# MAHA BARATHI ENGINEERING COLLEGE

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**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**

## Even Semester

## (Regulation 2021)

**II Year/ IV Semester**

# EC 3461 COMMUNICATION SYSTEMS LABORATORY

**(As per Anna University, Syllabus)**

## Department of Electronics and Communication Engineering

### EC 3461 COMMUNICATION SYSTEMS LABORATORY

**List of Experiments**

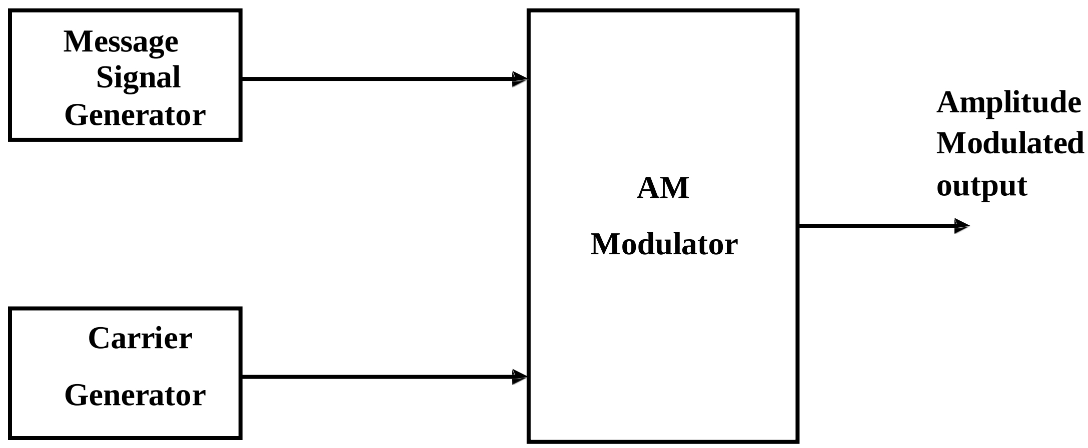
1. AM- Modulator and Demodulator
2. FM - Modulator and Demodulator
3. Pre-Emphasis and De-Emphasis.
4. Signal sampling and TDM.
5. Pulse Code Modulation and Demodulation.
6. Pulse Amplitude Modulation and Demodulation.
7. Pulse Position Modulation and Demodulation and Pulse Width Modulation and Demodulation.
8. Digital Modulation – ASK, PSK, FSK.
9. Delta Modulation and Demodulation.
10. Simulation of ASK, FSK, and BPSK Generation and Detection Schemes.
11. Simulation of DPSK, QPSK and QAM Generation and Detection Schemes.
12. Simulation of Linear Block and Cyclic Error Control coding Schemes.

**TOTAL = 45 PERIODS**

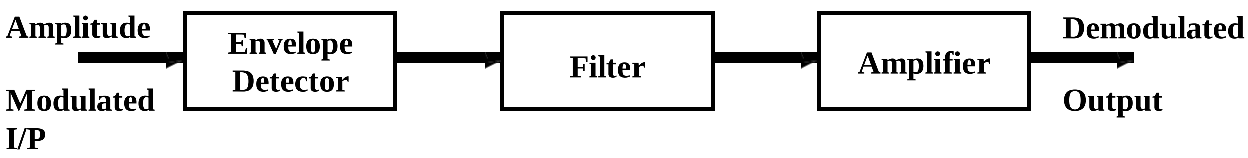
## TABLE OF CONTENTS

**BLOCK DIAGRAM**

**AM MODULATOR:**




**AM DEMODULATOR:**



## Ex.No:1 AM MODULATOR AND DEMODULATOR

**AIM:**

To amplitude modulate the given message signal and to recover the message signal by demodulation.

**APPARATUS REQUIRED:**

1. AM Modulation Kit
2. AM Demodulation Kit
3. Connecting probes
4. CRO

**THEORY:**

Changing the characteristics of carrier signal in accordance with the message signal is called modulation. In AM modulation, the amplitude of carrier signal is changed in accordance with the message signal. Both message and carrier signal is are analog signal. The carrier frequency remains same, but its amplitude varies according to amplitude variations of the modulating signal. Modulation index **= m = $E_m$ / $E_C$** = maximum amplitude of modulating signal / carrier signal

Value of $E_m < E_C$ to avoid any distortion in the modulated signal.

**Maximum value of m = 1 when $E_m = E_c$**

**Minimum value of m = 0**

If m > 1 is called over modulation, m < 1 is called under modulation.

Modulation index is calculated from the equation **$m = (E_{max} - E_{min}) / (E_{max} + E_{min})$**

**Bandwidth = $2f_m$**

AM signal has three components; un modulated carrier, lower sideband and upper sideband.

**Total power $P = P_c (1 + m^2 / 2)$**

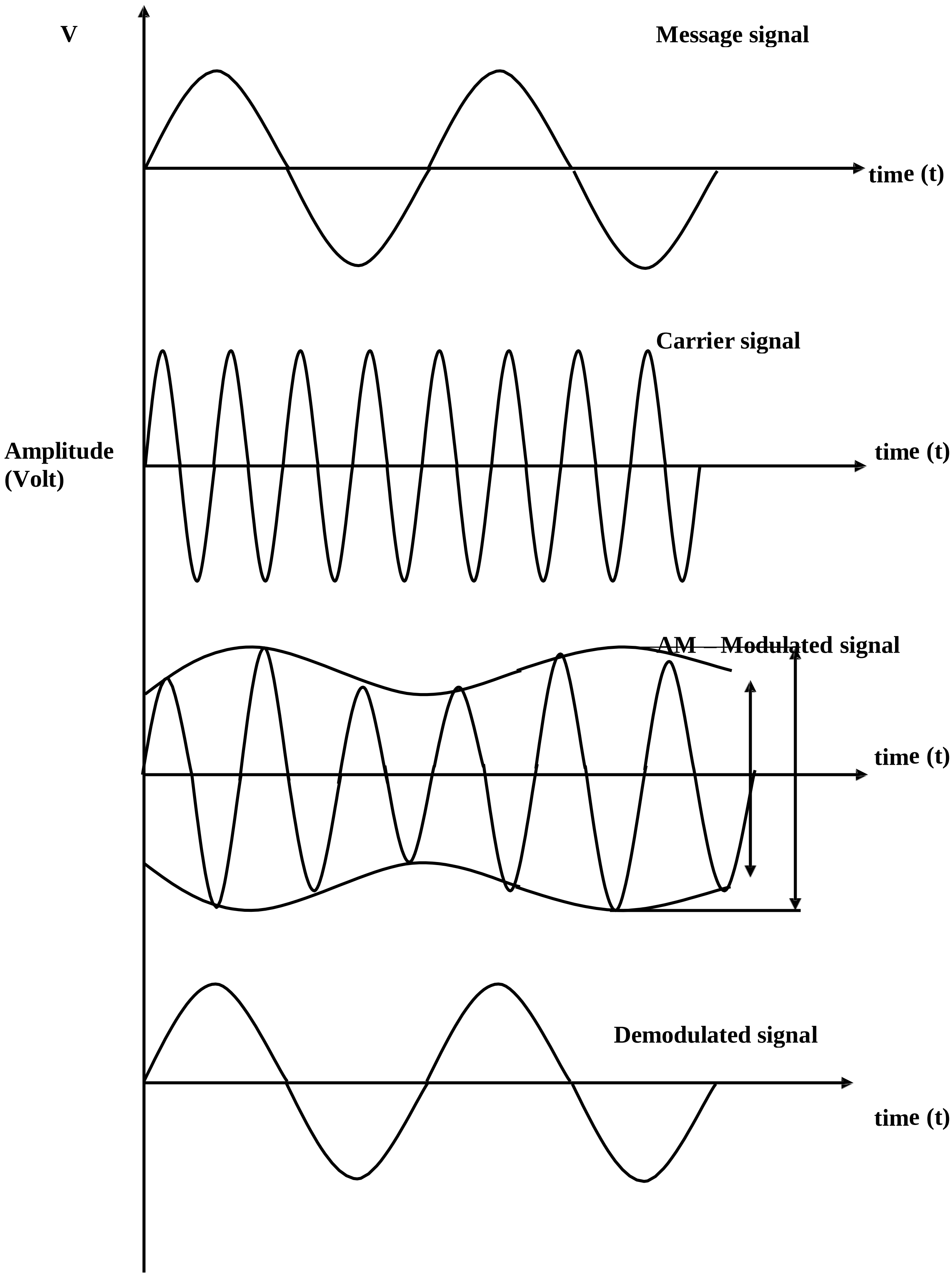
AM modulation is done by

1. Transistor modulator of base, emitter and collector type
2. Low level modulator
3. Medium power AM modulator

AM demodulation is done by

Envelope detector (or) diode detector.

**MODEL GRAPH: -**


V
Message signal
time (t)
Carrier signal
Amplitude
(Volt)
time (t)
AM – Modulated signal
time (t)
Demodulated signal
time (t)

**PROCEDURE:**

1. Connections must be given as per the diagram.
2. Low frequency message signal is given as one input to AM modulator.
3. High frequency message signal is given as one input to AM modulator.
4. The amplitude modulated waveform obtained is viewed in CRO.
5. Readings are taken for message, carrier and amplitude modulated wave.
6. The modulated wave is given as input to envelope detector.
7. The demodulated output is noted in CRO.
8. Modulation index have to be calculated as per formula.

**CALCULATION:-**

$$\text{Modulation Index} = \frac{E_{\max} - E_{\min}}{E_{\max} + E_{\min}}$$

**TABULATION:**

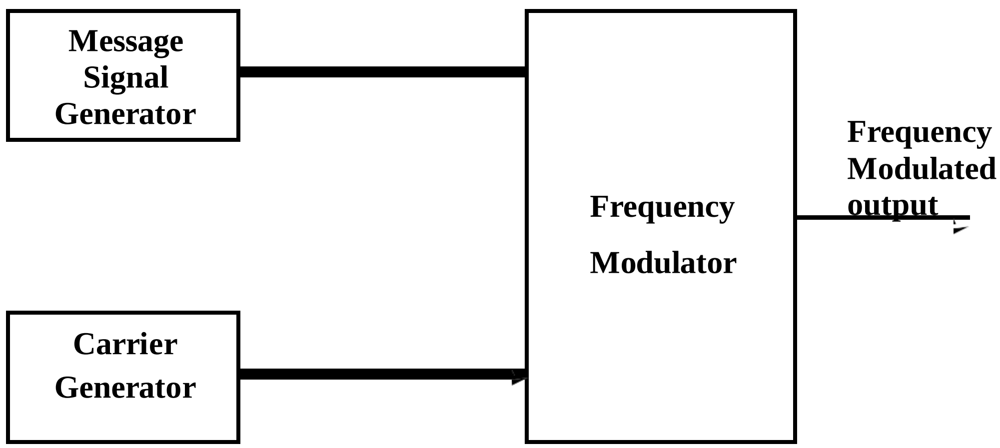
| Signal | Amplitude (V) | Time (ms) |
|---|---|---|
| | | |

**RESULT:**

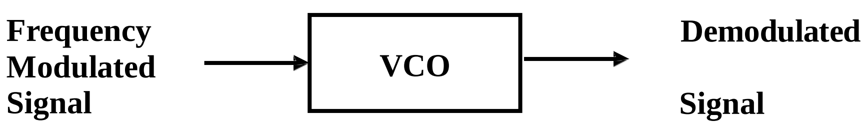
The amplitude modulation and demodulation operations were performed with the given message and carrier signals and the observed waveforms were plotted in the graph.

**BLOCK DIAGRAM**

**FM MODULATOR:**




**FM DEMODULATOR:**



## Ex. No: 2 FM MODULATOR AND DEMODULATOR

**AIM:**

To frequency modulate the given message signal and to recover the message signal by demodulation.

**APPARATUS REQUIRED:**

1. FM Modulation Kit
2. FM Demodulation Kit
3. Connecting probes
4. CRO

**THEORY:**

Frequency of the carrier signal varies in accordance with the message signal is called frequency modulation. Amplitude of the modulated carrier remains constant.

Modulation index $\mathbf{m = K_1 E_m / W_m}$

Modulation index of FM is directly proportional to peak modulating voltage.

$$\mathbf{m = \delta / f_m = \text{Maximum frequency deviation / Modulating frequency}}$$

m < 1 is called narrow band FM. FCC allows $\delta$ of 75KHz and $f_c$ = 100MHz. Angle modulated signal contains large number of sidebands depending upon the modulation index.

$$\mathbf{Bandwidth = 2f_m\ HZ = 2\delta = 2nf_m}$$

Where 'n' is the number of significant sidebands obtained from Bessel table.

Based on Carson's rule, **Bandwidth = 2[$\delta$ + $f_m$(max)] HZ.**

Total power = $E_c^2 / 2R$. It is constant in FM.

Since, amplitude of FM is constant the noise interference is minimum in FM.

The frequency modulation is done by

i) Direct FM using

a) FET reactance modulator; b) Varactor diode

ii) Indirect FM – Armstrong method

The demodulation is done by

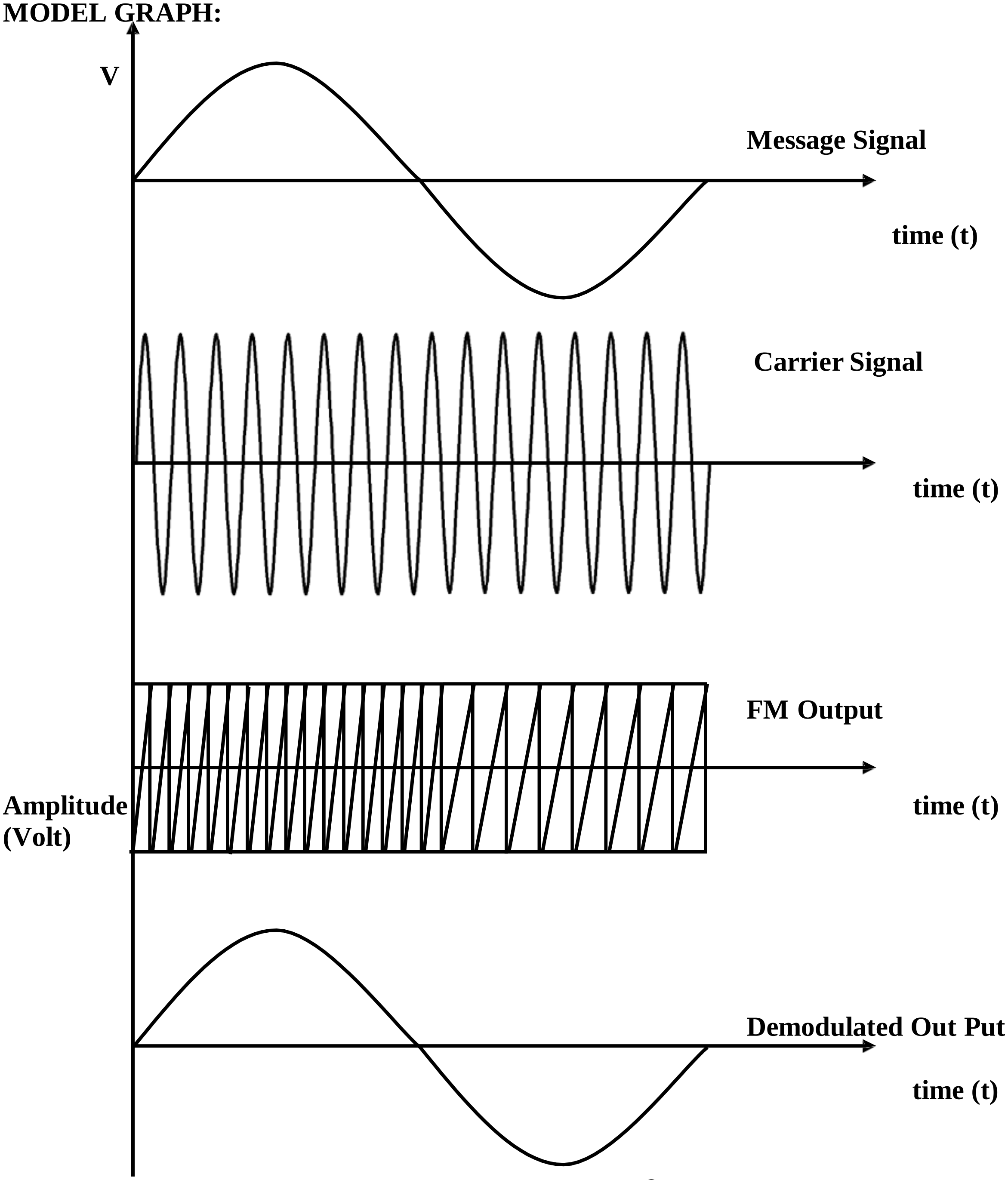
1. Balanced slope detector (or) Round Travis detector
2. Foster seeley discriminator (phase discriminator)
3. Ratio detector

The FM detector should be able to produce the signal whose amplitude is proportional to the deviation in the frequency of FM signal.

**PROCEDURE:-**

1. Connections must be given as per the diagram.
2. Low frequency message signal is given as one input to FM modulator.
3. High frequency message signal is given as one input to FM modulator.
4. The amplitude modulated waveform obtained is viewed in CRO.
5. Readings are taken for message, carrier and amplitude modulated wave.
6. The modulated wave is given as input to envelope detector.
7. The demodulated output is noted in CRO.
8. Modulation index have to be calculated as per formula.

