TITLE: **ANALOG AND PHASE MODULATION**

OBJECTIVE:

TO CONSTRUCT AMPLITUDE MODULATION, FREQUENCY MODULATIONAND PHASE MODULATION.

THEORY:

Modulation is a fundamental concept in electronics, telecommunications, and signal processing. It refers to the process of modifying or encoding a signal (known as the "carrier signal") in order to convey information, such as audio, video, or data, over a communication channel more efficiently and effectively. Mathematically,

m = m (t) * c (t), where m (t) = Message Signal

c (t) = Carrier Signal

Hence in general, it is a process where we amplify message signal to the carrier signal.

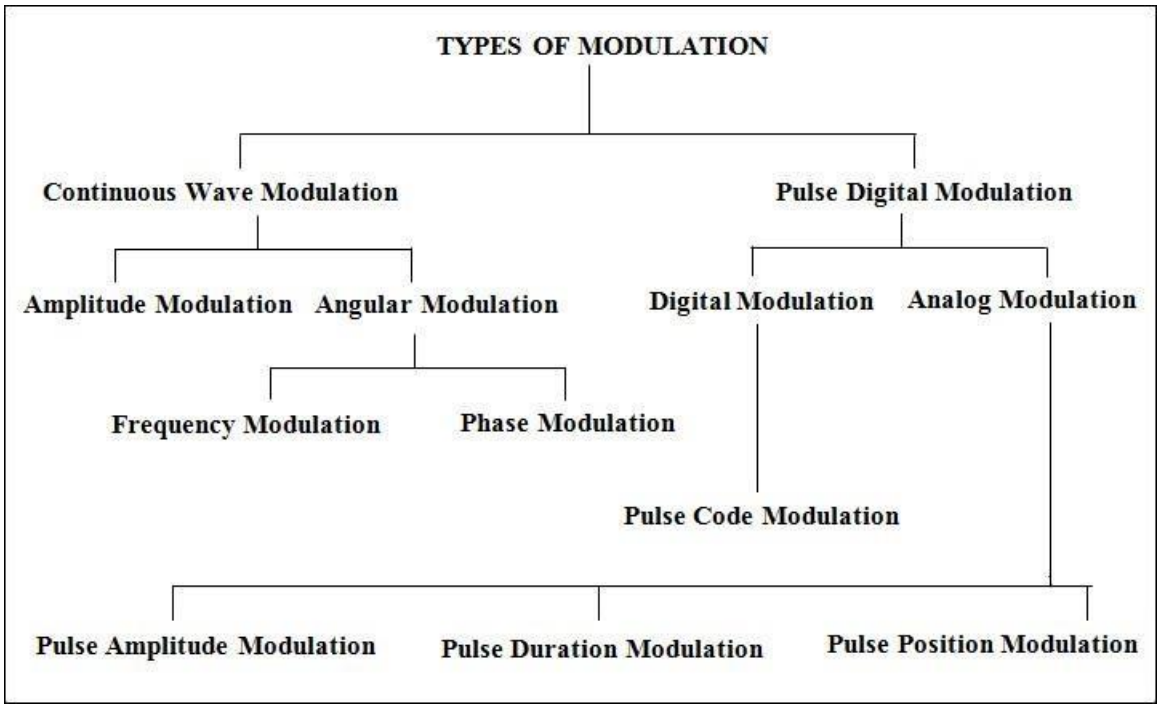


Fig: Block Diagram showing different types of Modulation

Amplitude Modulation

Amplitude Modulation (AM) is a method of encoding information on a carrier wave by varying its amplitude. It is one of the oldest and simplest methods of analog modulation used in communication systems. In AM, the amplitude of the carrier signal is altered in proportion to the instantaneous amplitude of the modulating signal, which contains the information to be transmitted.AM is still used in various applications, especially in radio broadcasting for AM radio stations, where it allows for long-range transmission due to its ability to travel long distances and propagate around obstacles. However, in modern communication systems, digital modulation methods have become more prevalent due to their improved efficiency and robustness in dealing with noise and interference.

Frequency Modulation

Frequency Modulation (FM) is a method of encoding information on a carrier wave by varying its frequency in proportion to the instantaneous amplitude of the modulating signal. It is a type of analog modulation widely used in various communication systems, especially in radio broadcasting and two-way radio communication.FM is widely used in radio broadcasting, where it has become the standard for high-fidelity music transmission. It is also used in various wireless communication systems, such as mobile phones, walkie-talkies, and wireless microphones. Additionally, FM is used in certain navigation systems, such as frequency-modulated continuous wave (FMCW) radar and radio-frequency identification (RFID) applications.

