signals y1(t)= sin 400π(t), y2(t)= cos1500πt, then plot. the signals

```
%Question 2.1 Generate and plot the signals y1(t)= sin 400π(t), y2(t)= cos1500πt

syms t;

y1 = sin(400*pi*t);
y2 = cos(1500*pi*t);

subplot(2,2,1);
fplot(y1,'r');
xlabel('time(sec)');
ylabel('y1(t)');
title('y1=sin(400πt)');
axis([-0.04 0.04 -2 2 ]);


subplot(2,2,2);
fplot(y2,'r');
xlabel('time(sec)');
ylabel('y2(t)');
title('y2= cos(1500πt)');
axis([-0.004 0.004 -2 2 ]);
```



2. m(t)= y1+y2 and n(t)= y1-y2

```
%Question 2.1 plot the signals
% m(t)= y1+y2 and n(t)= y1-y2

syms t;

y1 = sin(400*pi*t);
y2 = cos(1500*pi*t);

m = y1+y2;
n = y1-y2;

subplot(2,2,1);
fplot(m);
xlabel('time(sec)');
ylabel('m(t)');
title('m(t)= y1+y2');
axis([-0.025 0.025 -2 2]);

subplot(2,2,2);
fplot(n);
xlabel('time(sec)');
ylabel('n(t)');
title('n(t)= y1-y2');
axis([-0.025 0.025 -2 2]);
```



3. Determine, using the MATLAB plots, if the sum and/or difference signals are periodic, determine its fundamental frequency.

```
%Question 2.2 if the sum and/or difference signals are periodic. In
%case a signal is periodic, determine its fundamental frequency.


frequency1 = (400.*pi)/(2.*pi);
frequency1 = round(frequency1);

frequency2 = (1500.*pi)/(2.*pi);
frequency1 = round(frequency1);


frequencyA = gcd(frequency1,frequency2);
frequencyB = gcd(frequency2,frequency2);

disp("The frequency of y1 is : ");
disp(frequency1);

disp("The frequency of y2 is : ");
disp(frequency2);

disp("The fundamental frequency of m is : ");
disp(frequencyA);

disp("The fundamental frequency of n is : ");
disp(frequencyB);
```

```
>> projSignal2q2
The frequency of y1 is :
   200

The frequency of y2 is :
   750

The fundamental frequency of m is :
    50

The fundamental frequency of n is :
   750

>>
```

m = y1 + y2:

Periodicity: Appears to be periodic.

Fundamental Period: 1

Alternation: Appears to be alternating.

n2 = y1 - y2:

Periodicity: Appears to be periodic.

Fundamental Period: 1

Alternation: Appears to be alternating.

In summary, none of m , n are expected to exhibit half-wave symmetry .

Question 2.

2. Delemine, if the Sum &/or Differ Signals are periodic
In Case periodic, delemin it's fundamental frequency

$m(t) = y_1 + y_2$

$n(t) = y_1 - y_2$

$y_1 + y_2 \Rightarrow m(t) = \sin(400\pi t) + \cos(1500\pi t)$

$= \cos(400\pi t - \frac{\pi}{2}) + \cos(1500\pi b)$

$\omega_1 = 400\pi$ rad/sec $\qquad \omega_2 = 1500\pi$ rad/sec

$f_1 = \frac{\omega_1}{2\pi} = \frac{400\pi}{2\pi} = 200 Hz \qquad f_2 = \frac{\omega_2}{2\pi} = \frac{1500\pi}{2\pi} = 750 Hz$

$\frac{f_1}{f_2} = \frac{200}{750} \rightarrow$ periodic (Both are Rational So it's periodic)

$\frac{n_1}{n_2} = \frac{4}{15} \rightarrow f_{15} = 15 \times f_0 \Rightarrow f_0 = \frac{750}{15} = 50 Hz$

$y_1 - y_2 \Rightarrow n(t) = \sin(400\pi t) - \cos(1500\pi t)$

$n(t) = \cos(400\pi t(-\frac{\pi}{2})) + \cos(1500\pi t + \pi)$

$\omega_1 = 400\pi$ rad/sec $\qquad \omega_2 = 1500\pi$ rad/sec

$f_1 = 200 Hz \qquad f_2 = 750 Hz$

$\frac{f_1}{f_2} = \frac{200}{750} \rightarrow$ periodic (Rational So it's periodic)

$\frac{n_1}{n_2} = \frac{4}{15} \rightarrow f_4 = 4 \times f_0 \Rightarrow f_0 = \frac{200}{4} \Rightarrow f_0 = 50 Hz$

Question III: Write the MATLAB scripts that solve the following differential equations using zero initial

conditions.

