INDIAN INSTITUTE OF INFORMATION TECHNOLOGY

SURAT

LABORATORY MANUAL

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

EC: 303: COMMUNICATION ENGINEERING

B.TECH II-SEMESTER III

NAME: GONDHA ANKITKUMAR GHANSHYAMBHAI

ROLL NO: UI21CS10

BRANCH: Computer science Engineering

INDIAN INSTITUTE OF INFORMATION AND TECHNOLOGY

Certificate

This is to certify that Mr./Ms. ANKIT GONDHA of 2nd year 3rd sem Class Roll No. UI21CS10 has Satisfactory completed the course in Communication Engineering laboratory practical during the Year 2022-2023 .

MS. SEJAL RATHOD
(COURSE COORDINATOR)

MS. SEJAL RATHOD
MR. RAHUL PATEL
MR. DHIRAJ PATEL

(LAB INSTRUCTORS)

SL NO.	AIM
1	Introduction to MATLAB and plotting of different types of periodic signals and aperiodic signals using mathematical functions in MATLAB.
2	To study and implement the Fourier Transforms of different periodic and aperiodic signals in MATLAB.
3	To study amplitude modulation and observe the waveforms for three different modulation indices and reception of AM signals using code in MATLAB Software and simulink.
4	To study amplitude modulation and observe the waveforms for three different Modulation AM,DSB-SC,SSB-SC and its frequency spectrum in MATLAB Software.
5	To perform sampling of input sinusoidal signal using code in MATLAB software and verify the Nyquist Criteria in MATLAB and simulink.
6	To study and implement PAM (Pulse Amplitude Modulation) ,PWM (Pulse Width Modulation) and PPM (Pulse Position Modulation) of analog signal in MATLAB software and simulink.
7	To obtain frequency modulation and demodulation using equations and in-built functions in MATLAB software and simulink.
8	To study about modulation and demodulation of Pulse Code Modulation (PCM) in MATLAB software and simulink.
9	To study and implement about delta modulation in MATLAB software.
10	To study and verify the outputs of PCM and PCM-TDM system on hardware kit.

EXPERIMENT 1

Periodic Signal

Aim: Creating six different periodic signals and display it on the MATLAB application

Theory:

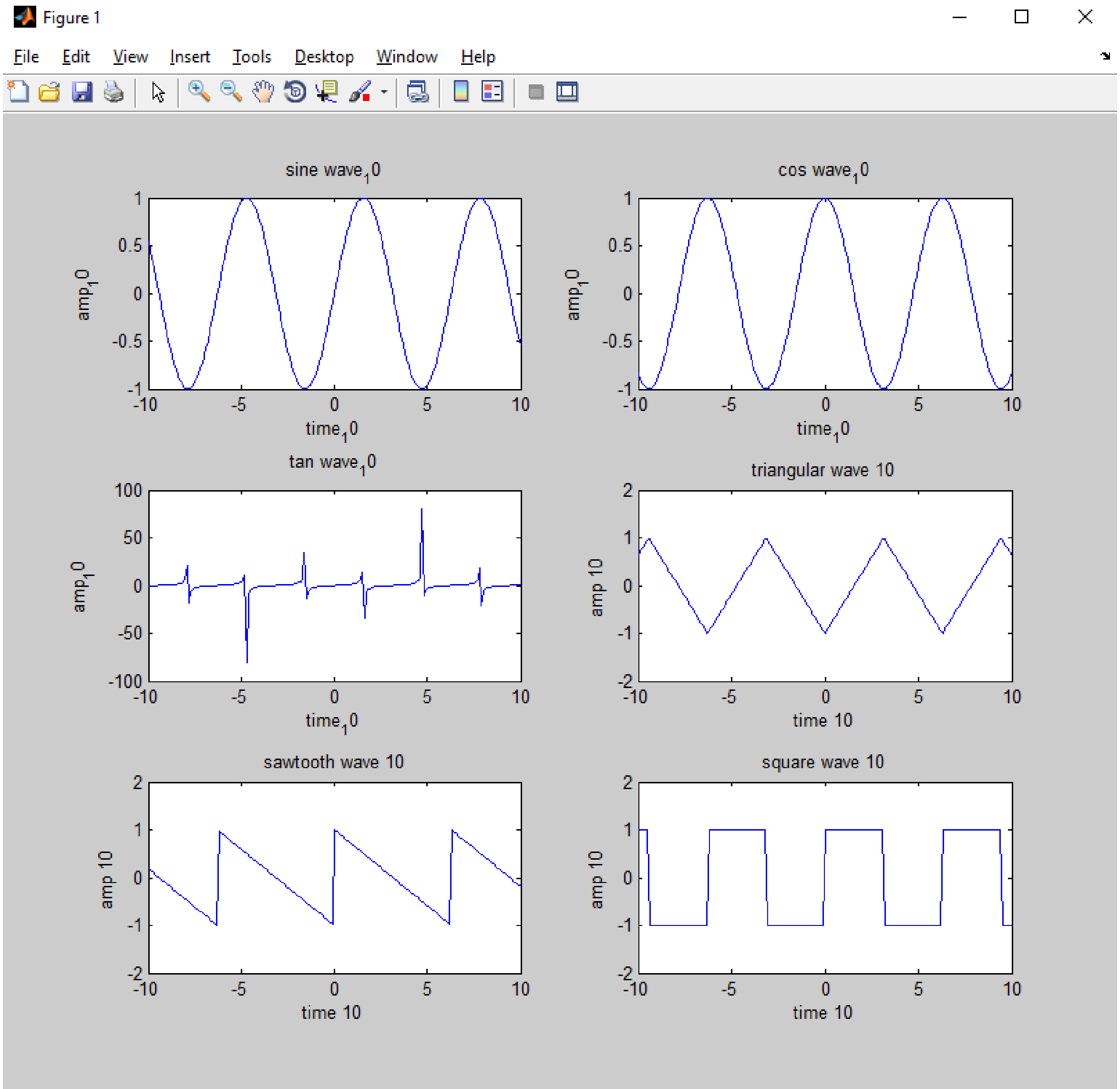
Functions for the six different periodic signals:

a Sine Wave: - sin(x), where x=input signal (x-axis)
b Cosine Wave: - cosine(x), where x=input signal (x-axis)
c Tangent Wave: - tangent(x), where x=input signal (x-axis)
d Square Wave: - square(x), where x=input signal (x-axis)
e Triangular Wave: - sawtooth(x,0), where x=input signal (x-axis)
f Saw tooth Wave: - sawtooth(x,0.5), where x=input signal (x-axis)

CODE

```
clc;
clear all;
close all;
figure;
t=[-10:0.1:10];
a=(sin(t));
subplot(3,2,1);
plot(t,a);
xlabel('time_10');
ylabel('amp_10');
%axis([-10 10 -2  2]);
title('sine wave_10');

t=[-10:0.1:10];
a=cos(t);
subplot(3,2,2);
plot(t,a);
xlabel('time_10');
ylabel('amp_10');
%axis([-10 10 -2  2]);
title('cos wave_10');

t=[-10:0.1:10];
a=tan(t);
subplot(3,2,3);
plot(t,a);
xlabel('time_10');
ylabel('amp_10');
```

```
%axis([-10 10 -2  2]);
title('tan wave_10');
```



Aperiodic Signal

Aim: Creating six different Aperiodic signals and display it on the MATLAB application

Theory:

Functions for the six different Aperiodic signals:

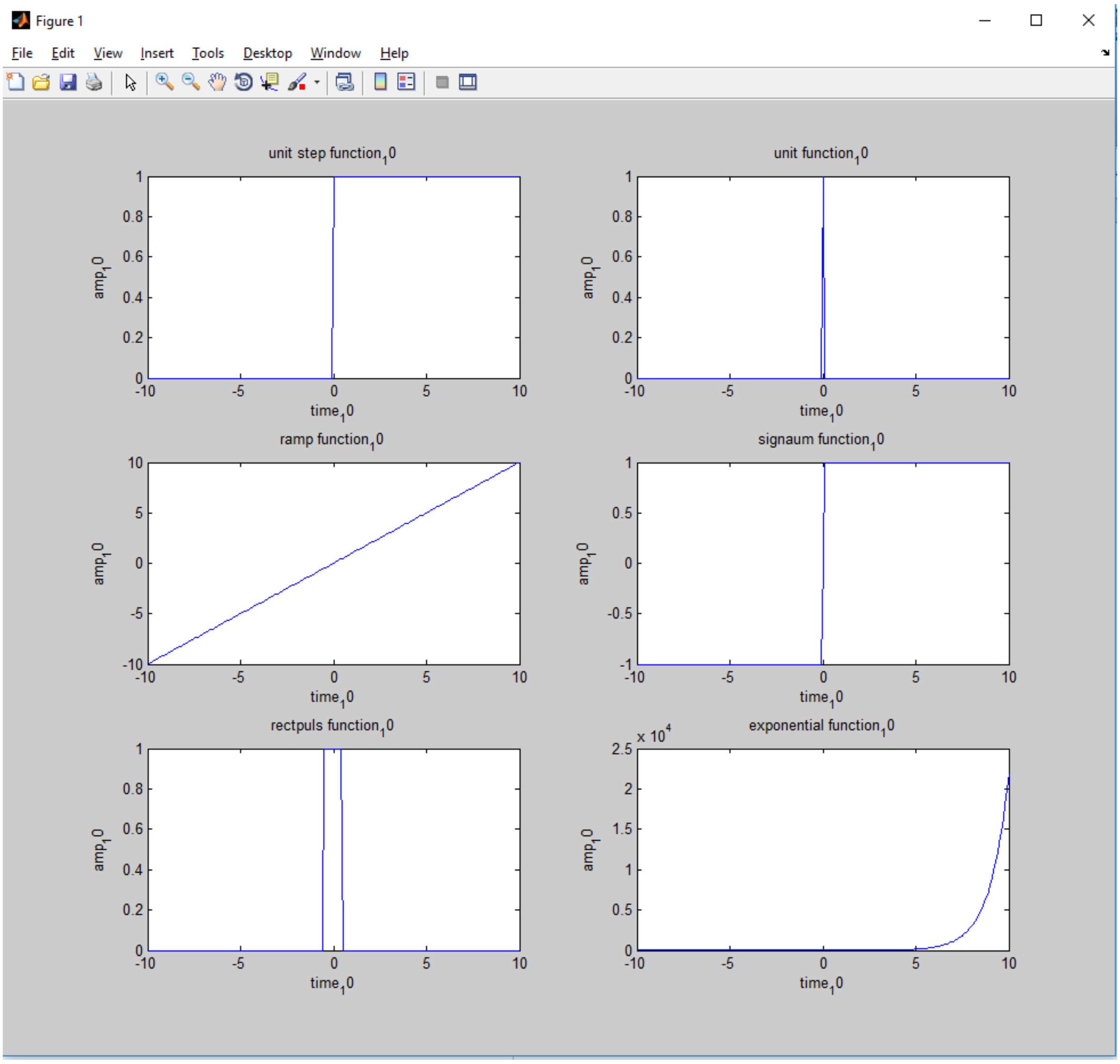
a Unit step function :
b Unit impulse function:
c Ramp signal:
d Signum function:
e Exponential Wave:

f rectangular Wave:

CODE

```
clc;
clear all;
close all;
figure;
t=[-10:0.1:10];
a=(t>=0);
subplot(3,2,1);
plot(t,a);
xlabel('time_10');
ylabel('amp_10');
%axis([-10 10 -2  2]);
title('unit step function_10');

t=[-10:0.1:10];
a=(t==0);
subplot(3,2,2);
plot(t,a);
xlabel('time_10');
ylabel('amp_10');
%axis([-10 10 -2  2]);
title('unit function_10');



t=[-10:0.1:10];
a=(t);
subplot(3,2,3);
plot(t,a);
xlabel('time_10');
ylabel('amp_10');
%axis([-10 10 -2  2]);
title('ramp function_10');

t=[-10:0.1:10];
a=sign(t);
subplot(3,2,4);
plot(t,a);
xlabel('time_10');
ylabel('amp_10');
%axis([-10 10 -2  2]);
title('signaum function_10');

t=[-10:0.1:10];
a=rectpuls(t);
subplot(3,2,5);
plot(t,a);
xlabel('time_10');
ylabel('amp_10');
%axis([-10 10 -2  2]);
title('rectpuls function_10');

t=[-10:0.1:10];
a=exp(t);
subplot(3,2,6);
plot(t,a);
```

```
xlabel('time_10');
ylabel('amp_10');
%axis([-10 10 -2  2]);
title('exponential function_10');
```



EXPERIMENT 2

Aim: To study and implement the Fourier Transforms of different periodic and aperiodic signals in MATLAB

Code :

```
clc;
clear all;
close all;
figure;

%sine
t=[-10:0.1:10];
a=sin(t);
subplot(6,2,1);
plot(t,a);
xlabel('time UI21CS10');
ylabel('amplitude UI21CS10');
axis([-10 10 -2 2]);
title('sinwave UI21CS10');

y=fftshift(abs(fft(a)));
subplot(6,2,2);
plot(y);
xlabel('time UI21CS10');
ylabel('amplitude UI21CS10');
title('sinwave UI21CS10');

%cosine
t=[-10:0.1:10];
a=cos(t);
subplot(6,2,3);
plot(t,a);
xlabel('time UI21CS10');
ylabel('amplitude UI21CS10');
axis([-10 10 -2 2]);
title('cosine UI21CS10');

y=fftshift(abs(fft(a)));
subplot(6,2,4);
```

```
plot(y);
xlabel('time UI21CS10');
ylabel('amplitude UI21CS10');
title('cosine UI21CS10');

%exponential
t=[-10:0.1:10];
a=exp(t);

subplot(6,2,5);
plot(t,a);
xlabel('time UI21CS10');
ylabel('amplitude UI21CS10');
axis([-10 10 -2 2]);
title('exponential UI21CS10');

y=fftshift(abs(fft(a)));
subplot(6,2,6);
plot(y);
xlabel('time UI21CS10');
ylabel('amplitude UI21CS10');
title('exponential UI21CS10');

%rectagular pulse
t=[-10:0.1:10];
a=rectpuls(t);

subplot(6,2,7);
plot(t,a);
xlabel('time UI21CS10');
ylabel('amplitude UI21CS10');
axis([-10 10 -2 2]);
title('rectagular pulse UI21CS10');

y=fftshift(abs(fft(a)));
subplot(6,2,8);
plot(y);
xlabel('time UI21CS10');
ylabel('amplitude UI21CS10');
title('rectagular pulse UI21CS10');

%sinc wave
t=[-10:0.1:10];
a=sinc(t);
```

```
subplot(6,2,9);
plot(t,a);
xlabel('time UI21CS10');
ylabel('amplitude UI21CS10');
axis([-10 10 -2 2]);
title('sinc wave UI21CS10');

y=fftshift(abs(fft(a)));
subplot(6,2,10);
plot(y);
xlabel('time UI21CS10');
ylabel('amplitude UI21CS10');
title('sinc wave UI21CS10');

%impulse
t=[-10:0.1:10];
a=(t==0);

subplot(6,2,11);
plot(t,a);
xlabel('time UI21CS10');
ylabel('amplitude UI21CS10');
axis([-10 10 -2 2]);
title('impulse UI21CS10');

y=fftshift(abs(fft(a)));
subplot(6,2,12);
plot(y);
xlabel('time UI21CS10');
ylabel('amplitude UI21CS10');
title('impulse UI21CS10');
```

