DIGITAL COMMUNICATION SYSTEMS LABORATORY

Recommend using MATLAB 2021a Version or later, others below version causes some error in some conditions because the below versions do not have all MATLAB Library function.

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SESSION: 2019-2020 ROLL: 1918016
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Experiment No: 01
Experiment Name: To observe Amplitude Modulation (AM) and Calculate Modulation index using MATLAB software.

```matlab
%Code for Amplitude Modulation....
clc;
close all;
clear all;

%%Input the values.....
Am=input('Enter message signal amplitude: ');
Ac=input('Enter carrier signal amplitude: ');
fm=input('Enter message frequency: ');      % fm<fc
fc=input('Enter carrier frequency: ');
m=input('Enter modulation index: ');        % Modulation index (m)<=1
t = 0:0.001:1;      %upto 1000 samples


% Equation of Message Signal...
y1=Am*sin(2*pi*fm*t);
subplot(3,1,1);
plot(t,y1,'blue','LineWidth',1);
xlabel('Time');
ylabel('Amplitude');
title('Message signal','color','red');


%Equation of Carrier Signal...
y2=Ac*sin(2*pi*fc*t);
subplot(3,1,2);
plot(t,y2,'magenta','LineWidth',1);
xlabel('Time');
ylabel('Amplitude');
title('Carrier signal','color','blue');

%The instantanous voltage of the resulting amplitude modulated wave is.....
y=Ac*(1+m*sin(2*pi*fm*t)).*sin(2*pi*fc*t);        % Equation of Modulated signal
%y=(Ac.*cos(wc*t)) + ((m*Ac./2).*cos(wc*t + wm*t)) + ((m*Ac./2).*cos(wc*t - wm*t));
subplot(3,1,3);
plot(t,y,'red');
xlabel('Time');
ylabel('Amplitude');
title('Modulated signal','LineWidth',1);
```

Enter message signal amplitude: 2
Enter carrier signal amplitude: 4
Enter message frequency: 5

Experiment No: 02
Experiment Name: To generate FM (Frequency Modulation) using MATLAB software.

```matlab
%Code for Frequency Modulation....
clc;
close all;
clear all;

%Input the values.....
vm = input('Enter Amplitude of the Message signal = ');
vc = input('Enter Amplitude of the Carrier signal = ');
fm = input('Enter Message frequency = ');
fc = input('Enter Carrier frequency = ');
m = input('Enter Modulation Index = ');          % Modulation index (m)>=1
t = 0:0.001:1;          %upto 1000 samples

%Equation of Message Signal...
y1 = vm * cos(2*pi*fm*t);
subplot(3,1,1);
plot(t,y1,'blue');
xlabel('Time');
ylabel('Amplitude');
title('Message Signal','color','red');
grid on;

%Equation of Carrier Signal...
y2 = vc*cos(2*pi*fc*t);
subplot(3,1,2);
plot(t,y2,'red');
xlabel('Time');
ylabel('Amplitude');
title('Carrier Signal','color','blue');
grid on;

%The instantaneous value of FM voltage wave is given by.........
y = vc*cos(2*pi*fc*t+m.*sin(2*pi*fm*t));          % Equation of Modulated signal
subplot(3,1,3);
plot(t,y,'magenta');
xlabel('Time');
ylabel('Amplitude');
```

title('FM Signal','color','red');
grid on;

Enter Amplitude of the Message signal = 2
Enter Amplitude of the Carrier signal = 4
Enter Message frequency = 5
Enter Carrier frequency = 100
Enter Modulation Index = 10

