GOVT. OF NCT OF DELHI

AMBEDKAR INSTITUTE OF TECHNOLOGY

SHAKARPURDELHI

DATA COMMUNICATIONPRACTICAL

Submitted To: Rakesh Nath Tiwari

Student's Name: Anshu

Roll No.: 1902051012

Branch: Computer Engineering

Semester: 4th

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Name Anshu 1902051012 Std. CE 4th Sem

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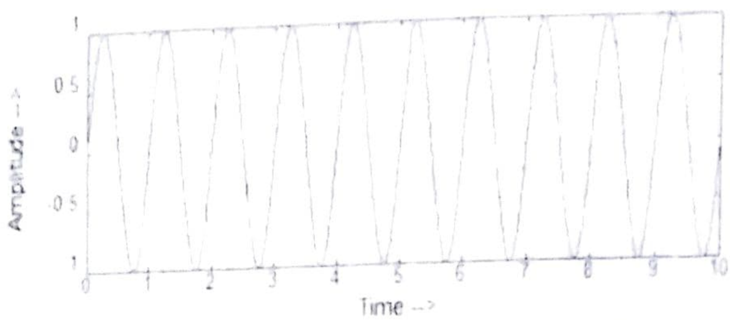
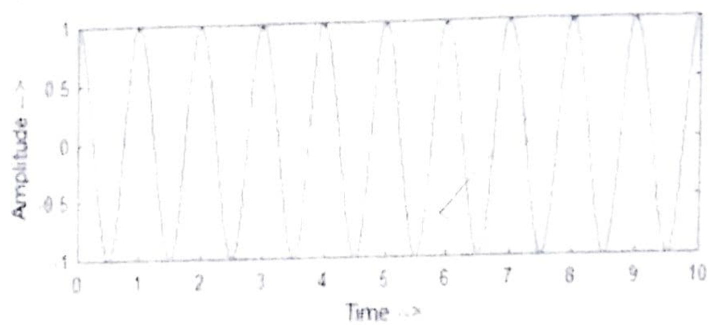
Select

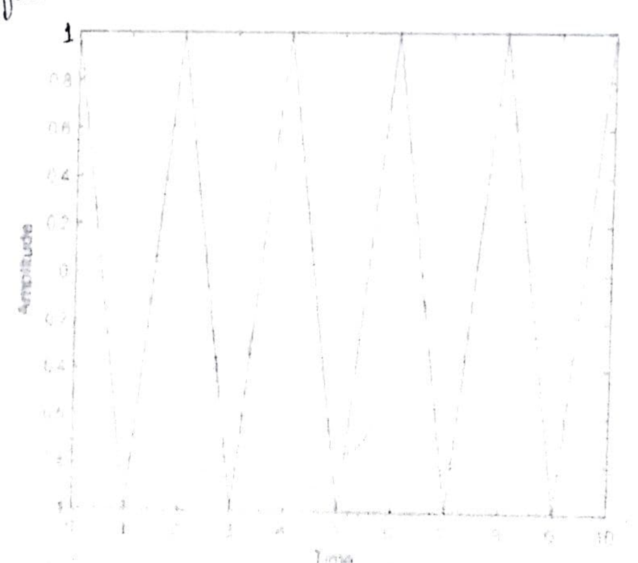
Output: Sine wave



Cosine wave:



Triangular wave



Experiment : 1

Date 29/1/2021

Page No. 1

Aim - To generate waveform(sine, cosine, triangular & square).

Software used - MATLAB R2015a

Code: -

To generate sine wave -

```
t = 0:.01:10;
y = sin(2*pi*t);
subplot(2,1,2); plot(t,y);
ylabel('Amplitude-->');
xlabel('Time-->');
```

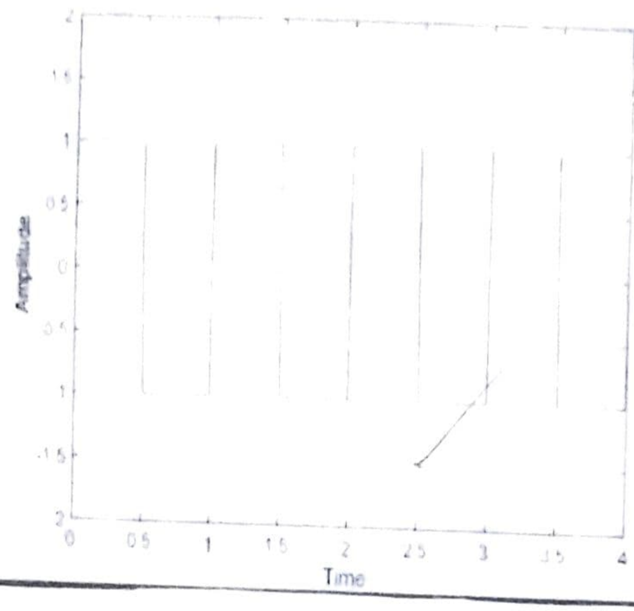
To generate cosine wave -

```
t = 0:.01:10;
y = cos(2*pi*t);
subplot(2,1,2); plot(t,y);
ylabel('Amplitude-->');
xlabel('Time->');
```

To generate triangular wave -

```
t = 0:10;
y = (-1).^t;
plot(t,y);
xlabel('Time->');
ylabel('Amplitude->');
```

Square wave:



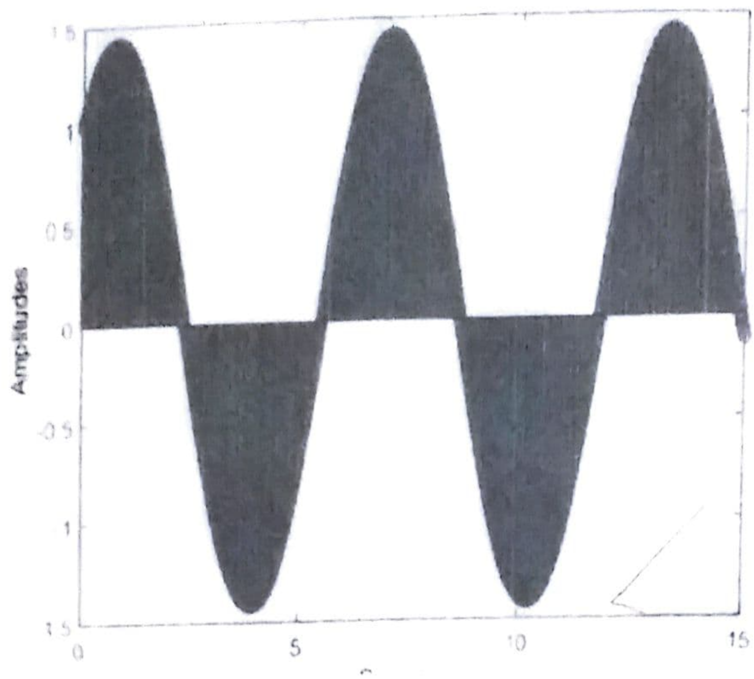
Experiment :

To generate square wave -

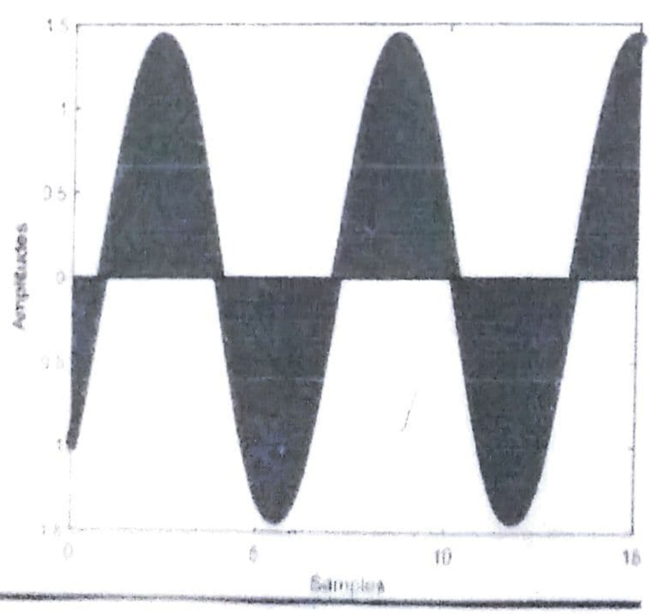
```
t= 0:0.01:4;
y = square(2*pi*t,50);
plot(t,y);
axis([0 4 -2 2]);
xlabel('Time ->');
ylabel('Amplitude ->');
title('Square Waveform');
```

Result - Generation of sine, cosine, triangular & square wave has been successfully done and it has been successfully verified.

Addition of sine and cosine wave:



Subtraction of sine and cosine wave



Experiment : 2

Date 29/01/2021

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Aim - To design adder, subtractor and multiplication of two sinusoidal signal using MATLAB.

Code -

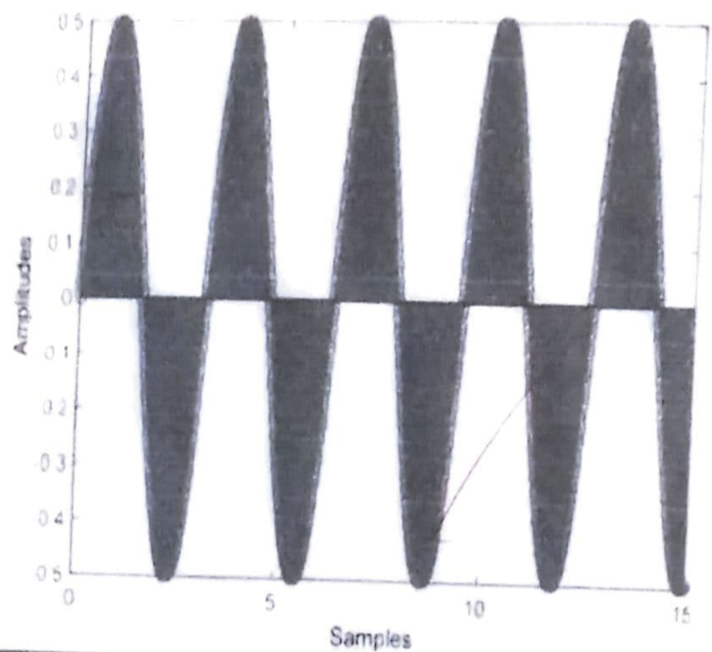
To add two sine and cosine wave.

```
disp('sinusoidal signal generator');
N=input('Enter no of sample');
n = 0:0.01:N;
x = sin(n);
y = cos(n);
z = x+y;
figure, stem(n,z);
xlabel('samples');
ylabel('Amplitudes');
```

