Experiment No:- 5

* Aim:- To Examine of Pulse Amplitude Modulation (PAM), Pulse Position Modulation (PPM) and Pulse width Modulation (PWM) and verify and draw the resultant waveforms. Illustrate the circuit diagram for PAM and PWM. Show & draw output waveform using Matlab Code using virtual Mode.

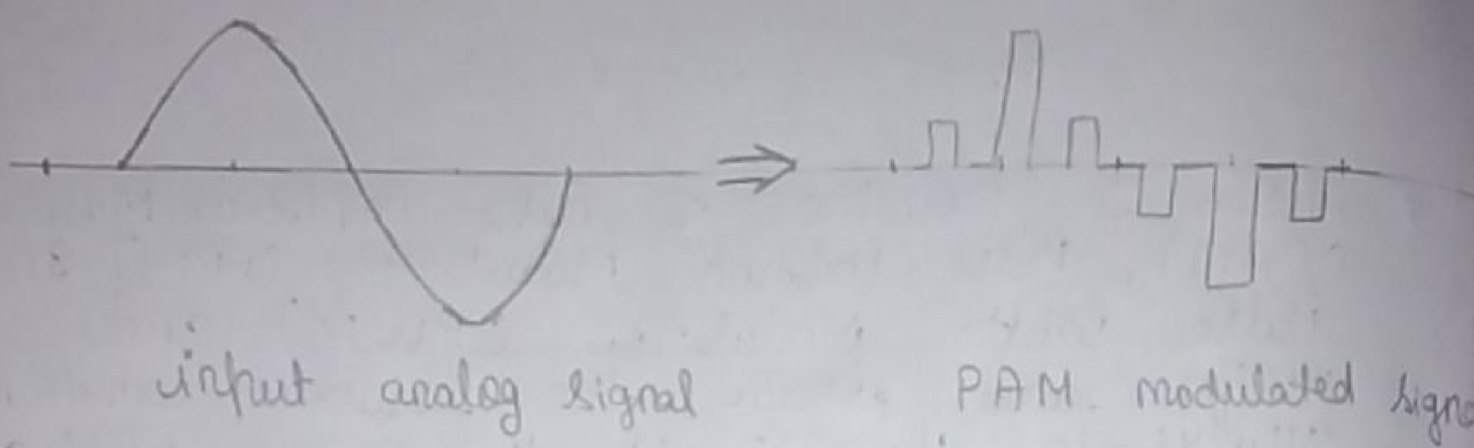
* Theory:-

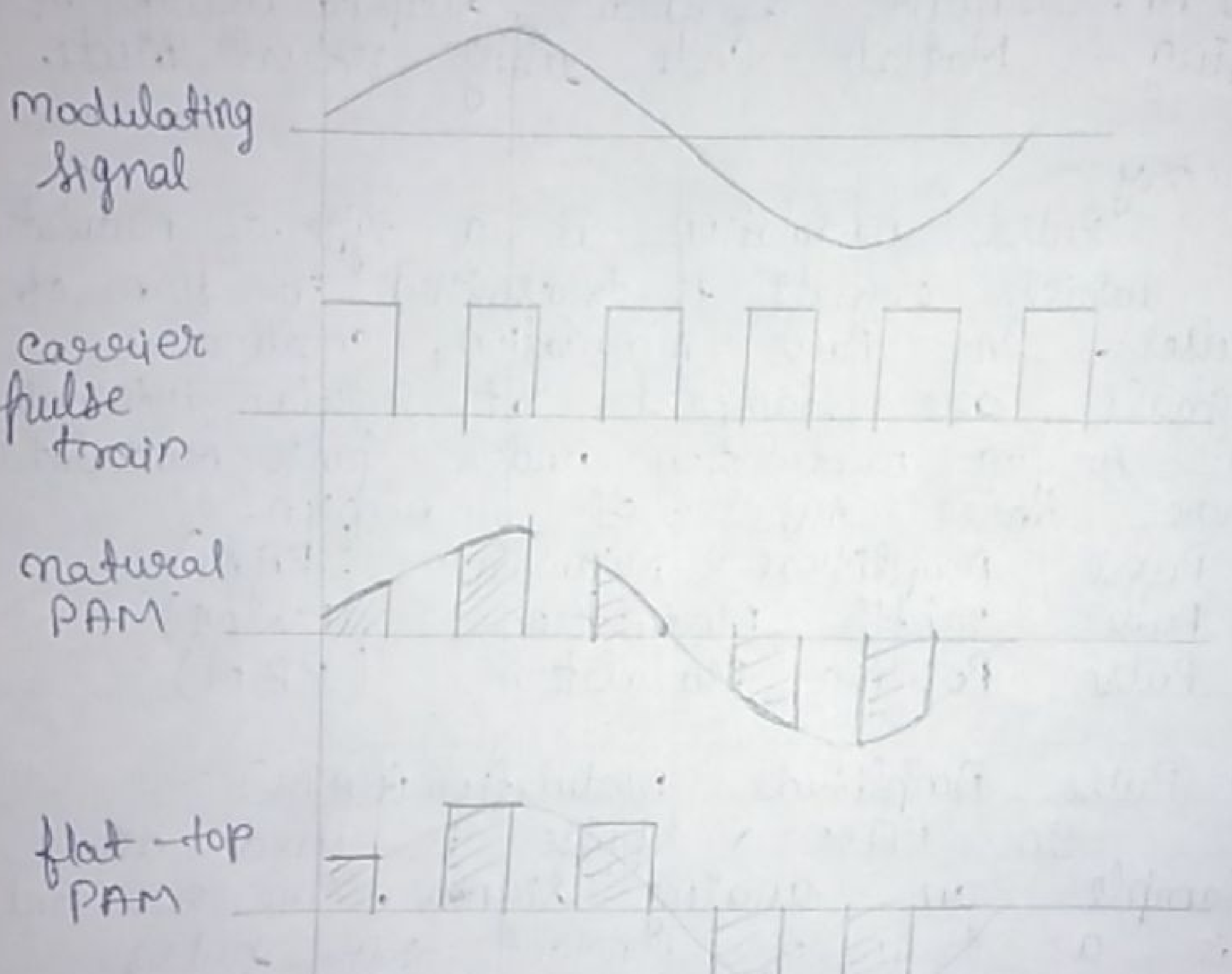
Pulse modulation is a type of modulation in which signals is transmitted in form of pulses. In Pulse modulation, continuous signals are sampled at regular interval. In Analog modulation under pulse modulation there three types of modulation.

