EXPT. NO. 5 NAME: PAM, PPM, & PWM

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EXPERIMENT 5 : [U19CS012]

PULSE AMPLITUDE MODULATION (P.A.M.)
PULSE POSITION MODULATION (P.P.M.)
PULSE WIDTH MODULATION (P.W.M.)

AIM : To examine pulse Amplitude modulation (PAM), Pulse Position modulation (PPM) and Pulse width modulation (PWM) and verify and draw the resultant waveform.

APPARATUS : MATLAB software online

THEORY :

1.) Pulse modulation is a type of modulation in which the signal is transmitted in the form of Pulses.

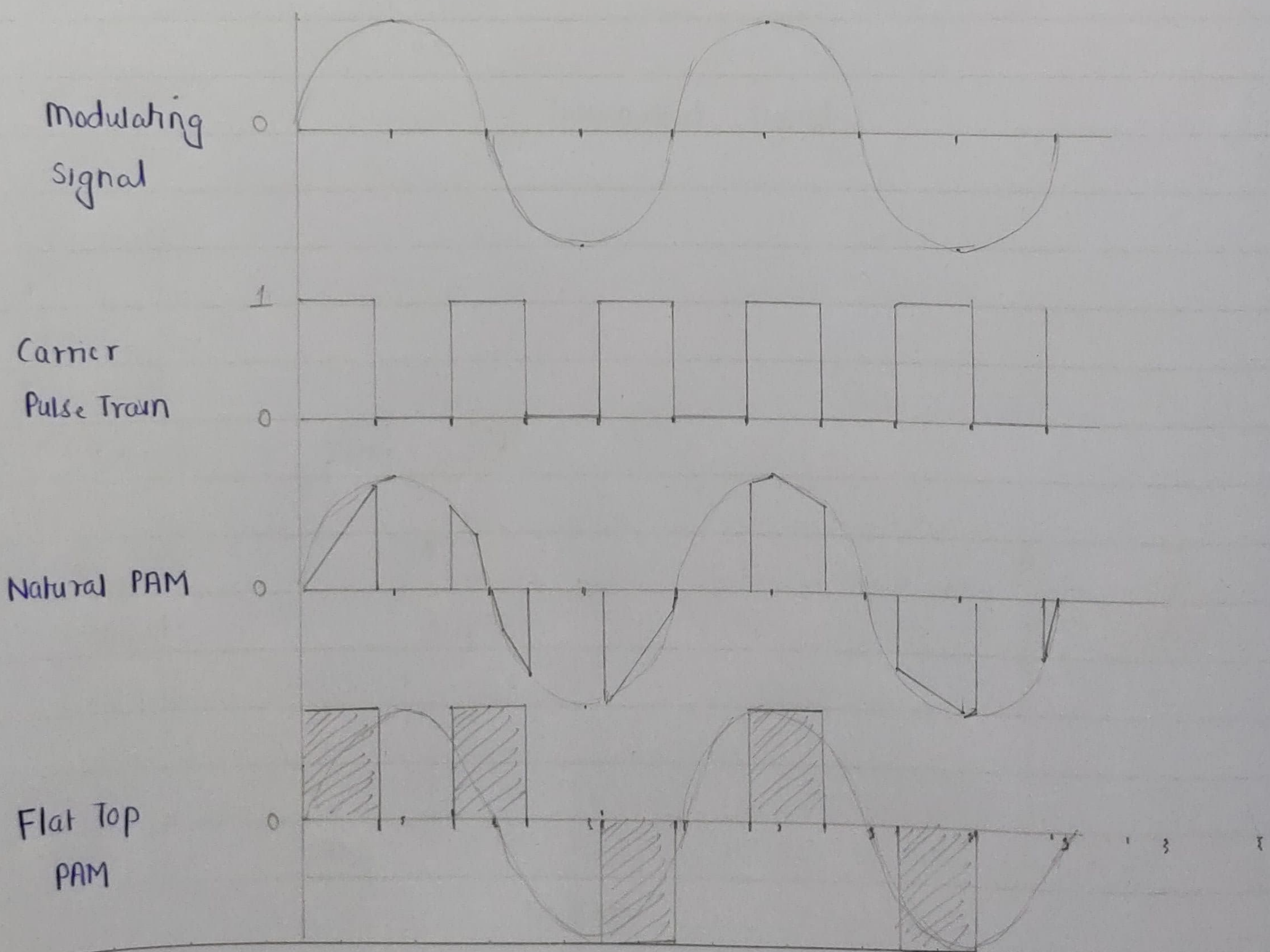
In Pulse Modulation, continuos signals are sampled at regular intervals. Pulse modulation is further divided into Analog and Digital communication and further analog and digital modulation is subdivided in PAM, PWM, PPM (analog) and PCM, DM (digital).

2.) Pulse Amplitude Modulation (PAM) :

→ In PAM, a pulse signal is used to sample an analog signal. The result is a train of constant-width pulses. The amplitude of each pulse is proportional to the amplitude of the message signal at the time of sampling. The PAM signal follows the amplitude of the original signal, as the signal traces on the path of the whole wave.

- Types of Modulation
  - Continuous-wave Modulation
    - Amplitude Modulation
    - Angle Modulation
      - Frequency Modulation
      - Phase Modulation
  - Pulse Modulation
    - Analog Modulation
      - PAM
      - PWM
      - PPM
    - Digital Modulation
      - Pulse Code Modulation
        - Delta Modulation

## Natural Sampling and Flat Top Sampling



→ PAM signal generation: We can generate PAM signal by two types of sampling process.

Natural Sampling: For a PAM signal produced with natural sampling, the sampled signal follows the wave-form of the input signal during the time that each sample is taken.

Flat-top Sampling: In this type of sampling, a sample and hold circuit is used to hold the amplitude of each pulse at a constant level.