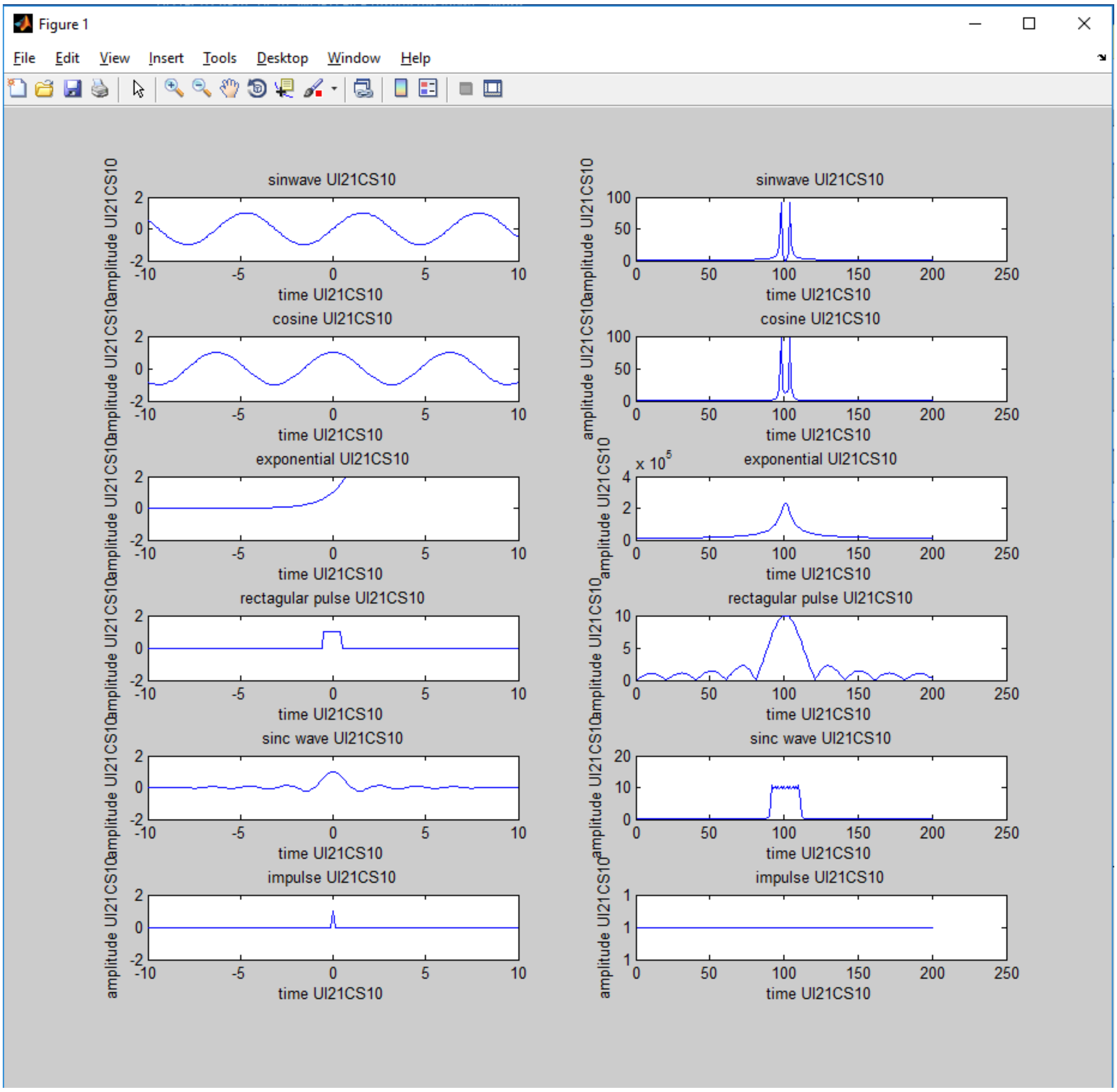
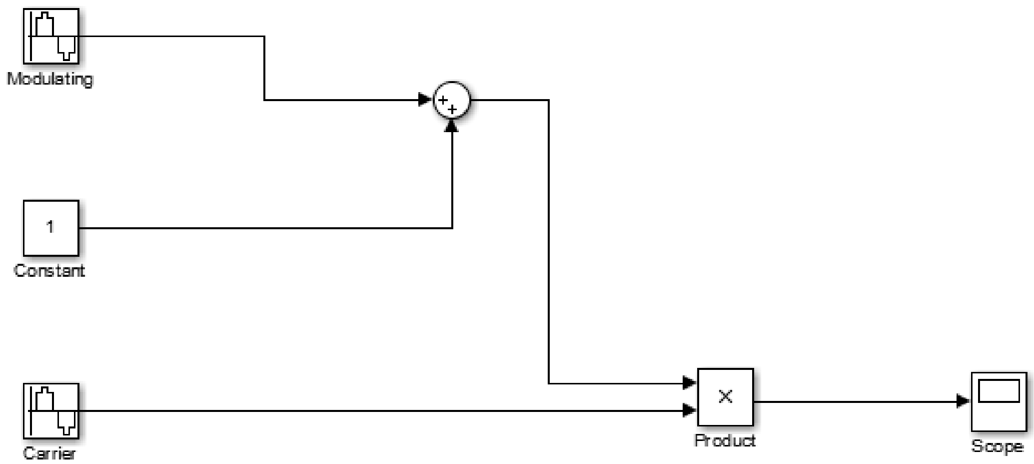


Figure 1
File Edit View Insert Tools Desktop Window Help
sinwave UI21CS10
cosine UI21CS10
exponential UI21CS10
rectagular pulse UI21CS10
sinc wave UI21CS10
impulse UI21CS10
time UI21CS10
amplitude UI21CS10
x 10^5

EXPERIMENT 3

Aim: To study amplitude modulation and observe the waveforms for three different modulation indices and reception of AM signals using code in MATLAB Software and simulink.



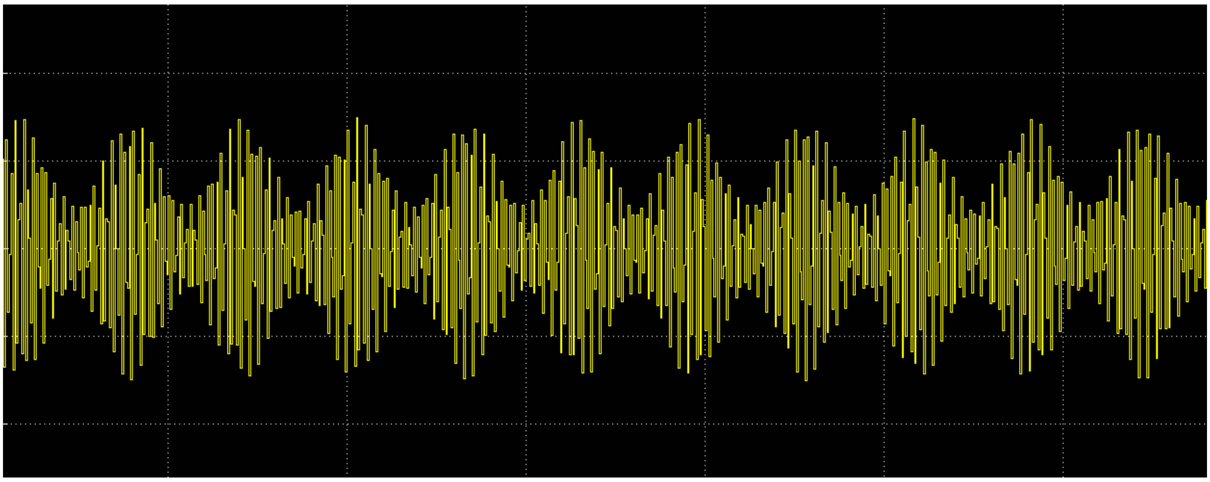
Frequency message = 10Hz

Frequency carrier = 1000Hz

Sample time = 0.01

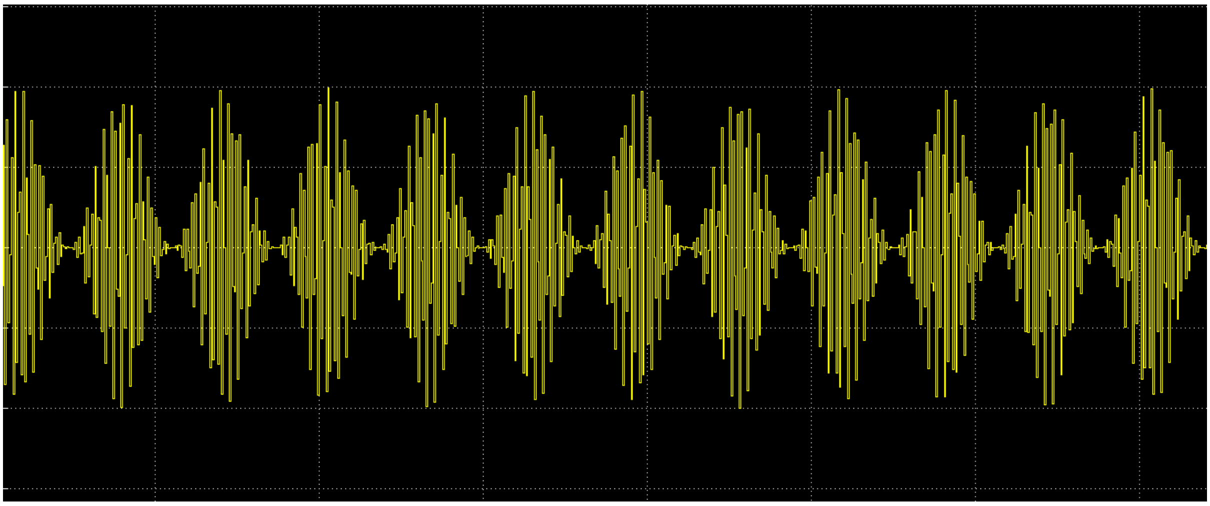
Case 1:

Am = 0.5 m<1



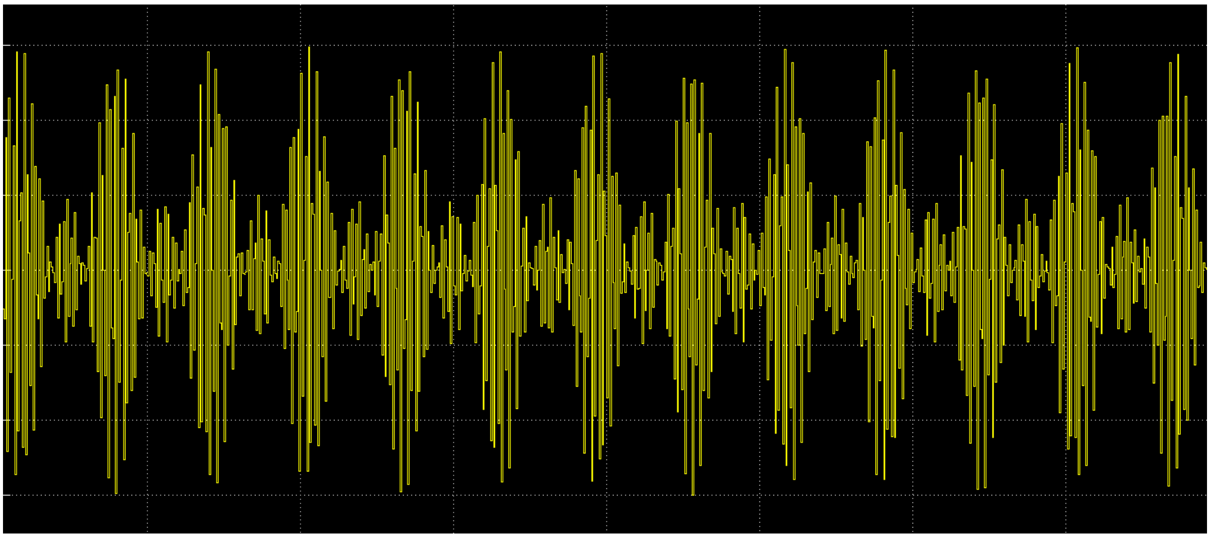
Case 2:

Am=1,m=1



Case 3:

Am=2,m>1

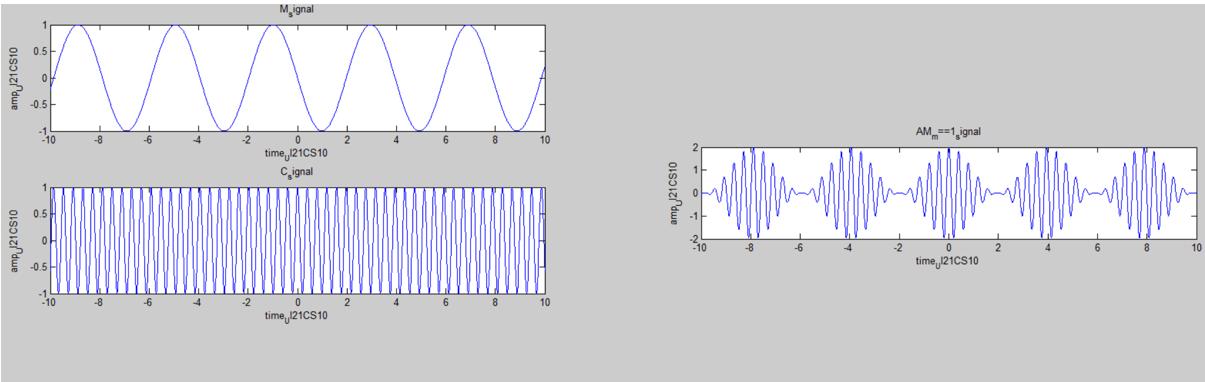


CODE:

M=0

```
clc;
clear all;
close all;
t=[-10:0.01:10];
em=1;
ec=1;
p=3.14;
m=em/ec;
fc=5000;
fm=500;
%M_SIGNAL
a=sin(2*p*fm*t);
subplot(4,2,1);
plot(t,a);
xlabel('time_UI21CS10');
ylabel('amp_UI21CS10');
title('M_signal');
%c_signal
b=ec*cos(2*p*fc*t);
subplot(4,2,3);
```

```
plot(t,b);
xlabel('time_UI21CS10');
ylabel('amp_UI21CS10');
title('C_signal');
%AM
s=ec*(1+m.*cos(2*p*fm*t)).*cos(2*p*fc*t);
subplot(5,2,4);
plot(t,s);
xlabel('time_UI21CS10');
ylabel('amp_UI21CS10');
title('AM_m==1_signal');
```

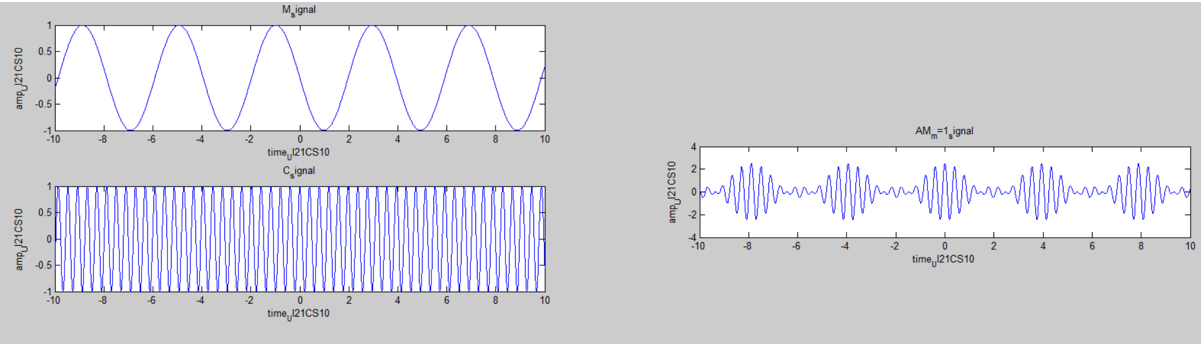


M>1

CODE

```
clc;
clear all;
close all;
t=[-10:0.01:10];
em=1.5;
ec=1;
p=3.14;
m=em/ec;
fc=5000;
fm=500;
%M_SIGNAL
a=sin(2*p*fm*t);
subplot(4,2,1);
plot(t,a);
xlabel('time_UI21CS10');
ylabel('amp_UI21CS10');
```

```
title('M_signal');
%c_signal
b=ec*cos(2*p*fc*t);
subplot(4,2,3);
plot(t,b);
xlabel('time_UI21CS10');
ylabel('amp_UI21CS10');
title('C_signal');
%AM
s=ec*(1+m.*cos(2*p*fm*t)).*cos(2*p*fc*t);
subplot(5,2,4);
plot(t,s);
xlabel('time_UI21CS10');
ylabel('amp_UI21CS10');
title('AM_m=1_signal');
```