To subtract sine and cosine wave -

```
disp('sinusoidal signal generator');
N= input('Enter no of sample');
n= 0:0.01:N;
x= sin(n);
y= cos(n);
z = x-y;
figure, stem(n,z);
xlabel('samples');
ylabel('Amplitude');
```

Multiplication of sine and cosine wave:



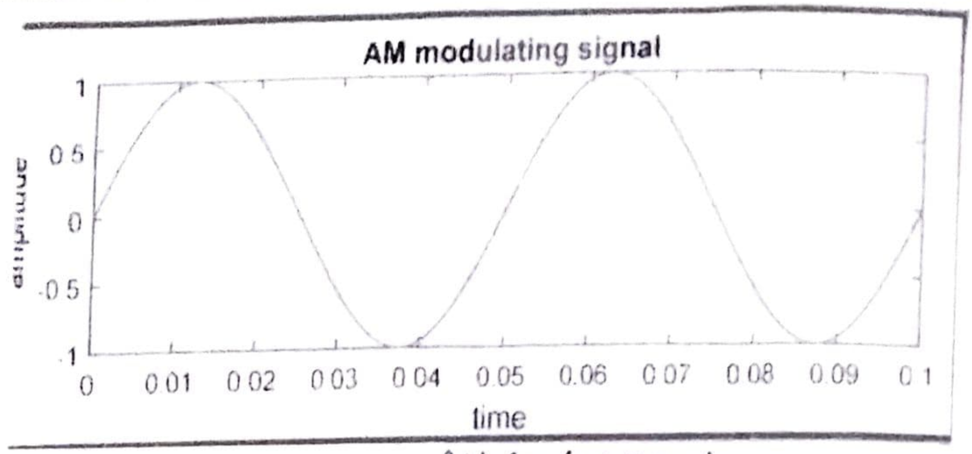
Experiment : Date ....

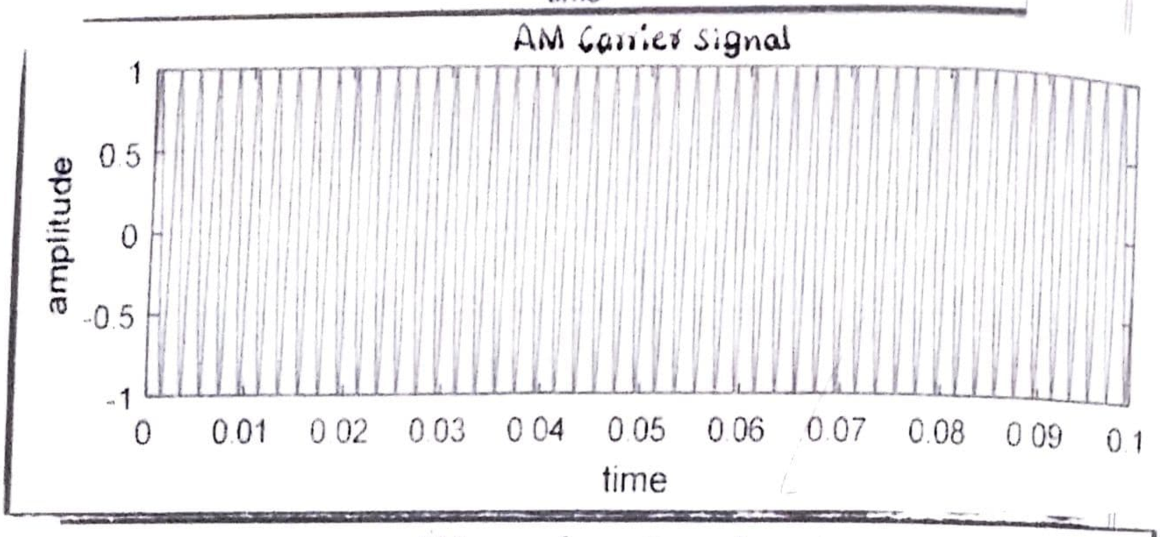
To multiply ~~sin~~ sine and cosine wave -

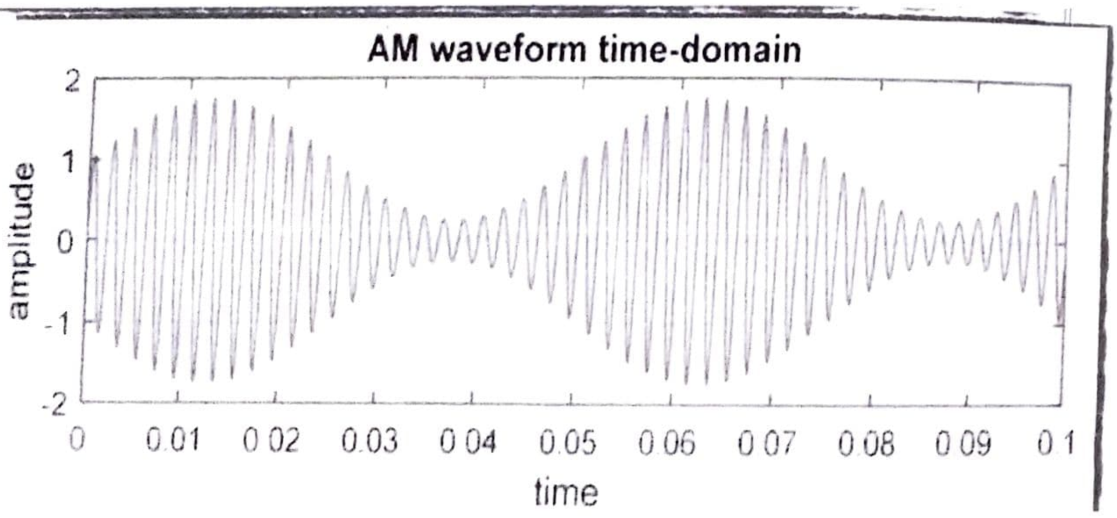
```
disp('sinusoidal signal generator');
N= input ('Enter no. of sample.');
n= 0:0.01:N;
x= sin(n);
y= cos(n);
z= x.*y;
figure, stem(n,z);
xlabel ('samples');
ylabel ('Amplitude');
```

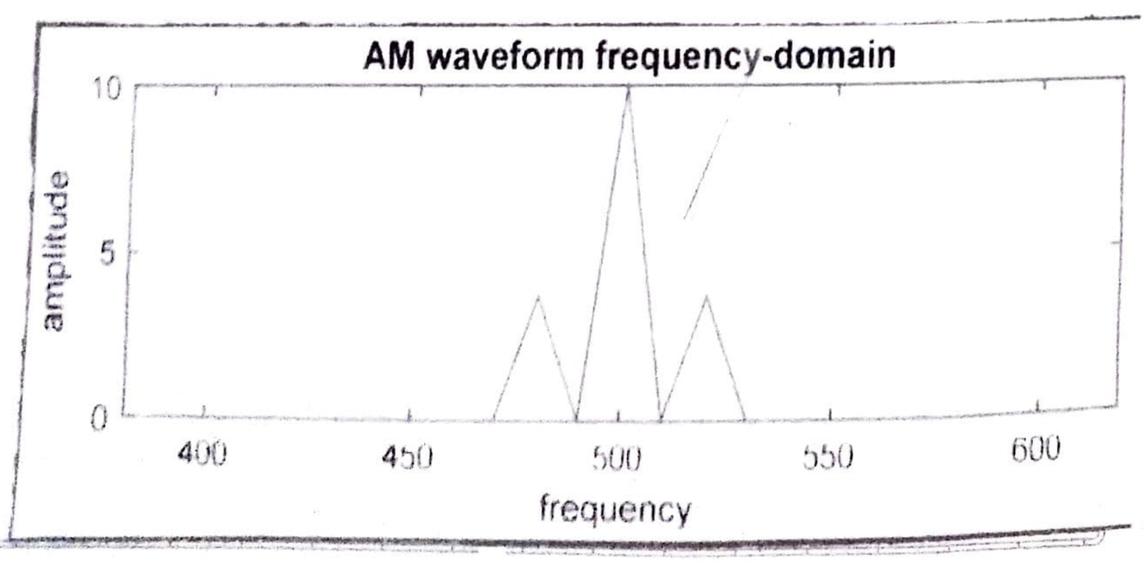
No. of samples = 15 for each case.

Result - Addition, subtraction and multiplication of sine wave and cosine wave have been successfully done.


AM modulating signal
1
0.5
0
-0.5
-1
0 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.1
time


AM Carrier Signal
amplitude
1
0.5
0
-0.5
-1
0 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.1
time


AM waveform time-domain
amplitude
2
1
0
-1
-2
0 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.1
time

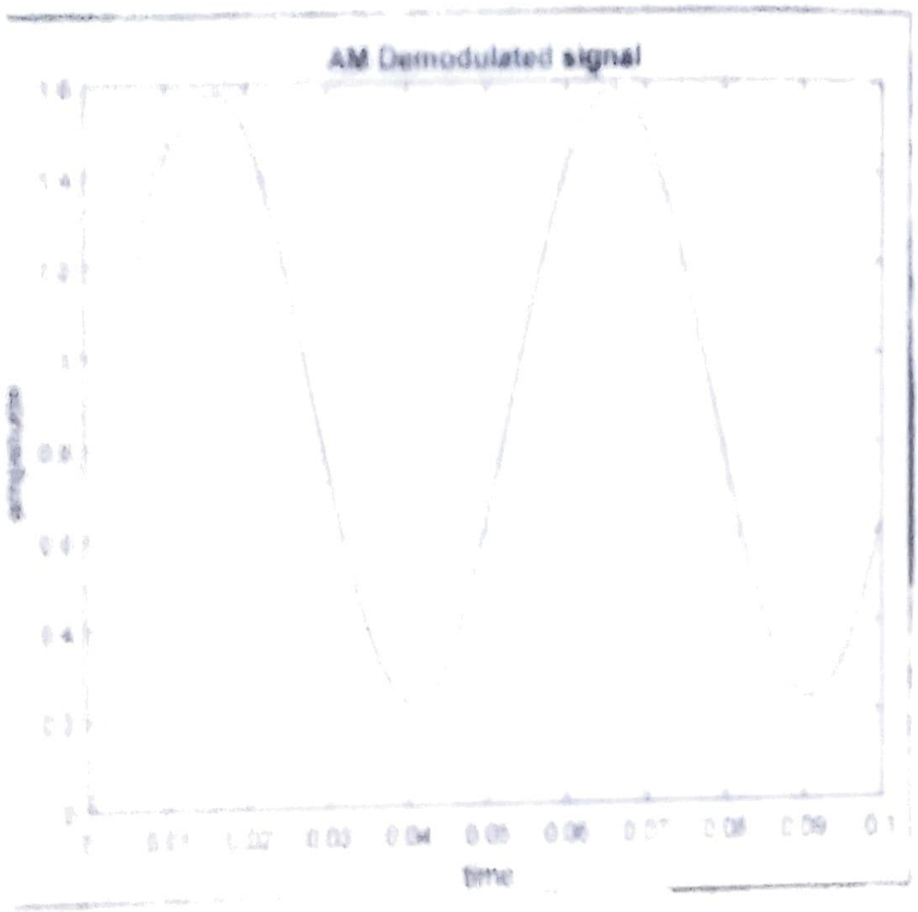

AM waveform frequency-domain
amplitude
10
5
0
400 450 500 550 600
frequency

Aim - To study the Amplitude Modulated signal, Demodulated signal (using synchronous detector) and spectrum of AM signal using MATLAB code.

