Communication Lab (EC303)

by

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181EC155

LAB - 1

Q1: Plot the magnitude and phase responses of a continuous-time signal.

Solution and Output's

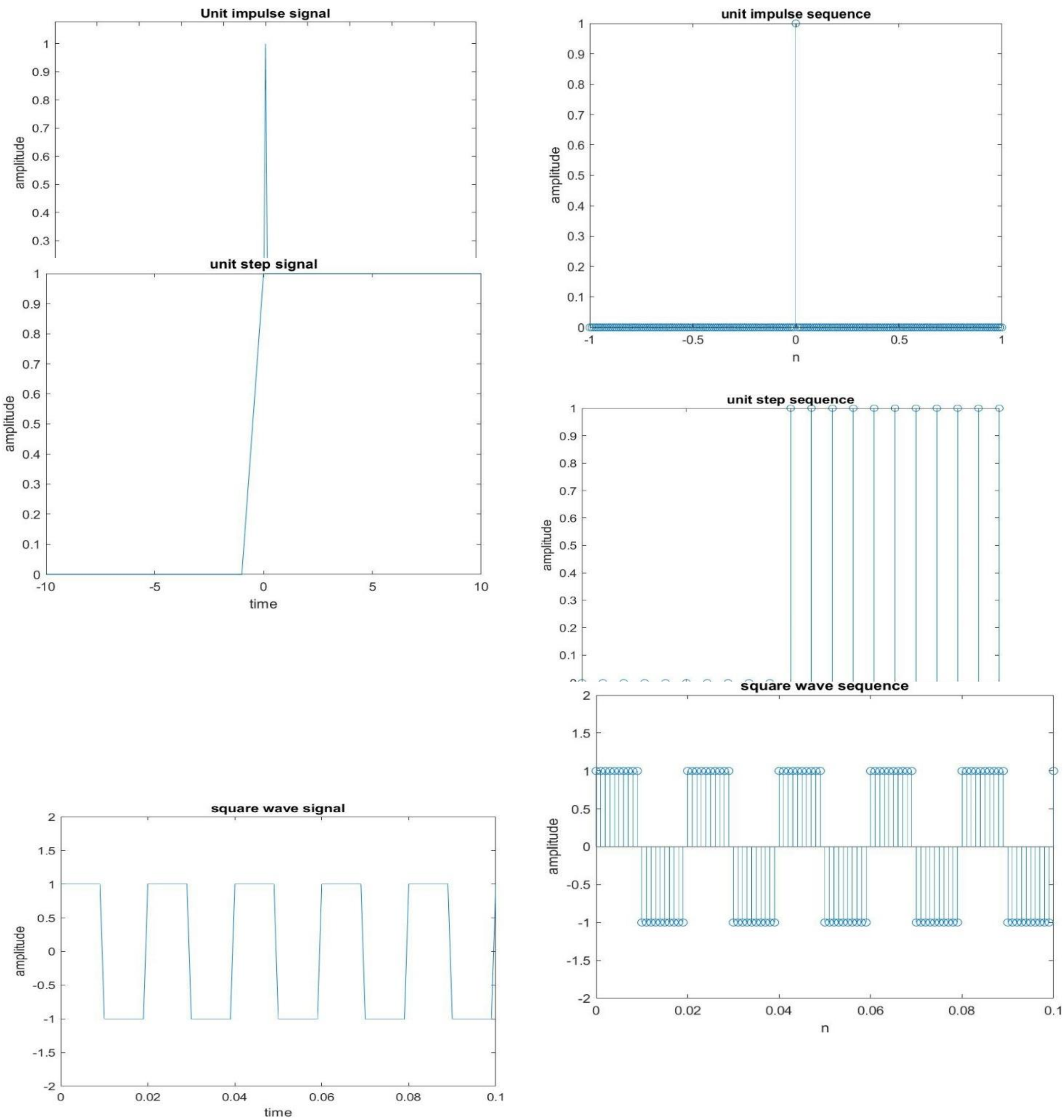
Code:

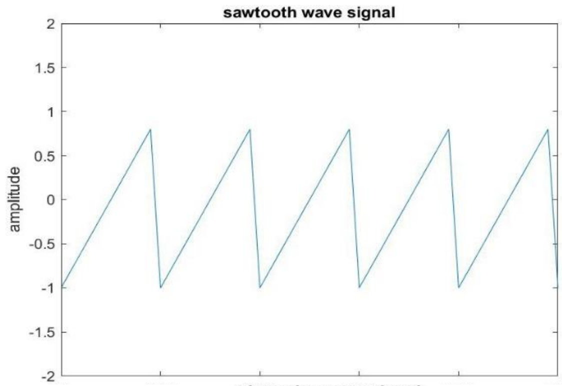
```
 clc;
clear all;
close all;
%Unit impulse signal
x1 = -1:0.001:1
y1 = (x1==0);
subplot(4,4,1);
plot(x1, y1);
xlabel('time'); ylabel('Volts');
title('Unit impulse signal');
%Unit impulse sequence
subplot(4, 4, 2);
stem(x1, y1);
xlabel('time'); ylabel('Volts');
title('Unit impulse sequence');
%Unit Step signal
x2 = -1:0.01:1;
y2 = (x2>0);
subplot(4, 4, 3);
plot(x2, y2);
xlabel('time'); ylabel('Volts');
title('Unit Step signal');
%Unit Step sequence
subplot(4, 4, 4);
stem(x2, y2);
```