1.) Pulse Amplitude modulation (PAM)
2.) Pulse width Modulation (PWM)
3.) Pulse Position Modulation (PPM)

1.) Pulse Amplitude Modulation (PAM) :-

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


input analog signal
PAM modulated signal

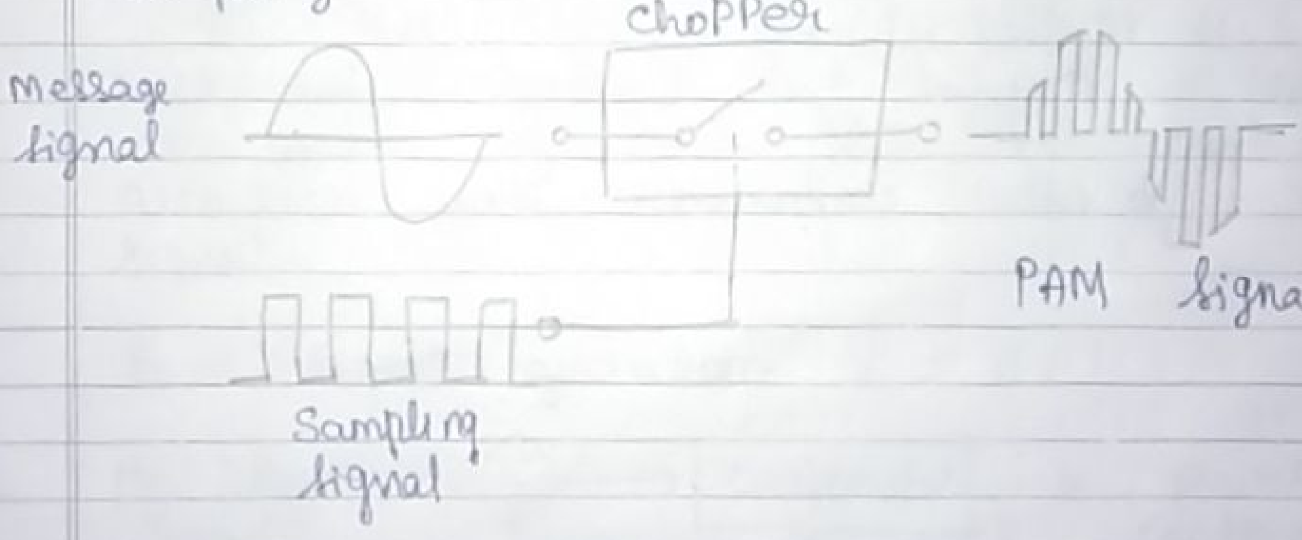

modulating signal
carrier pulse train
natural PAM
flat-top PAM

* PAM signal generation.

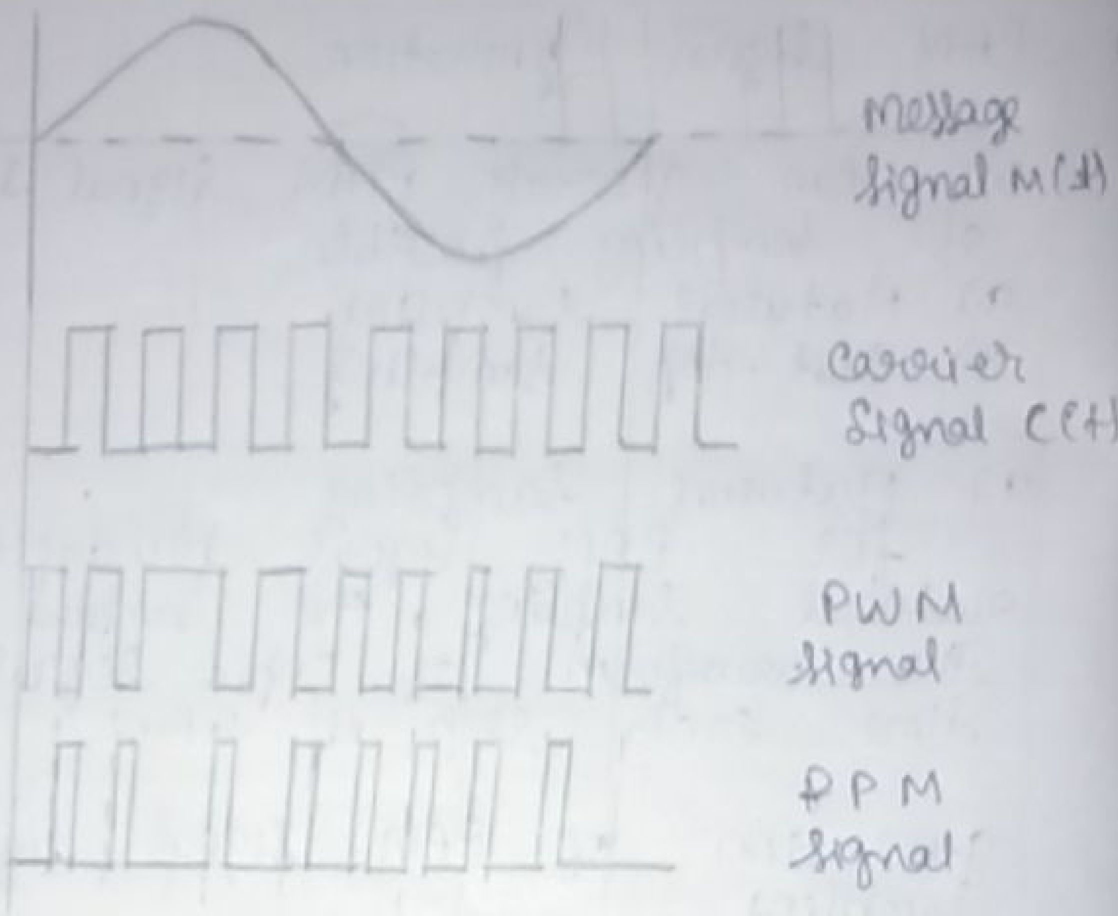
we can generate PAM signal by two types of sampling possible
a.) Natural sampling
b) flat-top sampling

a.) Natural sampling
for PAM signal produced with natural sampling, the sampled signal follows the waveform of input signal during the time each step is taken.

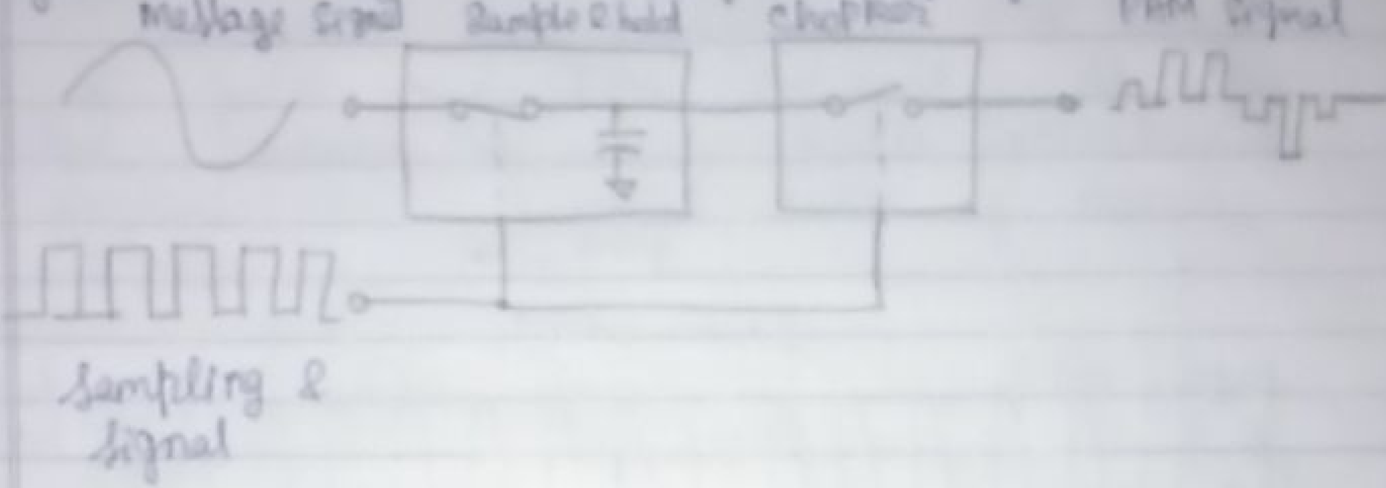
generation of PAM signal by natural sampling



b) flat top sampling :- In this sampled signal can be represented in pulses for which the amplitude of signal cannot be changed with respect to analog signal to be sampled.


