Sri Sivasubramaniya Nadar College of Engineering, Kalavakkam – 603 110

(An Autonomous Institution, Affiliated to Anna University, Chennai)

Department of CSE

UEC 1351 Principles of Communication Engineering

Batch: 2018-2022

Semester: 03

MATLAB Simulation

Assignment report

PULSE AMPLITUDE MODULATION

Project members

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AIM

The aim of this project is to realize **Pulse Amplitude Modulation** **(PAM)** through a simulation in the MATLAB software.

Project Description

PAM is an analog to digital conversion method where the message information is encoded in the amplitude of the series of signal pulses.

The most common analog input is a sinusoidal wave. However, in this project, several different types of analog signals are subjected to PAM in order to investigate and study the changes in the resultant waveform.

For this purpose, MATLAB software is used.

The project objectives include:

1. Understanding pulse amplitude modulation.
2. Demonstrating the generation of a pulse amplitude modulated wave.
3. Recognizing the similarities and differences of the PAM signal for different message signal inputs.
4. Exploring its advantages and applications in communication systems.

SOFTWARE USED

Description

MATLAB is a software used to analyze and design several systems and products. The matrix-based MATLAB language is primarily used to express computational mathematics. Built-in graphics make it easy to visualize and gain insights from large data sets.

The plethora of MATLAB tools and capabilities along with the desktop environment make it ideal for obtaining suitable results for the undertaken project.

Software Name: MATLAB R2019a - - The Language of Technical Computing

Version: MATLAB 9.6

Release Name: R2019a

Release Year: 2019

Developer: MathWorks

Filename Extensions: .m

THEORY

PULSE AMPLITUDE MODULATION

Introduction

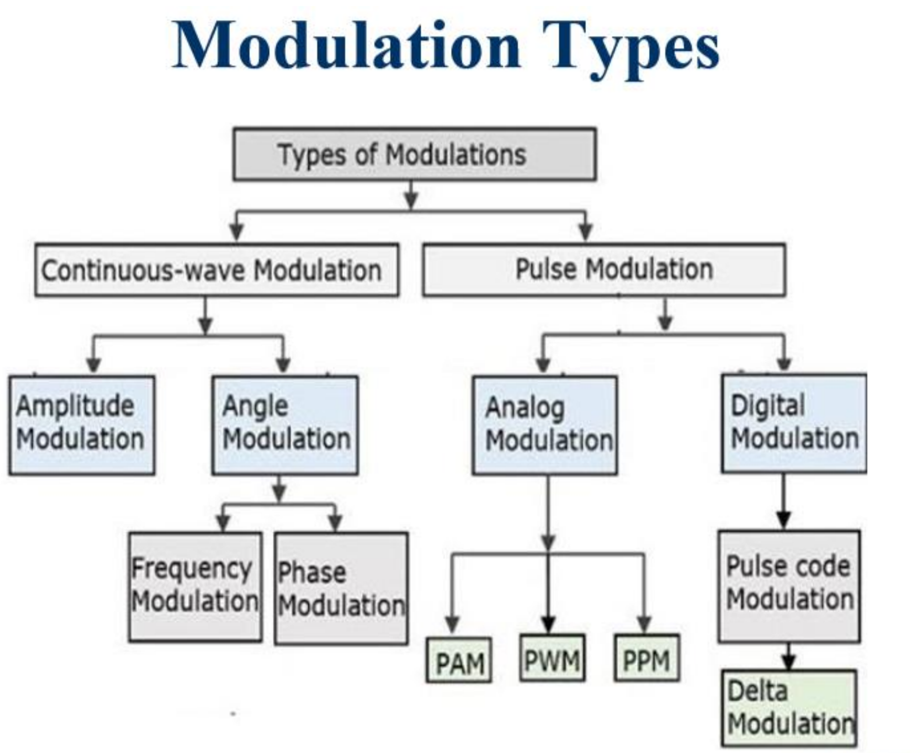
Today communication is the heart of the technology. Communication is achieved over a transmitter and a receiver through signals. These signals carry the information through modulation. **Pulse Amplitude Modulation (PAM)** is one of the kinds of modulation techniques used in signal transmission.

Pulse amplitude modulation is the simplest form of modulation.

It is Analog to digital conversion method where the message information is encoded in the amplitude of the series of signal pulses.