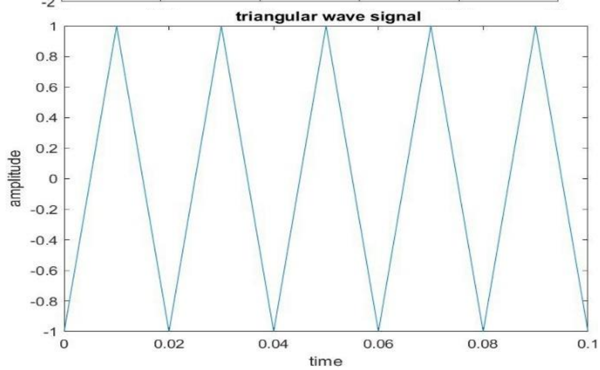
```
xlabel('time'); ylabel('Volts');
title('Unit Step sequence');
%Square wave signal
x3 = -1:0.01:1;
y3 = square(2*pi*2*x3);
subplot(4, 4, 5);
plot(x3, y3);
xlabel('time'); ylabel('Volts');
title('Square wave signal');
%Square wave sequence
subplot(4, 4, 6);
stem(x3, y3);
xlabel('time'); ylabel('Volts');
title('Square wave sequence');
%Sawtooth signal
x4 = -1:0.01:1;
y4 = sawtooth(2*pi*2*x3);
subplot(4, 4, 7);
plot(x4, y4);
xlabel('time'); ylabel('Volts');
title('Sawtooth signal');
%Sawtooth sequence
subplot(4, 4, 8);
stem(x4, y4);
xlabel('time'); ylabel('Volts');
title('Sawtooth sequence');
%Ramp signal
x5 = -1:0.01:1;
y5 = x5;
subplot(4, 4, 9);
plot(x5, y5);
xlabel('time'); ylabel('Volts');
title('Ramp signal');
%Ramp sequence
subplot(4, 4, 10);
stem(x5, y5);
xlabel('time'); ylabel('Volts');
title('Ramp sequence');
%Triangular wave signal
x6 = -1:0.01:1;
```

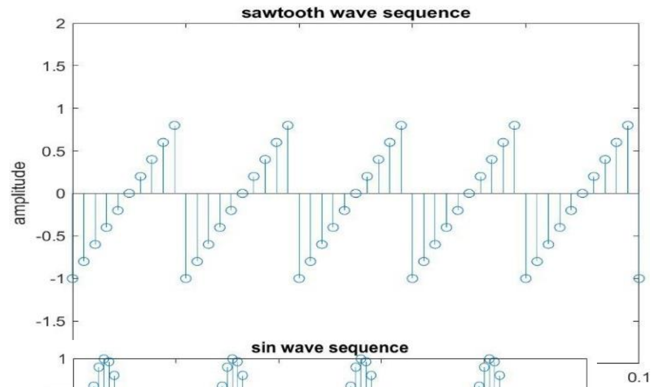
```
y6 = sawtooth(2*pi*2*x6,0.5);
subplot(4, 4, 11);
plot(x6, y6);
xlabel('time'); ylabel('Volts');
title('Triangular wave signal');
%Triangular wave sequence
subplot(4, 4, 12);
stem(x6, y6);
xlabel('time'); ylabel('Volts');
title('Triangular wave sequence');
%Sinusoidal wave signal
x7 = -1:0.01:1;
y7 = sin(2*pi*1*x6);
subplot(4, 4, 13);
plot(x7, y7);
xlabel('time'); ylabel('Volts');
title('Sinusoidal wave signal');
%Sinusoidal wave sequence
subplot(4, 4, 14);
stem(x7, y7);
xlabel('time'); ylabel('Volts');
title('Sinusoidal wave sequence');
%Sinc wave signal
x8 = -4:0.1:4;
y8 = sinc(x8);
subplot(4, 4, 15);
plot(x8, y8);
xlabel('time'); ylabel('Volts');
title('Sinc wave signal');
%Sinc wave sequence
subplot(4, 4, 16);
stem(x8, y8);
xlabel('time'); ylabel('Volts');
title('Sinc wave sequence');
```