**MODEL GRAPH:**



**TABULATION:**

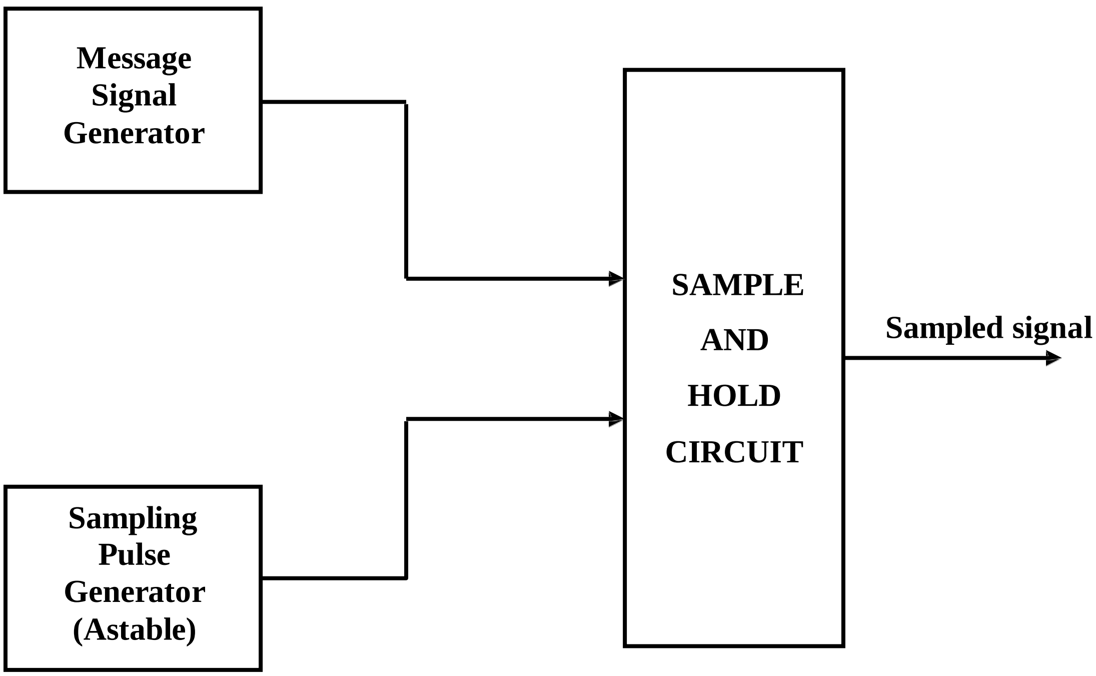
| Signal | Amplitude (V) | Time (ms) |
|---|---|---|
| | | |

**RESULT:**

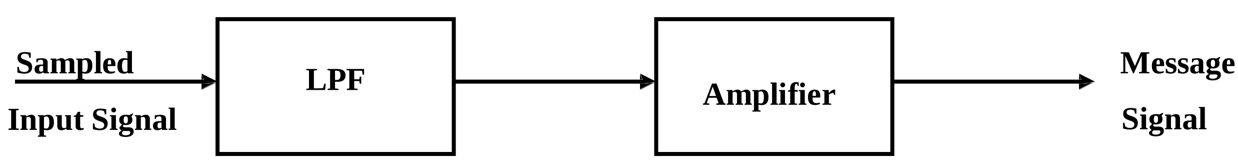
The frequency modulation and demodulation operations were performed with the given message and carrier signals and the observed waveforms were plotted in the graph.

**BLOCK DIAGRAM**

**SAMPLER**




**RECONSTURCTION CIRCUIT**



## Ex.No:3(a) SIGNAL SAMPLING AND RECONSTRUCTION

**AIM:**

To get the samples of the given message signal by natural sampling method and to reconstruct the message signal from the samples.

**APPARATUS REQUIRED:**

1. Analog signal sampler kit
2. Reconstruction Kit
3. CRO
4. Connecting probes

**THEORY:**

The sampling process is defined as converting the analog signal into a digital signal by using the sampling and hold circuit.

Types of sampling is

i. Natural sampling
ii. Impulse sampling

Sampling is performed based on sampling theorem:

A band limited signal having no spectral components above $f_m$ HZ can be determined uniquely by values sampled at uniform intervals of

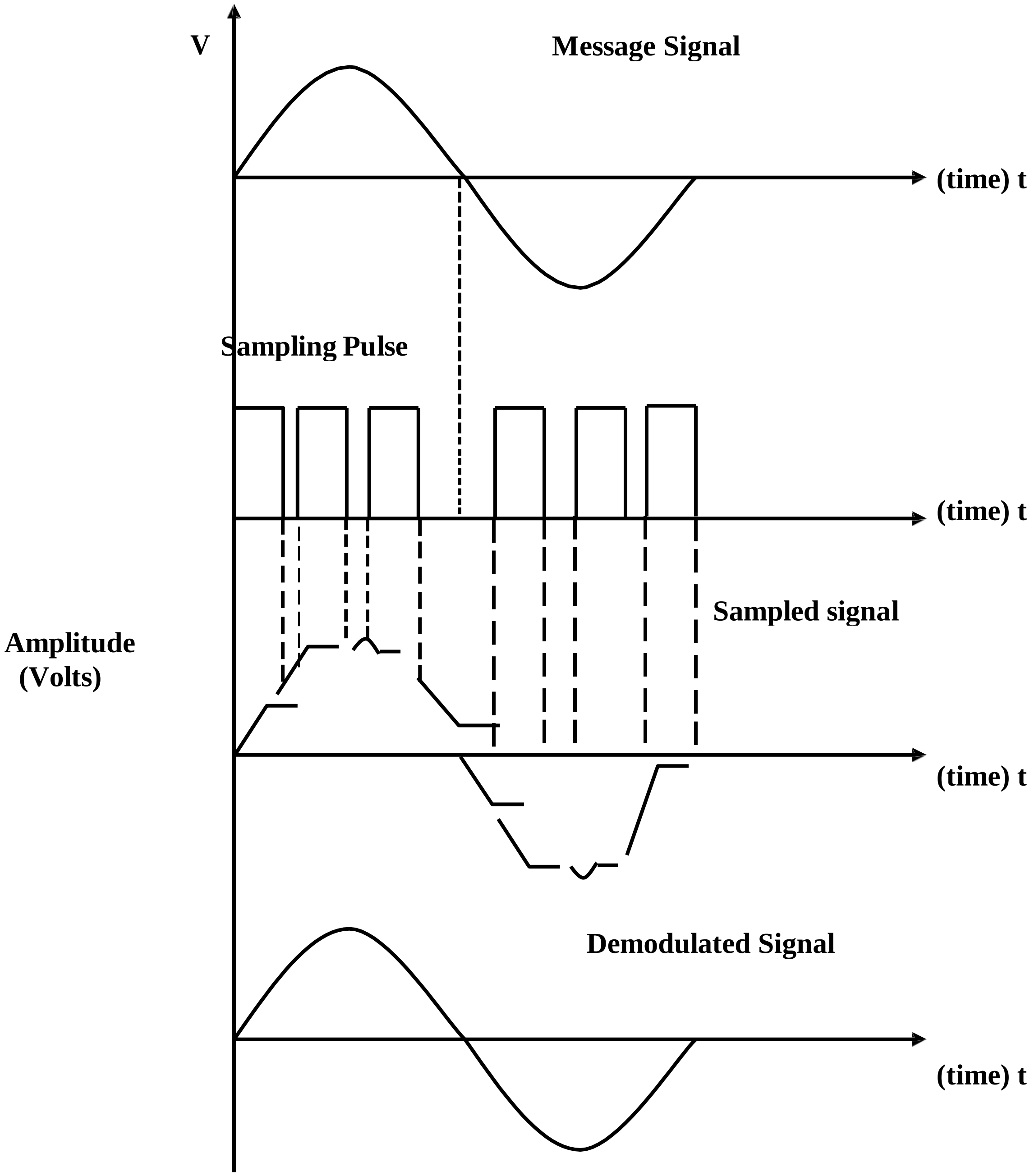
**$T_S \leq 1/2f_m$ sec.**

Nyquist rate $f_S \geq 2f_m$ which gives the minimum sampling frequency needed to reconstruct the analog signal from sampled waveforms.

The sampling is implemented by a circuit sampler is most commonly done with a Sample and Hold circuit.

If we under sample $f_S <$ f Nyquiset then aliasing occurs. Aliasing means overlapping adjacent spectrum replicates. It leads to loss of information. So, antialiasing filters are used to overcome it.

## MODEL GRAPH


V
Message Signal
(time) t
Sampling Pulse
(time) t
Sampled signal
Amplitude
(Volts)
(time) t
Demodulated Signal
(time) t

**PROCEDURE:-**

1. Connections must be given as per the diagram.
2. Low frequency message signal is given as one input to sample / hold circuit
3. Carrier pulse signal is given as another input to to sample / hold circuit.
4. The sampling pulse waveform obtained is viewed in CRO.
5. Readings are taken for message, carrier and sampling pulse.
6. The sampled wave is given as input to reconstruction circuit.
7. The reconstructed circuit output is noted in CRO

**TABULATION:-**

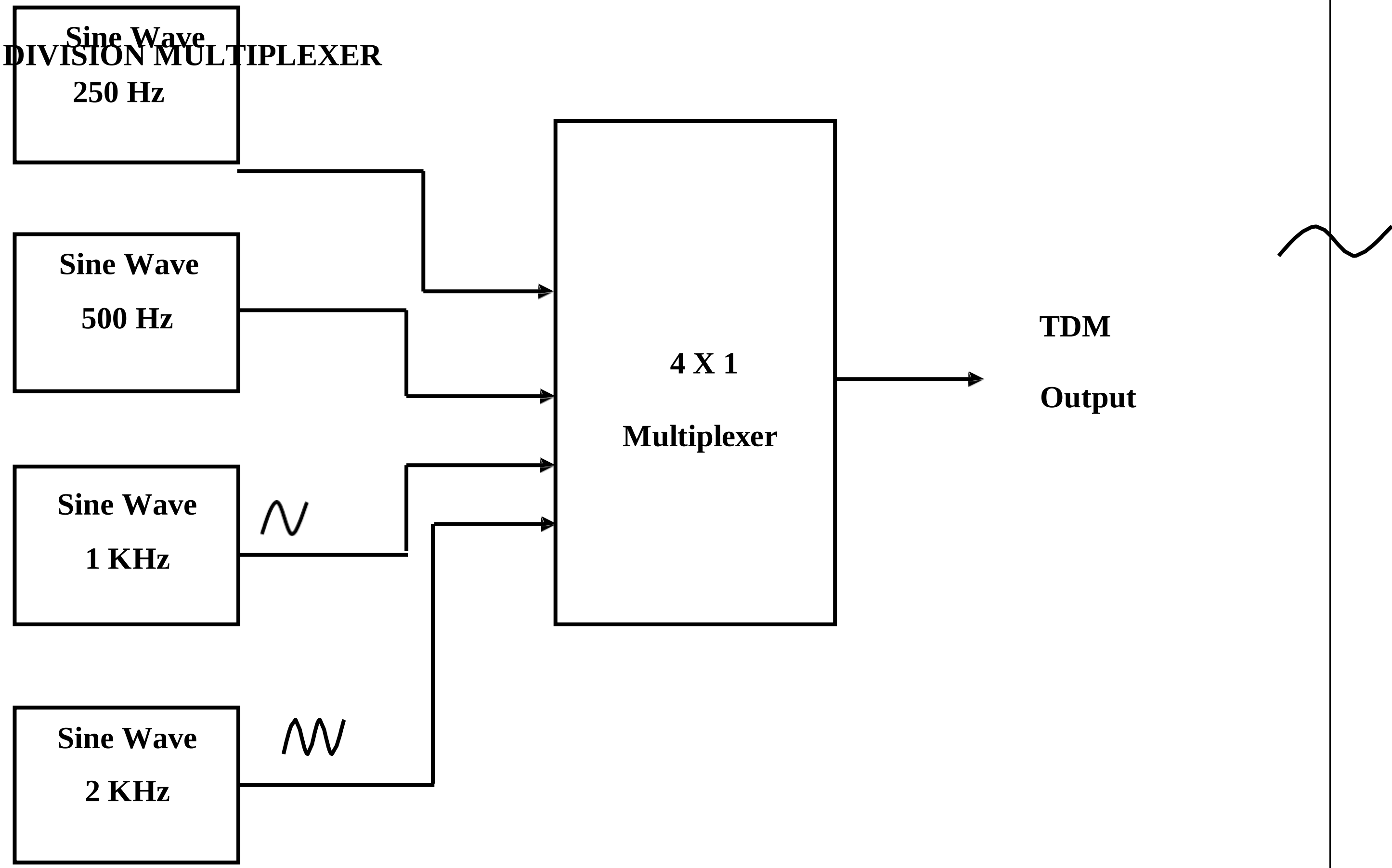
| Signal | Amplitude (V) | Time (ms) |
|---|---|---|
| | | |

**RESULT:**

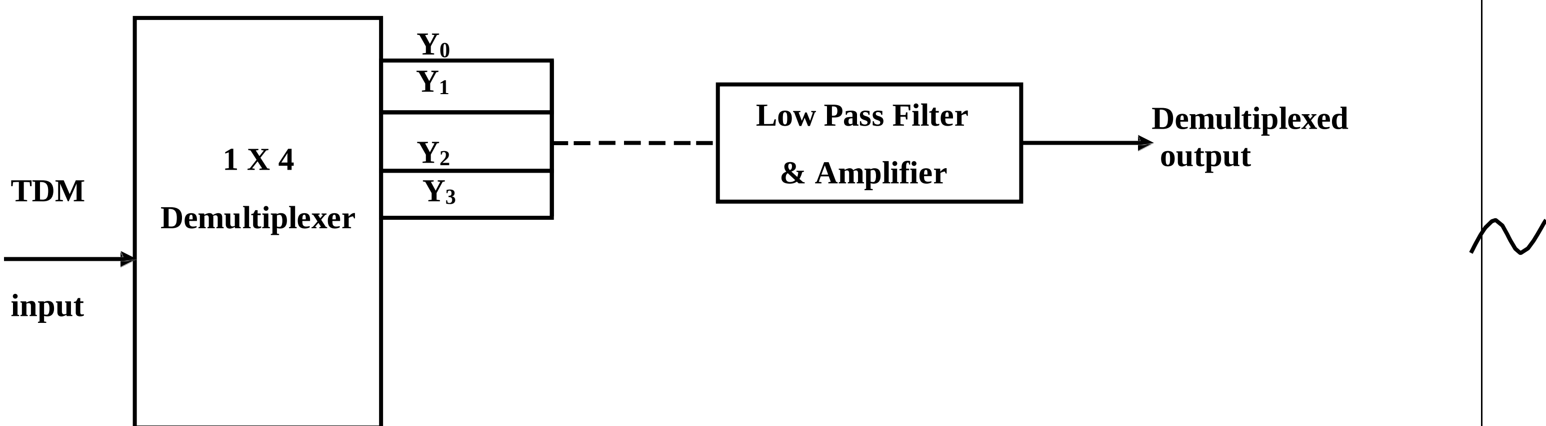
The message signal was sampled and transmitted and the same message has been reconstructed is obtained at the receiving end. The observed waveforms were plotted in graph.

**BLOCK DIAGRAM**

**TIME DIVISION MULTIPLEXER**




**TDM DEMULTIPLEXER**



## Ex.No:3(b) TIME DIVISION MULTIPLEXING (TDM)

**AIM:**

To obtain time division multiplexed signals for given 3 or 4 signals and also to demultiplex it.

**APPARATUS REQUIRED:**

1. TDM – multiplexing Kit
2. TDM – demultiplexing Kit
3. CRO
4. Connecting probes

**THEORY:**

The sampling theorem provides a basis for transmitting the information of band limited signal as sequence of samples uniformly at a rate slightly higher than the Nyquist rate. The important feature of the sampling process is a conservation of time.

The principle of TED:

The principle of TDM is sharing common communication channel by independent message sources without mutual interference among them.

***The basic operations of TDM system is:***

i) Filtering

ii) Selection of samples

iii) Pulse modulation

iv) Demodulation

v) Distribution of narrow samples

Each input message signal is restricted in bandwidth by a filter. Selection of samples is the function of commentator. Then it is modulated and transmitted via channel. In the receiver, the demodulated signal is distributed by decommentator.

***Merits:***

i) It can easily accommodate both analog and digital sources.