Experiment No: 03
Experiment Name: To generate PM (Phase Modulation) using MATLAB software.

```
%Code for Phase Modulation....
clc;
close all;
clear all;
%Input the values.....
vm = input('Enter Amplitude of the Message signal = ');
vc = input('Enter Amplitude of the Carrier signal = ');
fm = input('Enter Message frequency = ');
fc = input('Enter Carrier frequency = ');
m = input('Enter Modulation Index = ');          % Modulation index (m)>=1
t = 0:0.001:1;              %upto 1000 samples

%Equation of Message Signal...
phase_m= pi/3;
y1 = vm * cos(2*pi*fm*t+phase_m);
subplot(3,1,1);
plot(t,y1,'blue');
xlabel('Time');
ylabel('Amplitude');
title('Message Signal','color','red');
grid on;

%Equation of Carrier Signal...
phase_c = 2*pi/6;
y2 = vc*cos(2*pi*fc*t + phase_c);
subplot(3,1,2);
plot(t,y2,'red');
xlabel('Time');
ylabel('Amplitude');
title('Carrier Signal','color','blue');
```

```
grid on;

%The instantaneous value of PM voltage wave is given by.........
y = vc*cos(2*pi*fc*t+m.*cos(2*pi*fm*t + phase_m));          % Equation of Modulated
signal
subplot(3,1,3);
plot(t,y,'magenta');
xlabel('Time');
ylabel('Amplitude');
title('PM Signal','color','red');
grid on;
```

Enter Amplitude of the Message signal = 2
Enter Amplitude of the Carrier signal = 4
Enter Message frequency = 5
Enter Carrier frequency = 100
Enter Modulation Index = 6

Experiment No: 04
Experiment Name: To generate Flap-Top PAM(Pulse Amplitude Modulation) using MATLAB software.

```
%Pulse Amplitude Modulation (Flap Top PAM) ......
clc;
close all;
clear all;

fc = 20;
fm =2;
t=1;
n = [0:0.001:t];
n = n(1:end-1);
dutycycle = 50;

%Message Signal...
m = sin(2*pi*fm*n);
subplot(3,1,1);
plot(n,m);
ylim([-1.2 1.2]);
title('Message Signal');
xlabel('time');
ylabel('amplitude');
```

```
%Pulse Carrier..
s = square(2*pi*fc*n,dutycycle);
s(find(s<0))=0;   %to make it unipolar
subplot(3,1,2);
plot(n,s);
ylim([-0.2 1.2]);
title('Pulse Carrier');
xlabel('time');
ylabel('amplitude');

%Pulse Amplitude Modulation Output....
period_sam = length(n)/fc;     %to find the number of samples in one period
ind = 1:period_sam:length(n);   %to find the starting sample index
on_samp = ceil(period_sam * dutycycle/100);   %no. of samples in on period of time
pam = zeros(1,length(n));
for i =1:length(ind)
    pam(ind(i):ind(i)+on_samp) = m(ind(i));
end

subplot(3,1,3);
plot(n,pam);
ylim([-1.2 1.2]);
title('PAM modulation(Flap Top PAM)');
xlabel('time');
ylabel('amplitude');
```

Experiment No: 05
Experiment Name: To generate Natural PAM using MATLAB software.

```
%Pulse Amplitude Modulation (Natural PAM)......
clc;
close all;
clear all;

t = 0:0.01:5;
d = 0:1/5:5;
fm = 1;

%Message Signal...
x = 5*sin(2*pi*fm*t);
subplot(3,1,1);
plot(t,x);
title('Message Signal');
xlabel('time');
```

```
ylabel('amplitude');

%Pulse Carrier..
y = pulstran(t,d,'rectpuls',0.1);
subplot(3,1,2);
plot(t,y);
title('Pulse Carrier');
xlabel('time');
ylabel('amplitude');

%Pulse Amplitude Modulation Output....
z=x.*y;
subplot(3,1,3)
plot(t,z);
title('PAM modulation(Natural PAM)');
xlabel('time');
ylabel('amplitude');
```