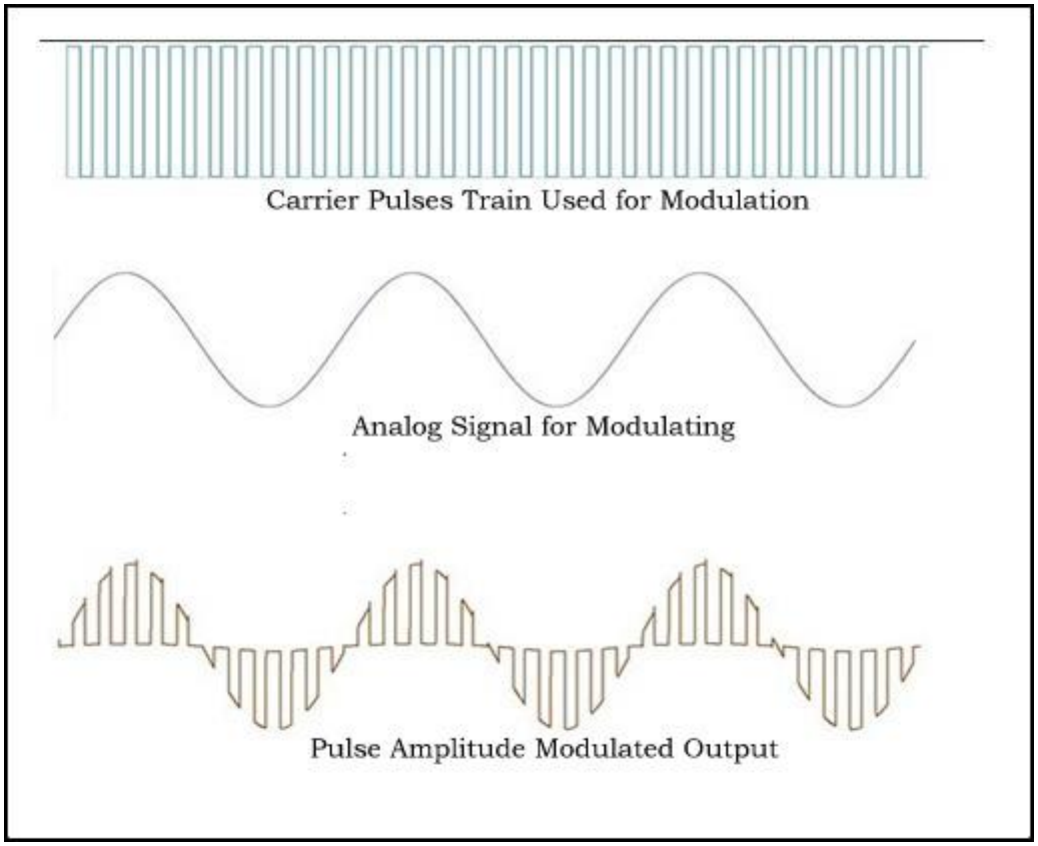
In this modulation, the signal is sampled at regular intervals and each sample is made proportional to the amplitude of the modulating signal.

These sample pulses can be transmitted directly using wired media or we can use a carrier signal for transmitting through wireless.



There are **two types of sampling techniques** for transmitting messages using pulse amplitude modulation:

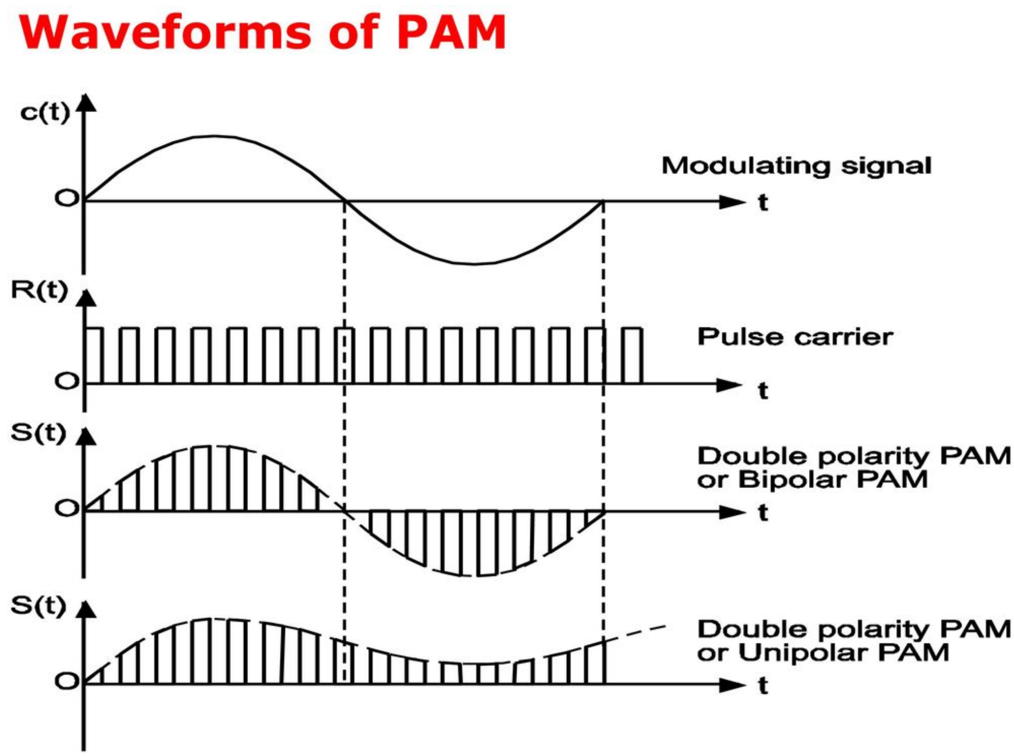
1. **Flat Top PAM:** The amplitude of each pulse is directly proportional to instantaneous modulating signal amplitude at the time of pulse occurrence and then keeps the amplitude of the pulse for the rest of the half cycle.
2. **Natural PAM:** The amplitude of each pulse is directly proportional to the instantaneous modulating signal amplitude at the time of pulse occurrence and then follows the amplitude of the modulating signal for the rest of the half cycle.



Flat top PAM is the best for transmission because we can easily detect and remove noise.

