Experiment -5

Pulse Amplitude Modulation (P.A.M)
Pulse Position Modulation (P.P.M)
Pulse Width Modulation (P.W.M)

Aim: To examine PAM, PPM and PWM and verify and draw the resultant waveforms. Illustrate the circuit diagram for PAM and PWM. Show and draw the output waveforms using Matlab code/simulink using virtual mode

Apparatus: Matlab software (online)

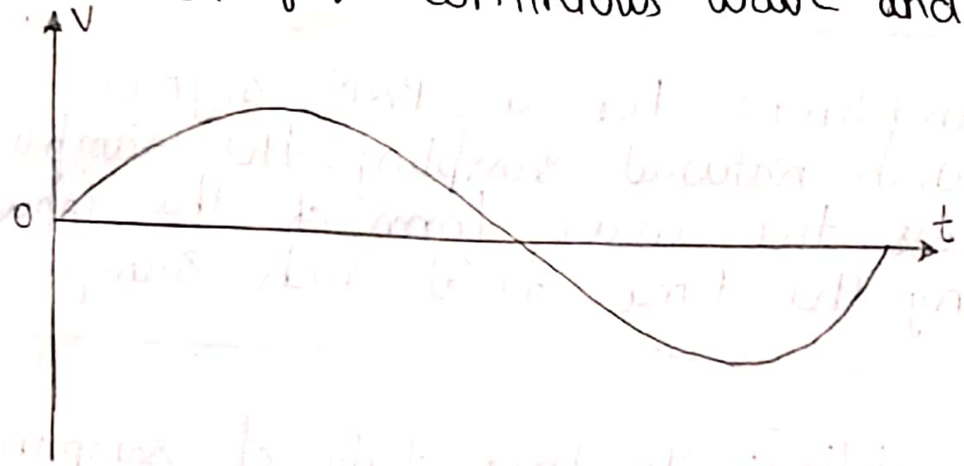
Theory:

1) Pulse modulation is a type of modulation in which the signal is transmitted in the form of Pulses. Pulse modulation is further divided into analog and digital communication and further analog and digital is subdivided in PAM, PWM, PPM, PCM, DM (digital Modulation).

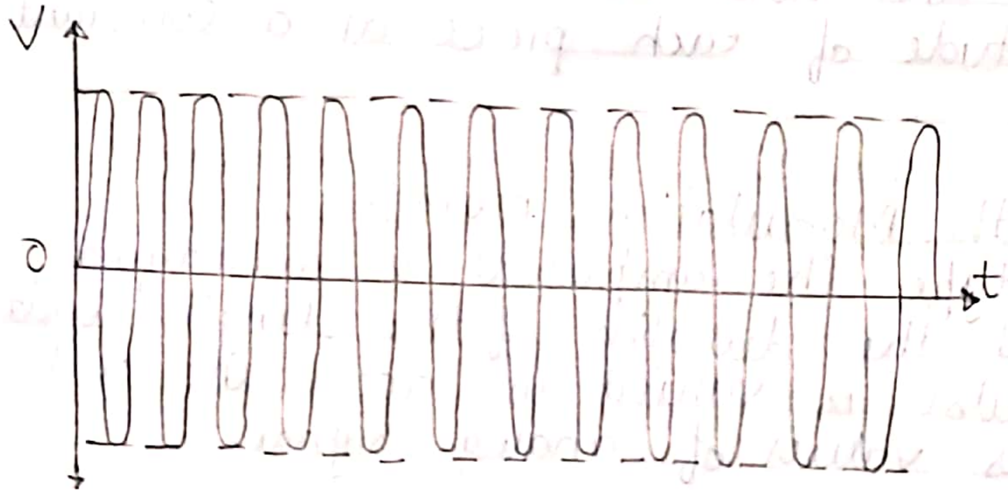
2) Pulse Amplitude Modulation (PAM)
In PAM, a pulse signal is used to sample an analog signal. The result is the train of constant width pulses. The amplitude of each pulses is propotional to the amplitude of message signal at the time of sampling.

→ PAM signal generation:- We can generate PAM signal by 2 types of sampling processes.

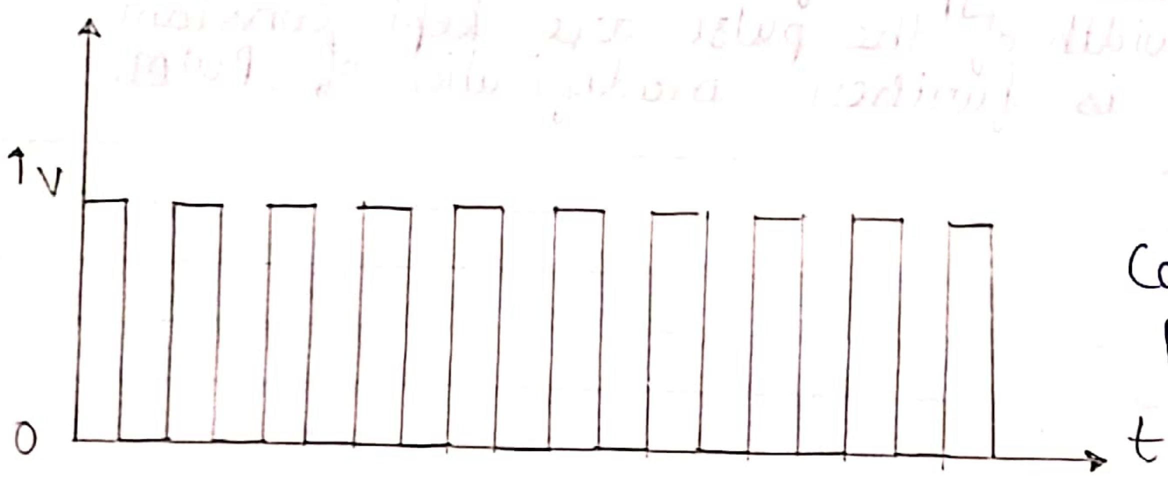
Carrier for Continious wave and pulse modulation



Modulating signal (same for both techniques)



Carrier for continious wave modulation (AM, FM, PM)



Carrier for pulse modulation

- Natural Sampling:- For a PAM signal produced with natural sampling, the sampling 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 piece at a constant level.

3) Pulse width Modulation (PWM):