Message
Signal M(t)
Carrier
Signal C(t)
PWM
Signal
PPM
Signal

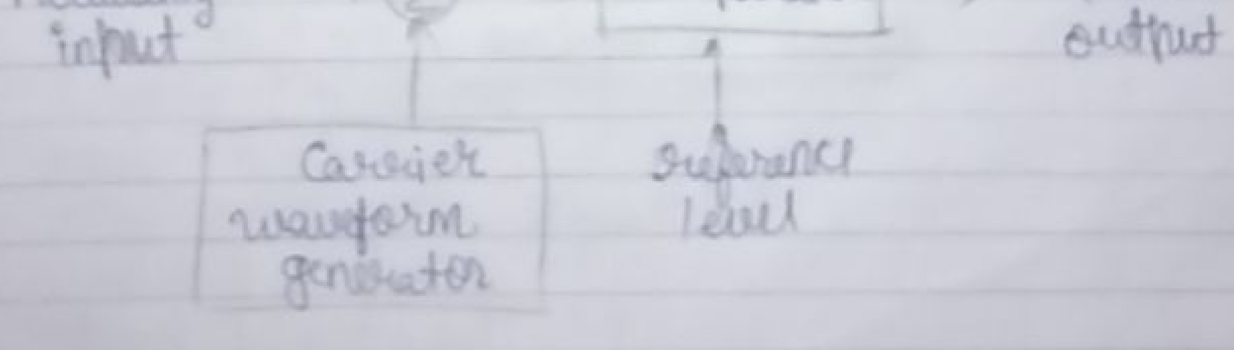
* Generation of PAM signal by flat-Top signal



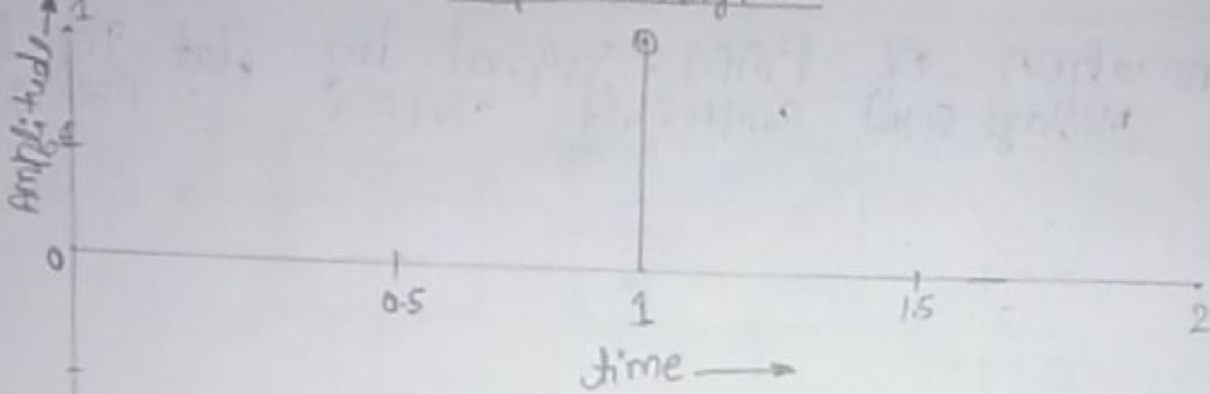
a sample & hold signal circuit is used to hold the amplitude of each pulse at a constant level

2.) Pulse width modulation:-
In this type, the amplitude is maintained constant but duration or length or width of each pulse is varied in accordance with instantaneous value of analog signal.

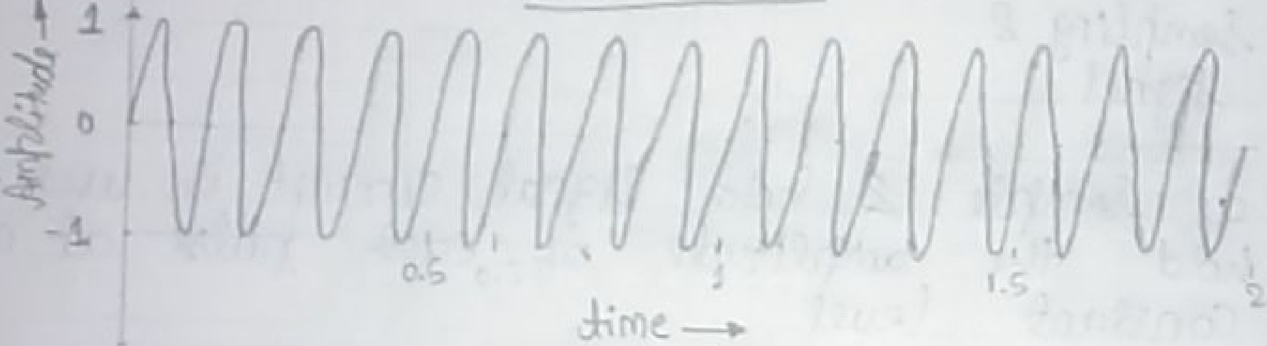
PWM signal generation.