Software Used - MATLAB R2015a

Code -

```
fm = 20;
fc = 500;
vm = 1;
Vc = 1;
mu = 0.75;  % Modulation Index
% x-axis : Time (second)
t = 0:0.00001:0.0999;
f = 0:1:9999;
% y-axis : Voltage (volt)
V1 = vc + mu* sin(2*pi*fm*t);  % upper envelop
V2 = -(vc + mu*sin(2*pi*fm*t));  % lower envelop
Vm = vm* sin(2*pi*fm*t);
Vc = vc* sin(2*pi*fc*t);
Vam = vc*(1+ mu* sin(2*pi*fm*t)).*(sin(2*pi*fc*t)); %AM signal
Vr = Vam.*Vc;  % synchronous detector
y = abs(fft(Vam, 10000))/500;  % Spectrum
[b a] = butter(3,0.002);
out = filter(b,a,Vr);
% Plot modulating, carrier signal
figure(1);
subplot(211)
plot(t,Vm);
title('AM modulating signal');
```


AM Demodulated signal
time

Experiment

Date

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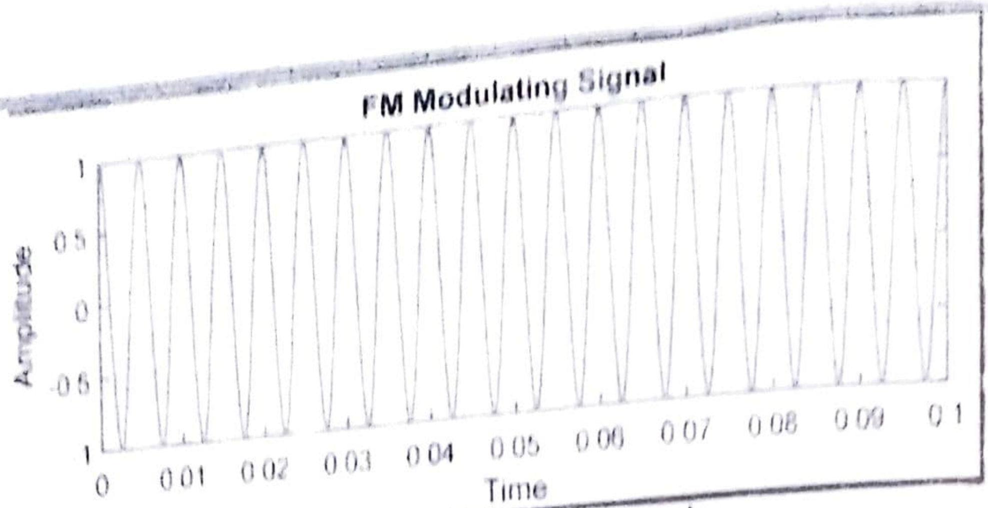
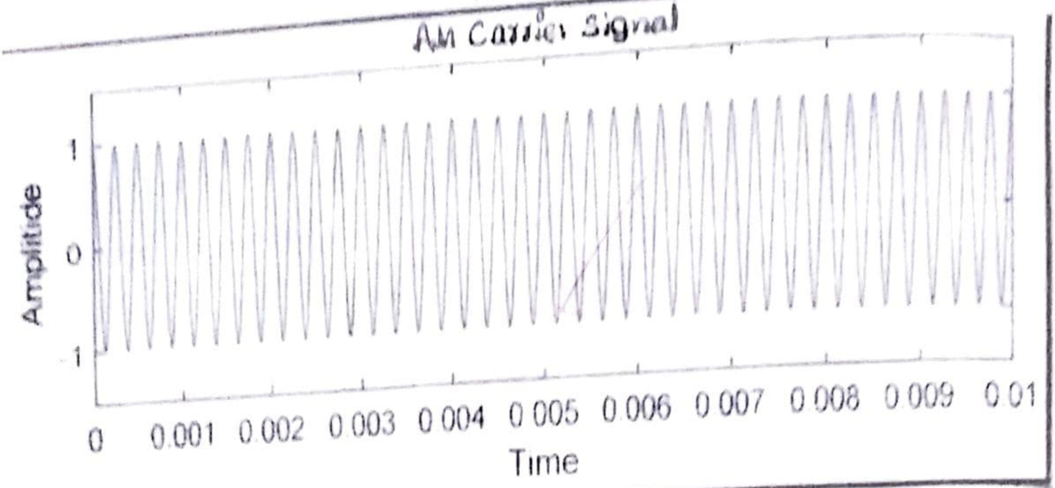
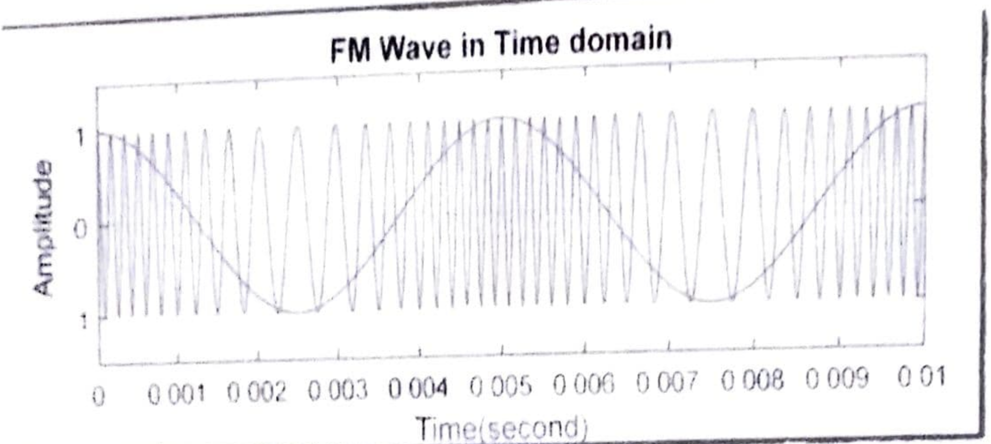
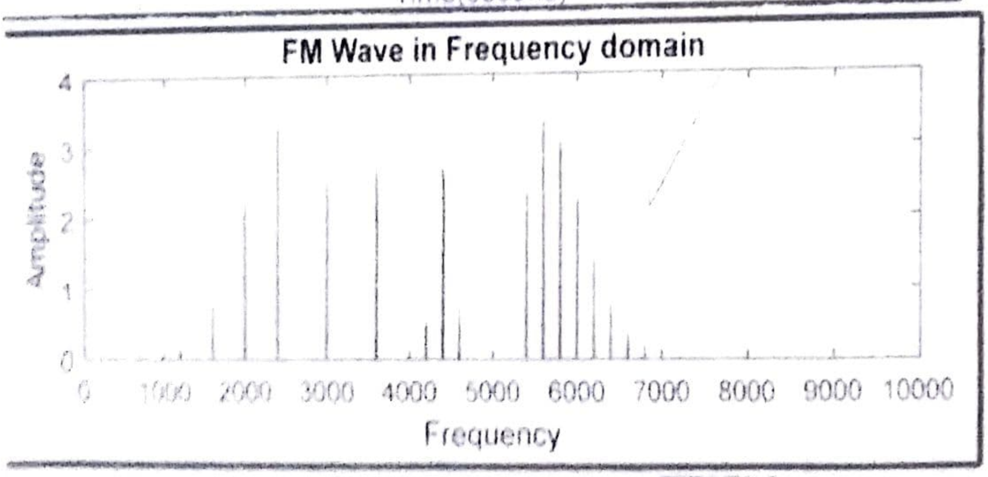
```
xlabel('time'), ylabel('amplitude'); grid on;
subplot(2,2)
plot(t,vc);
title('AM carrier signal');
xlabel('time'), ylabel('amplitude'); grid on;
% Plot AM in time domain and frequency domain
figure(2);
subplot(2,1)
plot(t,Vam);
title('AM waveform time-domain');
xlabel('time'), ylabel('amplitude'); grid on;
subplot(2,2)
plot(f*10,vf);
axis([(fc-6*fm) (fc+6*fm) 0 10]);
title('AM waveform frequency domain');
xlabel('frequency'), ylabel('amplitude'); grid on;
figure(3)
plot(t,1.81*out);
title('AM Demodulated signal');
xlabel('time'); ylabel('amplitude'); grid
```


FM Modulating Signal
Amplitude
1
0.5
0
-0.5
-1
0 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.1
Time


AM Carrier Signal
Amplitude
1
0
-1
0 0.001 0.002 0.003 0.004 0.005 0.006 0.007 0.008 0.009 0.01
Time


FM Wave in Time domain
Amplitude
1
0
-1
0 0.001 0.002 0.003 0.004 0.005 0.006 0.007 0.008 0.009 0.01
Time(second)

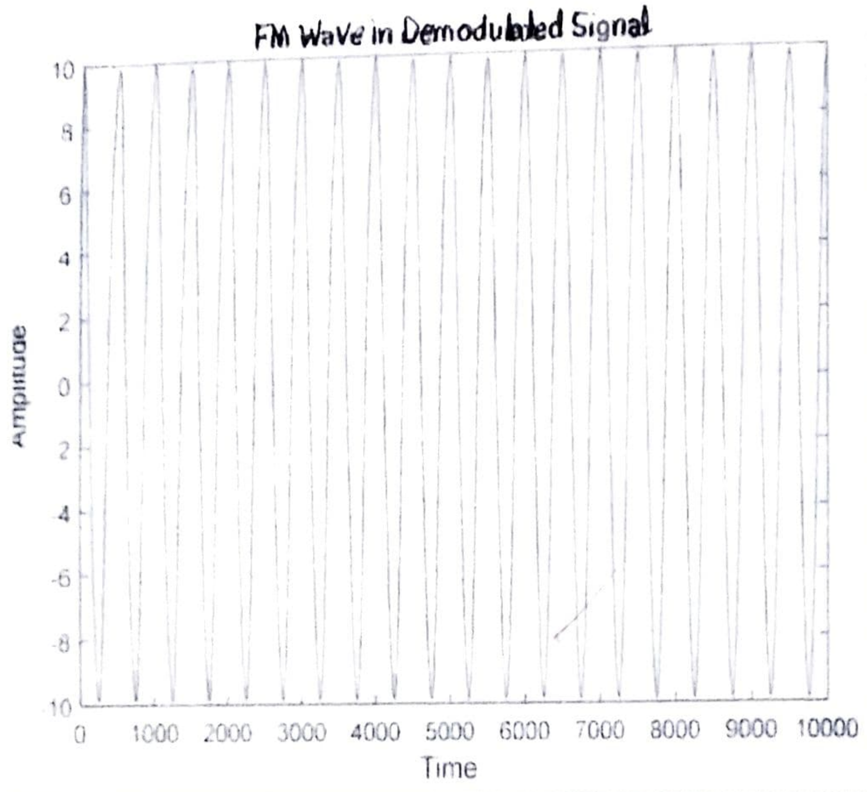

FM Wave in Frequency domain
Amplitude
4
3
2
1
0
0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000
Frequency

Aim- To study the Frequency Modulated (FM) signal, spectrum of FM signal and FM demodulated signal using MATLAB.