Experiment No: 06
Experiment Name: To generate Pulse Width Modulation (PWM) using MATLAB software.

```
%Pulse Width Modulation.....
clc;
close all;
clear all;

fm = 2;
fs = 10;
a = 2;
t = 0:0.0001:1;          %sampling rate of 10kHz

%Message Signal.....
msg = a.*sin(2*pi*fm*t);
subplot(3,1,1);
plot(t,msg);
title('Message Signal');

%Carrier Wave Signal(Sawtooth Signal)...
stooth=1.01*a.*sawtooth(2*pi*fs*t); %generating a sawtooth wave
%to make the two non zero lobes of pwm not to overlap the amplitude of
%sawtooth wave must be atleast more than a bit to the message amplitude
```

```
subplot(3,1,2);
plot(t,stooth); % plotting the sawtooth wave
title('Pulse Carrier Wave');

%Plotting the Pulse Width Modulation.....
for i=1:length(stooth)
if (msg(i)>=stooth(i))
    pwm(i)=1; %is message signal amplitude at i th sample is greater than
    %sawtooth wave amplitude at i th sample
else
    pwm(i)=0;
end
end

subplot(3,1,3);
plot(t,pwm,'r');
title('PWM');
axis([0 1 0 1.1]); %to keep the pwm visible during plotting.
```

Experiment No: 07
Experiment Name: To generate Pulse Position Modulation (PPM) using MATLAB software.

```
% Parameters
fs = 10000; % Sampling frequency
T = 1; % Time duration
t = 0:1/fs:T-1/fs; % Time vector

% Message signal
m = sin(2*pi*5*t);

% Square pulse carrier wave
c = square(2*pi*10*t);

% PWM signal
pwm = zeros(size(t));
for i=1:length(t)
    if m(i) > c(i)
        pwm(i) = 1;
    else
        pwm(i) = -1;
    end
end
```

```matlab
% PPM signal
ppm = zeros(size(t));
pulse_width = round(fs/10);
for i=1:pulse_width:length(t)-pulse_width+1
    [~, idx] = max(pwm(i:i+pulse_width-1));
    ppm(i+idx-1) = 1;
end

% Plot signals
subplot(4, 1, 1);
plot(t, m);
title('Message Signal');
xlabel('Time (s)');
ylabel('Amplitude');

subplot(4, 1, 2);
plot(t, c);
title('Square Pulse Carrier Wave');
xlabel('Time (s)');
ylabel('Amplitude');

subplot(4, 1, 3);
plot(t, pwm);
title('PWM Signal');
xlabel('Time (s)');
ylabel('Amplitude');

subplot(4, 1, 4);
plot(t, ppm);
title('PPM Signal');
xlabel('Time (s)');
ylabel('Amplitude');
```

Another:

```matlab
close all
clear all
clc
fc=100;
fs=1000;
f1=80;
t=0:1/fs:((2/f1)-(1/fs));
```

```matlab
x1=0.4*cos(2*pi*f1*t)+0.5;
%modulation
y1=modulate(x1,fc,fs,'ppm');
subplot(311);
plot(x1);
axis([0 15 0 1]);
title('original signal taken mesage,f1=80,fs=1000')
subplot(312);
plot(y1);
axis([0 250  -0.2 1.2]);
title('PPM')
%demodulation
x1_recov=demod(y1,fc,fs,'ppm');
subplot(313);
plot(x1_recov);
title('time domain recovered, single tone,f1=80')
axis([0 15 0 1]);
```