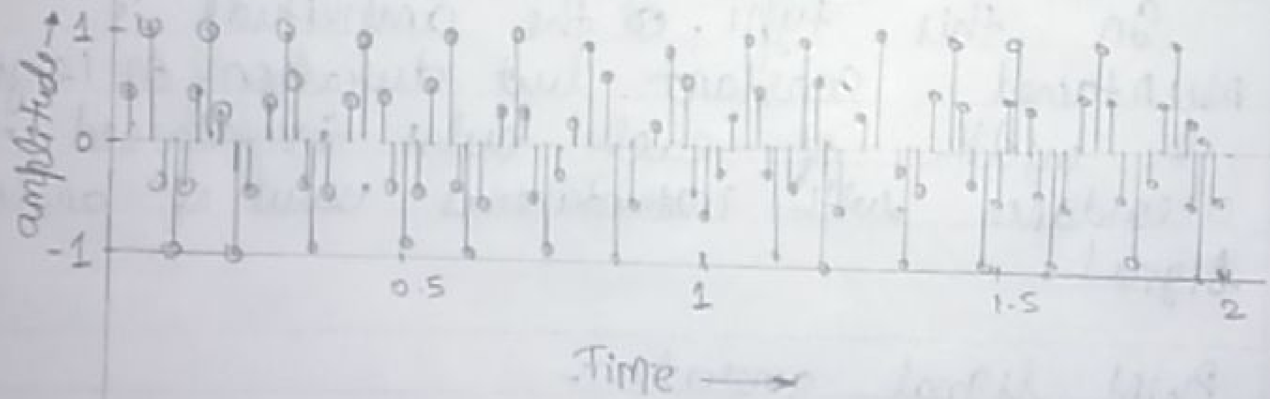
Impulse signal



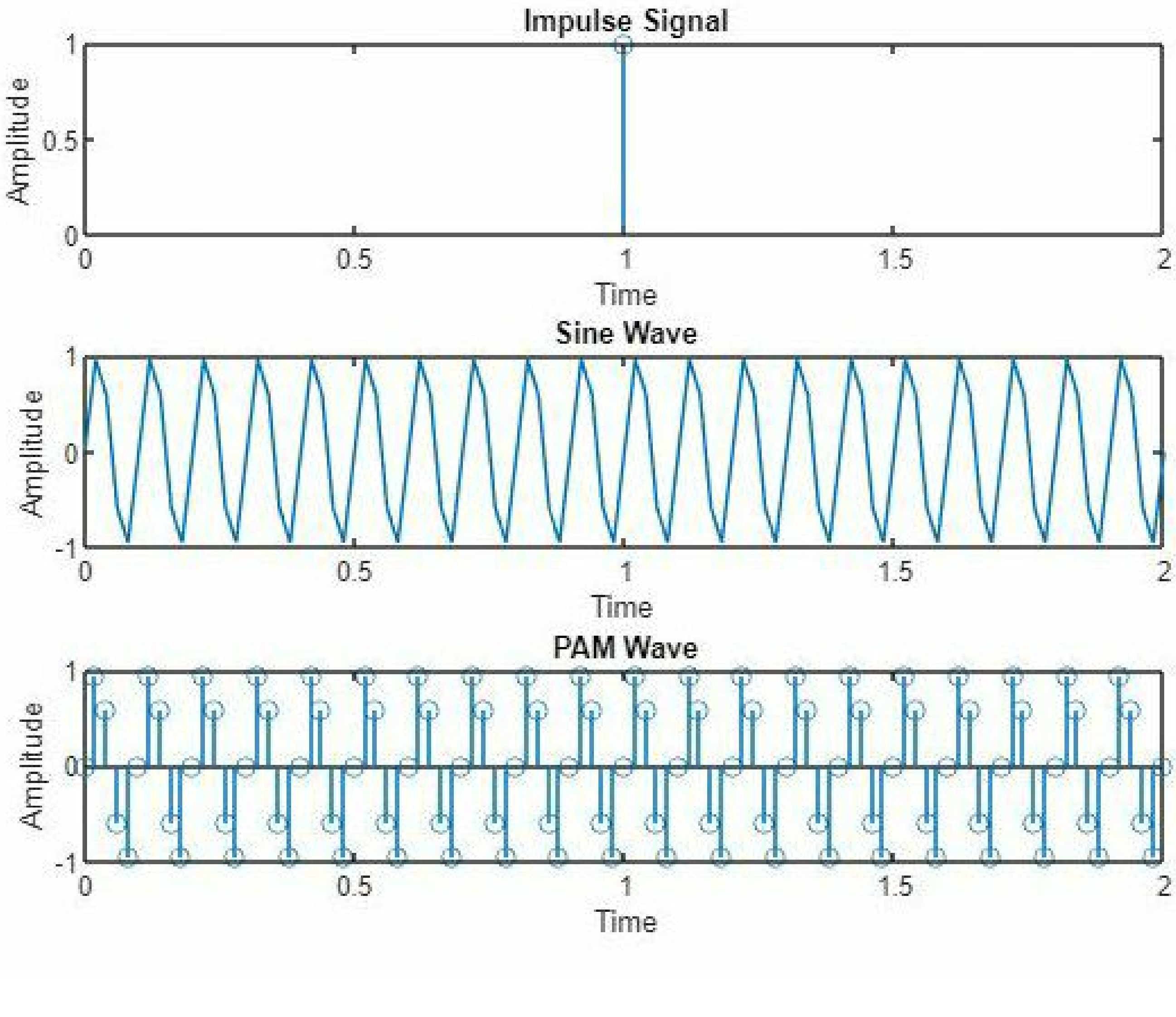
Sine wave



PAM Wave:

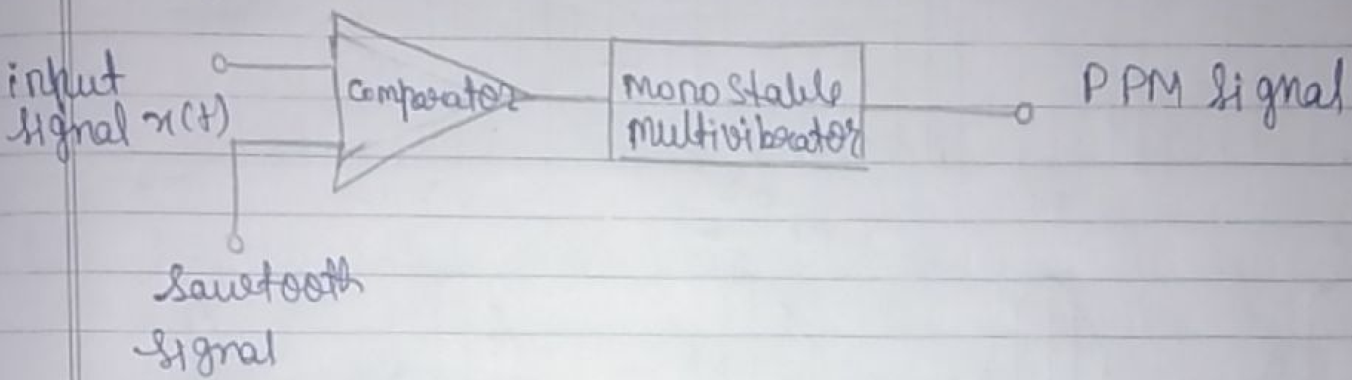


Ideal Sampling



Impulse Signal
Amplitude
Time
Sine Wave
Amplitude
Time
PAM Wave
Amplitude
Time

* Pulse Position Modulation (PPM) :-
In this both amplitude and width of pulse are kept constant. We vary the position of each pulse according to instantaneous sampled value of message signal