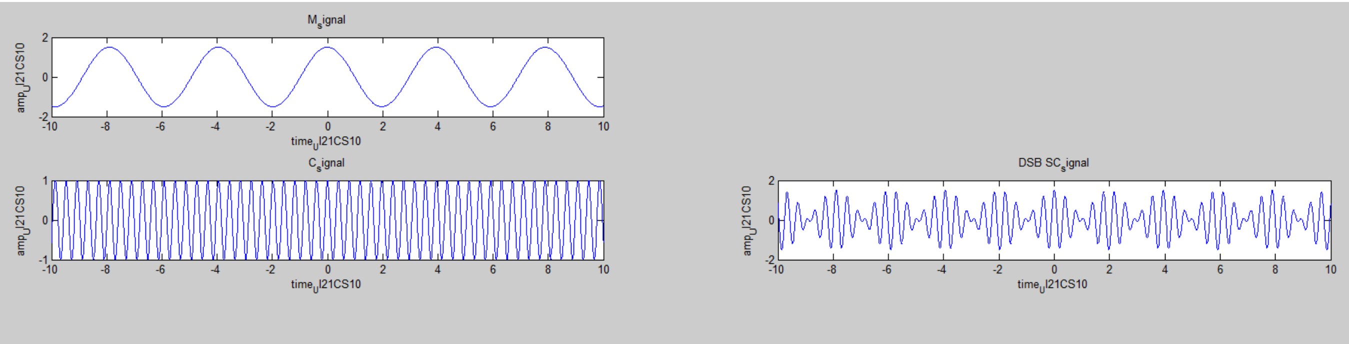


DSB SC

CODE

```
clc;
clear all;
close all;
t=[-10:0.01:10];
em=1.5;
ec=1;
p=3.14;
m=em/ec;
fc=5000;
fm=500;
%M_SIGNAL
a=em*cos(2*p*fm*t);
subplot(5,2,1);
```

```
plot(t,a);
xlabel('time_UI21CS10');
ylabel('amp_UI21CS10');
title('M_signal');
%c_signal
b=ec*cos(2*p*fc*t);
subplot(5,2,3);
plot(t,b);
xlabel('time_UI21CS10');
ylabel('amp_UI21CS10');
title('C_signal');
%DSB SC
s=a.*b;
subplot(5,2,4);
plot(t,s);
xlabel('time_UI21CS10');
ylabel('amp_UI21CS10');
title('DSB SC_signal');
```

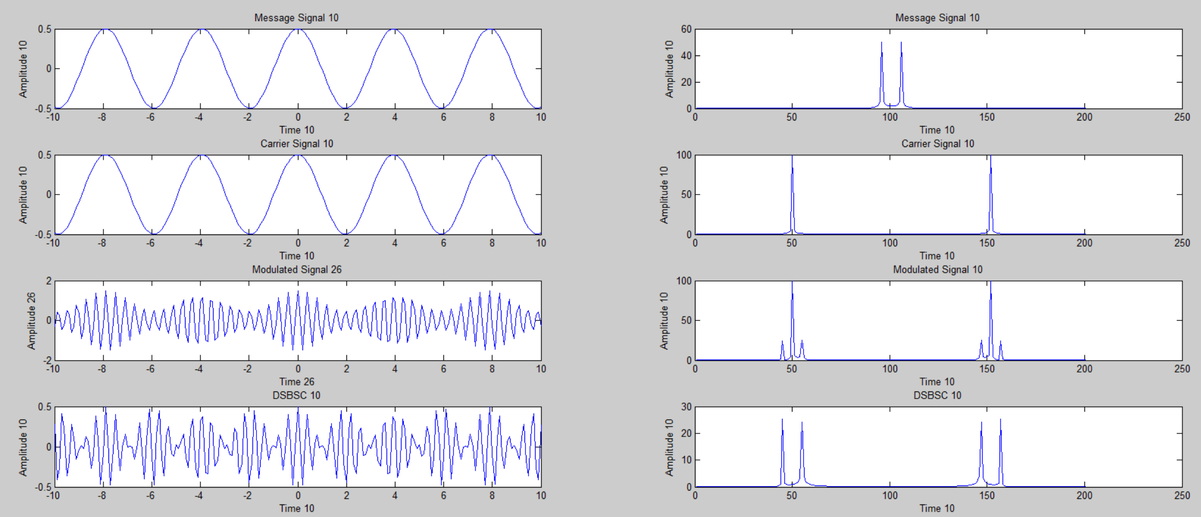


EXPERIMENT 4

AIM: To study amplitude modulation and observe the waveforms for three different Modulation AM,DSB-SC,SSB-SC and its frequency spectrum in MATLAB Software.

```
clc;
clear all;
close all;
figure;
t = [-10:0.1:10];
pi = 3.14;
Em = 0.5;
Ec = 1;
Fm = 500;
Fc = 5000;
M = Em/Ec;
%Message Signal
m = Em.*cos(2.*pi.*Fm.*t);
subplot(5,2,1);
plot(t,m);
xlabel('Time 10');
ylabel('Amplitude 10');
title('Message Signal 10');
y=fftshift(abs(fft(m)));
subplot(5,2,2);
plot(y);
xlabel('Time 10');
ylabel('Amplitude 10');
title('Message Signal 10');
%Carrier Signal
c = Ec.*cos(2.*pi.*Fc.*t);
subplot(5,2,3);
plot(t,m);
xlabel('Time 10');
ylabel('Amplitude 10');
title('Carrier Signal 10');
y=fftshift(abs(fft(c)));
subplot(5,2,4);
plot(y);
```

```
xlabel('Time 10');
ylabel('Amplitude 10');
title('Carrier Signal 10');
%Amplitude Modulation
Mod = (1 + M.*cos(2.*pi.*Fm.*t)).*c;
subplot(5,2,5);
plot(t,Mod);
xlabel('Time 10');
ylabel('Amplitude 10');
title('Modulated Signal 10');
y=fftshift(abs(fft(Mod)));
subplot(5,2,6);
plot(y);
xlabel('Time 10');
ylabel('Amplitude 10');
title('Modulated Signal 10');
%DSB-SC
dsbsc = m.*c;
subplot(5,2,7);
plot(t,dsbsc);
xlabel('Time 10');
ylabel('Amplitude 10');
title('DSBSC 10');
y=fftshift(abs(fft(dsbsc)));
subplot(5,2,8);
plot(y);
xlabel('Time 10');
ylabel('Amplitude 10');
title('DSBSC 10');
%SSB-SC
ssbsc = m.*c + m'.*c';
subplot(5,2,9);
plot(t,ssbsc);
xlabel('Time 10');
ylabel('Amplitude 10');
title('SSBSC 10');
y=fftshift(abs(fft(ssbsc)));
subplot(5,2,10);
plot(y);
xlabel('Time 10');
ylabel('Amplitude 10');
title('SSBSC 10');
```


Message Signal 10
Amplitude 10
Time 10
Carrier Signal 10
Amplitude 10
Time 10
Modulated Signal 26
Amplitude 26
Time 26
DSBSC 10
Amplitude 10
Time 10
Message Signal 10
Amplitude 10
Time 10
Carrier Signal 10
Amplitude 10
Time 10
Modulated Signal 10
Amplitude 10
Time 10
DSBSC 10
Amplitude 10
Time 10

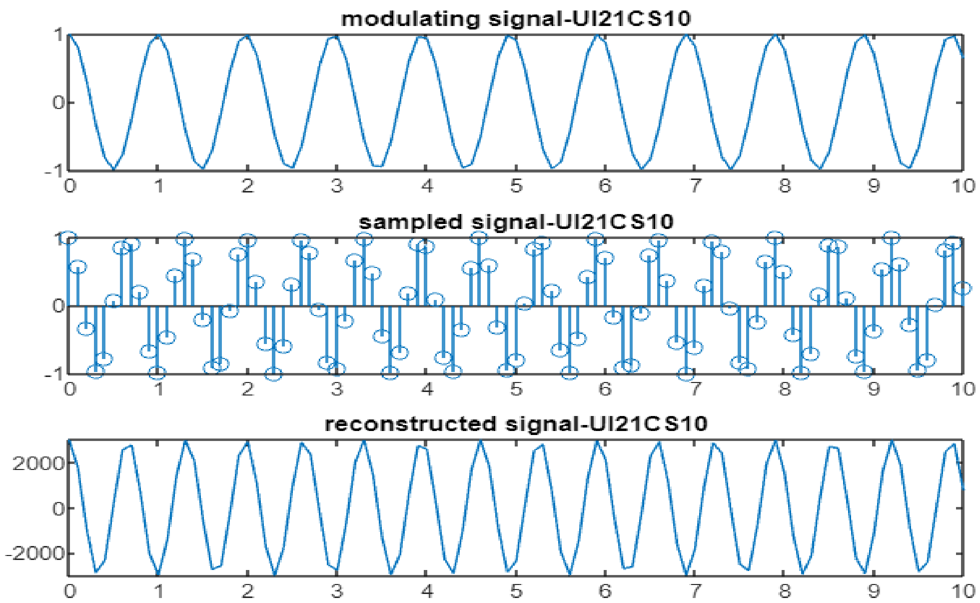
EXPERIMENT 5

Aim: To perform sampling of input sinusoidal signal using code in MATLAB software and verify the Nyquist Criteria in MATLAB and simulink.

```
clc;
clear ALL;
close all;
t= 0:0.1:10;
fm=input('enter frequency fm= ');
fs=input('enter frequency fs= ');
pi=3.14;

x=cos(2*fm*pi*t);
subplot(3,1,1);
plot(t,x);
title('modulating signal-UI21CS10');

y=cos(2*fs*pi*t);
subplot(3,1,2);
stem(t,y);
title('sampled signal-UI21CS10');

h=filter(fs,1,y);
subplot(3,1,3);
plot(t,h);
title('reconstructed signal-UI21CS10');
```

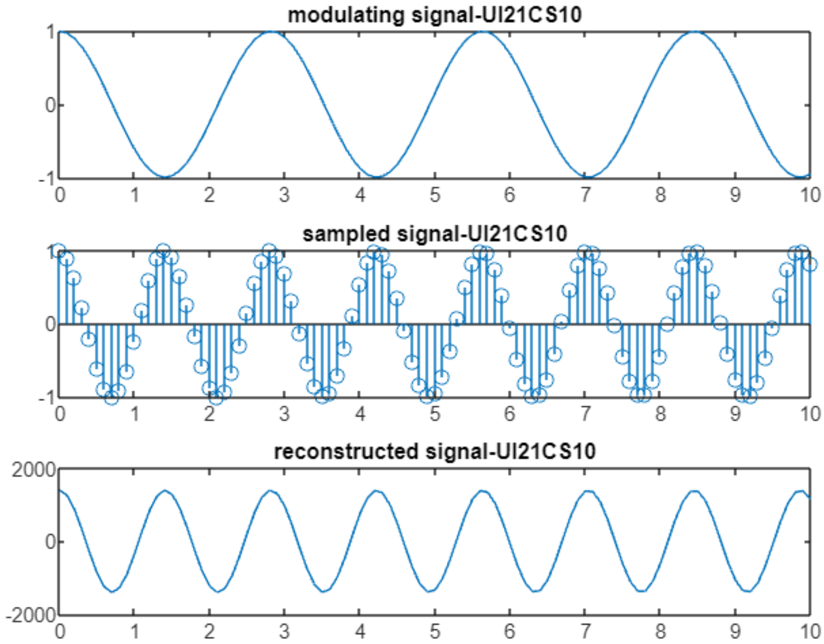
CASE-I: Under-Sampling

- **Fs <2*Fm**
- **Fm = 2000**
- **Fs = 3000**



CASE-II: Perfect Sampling

- **Fs = 2*Fm**
- **Fs = 700**
- **Fm =1400**



CASE-III: Over Sampling

- **Fs > 2*Fm**
- **Fm= 500**
- **Fs= 1100**

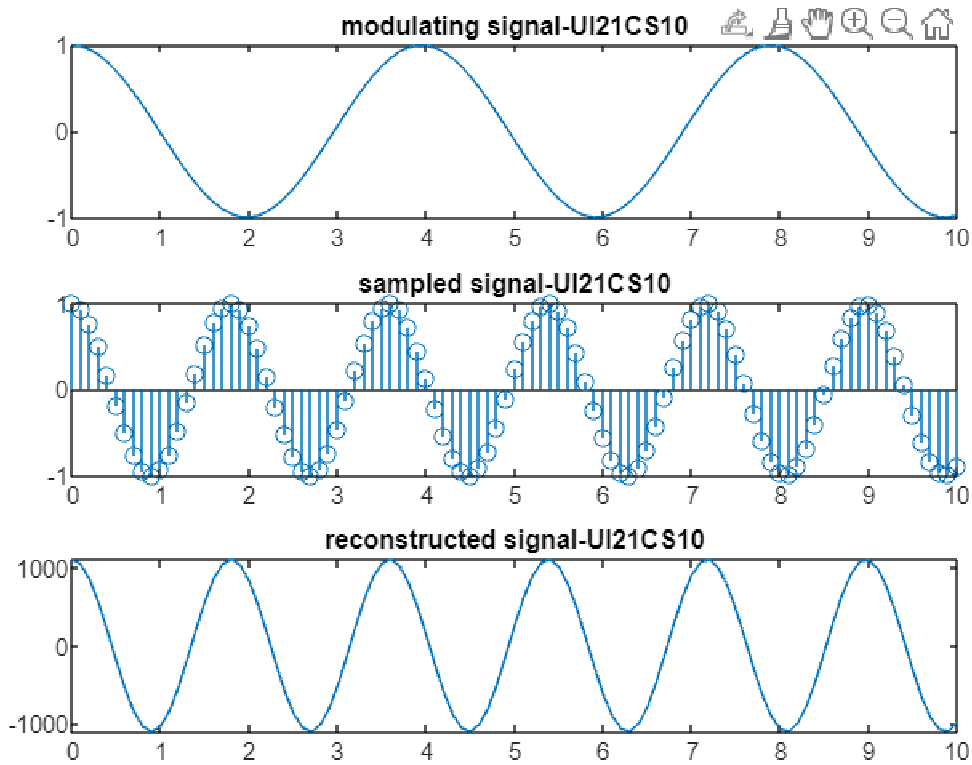
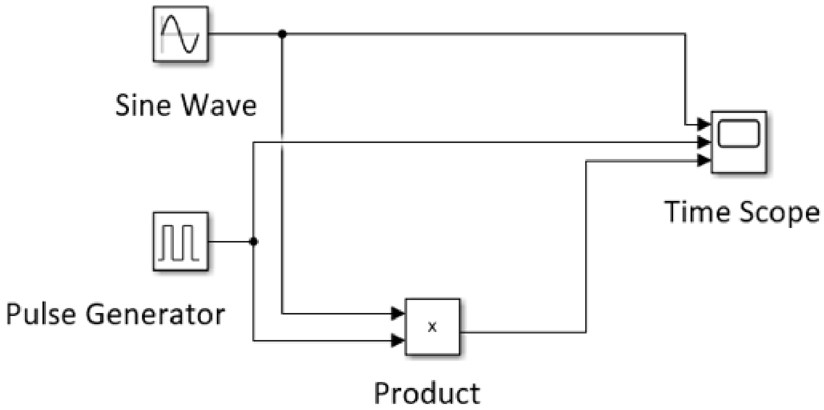
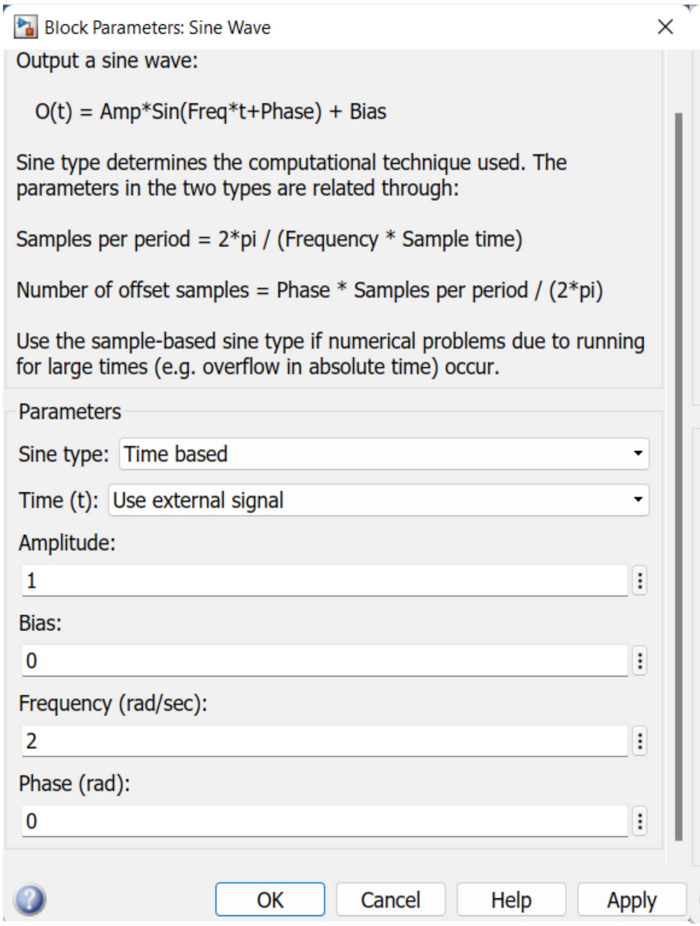
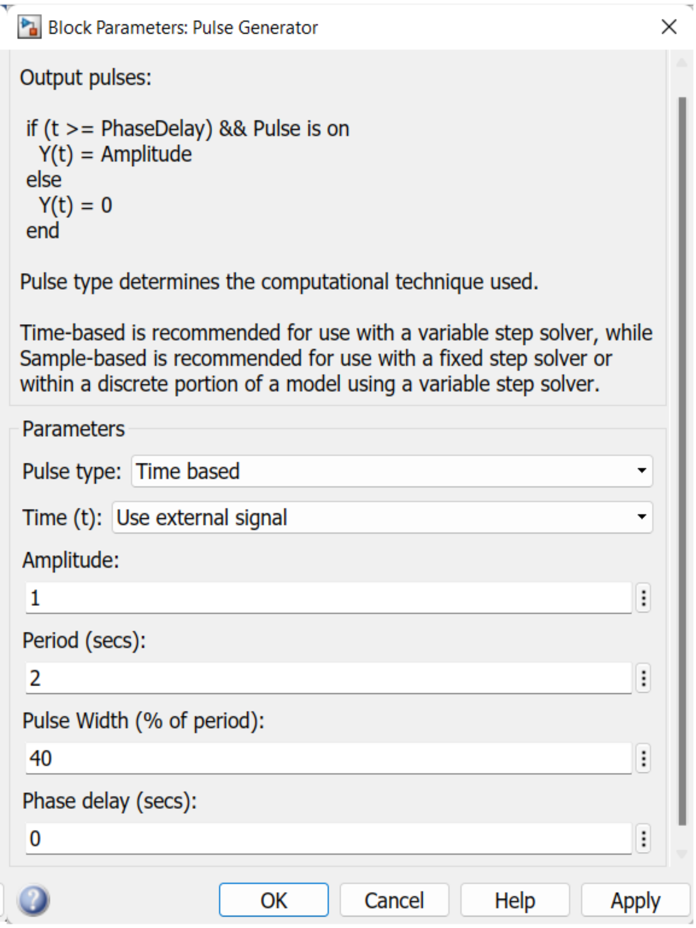


