22AIE211 Introduction to Communications and IoT

Lab Assignment 2

Modulation Techniques

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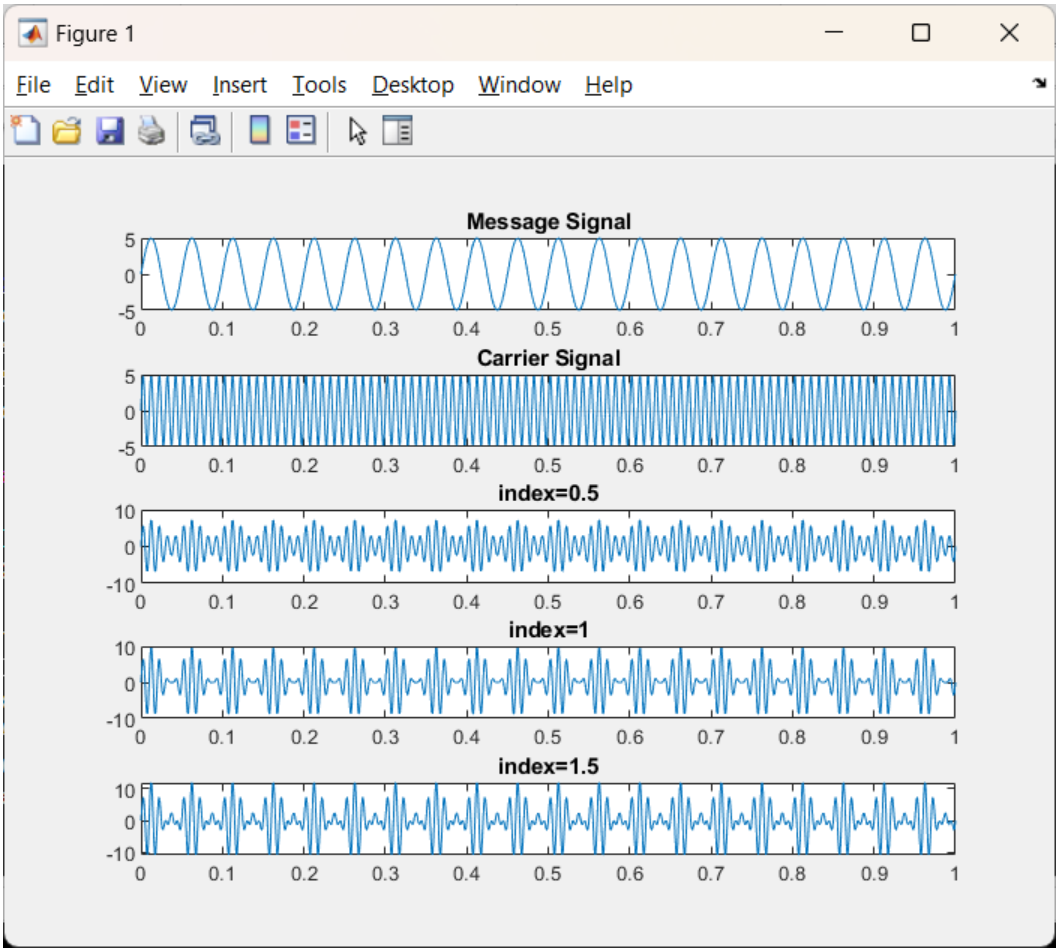
1. Generate AM wave for different modulation indices(m=1, 0.5 and 1.5). Plot all the waveforms(in a single figure).(Am=Ac=5V, fs=1000Hz, fm=20Hz)

CODE :

```
clc;
close all;
clear all;

m = [0.5 1 1.5];
Am = 5; %Amplitude of modulating signal
fm = 20; %frequency of modulating signal
Tm = 1/fm;
t = 0:0.001:1;
ym = Am*sin(2*pi*fm*t);

subplot(5,1,1);
plot(t,ym)
title('Message Signal');

%Carrier signal
Ac = Am;
fc = 100;
Tc = 1/fc;
yc = Ac*sin(2*pi*fc*t);
subplot(5,1,2);
plot(t,yc)
grid on;
title('Carrier Signal');

%AM Modulation
index = 0;
titles = {'index=0.5', 'index=1', 'index=1.5'};
for i = m
    subplot(5,1,3+index);
    index = index + 1;
    y = Ac * (1+i*sin(2*pi*fm*t)).*sin(2*pi*fc*t);
    plot(t,y)
    title(titles{index});
end
```

OUTPUT :