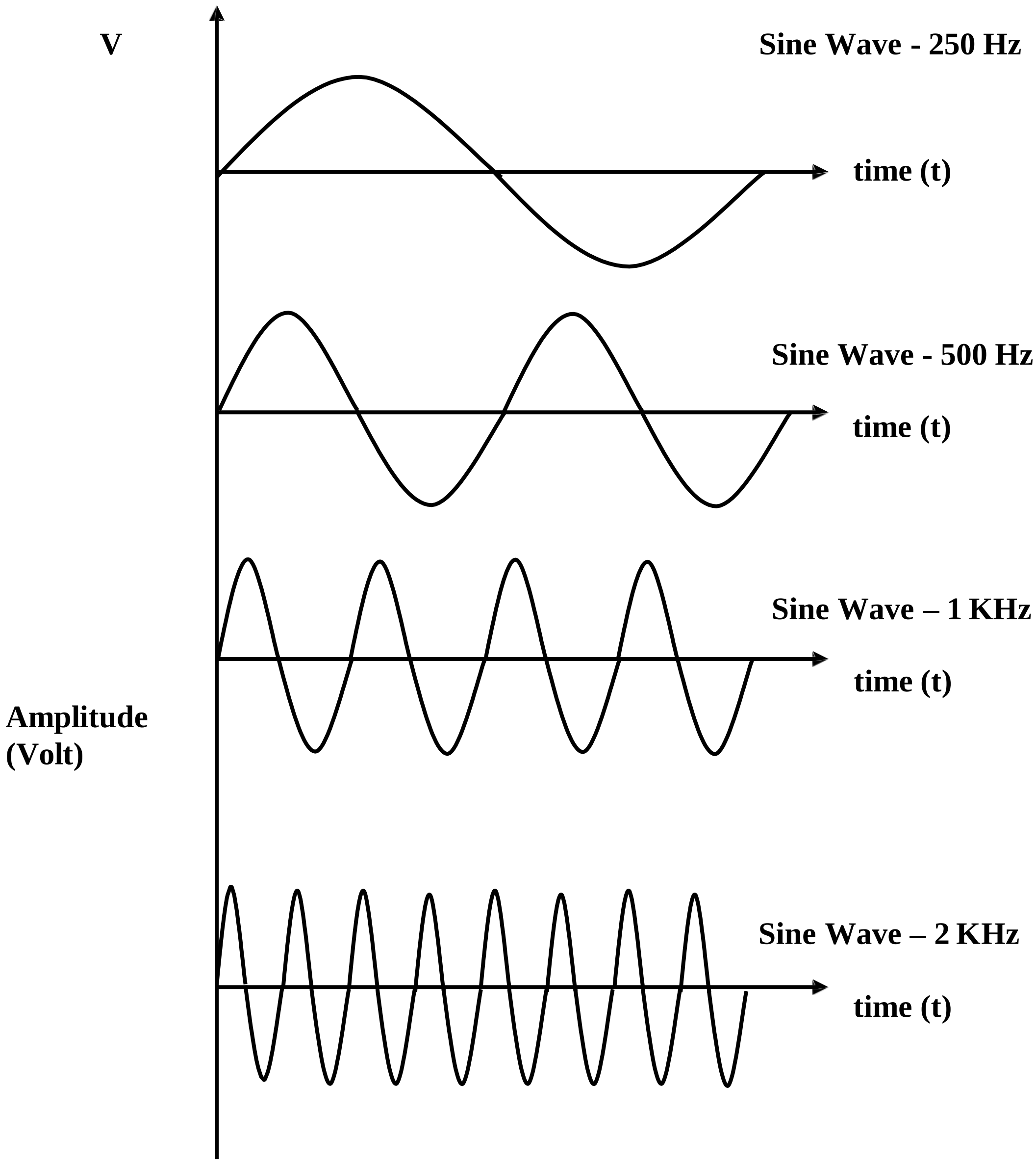
ii) TDM has immune to non-linearity's in the channel.

***Demerits:***

It is highly sensitive to amplitude, phase variations in the channel.

**MODEL GRAPH:-**

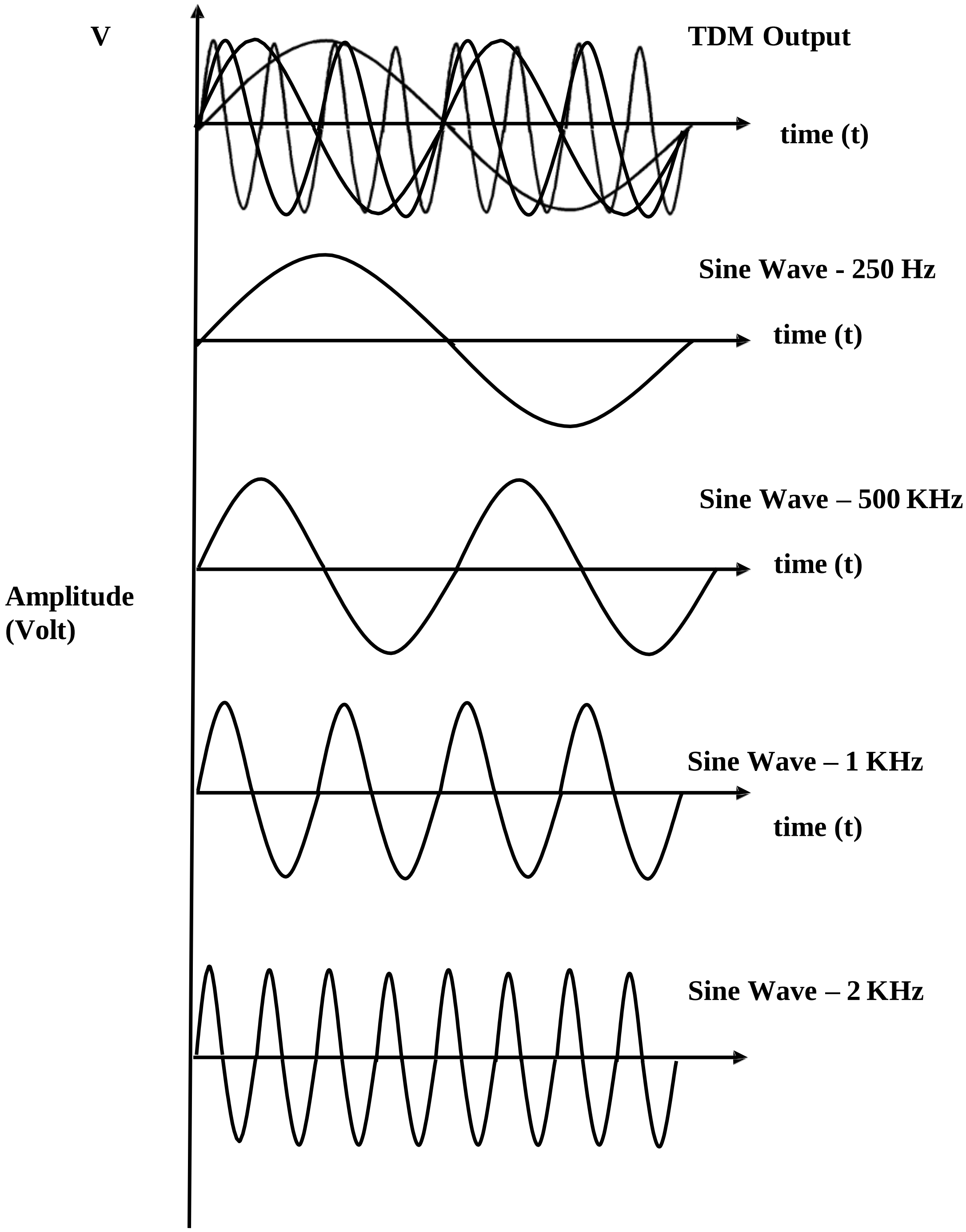
**TDM INPUT**



**PROCEDURE:-**

1. Connections must be given as per the diagram.
2. Four different frequency message signals are given as input to TDM amplitude.
3. The multiplexed waveform obtained is viewed in CRO.
4. Readings are taken for each message signal.
5. The multiplexed wave is given as input to demultiplexer circuit.
6. The demulteplexed output is noted in CRO.
7. The graph is plotted for multiplexed signal, demultiplexed signal.

**TDM OUTPUT**


V
TDM Output
time (t)
Sine Wave - 250 Hz
time (t)
Sine Wave – 500 KHz
time (t)
Amplitude
(Volt)
Sine Wave – 1 KHz
time (t)
Sine Wave – 2 KHz

**TABULATION:**

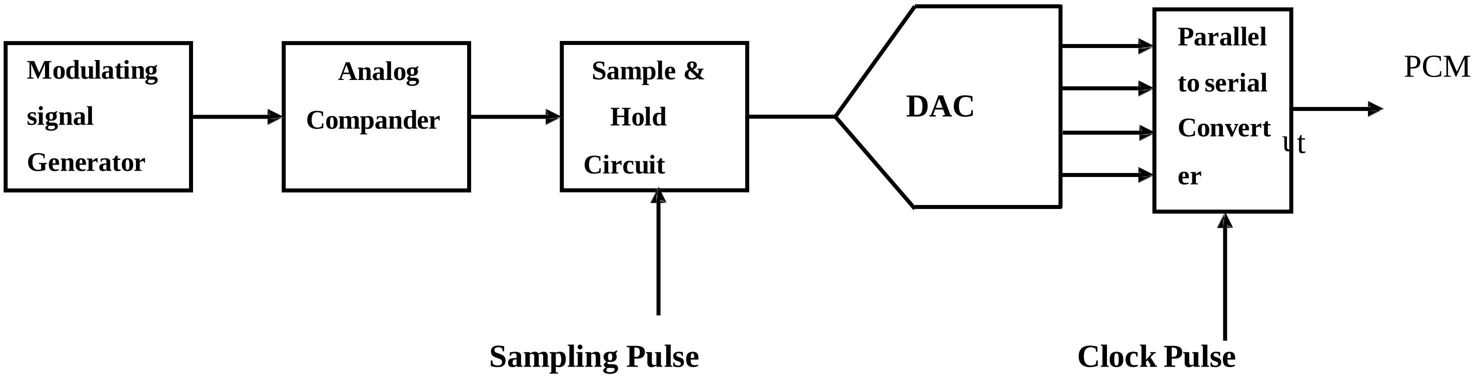
| Signal | Amplitude (V) | Time (ms) |
|---|---|---|
| **Transmitter section:**<br>Sine wave (250 Hz)<br>Sine wave (500 Hz)<br>Sine wave (1K Hz)<br>Sine wave (2 KHz)<br><br>**TDM wave** (Composite of all above 4 signals)<br><br><br>**Receiver section:**<br>Sine wave (250 Hz)<br>Sine wave (500 Hz)<br>Sine wave (1K Hz)<br>Sine wave (2 KHz) | | |

**RESULT:**

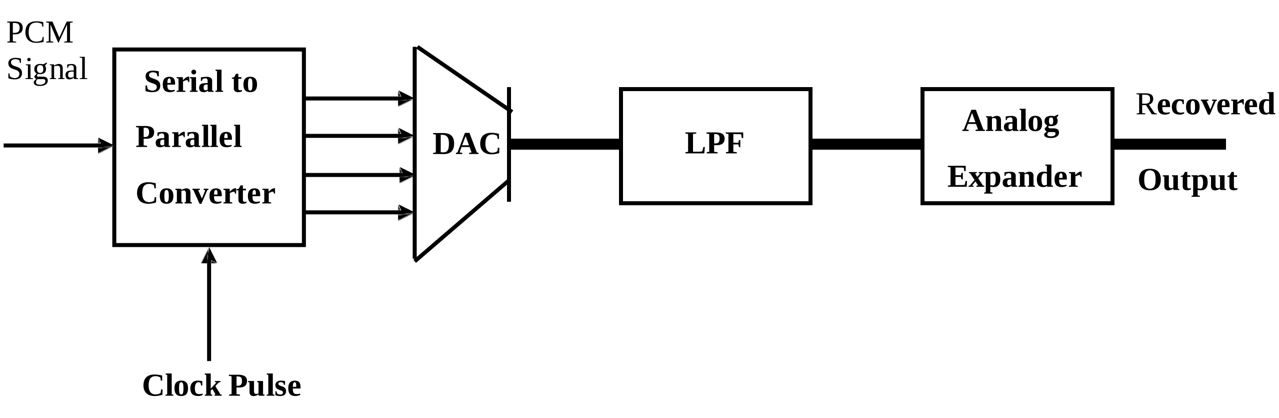
The time division multiplexing and demultiplexing operations were performed with the given multiple number of message signals and the waveforms were observed and plotted.

**BLOCK DIAGRAM**

**PCM – PULSE CODE MODULATOR:-**




**PCM – DEMODULATOR:-**



**Ex.No:4** **Pulse Code Modulation and Demodulation**

**AIM:**

To obtain the PCM – Modulated and Demodulated signal for give message signal.

**APPARATUS REQUIRED:**

1. PCM – Modulation Kit
2. PCM – Demodulation Kit
3. CRO
4. Connecting probes

**THEORY:**

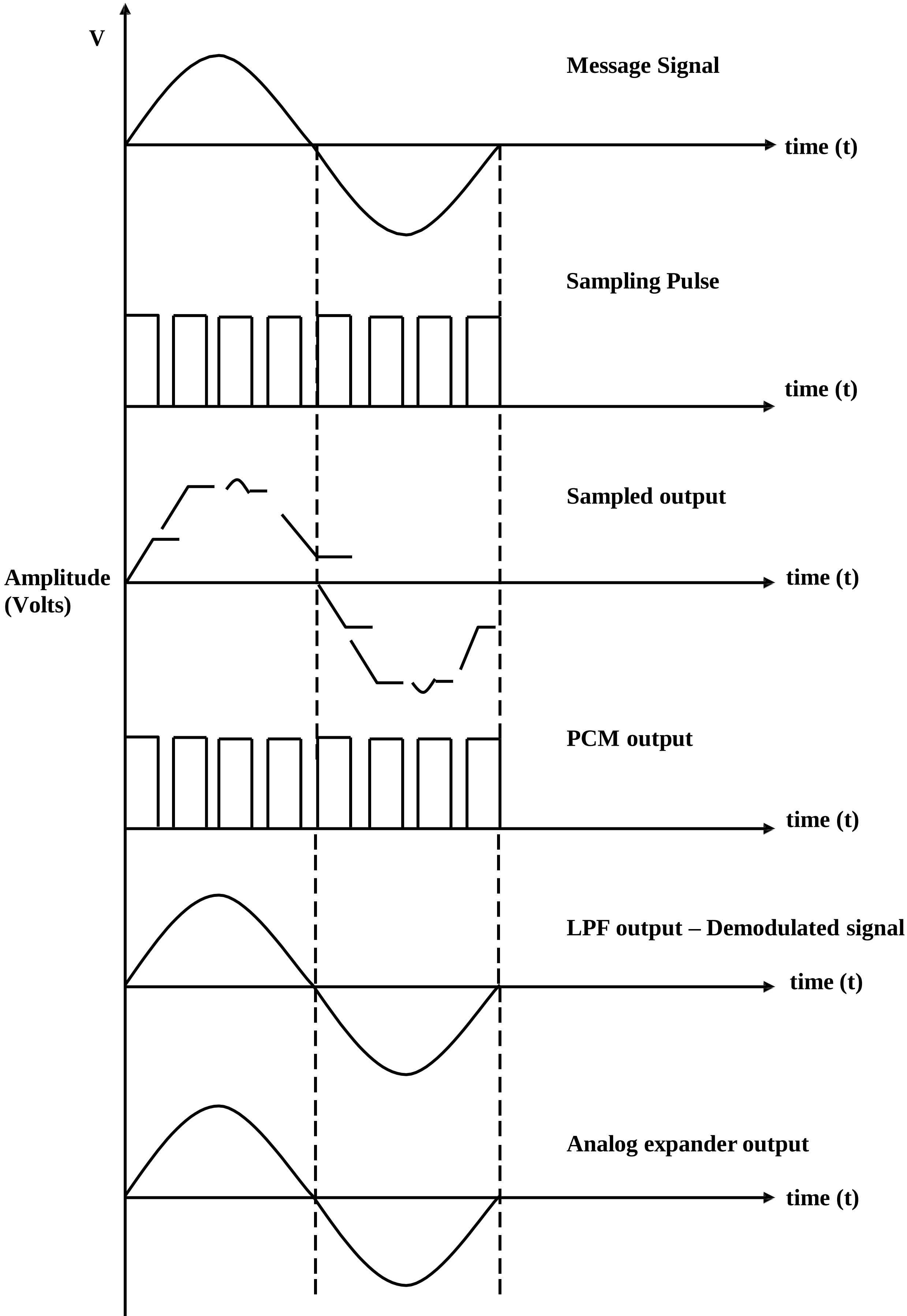
In PCM, a message signal is represented by sequence of coded pulses. So the signal is discrete in both time and amplitude.

The basic operations performed in PCM system are

(i) Sampling (ii) Quantizing (iii) Encoding

The incoming message signal is sampled with a train of rectangular pulses. To ensure perfect reconstruction at the receiver, sampling rate $f_s > 2w$ is used. The rounding off sampled signal is called quantization. So that quantized signal is discrete in both time and amplitude. Then, the quantized signal is translated into a more appropriate form of code format by encoding. In the channel regenerators are used to increase the immunity of signal against noise. The receiver has to regenerate, reshape the received pulses and then regroup them into a recovered signal.