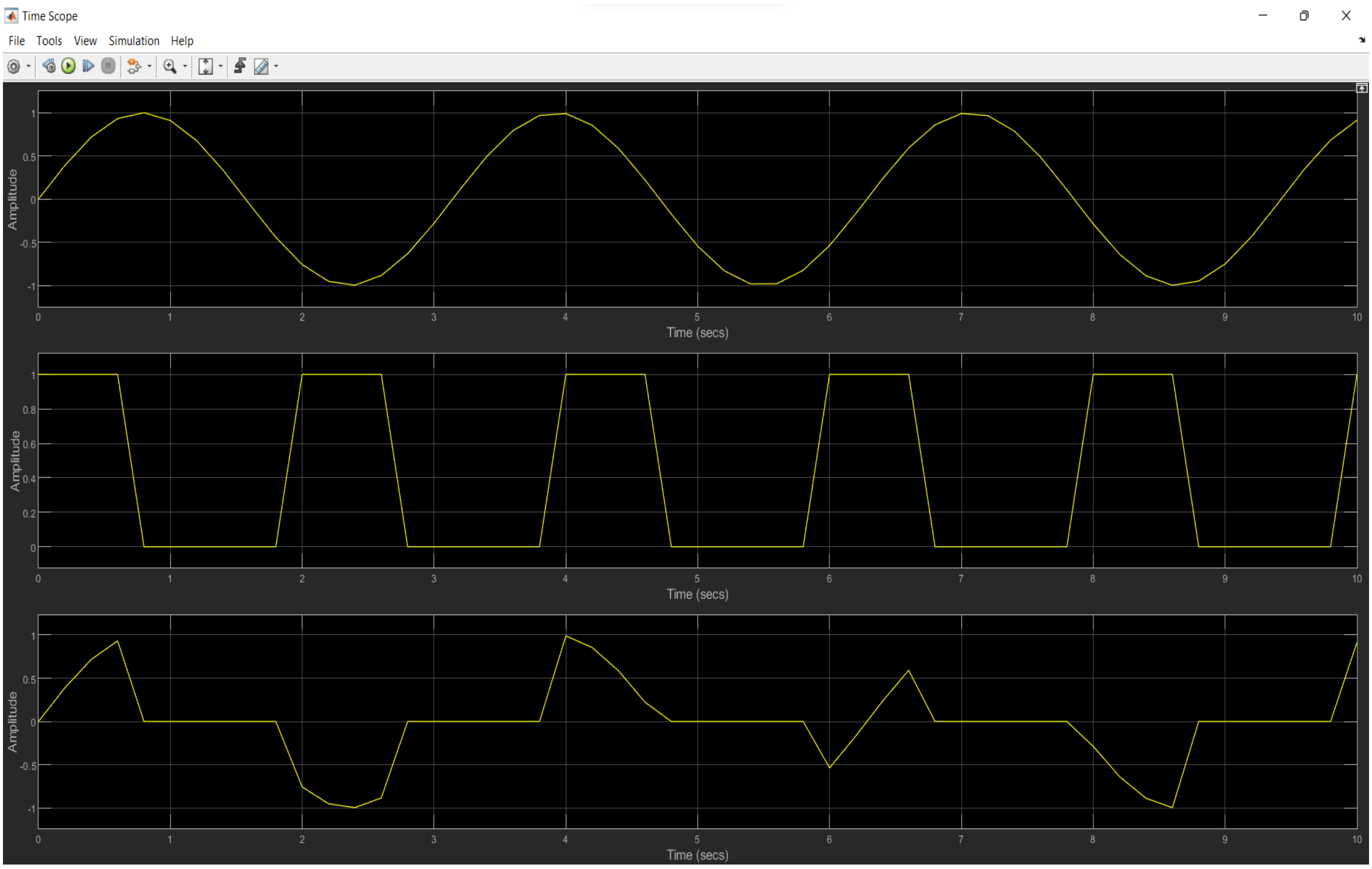
Figure:-



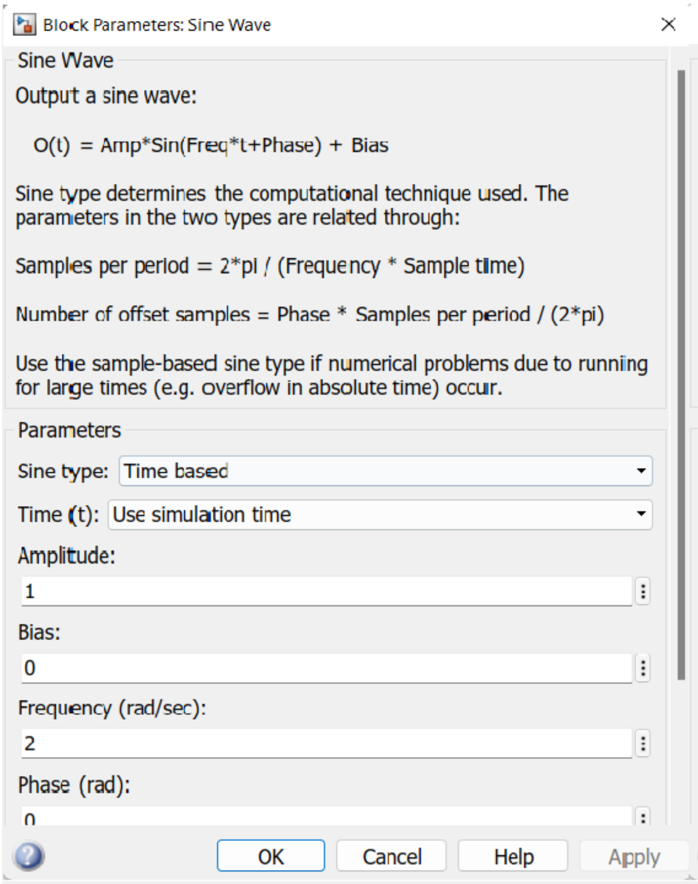
CASE-I: Under-Sampling

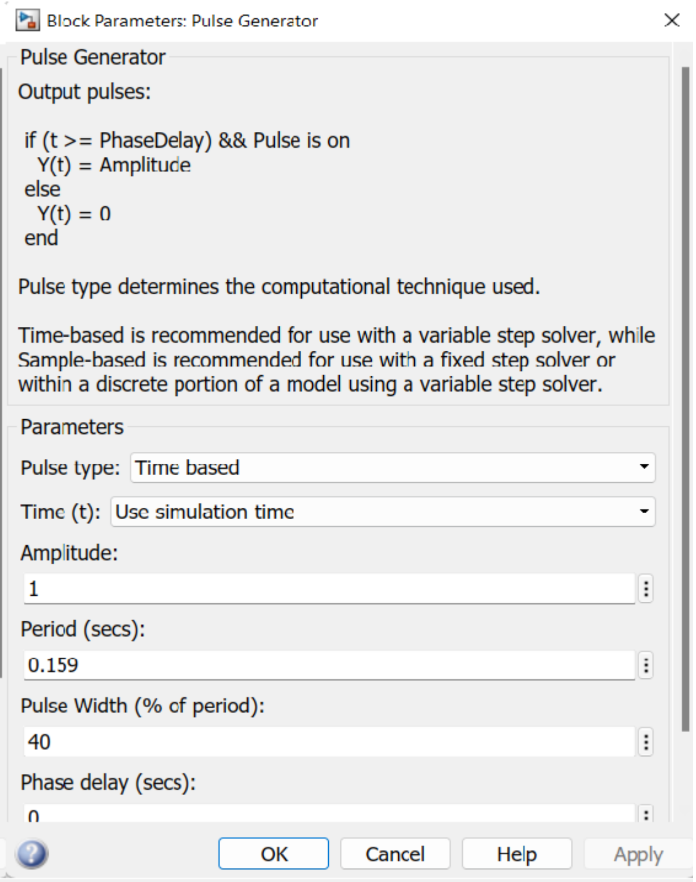


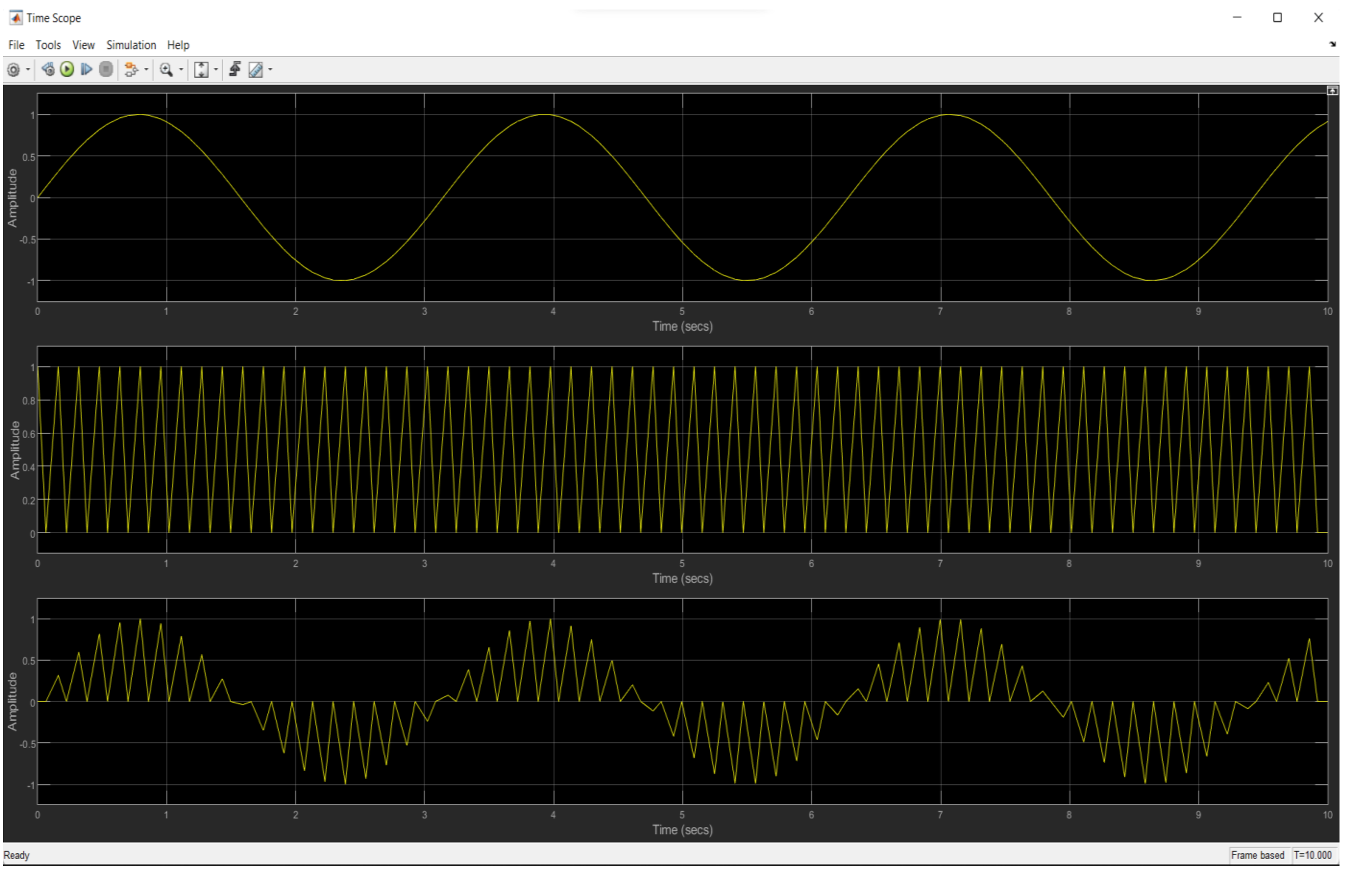




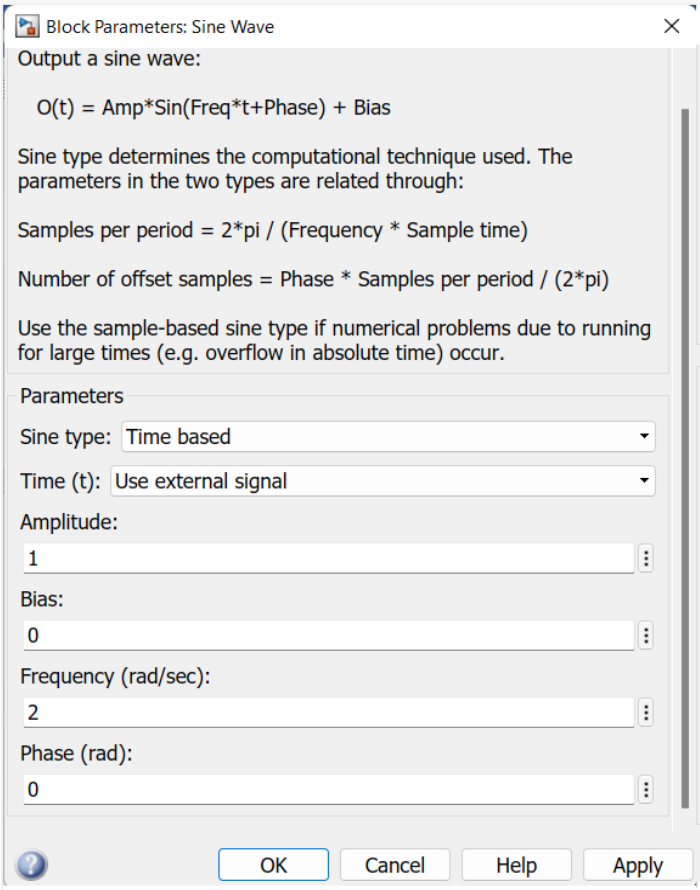
CASE-II: Perfect Sampling

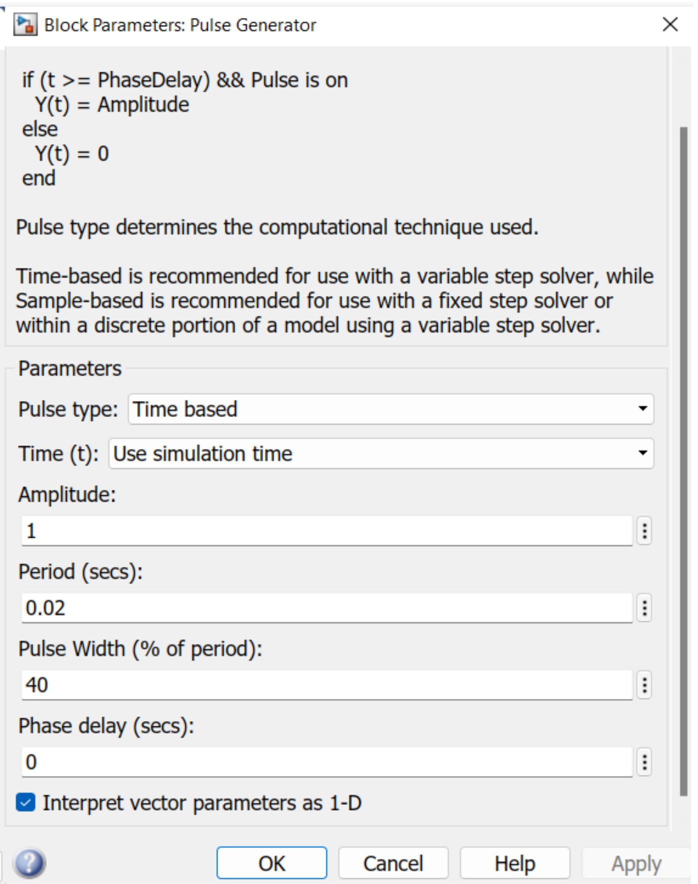


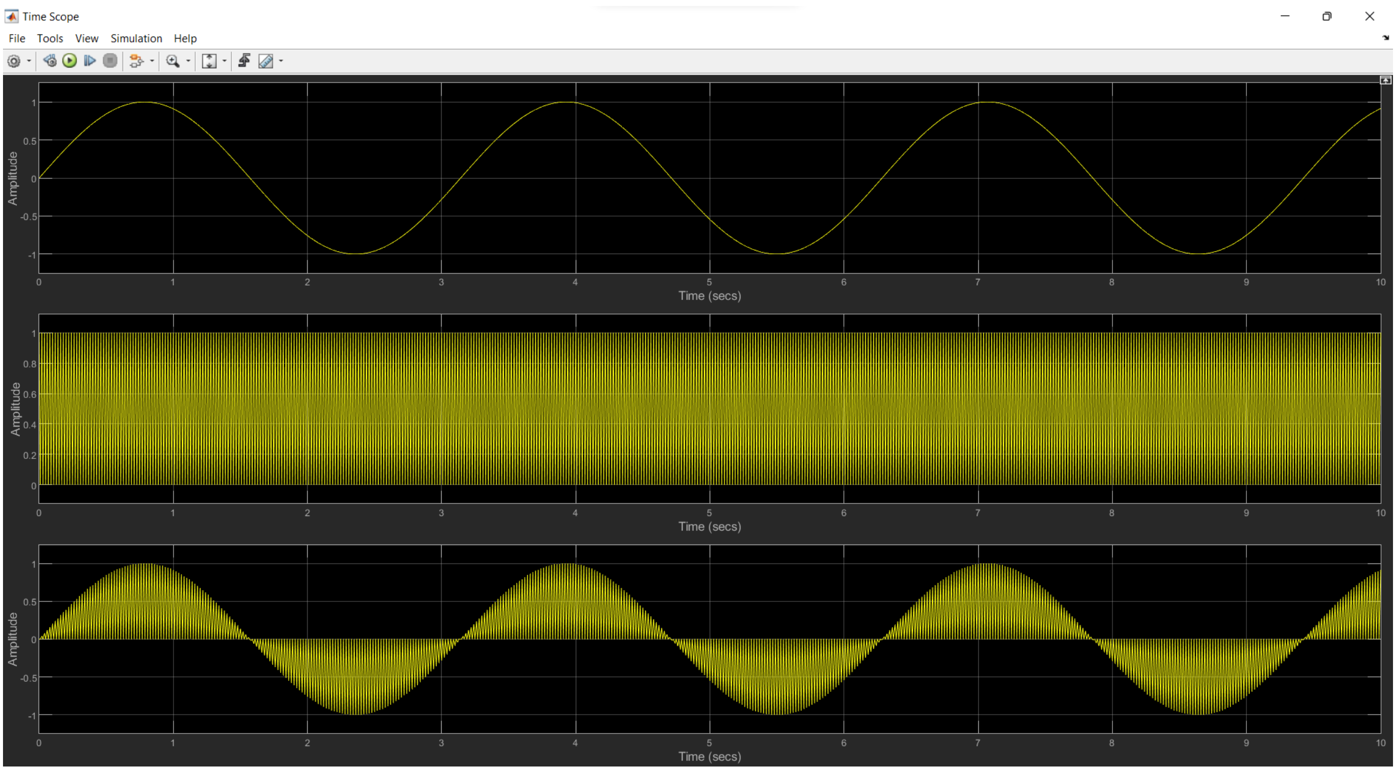




CASE-III: Over Sampling





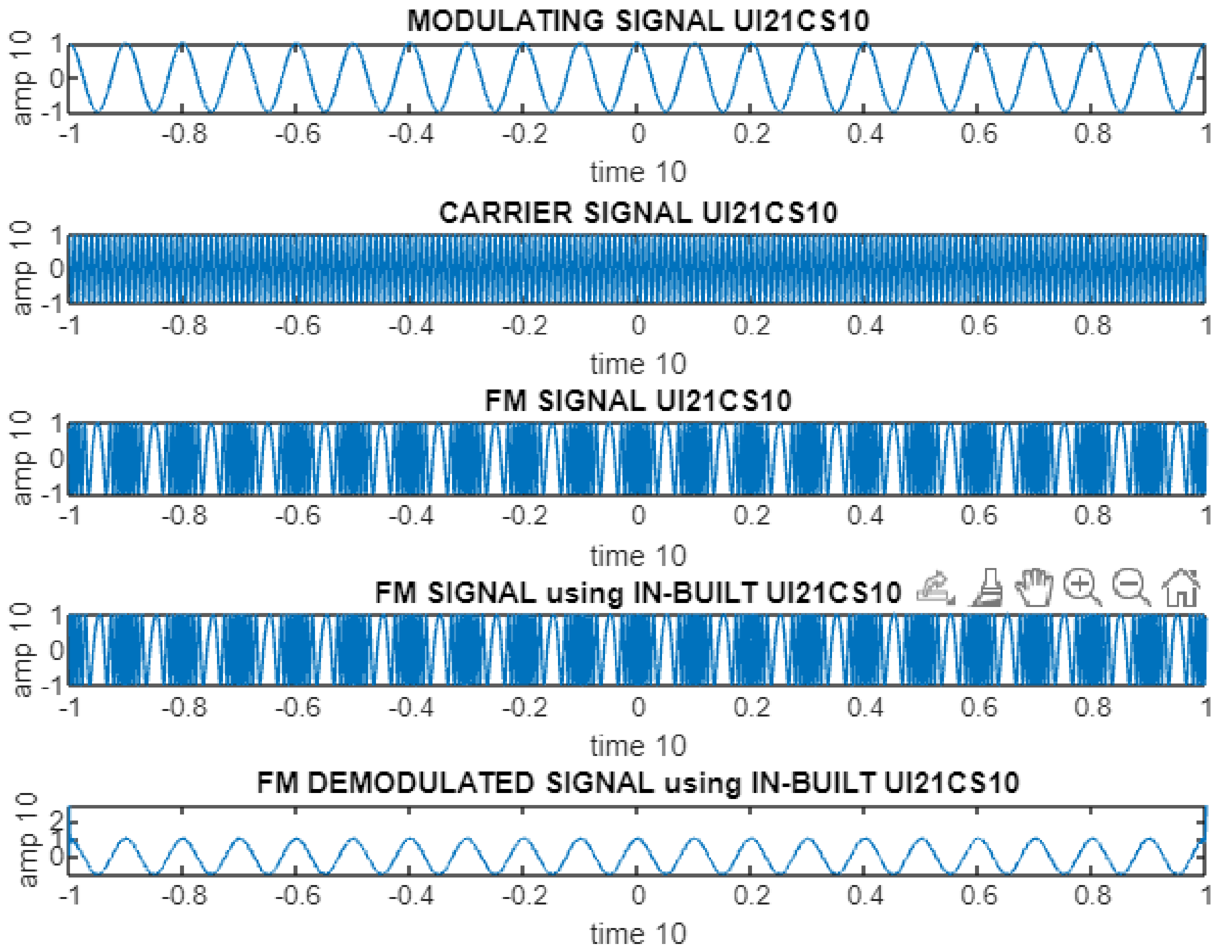


EXPERIMENT 6

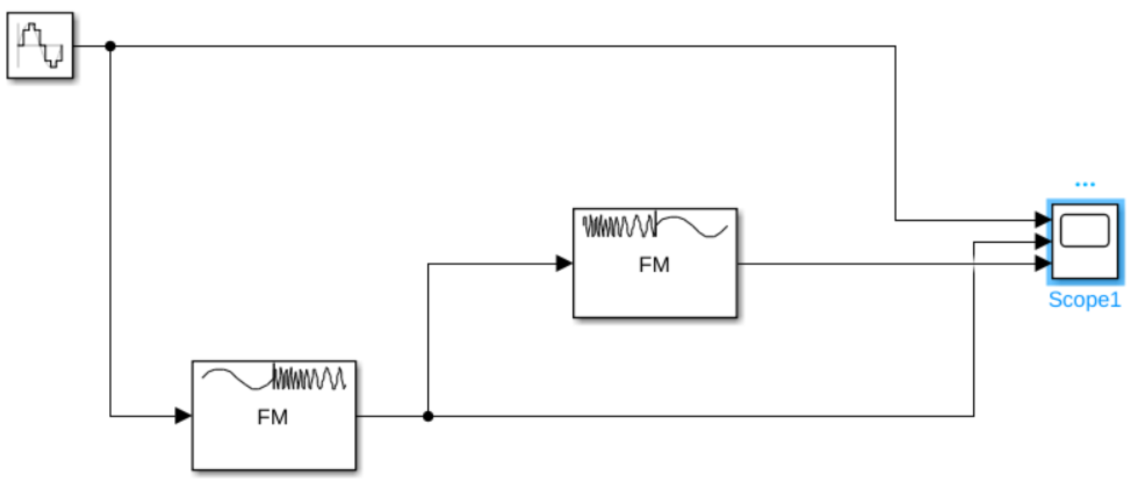
Aim: To study and implement PAM (Pulse Amplitude Modulation) ,PWM (Pulse Width Modulation) and PPM (Pulse Position Modulation) of analog signal in MATLAB software and simulink.

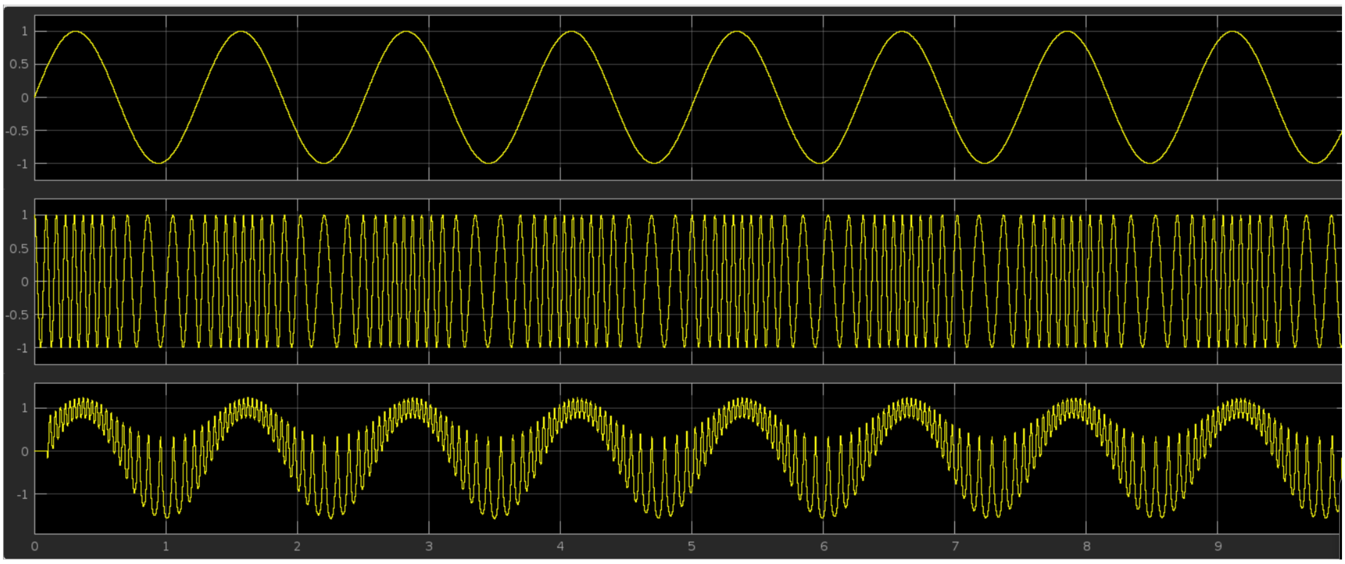
```
clc;
clear ALL;
close all;
%LAB 6 UI21CS10 FM SIGNAL
% MODULATING SIGNAL
figure;
fs=10000;
t = -1:1/fs:1;
pi=3.14;
fm=10;