There are **two types of pulse amplitude modulation based on signal polarity**

1. **Single Polarity PAM:** In single polarity pulse amplitude modulation, there is fixed level of DC bias added to the message signal or modulating signal, so the output of modulating signal is always positive.
2. **Double Polarity PAM:** In the double polarity pulse amplitude modulation, the output of modulating signal will have both positive and negative ends.



ADVANTAGES of Pulse Amplitude Modulation (PAM):

- It is the base for all digital modulation techniques, and the process is simple for both modulation and demodulation.
- No complex circuitry is required for both transmission and reception.
- PAM can generate other pulse modulation signals and can carry the message or information at same time.

DISADVANTAGES of Pulse Amplitude Modulation (PAM):

- Bandwidth should be large for transmitting the pulse amplitude modulation signal due to the Nyquist criteria.
- The frequency varies according to the modulating signal or message signal. As a result of these variations in the signal frequency, interference is observed. Therefore, for PAM, noise immunity is less when compared to other modulation techniques.
- Pulse amplitude signal varies, so power required for transmission increases.

APPLICATIONS of Pulse Amplitude Modulation (PAM):

- It is mainly used in Ethernet, which is a type of computer network communication.
- It is also used for photo biology which is a study of photosynthesis.
- Used as electronic driver for LED lighting.
- Used in many micro controllers for generating the control signals etc.

MATLAB CODE

Source Code for the Generation of Different Pulse Amplitude Modulated Signals

```
%FIXING FREQUENCY OF CARRIER AND MESSAGE SIGNAL
clc;

fc=input('Enter carrier signal frequency (in Hz): ');
fs=input('Enter sampling frequency      (in Hz): ');   %sampling frequency
t_bound=0.5;

%Creation of a Vector of Sampling Instants (Step Size of 1/fs)

samples=0:1/fs:t_bound;
samples= samples(1:end-1); %To have exactly 500 samples

%GENERATION OF SQUARE WAVE
duty = 20;
pulse = square(2*pi*fc*samples,duty);
pulse(pulse<0) = 0;
%plot(samples, pulse)

%MESSAGE SIGNAL
type=input('Type of message signal:\n    1. Sine\n    2. Cosine\n    3. Sine+Cosine\n    4. Square\n    5. Sawtooth\n    6. Heaviside\n    7. Exponential\n    8. Random analog signal\n    9. Random digital signal\nEnter type: ');

if type==3
    fm1=input('Enter message signal frequency (in Hz):\n    Sine component  : ');
    fm2=input('    Cosine component: ');
elseif type==8 || type==9
else
```

```
    fm=input('Enter message signal frequency (in Hz): ');
end

switch(type)
    case 1
        m=sin(2*pi*fm*samples);
    case 2
        m=cos(2*pi*fm*samples);
    case 3
        m=sin(2*pi*fm1*samples)+cos(2*pi*fm2*samples);
    case 4
        m=square(2*pi*fm*samples);
    case 5
        m=sawtooth(2*pi*fm*samples);
    case 6
        m=heaviside(2*pi*fm*samples);
    case 7
        m=exp(2*pi*fm*samples);
    case 8
        m=rand(1,length(samples));
    case 9
        m=randi([0 1],1,length(samples));
    otherwise
        m=sin(2*pi*fm*samples);
end

%plot(samples, m)
```

```
%PAM WAVE
period_samp = floor(2*length(samples)/fc);        %No. of samples in each pulse duration
indices = 1:period_samp:length(samples);    %First sample in each pulse duration
on_samp = ceil(period_samp * duty/100);     %No. of samples during positive cycle
pam = zeros(1,length(samples)); %Setting it to 0
uni_pam= pam;
for i=1:length(indices)
    if indices(i) + on_samp<=length(samples)
        pam(indices(i):indices(i) + on_samp) = m(indices(i));
    end
end

for i=1:length(samples)
   uni_pam(i)= abs(pam(i));
end



%plot(samples, pam)
%hold
%plot(samples, m)

%FINAL OUTPUT
subplot(4,1,1);
plot(samples,pulse,'r');
title('CARRIER SIGNAL');
xlabel({'Frequency','(in Hertz)'});
ylabel('Amplitude');
```

```
subplot(4,1,2);
plot(samples,m,'b');
title('MESSAGE SIGNAL');
xlabel({'Frequency','(in Hertz)'});
ylabel('Amplitude');

subplot(4,1,3);
plot(samples,uni_pam,'g');
title('UNIPOLAR PULSE AMPLITUDE MODULATED SIGNAL');
xlabel({'Frequency','(in Hertz)'});
ylabel('Amplitude');

subplot(4,1,4);
plot(samples,pam,'m');
title('BIPOLAR PULSE AMPLITUDE MODULATED SIGNAL');
xlabel({'Frequency','(in Hertz)'});
ylabel('Amplitude');

clc;
```