1. dy(t)/dt + 3y(t) = 12 (y (0) =0)

```
%Question 3.1 dy(t)/dt + 3y(t) = 12  ,(y(0) =0)

syms y(t);
init = y(0) == 0;
dy1 = diff(y);
%or by dy1(t) = diff(y(t),t,1);

MyEq1 = (dy1) + (3 * y) == 12;
dsolve(MyEq1,init);
```

```
val =

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

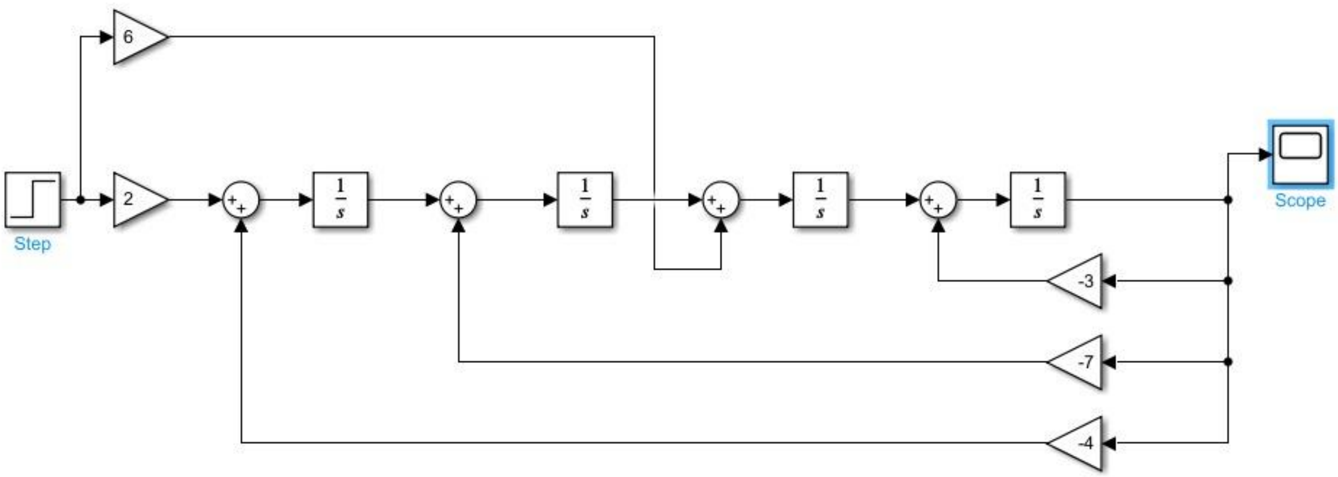
2. d2y(t)/dt2 + 10 dy/dt + 9y(t) = 5 cos2000t (y (0) =1, y’ (0) =2);

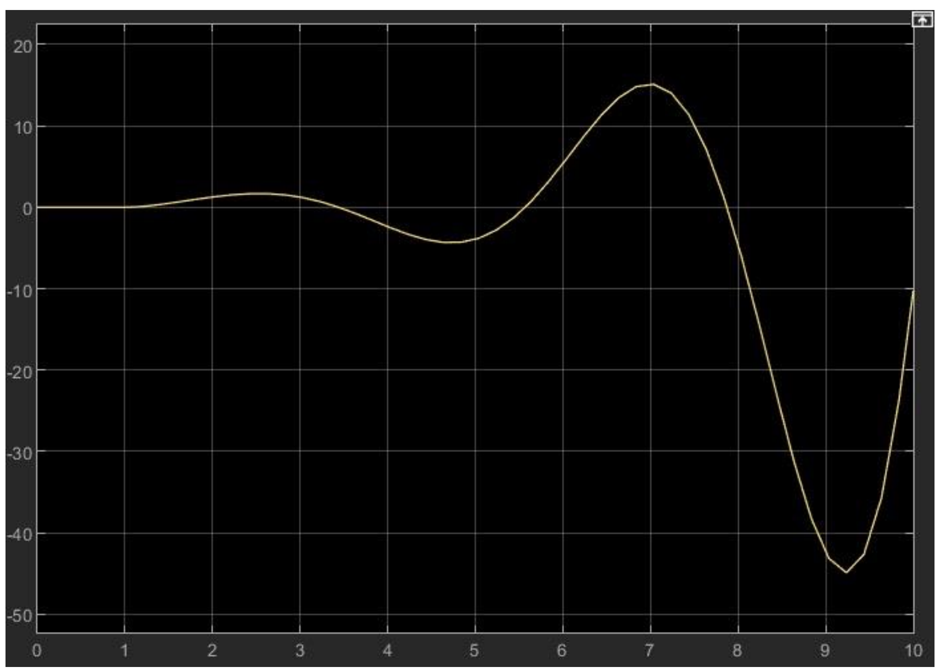
```
%Question 3.2 d^2y(t)/dt^2 + 10 dy/dt + 9y(t) = 5 cos2000t (y (0) =1, y’ (0) =2);