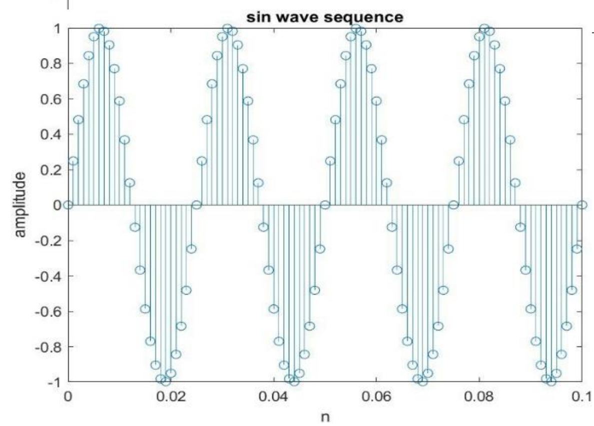
OUTPUT Graphs

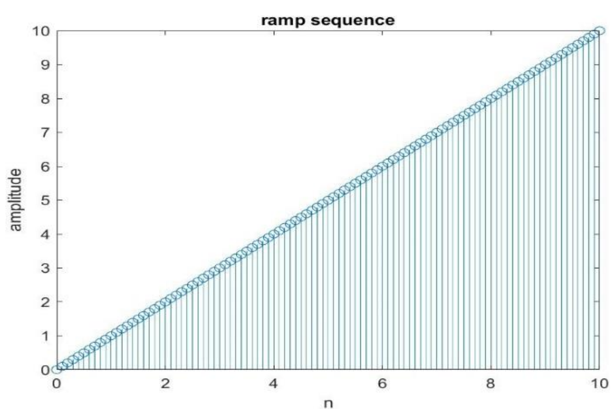


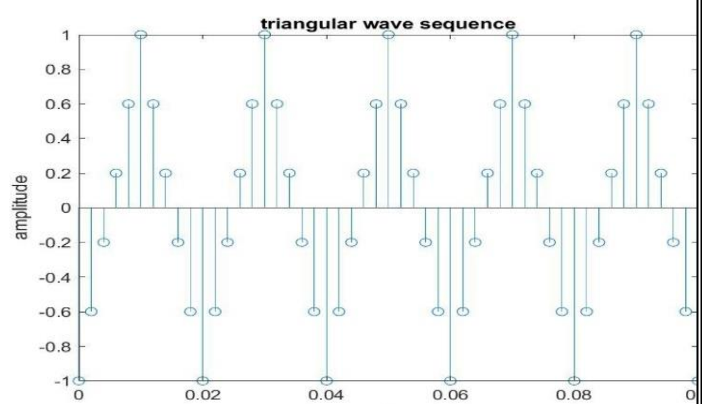

sawtooth wave signal
amplitude

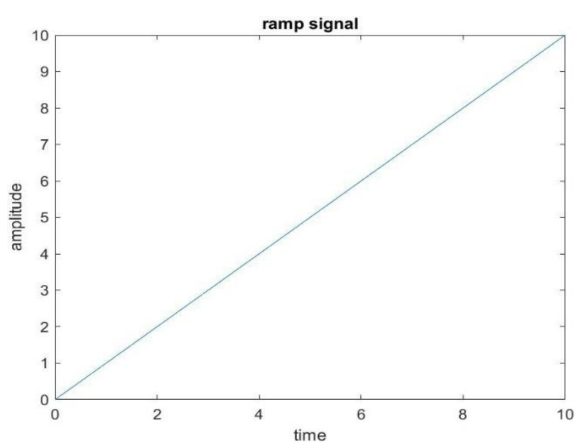

triangular wave signal
amplitude
time

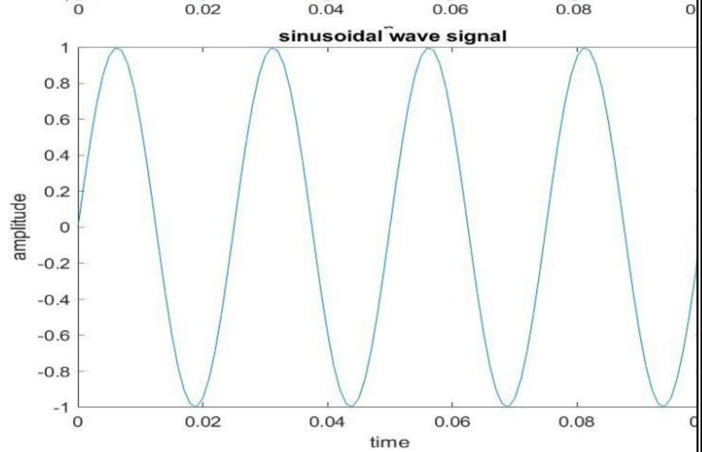

sawtooth wave sequence
amplitude

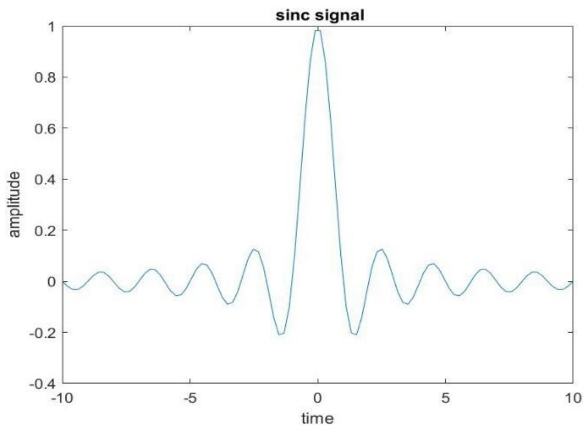

sin wave sequence
amplitude
n

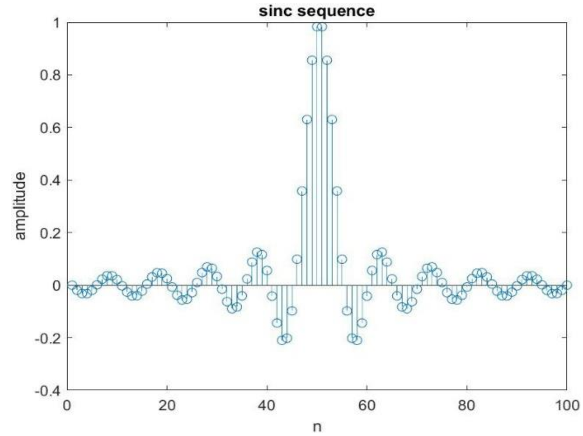

ramp sequence
amplitude
n


triangular wave sequence
amplitude


ramp signal
amplitude
time


sinusoidal wave signal
amplitude
time





Q2: Perform basic signal operations.

Solution and Output’s

Code:

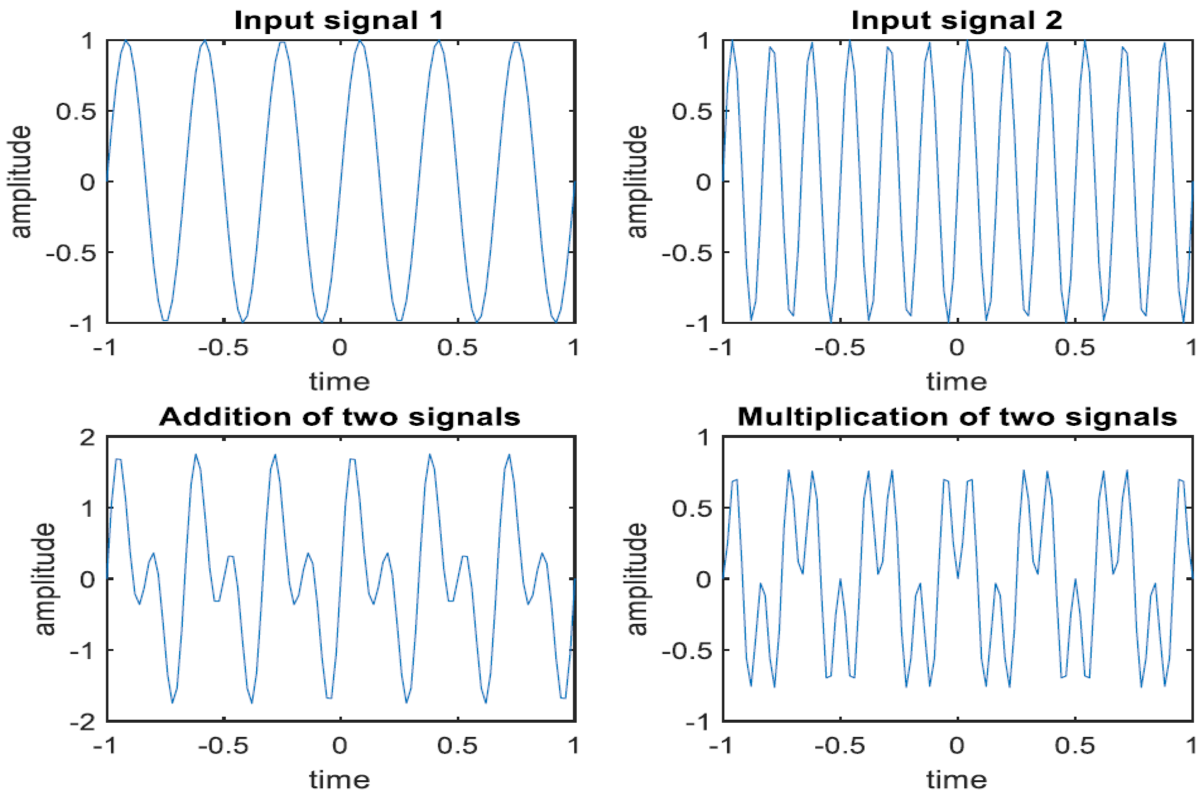
```
clc;
clear all;
close all;
%~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
% generating two input signals
t = -1:0.02:1;
x1 = sin(2*pi*3*t);
x2 = sin(2*pi*6*t);
subplot(2, 2, 1);
plot(t, x1);
xlabel('time');
ylabel('amplitude');
title('Input signal 1');
subplot(2, 2, 2);
plot(t, x2);
xlabel('time');
ylabel('amplitude');
title('Input signal 2');
% Addition of signals
y1 = x1 + x2;
subplot(2, 2, 3);
plot(t, y1);
```