fc=100;
Am=1;
Ac=1;
B=8;%modulation index
freqdev=B*fm;

m=Am*cos(2*pi*fm*t);
subplot(5,1,1);
plot(t,m);
xlabel('time 10');
ylabel('amp 10');
title('MODULATING SIGNAL UI21CS10');

% CARRIER SIGNAL
c=Ac*cos(2*pi*fc*t);
subplot(5,1,2);
plot(t,c);
xlabel('time 10');
ylabel('amp 10');
title('CARRIER SIGNAL UI21CS10');

% FM SIGNAL
s=Ac*cos(2*pi*fc*t+(B*sin(2*pi*fm*t)));
subplot(5,1,3);
plot(t,s);
xlabel('time 10');
ylabel('amp 10');
title('FM SIGNAL UI21CS10');

%IN-BUILT FM SIGNAL
y=fmmod(m,fc,fs,freqdev);
subplot(5,1,4);
plot(t,y);
xlabel('time 10');
ylabel('amp 10');
title('FM SIGNAL using IN-BUILT UI21CS10');

%IN-BUILT FM DEMODULATION SIGNAL
```

```
z=fmdemod(s,fc,fs,freqdev);
subplot(5,1,5);
plot(t,z);
xlabel('time 10');
ylabel('amp 10');
title('FM DEMODULATED SIGNAL using IN-BUILT UI21CS10');
```



Simulink:





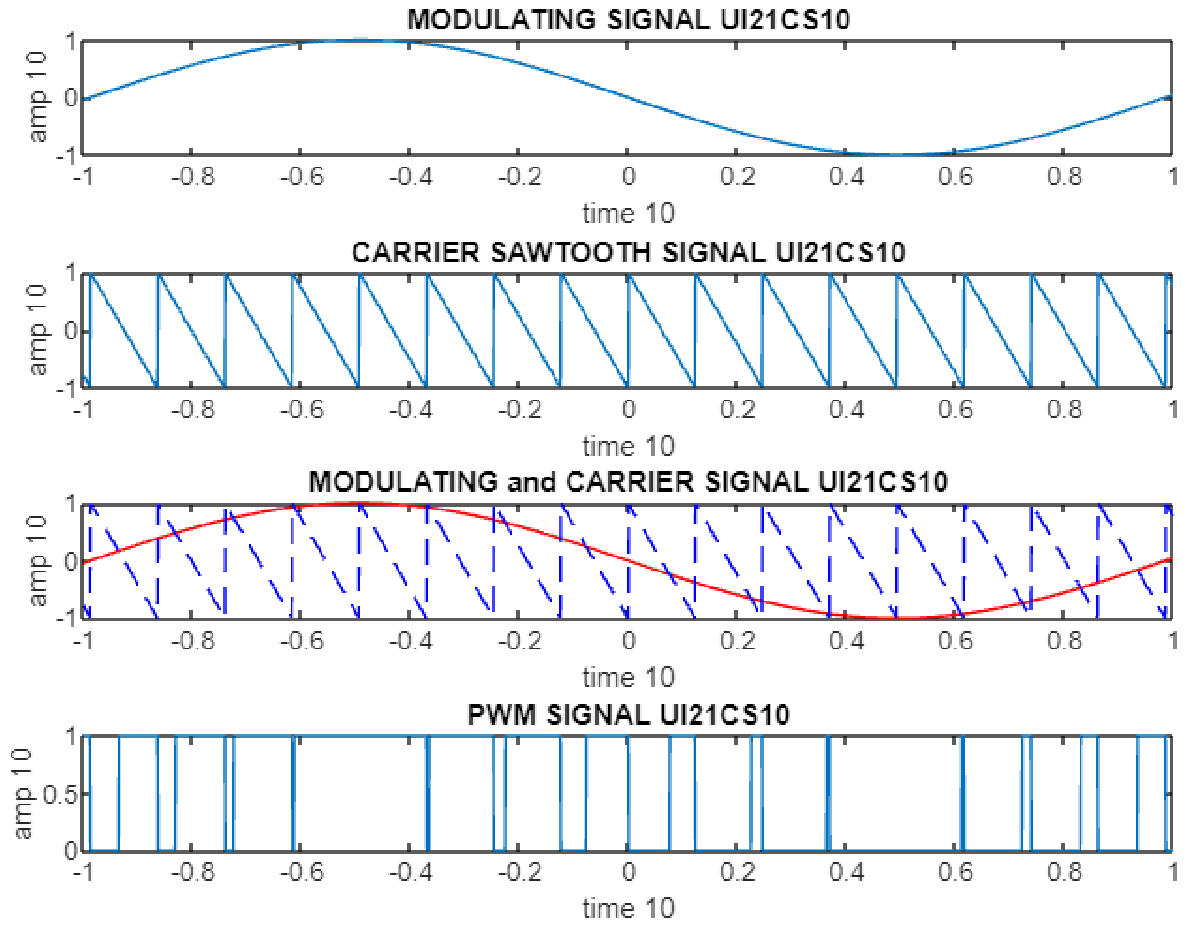
EXPERIMENT 7

Aim: To obtain frequency modulation and demodulation using equations and in-built functions in MATLAB software and simulink.

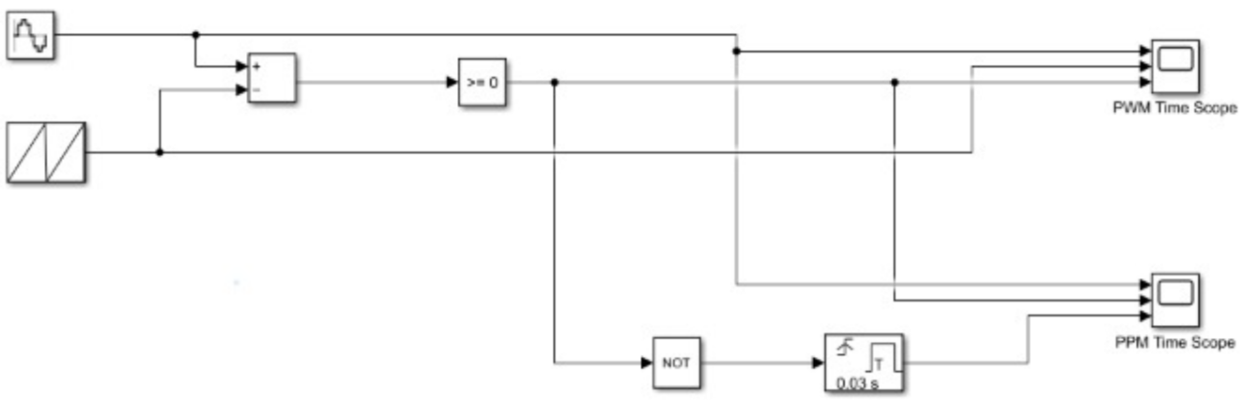
Code:

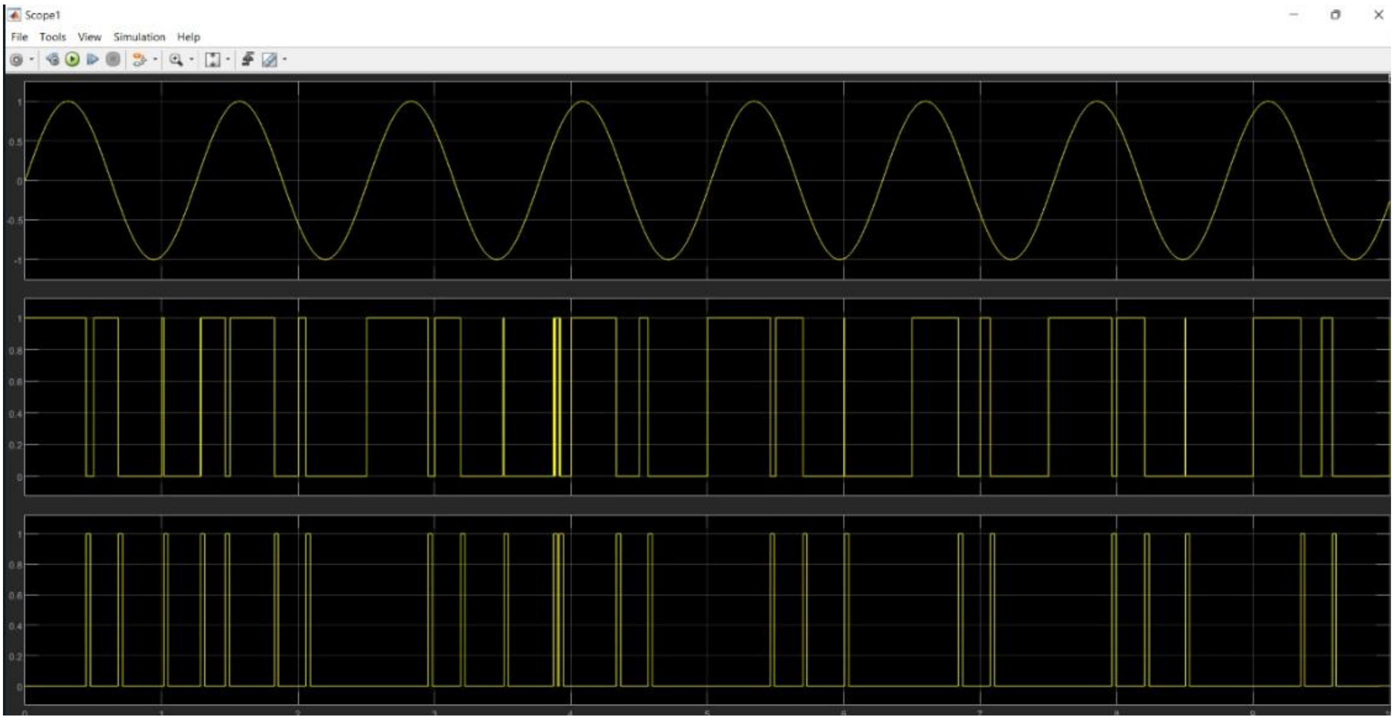
```
clc;
clear ALL;
close all;
%LAB 7 UI21CS10 PAM - PWM - PPM SIGNAL
% MESSAGE SIGNAL
figure;
fs=10000;
t = -1:0.001:1;
pi=3.14;
fm=1000;
fc=16000;
m=sin(2*pi*fm*t);
subplot(4,1,1);
plot(t,m);
xlabel('time 10');
ylabel('amp 10');
title('MODULATING SIGNAL UI21CS10');

% SAWTOOTH CARRIER SIGNAL
c=sawtooth(2*pi*fc*t);
subplot(4,1,2);
plot(t,c);
xlabel('time 10');
ylabel('amp 10');
title('CARRIER SAWTOOTH SIGNAL UI21CS10');

subplot(4,1,3);
plot(t,m,'r',t,c,'b--');
xlabel('time 10');
ylabel('amp 10');
title('MODULATING and CARRIER SIGNAL UI21CS10');
n=length(c);
for i = 1:n
    if m(i)>=c(i)
        pwm(i)=1;
    else
        pwm(i)=0;
    end
end
subplot(4,1,4);
plot(t,pwm);
xlabel('time 10');
ylabel('amp 10');
title('PWM SIGNAL UI21CS10');
```

Output


MODULATING SIGNAL UI21CS10
amp 10
time 10
CARRIER SAWTOOTH SIGNAL UI21CS10
amp 10
time 10
MODULATING and CARRIER SIGNAL UI21CS10
amp 10
time 10
PWM SIGNAL UI21CS10
amp 10
time 10

Simulink:


>= 0
NOT
0.03 s
PWM Time Scope
PPM Time Scope


Scope1
File Tools View Simulation Help

EXPERIMENT 8

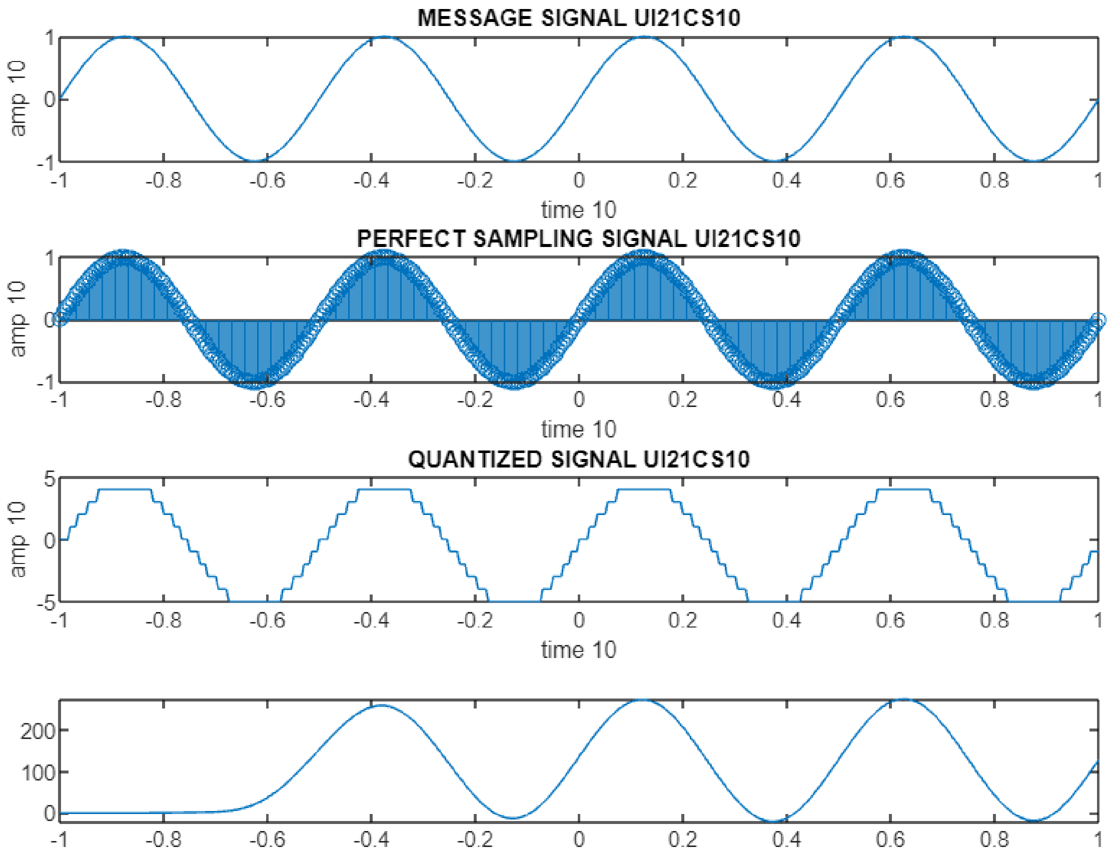
Aim: To study about modulation and demodulation of Pulse Code Modulation (PCM) in MATLAB software and simulink.

Code:

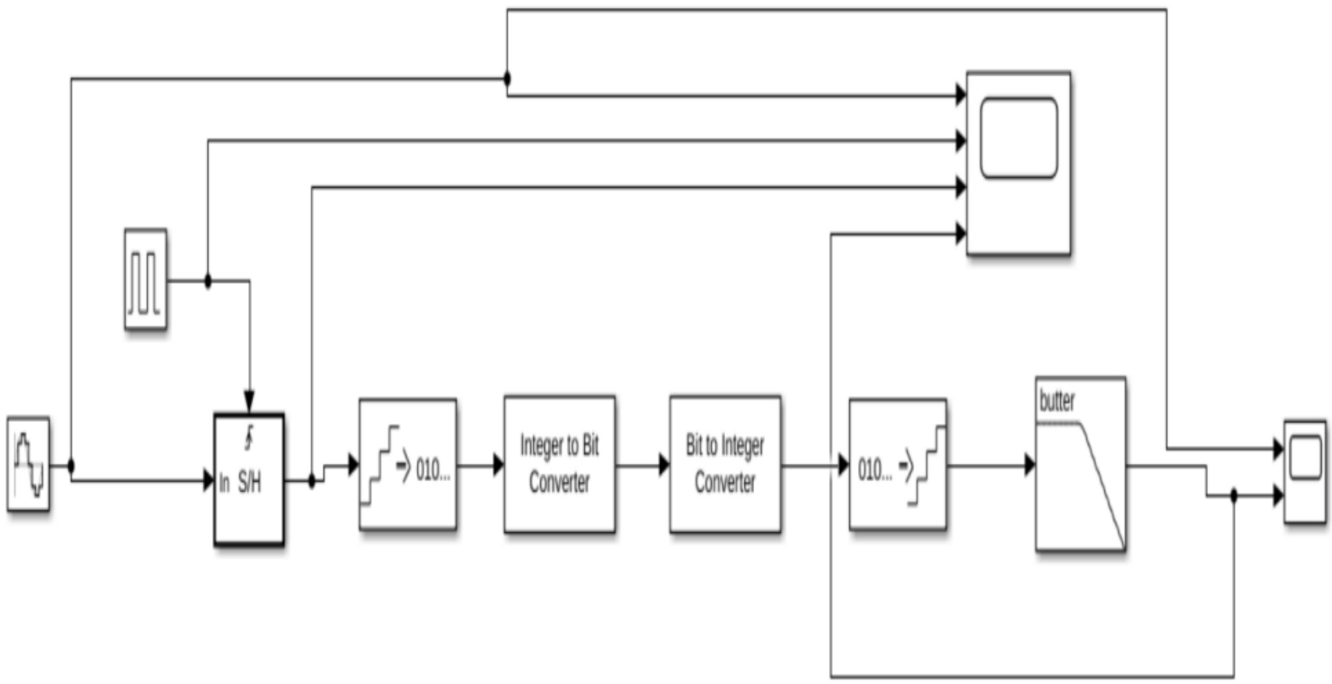
```
clc;
clear All;
close all;
%LAB 8 UI21CS10 ANALOG TO DIGITAL CONVERSION
% MESSAGE SIGNAL
figure;
t = -1:0.005:1;
pi=3.14;
fm=2;
m=sin(2*pi*fm*t);
subplot(4,1,1);
plot(t,m);
xlabel('time 10');
ylabel('amp 10');
title('MESSAGE SIGNAL UI21CS10');
% PERFECT SAMPLING
fm=1000;
subplot(4,1,2);
stem(t,m);
```

```
xlabel('time 10');
ylabel('amp 10');
title('PERFECT SAMPLING SIGNAL UI21CS10');
x=floor(m/0.2);
y=dec2bin(x);
subplot(4,1,3);
plot(t,x);
xlabel('time 10');
ylabel('amp 10');
title('QUANTIZED SIGNAL UI21CS10');
z=bin2dec(y);s
disp(z);
output1=filter(1,1,z);
[B,A]=butter(5,1/42,'low');
output2=filter(B,A,output1);
subplot(4,1,4);
plot(t,output2);
```