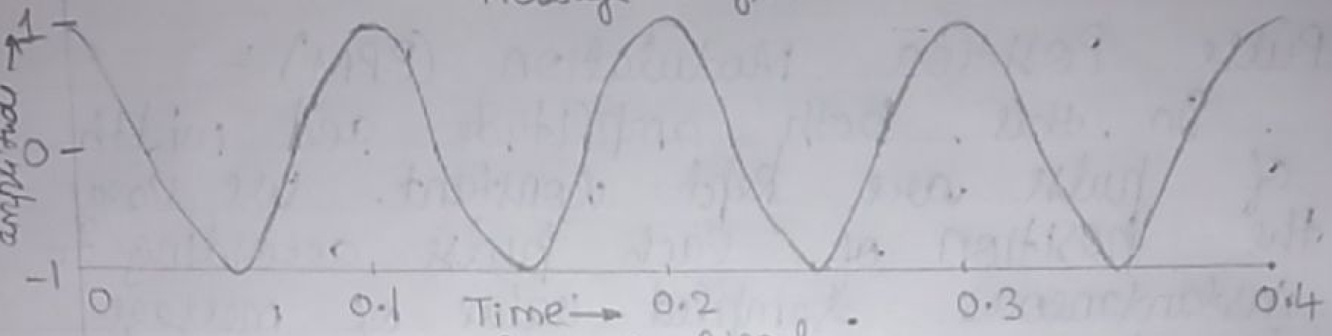


* Matlab Code for PAM :-

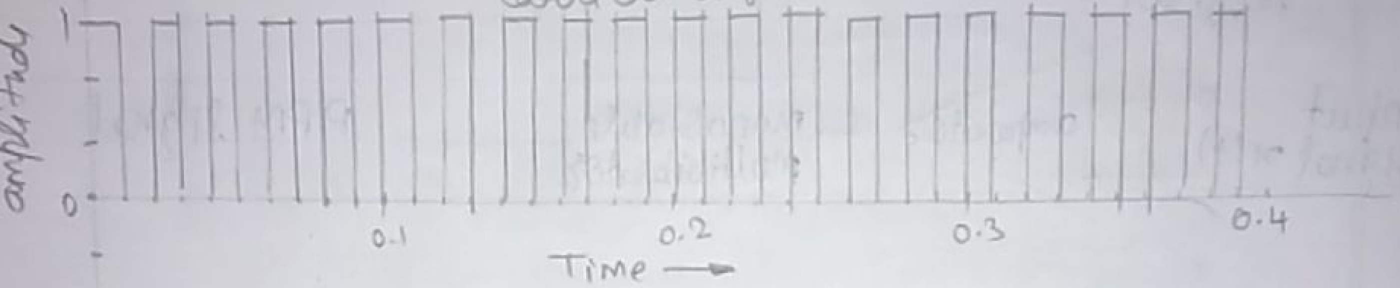
a.) ideal sampling

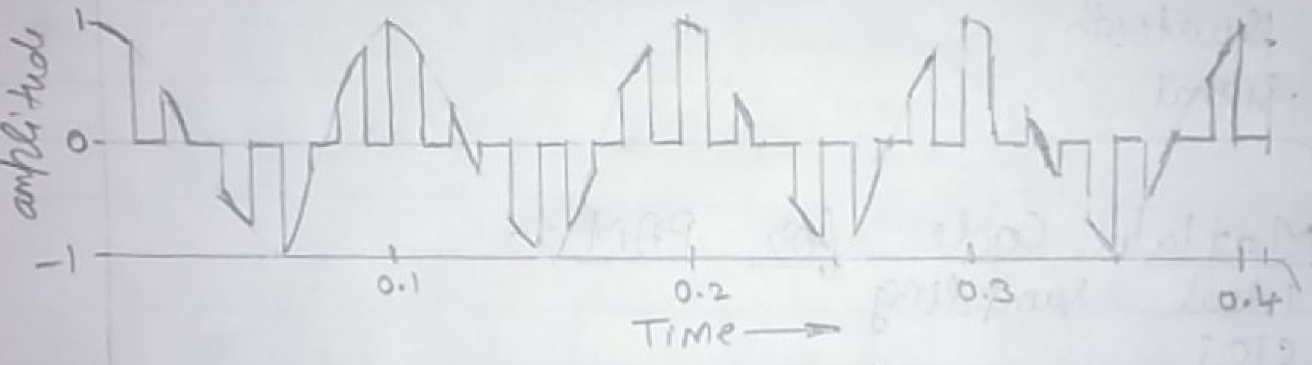
```
clc;
close all;
clear all;
a= input ('Enter the amplitude = ');
f= input ( 'Enter the frequency = ');
t = 0 : 0.02 : 2;
x1 = 1
x2= a* sin (2* pi * f * t);
y = x1.* x2;
subplot ( 3, 1,1);
stem (x1) ;
title ('Impulse signal');
xlabel ( 'Time')
ylabel ('Amplitude ');
subplot (3,1,2) ;
```

message signal.

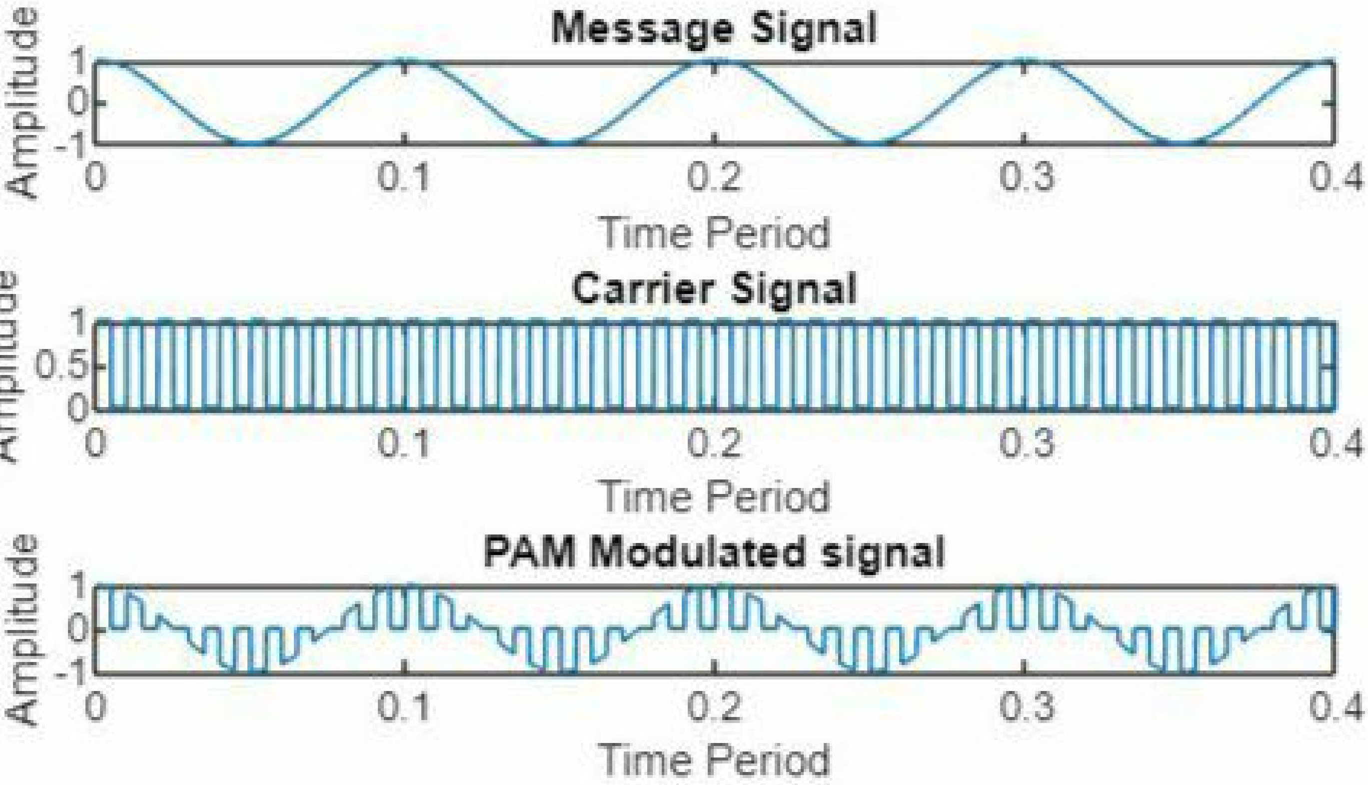


Carrier signal





PAM Modulated signal



Message Signal
Amplitude
1
0
-1
0
0.1
0.2
0.3
0.4
Time Period
Carrier Signal
Amplitude
1
0.5
0
0
0.1
0.2
0.3
0.4
Time Period
PAM Modulated signal
Amplitude
1
0
-1
0
0.1
0.2
0.3
0.4
Time Period

```
plot (t, x2);
title ('sine wave');
xlabel (' Time ');
ylabel (' Amplitude ');
subplot (3,1,3)
stem (t,y);
title ('PAM wave'),
xlabel ('Time');
ylabel ('Amplitude');
```