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

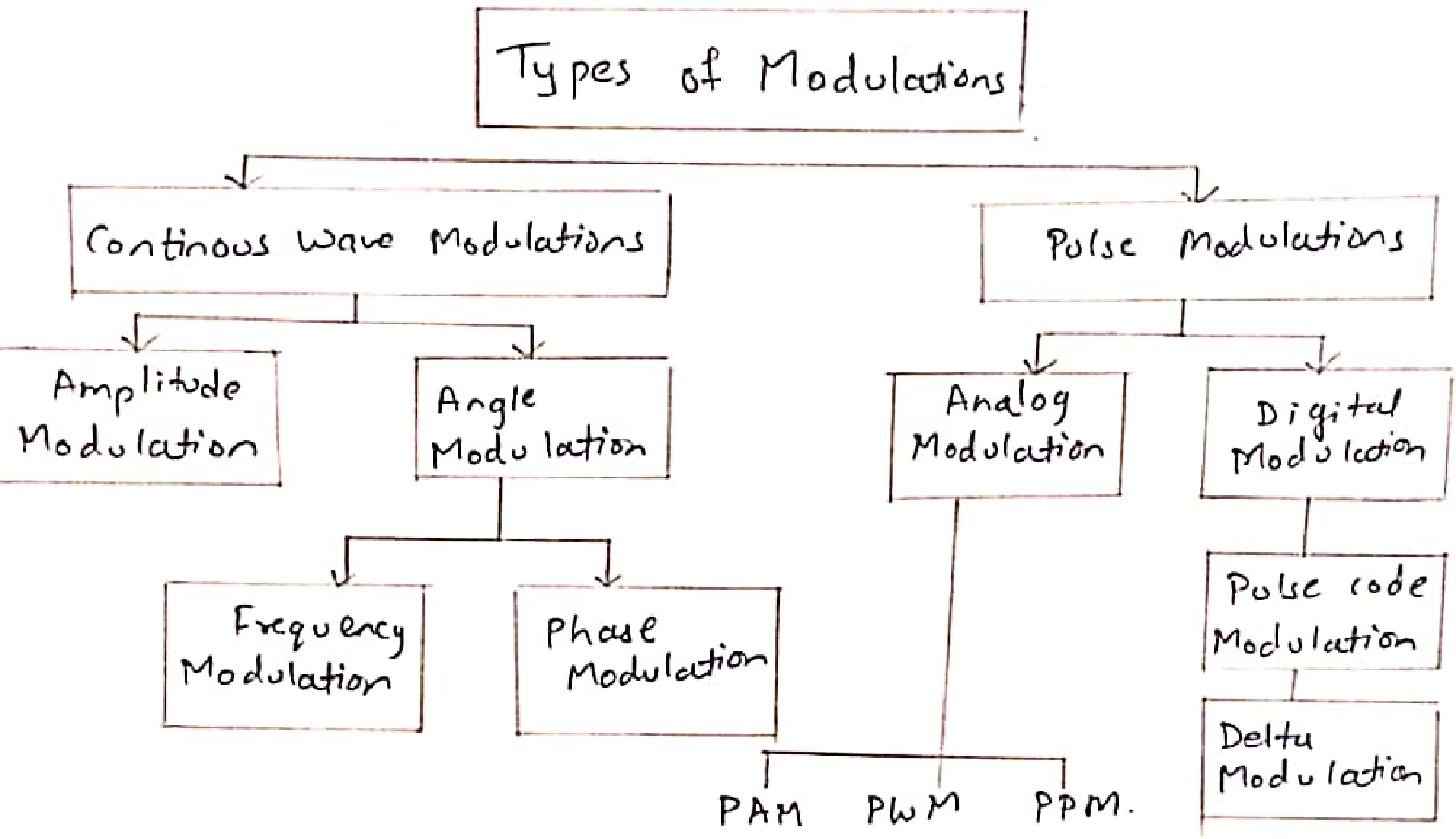
4) Pulse position Modulation (PPM):-

In this type of modulation, both the amplitude and width of the pulse are kept constant.

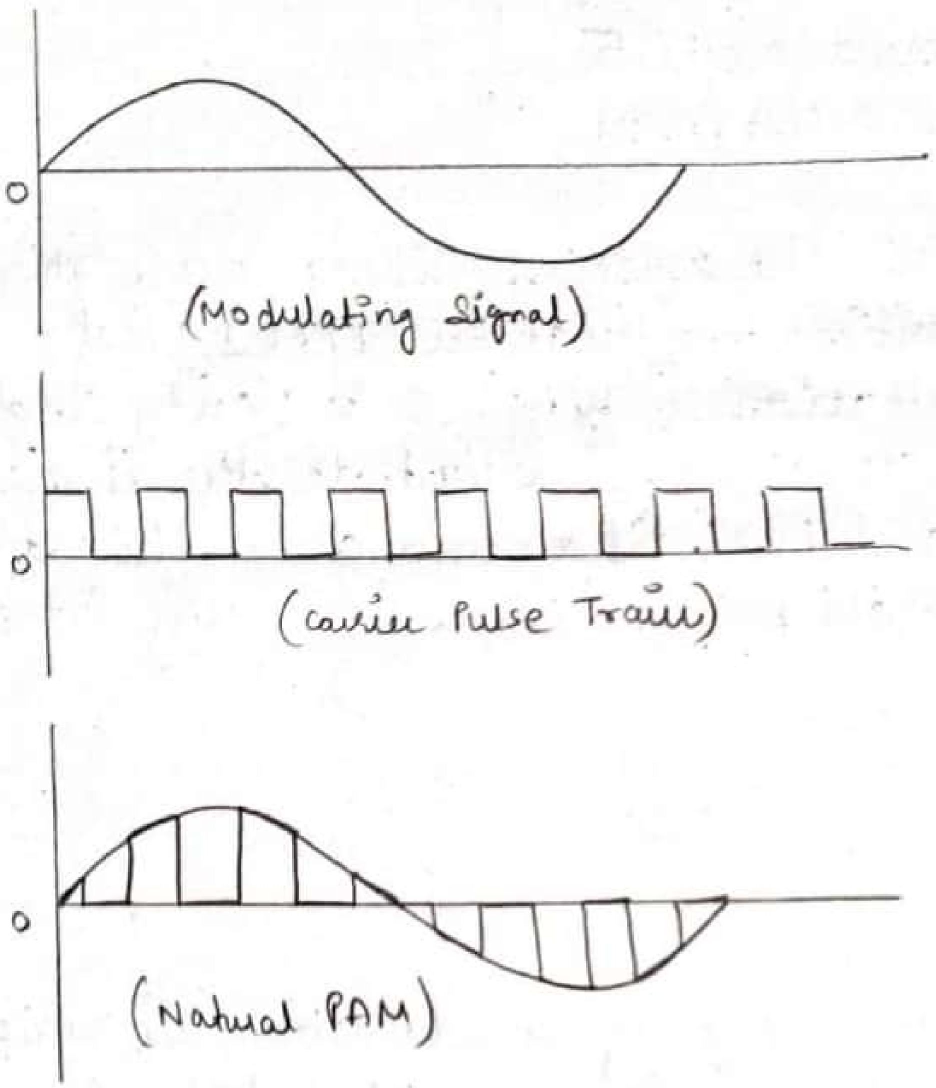
→ PPM is further modification of PWM.

Teacher's Signature :