syms y(t);
init1 = y(0) == 1;
init2 = dy1(0) == 2;
dy1 = diff(y);
dy2 = diff(y,2);
%or by dy2(t) = diff(y(t),t,2);

MyEq1 = dy2 + 10*dy1 + 9*y == 5 * cos(2000*t) ;
dsolve(MyEq1,init1,init2);
```

```
val =

(22000003*exp(-t))/16000004 - (6000099*exp(-9*t))/16000324 - (5*16000328000081^(1/2)*cos(2000*t + atan(20000/3999991)))/16000328000081
```

Question IV: Use Simulink (MATLAB) to simulate the following systems then plot the step response of the system, and determine if the system is stable.

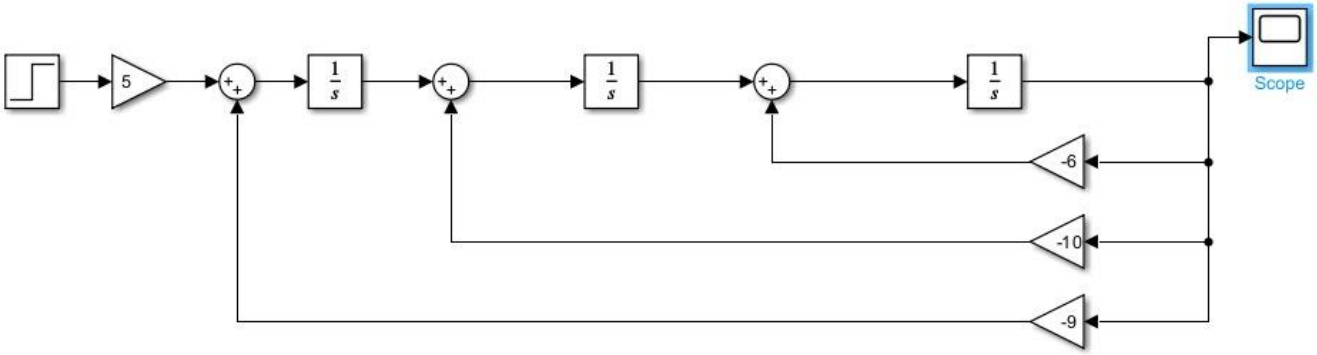