b.) 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)
subplot (4,1,2);
```

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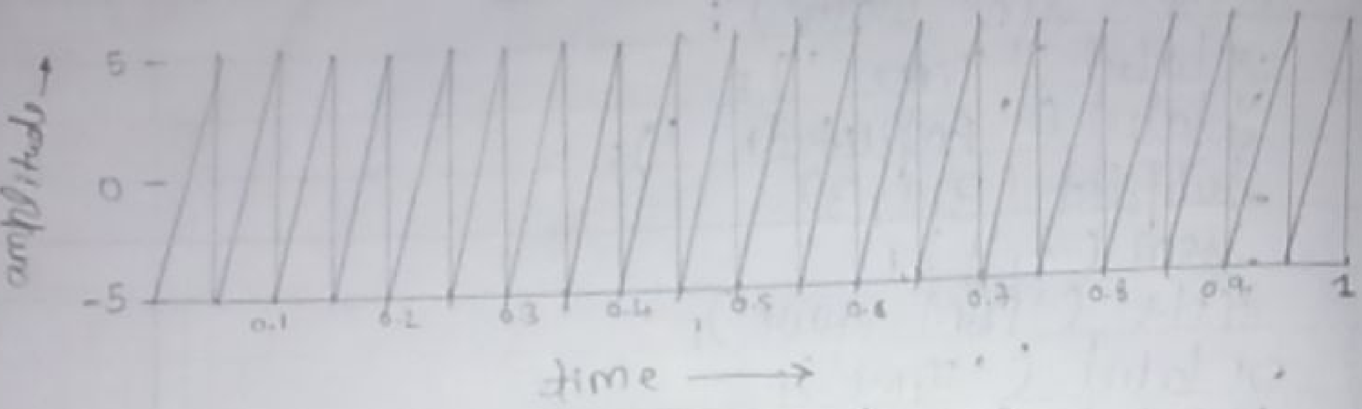
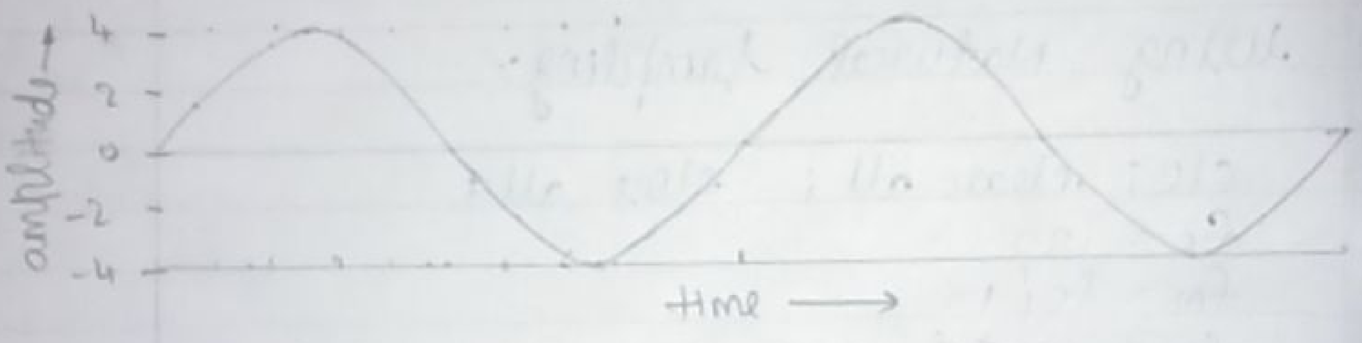
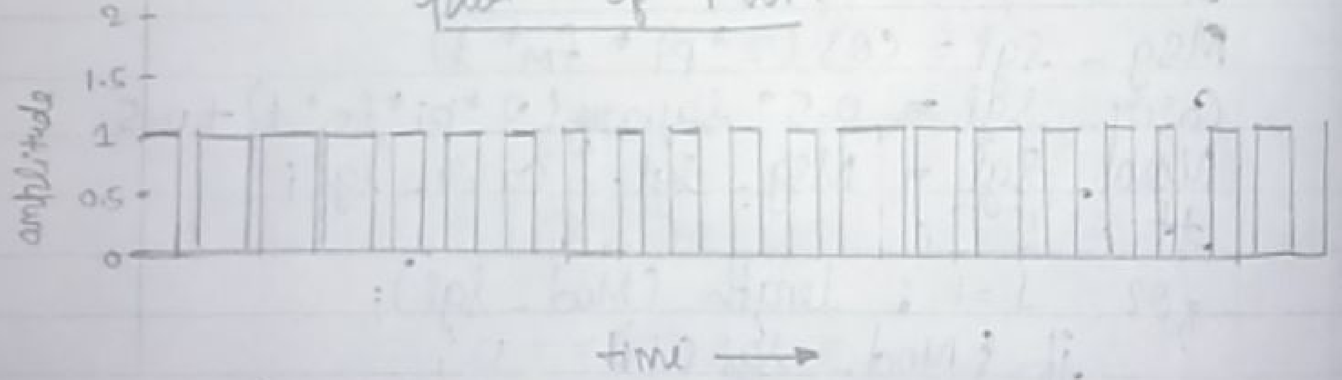
carrier sawtooth

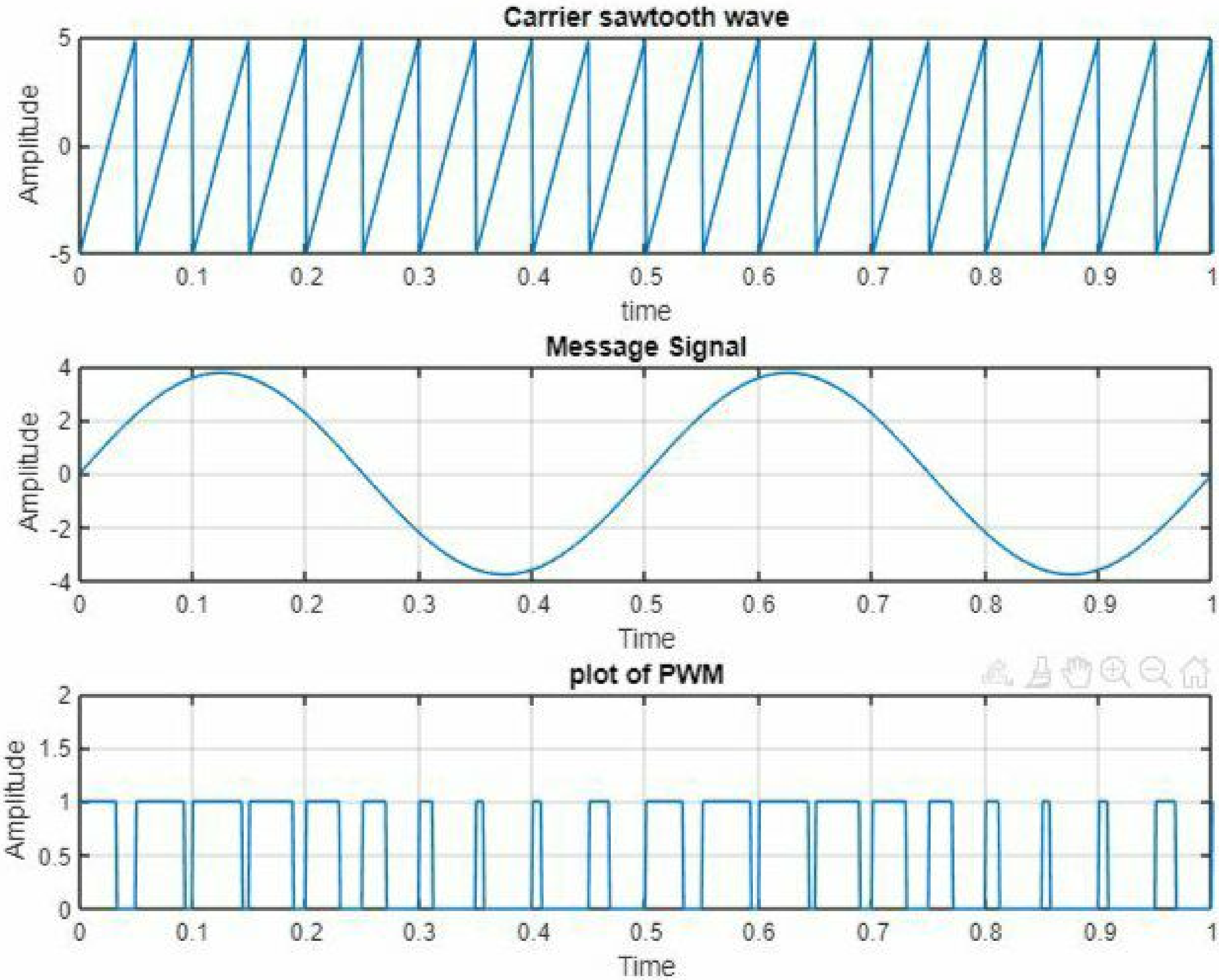


Message signal



plot of PWM





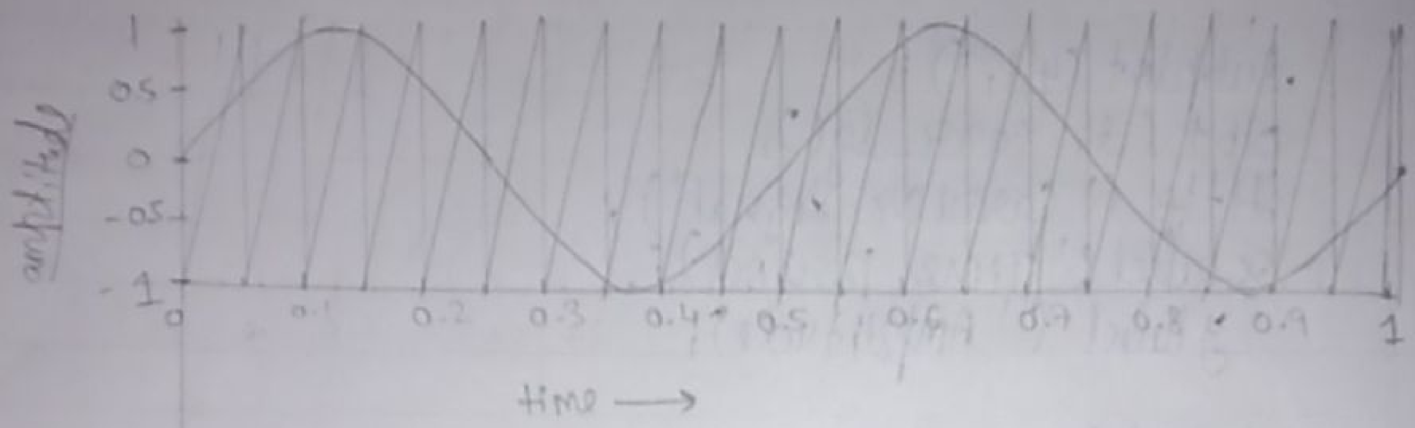
Carrier sawtooth wave
Amplitude
time
Message Signal
Amplitude
Time
plot of PWM
Amplitude
Time