3.) Pulse Width Modulation (PWM)

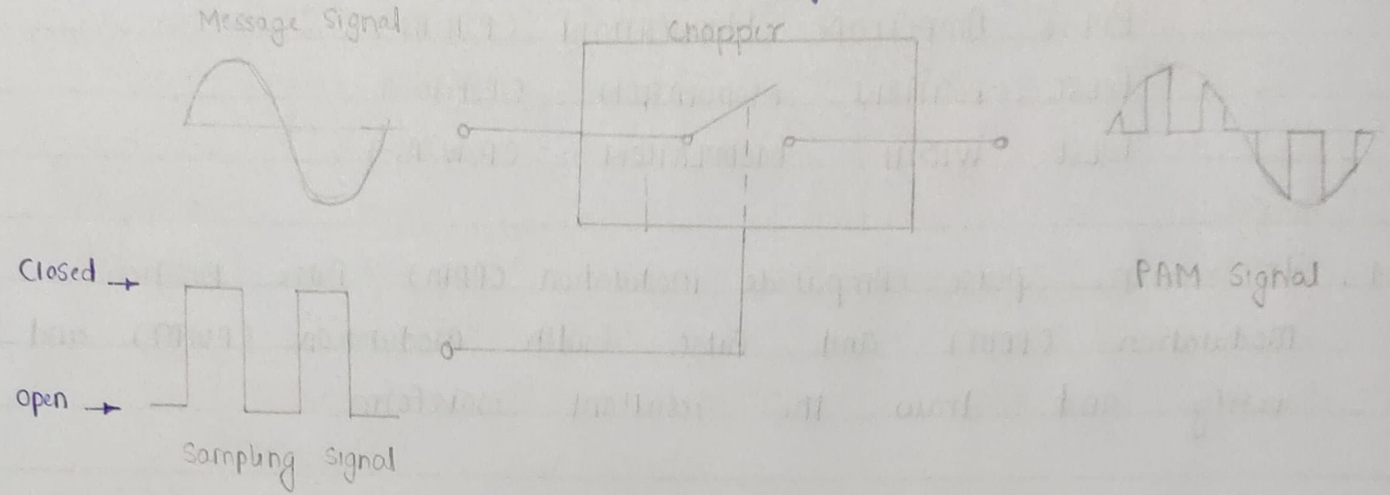
→ In this type, the amplitude is maintained constant but the duration or length or width of each pulse is varied in accordance with instantaneous value of analog signal.

4.) Pulse Position Modulation (PPM)

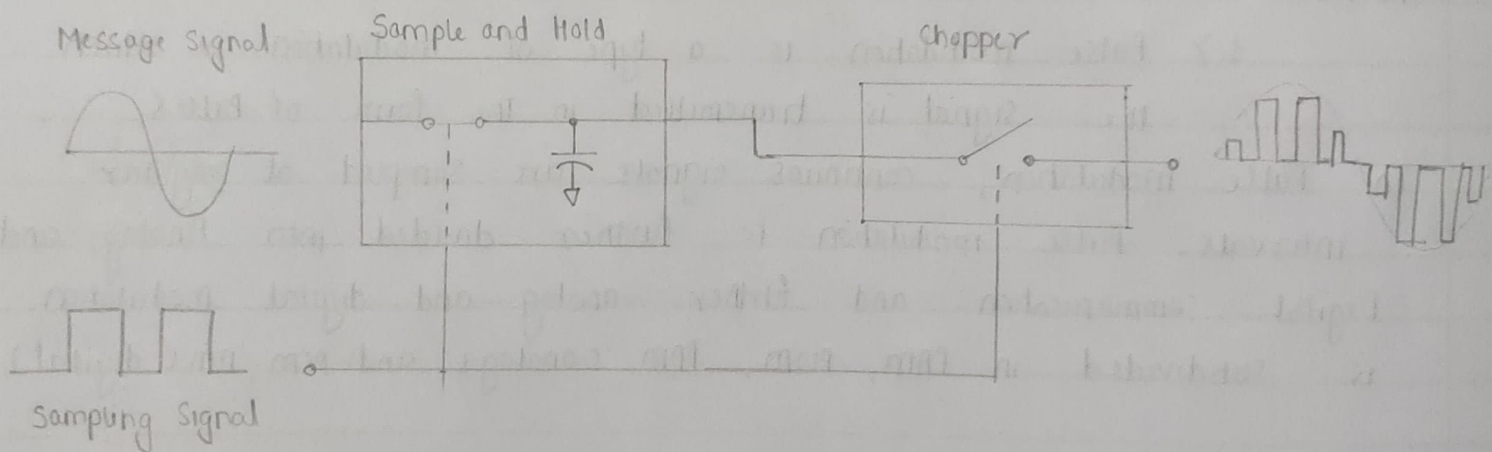
→ In this types of modulation, both the amplitude and width of the pulse are kept constant. we vary the position of each pulse according to the instantaneous sampled value of the message signal.

→ PPM is further modification of PWM

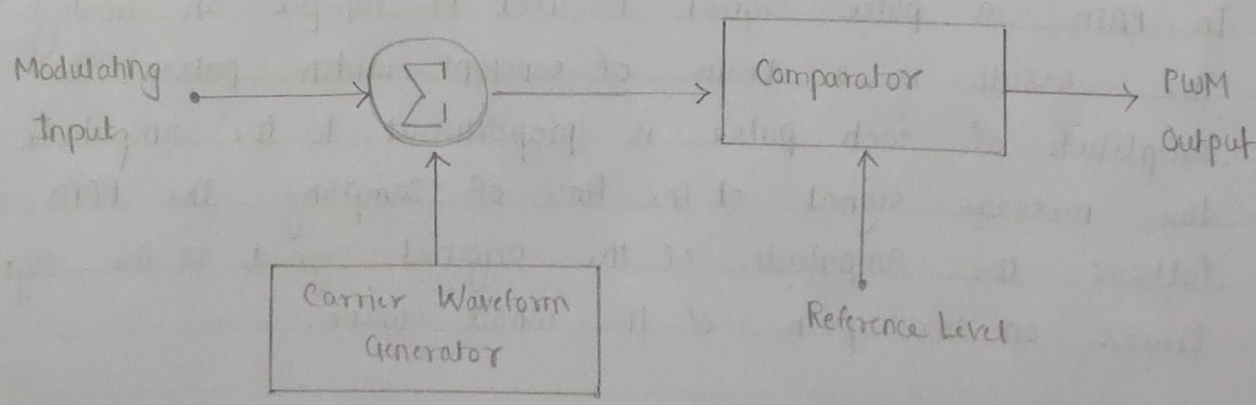
## Generation of PAM by Natural Sampling :