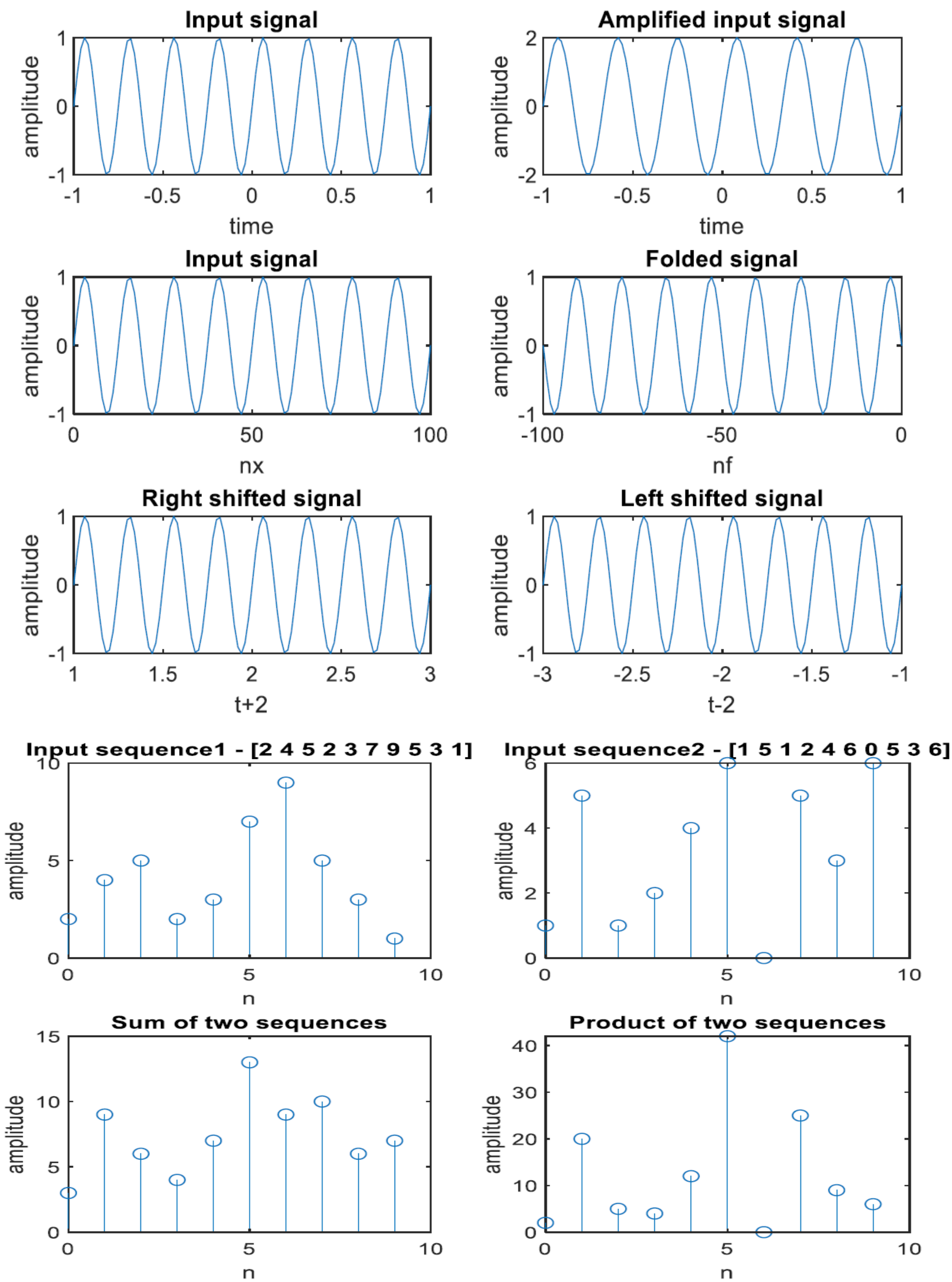
```
xlabel('time');
ylabel('amplitude');
title('Addition of two signals');
% Multiplication of signals
y2 = x1.*x2;
subplot(2, 2, 4);
plot(t, y2);
xlabel('time');
ylabel('amplitude');
title('Multiplication of two signals');
% scaling of a signal
% input signal
x3 = -1:0.02:1;
y3 = sin(2*pi*4*x3);
figure;
subplot(3, 2, 1);
plot(x3, y3);
xlabel('time');
ylabel('amplitude');
title('Input signal')
A = 2;
y4 = A*x1;
subplot(3, 2, 2);
plot(x3, y4);
xlabel('time');
ylabel('amplitude');
title('Amplified input signal');
% folding of a signal
h = length(y3);
nx = 0:h-1;
subplot(3, 2, 3);
plot(nx, y3);
xlabel('nx');
ylabel('amplitude');
title('Input signal');
y4 = fliplr(y3);
nf = -fliplr(nx);
subplot(3, 2, 4);
plot(nf, y4);
xlabel('nf');
```

```
ylabel('amplitude');
title('Folded signal');
%shifting of a signal
subplot(3, 2, 5);
plot(t+2, y3);
xlabel('t+2');
ylabel('amplitude');
title('Right shifted signal');
subplot(3, 2, 6);
plot(t-2, y3);
xlabel('t-2');
ylabel('amplitude');
title('Left shifted signal');
%~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
%operations on sequences
n = 0:1:9;
s1 = [2 4 5 2 3 7 9 5 3 1];
figure;
subplot(2, 2, 1);
stem(n, s1);
xlabel('n');
ylabel('amplitude');
title('Input sequence1 - [2 4 5 2 3 7 9 5 3 1]');
s2=[1 5 1 2 4 6 0 5 3 6];
subplot(2, 2, 2);
stem(n, s2);
xlabel('n');
ylabel('amplitude');
title('Input sequence2 - [1 5 1 2 4 6 0 5 3 6]');
% Addition of sequences
s3 = s1 + s2;
subplot(2, 2, 3);
stem(n, s3);
xlabel('n');
ylabel('amplitude');
title('Sum of two sequences');
% Multiplication of sequences
s4 = s1.*s2;
subplot(2, 2, 4);
stem(n, s4);
```

```
xlabel('n');
ylabel('amplitude');
title('Product of two sequences');
%~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
% Program for energy of a sequence
s = input('Enter the input sequence whose energy and
power to be calculated');
E1 = sum(abs(s).^2);
disp('The energy of given sequence is');E1
% Power of sequence
P1 = (sum(abs(s).^2))/length(s);
disp('The power of given sequence is');P1
% Program for energy of a signal
t = 0:pi:10*pi;
y = cos(2*pi*50*t).^2;
E2 = sum(abs(y).^2);
disp('Energy of signal is');E2
% Power of a signal
P2 = (sum(abs(y).^2))/length(y);
disp('The power of signal is');P2
```

OUTPUT Graphs


Input signal 1
Input signal 2
Addition of two signals
Multiplication of two signals
amplitude
time
1
0.5
0
-0.5
-1
2
-2


Input signal
Amplified input signal
Input signal
Folded signal
Right shifted signal
Left shifted signal
Input sequence1 - [2 4 5 2 3 7 9 5 3 1]
Input sequence2 - [1 5 1 2 4 6 0 5 3 6]
Sum of two sequences
Product of two sequences
amplitude
time
nx
nf
t+2
t-2
n

Output:

Enter the input sequence whose energy and power to be calculated [1 2 3 6 5 1 5]
The energy of given sequence is
E1 =
101
The power of given sequence is
P1 =
14.4286
Energy of signal is
E2 =
4.0388
The power of signal is
P2 =
0.3672