Software used - MATLAB R2015a

Code -

```
%Frequency modulation (FM) signal in time domain and frequency
domain.
% fm= 200Hz;.
vc = 1;
vm = 1;
fm = 200;
fc = 4000;
m = 10;
Kf. = 120;
t = 0:0.00001:0.09999;
carrier = vc*cos(2*pi*fc*t);
massage = vm*cos(2*pi*fm*t);
FM = vc* cos((2*pi*fc*t) + 10*sin(2*pi*fm*t)); %FM wave
dem=(1/2*pi*10)*diff(10*sin(2*pi*fm*t))/0.2; %demodulating PLL
vf =(fft(FM,10^4))/500;
figure(1);
subplot(211); plot(t,messag);
xlabel('Time'); ylabel('Amplitude');
title('FM modulating signal');
grid on;
subplot(212); plot(t,carrier);
xlabel('Time'); ylabel('Amplitude');
axis([0 0.01 -1.5 1.5]);
title('FM Carrier Signal')
```

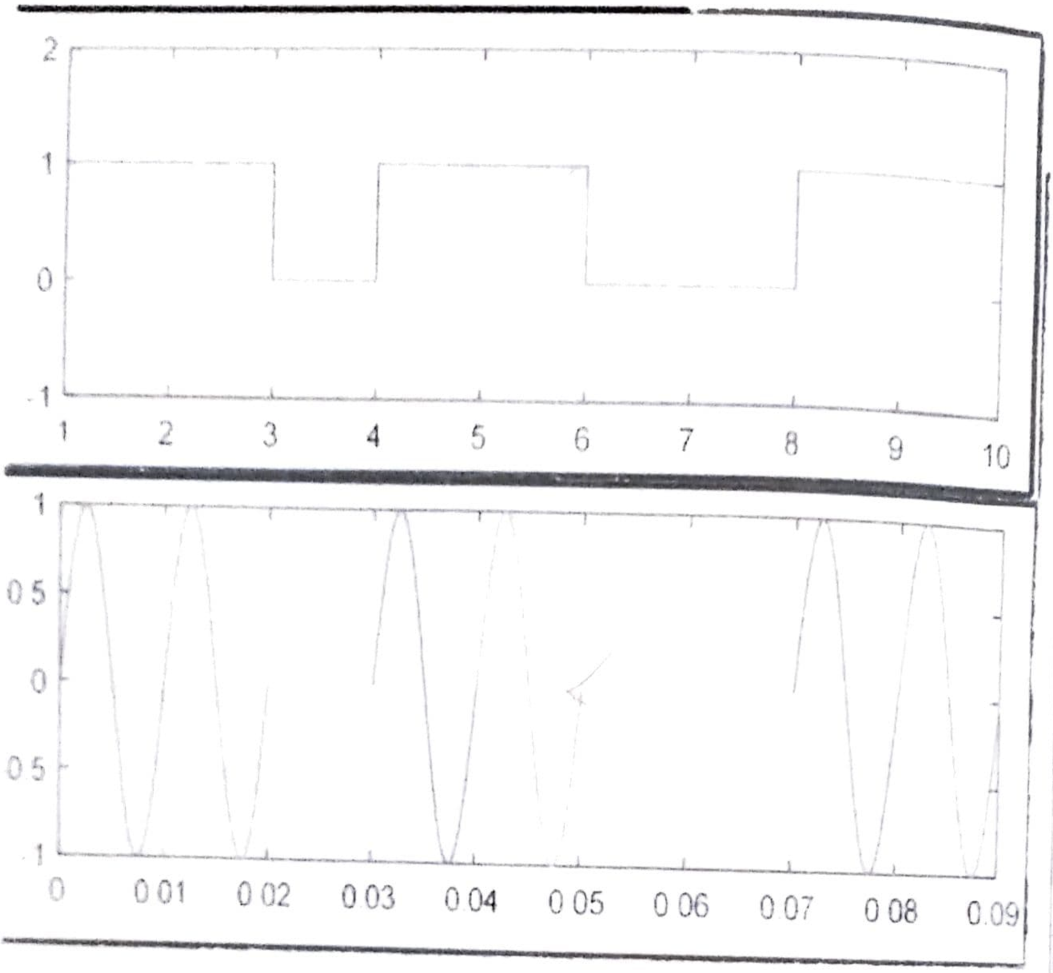


FM Wave in Demodulated Signal
Amplitude
10
8
6
4
2
0
-2
-4
-6
-8
-10
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
Time

Experiment :

Date ....


```
gridon;
figure(2);
subplot(211); plot(t, FM); hold on;
plot(t, message, 'r');
axis([0, 0.01 -1.5 1.5]);
xlabel('Time (second)'); ylabel('Amplitude');
title('FM wave in time domain');
grid on;
subplot(212);
plot(f, vf);
axis([0 10^4 0 4]);
xlabel('frequency'); ylabel('Amplitude');
title('FM wave in frequency domain');
grid on;
figure (3);
plot dem;
xlabel('Time'); ylabel('Amplitude');
title('FM wave in frequency domain');
grid on;
figure(3);
plot(dem);
xlabel('Time'); ylabel('Amplitude');
title('FM wave in Demodulated signal');
grid on;
```


2
1
0
-1
1
2
3
4
5
6
7
8
9
10
1
0.5
0
-0.5
-1
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09

Experiment : 5

Date 2/02/2021

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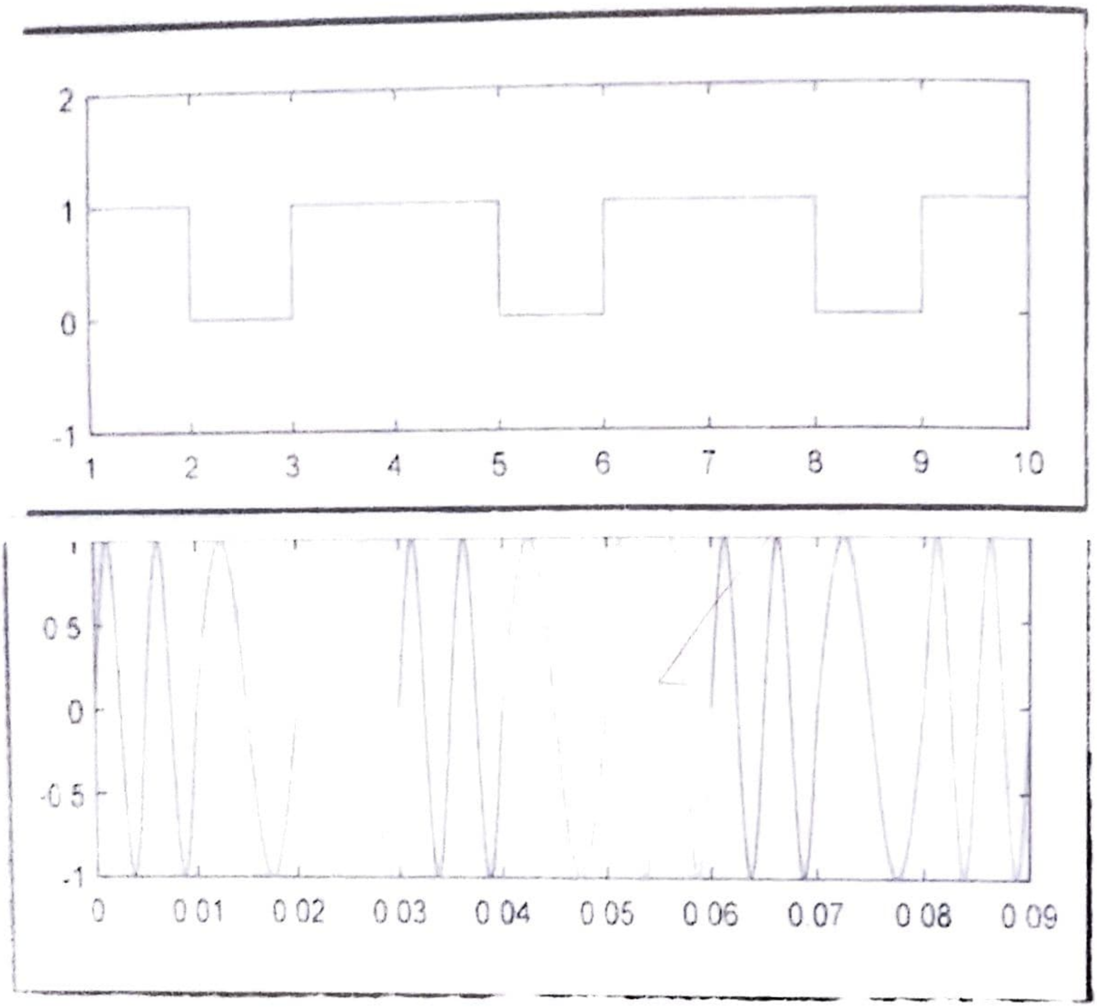
Aim - To design ASK using MATLAB.