GRAPHS OBTAINED

SINE WAVE

Enter carrier signal frequency (in Hz): 250

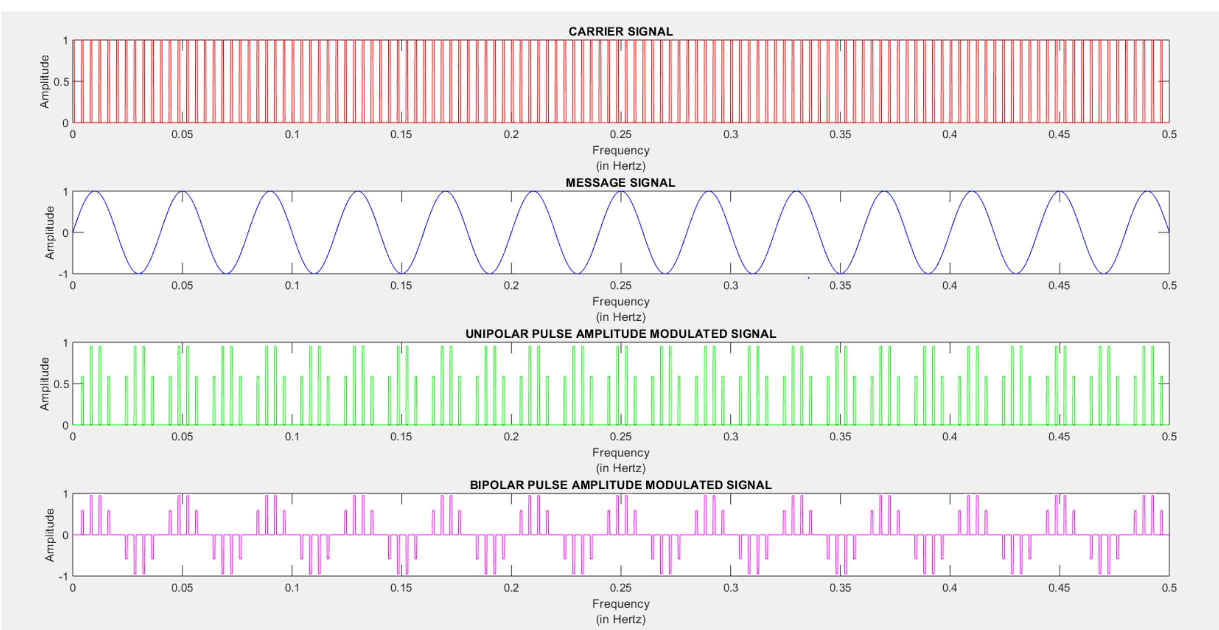
Enter sampling frequency   (in Hz): 10000

Type of message signal:

1. Sine
2. Cosine
3. Sine+Cosine
4. Square
5. Sawtooth
6. Heaviside
7. Exponential
8. Random analog signal
9. Random digital signal

Enter type: 1

Enter message signal frequency (in Hz): 25



COSINE WAVE

Enter carrier signal frequency (in Hz): 250

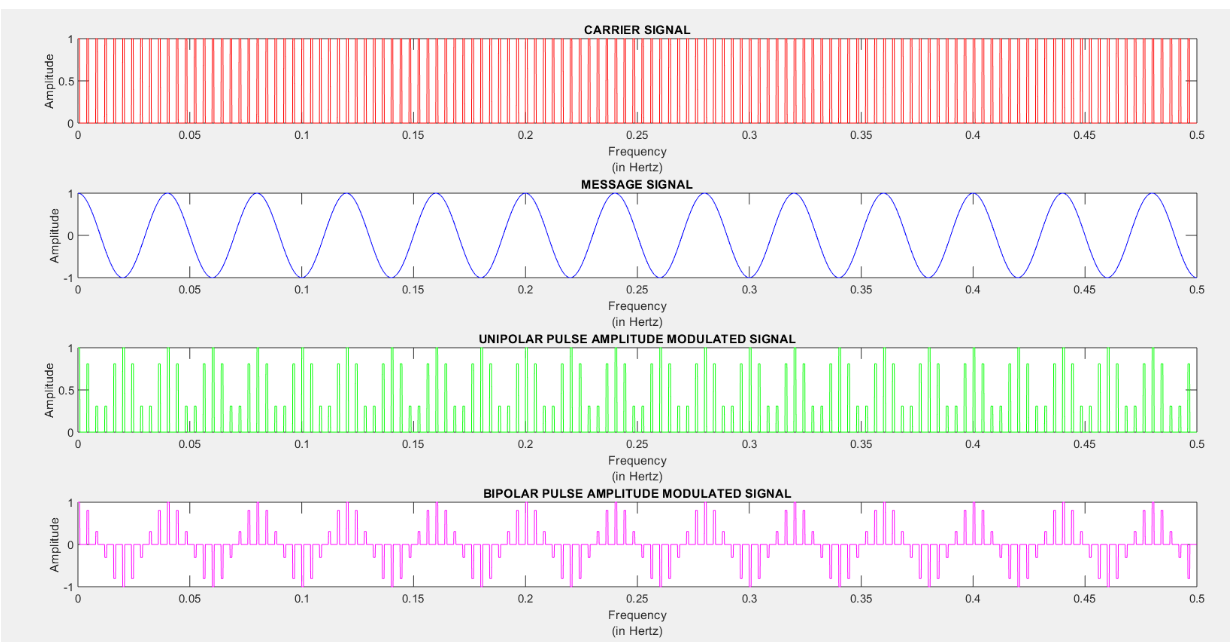
Enter sampling frequency (in Hz): 10000

Type of message signal:

1. Sine
2. Cosine
3. Sine+Cosine
4. Square
5. Sawtooth
6. Heaviside
7. Exponential
8. Random analog signal
9. Random digital signal

Enter type: 2

Enter message signal frequency (in Hz): 25



SINE+COSINE WAVE

Enter carrier signal frequency (in Hz): 250

Enter sampling frequency (in Hz): 10000

Type of message signal:

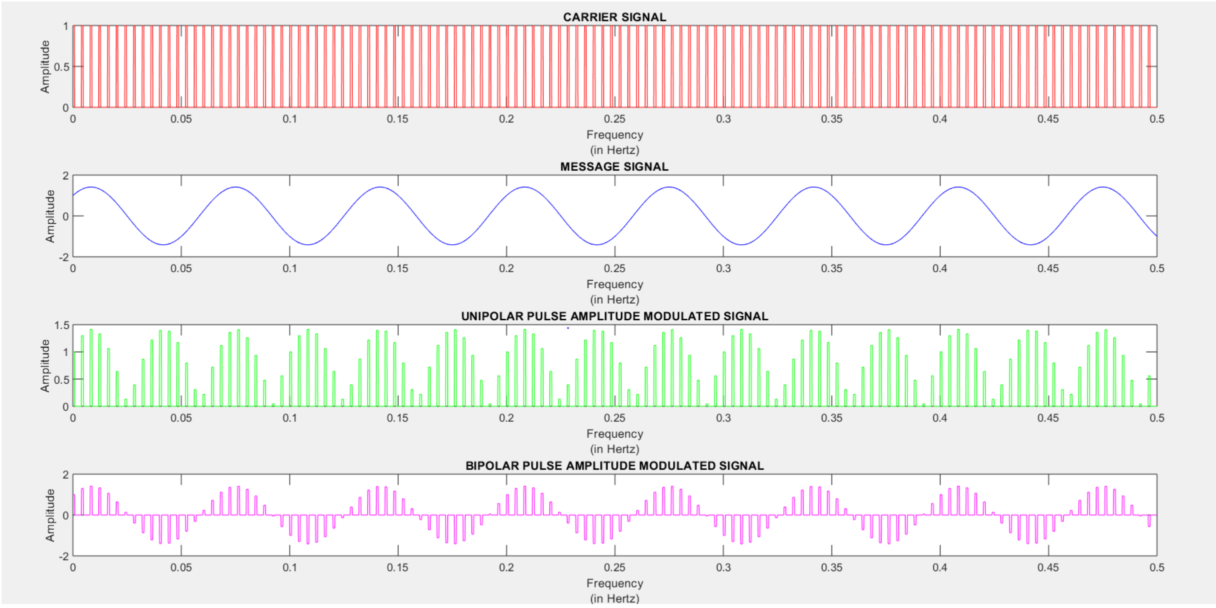
1. Sine
2. Cosine
3. Sine+Cosine
4. Square
5. Sawtooth
6. Heaviside
7. Exponential
8. Random analog signal
9. Random digital signal

Enter type: 3

Enter message signal frequency (in Hz):

Sine component : 15

Cosine component: 15



SQUARE WAVE

Enter carrier signal frequency (in Hz): 250

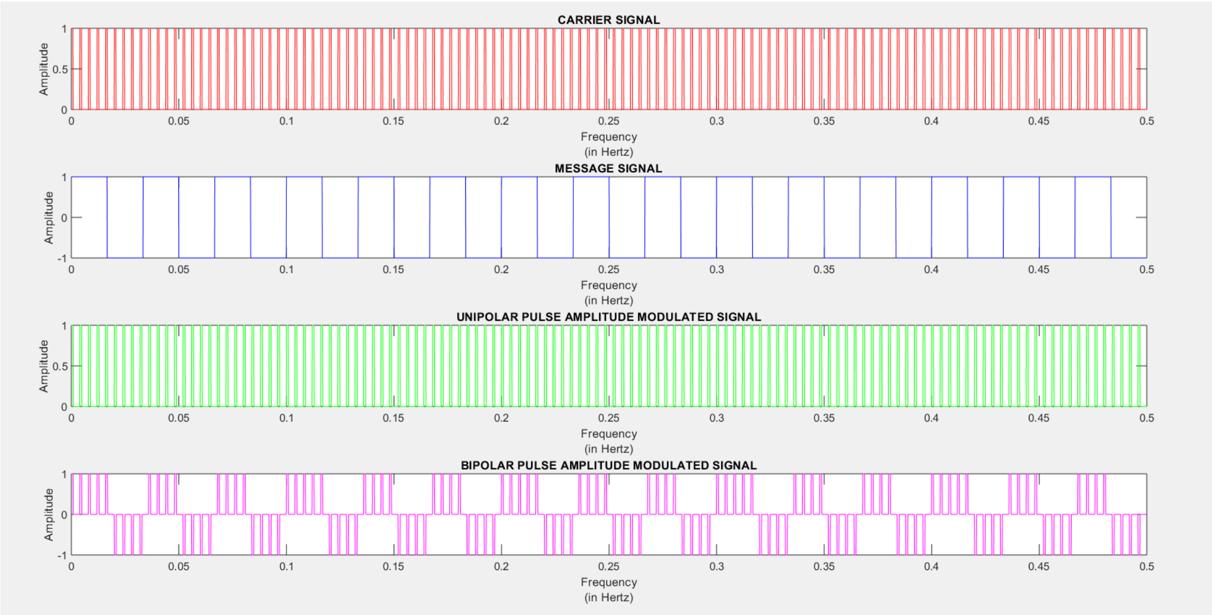
Enter sampling frequency   (in Hz): 10000