1. $\frac{d^4y(t)}{dt^4} + 3\frac{d^3y(t)}{dt^3} + 7\frac{dy(t)}{dt} + 4y(t) = 6\frac{d^2x(t)}{dt^2} + 2x(t)$

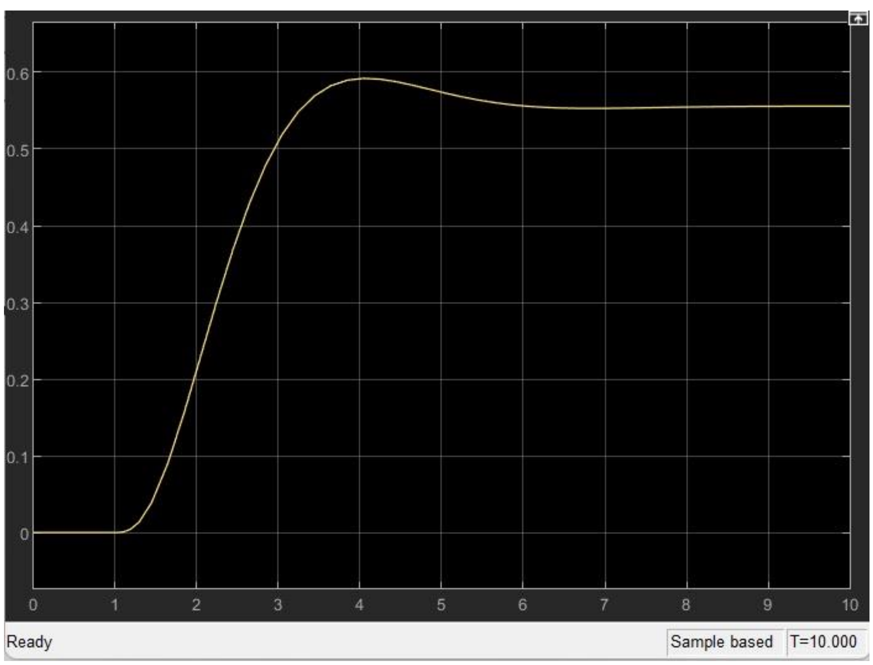




UnStable System .

2. $\frac{d^3y(t)}{dt^3} + 6\,\frac{d^2y(t)}{dt^2}\,10\,\frac{dy}{dt} + 9y(t) = 5\,x(t)$



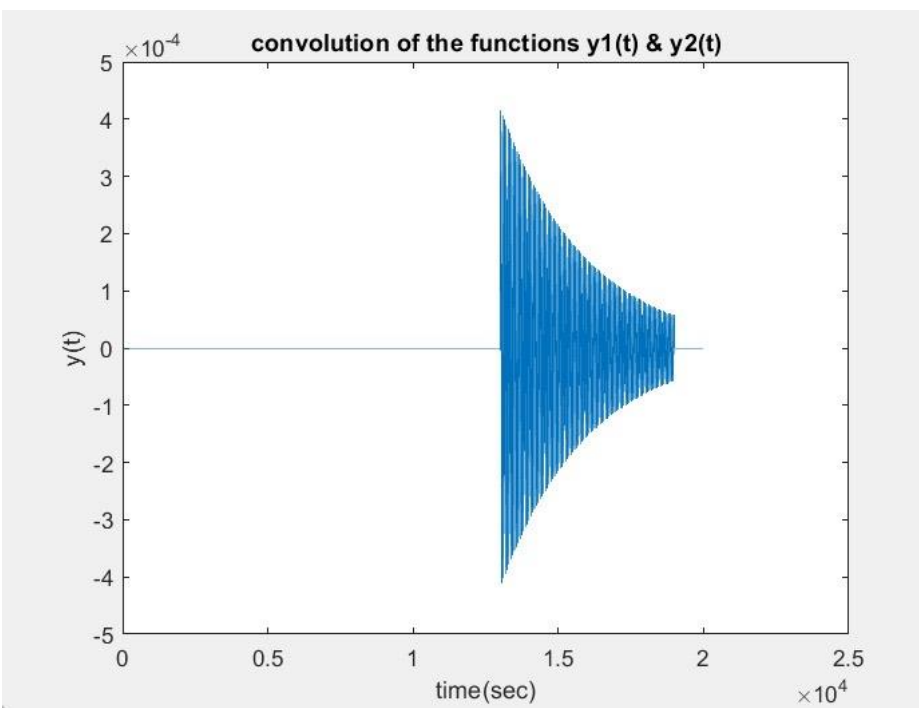


Asymptotically Stable System.

Question V: Write a program that computes and plots the convolution of the functions.

$$y(t) = (5e^{-t})\,\pi((t\text{-}18)/16),\ \ y(t) = (10e^{-\frac{t}{3}} \cos 100t)\,\pi((t\text{-}6)/6)$$

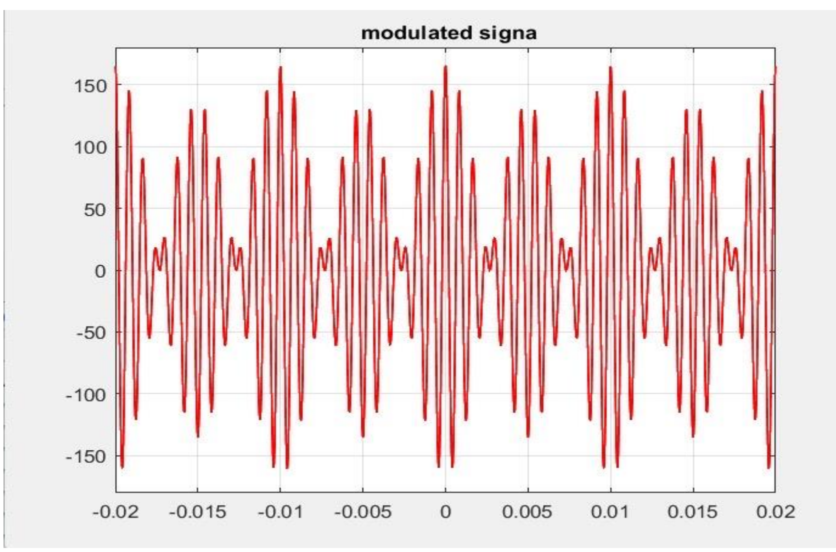
```
clc;
clear all;
t= 0:0.001:10;