## Generation of PAM signal by Flat-top Sampung




## Generation of PWM Signal



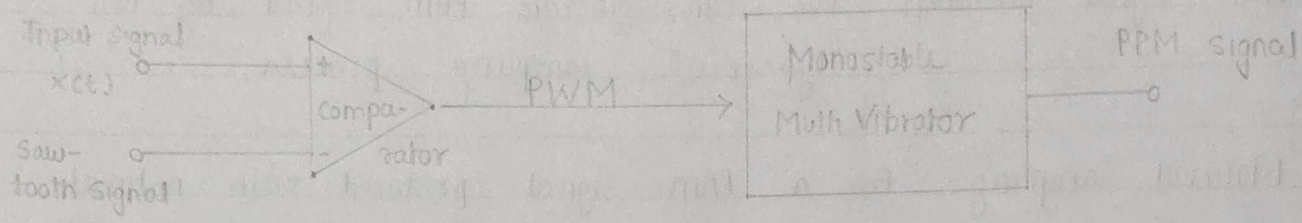
5.) Comparision of PAM, PWM and PPM :

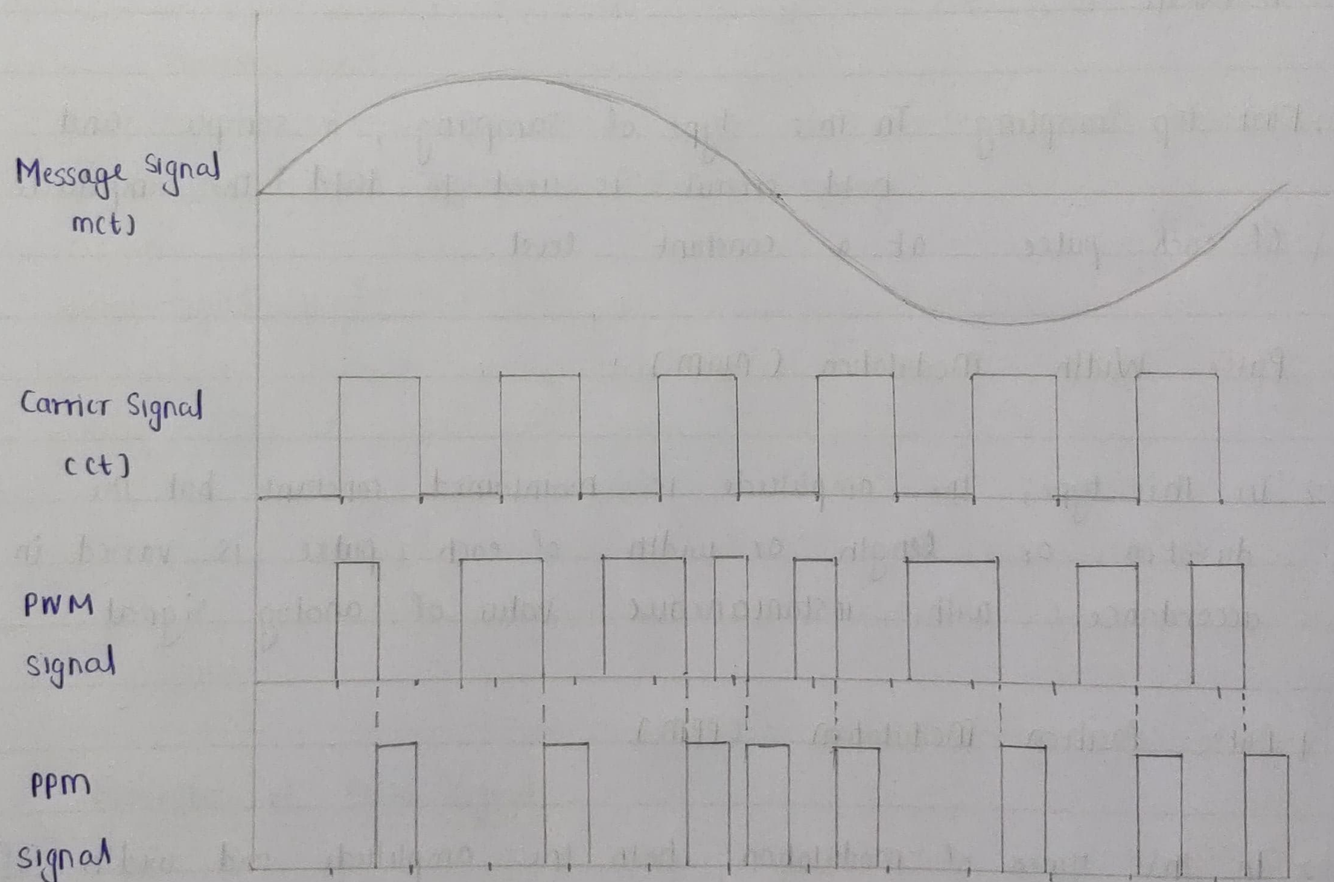
| Sr No | Pulse Amplitude modulation (PAM) | Pulse Width modulation (PWM) | Pulse Position modulation (PPM) |
|---|---|---|---|
| 1.) | Amplitude of the pulse proportional to amplitude of modulating signal. | Width of the pulse is proportional to amplitude of modulating signal. | The relative position of the pulse is proportional to amplitude of modulating signal. |
| 2.) | Bandwidth of the transmission channel depends on the pulse width. | Here, it depends on the rise time of the pulse. | Here, it depends on Rising time of the Pulse. |
| 3.) | Instantaneous power of transmitter varies. | Instantaneous power of transmitter varies. | Instantaneous power of the transmitter is constant. |
| 4.) | Noise interference is high. | Noise interference is minimum. | Noise interference is minimum. |
| 5.) | System is complex to implement | System is simple to implement | System is simple to implement. |
| 6.) | Similar to Amplitude Mod. | Similar to Frequency mod. | Similar to Phase Mod. |

> CONCLUSION : We successfully examined Pulse Amplitude modulation, Pulse Position modulation, Pulse width modulation and also verified their waveforms. We also illustrated circuits for PAM and PWM. We performed our experiment successfully using MATLAB.