LAB – 2

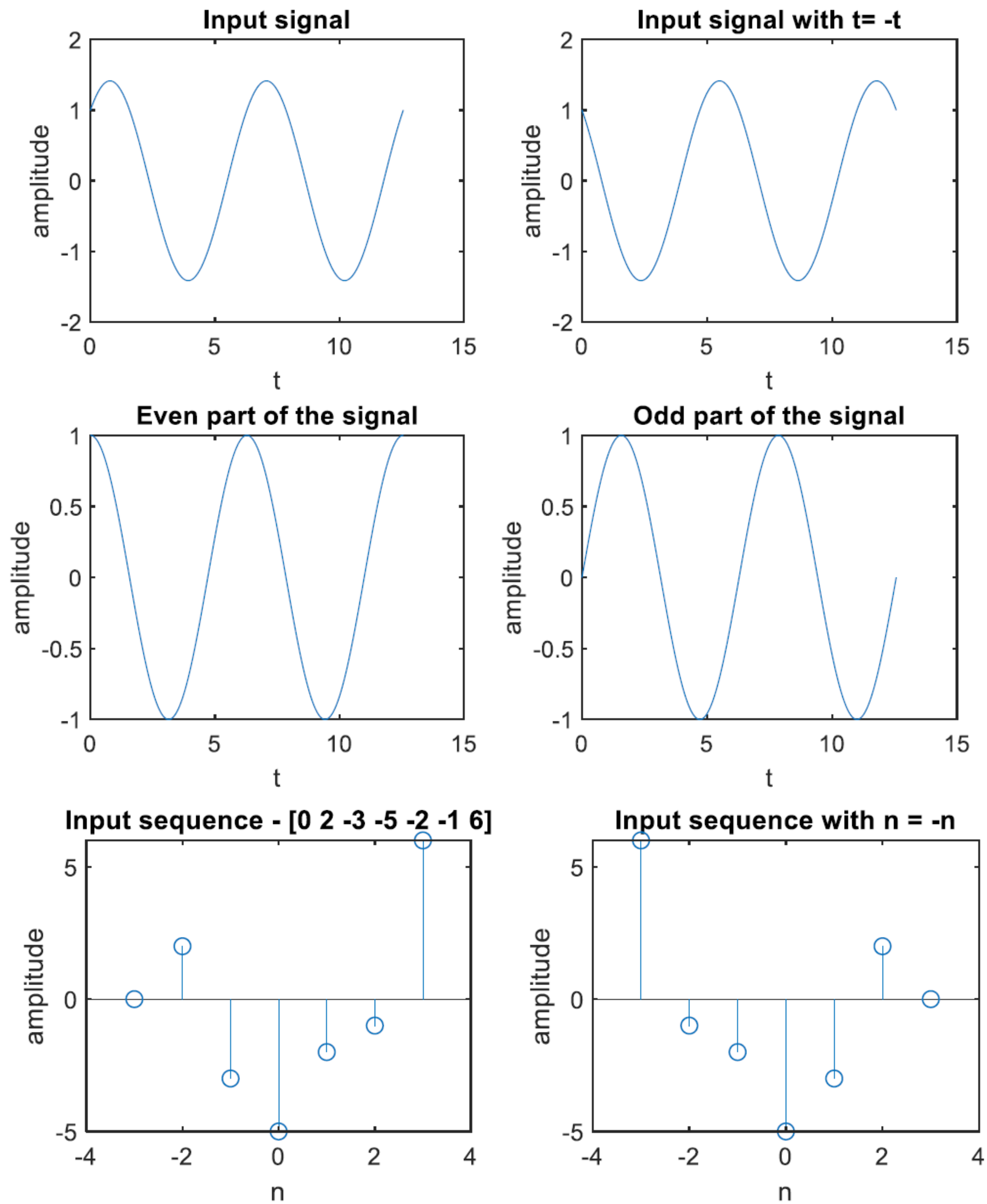
Q: Find the even and odd parts and real and imaginary parts of the signals.

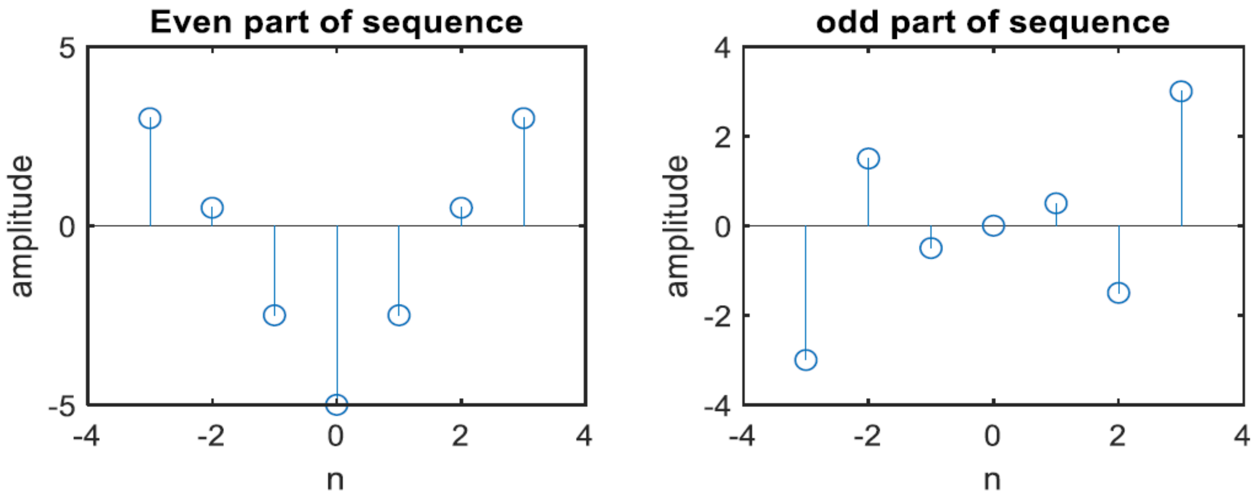
Solution and Code:

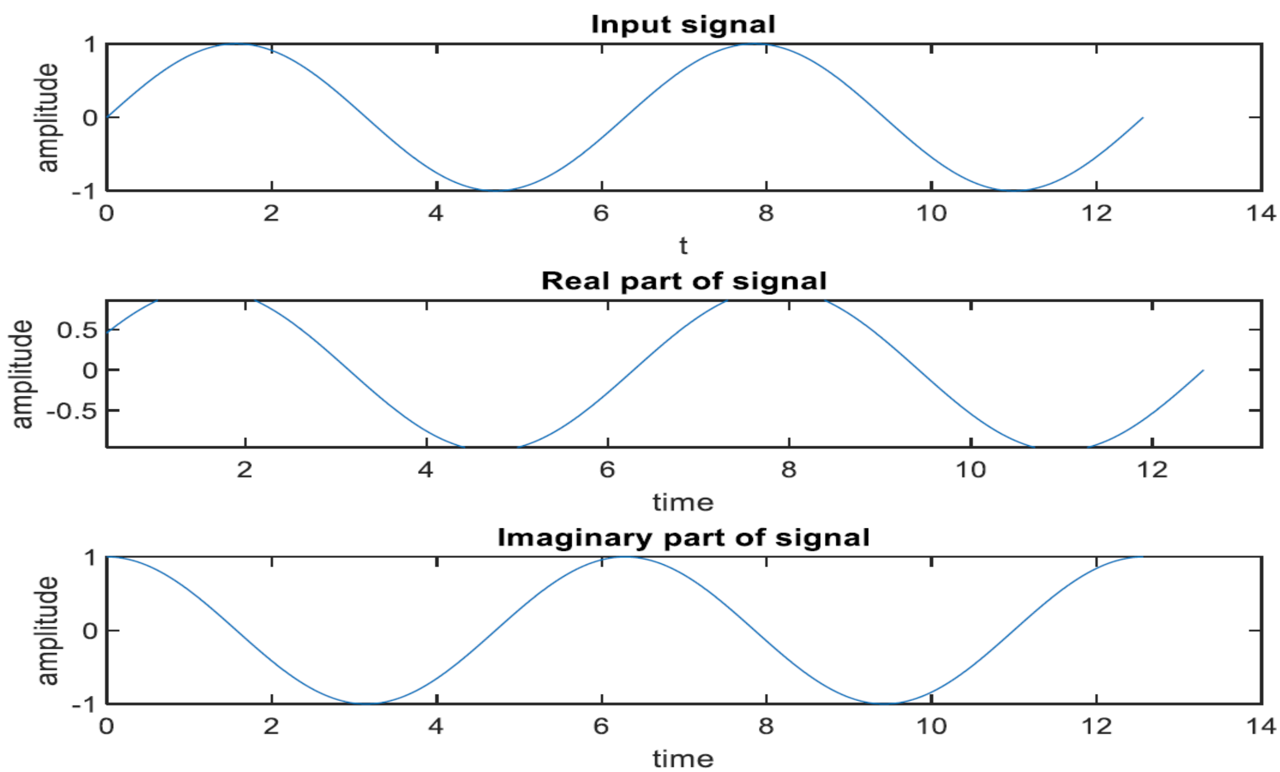
```
clc
close all;
clear all;
%Even and Odd parts of a signal
t = 0:.001:4*pi;
x = sin(t) + cos(t);
subplot(2,2,1);
plot(t, x);
xlabel('t');
ylabel('amplitude');
title('Input signal');
y = sin(-t) + cos(-t); % y(t)=x(-t)
subplot(2,2,2);
plot(t, y);
xlabel('t');
ylabel('amplitude')
title('Input signal with t= -t');
even = (x + y)/2;
subplot(2, 2, 3);
plot(t, even);
xlabel('t');
ylabel('amplitude')
title('Even part of the signal')
odd = (x - y)/2;
subplot(2, 2, 4);
plot(t, odd);
xlabel('t');
ylabel('amplitude');
title('Odd part of the signal');
% Even and odd parts of a sequence
s1 = [0 2 -3 -5 -2 -1 6];
n = -3:3;
y1 = fliplr(s1); %y1(n)=s1(-n)
figure;
subplot(2, 2, 1);
```

```
stem(n, s1);
xlabel('n');
ylabel('amplitude');
title('Input sequence - [0 2 -3 -5 -2 -1 6]');
subplot(2, 2, 2);
stem(n, y1);
xlabel('n');
ylabel('amplitude');
title('Input sequence with n = -n');
even1 = .5*(s1 + y1);
odd1 = .5*(s1 - y1);
% Plotting even and odd parts of the sequence
subplot(2,2,3);
stem(n, even1);
xlabel('n');
ylabel('amplitude');
title('Even part of sequence');
subplot(2, 2, 4);
stem(n, odd1);
xlabel('n');
ylabel('amplitude');
title('odd part of sequence');
% Plotting real and imaginary parts of the signal
x = sin(t) + j*cos(t);
figure;
subplot(3, 1, 1);
plot(t, x);
xlabel('t');
ylabel('amplitude');
title('Input signal');
subplot(3, 1, 2);
plot(t,real(x));
xlabel('time');
ylabel('amplitude');
title('Real part of signal');
subplot(3, 1, 3);
plot(t, imag(x));
xlabel('time');
ylabel('amplitude');
title('Imaginary part of signal');
```

OUTPUT Graphs




Even part of sequence
amplitude
n
odd part of sequence
amplitude
n


Input signal
amplitude
t
Real part of signal
amplitude
time
Imaginary part of signal
amplitude
time