Phase Modulation

Phase Modulation (PM) is a method of encoding information on a carrier wave by varying its phase in proportion to the instantaneous amplitude of the modulating signal. Like Frequency Modulation (FM), it is a type of analog modulation used in communication systems. While FM varies the frequency of the carrier, PM changes the carrier wave's phase. PM is less commonly used in communication systems compared to FM and AM, but it has some applications in certain specialized areas. It is used in various types of digital modulation schemes, such as phase-shift keying (PSK) and quadrature phase-shift keying (QPSK), which are employed in digital communication systems and data transmission. In these digital systems, the phase of the carrier wave is manipulated to represent digital bits, allowing for efficient and robust data transmission.

DISCUSSION AND CONCLUSION:

In this lab, we aimed to explore and understand the principles of analog and phase modulation by implementing a program to demonstrate three different types of modulation techniques: Amplitude Modulation (AM) with 100% modulation, over-modulation, and under-modulation, Phase Modulation (PM), and Frequency Modulation (FM). Throughout the experiment, we sought to observe how these modulation methods affect the transmitted signals and how they differ from each other in terms of their characteristics and performance.

Analog modulation and phase modulation are two essential techniques used in communication systems to transmit analog and digital signals, respectively. Analog modulation, represented by AM and FM, is simple but limited by susceptibility to noise and interference. It finds applications in analog radio broadcasting and some voice communication systems.

On the other hand, phase modulation, especially in the form of PSK, provides a robust and efficient way to transmit digital data. Its resistance to noise and interference makes it ideal for various modern digital communication systems, including wireless networks and satellite links.

As technology continues to evolve, digital modulation techniques, including phase modulation, are expected to dominate the communication landscape due to their advantages in efficiency, data integrity, and noise tolerance. Analog modulation may still find some niche applications, but the shift towards digital communication is likely to continue, driven by the increasing demand for faster and more reliable data transmission.

TITLE: DIGITAL MODULATION

OBJECTIVE:

TO SHOW AMPLITUDE SHIFT KEYING (ASK), PHASE SHIFT KEYING (PSK) AND FREQUENCY SHIFT KEYING (FSK).

THEORY:

Digital modulation refers to the process of modifying or encoding a digital data signal onto an analog carrier signal to facilitate its transmission over a communication channel. In digital communication systems, data is represented using discrete symbols, typically in the form of binary digits (0s and 1s). These digital signals need to be converted into analog signals for transmission over analog communication channels, such as radio waves, optical fibers, or coaxial cables.

Digital modulation achieves this conversion by varying certain characteristics of the analog carrier signal, such as amplitude, frequency, or phase, according to the digital data. The variations in the carrier signal's characteristics correspond to the binary data symbols, allowing the receiver to decode the transmitted information accurately.

Categories:

- Amplitude Shift Keying (ASK)
- Frequency Shift Keying (FSK)
- Phase Shift Keying (PSK)

Amplitude Shift Keying (ASK)

Amplitude Shift Keying (ASK) is a type of digital modulation technique that encodes digital data onto an analog carrier signal by varying the carrier signal's amplitude. In ASK, the amplitude of the carrier signal is modified based on the binary data to be transmitted, where one amplitude represents one digital symbol (typically binary 1) and another amplitude represents a different digital symbol (typically binary 0).

ASK modulation is relatively simple to implement and is commonly used in low-cost communication systems. However, it is susceptible to noise and interference since changes in the amplitude can be affected by channel conditions. As a result, ASK is more commonly used in applications where noise immunity is not a primary concern and where simplicity is preferred over higher data rates.

Frequency Shift Keying (FSK)

Frequency Shift Keying (FSK) is a digital modulation technique that encodes digital data onto an analog carrier signal by varying the carrier signal's frequency. In FSK, different frequencies are used to represent different digital symbols, typically binary 0 and binary 1.