Experiment No: 08
Experiment Name: To generate Amplitude Shift Keying (ASK) using MATLAB software.

```matlab
%Amplitude Shift keying...
clc;
close all;
clear all;

fc=input('Enter the freq of Sine Wave carrier:');
fp=input('Enter the freq of Periodic Binary pulse (Message):');
amp=input('Enter the amplitude (For Carrier & Binary Pulse Message):');
t=0:0.001:1; % For setting the sampling interval

% For Generating Carrier Sine wave
c=amp.*sin(2*pi*fc*t);
subplot(3,1,1);
plot(t,c);
xlabel('Time');
ylabel('Amplitude');
title('Carrier Wave');

%For Generating Square wave message
m=amp/2.*square(2*pi*fp*t)+(amp/2);
```

```
subplot(3,1,2);
plot(t,m);
xlabel('Time');
ylabel('Amplitude');
title('Binary Message Pulses');

% The Shift Keyed Wave
w=c.*m;
subplot(3,1,3); %For Plotting The Amplitude Shift Keyed Wave
plot(t,w);
xlabel('Time');
ylabel('Amplitude');
title('Amplitide Shift Keyed Signal');
```
Enter the freq of Sine Wave carrier:100
Enter the freq of Periodic Binary pulse (Message):10
Enter the amplitude (For Carrier & Binary Pulse Message):4

Experiment No: 09
Experiment Name: To generate Frequency Shift Keying (FSK) using MATLAB software.

```
%Frequenct Shift Keying...
clc;
close all;
clear all;

fc1=input('Enter the freq of 1st Sine Wave carrier:');
fc2=input('Enter the freq of 2nd Sine Wave carrier:');
fp=input('Enter the freq of Periodic Binary pulse (Message):');
amp=input('Enter the amplitude (For Both Carrier & Binary Pulse Message):');
amp=amp/2;
t=0:0.001:1; % For setting the sampling interval

% For Generating 1st Carrier Sine wave
c1=amp.*sin(2*pi*fc1*t);

% For Generating 2nd Carrier Sine wave
c2=amp.*sin(2*pi*fc2*t);

subplot(4,1,1); %For Plotting The Carrier wave
plot(t,c1);
xlabel('Time');
```

```matlab
ylabel('Amplitude');
title('Carrier 1 Wave');

subplot(4,1,2) %For Plotting The Carrier wave
plot(t,c2);
xlabel('Time');
ylabel('Amplitude');
title('Carrier 2 Wave');

%For Generating Square wave message
m=amp.*square(2*pi*fp*t)+amp;
subplot(4,1,3); %For Plotting The Square Binary Pulse (Message)
plot(t,m);
xlabel('Time');
ylabel('Amplitude');
title('Binary Message Pulses');


for i=0:1000 %here we are generating the modulated wave
    if m(i+1)==0
        mm(i+1)=c2(i+1);
        else
        mm(i+1)=c1(i+1);
    end
end

subplot(4,1,4); %For Plotting The Modulated wave
plot(t,mm);
xlabel('Time');
ylabel('Amplitude');
title('Modulated Wave');
```

% Enter the freq of 1st Sine Wave carrier:10
% Enter the freq of 2nd Sine Wave carrier:30
% Enter the freq of Periodic Binary pulse (Message):5
% Enter the amplitude (For Both Carrier & Binary Pulse Message):4

Experiment No: 10
Experiment Name: To generate Phase Shift Keying (PSK) using MATLAB software.
%Phase Shift keying...
clc;

```matlab
close all;
clear all;
t=0:.001:1;

fc=input('Enter frequency of Carrier Sine wave: ');
fm=input('Enter Message frequency : ');
amp=input('Enter Carrier & Message Amplitude(Assuming Both Equal):');

% Generating Carrier Sine
c=amp.*sin(2*pi*fc*t);
subplot(3,1,1); %For Plotting The Carrier wave
plot(t,c);
xlabel('Time');
ylabel('Amplitude');
title('Carrier');

% For Plotting Message signal
m=square(2*pi*fm*t);
subplot(3,1,2)
plot(t,m)
xlabel('time')
ylabel('ampmplitude')
title('Message Signal')% Sine wave multiplied with square wave in order to generate
PSK

x=c.*m;
subplot(3,1,3) % For Plotting PSK (Phase Shift Keyed) signal
plot(t,x);
xlabel('t');
ylabel('y');
title('PSK');

% Enter frequency of Carrier Sine wave: 60
% Enter Message frequency : 10
% Enter Carrier & Message Amplitude(Assuming Both Equal):3
```