**MODEL GRAPH:-**



V
Message Signal
time (t)
Sampling Pulse
time (t)
Sampled output
Amplitude
(Volts)
time (t)
PCM output
time (t)
LPF output – Demodulated signal
time (t)
Analog expander output
time (t)

**PROCEDURE:-**

1. Connections must be given as per the diagram.
2. Low frequency message signal is given as one input to sampler.
3. Clock pulse signal is given as another input to sampler.
4. The sampled, encoded waveform obtained is viewed in CRO
5. Readings are taken for message, pulse and PCM wave.
6. The PCM wave is given as input to demodulator circuit.
7. The demodulated. output is noted in CRO.
8. The graph is plotted for PCM, modulated and demodulated wav

**TABULATION:-**

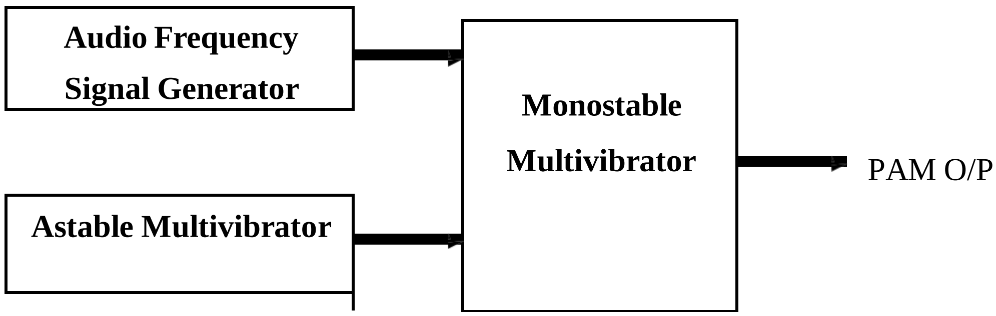
| Signal | Amplitude (V) | Time (ms) |
|---|---|---|
| | | |

**RESULT:**

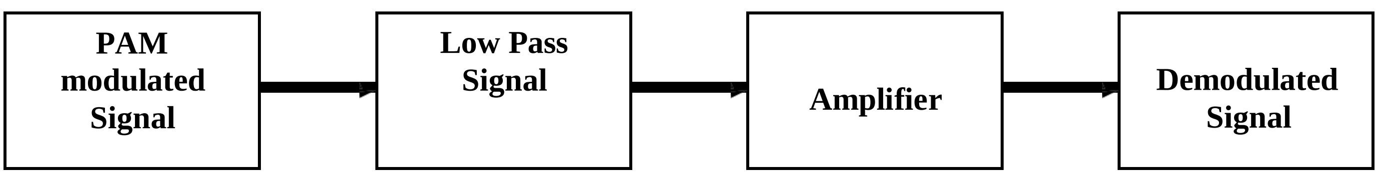
The Pulse code modulation and demodulation has been performed with the given message signal and the observed waveforms was plotted in graph.

**BLOCK DIAGRAM**

**PULSE AMPLITUDE MODULATOR**




**DEMODULATOR**




**TABULATION:**

| Signal | Amplitude (V) | Time (ms) |
|---|---|---|
| | | |

**EX.NO:05** **PULSE AMPLITUDE MODULATION**

**AIM:**

To obtain the pulse amplitude modulated waveform for given message signal.

**APPARATUS REQUIRED:**

1. PAM Modulation Kit and Demodulation Kit
2. CRO
3. Connecting probes

**THEORY:**

The amplitude of the train of rectangular pulses are varied in accordance with the message signal is called pulse amplitude modulation.

The message signal is an analog signal

PAM use sampling of two types

i) Natural sampling

ii) Flat top sampling

It is better to use flat top PAM, because during transmission noise interferes the top of pulses. This noise can be removed easily.

Bandwidth of the transmission channel depends on width of the pulse.

In PAM, noise interference is high.

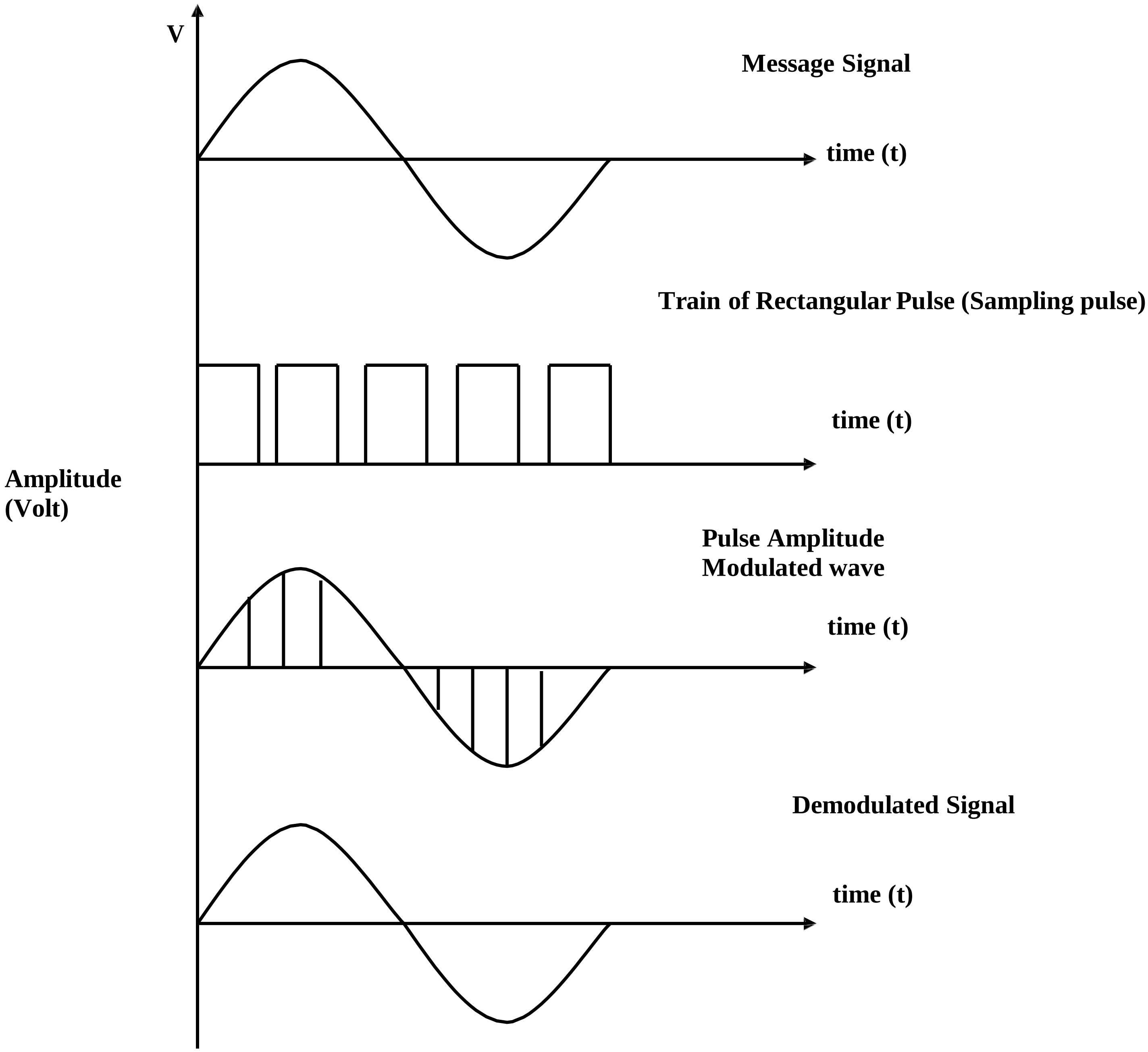
It requires less transmitting power.

Multiplexing of several PAM signal at different time is possible with PAM.

**PROCEDURE:-**

1. Connections must be given as per the diagram.
2. Low frequency message signal is given as one input to PAM modulator.
3. Carrier pulse signal is given as another input to PAM modulator.
4. The pulse amplitude modulated waveform obtained is viewed in CRO.
5. Readings are taken for message, carrier and pulse amplitude modulated wave.
6. The modulated wave is given as input to demodulator
7. The demodulated output is noted in CRO.
8. The graph is plotted for PAM.

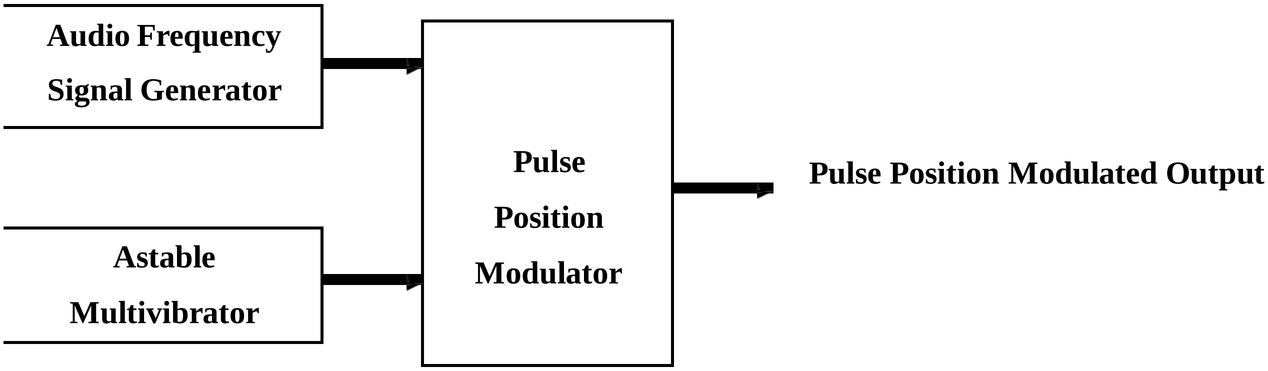
**MODEL GRAPH:**

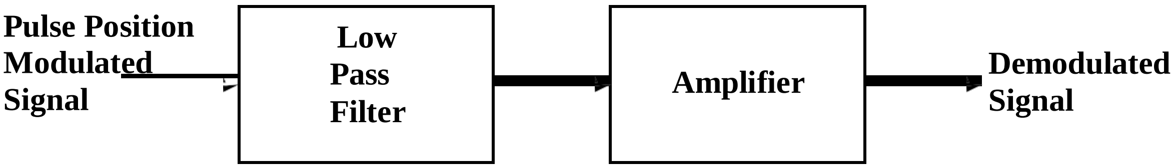

V
Message Signal
time (t)
Train of Rectangular Pulse (Sampling pulse)
time (t)
Amplitude
(Volt)
Pulse Amplitude
Modulated wave
time (t)
Demodulated Signal
time (t)

**RESULT:**

Thus for given message signal PAM modulation and demodulation is obtained. It is plotted in graph.

**BLOCK DIAGRAM**




**TABULATION:**

| Signal | Amplitude (V) | Time (ms) |
|---|---|---|
| | | |

**EX.NO:6 (a)** **PULSE POSITION MODULATION**

**AIM:**

To obtain the pulse position modulated waveform for given message signal.

**APPARATUS REQUIRED:**

1. PPM Modulation Kit and Demodulation Kit
2. CRO
3. Connecting probes

**THEORY:**

The positions of the regularly spaced train of pulses are varied in accordance with the message signal. Bandwidth of transmission channel depends on rising time of the pulse.

$$\mathbf{B_T \geq 1 / 2t_r}$$

PPM has minimum noise interference. This modulation is similar to PM. It requires less transmitting power.

$$\mathbf{P_T\ (PPM) << P_T\ (PWM).}$$

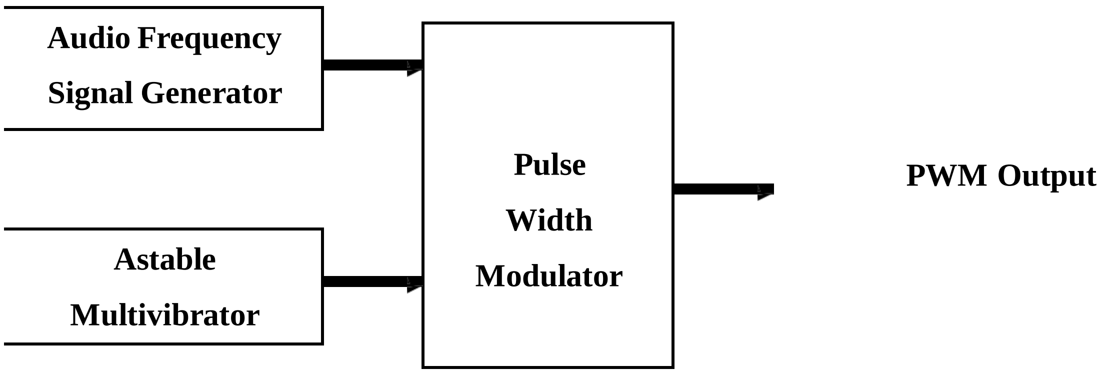
**PROCEDURE:-**

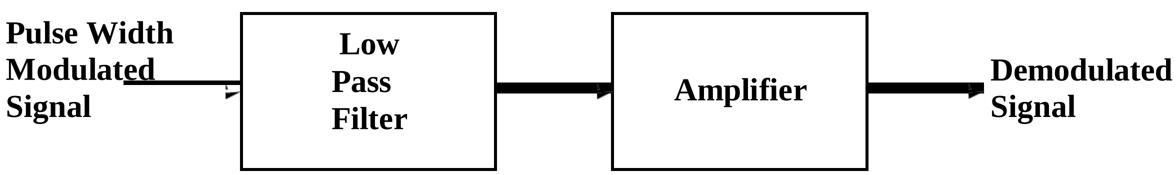
1. Connections must be given as per the diagram.
2. Low frequency message signal is given as one input to PPM modulator.
3. Carrier pulse signal is given as another input to PPM modulator.
4. The pulse amplitude modulated waveform obtained is viewed in CRO.
5. Readings are taken for message, carrier and pulse position modulated wave.
6. The modulated wave is given as input to demodulator
7. The demodulated output is noted in CRO.
8. The graph is plotted for PPM.

**RESULT:**

Thus for given message signal PPM modulation and demodulation is obtained. It is plotted in graph.

**BLOCK DIAGRAM**




**TABULATION:**

| Signal | Amplitude (V) | Time (ms) |
|---|---|---|
| | | |

**EX.NO:6(b)** **PULSE WIDTH MODULATION**

**AIM:**

To obtain the pulse width modulation for given message signal.

**APPARATUS REQUIRED:**

1. PWM Modulation Kit and Demodulation Kit
2. CRO
3. Connecting probes

**THEORY:**

The widths of regularly spaced train of pulses are varied in accordance with the message signal. Bandwidth of transmission channel depends on rise time of the pulse.

$$\mathbf{B_T >> 1 / 2t_r}$$

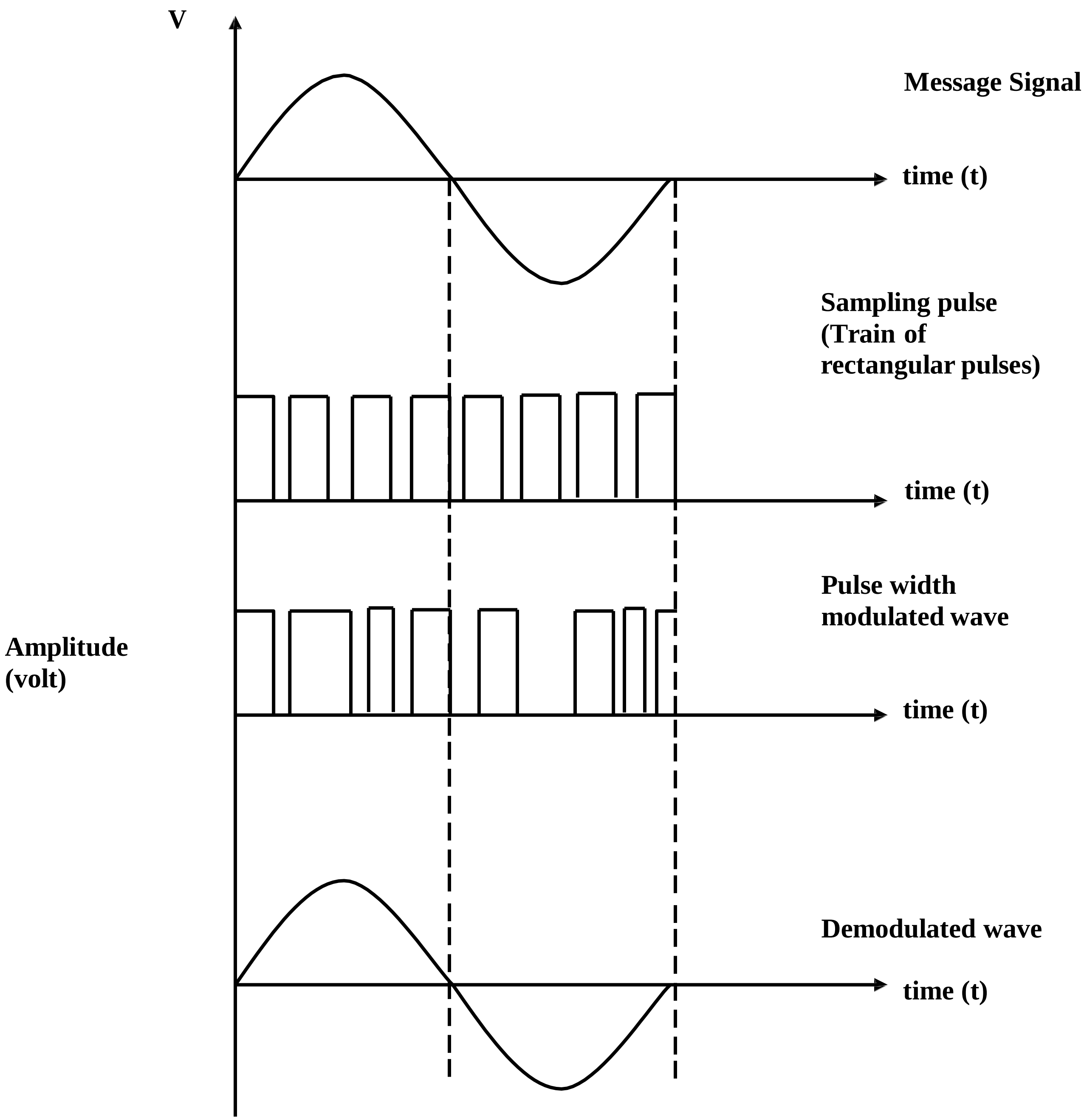
PWM has less noise interference. This type of modulation is similar to FM.