Software Used - MATLAB R2015a

Code :

```
f=100; t= 0:1/(100*f):1/f; x= rand(1,100);
for i=1:10
    if x(i)<0.5;
        x(i)=0;
    else
        x(i)=1;
    end
end
subplot(2,1,1); stairs(x);
axis([1,10,-1,2])
for i=1:10
    if x(i)==1
        subplot(2,1,2);
        plot(t,sin(2*pi*f*t));
        axis([0,0.09,-1,1]);
    else
        x(i)=0;
        plot(0);
    end
    hold on;
    t = t+1/f;
end
```

Result - The ASK signals have been successfully verified



2
1
0
-1
1 2 3 4 5 6 7 8 9 10
1
0.5
0
-0.5
-1
0 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09

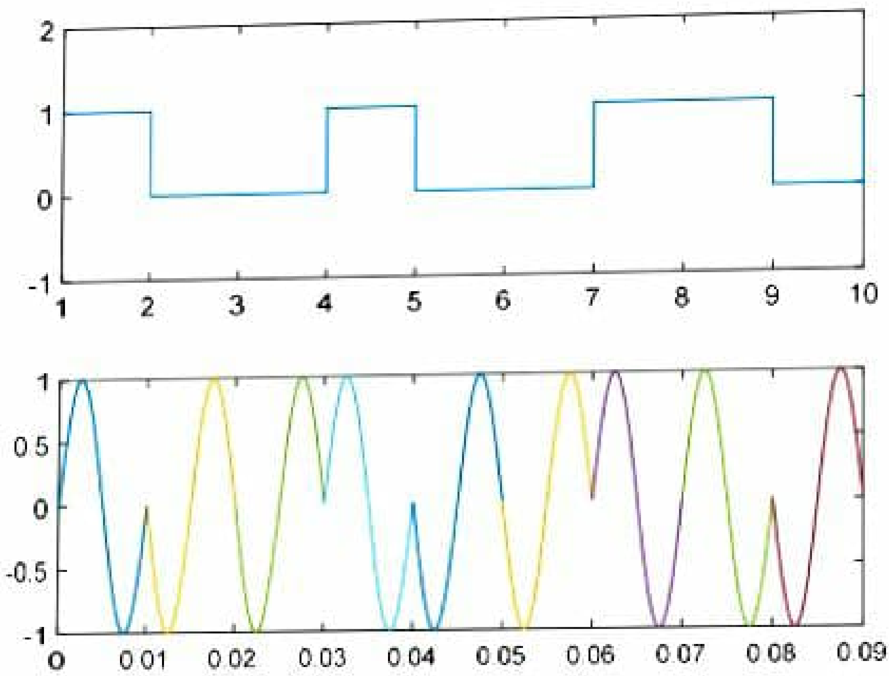
Aim: To design FSK signal using MATLAB

Software Used: MATLAB R2015a

Code

```
clear;
f= 100; t= 0:1/(100*f):1/f ; x= rand(1,1000);
for i= 1:10
    if x(i) < 0.5 ;
        x(i) =1;
    else
        x(i) = 0;
    end
end
subplot(2,1,1);
stairs(x);
axis([1,10,-1,2])
for i=1:10
    if x(i)==1
        subplot(2,1,2);
        plot(t, sin(4*pi*f*t));
        axis([0 0.09 -1 1]);
    else
        subplot(2,1,2)
        plot(t, sin(2*pi*f*t));
        axis([0 0.09 -1 1]);
    end
    hold on;
    t= t+1/f;
end
```

Result - The FSK signals have been successfully realized.



2
1
0
-1
1
2
3
4
5
6
7
8
9
10
1
0.5
0
-0.5
-1
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09

Experiment : 7.

Date 8/03/2021

Page No.

Aim - To design PSK signal using MATLAB.

Software Used - MATLAB R2015a

MATLAB Code -

```
%% PSK Signal %%
clear;
f=100; t=0:1/(100*f):1/f; x= rand(1,15);
for i= 1:15
if x(i)<0.5;
      x(i) = 0;
else
      x(i) =1;
   end
 end
subplot(2,1,1);
stairs(x);
axis([1,10,-1,2])
for i= 1:15
if x(i)= =1
subplot(2,1,2);
plot(t, sin(2*pi*f*t));
axis([0,0.09,-1,1]);
else
 x(i) =0;
 plot(0),
 plot(t, -sin(2*pi*f*t));
end
hold on;
t= t+1/f;
end
```

Experiment : 8

Date 22/03/2022

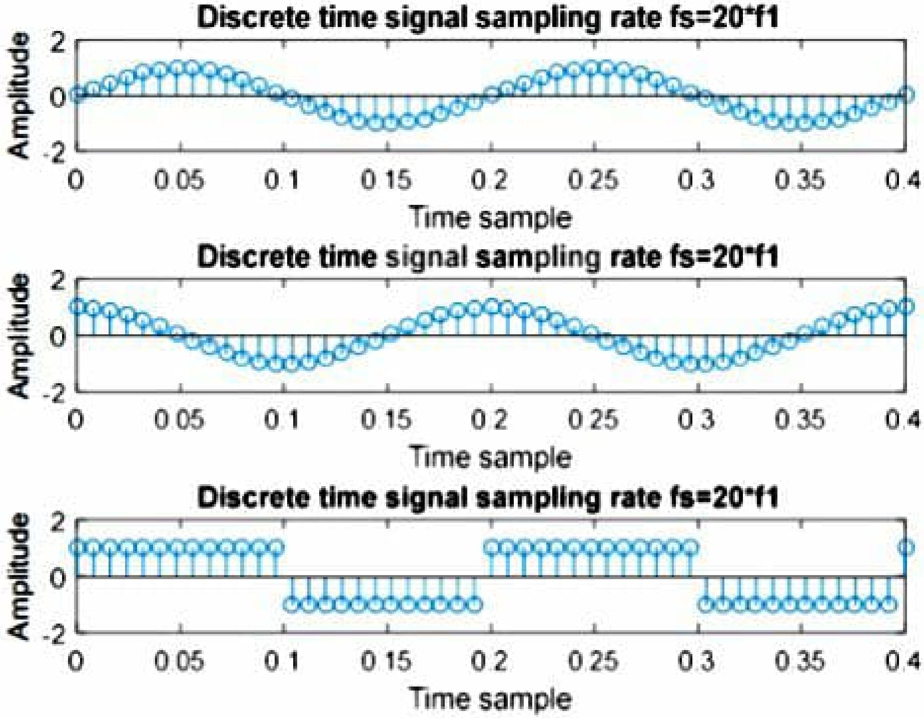
Page No.

Aim - Write a MATLAB program to implement Time Division Multiplexing (TDM) and demultiplexing.

Software Used - MATLAB R2015a

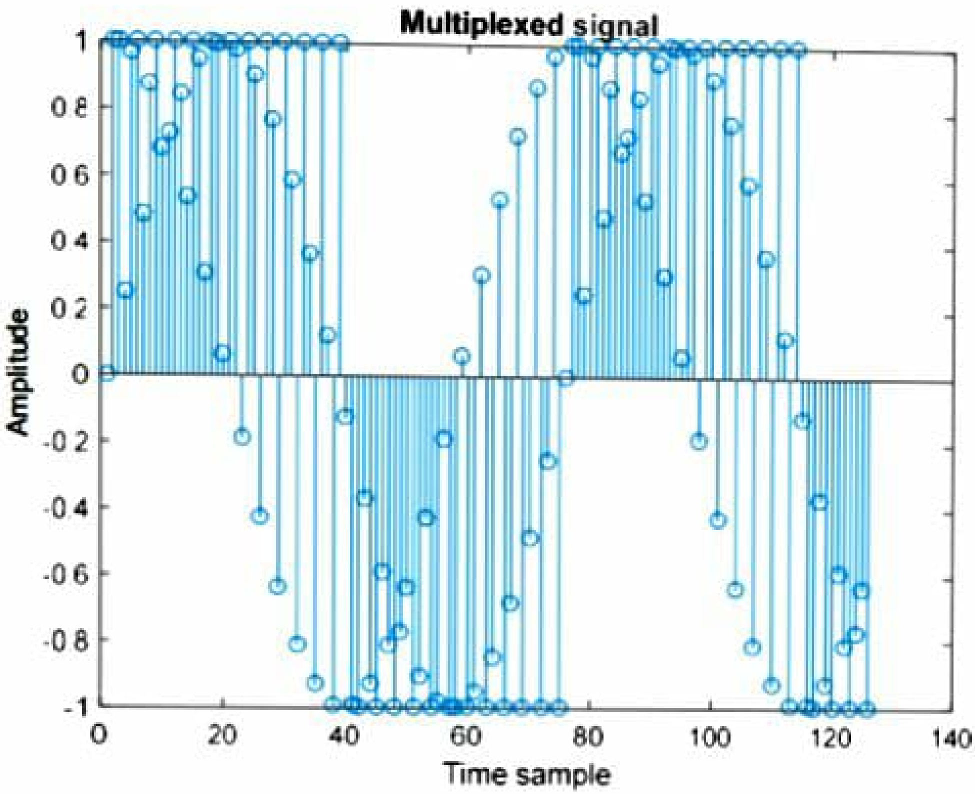
MATLAB Code -

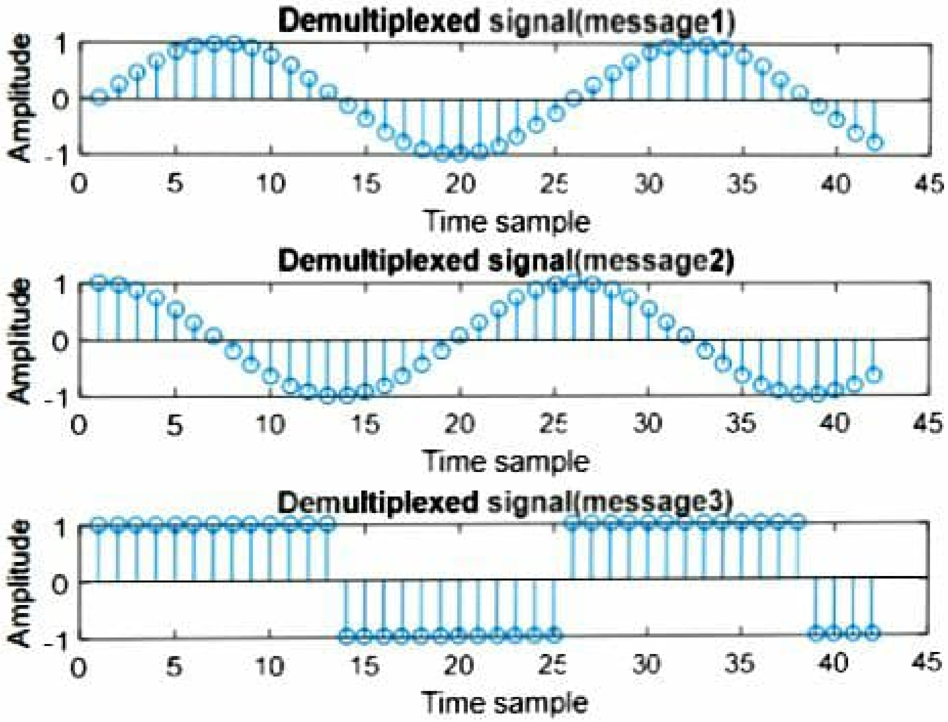
```
clc;
t = -5:0.0001:5;
f1 = 5;
%% Message signals %%
%% 1 %%
fs1 = 25*f1;
ts1 = 1/fs1;
n1 = 0:ts1:0.4;
message1 = sin(2*pi*f1*n1);
%% 2 %%
fs2 = 25*f1;
ts2 = 1/fs2;
n2 = 0:ts2:0.4;
message2 = cos(2*pi*f1*n2);
%% 3 %%
fs3 = 25*f1;
ts3 = 1/fs3;
n3 = 0:ts3:0.4;
message3 = square(2*pi*f1*n3);
%% Multiplexing %%
k = 1
for i = 1:3:125
multiplex(i) = (message1(k));
multiplex(i+1) = (message2(k));
```