FSK modulation is widely used in various communication systems, particularly in applications where noise immunity is essential. Since the binary information is represented by distinct frequencies, FSK is less susceptible to amplitude-based noise and interference compared to other modulation techniques like Amplitude Shift Keying (ASK). This makes FSK a popular choice for applications such as radio broadcasting, wireless data communication, and certain digital audio transmission systems. Additionally, FSK can achieve relatively high data rates and provides reliable data transmission in noisy environments.

Phase Shift Keying (PSK)

Phase Shift Keying (PSK) is a digital modulation technique that encodes digital data onto an analog carrier signal by varying the carrier signal's phase. In PSK, different phase PSK modulation is commonly used in digital communication systems, especially in applications where robustness against noise and interference is crucial. Since the binary information is represented by phase shifts rather than amplitude or frequency variations, PSK is less affected by amplitude-based noise and frequency drifts. This makes PSK suitable for applications such as satellite communication, digital subscriber lines (DSL), and wireless communication systems.

PSK modulation is commonly used in digital communication systems, especially in applications where robustness against noise and interference is crucial. Since the binary information is represented by phase shifts rather than amplitude or frequency variations, PSK is less affected by amplitude-based noise and frequency drifts. This makes PSK suitable for applications such as satellite communication, digital subscriber lines (DSL), and wireless communication systems.

Q. Construct an Amplitude Shift Keying modulated sinusoidal signal with amplitude5 units and frequency 4Hz, then plot the signal.

Solution:

Source code (ASK)

```
clc; clear
all; close
all;
Amp=5;
fp=4;
fc=50;
t=0:0.001:1;
x=Amp.*sin(2*pi*fc*t);
subplot(3,1,1);
plot(t,x);
grid on;
xlabel('Time');
ylabel('Amplitude');
title('Amplitude Shift Keying / Ashwin / 020’);
legend("Carrier Wave");
y=Amp/2.*square(2*pi*fp*t)+(Amp/2);
subplot(3,1,2);
plot(t,y);
grid on;
xlabel('Time');
ylabel('Amplitude');
a=x.*y;
subplot(3,1,3);
plot(t,a);
grid on;
xlabel('Time');
ylabel('Amplitude');
legend("Amplitude Shift Keying Signal");
```

Q. Construct a Frequency Shift Keying modulated sinusoidal signal with amplitude5 units and frequency 4Hz, then plot the signal.

Solution:

Source code (FSK)

```
clc; clear
all; close
all;
Amp=5;
fp=4;
fc1=50;
fc2=100;
t=0:0.001:1;
c1=Amp/2.*sin(2*pi*fc1*t);
c2=Amp/2.*sin(2*pi*fc2*t);
subplot(4,1,1);
plot(t,c1); grid
on;
xlabel('Time');
ylabel('Amplitude');
title('Frequency Shift Keying / Ashwin / 020');
legend("Carrier 1 Wave");
subplot(4,1,2);
plot(t,c2); grid
on;
xlabel('Time');
ylabel('Amplitude');
legend("Carrier 2 Wave");
m=Amp/2.*square(2*pi*fp*t)+(Amp/2);
subplot(4,1,3);
plot(t,m);
grid on;
xlabel('Time');
ylabel('Amplitude');
legend("Message Signal");
for i=0:1000
if     m(i+1)==0
```

```
a(i+1)=c2(i+1);
else
a(i+1)=c1(i+1);
end
end
subplot(4,1,4);
plot(t,a);
grid on;
xlabel('Time');
ylabel('Amplitude');
legend("Frequency Shift Keying Signal");
```

DISCUSSION AND CONCLUSION:

With the reference to the theoretical knowledge regarding the MATLAB, we were able to use it and also code some programs to plot different kind of wave Signal.

The generated signals exhibited distinct characteristics:

- Sine Wave: A smooth and periodic signal with specific frequency and amplitude B Noise: A random signal with no discernible pattern
- Noise + Sine: A combination of periodic and random components
- DT and CT: A waveform consisting of abrupt transition at Signum function Specific
- Sin C wave: A continuous waveform with oscillations derived from the sine function.
- CT and DT: A Signal with a Signal impulse at a particular Unit Impulse time. CT and DT: A periodic signal alternating between high and low Square Signal levels
- CT and DT: A linearly increasing or cheerleading signal Ramp Signal

In lab work, we explored and generated. Various basic elementary signals commonly used in data communication. MATLAB was used to implement these signals, and their properties were analyzed

Q. Construct a Phase Shift Keying modulated sinusoidal signal with amplitude 5units and frequency 4Hz, then plot the signal.