Transmitting power $\mathbf{P_T}$ **(PWM) >>** $\mathbf{P_T}$ **(PPM).**

**PROCEDURE:-**

1. Connections must be given as per the diagram.
2. Low frequency message signal is given as one input to PWM modulator.
3. Carrier pulse signal is given as another input to PWM modulator.
4. The pulse width modulated waveform obtained is viewed in CRO.
5. Readings are taken for message, carrier and pulse width modulated wave.
6. The modulated wave is given as input to demodulator
7. The demodulated output is noted in CRO.
8. The graph is plotted for PWM.

**MODEL GRAPH: -**

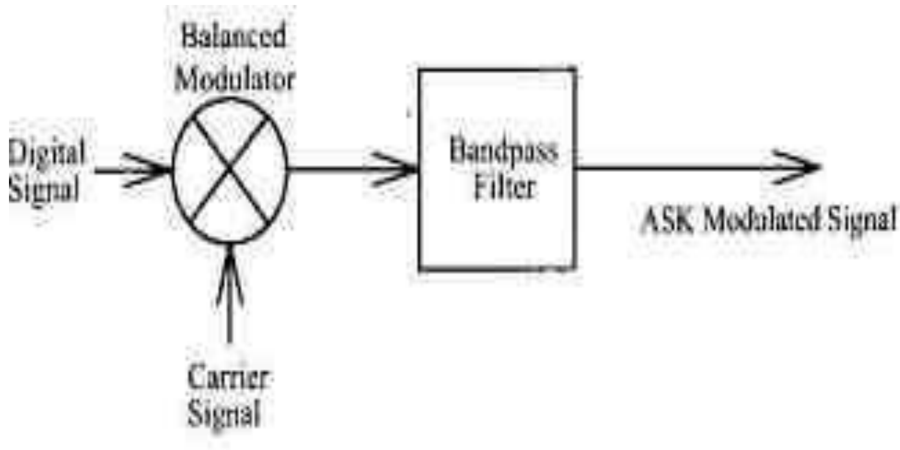

V
Message Signal
time (t)
Sampling pulse
(Train of
rectangular pulses)
time (t)
Pulse width
modulated wave
Amplitude
(volt)
time (t)
Demodulated wave
time (t)

**RESULT:**

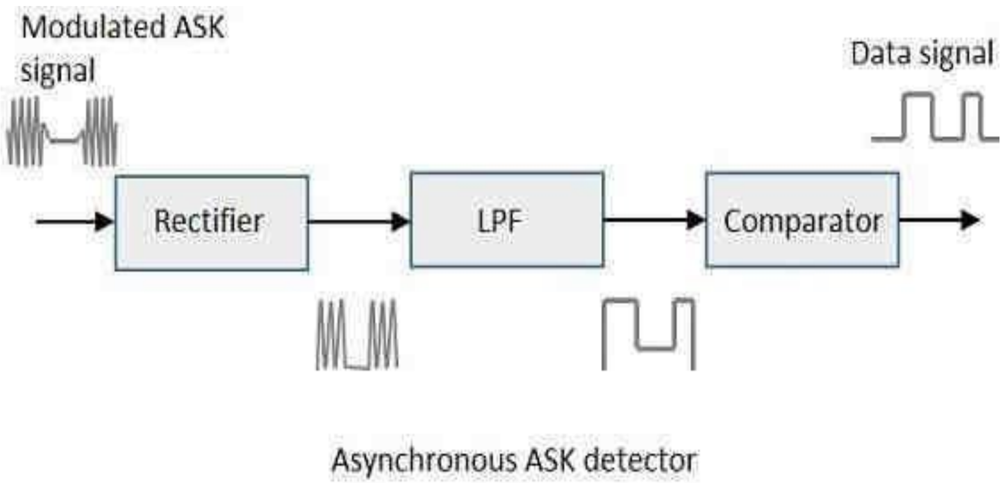
Thus for given message signal PWM modulation and demodulation is obtained. It is plotted in graph.

**BLOCK DIAGRAM**

**ASK MODULATOR**




**ASK DEMODULATOR**



**Ex No:7(a)** **GENERATION AND DETECTION OF ASK**

AIM

To construct and generate Amplitude Shift Keying signal and detect the message signal.

APPARATUS REQUIRED

ASK kit, CRO and connecting probes

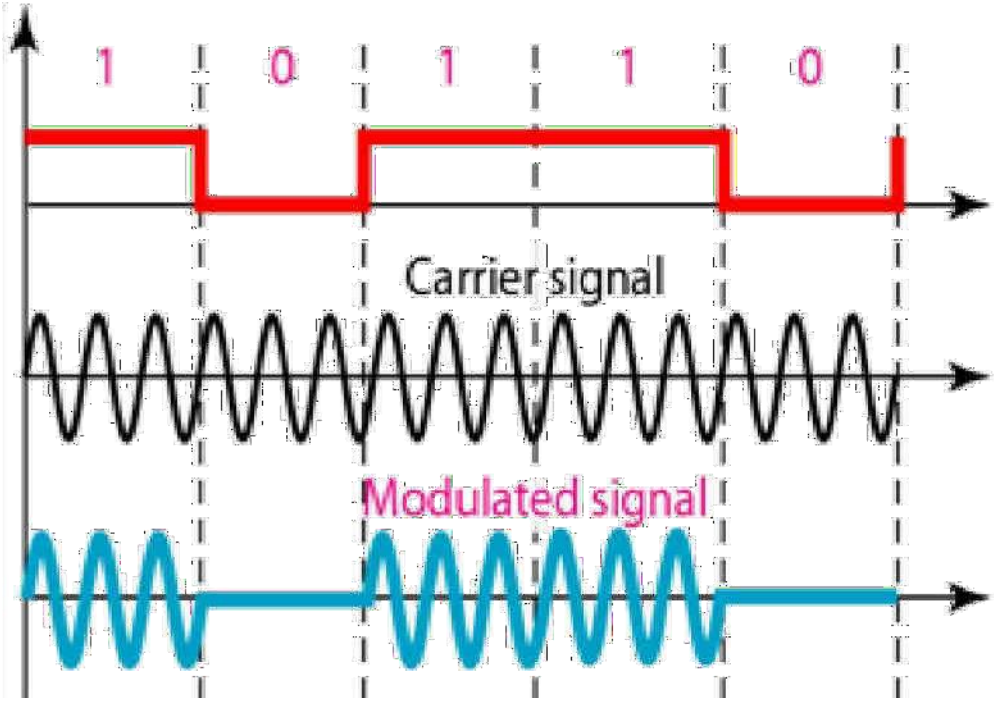
THEORY

ASK or ON-OFF key is the simplest digital modulation technique. In this method there is only one unit energy carrier it is switched ON/OFF depending upon the input binary sequence to transmit symbol 0 & 1. No pulse is transmitted output contains some complete no of cycle of carrier frequency. The disadvantage of ASK is the modulated carrier signal is not continuously transmitted. The peak power requirement is also high. The bit error probability rate is also not required in this technique.

PROCEDURE

1. Make connections as shown in the diagram.
2. Set the input signal and carrier signal.
3. Obtain ASK signal
4. Measure the amplitude and frequency
5. Obtain the demodulated output.

MODEL GRAPHH




TABULAR COLUMN

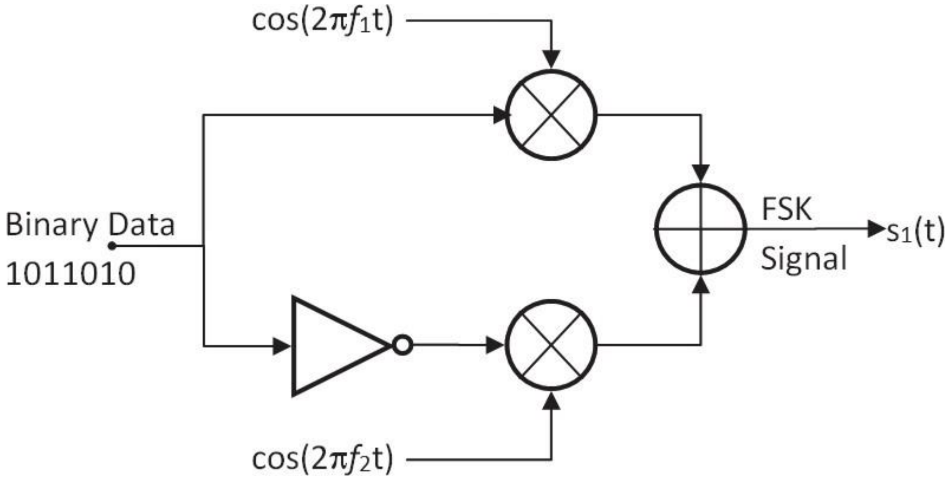
| S.No | Name of the signal | Amplitude in V | Time period in Sec | Frequency in Hz |
|---|---|---|---|---|
| 1 | Modulating Signal | | | |
| 2 | Carrier Signal | | | |
| 3 | Modulated Signal | | | |
| 4 | Demodulated Signal | | | |

RESULT

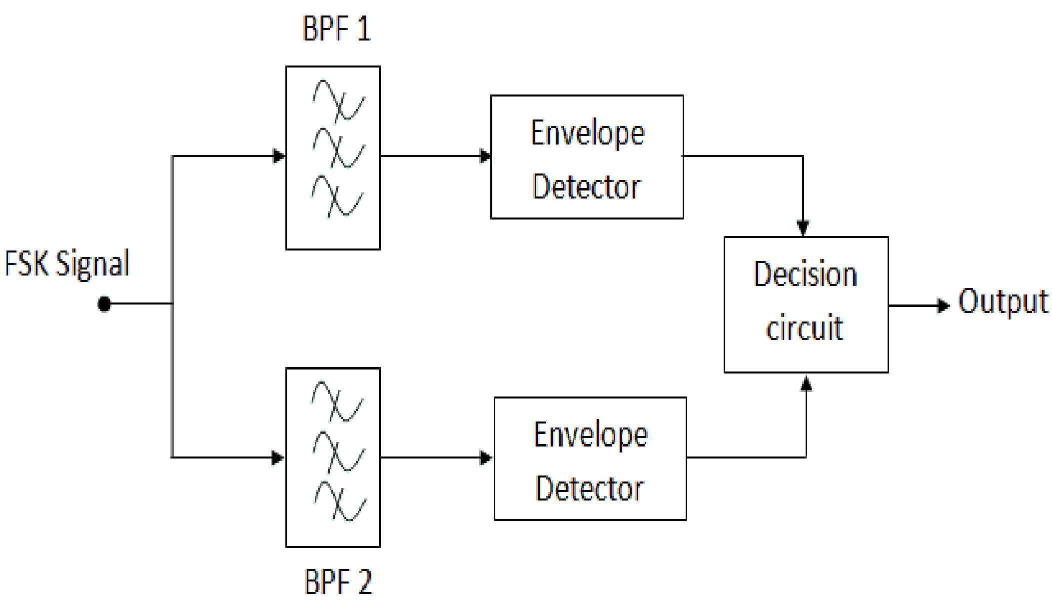
Thus the Amplitude Shift Keying signal was generated and the message signal was reconstructed

**BLOCK DIAGRAM**

**FSK MODULATOR**




FSK DEMODULATOR



## Exp No : 7(b) GENERATION AND DETECTION OF FSK

AIM

To generate a Frequency Shift Keying signal using FSK modulator and detect the message signal from FSK signal using FSK detector.

APPARATUS REQUIRED

FSK kit, CRO and connecting probes

THEORY

Frequency Shift Keying is the process generating a modulated signal from a digital data input. If the incoming bit is 1, a signal with frequency f1 is sent for the duration of the bit. If the bit is 0, a signal with frequency f2 is sent for the duration of this bit. This is the basic principle behind FSK modulation.

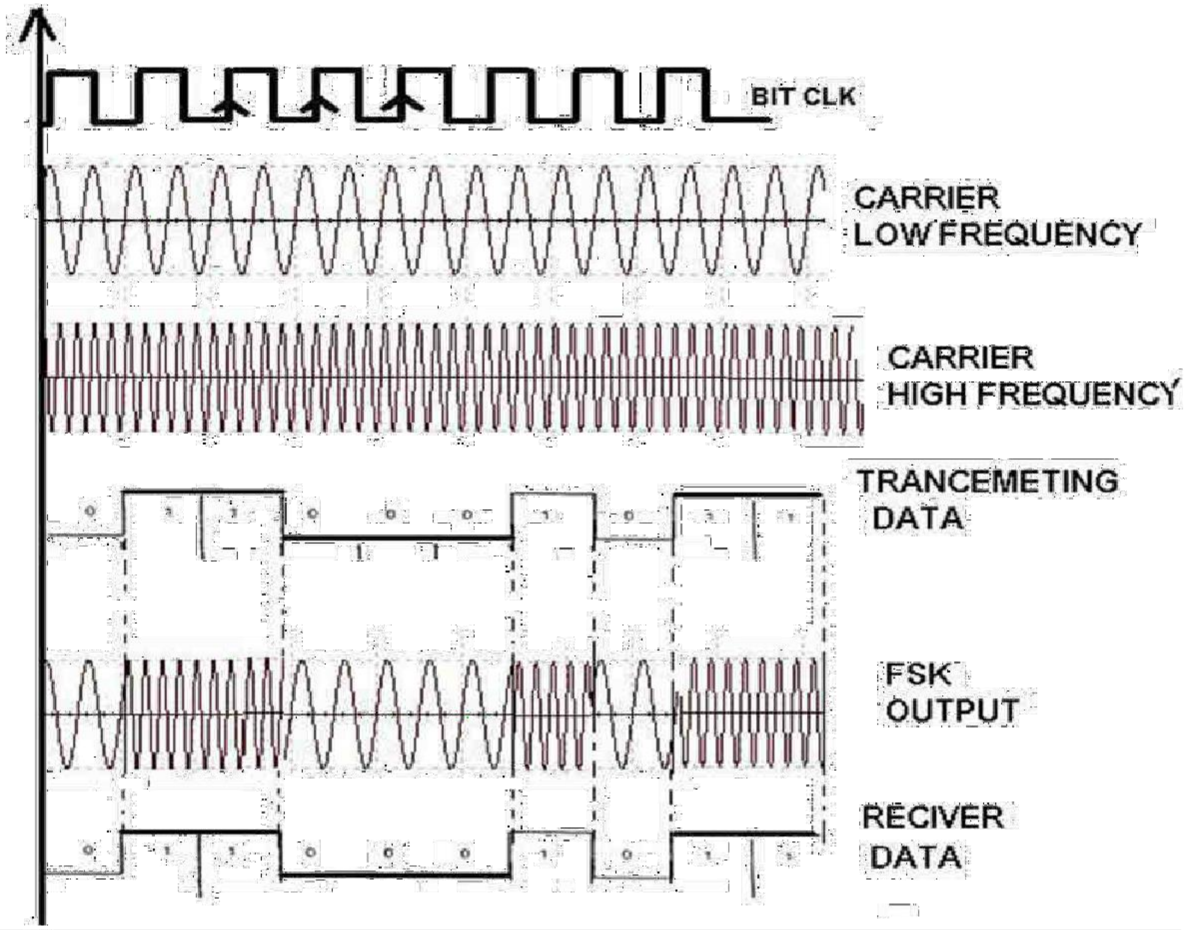
Basically a 555 timer is used as an Astable multivibrator, which generates a clock pulse of frequency determined by the values of R and C in this circuit. This is divided by 2, 4, 8 and 16 using 74163 IC, and two of these outputs are used in a NAND logic gates circuit, to generate a FSK modulated wave. To this NAND gates circuit a binary data sequence is also supplied. The circuit operation causes a frequency f1 for bit 1, and f2 for bit 0.

In the demodulator circuit, the FSK modulated signal is applied to a high Q tuned filter. This filter is tuned to the frequency of either 0 or 1. This filter passes the selected frequency and rejects the other. The output is then passed through a FWR (Full Wave Rectifier) circuit and the output is now above zero volts only. It is then passed through a comparator; if the input to the comparator is greater than threshold value, the output is 1, else it is 0. This digital output of the comparator is the demodulated FSK output.

PROCEDURE:

1. Make connections as shown in the circuit diagram.
2. Set the input signal and carrier signal.
3. Obtain FSK signal
4. Tabulate the output data and draw the graph.
5. Justify the obtained output with theoretical calculation.