Teacher's Signature:

## Generation of PPM Signal



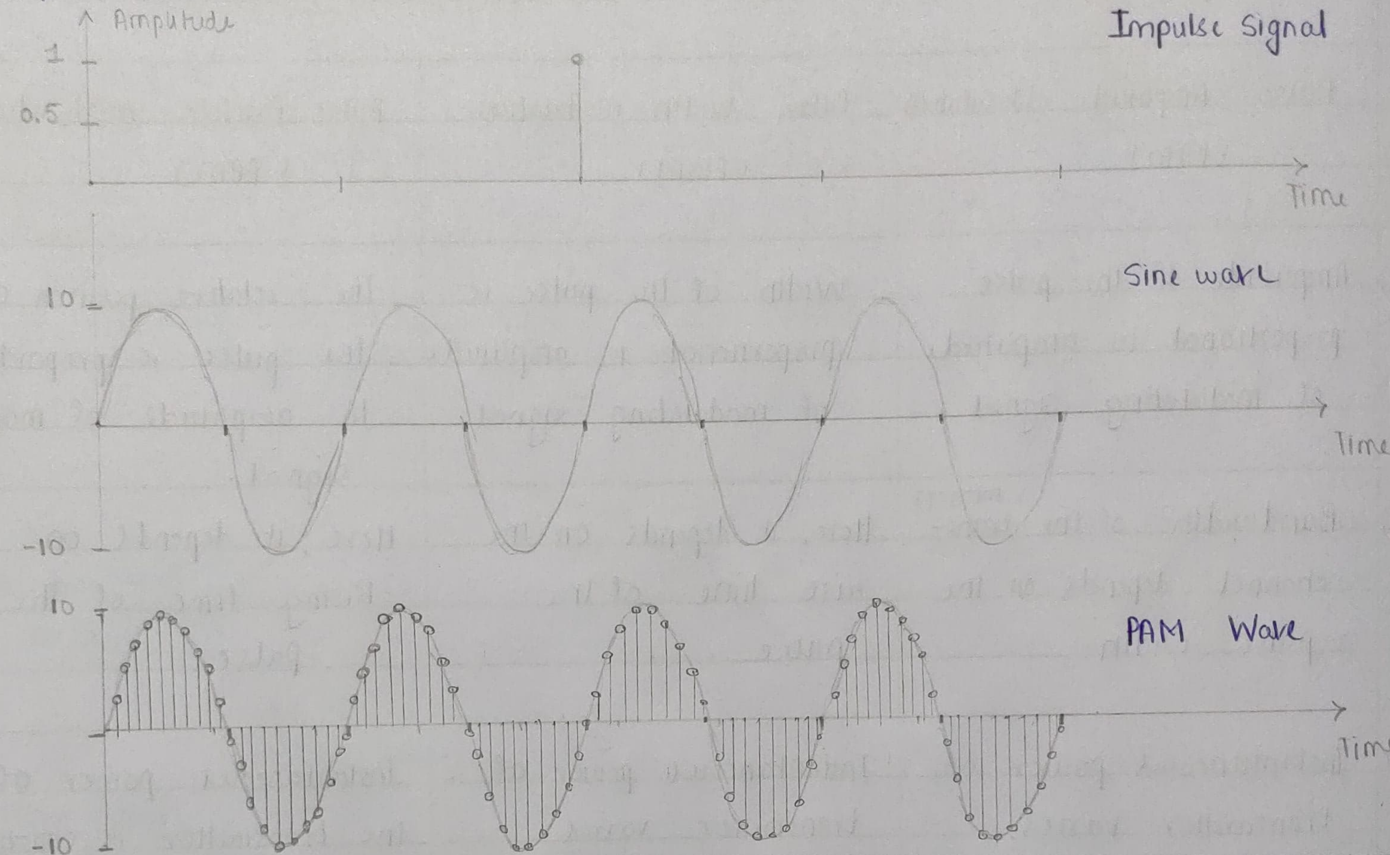

Waveform representation of PPM signal generation

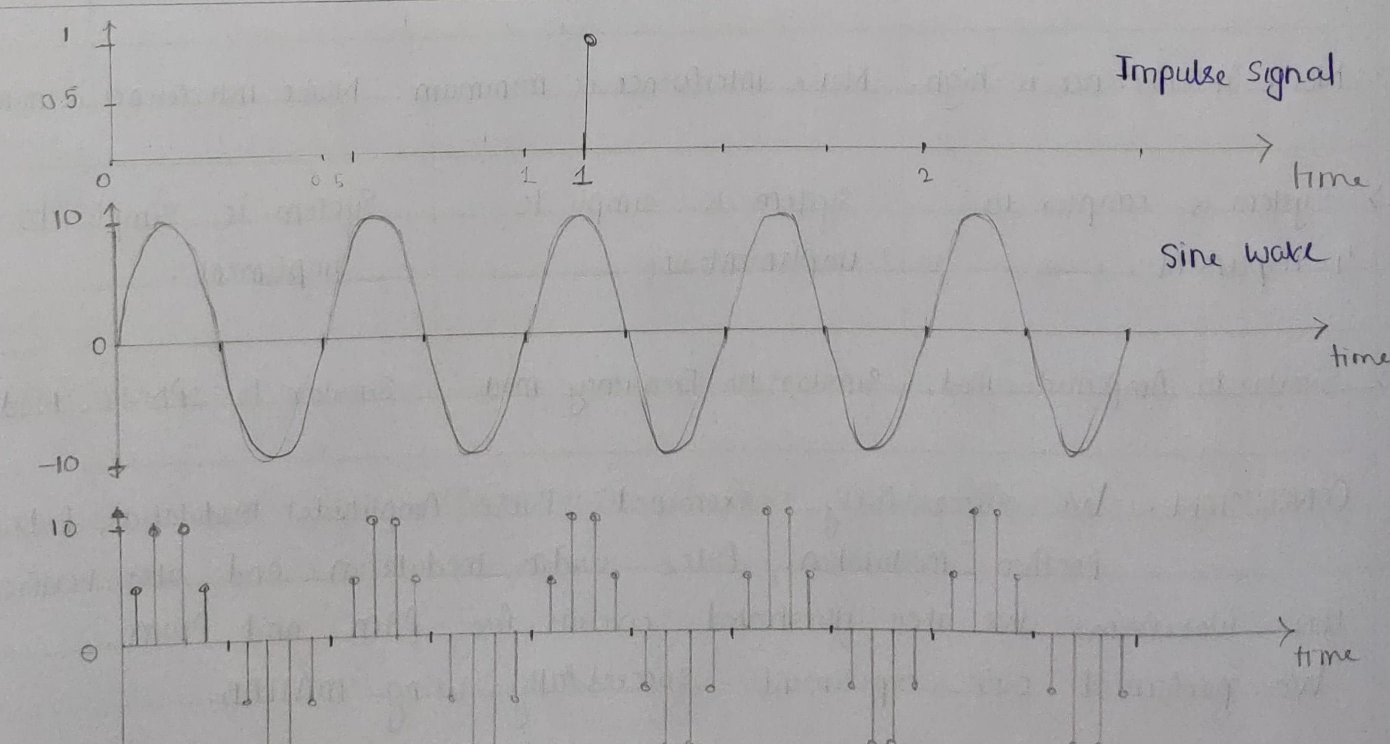
MATLAB CODE :

```
% PAM using Ideal Sampling
clc;
close all;
clear all;
a = input('Enter the amplitude = ');
f= input('Enter the frequency = ');
t= 0:0.02:2;
x1 = 1;                          % generation of Impulse signal
x2 = a * sin(2*pi*f*t);          % generation of sine wave
y= x1.*x2;                       % modulation step
subplot(3,1,1);                  % for impulse signal plot
stem(x1);
title('Impulse Signal');
xlabel('Time');
ylabel('Amplitude');
subplot(3,1,2);                  % for sine wave plot
plot(t,x2);
title('Sine Wave');
xlabel('Time');
ylabel('Amplitude');
subplot(3,1,3);                  % for PAM waveplot
stem(t,y);
title('PAM wave');
xlabel('Time');
ylabel('Amplitude');