```
subplot (4,1,1);
plot (t, carr_sgl);
title ('carrier signal');
xlabel ('Time period);
ylabel ('Amplitude);

subplot (4,1,2);
plot (t, carr_sgl);
title ('carrier signal');

subplot (4,1,3);
plot (t, Mod_sgl);
title ('PAM Modulated signal');
```

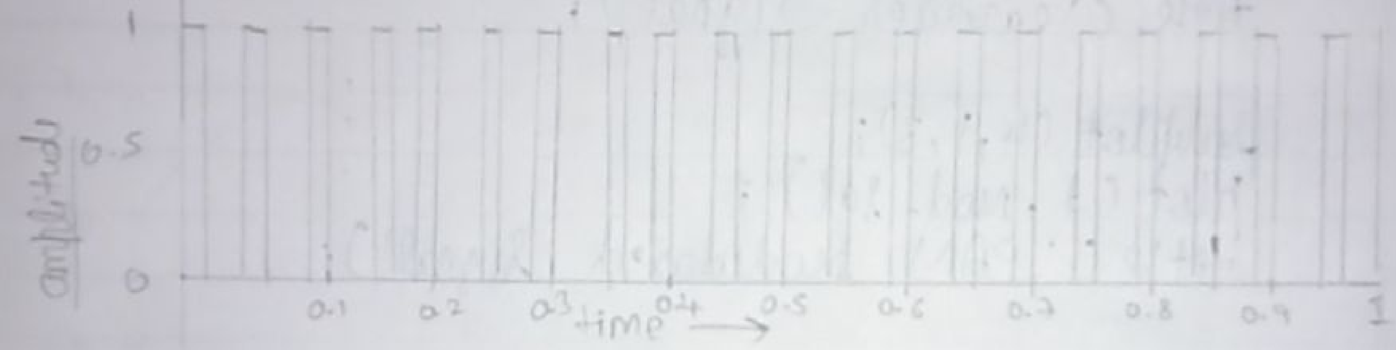
2.) PWM Signal