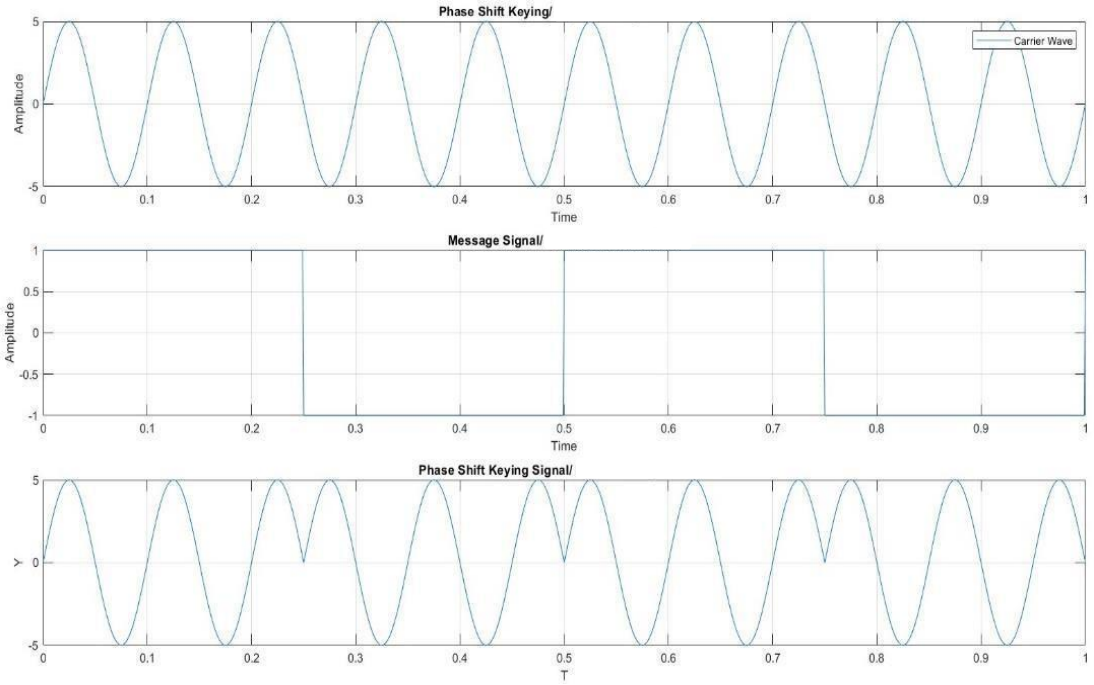
Solution:

Source code (PSK)

```
clc; clear
all; close
all; amp
= 5;
fm = 2;
fc = 10;
t = 0:0.001:1;
x = amp.*sin(2*pi*fc*t);
subplot(3,1,1);
plot(t,x);
grid on;
xlabel('Time');
ylabel('Amplitude');
title('Phase Shift Keying/ Ashwin / 020’);
legend("Carrier Wave");
y = square(2*pi*fm*t);

subplot(3,1,2);
plot(t,y);
grid on;
xlabel('Time');
ylabel('Amplitude');
title('Message Signal/ Ashwin / 020’);
a = x.*y;
subplot(3,1,3);
plot(t,a);
grid      on;
xlabel('T');
ylabel('Y');
title('Phase Shift Keying Signal/ Ashwin / 020’)
```

<u>Output</u> (PSK)



DISCUSSION AND CONCLUSION:

In this lab, we set out to explore and understand three digital modulation techniques: Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), and Phase Shift Keying (PSK). We accomplished this objective by constructing modulated sinusoidal signals with specific characteristics using MATLAB.

Digital modulation is a key technique used in modern communication systems to transmit digital data over analog channels. It involves converting digital information, represented by discrete symbols (0s and 1s), into analog signals suitable for transmission through various media like radio waves, optical fibers, or coaxial cables. There are several popular digital modulation techniques, including Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), and Quadrature Amplitude Modulation (QAM).

Digital modulation plays a crucial role in modern communication systems, enabling efficient and reliable data transmission over analog channels. As technology continues to advance, the demand for higher data rates and spectral efficiency will drive further innovation in digital modulation techniques. From wireless communication and satellite links to wired data transmission, digital modulation techniques will continue to be at the heart of efficient and robust data communication in the digital age.