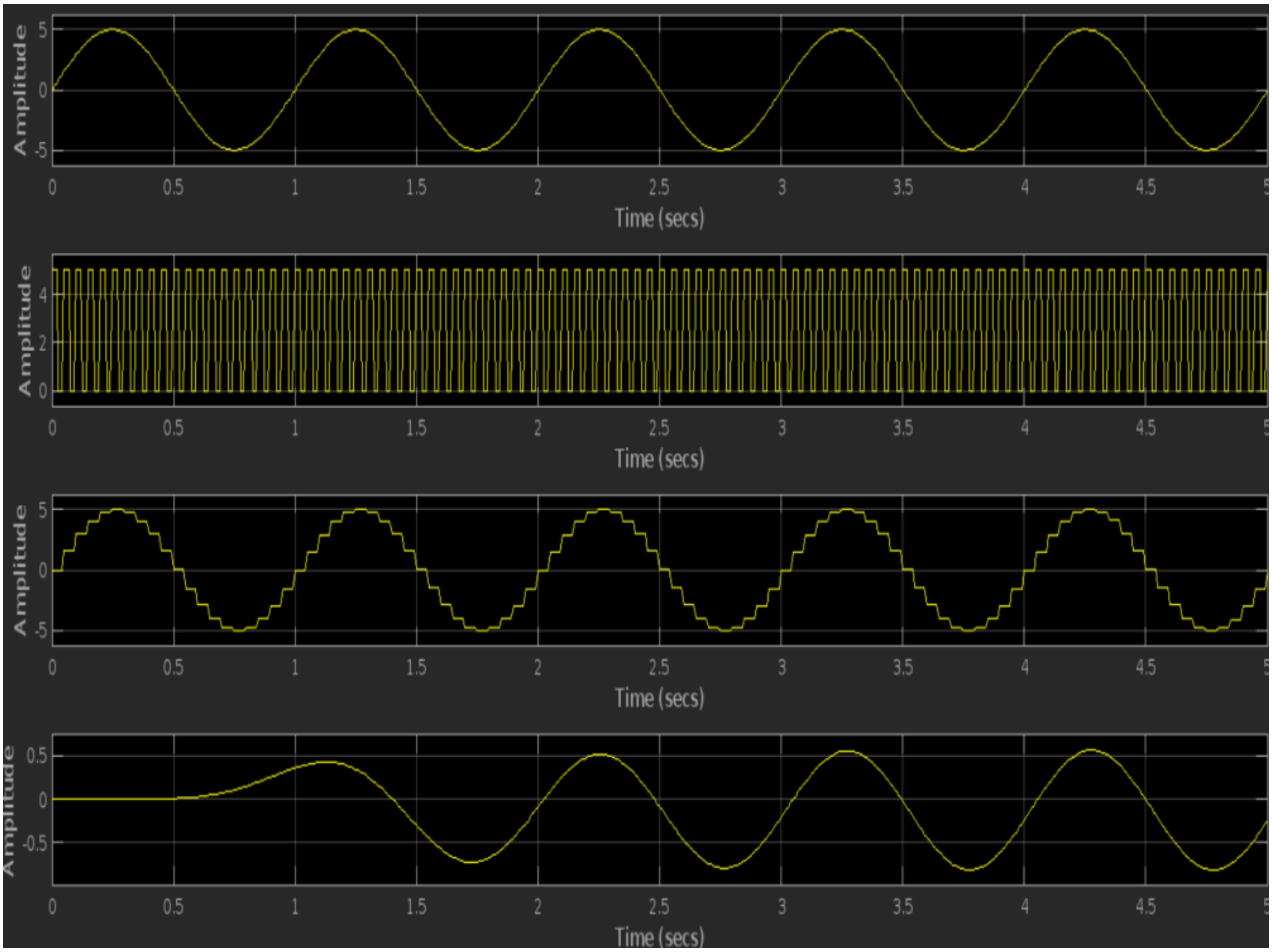
OUTPUT:

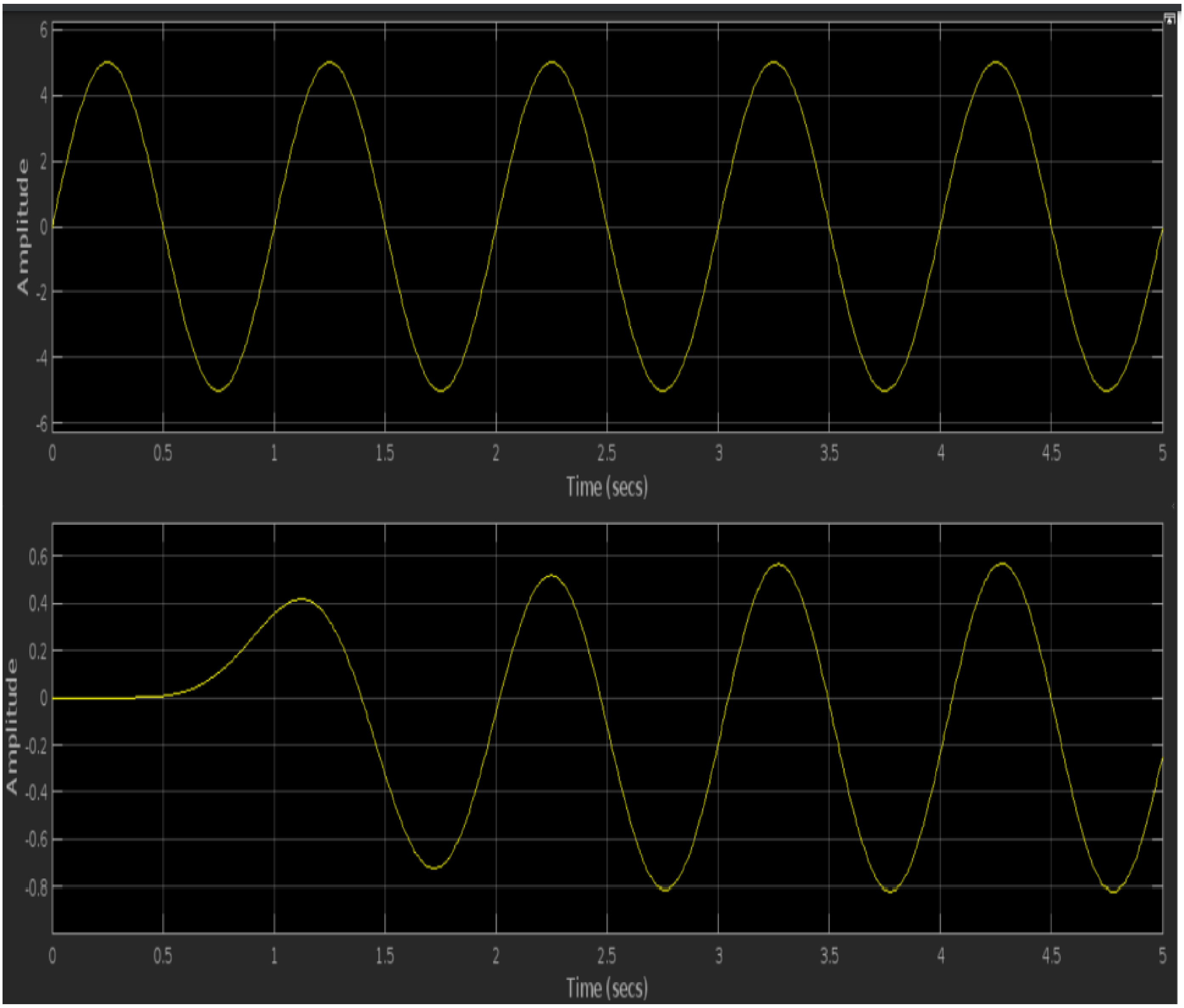

MESSAGE SIGNAL UI21CS10
amp 10
time 10
PERFECT SAMPLING SIGNAL UI21CS10
amp 10
time 10
QUANTIZED SIGNAL UI21CS10
amp 10
time 10

SIMULINK:


In S/H
010...
Integer to Bit Converter
Bit to Integer Converter
010...
butter

OUTPUT:


Amplitude
Time (secs)
Amplitude
Time (secs)
Amplitude
Time (secs)
Amplitude
Time (secs)


Amplitude
6
4
2
0
-2
-4
-6
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (secs)
Amplitude
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (secs)

EXPERIMENT 9

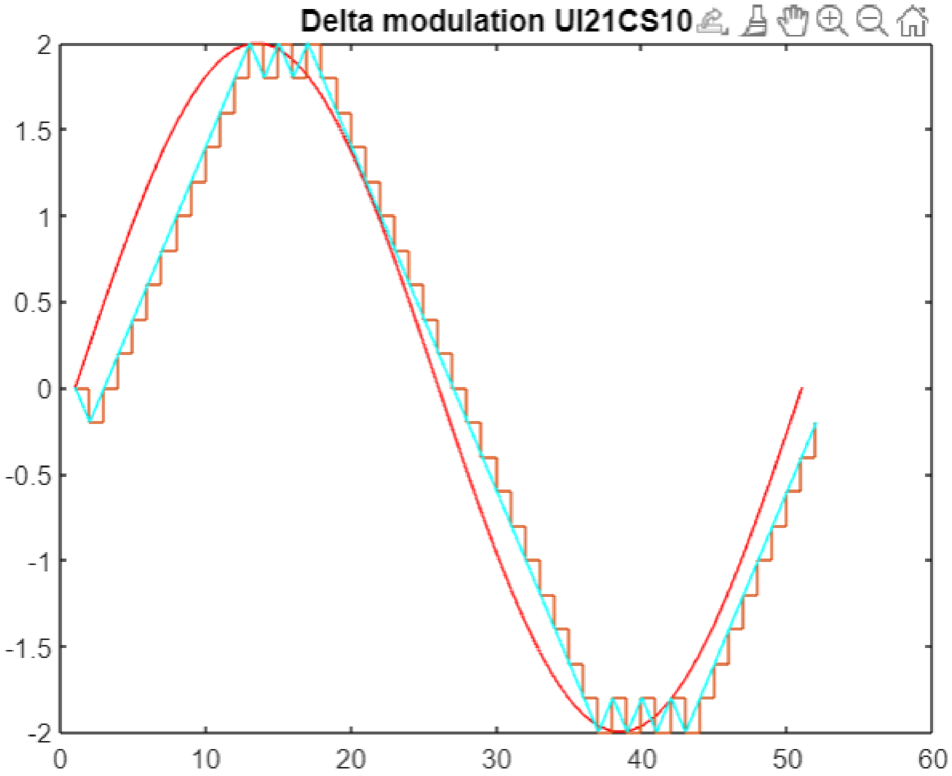
AIM:-The study And emplemnt the delta modulation

CODE:

```
clc;
clear all;
close all;
a=2;
t=0:2*pi/50:2*pi;
x = a*sin(t);
l = length(x);
plot(x,'r');
title('Delta modulation UI21CS10');
delta = 0.2;

hold on
xn = 0;
for i=1:l
if x(i)> xn(i)
d(i) = 1;
xn(i+1) = xn(i)+delta;
else
d(i) = 0;
xn(i+1)= xn(i)-delta;
end
end
stairs(xn)
hold on
for i=1:d
if d(i)>xn(i)
d(i) = 0;
xn(i+1) = xn(i)-delta;
else
d(i) = 1;
xn(i+1) = xn(i)+delta;
end
end
```

```
plot(xn,'c');
```

OUTPUT:

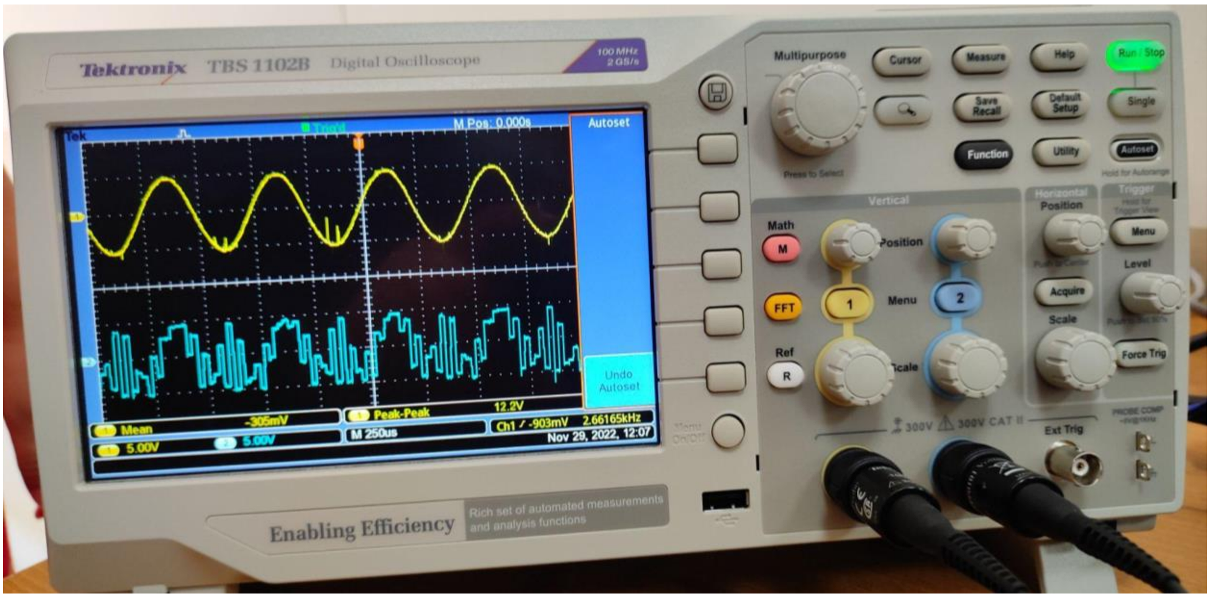


EXPERIMENT 10

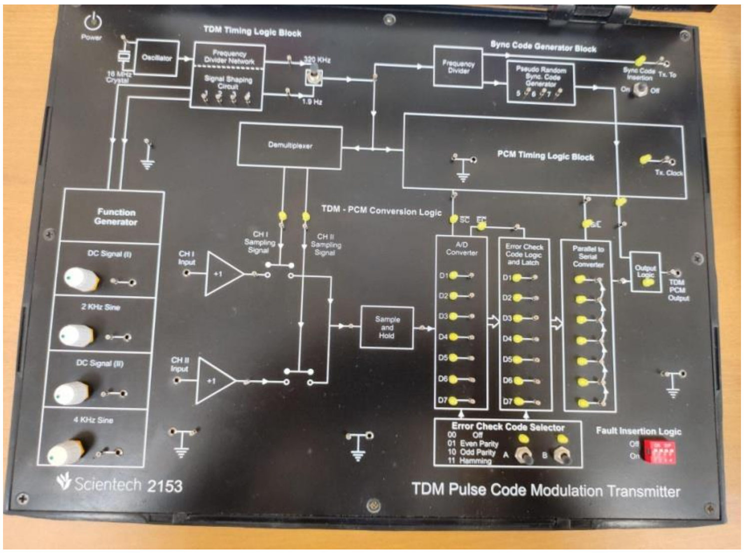
AIM:-The study construction and execution of PCM and PCM-TDM signals using Transmission and Reciever kit.