Discrete time signal sampling rate fs=20*f1
Amplitude
2
0
-2
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
Time sample
Discrete time signal sampling rate fs=20*f1
Amplitude
2
0
-2
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
Time sample
Discrete time signal sampling rate fs=20*f1
Amplitude
2
0
-2
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
Time sample

Experiment : Date .... Page No. ....

```
multiplex(i+2) = (message.3(k));
K = k+1;
end
%% Demultiplexing %%
q = 1;
for p = 1:1:125
if (q< 125)
demul1(p) = multiplex(q);
demul2(p) = multiplex(q+1);
demul3(p) = multiplex(q+2);
q = q+3
end
end
figure(1)
subplot(311); stem(n1, message1)
axis([0 0.4 -2 2])
xlabel('Time sample'); ylabel('Amplitude');
title('Discrete time signal sampling rate fs = 20*f1');
subplot(312); stem(n2, message2)
axis([0 0.4 -2 2])
xlabel('Time sample'); ylabel('Amplitude');
title('Discrete time signal sampling rate fs = 20*f1');
subplot(313); stem(n1, message3)
axis([0 0.4 -2 2])
xlabel('Time sample'); ylabel('Amplitude');
title('Discrete time signal sampling rate fs = 20*f1');
figure(2)
stem(multiplex)
xlabel('Time sample'); ylabel('Amplitude');
title('Multiplexed Signal');
```


Multiplexed signal
Amplitude
Time sample


Demultiplexed signal(message1)
Demultiplexed signal(message2)
Demultiplexed signal(message3)
Amplitude
Time sample

Experiment :

Date

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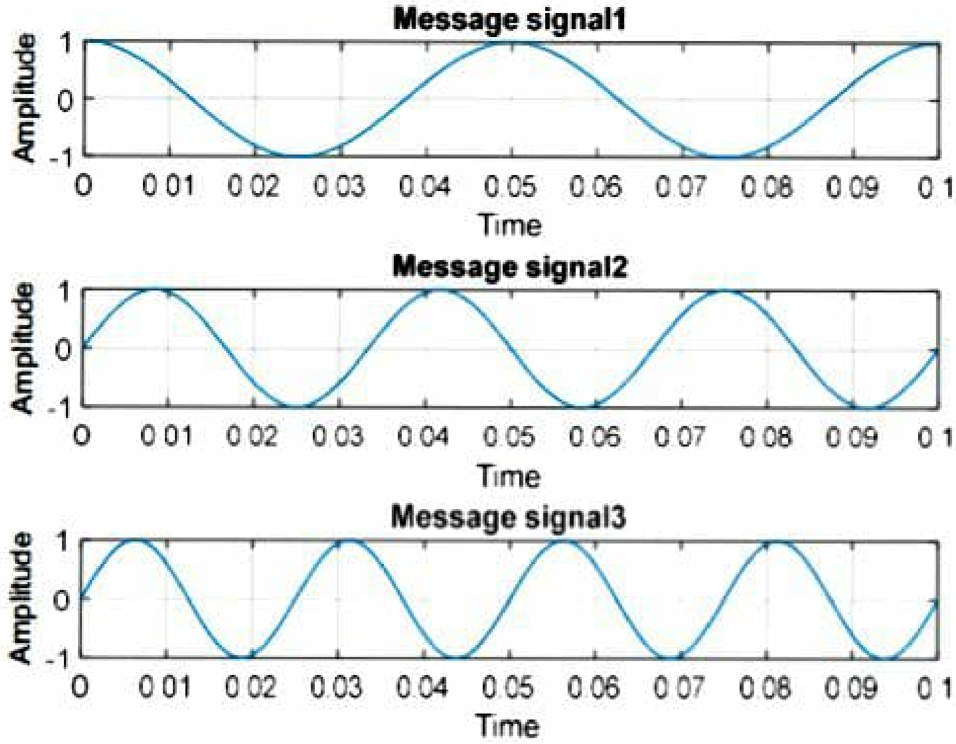
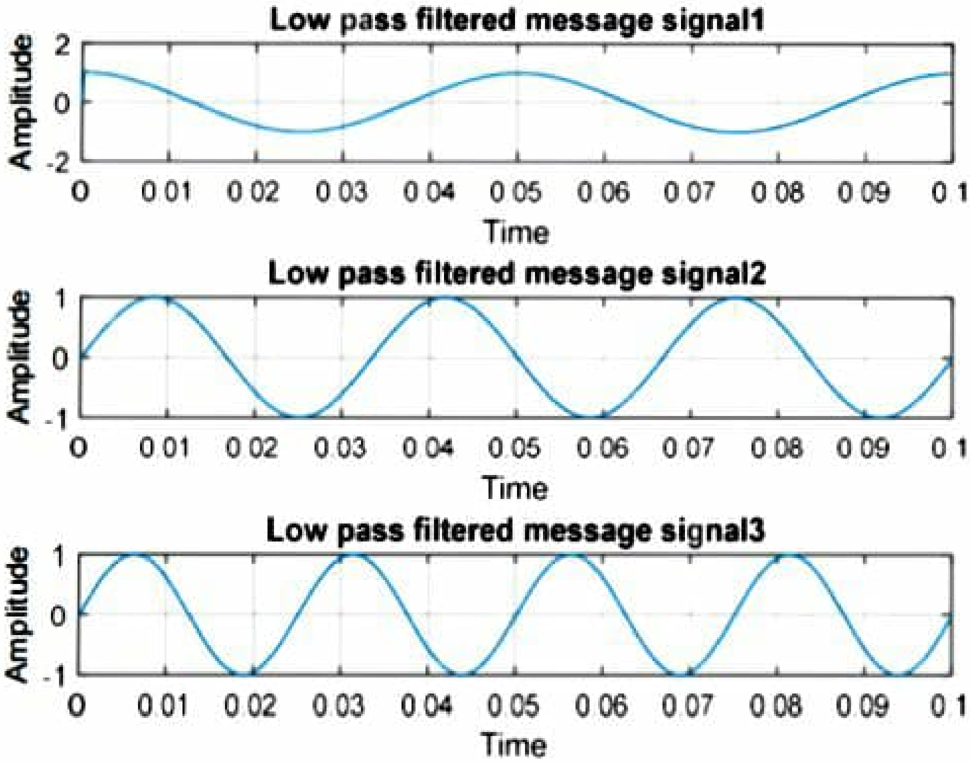
```
figure(3)
subplot(3 1 1); stem(demul1)
xlabel('Time sample'); ylabel('Amplitude');
title('Demultiplexed signal (message 1)');
subplot(3 1 2); stem(demul2)
xlabel('Time sample'); ylabel('Amplitude');
title('Demultiplexed signal (message 2)');
subplot(3 1 3); stem(demul3)
xlabel('Time sample'); ylabel('Amplitude');
title('Demultiplexed signal (message 3)');
```

Output Waveforms:

(i) Message signals



(ii) Low pass filtered message signals



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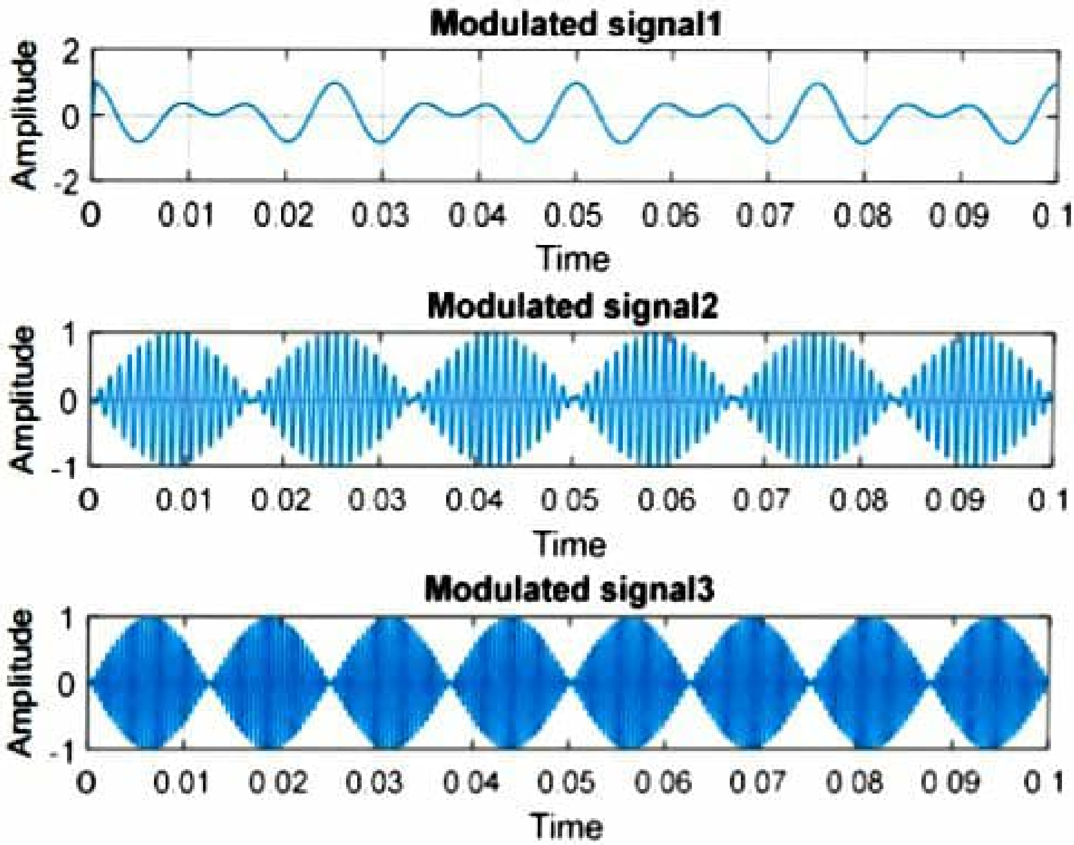
Aim - Write a MATLAB program to implement frequency Division multiplexing and demultiplexing.