```

# PAM with Ideal Sampling

1.7 A = 1V f = 2 Hz




PAM

% PAM using Natural sampling

```
clc; clear all; close all;
fc = 100
fm = fc/10
fs = 100*fc
t = 0: 1/fs : 4/fm;
Msg_sgl = cos(2*pi*fm*t);
Carr_sgl = 0.5* square(2*pi*fc*t) +0.5
Mod_sgl = Msg_sgl.*Carr_sgl;
tt = [];
for i=1: length(Mod_sgl);
    if Mod_sgl(i)==0;
        tt = [tt, Mod_sgl(i)];
    else
        tt = [tt, Mod_sgl(i)+2];
    end
end
figure(1)
```

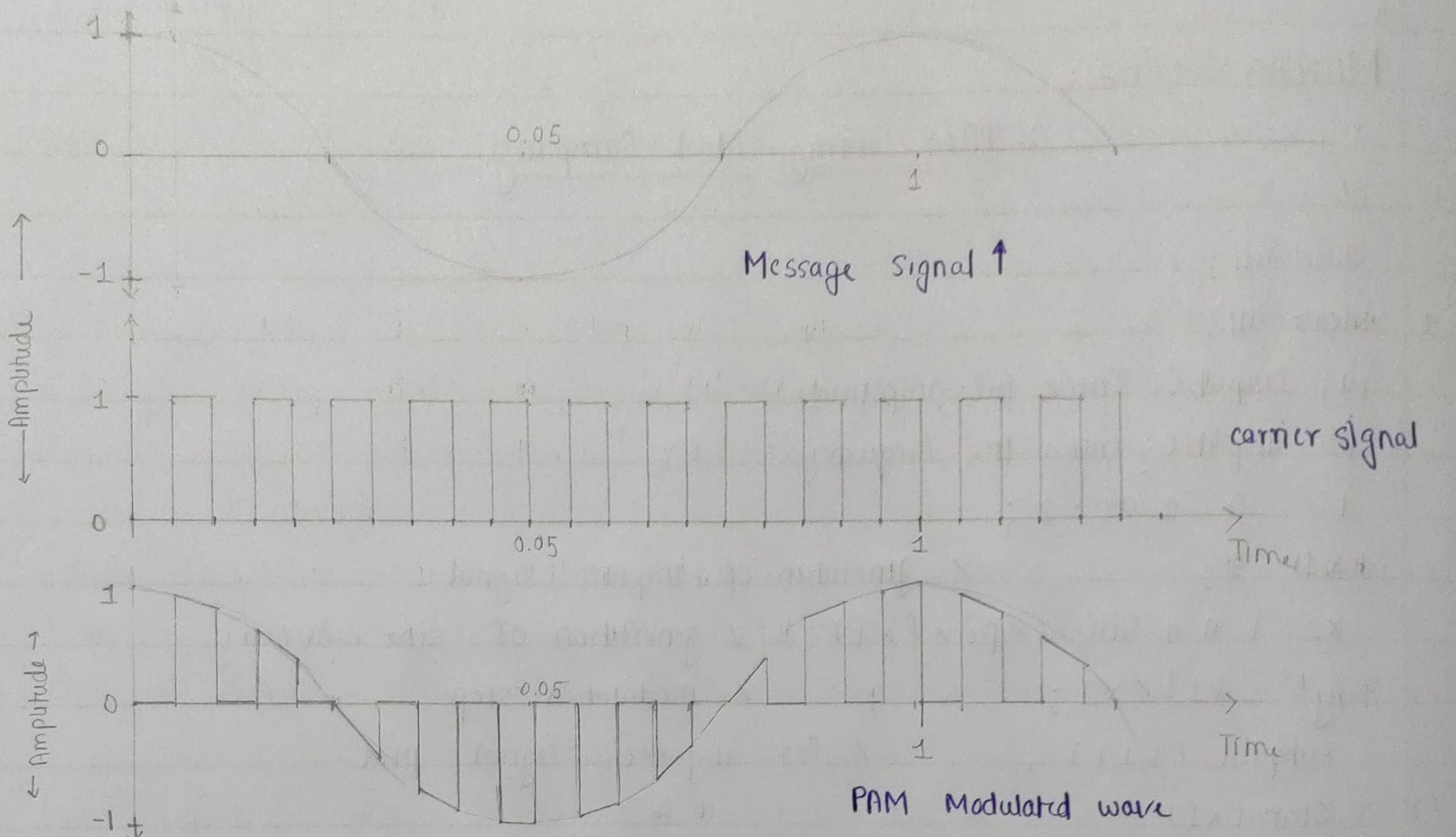
| Message | Carrier | PAM Modulated |
|---|---|---|
| subplot(4,1,1); | subplot(4,1,2); | subplot(4,1,3); |
| plot(t, Msg_sgl); | plot(t, Carr_sgl); | plot(t, Mod_sgl); |
| title('message Signal'); | title('Carrier Signal'); | title('PAM modulated signal') |
| xlabel('Time period'); | xlabel('Time period'); | xlabel('Time Period') |
| ylabel('Amplitude'); | ylabel('Amplitude'); | ylabel('Amplitude') |