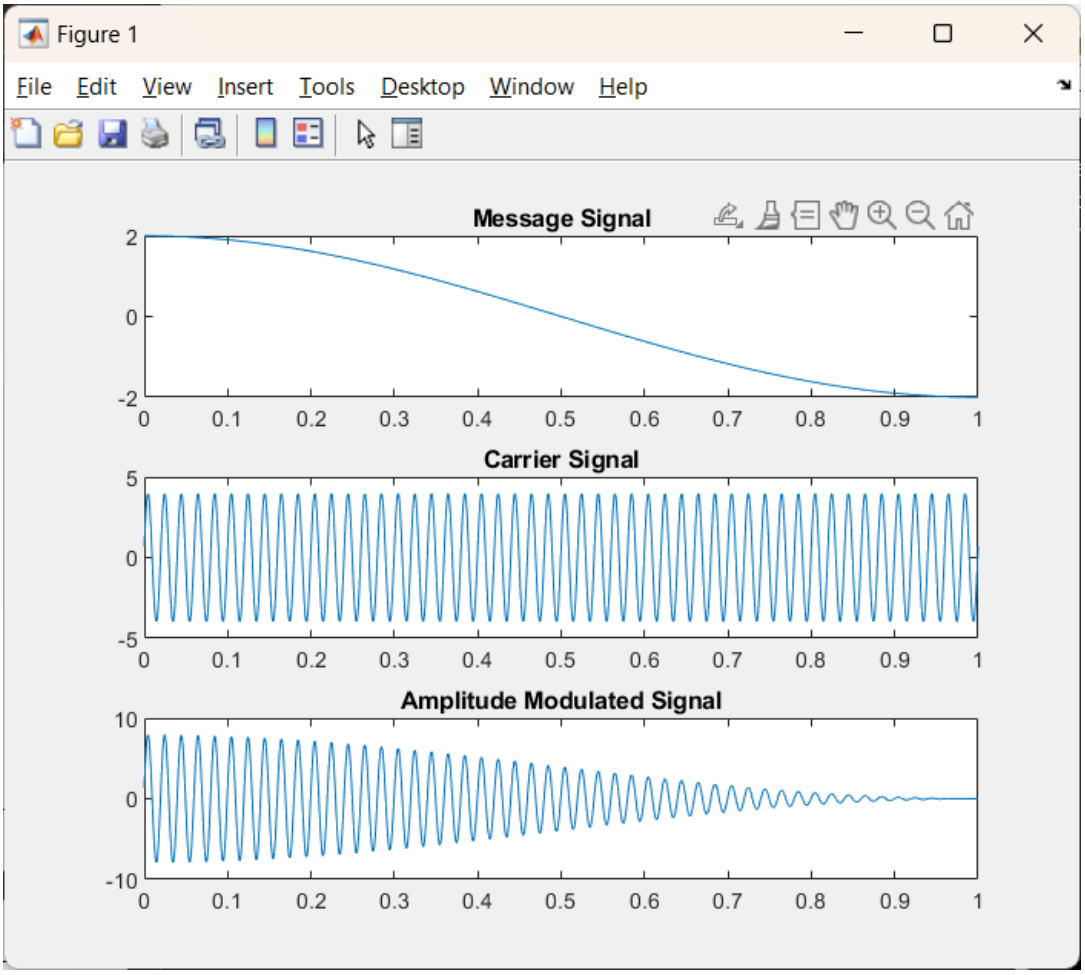


2. Generate an AM wave with message signal 2cos(πt) and carrier 4Sin(1000πt +10). (Use deg2rad() function to convert phase from degrees to radians)

CODE :

```
clc;
close all;
clear all;

t = 0:0.001:1;

ym = 2*cos(pi*t); % message signal
yc = 4*sin(100*pi*t + deg2rad(10)); % carrier signal
yam = 4*(1+cos(pi*t)).*sin(100*pi*t + deg2rad(10)); % Amplitude modulated Signal

subplot(3, 1, 1);
plot(t, ym);
title("Message Signal");

subplot(3, 1, 2);
plot(t, yc);
title("Carrier Signal");

subplot(3, 1, 3);
plot(t, yam);
title("Amplitude Modulated Signal");
```

OUTPUT :