y1 = (5*exp(-t)).* rectangularPulse(10,26,t);
y2 = ((10*exp(-t/3)).*cos(100*t)).* rectangularPulse(3,9,t);

convolution = conv(y1, y2);

t= 0:0.001:20;
plot(convolution);

xlabel('time(sec)');
ylabel('y(t)');
title('convolution of the functions y1(t) & y2(t)');
```



Question VI: A signal tone signal with amplitude 10 and frequency 100Hz modulates a sinusoidal carrier
amplitude (with carrier frequency 1200 Hz and amplitude 15). The carrier is transmitted with the
modulated signal in what is called standard AM or double sideband with carrier transmitted.

1. Compute the modulated signal and say if it is periodic.

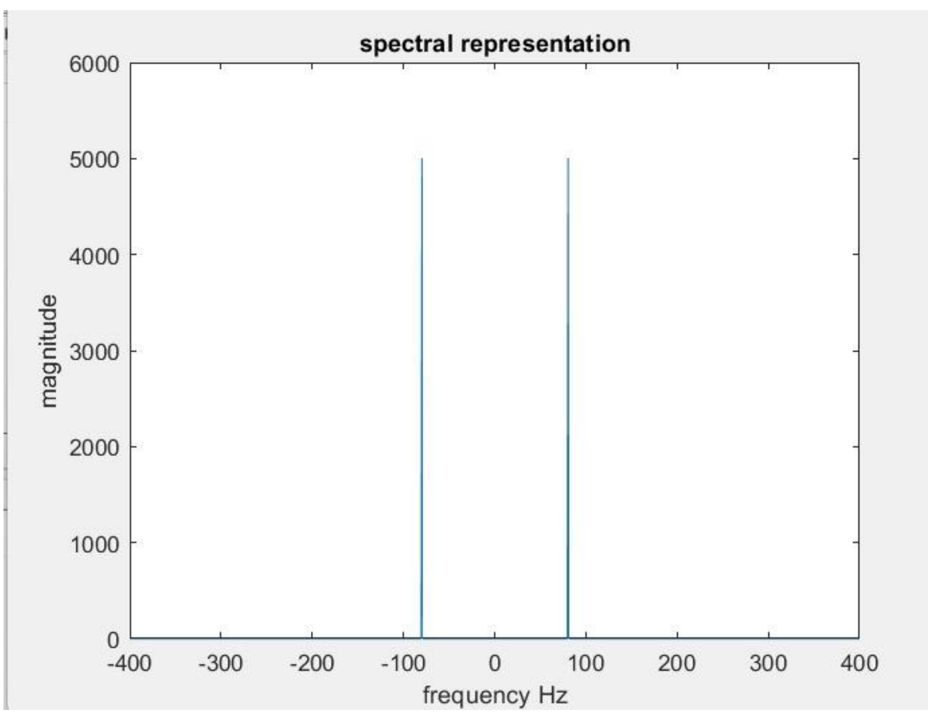
```
%Question 6.1 Compute the modulated signal and say if it is periodic.
%e signal with amplitude A=10 and frequency f=100Hz modulates a sinusoidal carrier
%amplitude (with carrier frequency fc=1200 Hz and amplitude Ac=15)