Software used - MATLAB R2015a

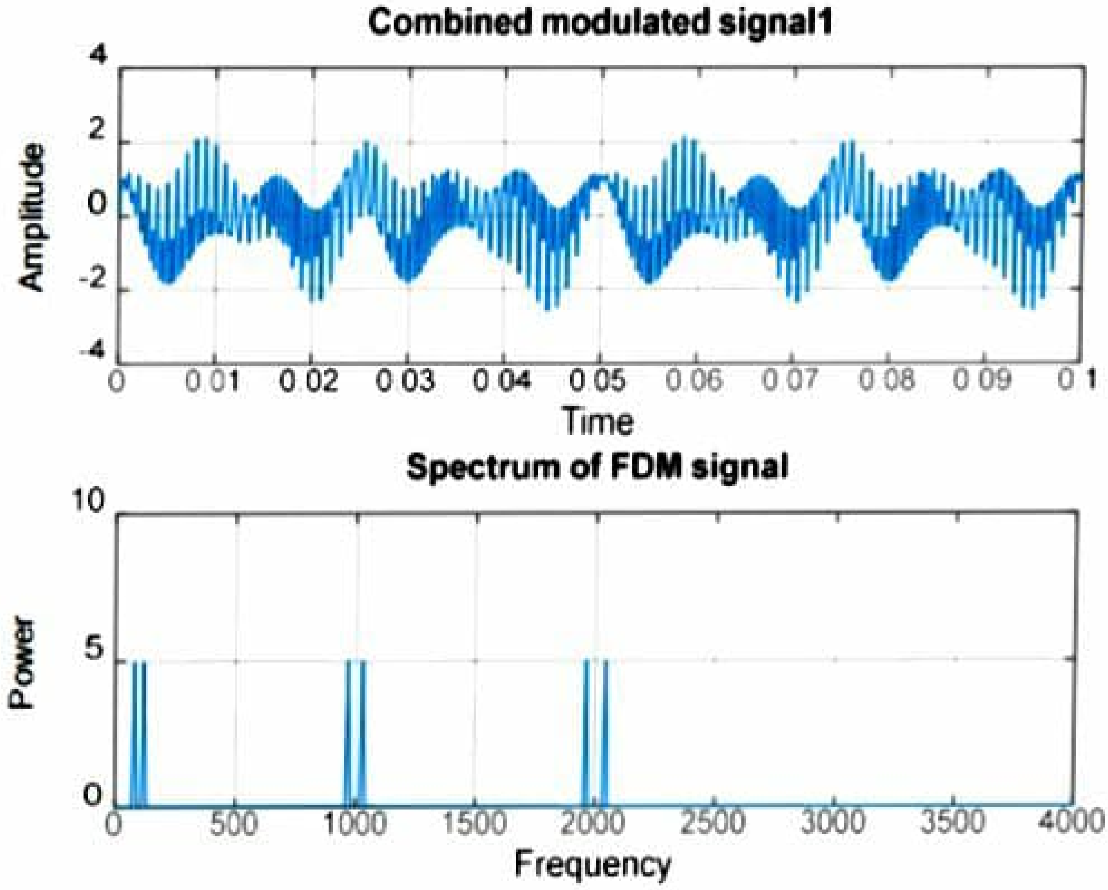
Code -

```
fm1= 20; fm2 = 30; fm3 = 40;
fc1 = 100; fc2 = 1000; fc3 = 2000;
t = 0:0.00001:0.0999;
f = 0:1:9999;
%% Message Inputs %%
message1 = cos(2*pi*fm1*t);
message2 = sin(2*pi*fm2*t);
message3 = sin(2*pi*fm3*t);
%% LPF outputs %%
[b1,a1] = butter(2,0.033)
m1 = filter(b1,a1,message1);
[b2,a2] = butter(2,0.05)
m2 = filter(b1,a1,message2);
[b3,a3] = butter(2,0.066)
m3 = filter(b1,a1,message3);
%% Modulator Outputs %%
y1 = ammod(m1,fc1,100000);
y2 = ammod(m2,fc2,100000);
y3 = ammod(m3,fc3,100000);
%% Combined Signal %%
y = y1 + y2 + y3;
%% Spectrum of frequency division multiplexed signal %%
Yf = abs(fft(y,100000))/500;
%% Band pass filter outputs %%
```

(iii) Modulated signals



(iv) Combined signal (FDM signal) and its spectrum



Experiment

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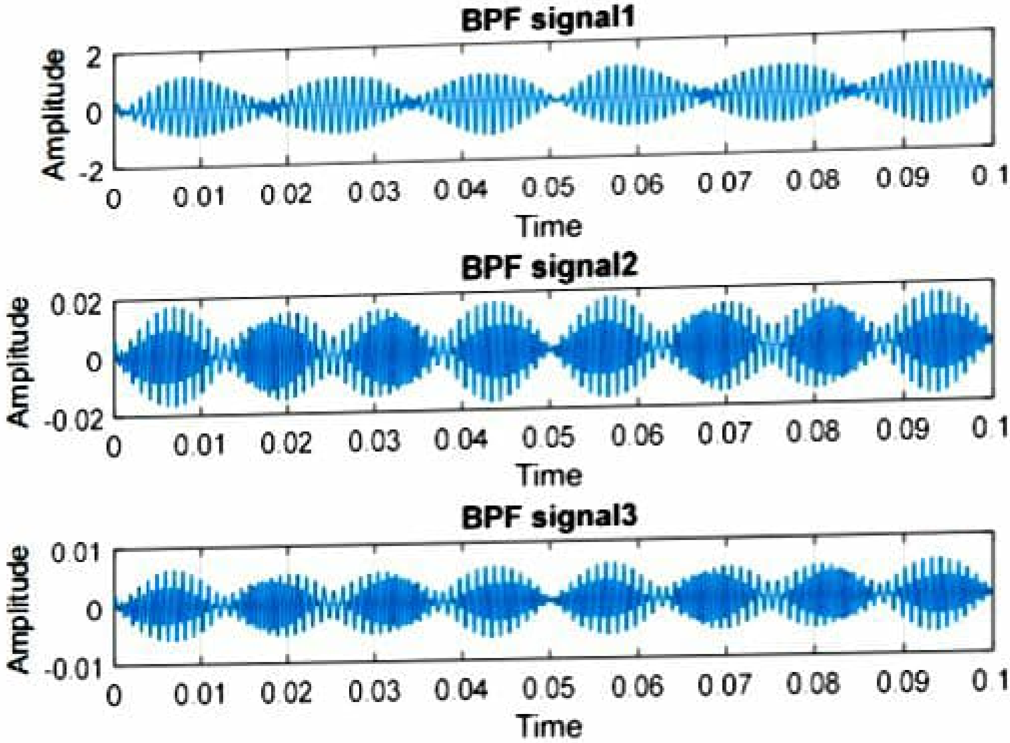
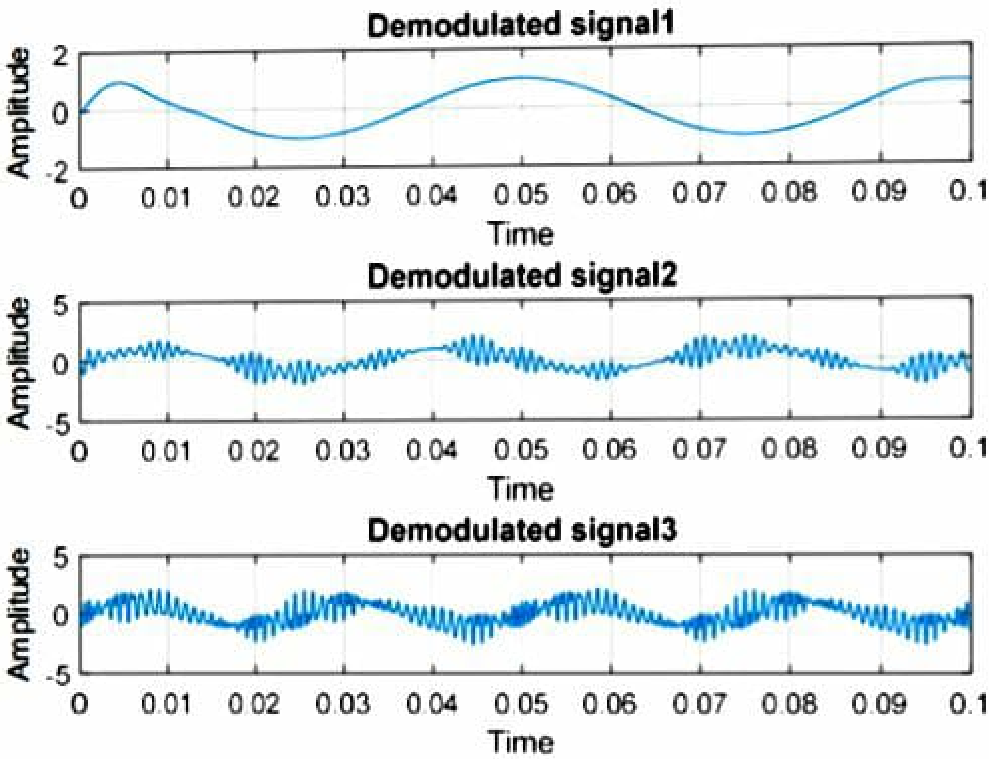
```
[b4, a4] = butter(1, [0.016 0.024], 'bandpass')
out1 = filter(b4, a4, y);
[b5, a5] = butter(1, [0.194 0.206], 'bandpass')
out2 = filter(b5, a5, y);
[b6, a6] = butter(1, [0.392 0.408], 'bandpass')
out3 = filter(b6, a6, y);
%% Demodulator outputs %%
demod1 = amdemod(y, fc1, 100000)
demod2 = amdemod(y, fc2, 100000)
demod3 = amdemod(y, fc3, 100000)
%% figures %%
figure(1)
subplot(311); plot(t, message1)
xlabel('Time'); ylabel('Amplitude')
title('Message signal1'); grid
subplot(312); plot(t, message2)
xlabel('Time'); ylabel('Amplitude')
title('Message signal 2'); grid
subplot(313); plot(t, message3)
xlabel('Time'); ylabel('Amplitude')
title('Message signal3'); grid
figure(2);
subplot(311); plot(t, m1)
xlabel('Time'); ylabel('Amplitude')
title('low pass filtered message signal 1'); grid
subplot(312); plot(t, m2)
xlabel('Time'); ylabel('Amplitude')
title('low pass filtered message signal2'); grid
subplot(313); plot(t, m3)
xlabel('Time'); ylabel('Amplitude')
```