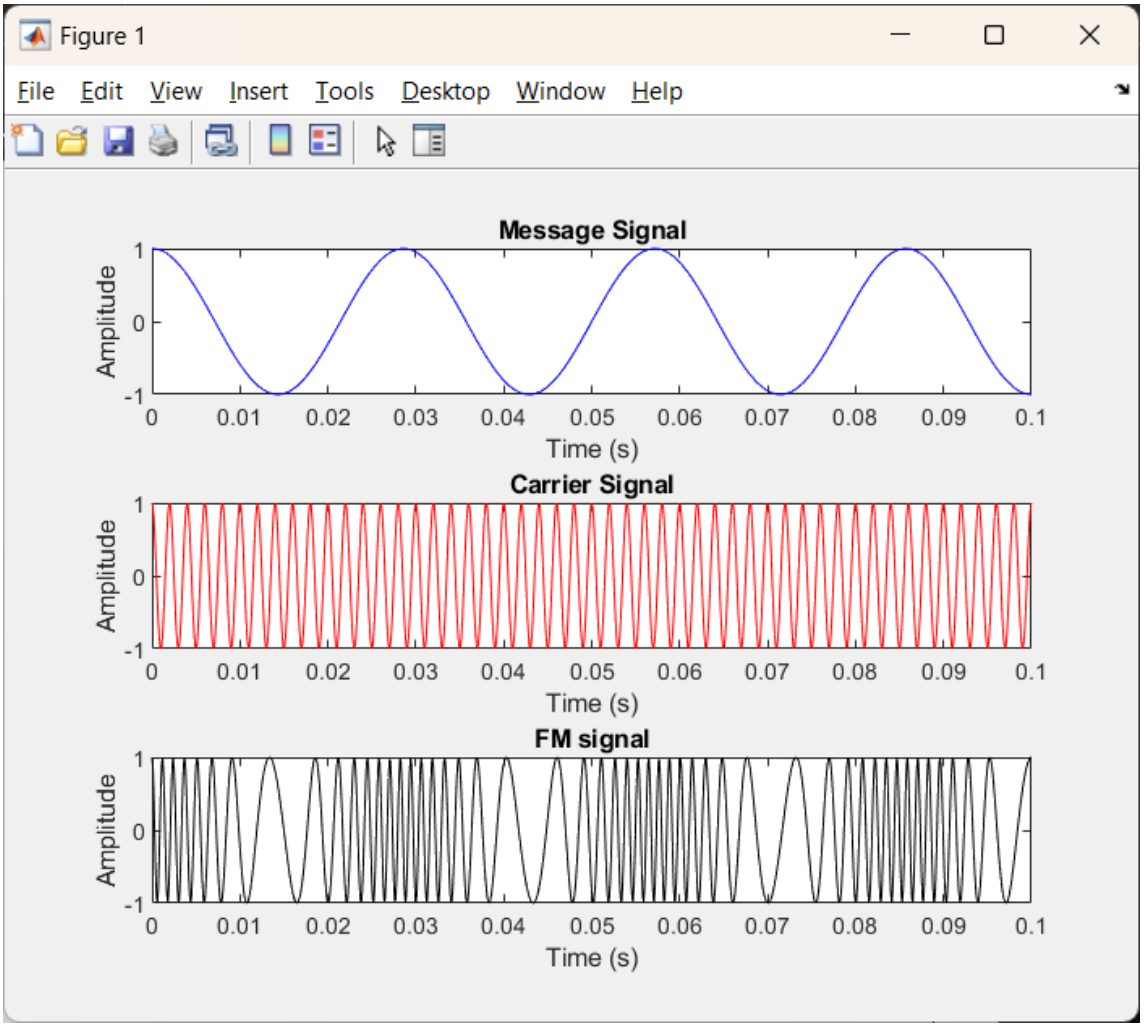
3. Generate an FM signal with mf =10. (fs=10KHz, fm=35Hz, fc=500Hz, Am=Ac=1V, time vector, t=(0:.1*fs)/fs))

CODE :

```
%parameters
fs = 10000;
fm = 35;
fc = 500;
Am = 1;
Ac = 1;
t = (0:.1*fs)/fs;

%carrier and message signals
carrier = Ac*cos(2*pi*fc*t);
message = Am*cos(2*pi*fm*t);

mf = 10;

%modulated signal
m =  Ac*cos((2*pi*fc*t)+mf*sin(2*pi*fm*t));

%plot
figure;
subplot(3,1,1);
plot(t, message, 'b');
title('Message Signal');
xlabel('Time (s)');
ylabel('Amplitude');
subplot(3,1,2);
plot(t, carrier, 'r');
title('Carrier Signal');
xlabel('Time (s)');
ylabel('Amplitude');
subplot(3,1,3);
```

```
plot(t, m, 'k');
title('FM signal');
xlabel('Time (s)');
ylabel('Amplitude');
```

OUTPUT :



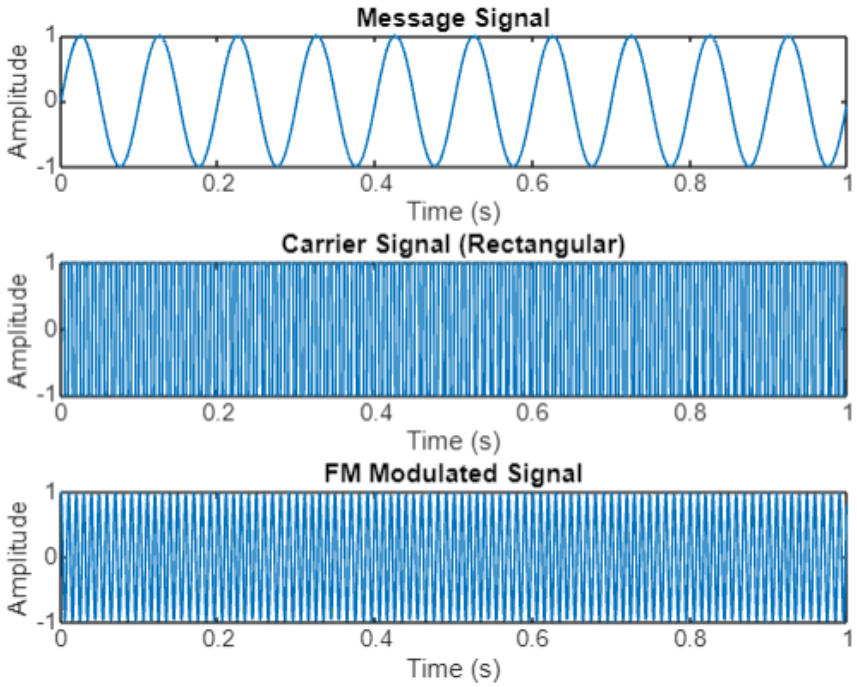
4. Generate an FM signal when message input is a sinusoidal wave and carrier is a rectangular waveform. (use in-built function, fmmod())