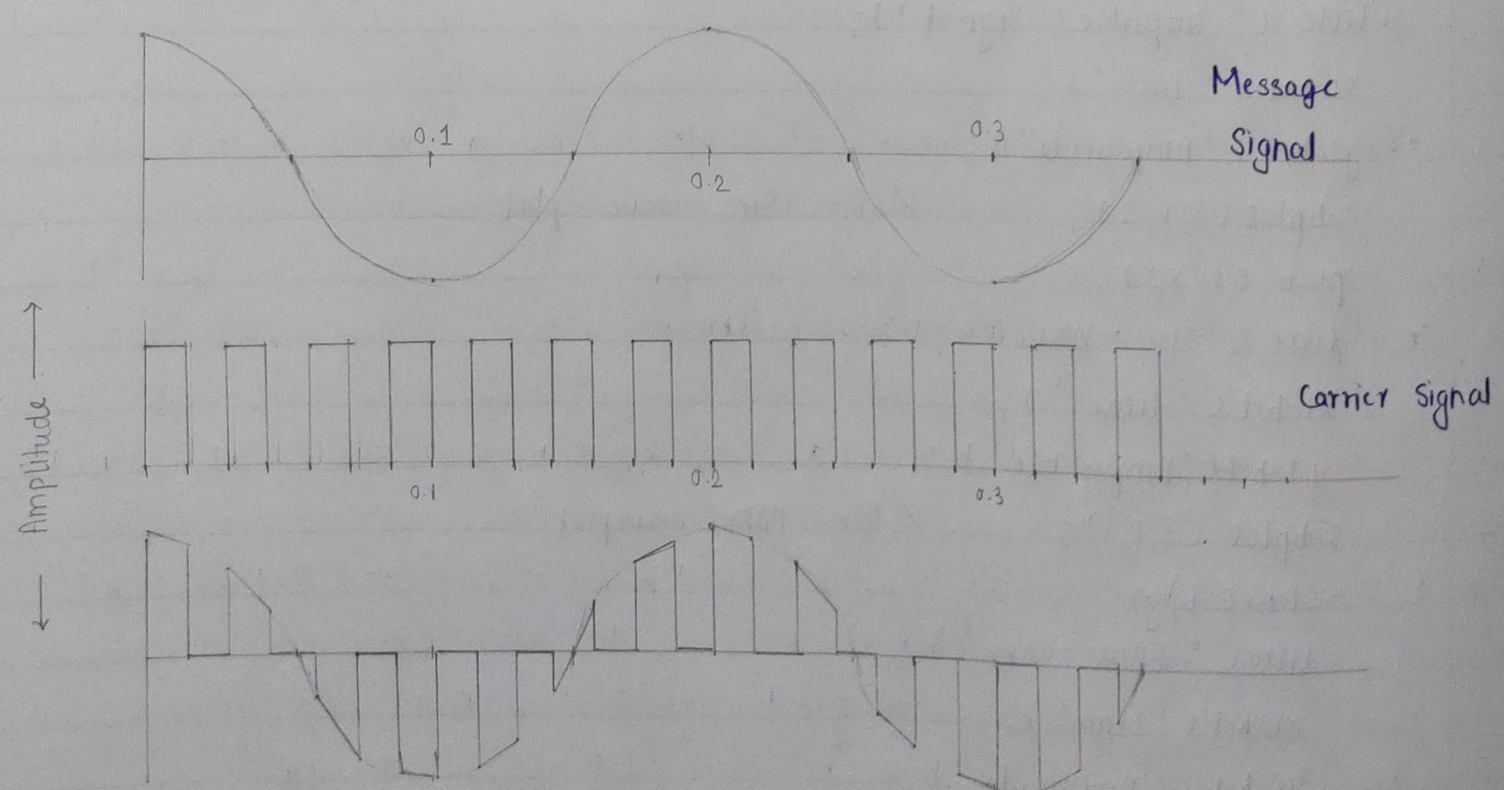
PAM Using Square Wave

(Natural Sampling)