MODEL GRAPH



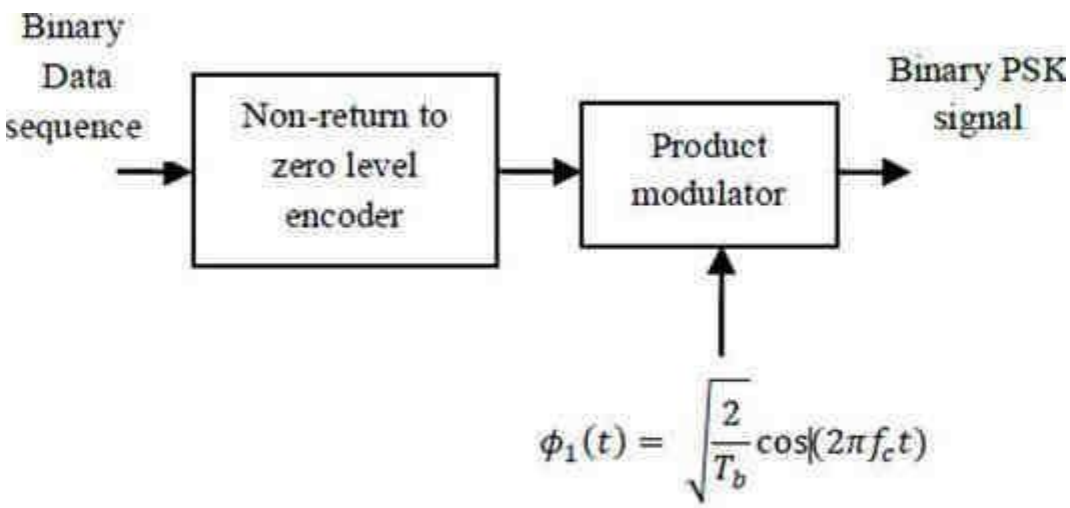

TABULAR COLUMN

| S.No | Name of the signal | Amplitude in V | Time period in Sec | Frequency in Hz |
|---|---|---|---|---|
| 1 | Modulating Signal | | | |
| 2 | Carrier Signal 1 | | | |
| 3 | Carrier Signal 2 | | | |
| 4 | Modulated Signal | | | |
| 5 | Demodulated Signal | | | |

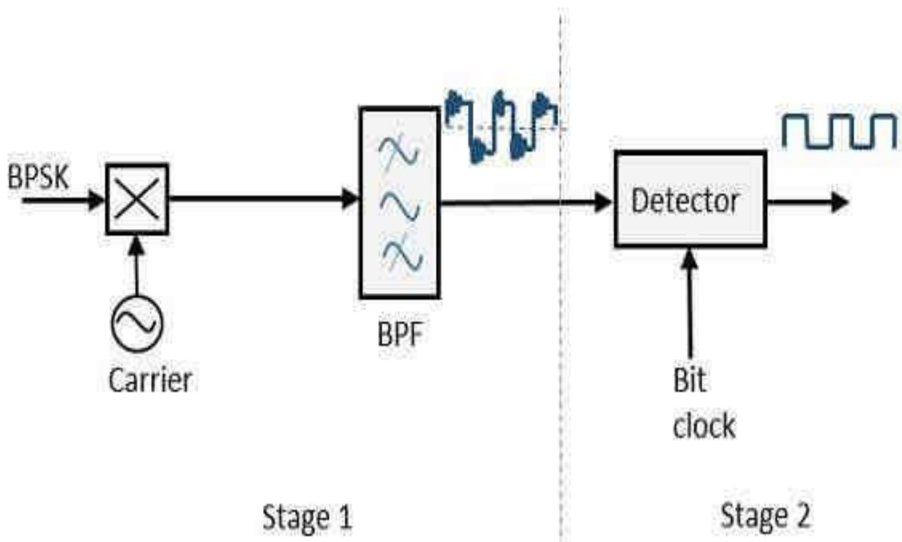
RESULT

Thus the Frequency Shift Keying signal wag generated using FSK modulator and the message signal was detected from FSK signal using FSK detector.

**BPSK MODULATOR**




**BPSK DEMODULATOR**



**Ex:No: 7(c)** **GENERATION AND DETECTION OF PSK**

**AIM:** To construct and generate Phase Shift Keying signal and detect the message signal.

**APPARATUS REQUIRED**

PSK kit, CRO and connecting probes

**THEORY**

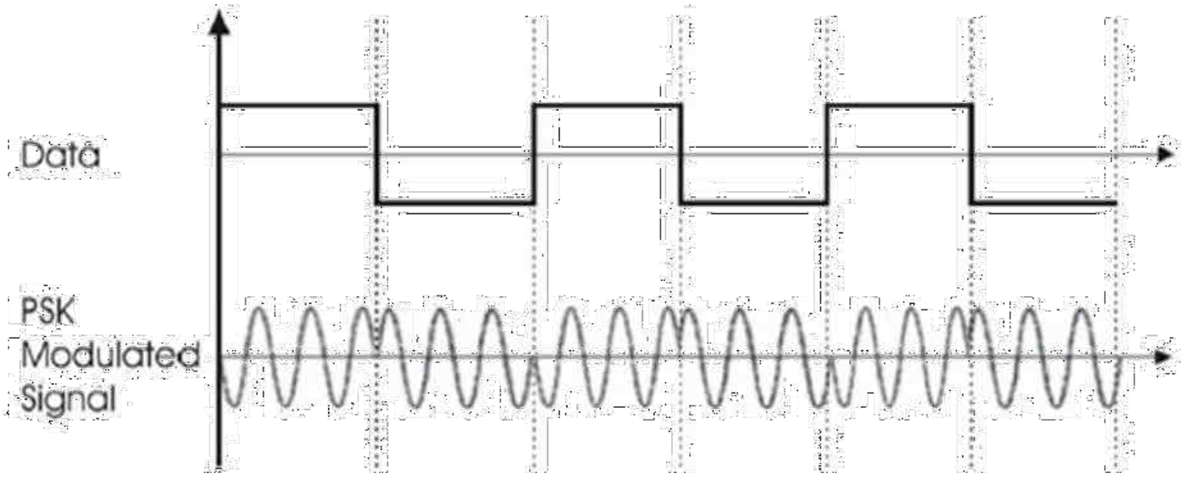
PSK is a digital modulation scheme which is analogues to phase modulation. In binary phase shift keying two output phases are possible for a single carrier frequency one out of phase represent logic 1 and logic 0. As the input digital binary signal change state the phase of output carrier shift two angles that are 180o out of phase.

In a PSK modulator the carrier input signal is multiplied by the digital data. The input carrier is multiplied by either a positives or negatives consequently the output signal is either +1sinwct or - 1sinwct. The first represent a signal that is phase with the reference oscillator the latter a signal that is 180o out of phase with the reference oscillator. Each time a change in input logic condition will change the output phase consequently for PSK the output rate of change equal to the input rate range and widest output bandwidth occurs when the input binary data are alternating 1/0 sequence. The fundamental frequency of an alternate 1/0 bit sequence is equal to one half of the bit rate.

PROCEDURE

1. Make connections as shown in the diagram.
2. Set the input signal and carrier signal.
3. Obtain PSK signal
4. Measure the output data and draw the graph.

MODEL GRAPH




TABULAR COLUMN

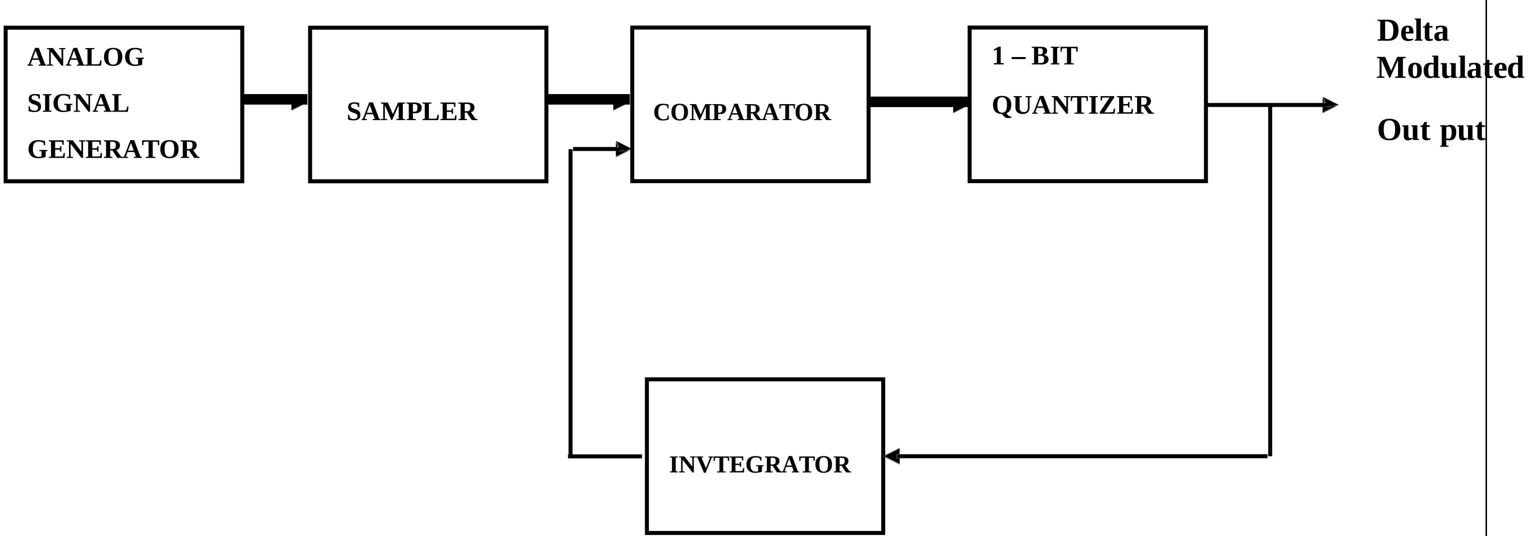
| S.No | Name of the signal | Amplitude in V | Time period in Sec | Frequency in Hz |
|---|---|---|---|---|
| 1 | Modulating Signal | | | |
| 2 | Carrier Signal | | | |
| 3 | Modulated Signal | | | |
| 4 | Demodulated Signal | | | |

RESULT

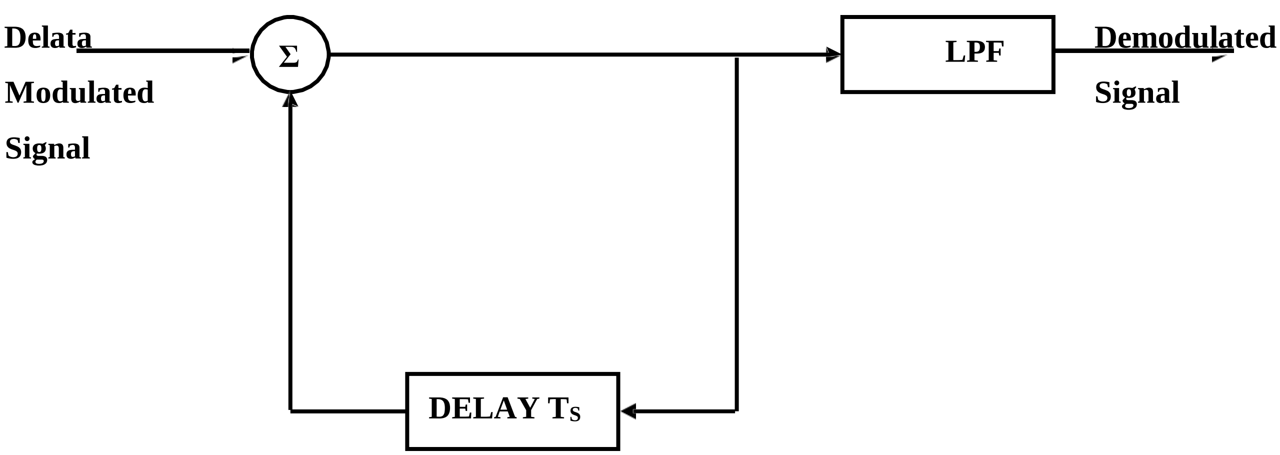
Thus the Phase Shift Keying signal wag generated using PSK modulator and the message signal was detected

**BLOCK DIAGRAM**

**DM – MODULATOR**




**DM – DEMODULATOR**



**Ex.No:8** **Delta Modulation and Demodulation**

**AIM:**

To obtain delta Modulated and Demodulated signal for give message signal.

**APPARATUS REQUIRED:**

1. Delta Modulation Kit
2. Delta Demodulation Kit
3. CRO
4. Connecting probes

**THEORY:**

Delta modulation is a 1 bit version of PCM. It transmits only one bit per sample. That is the present sample value is compared with the previous sample value. The input signal x(t) is approximated to step signal by the delta modulator. This step size is fixed. The step size has two levels + δ and - δ.

i) If the difference between the input signal is positive, then step size is increased by one step.

ii) If the difference is negative, then step size is decreased by one step.

+ δ means ‘1’ is transmitted

- δ means ‘0’ is transmitted

The basic building blocks of delta modulator is

i) One bit quantizer ii) Accumulator iii) Summer

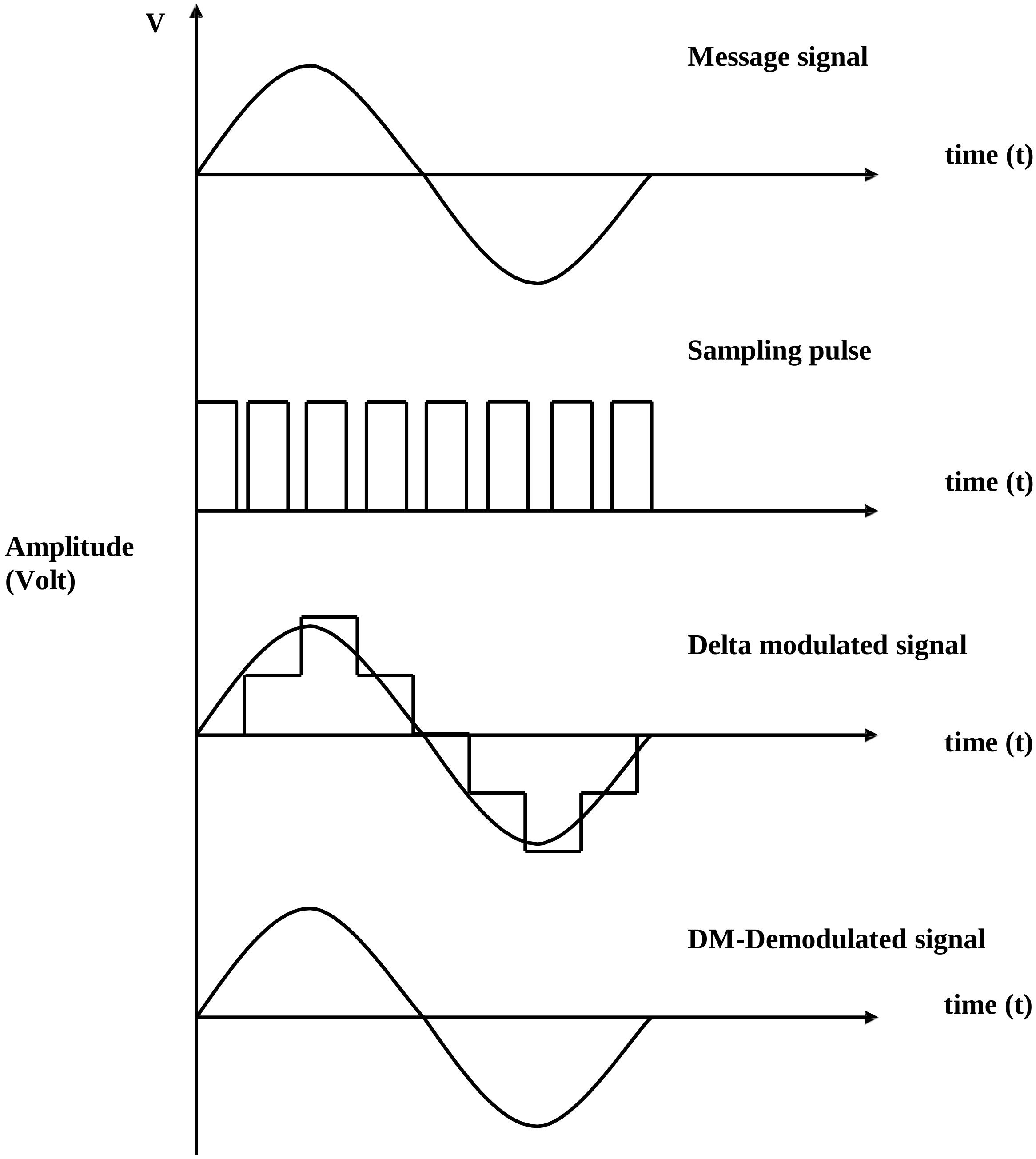
At the receiver, i) the accumulator ii) filter are used.

Advantages:

i) Signaling rate and transmission channel bandwidth is quite small.

ii) Simple modulation and demodulation circuits are used.