CODE :

```
% Parameters
Fs = 1000;
T = 1/Fs;
t = 0:T:1-T;
% Generate message signal (sinusoidal wave)
fm = 10;
Am = 1;
msg_signal = Am * sin(2*pi*fm*t);
% Generate carrier signal (rectangular waveform)
fc = 100;
Ac = 1;
carrier_signal = square(2*pi*fc*t);
% Generate FM signal using fmmod()
kf = 5;
fm_signal = fmmod(msg_signal, fc, Fs, kf);

% Plot
subplot(3,1,1);
plot(t, msg_signal);
title('Message Signal');
```

```
xlabel('Time (s)');
ylabel('Amplitude');
subplot(3,1,2);
plot(t, carrier_signal);
title('Carrier Signal (Rectangular)');
xlabel('Time (s)');
ylabel('Amplitude');
subplot(3,1,3);
plot(t, fm_signal);
title('FM Modulated Signal');
xlabel('Time (s)');
ylabel('Amplitude');
```

OUTPUT :



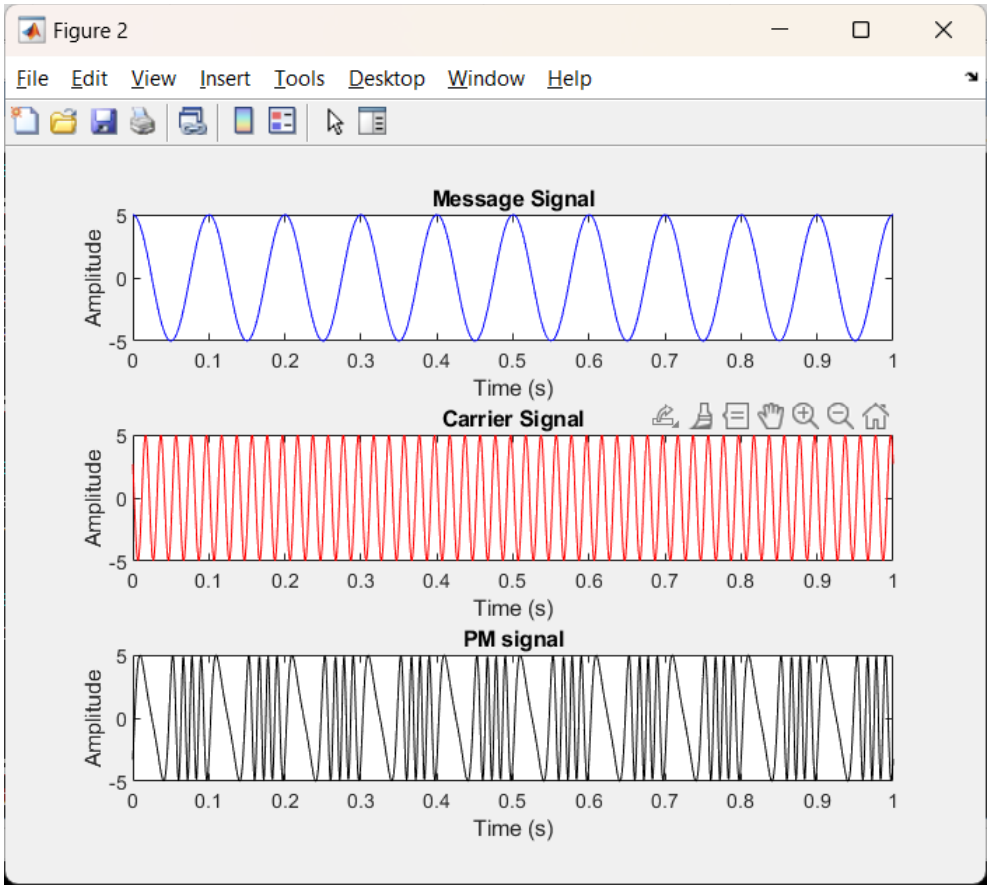
5. Generate a PM signal for modulation index, mp = 4. (Am=Ac = 5V, fm = 10Hz, fc=50Hz, timevector,t = 0:0.001:1).

CODE :

```
%parameters
Am = 5;
Ac = 5;
fm = 10;
fc = 50;
t = 0:0.001:1;
mp = 4;
%carrier and message signals
message = Am*cos(2*pi*fm*t);
carrier = Ac*cos(2*pi*fc*t + 1);
%modulated signal
m =  Ac*cos((2*pi*fc*t)+mp*cos(2*pi*fm*t));
%plot
figure;
subplot(3,1,1);
plot(t, message, 'b');
title('Message Signal');
xlabel('Time (s)');
ylabel('Amplitude');
subplot(3,1,2);
plot(t, carrier, 'r');
```

```
title('Carrier Signal');
xlabel('Time (s)');
ylabel('Amplitude');
subplot(3,1,3);
plot(t, m, 'k');
title('PM signal');
xlabel('Time (s)');
ylabel('Amplitude');
```

OUTPUT :