1> $F_c = 100$ $F_m = 10$ $F_s = 10,000$



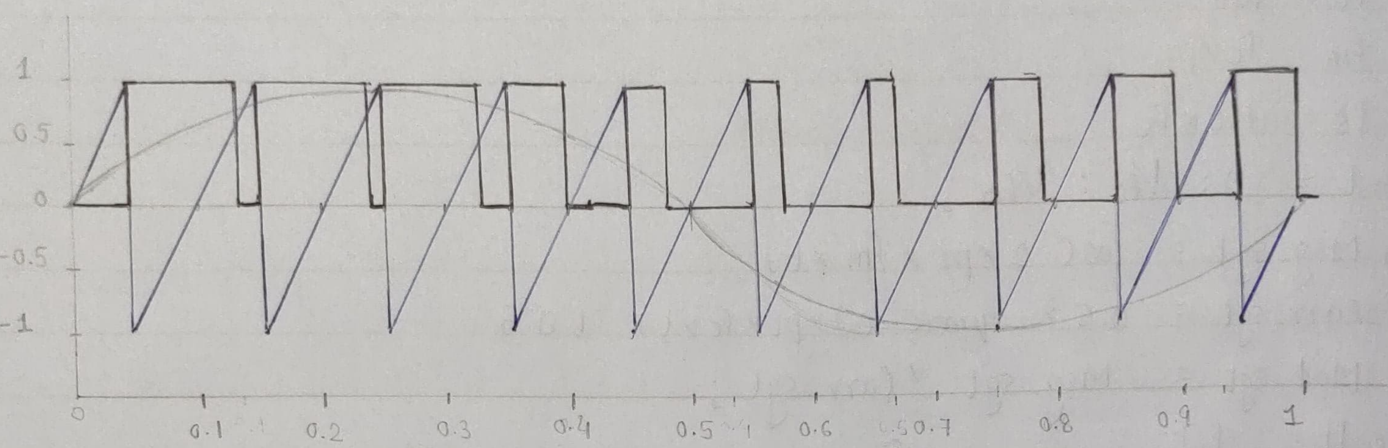



% PWM Signal

```
clc;
close all;
clear all;
t= 0: 0.0001 : 1;
s= sawtooth (2*pi* 10*t +pi);
m= 0.75* sin(2*pi* 1*t);
n= length(s)
for i=1:n
    if ( m(i)>=s(i))
        pwm(i) =1;
    elseif ( m(i)<=s(i))
        pwm(i) =0;
    end
end
plot (t, pwm,'g', t,m,'r', t, s,'b');
ylabel ('Amplitude');
axis ([0 1 -1.5 1.5]);
xlabel ('Time index');
title ('PWM wave');
grid on;
```

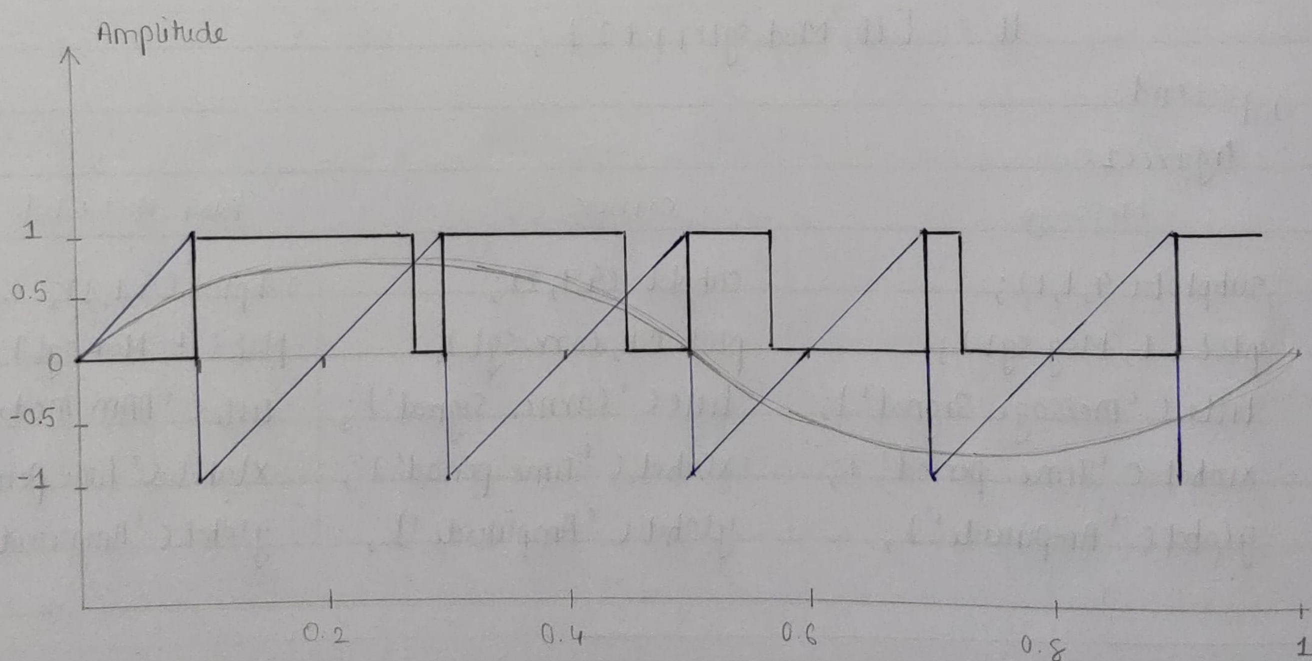
# PWM

1.) S = sawtooth (2*pi* 10*t + pi);




— : Saw tooth — : PWM signal — : Message signal

2.) S = sawtooth (2*pi*5*t + pi);




— : saw tooth — : PWM signal — : Message signal

[U19CS012]