**MODEL GRAPH:**




**TABULATION:**

| Signal | Amplitude (V) | Time (ms) |
|---|---|---|
| Message Signal<br>Clock Pulse DM<br>Wave Demodulated<br>Wave | | |

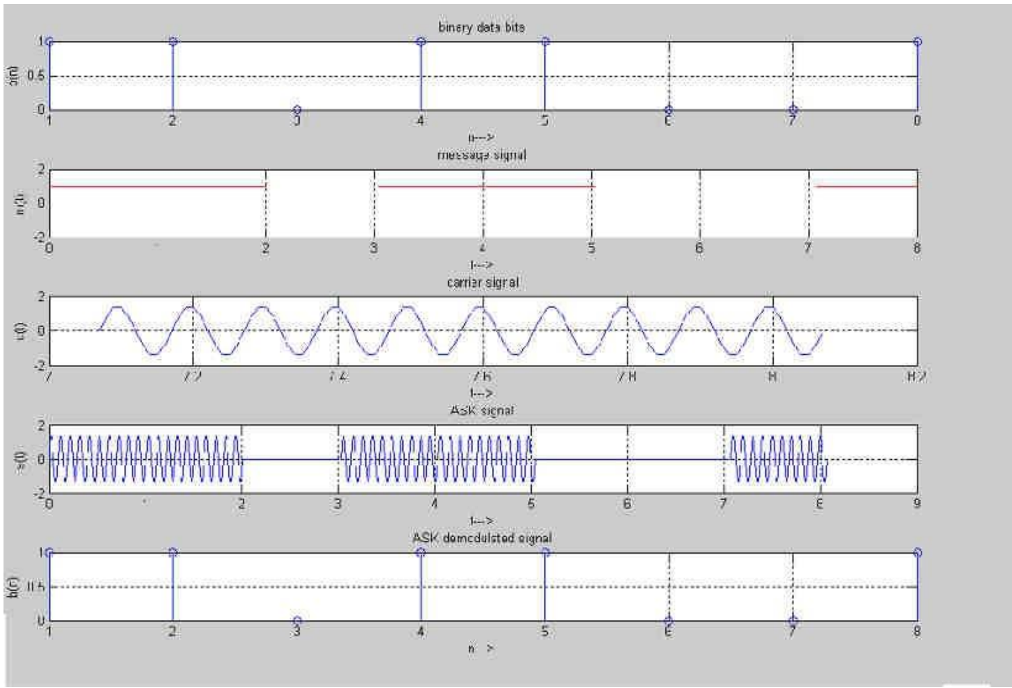
**PROCEDURE:-**

1. Connections must be given as per the diagram.
2. Low frequency message signal is given as one input to DM modulator circuit
3. pulse signal is given as another input to DM modulator circuit
4. The delta modulated waveform obtained is viewed in CRO
5. Readings are taken for message, pulse and DM wave.
6. The delta modulated wave is given as input to demodulator circuit.
7. The demodulated output is noted in CRO.
8. The graph is plotted for delta modulated and demodulated wave.

**RESULT:**

The delta modulation and demodulation were performed with the given message signal and the observed waveforms were plotted.

## SIMULATION WAVEFORM



**Exp.No:9(a)** **SIMULATION OF ASK GENERATION AND DETECTION SCHEME**

**Aim:**

To generate and demodulate amplitude shift keyed (ASK) signal using MATLAB.

**Theory**

**Generation of ASK**

Amplitude shift keying - ASK - is a modulation process, which imparts to a sinusoid two or more discrete amplitude levels. These are related to the number of levels adopted by the digital message. For a binary message sequence there are two levels, one of which is typically zero. The data rate is a sub-multiple of the carrier frequency. Thus the modulated waveform consists of bursts of a sinusoid. One of the disadvantages of ASK, compared with FSK and PSK, for example, is that it has not got a constant envelope. This makes its processing (eg, power amplification) more difficult, since linearity becomes an important factor. However, it does make for ease of demodulation with an envelope detector.

**Demodulation**

ASK signal has a well defined envelope. Thus it is amenable to demodulation by an envelope detector. Some sort of decision-making circuitry is necessary for detecting the message. The signal is recovered by using a correlator and decision making circuitry is used to recover the binary sequence.

**Algorithm**

Initialization commands

**ASK modulation**

1. Generate carrier signal.
2. Start FOR loop
3. Generate binary data, message signal(on-off form)
4. Generate ASK modulated signal.
5. Plot message signal and ASK modulated signal.
6. End FOR loop.
7. Plot the binary data and carrier.

**ASK demodulation**

1. Start FOR loop
2. Perform correlation of ASK signal with carrier to get decision variable
3. Make decision to get demodulated binary data. If x>0, choose '1' else choose '0'

**Program**

**%ASK Modulation**

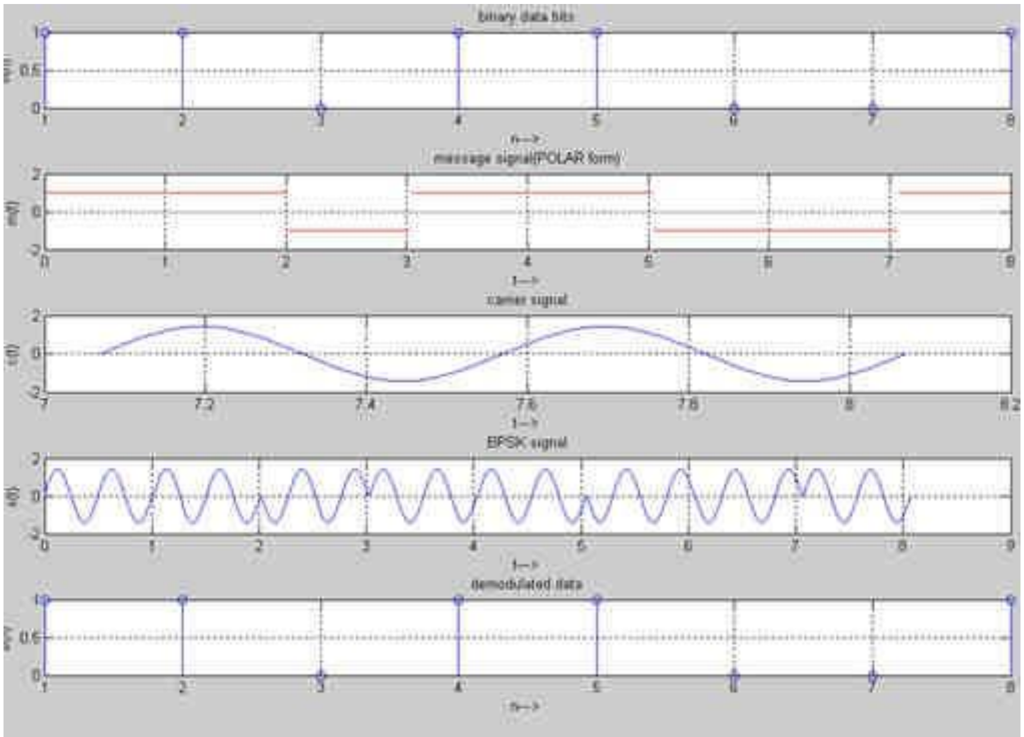
```
clc;
clear all;
close all;
%GENERATE CARRIER SIGNAL
Tb=1; fc=10;
t=0:Tb/100:1;
c=sqrt(2/Tb)*sin(2*pi*fc*t);
%generate message signal
N=8;
m=rand(1,N);
t1=0;t2=Tb
for i=1:N
t=[t1:.01:t2]
if m(i)>0.5 m(i)=1;
m_s=ones(1,length(t));
else
m(i)=0;
m_s=zeros(1,length(t));
end
message(i,:)=m_s;
%product of carrier and message
ask_sig(i,:)=c.*m_s;
t1=t1+(Tb+.01);
t2=t2+(Tb+.01);
%plot the message and ASK signal subplot(5,1,2);
axis([0 N -2 2]);
plot(t,message(i,:),'r');
title('message signal');
xlabel('t--->');
ylabel('m(t)');
grid on
hold on
```

```
subplot(5,1,4);
plot(t,ask_sig(i,:));
title('ASK signal');
xlabel('t--->');
ylabel('s(t)');grid on
hold on
end
hold off
%Plot the carrier signal and input binary data
subplot(5,1,3);plot(t,c);
title('carrier signal');xlabel('t--->');ylabel('c(t)');grid on
subplot(5,1,1);stem(m);
title('binary data bits');xlabel('n--->');ylabel('b(n)');grid on
% ASK Demodulation
t1=0;t2=Tb for
i=1:N
t=[t1:Tb/100:t2]
%correlator
x=sum(c.*ask_sig(i,:));
%decision device
if x>0
demod(i)=1;
else
demod(i)=0;
end
t1=t1+(Tb+.01);
t2=t2+(Tb+.01);
end
%plot demodulated binary data bits
subplot(5,1,5);stem(demod);
title('ASK demodulated signal');
xlabel('n--->');
ylabel('b(n)');
grid on
```

**Result**

The program for ASK modulation and demodulation has been simulated in MATLAB and necessary graphs are plotted.

## SIMULATION WAVEFORM



## Exp.No:9(b) SIMULATION OF BPSK GENERATION AND DETECTION SCHEMES

**Aim:**

To generate and demodulate Binary phase shift keyed (BPSK) signal using MATLAB

**Generation of PSK signal**

PSK is a digital modulation scheme that conveys data by changing, or modulating, the phase of a reference signal (the carrier wave). PSK uses a finite number of phases, each assigned a unique pattern of binary digits. Usually, each phase encodes an equal number of bits. Each pattern of bits forms the symbol that is represented by the particular phase. The demodulator, which is designed specifically for the symbol-set used by the modulator, determines the phase of the received signal and maps it back to the symbol it represents, thus recovering the original data.

In a coherent binary PSK system, the pair of signal $S_1(t)$ and $S_2(t)$ used to represent binary symbols 1 & 0 are defined by

$S_1(t) = \sqrt{2E_b/T_b} \, \text{Cos } 2\pi f_c t$

$S_2(t) = \sqrt{2E_b/T_b} \, (2\pi f_c t + \pi) = -\sqrt{2E_b/T_b} \, \text{Cos } 2\pi f_c t$ where $0 \leq t < T_b$ and

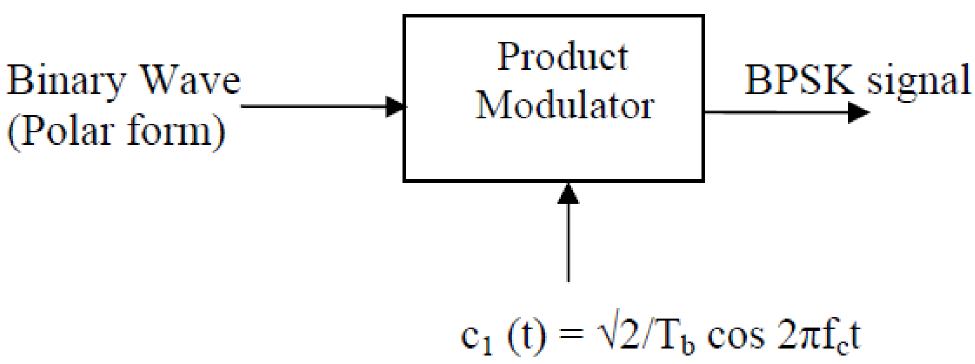
Eb = Transmitted signed energy for bit

The carrier frequency $f_c = n/T_b$ for some fixed integer n.

**Antipodal Signal:**

The pair of sinusoidal waves that differ only in a relative phase shift of 180° are called antipodal signals.

**BPSK Transmitter**



**Program**

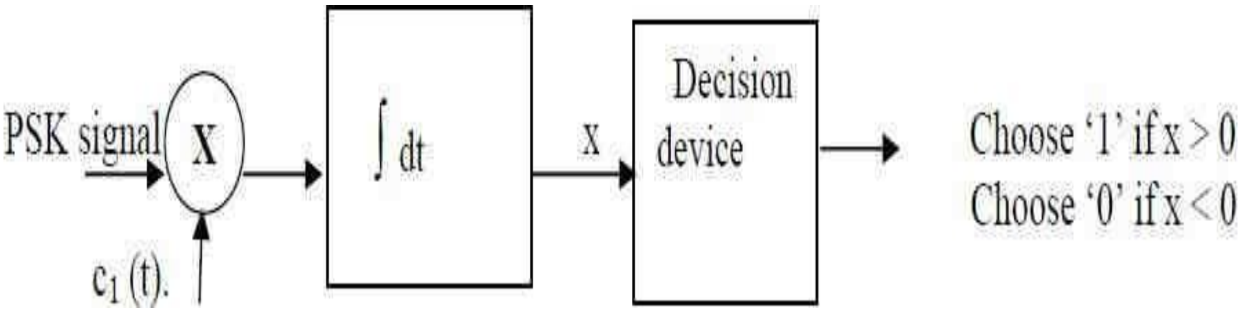
**% BPSK modulation**

```
clc;
clear all;
close all;
%GENERATE CARRIER SIGNAL
Tb=1;
t=0:Tb/100:Tb; fc=2;
c=sqrt(2/Tb)*sin(2*pi*fc*t);
%generate message signal
N=8;
m=rand(1,N);
t1=0;t2=Tb
for i=1:N
t=[t1:.01:t2]
if m(i)>0.5 m(i)=1;
m_s=ones(1,length(t));
else
m(i)=0;
m_s=-1*ones(1,length(t));
end
message(i,:)=m_s;
%product of carrier and message signal
bpsk_sig(i,:)=c.*m_s;
%Plot the message and BPSK modulated signal
subplot(5,1,2);axis([0 N -2 2]);plot(t,message(i,:),'r');
title('message signal(POLAR form)');xlabel('t--->');ylabel('m(t)');
grid on; hold on;
subplot(5,1,4);plot(t,bpsk_sig(i,:));
title('BPSK signal');xlabel('t--->');ylabel('s(t)');
```

grid on; hold on;

The input binary symbols are represented in polar form with symbols 1 & 0 represented by constant amplitude levels √Eb& -√Eb. This binary wave is multiplied by a sinusoidal carrier in a product modulator. The result in a BSPK signal.

**BSPK Receiver**:




The received BPSK signal is applied to a correlator which is also supplied with a locally generated reference signal $c_1$ (t). The correlated o/p is compared with a threshold of zero volts. If x> 0, the receiver decides in favour of symbol 1. If x< 0, it decides in favour of symbol 0.

**Algorithm**

Initialization commands

**BPSK modulation**

1. Generate carrier signal.
2. Start FOR loop
3. Generate binary data, message signal in polar form
4. Generate PSK modulated signal.
5. Plot message signal and PSK modulated signal.
6. End FOR loop.
7. Plot the binary data and carrier.

**BPSK demodulation**

1. Start FOR loop
2. Perform correlation of PSK signal with carrier to get decision variable
3. Make decision to get demodulated binary data. If x>0, choose '1' else choose '0'
4. Plot the demodulated binary data

```
t1=t1+1.01; t2=t2+1.01;
end
hold off
%plot the input binary data and carrier signal
subplot(5,1,1);stem(m);
title('binary data bits');xlabel('n--->');ylabel('b(n)');
grid on;
subplot(5,1,3);plot(t,c);
title('carrier signal');xlabel('t--->');ylabel('c(t)');
grid on;
```

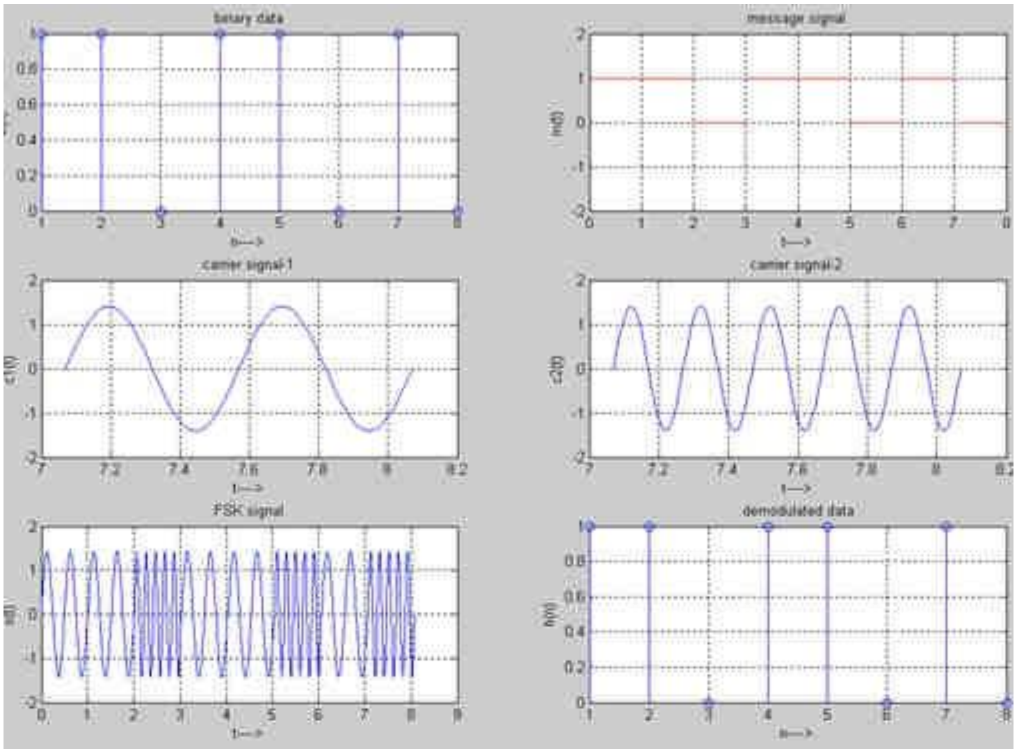
**% PSK Demodulation**

```
t1=0;t2=Tb
for i=1:N
t=[t1:.01:t2]
%correlator
x=sum(c.*bpsk_sig(i,:));
%decision device
if x>0
demod(i)=1;
else
demod(i)=0;
end
t1=t1+1.01;
t2=t2+1.01;
end
%plot the demodulated data bits
subplot(5,1,5);stem(demod);
title('demodulated data');xlabel('n--->');ylabel('b(n)');
grid on;
```

**Result**

Thus the program for BPSK modulation and demodulation has been simulated in MATLAB and necessary graphs are plotted

## SIMULATION WAVEFORM



**Exp.No:9(c)** **SIMULATION OF FSK GENERATION AND DETECTION SCHEME**

**Aim** To generate and demodulate frequency shift keyed (FSK) signal using MATLAB

**Theory**

**Generation of FSK**

Frequency-shift keying (FSK) is a frequency modulation scheme in which digital information is transmitted through discrete frequency changes of a carrier wave. The simplest FSK is binary FSK (BFSK). BFSK uses a pair of discrete frequencies to transmit binary (0s and 1s) information. With this scheme, the "1" is called the mark frequency and the "0" is called the space frequency.