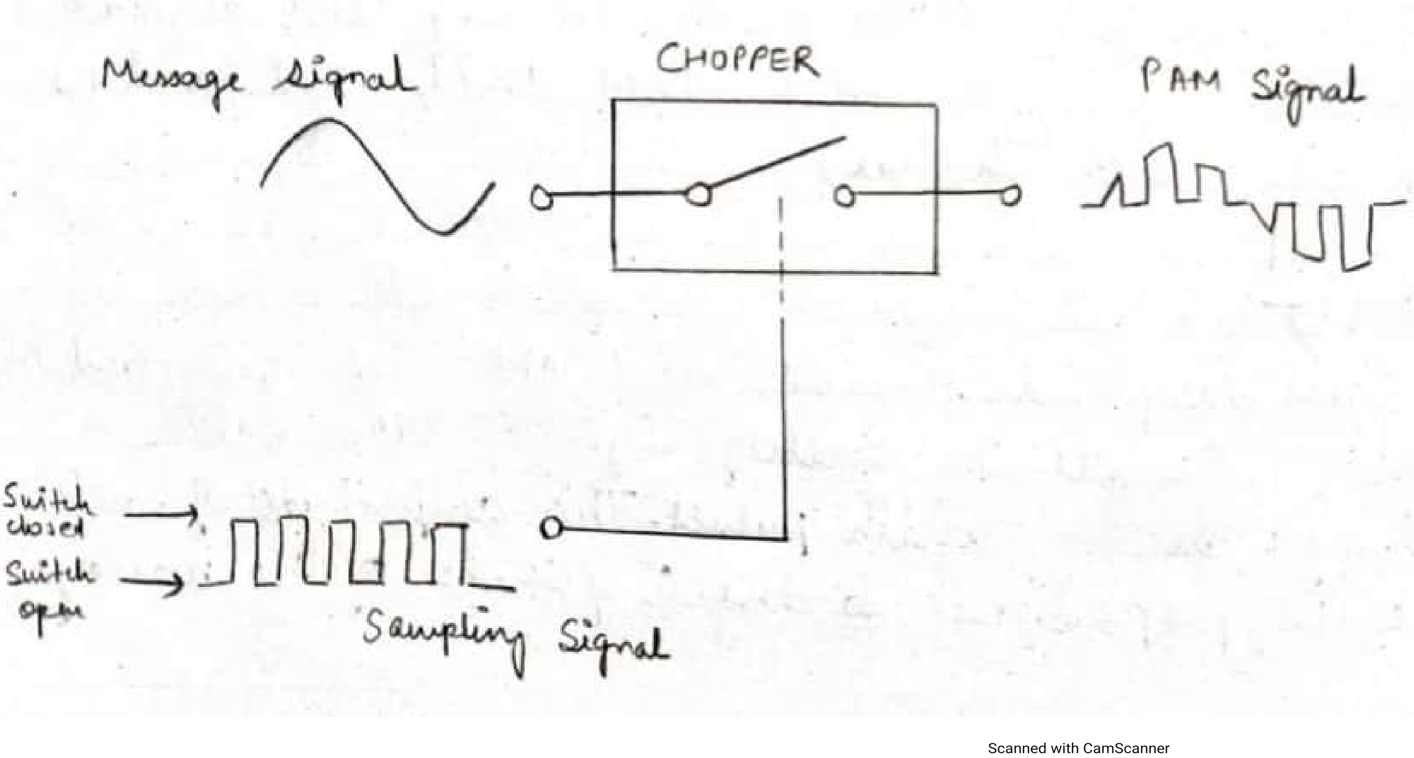
Block Diagram Showing Basic Classification



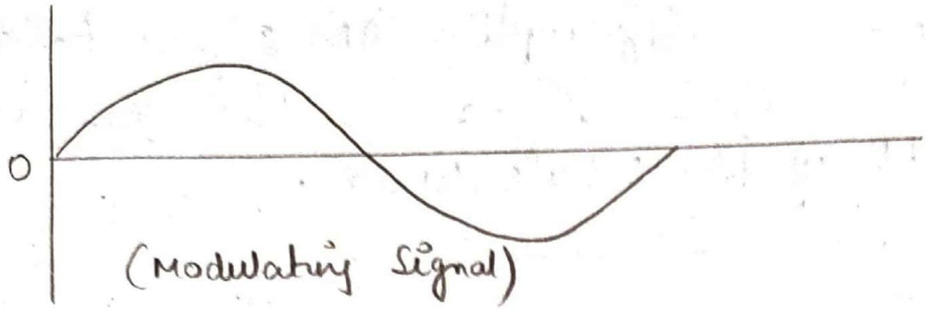
Natural Sampling :—



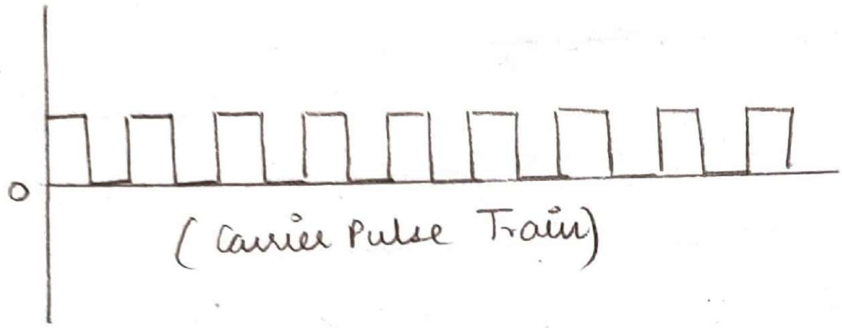
Generation of PAM by Natural Sampling :



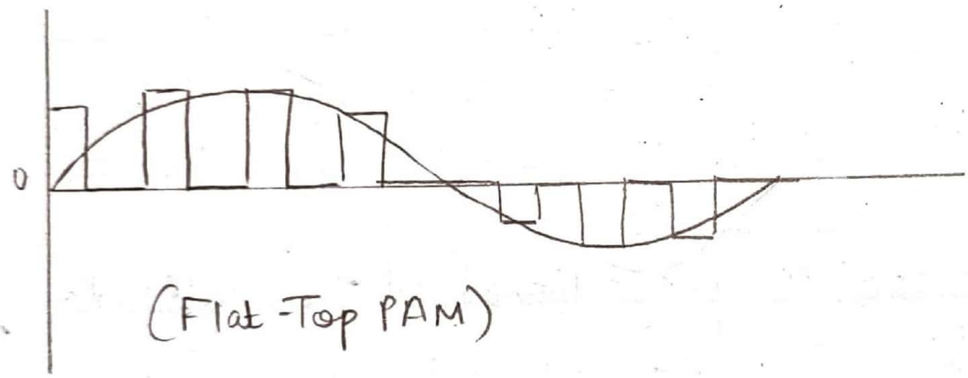
Flat Top Sampling :-



(Modulating Signal)

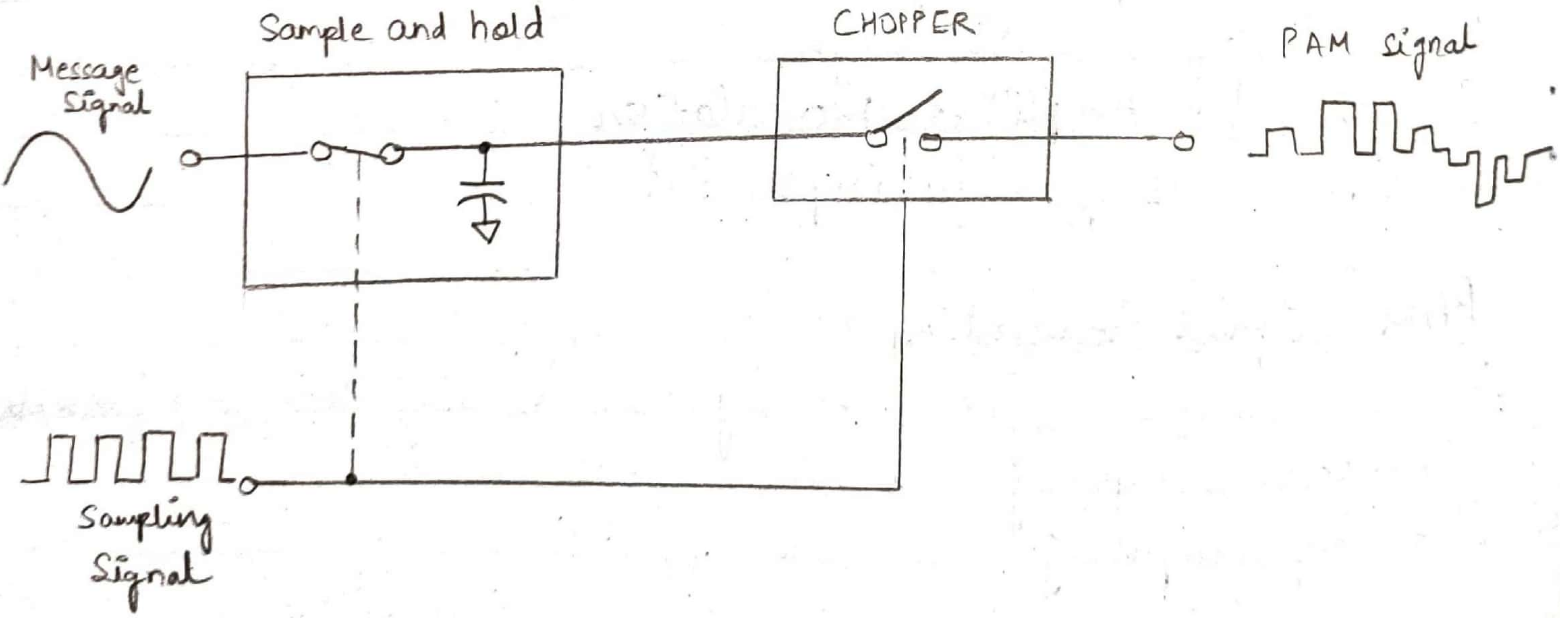


(Carrier Pulse Train)