Type of message signal:

1. Sine
2. Cosine
3. Sine+Cosine
4. Square
5. Sawtooth
6. Heaviside
7. Exponential
8. Random analog signal
9. Random digital signal

Enter type: 4

Enter message signal frequency (in Hz): 30



SAWTOOTH

Enter carrier signal frequency (in Hz): 250

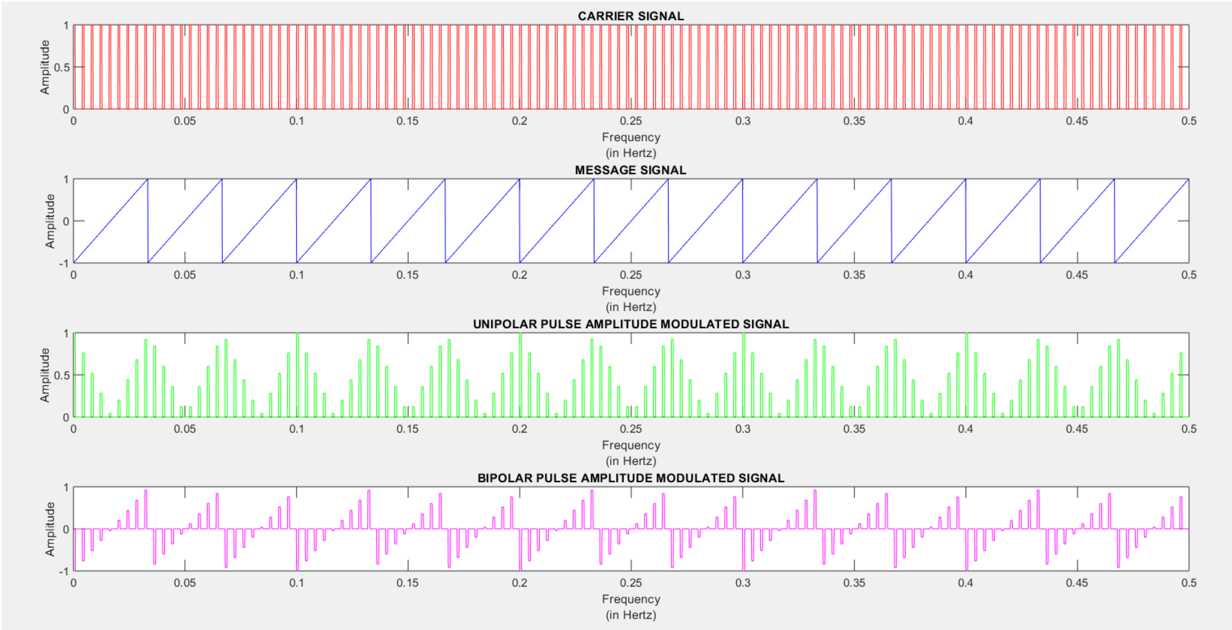
Enter sampling frequency (in Hz): 10000

Type of message signal:

1. Sine
2. Cosine
3. Sine+Cosine
4. Square
5. Sawtooth
6. Heaviside
7. Exponential
8. Random analog signal
9. Random digital signal