syms t;

y1 = 10 * cos(200*pi*t);
y2 = 15 * cos(2400*pi*t);

modulatedSignal = (1 + y1) .* y2;
fplot(modulatedSignal,'r','LineWidth',1);
axis([-0.02 0.02 -180 180])


title(' modulated signa');
grid on;
```



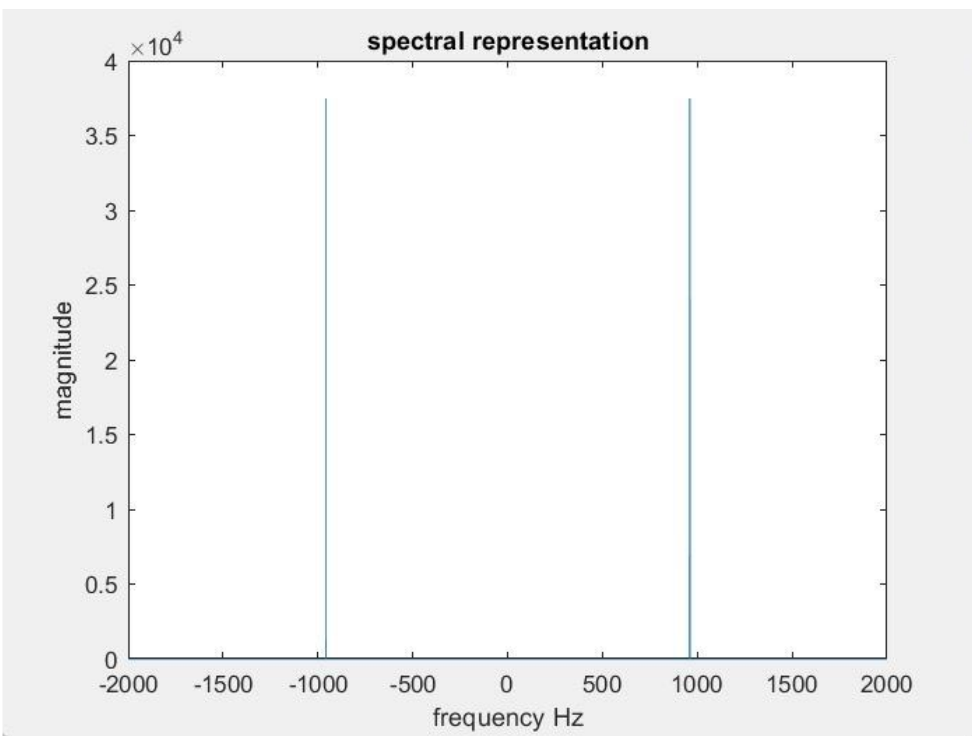
It can be inferred from the figure that the modulated signal exhibits periodicity.

2. Plot the spectral representation of the message, the carrier, and the modulated signal.