(v) Band pass filter outputs



(vi) Demodulated signals



Experiment :

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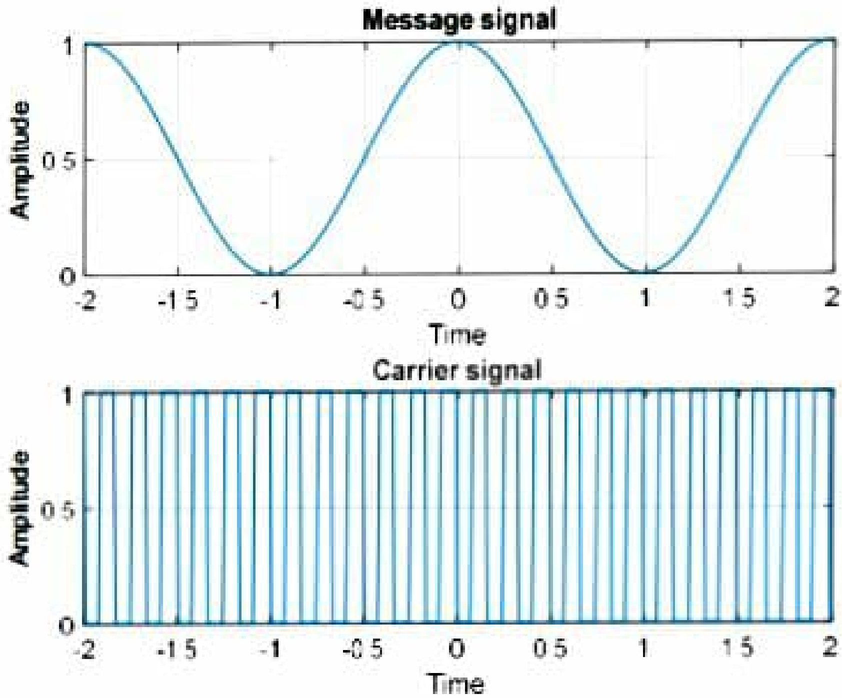
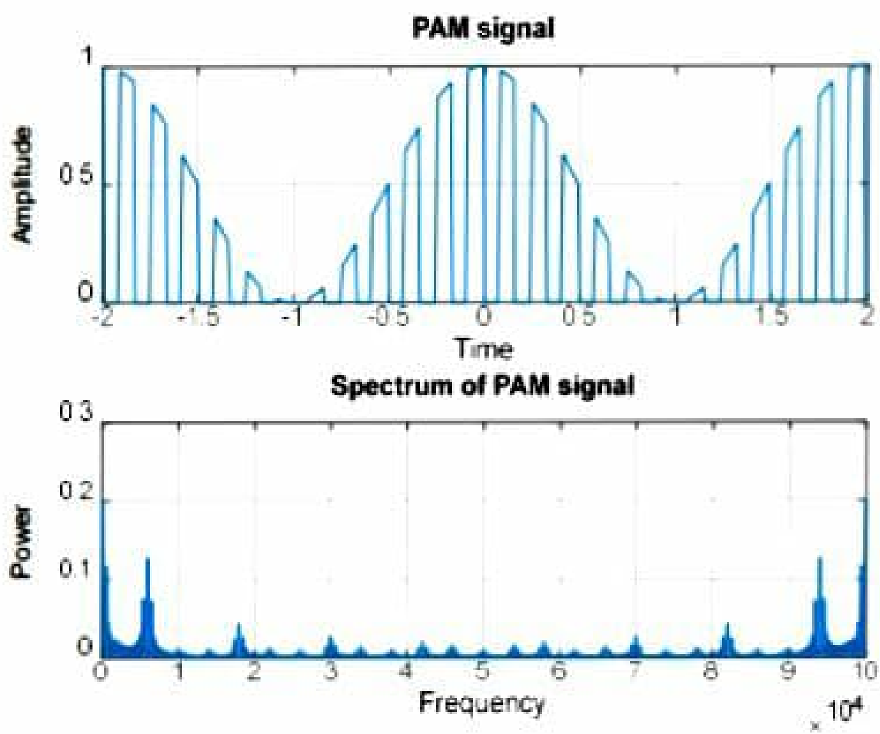
```
figure (5)
subplot(3 1 1); plot ( t, Out 1 )
xlabel ('Time'); ylabel ('Amplitude')
title ('BPF signal1'); grid
subplot ( 3 1 2 ); plot (t, out 2)
xlabel ('Time'); y label ('Amplitude')
title ('BPF signal 2'); grid
subplot ( 3 1 3 ); plot ( t, out 3 )
xlabel ('Time'); ylabel ('Amplitude')
title ('BPF signal3'); grid
figure (6)
subplot ( 3 1 1 ); plot( t, demod1 )
xlabel ('Time'); ylabel ('Amplitude')
title ('Demodulated signal 1'); grid
subplot ( 3 1 2 ); plot ( t, demod 2 )
xlabel ('time'); ylabel ('Amplitude')
title ('Demodulated signal 2'); grid
subplot (3 1 3); plot (t, demod 3)
xlabel ('Time'); ylabel ('Amplitude')
title ('Demodulated signal 3'); grid
```

Output Waveforms

(i) Message signals



(ii) Pulse amplitude modulated signal and its spectrum



Experiment : 10

Date 12/04/2021

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Aim - Write a MATLAB code to generate pulse amplitude modulated (PAM) signal and spectrum of PAM signal.

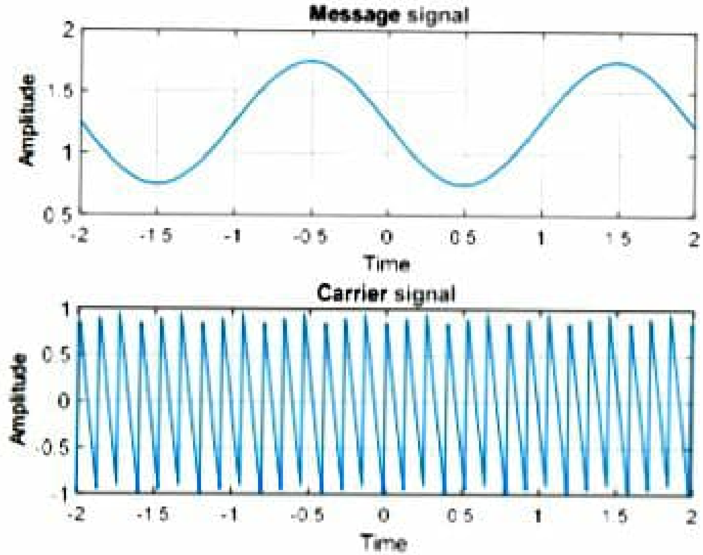
Software used - MATLAB R2015a

Code -

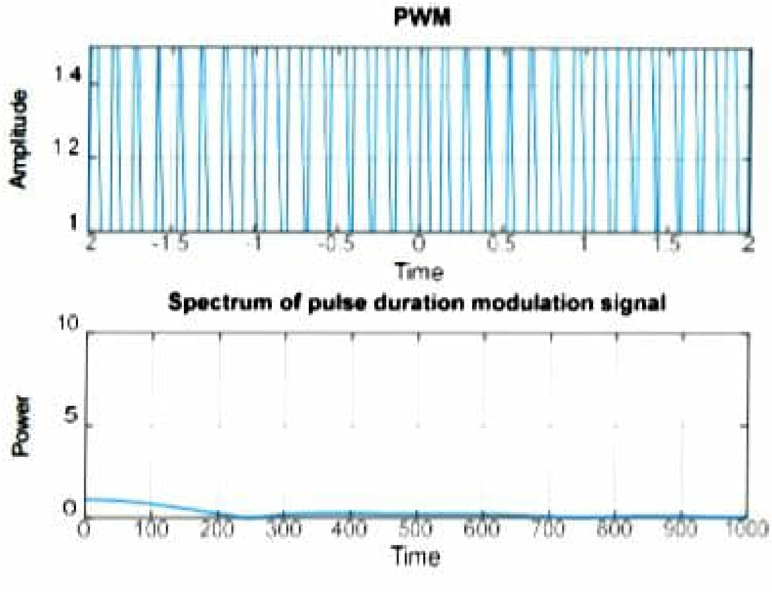
```
fm = 100; fc = 1200; t = -2:0.00995:2; f=0:1:9999;
message =(1+ cos(2*pi*fm*t))/2;
carrier = (1+ square(2*pi*fc*t))/2;
pam = message.*carrier;
spectrum = abs(fft(pam,10000))/500;
figure(1)
subplot(211); plot(t, message);
xlabel('Time'); ylabel('Amplitude');
title('Message signal'); grid on;
subplot(212); plot(t, carrier);
xlabel('Time'); ylabel('Amplitude');
title('Carrier signal'); grid on;
figure(2)
subplot(211); plot(t, pam)
xlabel('Time'); ylabel('Amplitude');
title('PAM signal'); grid on;
subplot(212); plot(f*10, spectrum);
xlabel('frequency'); ylabel('Power');
title('Spectrum of PAM signal'); grid on;
```

Output Waveforms

(i) Message signals



(ii) Pulse width modulated signal and its spectrum



Experiment : 11

Date 13/04/2021

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Aim - Write a MATLAB code to generate pulse width modulated (PWM) signal, and spectrum of PWM signal.

Software used - MATLAB R2015a

Code -

```
fm=100; fc=1500; t=-2:0.00995:2; f=0:1:9999;
message = (2.5+sin(2*pi*fm*t))/2;
Carrier = sawtooth(2*pi*fc*t);
pwm = message + carrier;
spectrum = abs(fft(pwm, 10000))/500;
figure(1)
subplot(211); plot(t, message)
xlabel('Time'); ylabel('Amplitude');
title('Message signal'); grid
subplot(212) plot(t, carrier);
xlabel('Time'); ylabel('Amplitude');
title('Carrier signal'); grid on;
figure(2)
subplot(211); plot(t, pwm)
axis([-2 2 1 1.5])
xlabel('Time'); ylabel('Amplitude');
title('PWM'); grid on;
subplot(212); plot(f*10, spectrum)
axis([(fc-15*fm) (fc-5*fm) 0 10]);
xlabel('Time'); ylabel('Power');
title('Spectrum of pulse duration modulation signal');
grid on;
```