% PPM Signal

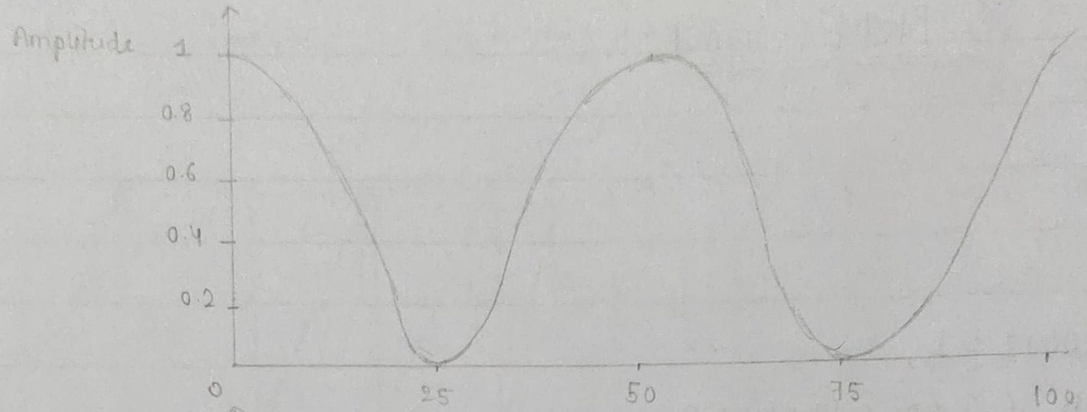
```
clc;
clear all;
close all;
fc = 10;
fs = 100;
fm = 2;
t = 0: 1/fs : ((2/fm) - (1/fs));
X = 0.5 * cos(2*pi*fm*t) + 0.5
Y = modulate (X, fc, fs, 'PPM');
subplot( 2,2,1);
plot (x);
title ('msg signal')

subplot (2,2,2)
plot(Y);
axis ( [0 20 -0.2 1.2]);
title ('PPM');
```

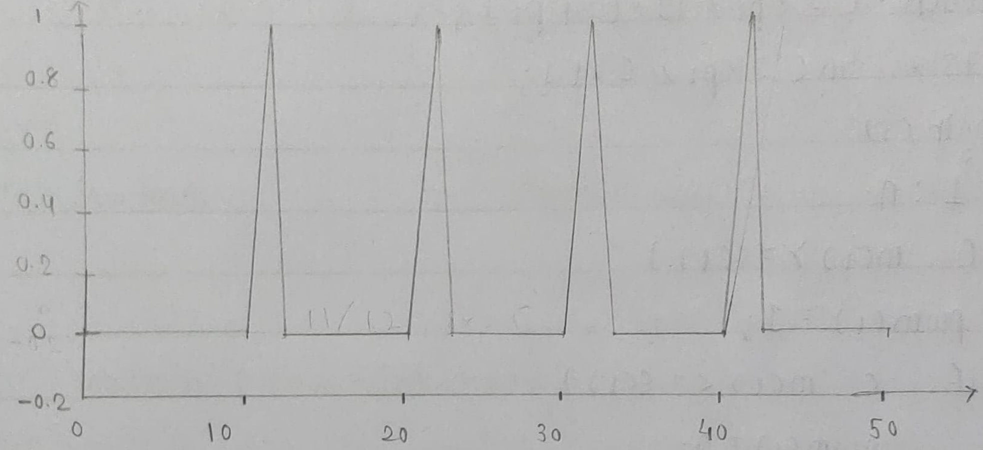
> CONCLUSION: We have successfully examined Pulse Amplitude Modulation Pulse Position modulation, Pulse Width Modulation and also verified their waveforms using MATLAB.

# PPM Signal

1.) $F_c$ = 10 $F_s$ = 100 $F_m$ = 2

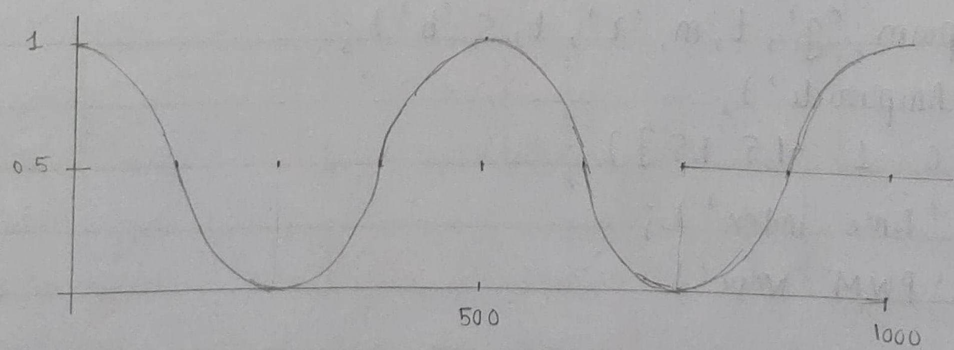



Msg Signal

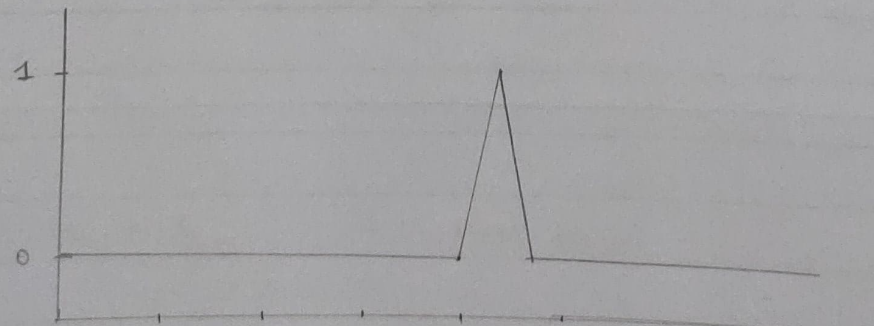



PPM

2.) $F_c$ = 40 $F_m$ = 1000 $F_m$ = 2




Msg Signal




PPM