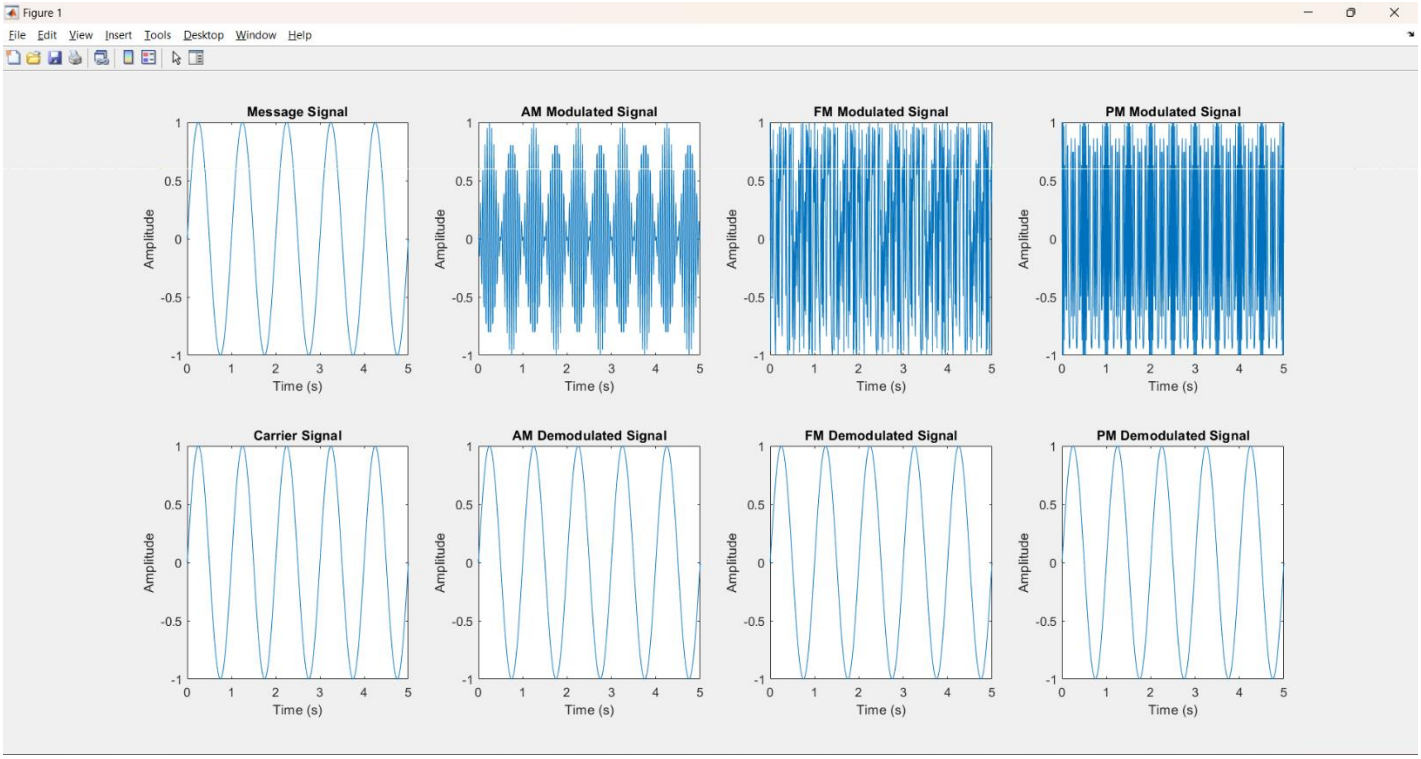
6. Generate the following signals using in-built functions in MATLAB. Perform both modulation and demodulation. a. AM signal (over modulation) b. FM signal c. PM signal

CODE :

```
clc;
close all;
clear all;

cf = 1;
Fs = 100;
mi_am = 5;
mi_fm = 5;
mi_pm = 2;
t = 0:1/Fs:5;
ym = sin(2*pi*1*t);
yc = sin(2*pi*cf*t);

yam = ammod(ym, cf, cf*mi_am);
tam = amdemod(yam, cf, cf*mi_am);

yfm = fmmod(ym, cf, cf*mi_fm, Fs);
tfm = fmdemod(yfm, cf, Fs, cf*mi_fm);

ypm = pmmod(ym, cf, cf*mi_pm, Fs);
tpm = pmdemod(ypm, cf, Fs, cf*mi_pm);
```

```
subplot(2,4,1);
plot(t, ym);
title('Message Signal');
xlabel('Time (s)');
ylabel('Amplitude');

subplot(2,4,5);
plot(t, yc);
title('Carrier Signal');
xlabel('Time (s)');
ylabel('Amplitude');

subplot(2,4,2);
plot(t, yam);
title('AM Modulated Signal');
xlabel('Time (s)');
ylabel('Amplitude');

subplot(2,4,3);
plot(t, yfm);
title('FM Modulated Signal');
xlabel('Time (s)');
ylabel('Amplitude');

subplot(2,4,4);
plot(t, ypm);
title('PM Modulated Signal');
xlabel('Time (s)');
ylabel('Amplitude');

subplot(2,4,6);
plot(t, ym);
title('AM Demodulated Signal');
xlabel('Time (s)');
ylabel('Amplitude');

subplot(2,4,7);
plot(t, ym);
title('FM Demodulated Signal');
xlabel('Time (s)');
ylabel('Amplitude');

subplot(2,4,8);
plot(t, ym);
title('PM Demodulated Signal');
xlabel('Time (s)');
ylabel('Amplitude');
```

OUTPUT :