Enter type: 5

Enter message signal frequency (in Hz): 30



HEAVISIDE

Enter carrier signal frequency (in Hz): 250

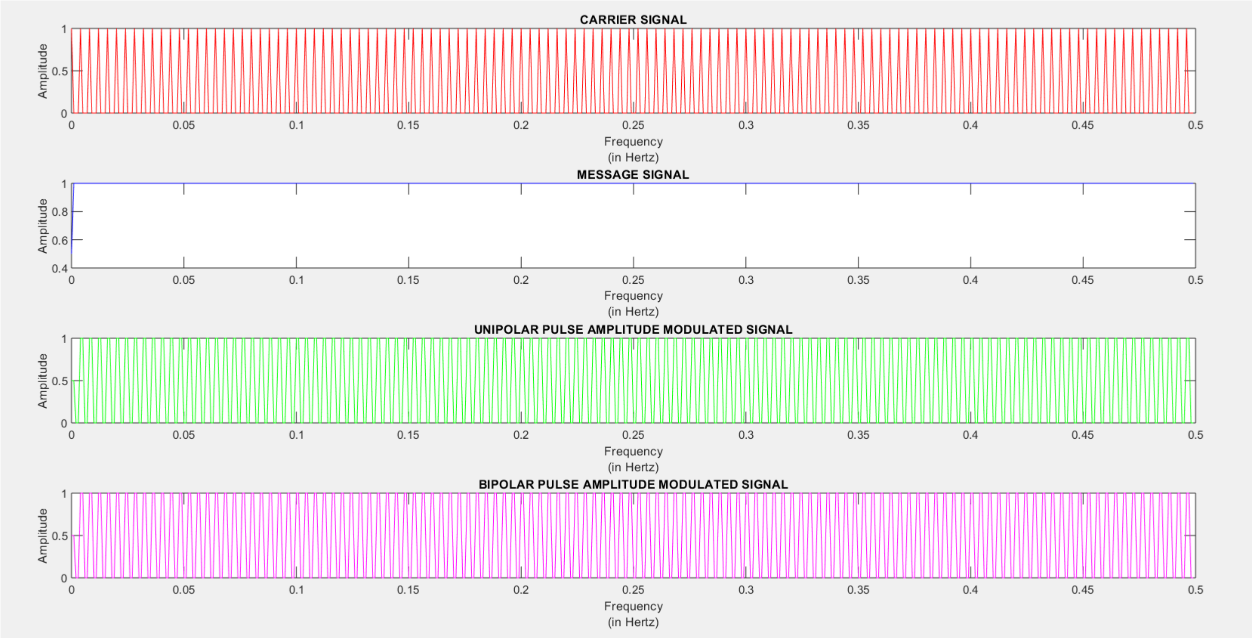
Enter sampling frequency (in Hz): 1000

Type of message signal:

1. Sine
2. Cosine
3. Sine+Cosine
4. Square
5. Sawtooth
6. Heaviside
7. Exponential
8. Random analog signal
9. Random digital signal

Enter type: 6

Enter message signal frequency (in Hz): 50



EXPONENTIAL

Enter carrier signal frequency (in Hz): 250

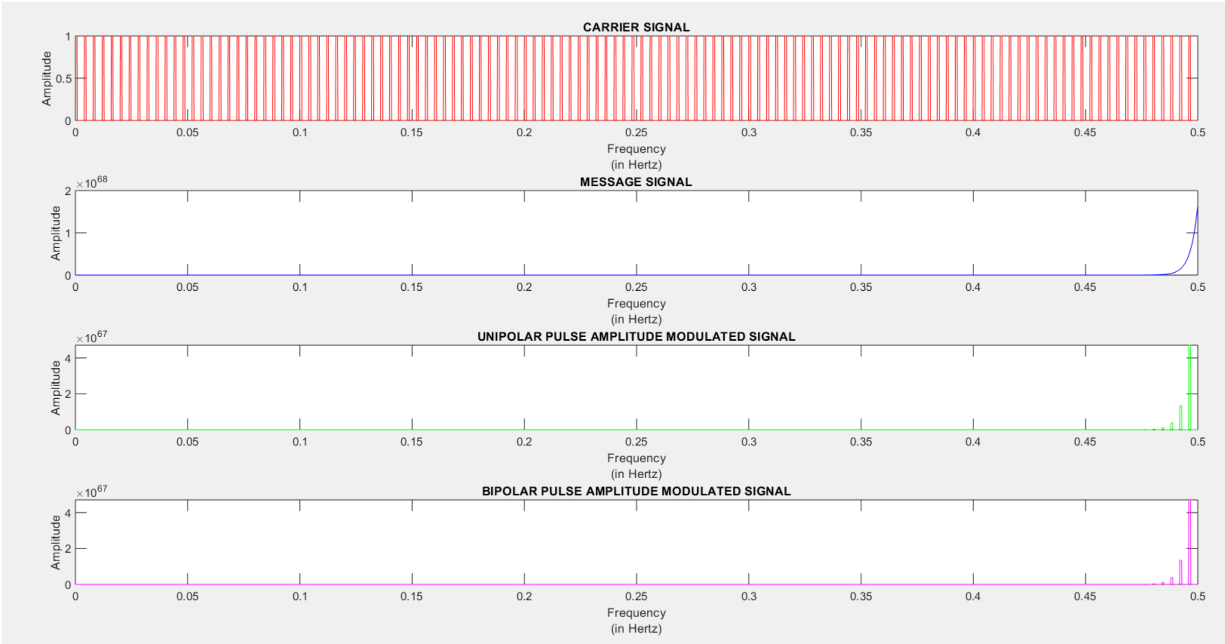
Enter sampling frequency (in Hz): 10000

Type of message signal:

1. Sine
2. Cosine
3. Sine+Cosine
4. Square
5. Sawtooth
6. Heaviside
7. Exponential
8. Random analog signal
9. Random digital signal