```
clc; clear all; close all;
F2 = input ('Message frequency=');
F1 = input ('carrier sawtooth frequency=');
A = 5
t = 0:0.001:1
c = A* sawtooth(2*pi*F1*t);
subplot (3,1,1);
plot (t,c);
xlabel ('time'); ylabel ('Amplitude');
title('carrier sawtooth wave');
grid on;
m= 0.75*A.*sin(2*pi*F2*t);
subplot (3,1,2);
plot (t,m);
xlabel (' Time'); ylabel ('Amplitude');
```

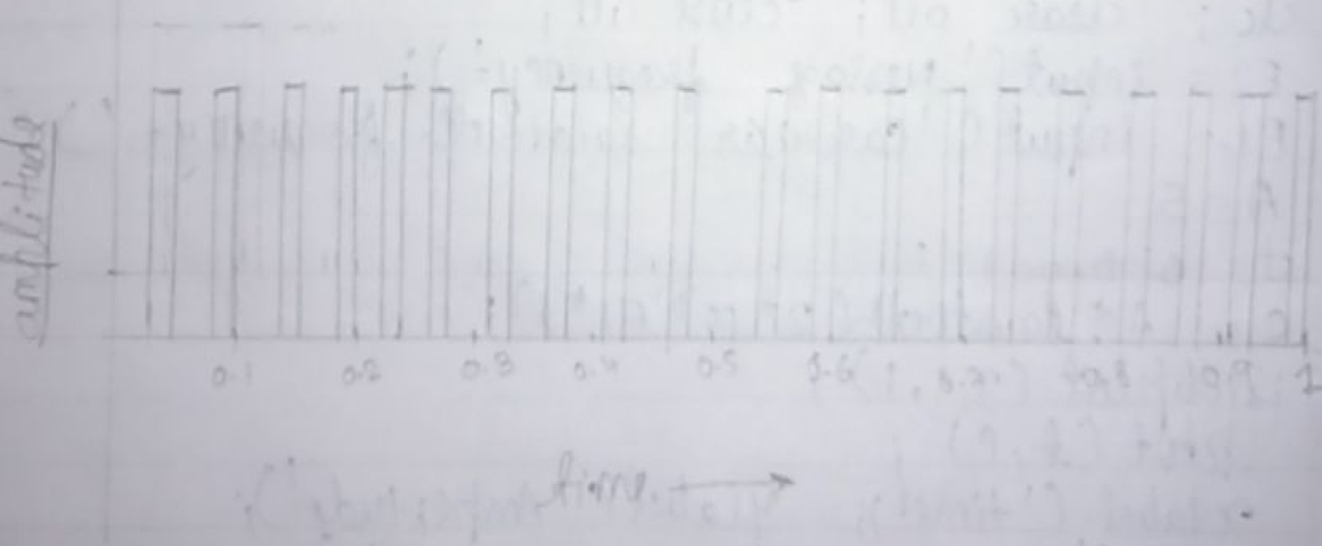
Message signal

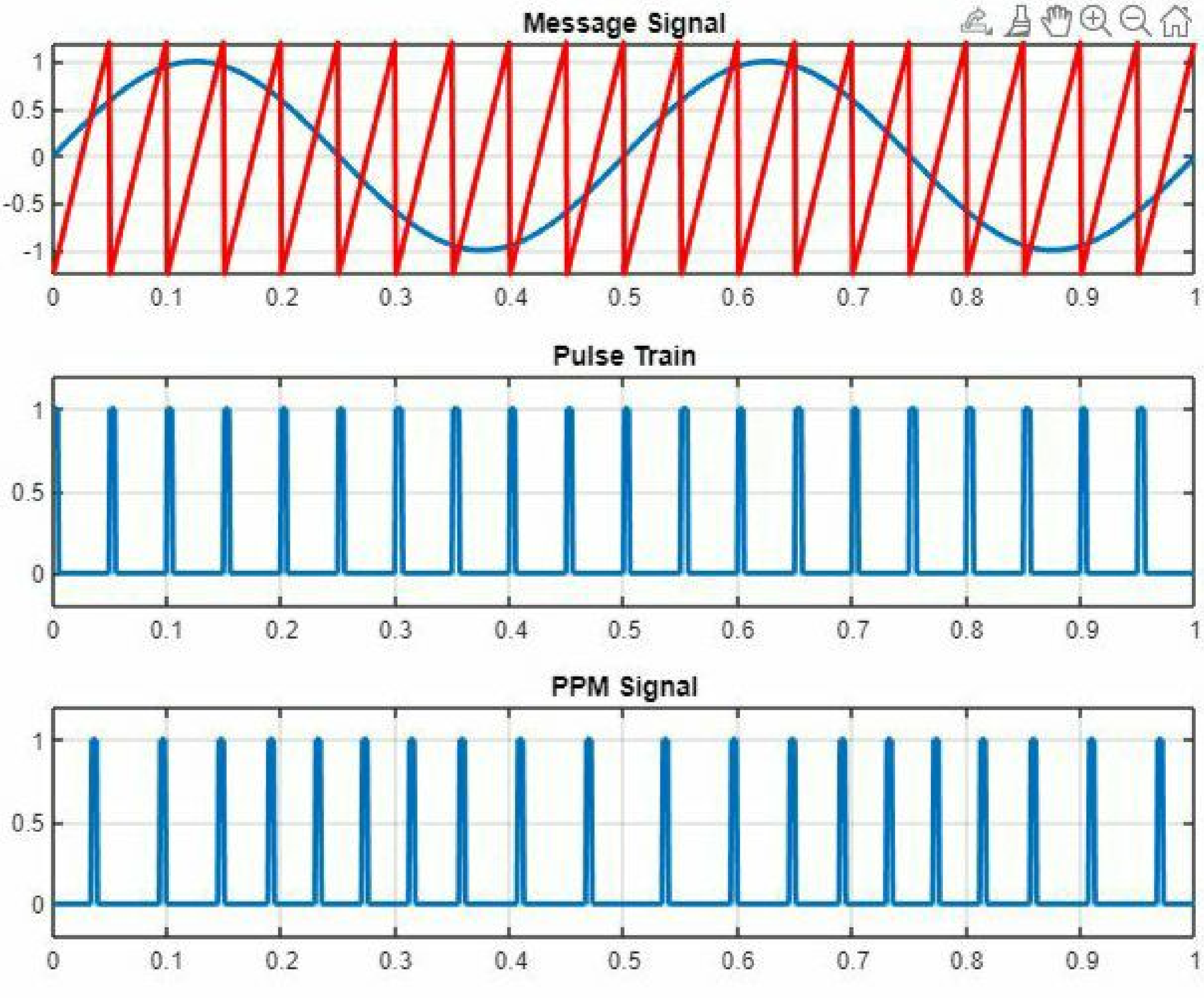


pulse train



PPM signal





Message Signal
Pulse Train
PPM Signal

```
title('Message Signal'); grid on;
n= length(c);
for i=1:n
    if (em(i)>=c(i))
        pwm(i)=1
    else
        pwm(i)=0
    end
end
subplot(3,1,3);
plot(t, pwm);
xlabel('Time'); ylabel('Amplitude');
title('plot of PWM');
axis([0 1 0 2]);
grid on;
```

3.) PPM Signal

```
clc; clear all; close all;
fc=20;
fm=2;
fs=1000;
t= 1;
n=[0:1/fs:t]
n=n(1:end-1);
duty=10;
per = fs/fc;
on_t = per/duty;
s = square(2*pi*fc*n, duty);
s(find(s<0))=0
m = sin(2*pi*fm*n);
```

```
% Triangular wave
A=1.25 ;
C= A.*sawtooth (2*pi*fc*n);

PPM = zeros(1, length(s));

id = find ( c > m);
idd = diff (id)
iddd = find (idd~=1)
temp(1) = id (1)
temp(2: length (iddd)+1) = id (iddd+1);

for i=1: length(temp)
    ppm(temp(i): temp(i)+ on_t-1)=1;
end

% plot.
subplot(3,1,1); plot(n,m,'linewidth',2);
title ('message signal'); hold on;
plot (n, c, 'r', 'linewidth',2) ; grid on;

subplot (3,1,2); plot(n,s,'linewidth', 2);
title('Pulse Train'); grid on;
ylim ([-0.2  1.2])
subplot (3,1,3) ; plot (n,ppm,'linewidth',2);
title ('PPM signal'); grid on;
ylim([-0.2 1.2]);
```

* Conclusion:- Successfully performed PAM, PWM and PPM over the matlab interface