LAB – 3

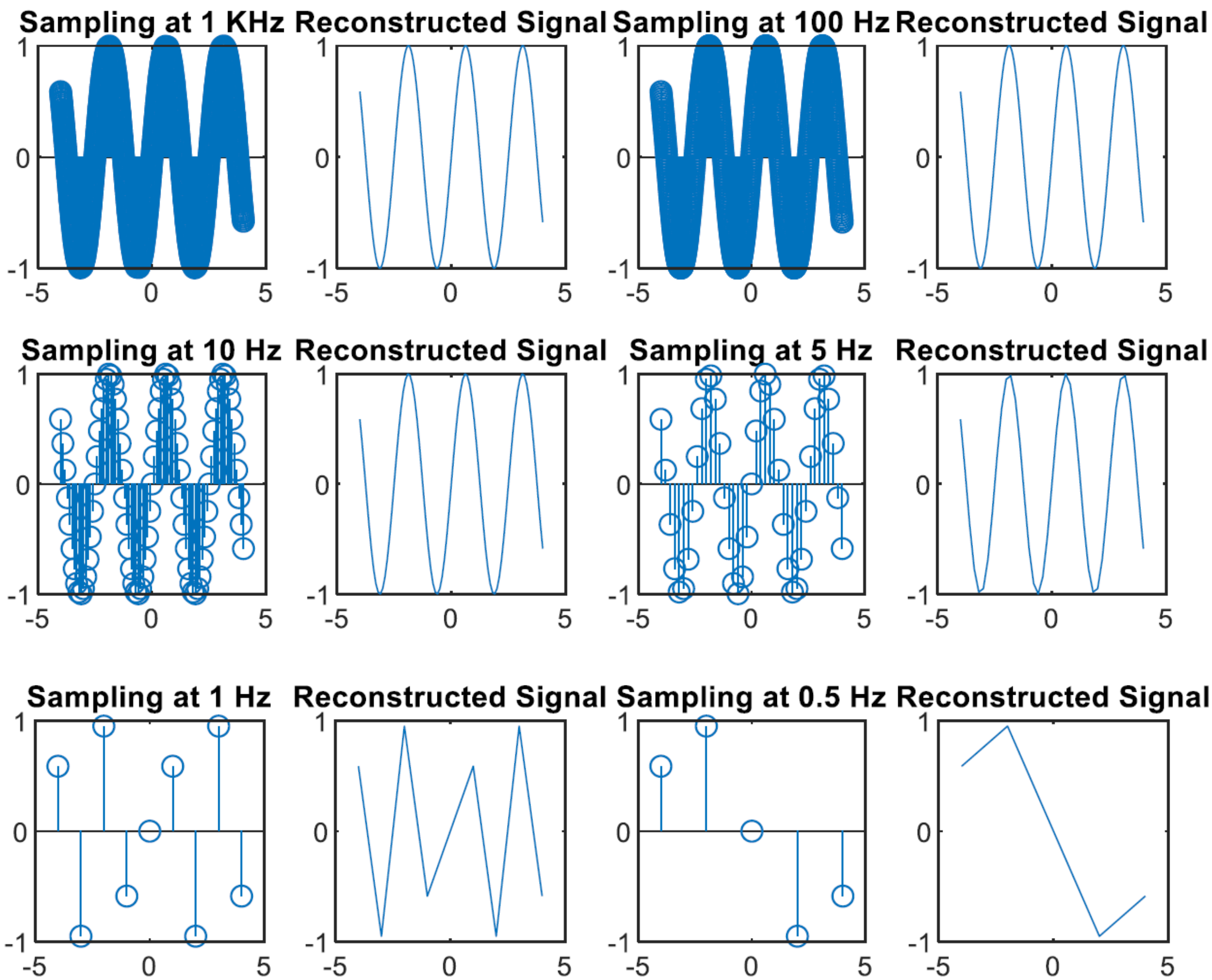
Q: Verification of signal sampling and reconstruction and study the effects of aliasing.

Solution and Code:

```
clc;
clear all;
close all;
% Sampling of input signal at different frequencies
% At 1 KHz
sf = 1000;
st = 1/sf;
x = -4:st:4;
y = sin(2*pi*0.4*x);
subplot(3, 4, 1);
stem(x, y);
title('Sampling at 1 KHz')
subplot(3, 4, 2);
plot(x, y);
title('Reconstructed Signal')
% At 100 Hz
sf = 100;
st = 1/sf;
x = -4:st:4;
y = sin(2*pi*0.4*x);
subplot(3, 4, 3);
stem(x, y);
title('Sampling at 100 Hz')
subplot(3, 4, 4);
plot(x, y);
title('Reconstructed Signal')
% At 10 Hz
sf = 10;
st = 1/sf;
x = -4:st:4;
y = sin(2*pi*0.4*x);
subplot(3, 4, 5);
stem(x, y);
```

```
title('Sampling at 10 Hz')
subplot(3, 4, 6);
plot(x, y);
title('Reconstructed Signal')
% At 5 Hz
sf = 5;
st = 1/sf;
x = -4:st:4;
y = sin(2*pi*0.4*x);
subplot(3, 4, 7);
stem(x, y);
title('Sampling at 5 Hz')
subplot(3, 4, 8);
plot(x, y);
title('Reconstructed Signal')
% At 1 Hz
sf = 1;
st = 1/sf;
x = -4:st:4;
y = sin(2*pi*0.4*x);
subplot(3, 4, 9);
stem(x, y);
title('Sampling at 1 Hz')
subplot(3, 4, 10);
plot(x, y);
title('Reconstructed Signal')
% At 0.5 Hz
sf = 0.5;
st = 1/sf;
x = -4:st:4;
y = sin(2*pi*0.4*x);
subplot(3, 4, 11);
stem(x, y);
title('Sampling at 0.5 Hz')
subplot(3, 4, 12);
plot(x, y);
title('Reconstructed Signal')
```

OUTPUT Graphs



LAB – 4

Q: Simulation to verify the Wiener-Khinchin theorem.

Solution and Code:

```
clc;
clear all;
close all;
t = 0:0.1:2*pi;
%input signal
x = sin(2*t);
subplot(3, 1, 1);
plot(t, x);
xlabel('time');
ylabel('amplitude');
title('Input signal');
%autocorrelation of input signal
xu = xcorr(x, x);
%fft of autocorrelation signal
y = fft(xu);
subplot(3, 1, 2);
plot(abs(y));
xlabel('f');
ylabel('amplitude');
title('fft of autocorrelation of input signal');
%fourier transform of input signal
y1 = fft(x);
%finding the power spectral density
y2 = (abs(y1)).^2;
subplot(3, 1, 3);
plot(y2);
xlabel('f');
ylabel('magnitude');
title('PSD of input signal');
```

OUTPUT GRAPHS