APPARATUS:-

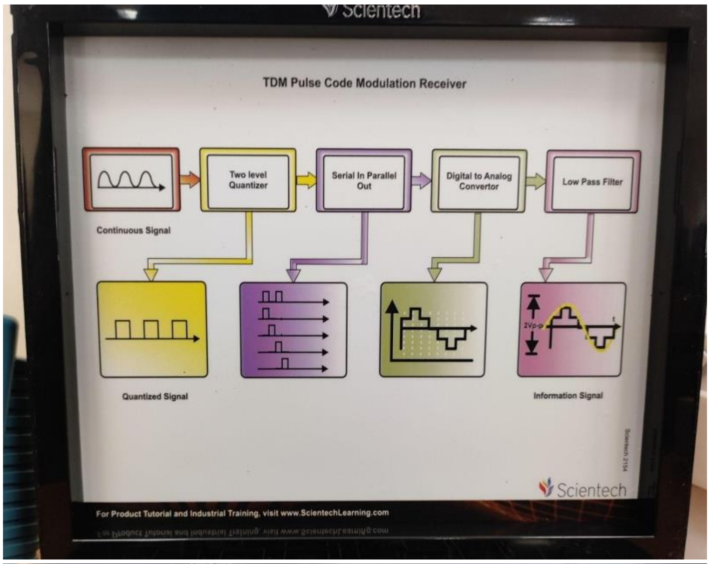
1.OSCILLOSCOPE

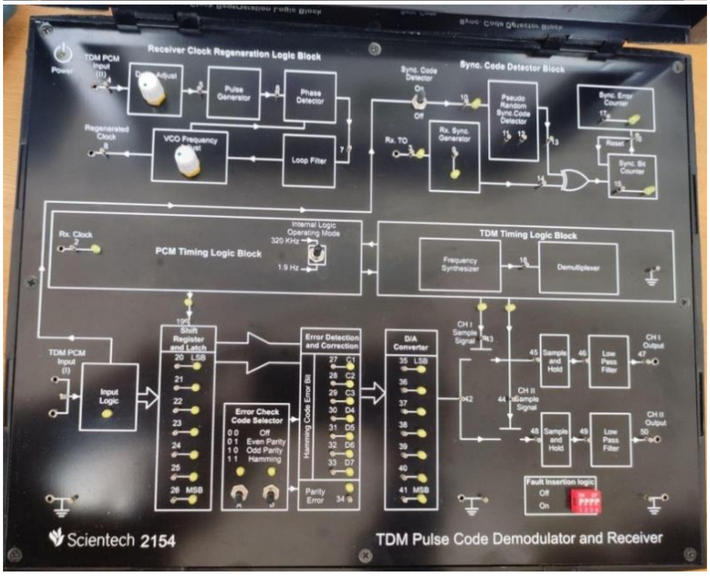


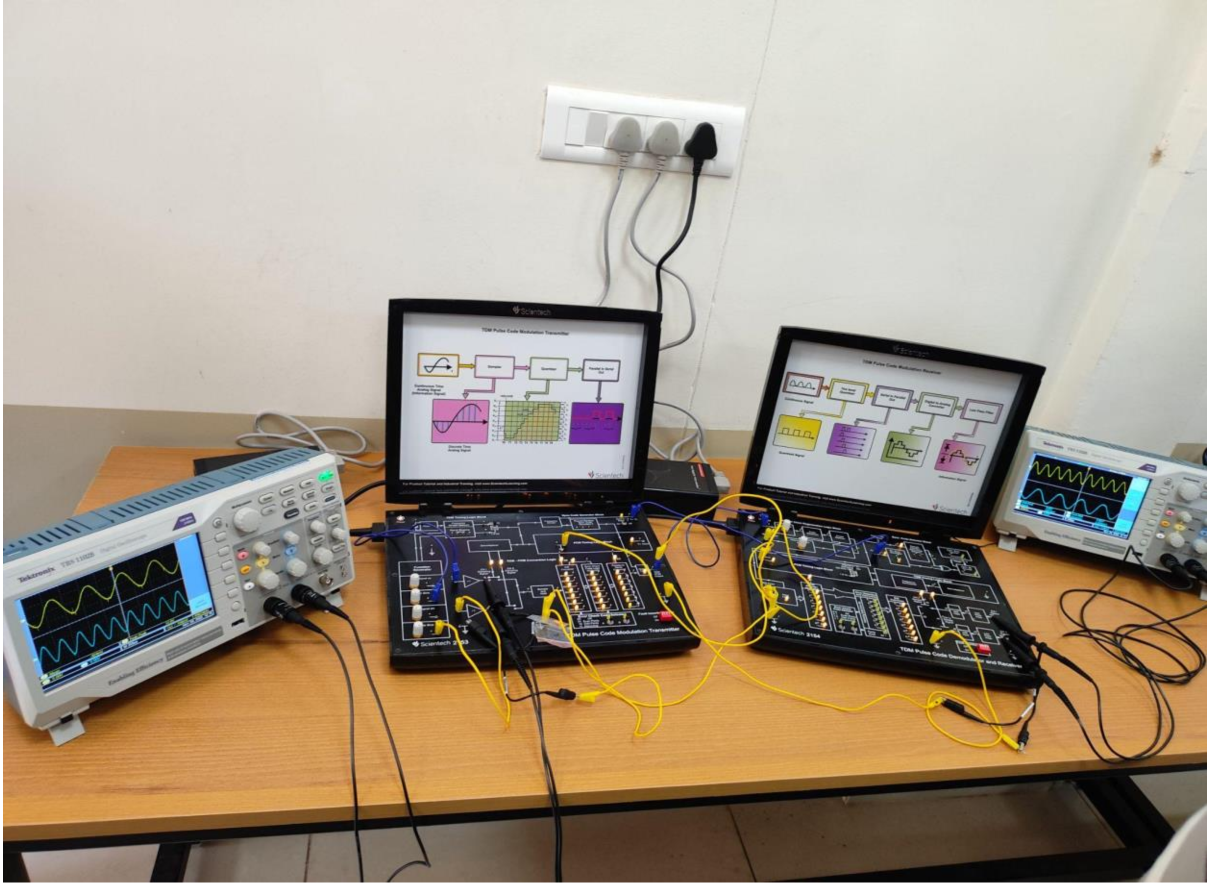
2. PCM-TDM TRANSMITTER:-



3.TDM DECODER and DEMODULATOR KIT:-

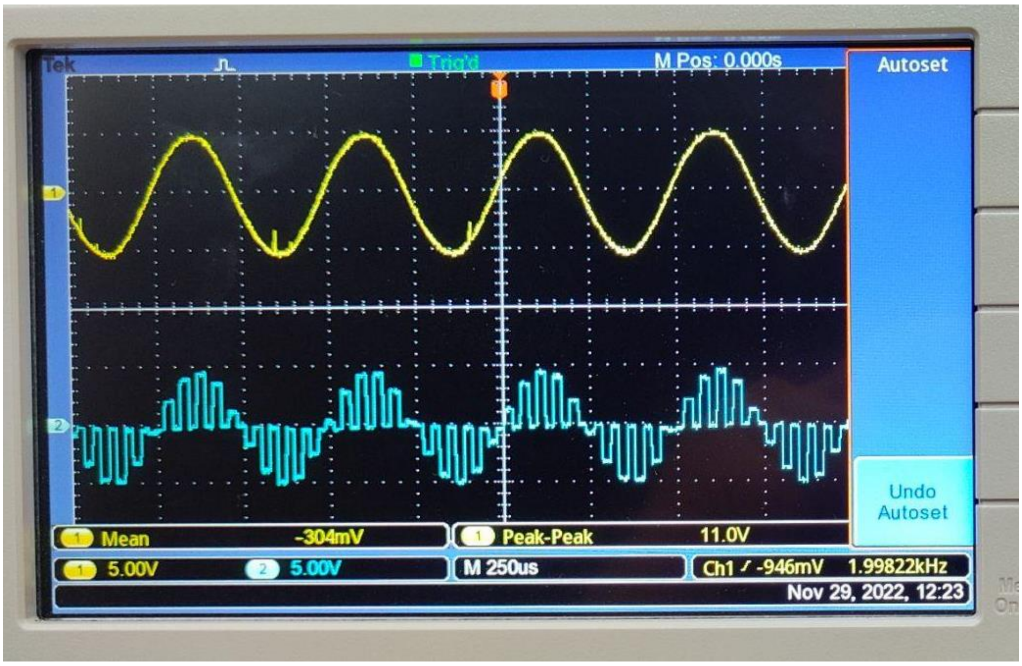




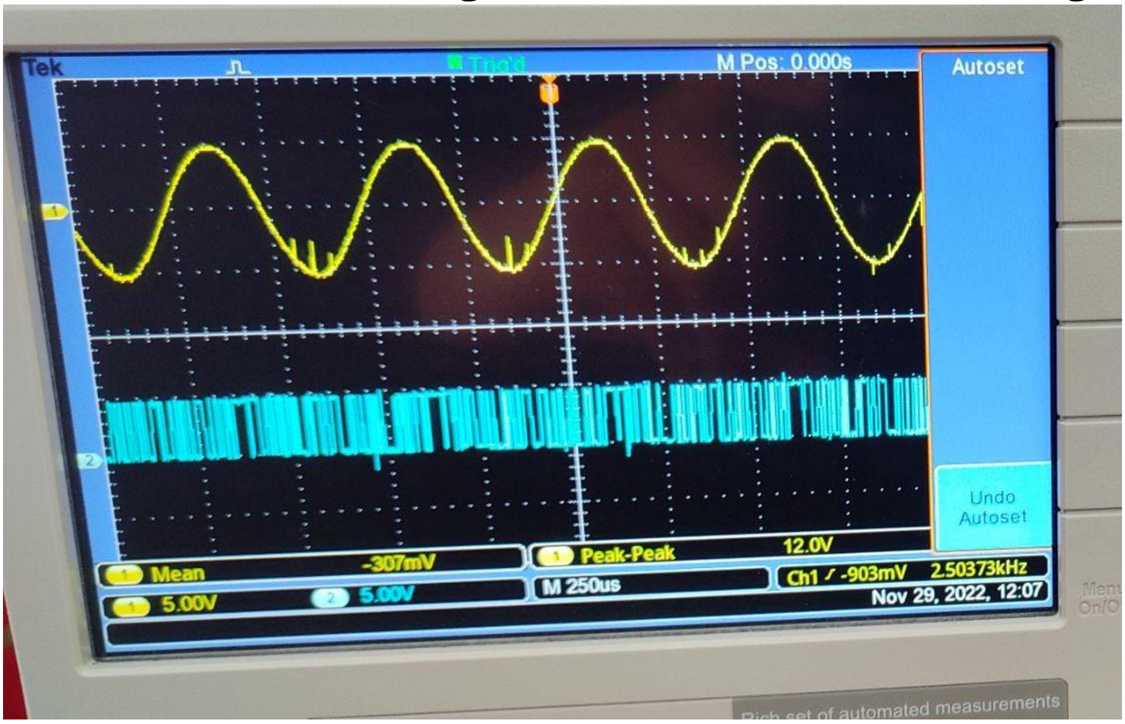


OBSERVATION: (PCM TX –RX)

MESSAGE Signal(2KHz) and its SAMPLED OUTPUT Signal:-

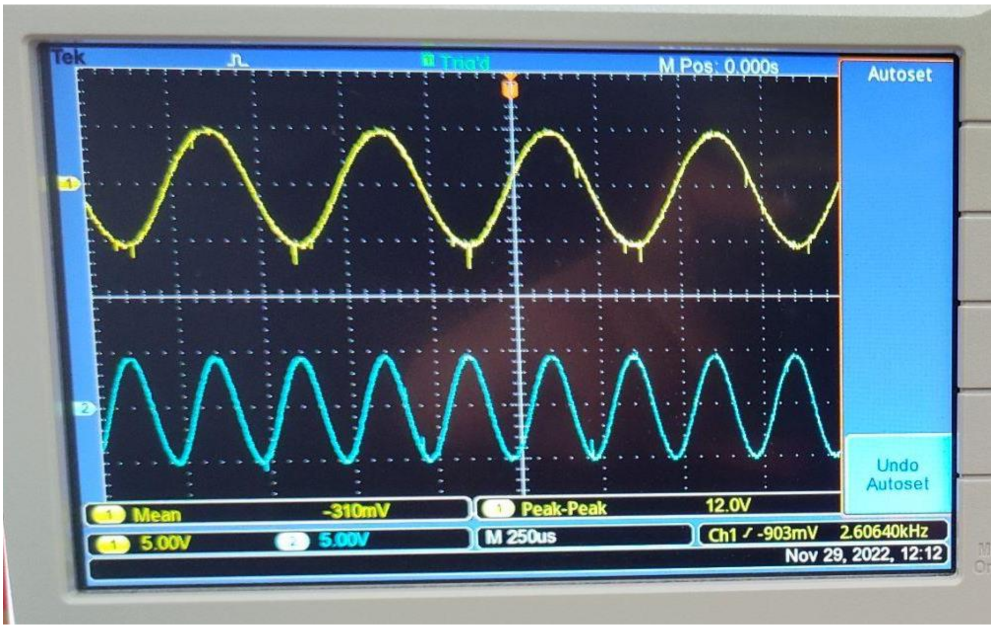


RECONSTRUCTED Signal and RECIEVED PCM Signal:-

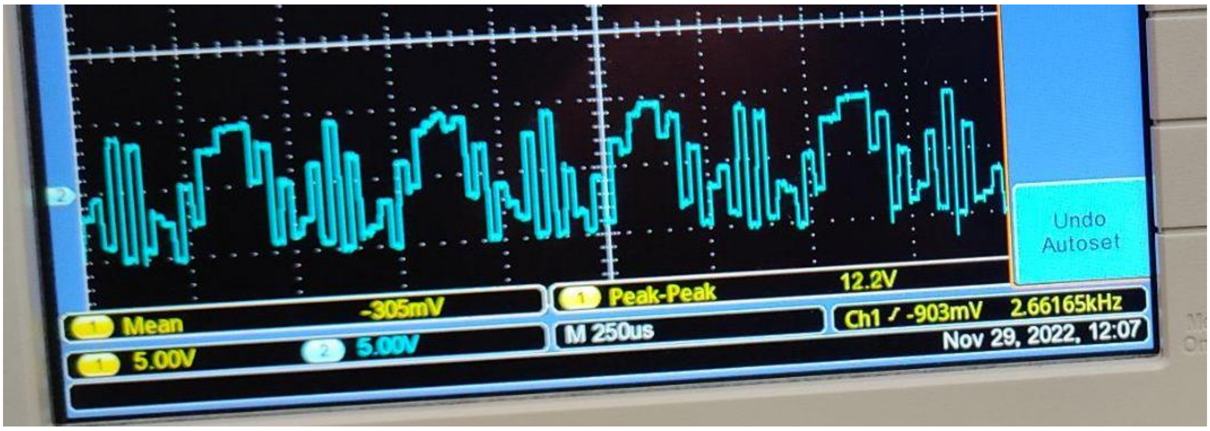


OBSERVATION: (PCM-TDM TX –RX)

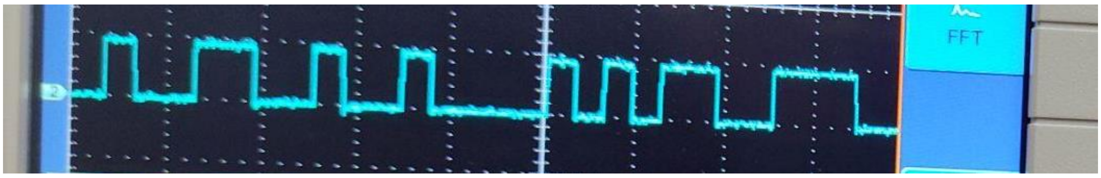
TWO MESSAGE SIGNAL (2KHz and 4KHz):-



TDM SAMPLED SIGNAL for both the SIGNALS (2KHz&4KHz):-



PCM Signal and RECONSTRUCTED Signal:-



TDM RECONSTRUCTED SIGNAL (2KHz and 4KHz):-

CONCLUSION:-

We learned how to createe ,transmit and recieve PCM,PCM-TDM signaal using TDM Transmission and Recieving Kit.