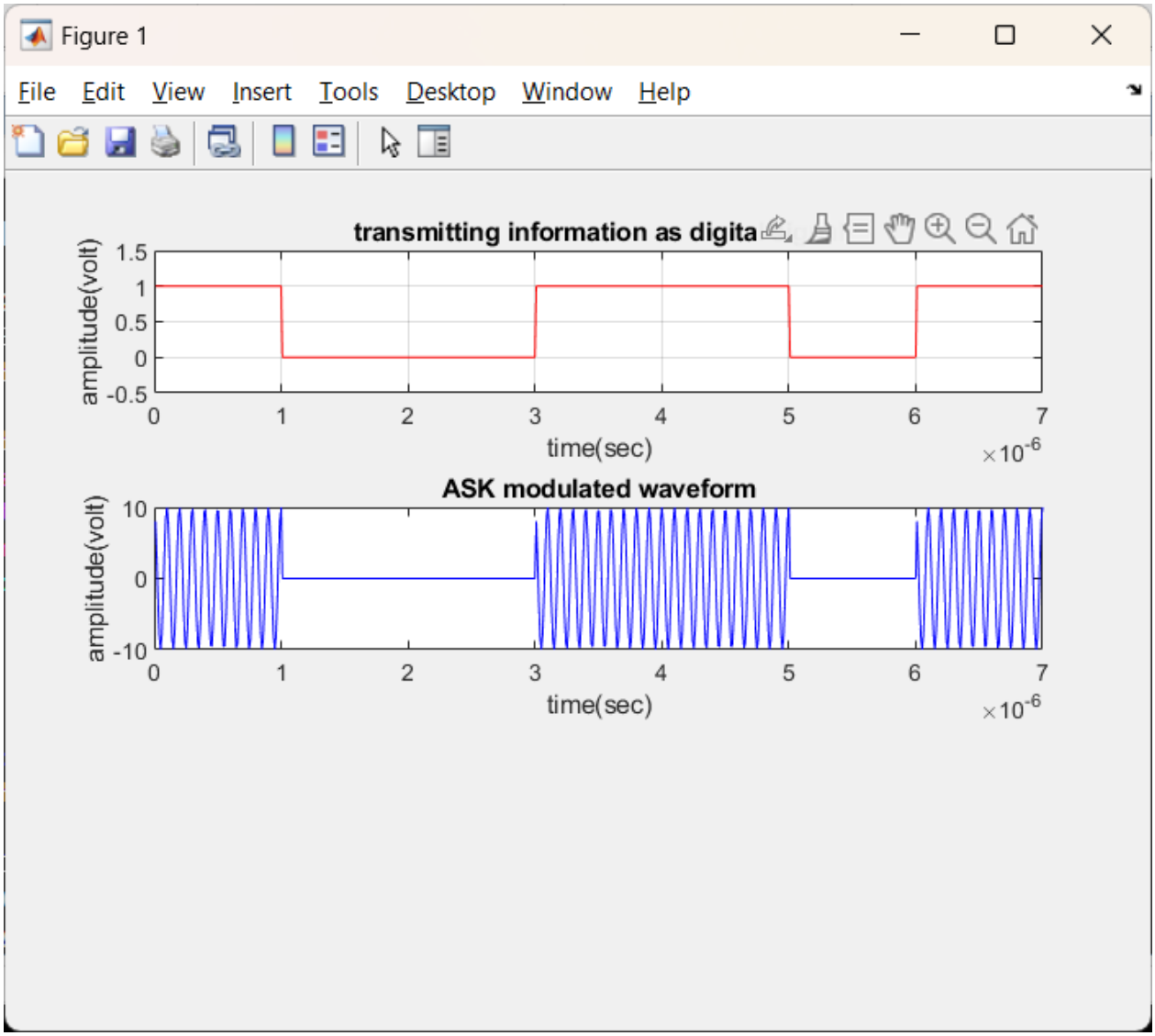


7. Generate ASK, FSK, PSK signal.

ASK :

```
x=[1 0 0 1 1 0 1];
bp=0.000001;
disp('Binary information at Transmitter :');
disp(x);
bit=[];
for n=1:1:length(x)
    if x(n)==1
        se=ones(1,100);
    elseif x(n)==0
        se=zeros(1,100);
    end
    bit=[bit se];
end
t1=bp/100:bp/100:100*length(x)*(bp/100);
subplot(3,1,1);
plot(t1,bit,'r');
grid on;
axis([0 bp*length(x) -.5 1.5]);
ylabel('amplitude(volt)');
xlabel('time(sec)');
title('transmitting information as digital signal');
% ASK modulation
A1=10;
A2=0;
br=1/bp;
f=br*10;
t2=bp/99:bp/99:bp;
ss=length(t2);
m=[];
for i=1:1:length(x)
    if x(i)==1
        y=A1*cos(2*pi*f*t2);
    else
        y=A2*cos(2*pi*f*t2);
    end
```