```
%Question 6.2 part one : Plot the spectral representation of the message,
% the carrier, and the modulated signal

d = 1;
t = 0:0.001:d-0.001;
y1 = 10 * cos(200*pi*t);
m = fft(y1);
magnitude = abs(m);
freq= linspace(-400,400,length(y1));

plot(freq,fftshift(magnitude));

xlabel('frequency Hz');
ylabel('magnitude');
title('spectral representation');
```

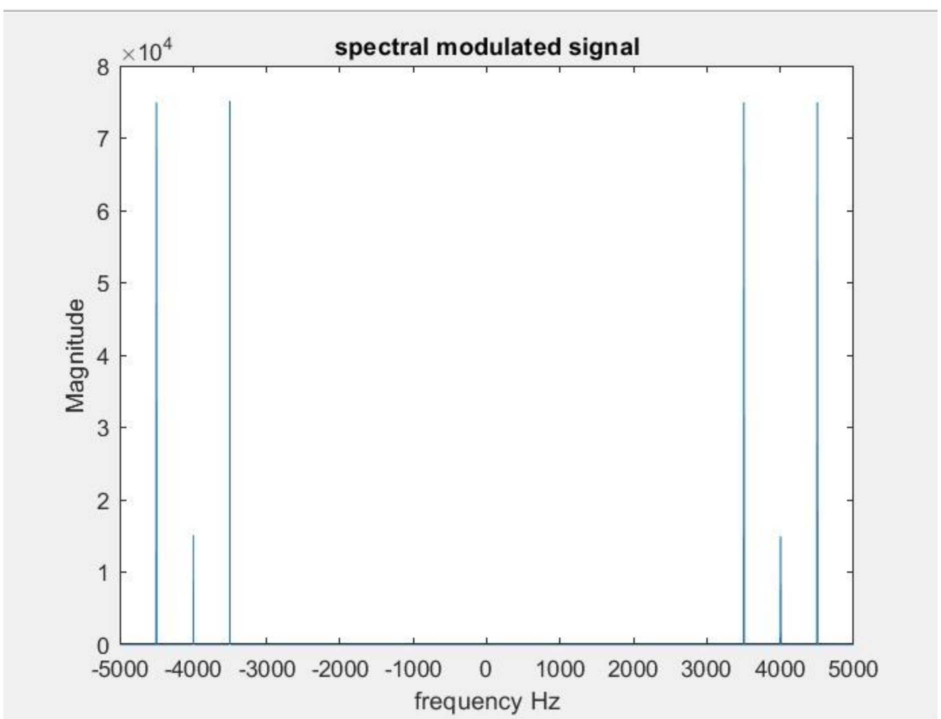


```
%Question 6.2 part two :Plot the spectral representation of the message, the carri

d = 1;
t = 0:0.0002:d-0.0002;
y2 = 15 * cos(2400*pi*t);
m = fft(y2);
magnitude = abs(m);
freq= linspace(-2000,2000,length(y2));

plot(freq,fftshift(magnitude));

xlabel('frequency Hz');
ylabel('magnitude');
title('spectral representation');
```



question6B3.m | question6C.m

```
t= 0:0.0005:0.99999;

y1 = 10 * cos(200*pi*t);
y2 = 15 * cos(2400*pi*t);

modulatedSignal = (1 + y1 ) .* y2;

ModSig= fft(modulatedSignal);
ModSigShift = fftshift(ModSig)
freq= linspace(-5000, 5000, length(ModSig));
dens = abs(ModSigShift);

plot(freq,dens);

xlabel('frequency Hz');
ylabel('Magnitude');
title('spectral modulated signal');
```



3. Plot the power spectral density of the modulated signal.

question6C.m

```
t= 0:0.0005:0.99999;

y1 = 10 * cos(200*pi*t);
y2 = 15 * cos(2400*pi*t);

modulatedSignal = (1 + y1 ) .* y2;

ModSig= fft(modulatedSignal);
ModSigShift = fftshift(ModSig)
freq= linspace(-5000, 5000, length(ModSig));
dens = abs(ModSigShift).^2;

plot(freq,dens);

xlabel('frequency Hz');
ylabel('Density');
title('power spectral density');
```