(Flat-Top PAM)

Generation of PAM by Flat-Top Sampling :

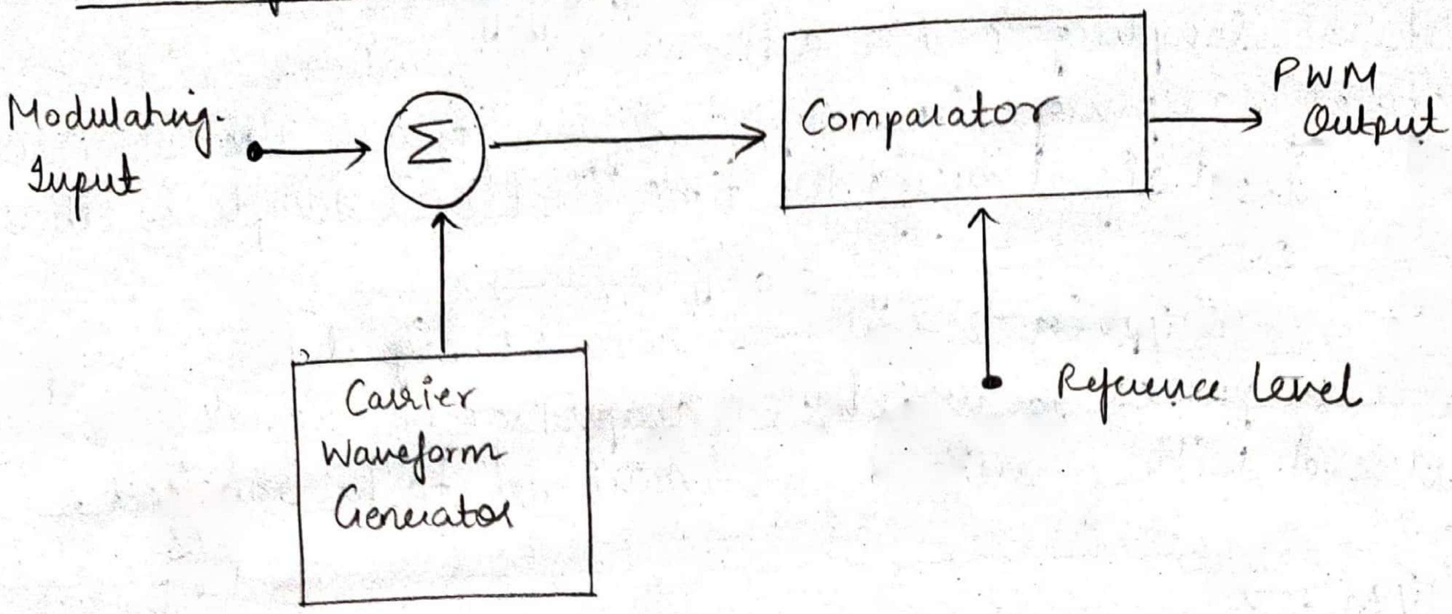


5) Comparison of PAM, PWM and PPM

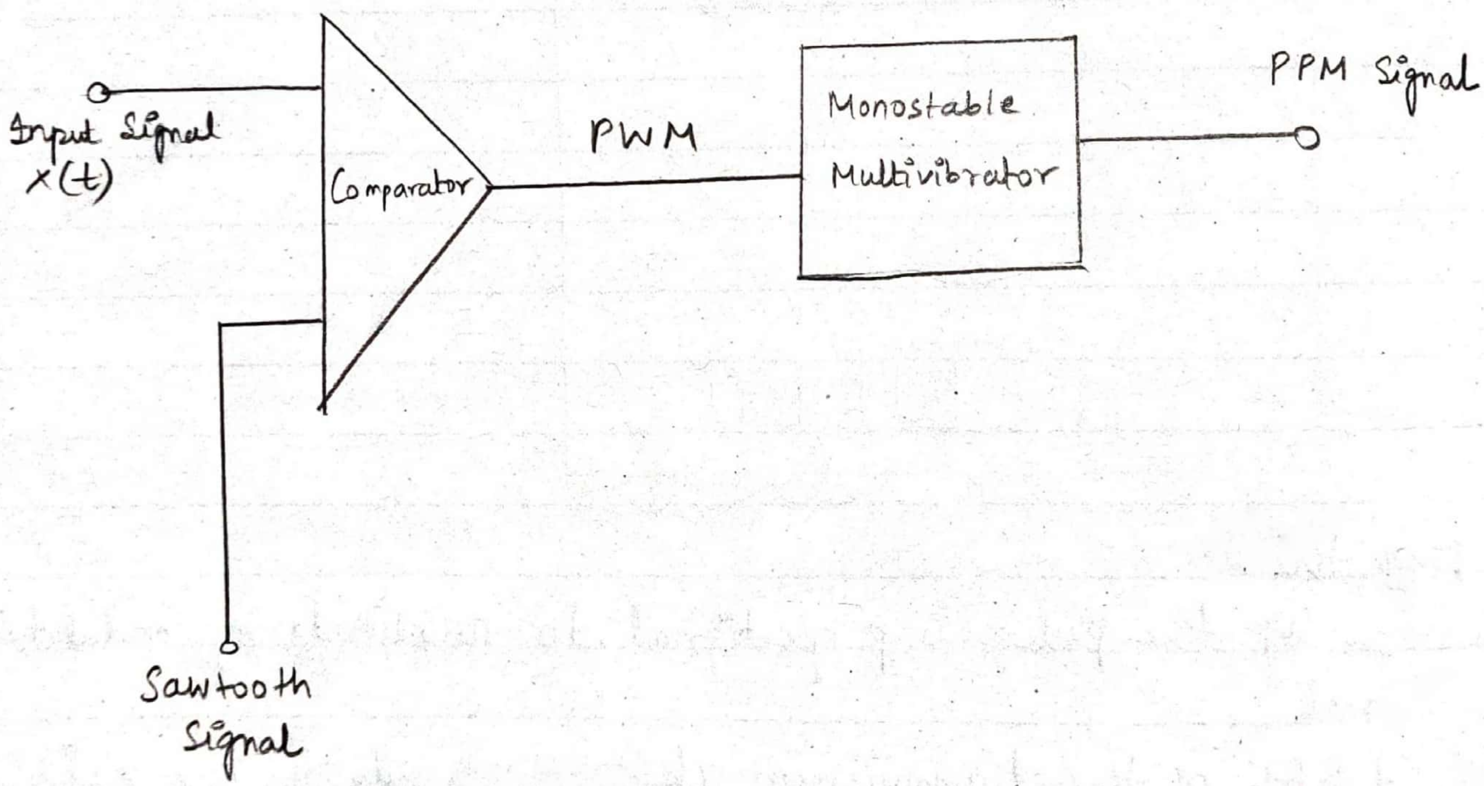
S.NO	PAM	PWM	PPM
1)	Amplitude of the pulse is propotional to amplitude of modulating signal	Width of the pulse is propotional to amplitude of modulating signal	Relative position of Pulse is propotional to amplitude of modulating signal
2)	Instantaneous power of transmitter varies	varies	Constant
3)	Bandwidth of the transmission channel depends on the pulse width	Here it depends on the rise of time of pulse	Depends on the rising time of pulse
4)	Noise interference is high	Minimum	minimum
5)	System is Complex to implement	simple to implement	simple to implement
6)	Similar to amplitude modulation	Frequency modulation	Phase modulation