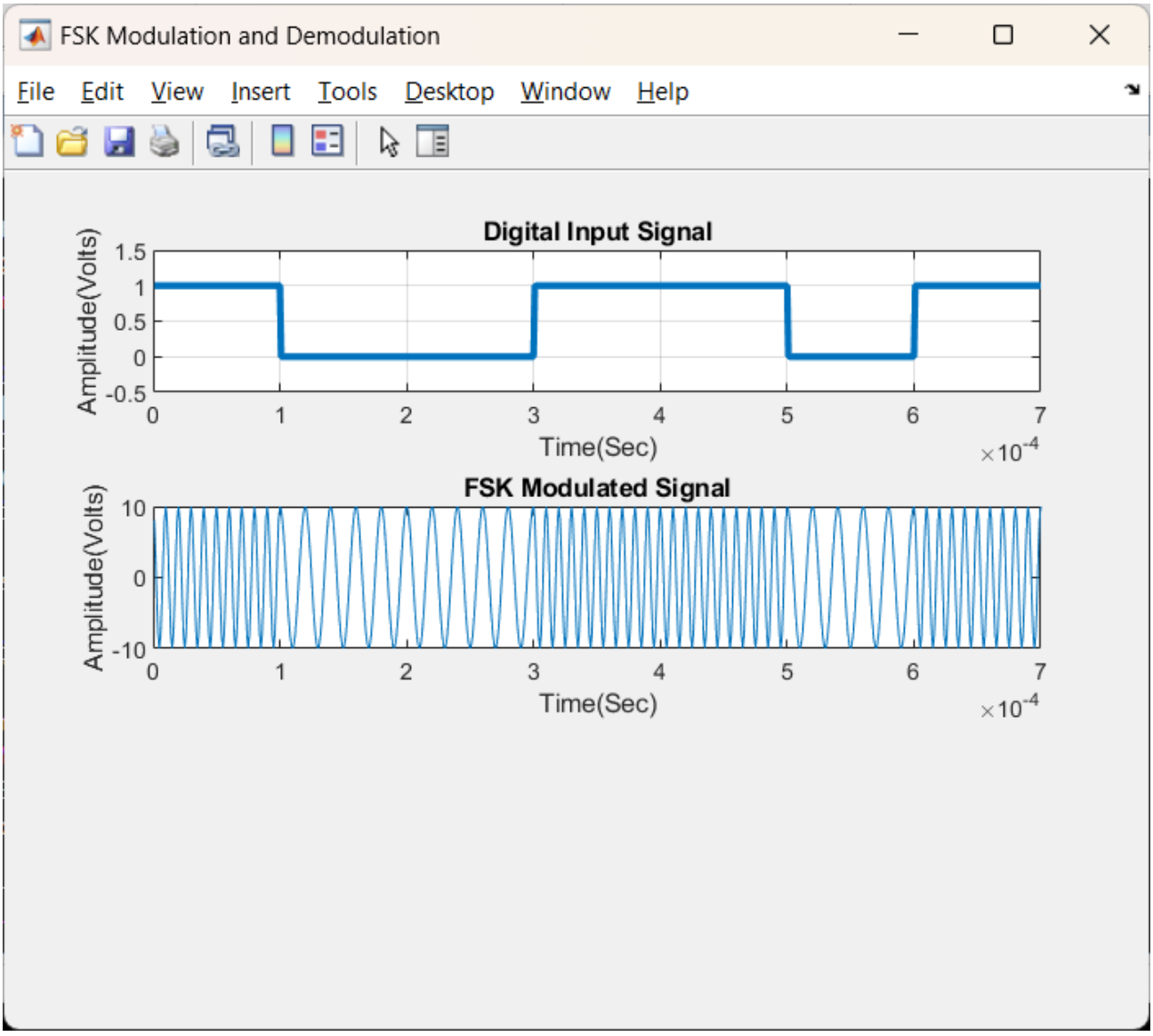
```
    m=[m y];
end
t3=bp/99:bp/99:bp*length(x);
subplot(3,1,2);
plot(t3,m,'b');
xlabel('time(sec)');
ylabel('amplitude(volt)');
title('ASK modulated waveform');
```



FSK :

```
x=[1 0 0 1 1 0 1];
N = length(x);
Tb = 0.0001;
disp('Binary Input Information at Transmitter: ');
disp(x);
nb = 100;   % Digital signal per bit
digit = [];
for n = 1:1:N
    if x(n) == 1;
       sig = ones(1,nb);
    else x(n) == 0;
        sig = zeros(1,nb);
    end
     digit = [digit sig];
end
t1 = Tb/nb:Tb/nb:nb*N*(Tb/nb);   % Time period
figure('Name','FSK Modulation and Demodulation','NumberTitle','off');
subplot(3,1,1);
```

```
plot(t1,digit,'LineWidth',2.5);
grid on;
axis([0 Tb*N -0.5 1.5]);
xlabel('Time(Sec)');
ylabel('Amplitude(Volts)');
title('Digital Input Signal');
Ac = 10;
br = 1/Tb;
Fc1 = br*10;
Fc2 = br*5;
t2 = Tb/nb:Tb/nb:Tb;
mod = [];
for (i = 1:1:N)
    if (x(i) == 1)
        y = Ac*cos(2*pi*Fc1*t2);
    else
        y = Ac*cos(2*pi*Fc2*t2);
    end
    mod = [mod y];
end
t3 = Tb/nb:Tb/nb:Tb*N;   % Time period
subplot(3,1,2);
plot(t3,mod);
xlabel('Time(Sec)');
ylabel('Amplitude(Volts)');
title('FSK Modulated Signal');
```