Enter type: 7

Enter message signal frequency (in Hz): 25



RANDOM ANALOG SIGNAL

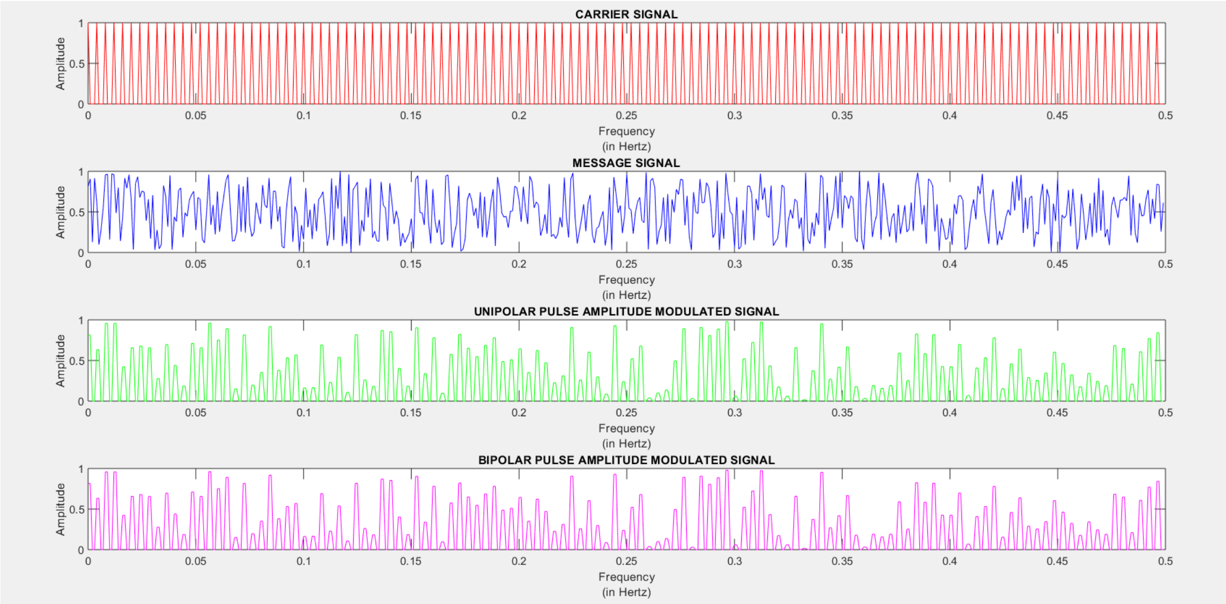
Enter carrier signal frequency (in Hz): 250

Enter sampling frequency (in Hz): 1000

Type of message signal:

1. Sine
2. Cosine
3. Sine+Cosine
4. Square
5. Sawtooth
6. Heaviside
7. Exponential
8. Random analog signal
9. Random digital signal

Enter type: 8



RANDOM DIGITAL SIGNAL

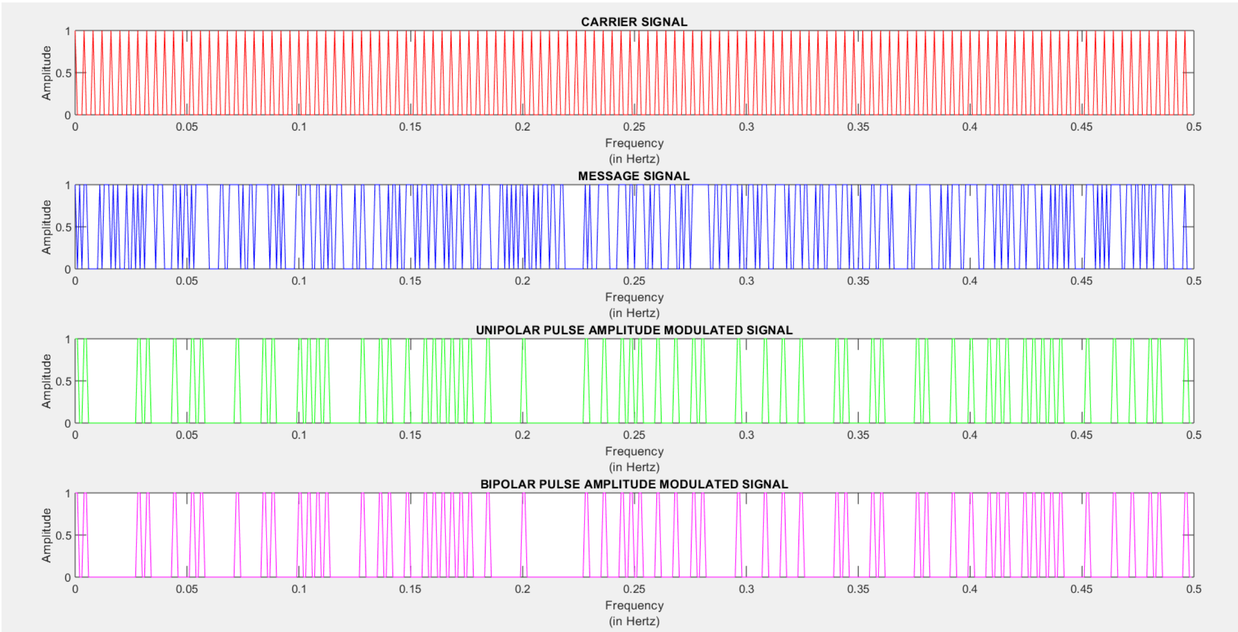
Enter carrier signal frequency (in Hz): 250

Enter sampling frequency (in Hz): 1000

Type of message signal:

1. Sine
2. Cosine
3. Sine+Cosine
4. Square
5. Sawtooth
6. Heaviside
7. Exponential
8. Random analog signal
9. Random digital signal

Enter type: 9



RESULT

Pulse Amplitude Modulation **(PAM)** for different types of input message signals were realized through a simulation in the MATLAB software.

REFERENCES

https://www.electronicshub.org/modulation-and-different-types-of-modulation/#2_Pulse_Amplitude_Modulation_PAM

https://www.elprocus.com/pulse-amplitude-modulation/

https://in.mathworks.com/help/matlab/

Modelling & Simulation Using MATLAB-Simulink – Dr. Shailendra Jain

MATLAB and its Applications in Engineering – SECOND EDITION -Pearson