Teacher's Signature :

PWM Signal Generation:



PPM Signal Generation:

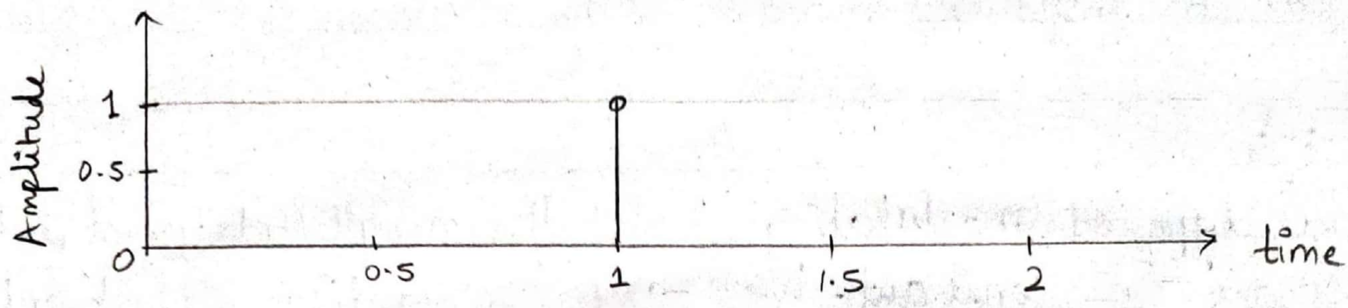


Matlab Code

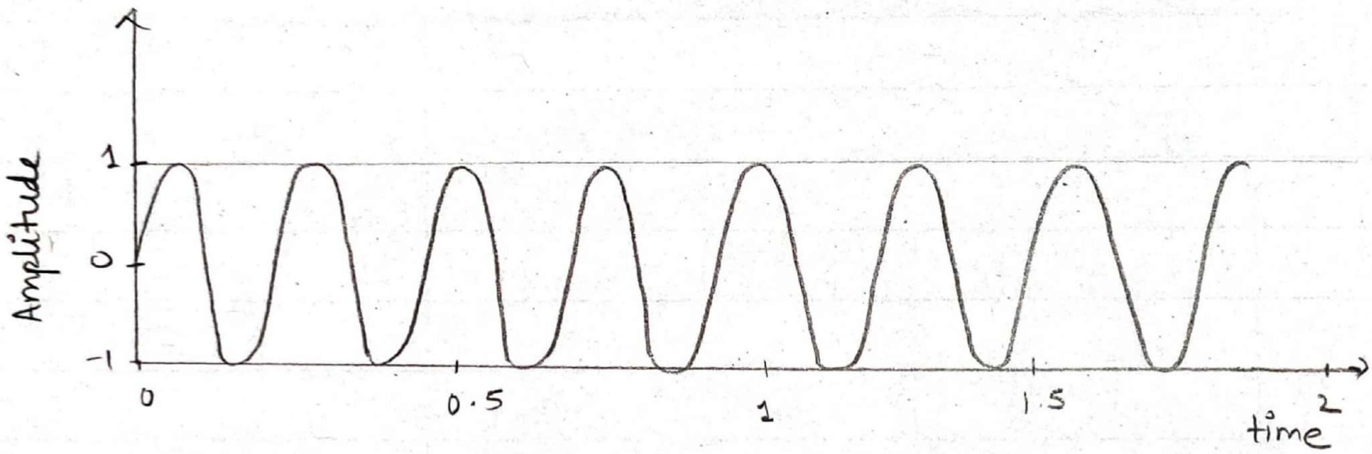
```
% PAM Signal
clc; clear all; close all;
 fc = 100
 fm  = fc/10
 fs  =  100 * fc
  t  =  0:1/fs:4/fm ;
 Msg-Sgl =  Cos (2* Pi* fm * t);
 carr_sgl = 0.5 * square (2* pi* fc*t) + 0.5
  Mod-sgl = Msg-sgl * Carr_sgl;
   tt [];
   for  i=1;   length ( mod_sgl)
          if  mod-sgl (i)  ==0;
          tt = [tt, Mod_sgl(i)];
          else
             tt= [tt, mod_sgl(i)+2];
          end.
end
figure(1)
subplot (4,1,1)
 plot (t, Msg-sgl , 'm');
 title ('message signal);
 x label ('Time period');
 y label ( 'Amplitude');

  Subplot (4,1,2);    Plot (t, Carr_sgl);
  title ('carrier signal');
  X- label ('time period');
```

(Amplitude = 1, freq = 5)

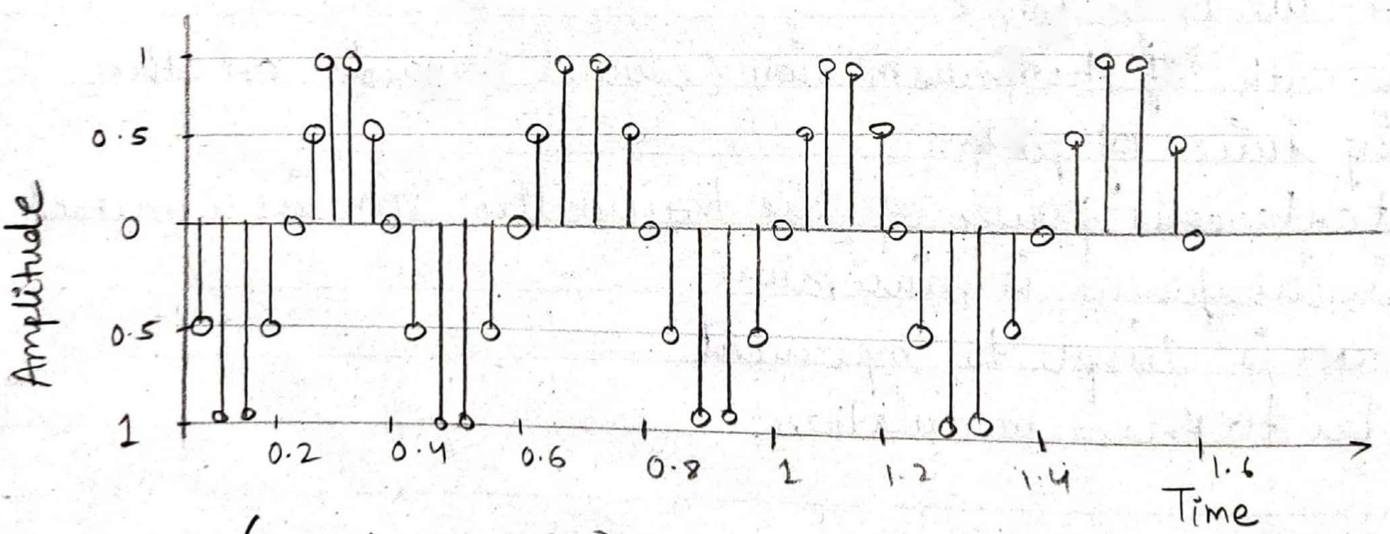
Impulse Signal:



Sine Wave:



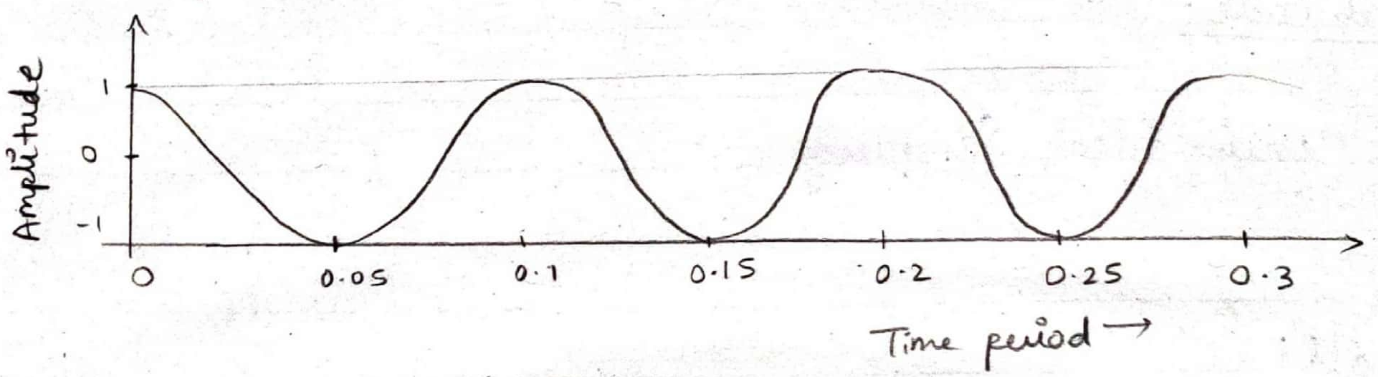
PAM Wave:



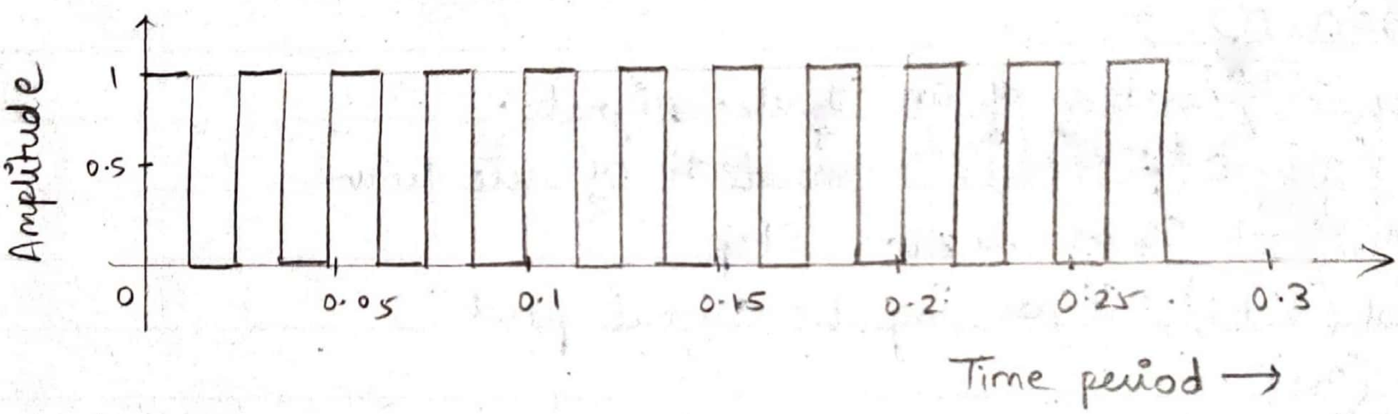
(Ideal Sampling)

```
ylabel ('Amplitude');
sub(4,1,3);   Plot(t, Mod_sgl, 'r');
title ('PAM Modulated Signal');
xlabel ('Time Period');
ylabel ('Amplitude');

% PPM Signal
clc; clear all; close all;
fc = 1000;
fs = 10,000;
fm = 200;
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 (2,1,1);   Plot(x);
title ('Msg-Signal');
subplot (2,1,2);   plot(y);
axis ([0,500 -0.2 1.2]);
title ('PPM');

% PWM - 1 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);
```

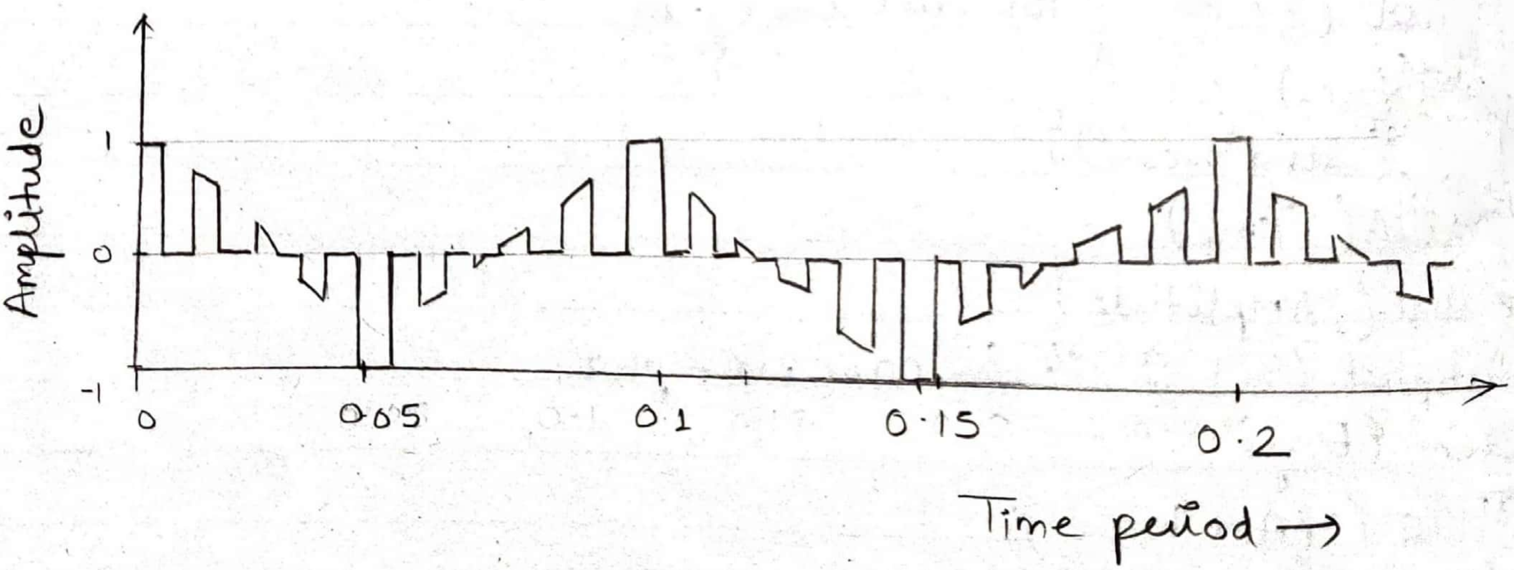
Message Signal:



Carrier Signal:

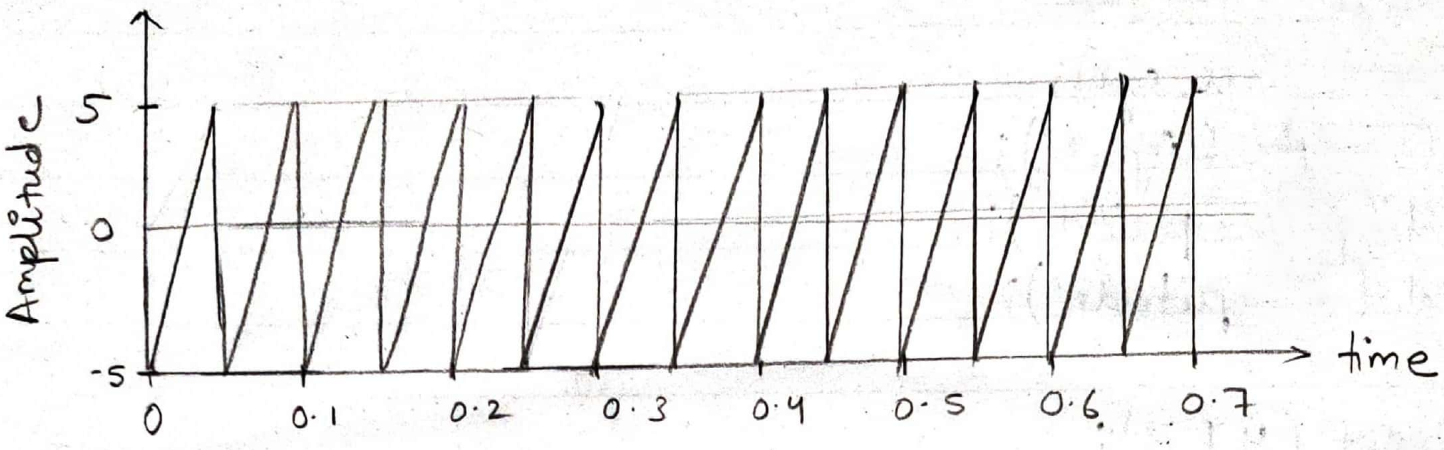


PAM Modulated Signal:

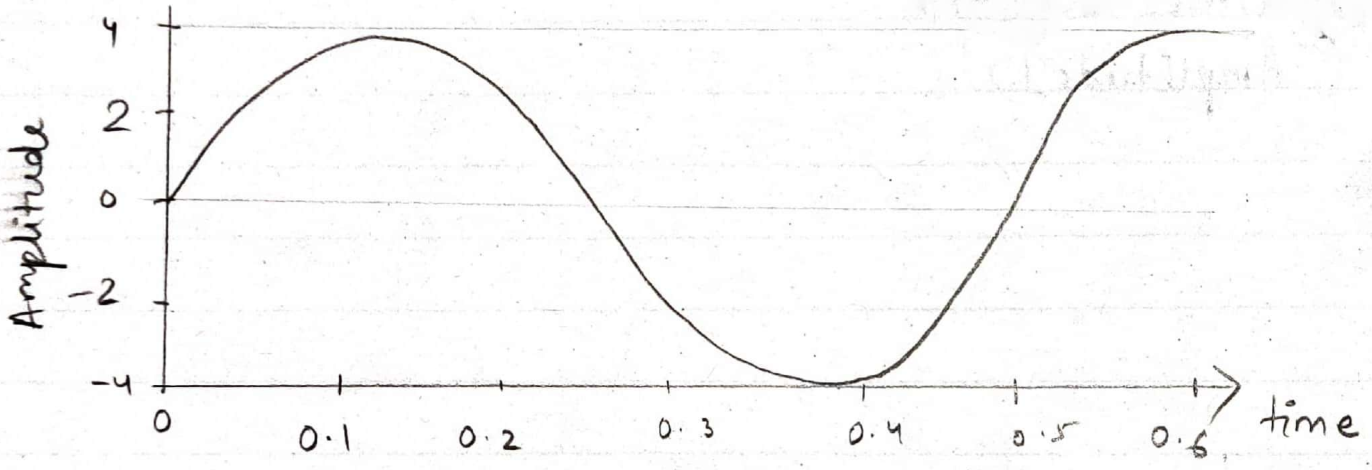


```
for i= 1:n
        if (m(i) >= S(i))
        PWM (i) = 1;
        else if (m(i) <= S(i))
         Pwm(i) = 0;
         end;
end;
Plot (t, PWM, 'o', t, m, m, 'r', t, s, 'b');
y label ('Amplitude');
axis ([0, 1, -1.5. 1.5]);
x label ('Time index');
title ('PWM wave');
grid on;


% PWM-2 signal
clc; clear all; close all;
 t= 0:0001:1;
 s= sawtooth (2*Pi*10*t + Pi);
 m= 0.75 x sin (2*Pi*1*t);
  n= length(s);
  for i=1:n
        if [m(i) >= s(i)]
         PWM (i) = 1;
        else if (m(i) <= s(i))
           pwm(i) = 0;
        end
end
```

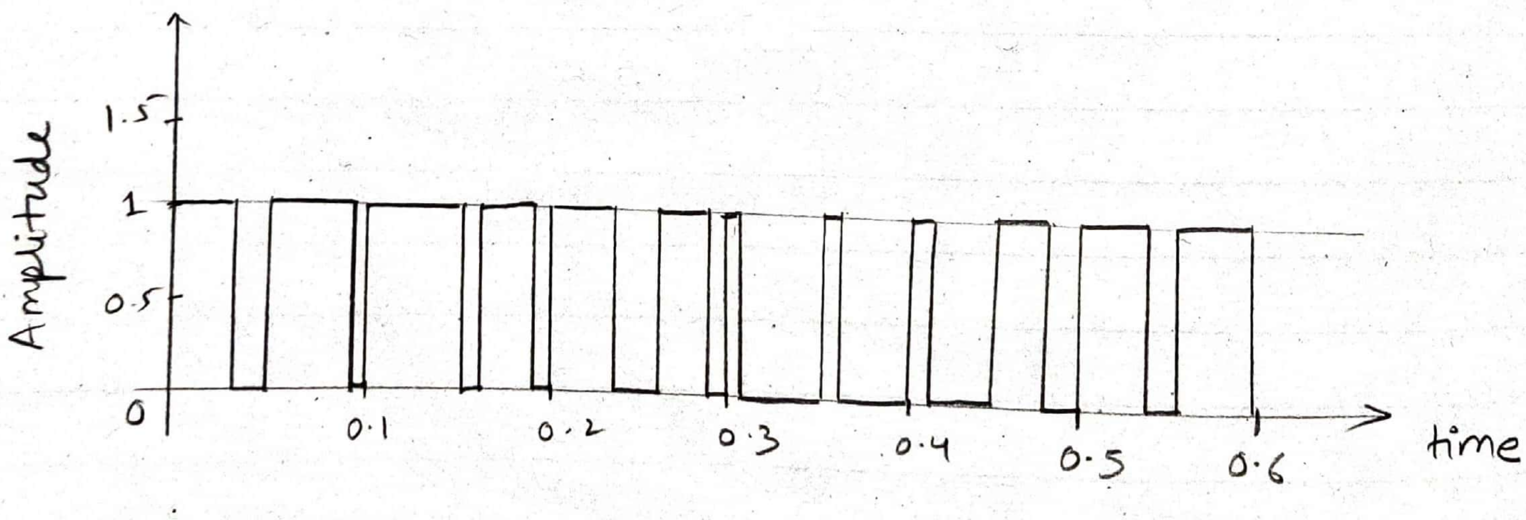
Carrier Sawtooth wave:



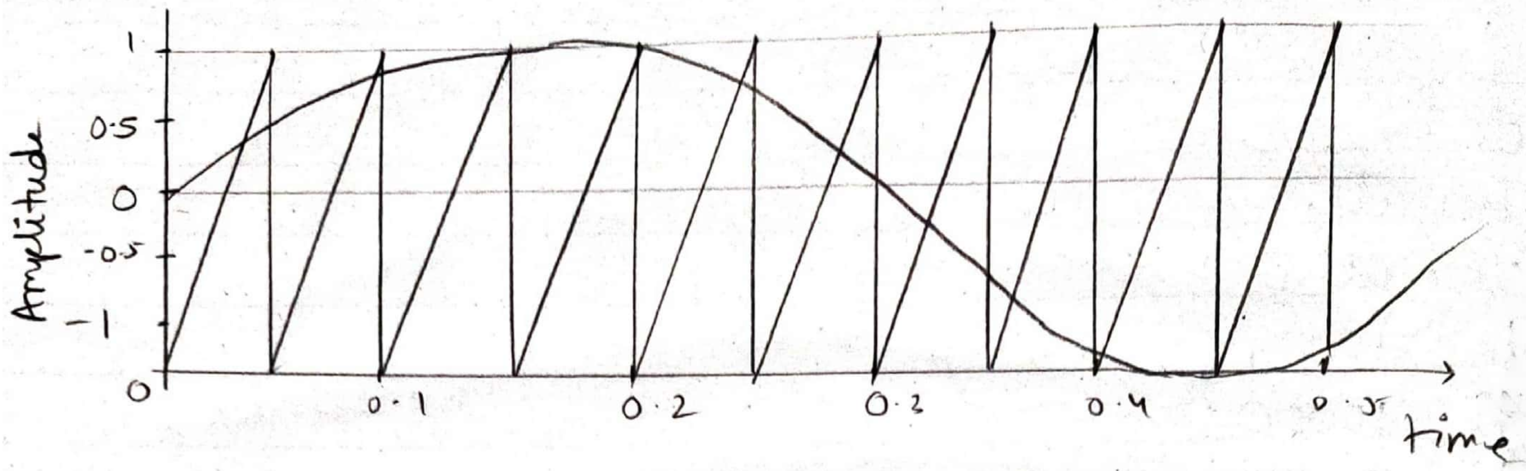
Message signal:



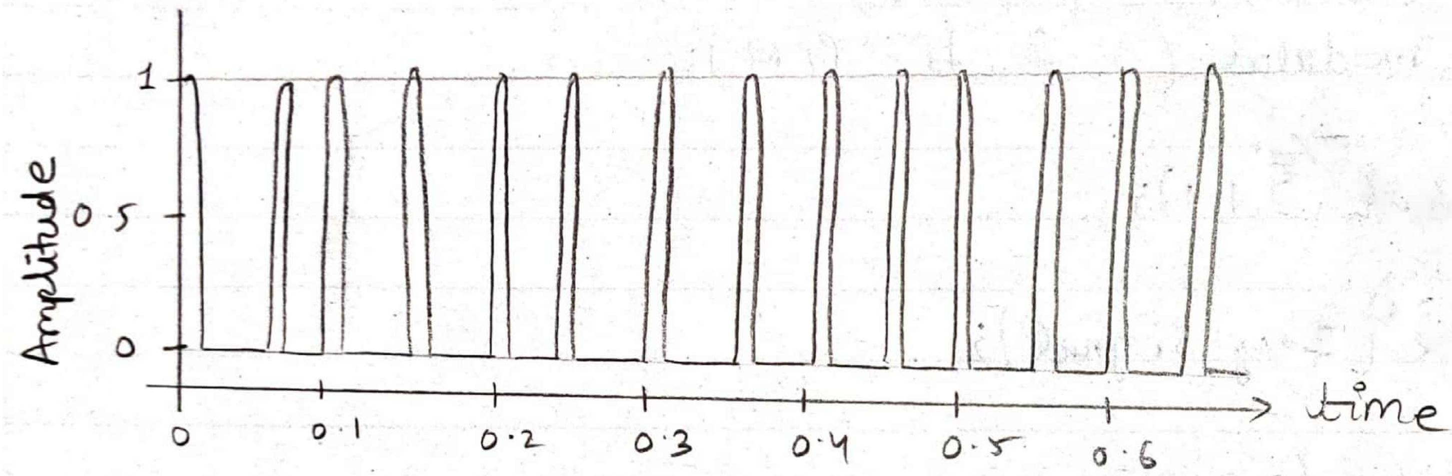
Plot of PWM:



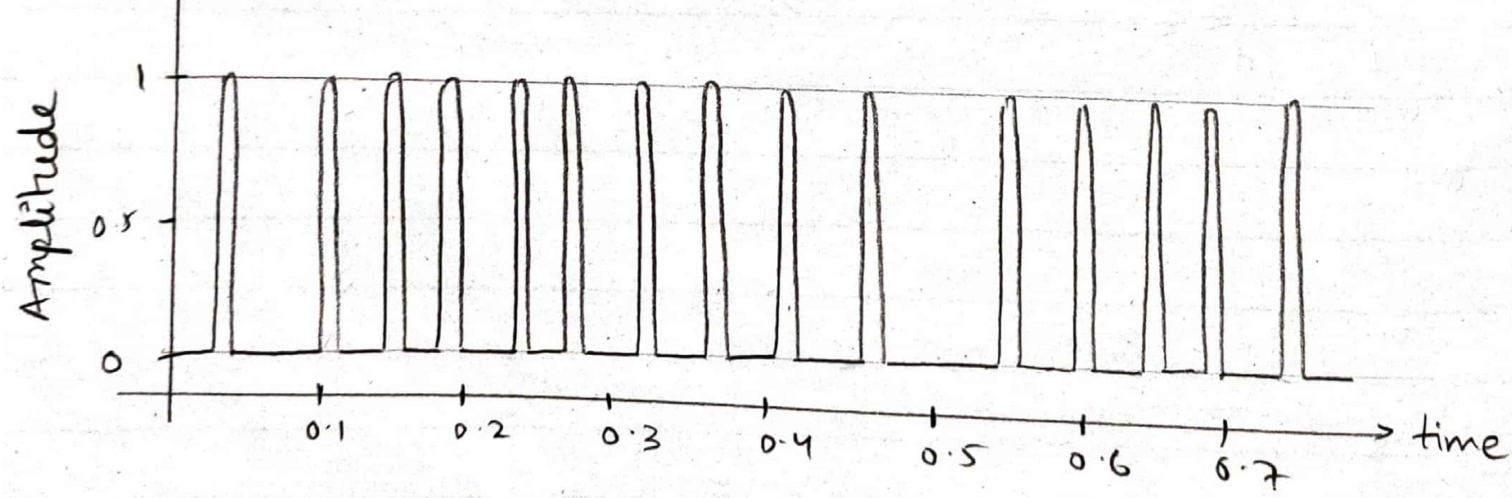
Message Signal:



Pulse Train:



PPM Signal:



```
subplot (3,1,1);
plot(t, m, 'm');
ylabel ('Amplitude');
axis ([0 1 -1.5 1.5]);
xlabel ('Time Index');
grid on;

subplot (3,1,2);
plot (t, s, 'b');
ylabel ('Amplitude');
axis ([0, 1 -1.5 1.5]);
xlabel ( 'Time index');
title ['PWM WAVE');
grid on;

subplot (3,1,3);
Plot (t, PWM, 'r');
ylabel('Amplitude');
axis ([0 1 -1.5 1.5]);
x-label ('Time index');
grid on;
```

Conclusion

We succesfully examined PAM, PWM, PPM and also verified their waveforms. We also illustrated circuits for PAM & PWM. We performed our experiment succesfully using MATLAB.

Teacher's Signature :