PSK :

```
x=[ 1 0 0 1 1 0 1];
bp=.000001;
disp(' Binary information at Trans mitter :');
disp(x);
bit=[];
for n=1:1:length(x)
    if x(n)==1;
       se=ones(1,100);
    else x(n)==0;
        se=zeros(1,100);
    end
     bit=[bit se];
end
t1=bp/100:bp/100:100*length(x)*(bp/100);
subplot(3,1,1);
plot(t1,bit,'lineWidth',2.5);grid on;
axis([ 0 bp*length(x) -.5 1.5]);
ylabel('amplitude(volt)');
xlabel(' time(sec)');
title('transmitting information as digital signal');
A=5;
br=1/bp;
f=br*2;
t2=bp/99:bp/99:bp;
ss=length(t2);
m=[];
for (i=1:1:length(x))
    if (x(i)==1)
        y=A*cos(2*pi*f*t2);
    else
        y=A*cos(2*pi*f*t2+pi);
    end
    m=[m y];
end
t3=bp/99:bp/99:bp*length(x);
subplot(3,1,2);
plot(t3,m);
xlabel('time(sec)');
ylabel('amplitude(volt)');
title('waveform for binary PSK modulation coresponding binary information');
```

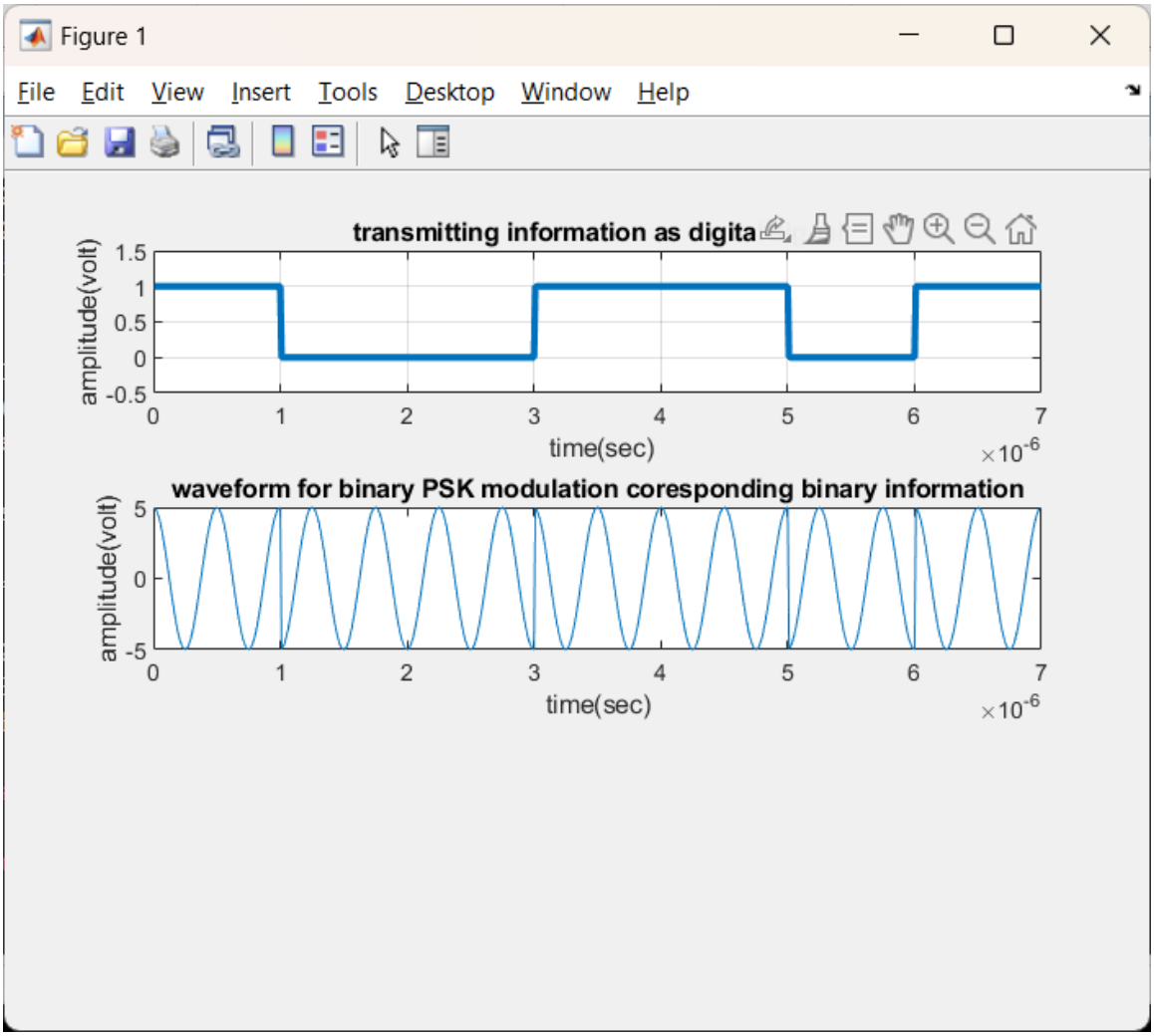


Figure 1
File Edit View Insert Tools Desktop Window Help
transmitting information as digita
amplitude(volt)
1.5
1
0.5
0
-0.5
0 1 2 3 4 5 6 7
time(sec)
×10^-6
waveform for binary PSK modulation coresponding binary information
amplitude(volt)
5
0
-5
0 1 2 3 4 5 6 7
time(sec)
×10^-6