In binary FSK system, symbol 1 & 0 are distinguished from each other by transmitting one of the two sinusoidal waves that differ in frequency by a fixed amount.

$S_i(t) = \sqrt{2E/T_b} \cos 2\pi f_i t \quad 0 \le t \le T_b$

0 elsewhere

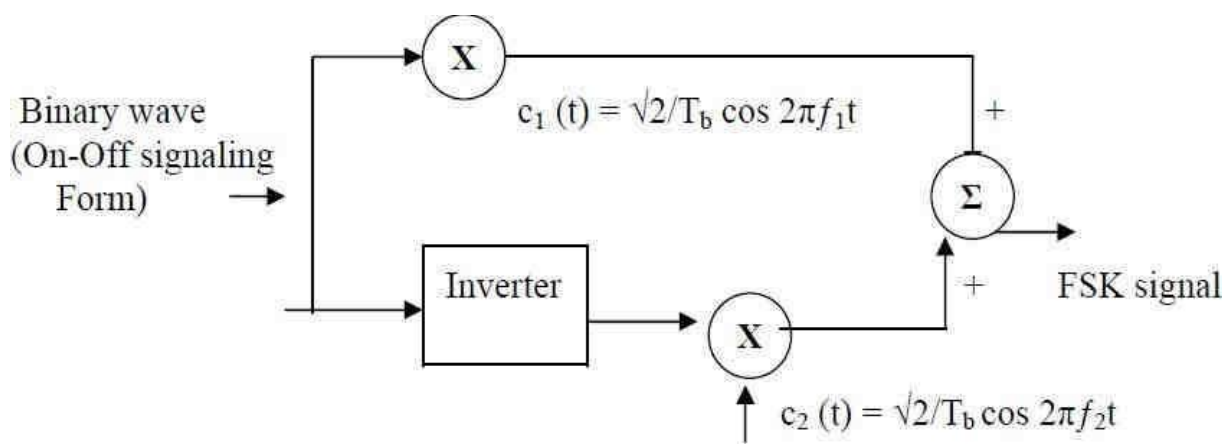
Where i=1, 2 & $E_b$=Transmitted energy/bit

Transmitted freq= $f_i = (nc+i)/T_b$, and n = constant (integer), $T_b$ = bit interval

Symbol 1 is represented by $S_1(t)$

Symbol 0 is represented by $S_0(t)$

**BFSK Transmitter**



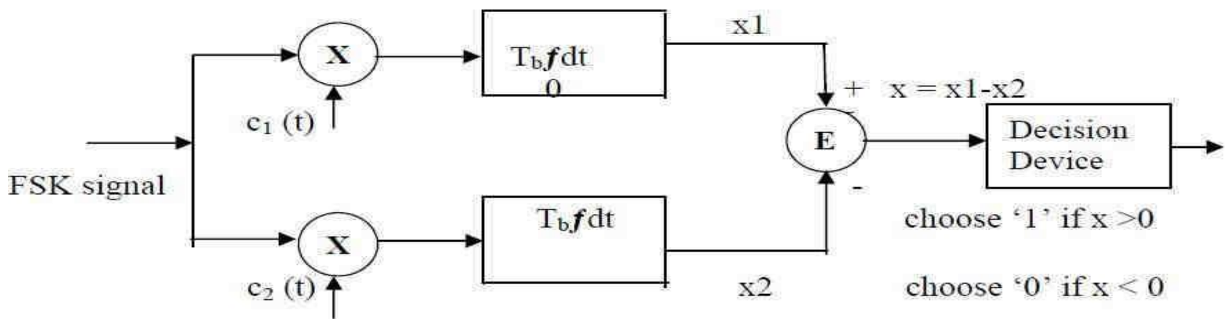

The input binary sequence is represented in its ON-OFF form, with symbol 1 represented by constant amplitude of $\sqrt{E_b}$with & symbol 0 represented by zero volts. By using inverter in the lower channel, we in effect make sure that when symbol 1is at the input, The two frequency f1& f2 are chosen to be equal integer multiples of the bit rate 1/$T_b$.By summing the upper & lower channel outputs, we get BFSK signal.

**Program**

```
% FSK Modulation
clc;
clear all;
close all;
%GENERATE CARRIER SIGNAL
Tb=1; fc1=2;fc2=5;
t=0:(Tb/100):Tb;
c1=sqrt(2/Tb)*sin(2*pi*fc1*t);
c2=sqrt(2/Tb)*sin(2*pi*fc2*t);
%generate message signal
N=8;
m=rand(1,N);
t1=0;t2=Tb
for i=1:N
t=[t1:(Tb/100):t2]
if m(i)>0.5
m(i)=1;
m_s=ones(1,length(t));
invm_s=zeros(1,length(t));
else
m(i)=0;
m_s=zeros(1,length(t));
invm_s=ones(1,length(t));
end
message(i,:)=m_s;
%Multiplier
fsk_sig1(i,:)=c1.*m_s;
fsk_sig2(i,:)=c2.*invm_s;
fsk=fsk_sig1+fsk_sig2;
%plotting the message signal and the modulated signal
subplot(3,2,2);axis([0 N -2 2]);plot(t,message(i,:),'r');
```

title('message signal');xlabel('t --->');ylabel('m(t)');grid on;hold on;

**BFSK Receiver**




The receiver consists of two correlators with common inputs which are supplied with locally generated coherent reference signals $c_1$(t) and $c_2$ (t).

The correlator outputs are then subtracted one from the other, and the resulting difference x is compared with a threshold of zero volts. If x >0, the receiver decides in favour of symbol 1 and if x <0, the receiver decides in favour of symbol 0.

**Algorithm**

Initialization commands

**FSK modulation**

1. Generate two carriers signal.
2. Start FOR loop
3. Generate binary data, message signal and inverted message signal
4. Multiply carrier 1 with message signal and carrier 2 with inverted message signal
5. Perform addition to get the FSK modulated signal
6. Plot message signal and FSK modulated signal.
7. End FOR loop.
8. Plot the binary data and carriers.

**FSK demodulation**

1. Start FOR loop
2. Perform correlation of FSK modulated signal with carrier 1 and carrier 2 to get two decision variables x1 and x2.
3. Make decisionon x = x1-x2 to get demodulated binary data. If x>0, choose '1' else choose '0'.
4. Plot the demodulated binary data.

```
subplot(3,2,5);plot(t,fsk(i,:));
title('FSK signal');xlabel('t --- >');ylabel('s(t)');grid on;hold on;
t1=t1+(Tb+.01); t2=t2+(Tb+.01);
end
hold off
%Plotting binary data bits and carrier signal
subplot(3,2,1);stem(m);
title('binary data');xlabel('n --->'); ylabel('b(n)');grid on;
subplot(3,2,3);plot(t,c1);
title('carrier signal-1');xlabel('t --- >');ylabel('c1(t)');grid on;
subplot(3,2,4);plot(t,c2);
title('carrier signal-2');xlabel('t --- >');ylabel('c2(t)');grid on;
```

% **FSK Demodulation**

```
t1=0;t2=Tb for
i=1:N
t=[t1:(Tb/100):t2]
%correlator
x1=sum(c1.*fsk_sig1(i,:));
x2=sum(c2.*fsk_sig2(i,:));
x=x1-x2;
%decision device
if x>0
demod(i)=1;
else
demod(i)=0; end
t1=t1+(Tb+.01);
t2=t2+(Tb+.01);
end
%Plotting the demodulated data bits
subplot(3,2,6);stem(demod);
title(' demodulated data');xlabel('n--- >');ylabel('b(n)'); grid on;
```

**Result**

Thus the program for FSK modulation and demodulation has been simulated in MATLAB and necessary graphs are plotted.

**Program**

```
% QPSK Modulation
clc;
clear all;
close all;
%GENERATE QUADRATURE CARRIER SIGNAL
Tb=1;t=0:(Tb/100):Tb;fc=1;
c1=sqrt(2/Tb)*cos(2*pi*fc*t);
c2=sqrt(2/Tb)*sin(2*pi*fc*t);
%generate message signal
N=8;m=rand(1,N);
t1=0;t2=Tb
for i=1:2:(N-1)
      t=[t1:(Tb/100):t2]
    if m(i)>0.5 m(i)=1;
        m_s=ones(1,length(t));
    else
        m(i)=0;
        m_s=-1*ones(1,length(t));
    end
    %odd bits modulated signal
    odd_sig(i,:)=c1.*m_s;
    if m(i+1)>0.5

        m(i+1)=1;
        m_s=ones(1,length(t));
    else
        m(i+1)=0;
        m_s=-1*ones(1,length(t));
    end
    %even bits modulated signal
    even_sig(i,:)=c2.*m_s;
    %qpsk signal
    qpsk=odd_sig+even_sig;
    %Plot the QPSK modulated signal
    subplot(3,2,4);plot(t,qpsk(i,:));
    title('QPSK signal');xlabel('t---->');ylabel('s(t)');grid on; hold on;
    t1=t1+(Tb+.01); t2=t2+(Tb+.01);
 end
hold off
%Plot the binary data bits and carrier signal
subplot(3,2,1);stem(m);
title('binary data bits');xlabel('n --- >');ylabel('b(n)');grid on;
subplot(3,2,2);plot(t,c1);
title('carrier signal-1');xlabel('t --- >');ylabel('c1(t)');grid on;
subplot(3,2,3);plot(t,c2);
title('carrier signal-2');xlabel('t --- >');ylabel('c2(t)');grid on;
```

**Exp:No:10** **Simulation of DPSK, QPSK and QAM Generation and Detection Schemes.**

**Aim:** To generate and demodulate quadrature phase shifted (QPSK) signal using MATLAB

**Theory**

**Generation of Quadrature phase shift keyed (QPSK) signal**

QPSK is also known as quaternary PSK, quadriphase PSK, 4-PSK, or 4-QAM. It is a phase modulation technique that transmits two bits in four modulation states.

Phase of the carrier takes on one of four equally spaced values such as p/4, 3p/4, 5p/4 and7p/4.

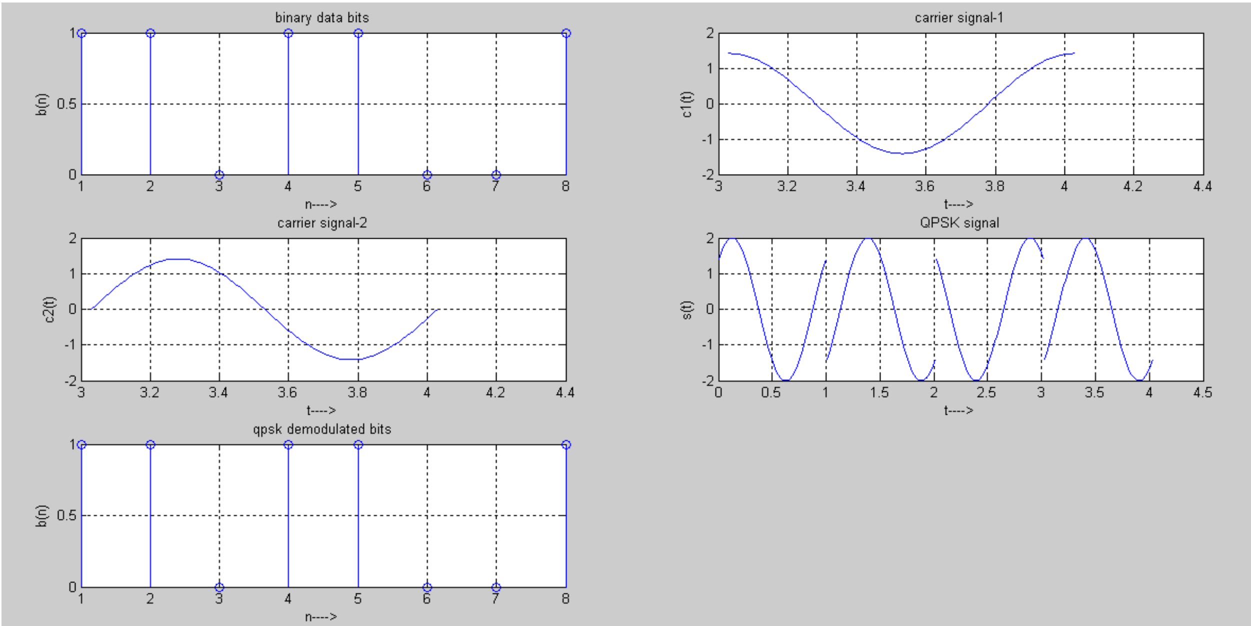
**Algorithm**

Initialization commands

**QPSK modulation**

1. Generate quadrature carriers.
2. Start FOR loop
3. Generate binary data, message signal(bipolar form)
4. Multiply carrier 1 with odd bits of message signal and carrier 2 with even bits of message signal
5. Perform addition of odd and even modulated signals to get the QPSK modulated signal
6. Plot QPSK modulated signal.
7. End FOR loop.
8. Plot the binary data and carriers.

:



binary data bits
b(n)
n---->
carrier signal-1
c1(t)
t---->
carrier signal-2
c2(t)
t---->
QPSK signal
s(t)
t---->
qpsk demodulated bits
b(n)
n---->

**Result**

The program for QPSK modulation and demodulation has been simulated in MATLAB and necessary graphs are plotted.

**LINEAR BLOCK CODE**

**PROGRAM: 1**

```
clc;
w=[1 1 1 1 1 1 1 0 1 0 0];
fprintf('The original code is:');
disp(w);
P=[1 1 0;0 1 1;0 0 1];
I=[1 0 0;0 1 0;0 0 1];
pt=P';
H=[pt,I];
ht=H';
disp('The value of ht matrix is');ht
for(i=1:3)
  s1=0;
for(j=1:6)
   s1=xor(s1,ht(j,i)*w(j));
end
s(i)=s1;
end
fprintf('The syndrome is:');
disp(s);
for(k=1:6)
   if(s==ht(k,:))
      temp=k;
   end
end
fprintf('The error is in the position %d\n',temp);
w(temp)=xor(w(temp),1);
disp('corrected code is:');
disp(w);
```

```
The original code is:     1     1     1     1     1     1     1     0     1     0     0
The value of ht matrix is
ht =

     1     1     0
     0     1     1
     0     0     1
     1     0     0
     0     1     0
     0     0     1

The syndrome is:     0     1     1
The error is in the position 2
corrected code is:
     1     0     1     1     1     1     1     0     1     0     0
```

**Ex.No: 11 SIMULATION OF LINEAR BLOCK AND CYCLIC ERROR CONTROL CODING SCHEMES**

**AIM:**

To generate various error control coding technique using MATLAB and to decode it.

**APPARATUS REQUIRED:**

1. Personal Computer
2. MATLAB software

**THEORY:**

Source coding is used to reduce all the redundant bits in the encoded data signal by applying the information theory concepts. As a result, it is not possible to arrive at a system with low error rate.

So, we go for channel coding. It builds redundancies in the signal so that the error can be rectified. Various channel codes are error control codes.

**They must have**

i) The capability to detect and correct errors.

ii) Work in a fast and efficient way.

**Types of error control methods are**

a) Error detection and retransmission (ARQ)

b) Error detection and correction (ECC)

**Error – correction codes are divided as**

a) Block codes and

b) Convolution codes.

**Algorithm:**

- Data is given as input(m).
- Generator matrix G=[ P $I_K$] is generated by using parity (P) and identity matrix ($I_K$).
- Code word is generated using C=mG matrix operation. It is transmitted through channel.
- The received vector has one error means it is detected using the syndrome(S)
  S=rHT
- H is the parity check matrix H=[ $P^T$ $I_{n-k}$ ]
- Syndrome matches with the row of H. So, the error present in which bit is detected.
- Correcet code word C=r EX-OR e[error pattern]

**PROGRAM: 2**

```
clc;
clear;
w=[1 0 0 0 1 0];
fprintf('The original code is:');
disp(w);
P=[1 1 0;0 1 1 ;0 0 1];
I=[1 0 0 ;0 1 0 ;0 0 1 ];
pt=P';
H=[pt,I];
ht=H';
disp('The value of ht matrix is');ht
for(i=1:3)
    s1=0;
for(j=1:6)
    s1=xor(s1,ht(j,i).*w(j));
end
s(i)=s1;
end
fprintf('The syndrome is:');
disp(s);
for(k=1:6)
    if(s==ht(k,:))
        temp=k;
    end
end
fprintf('The error is in the position %d\n',temp);
w(temp)=xor(w(temp),1);
disp('corrected code is:');
disp(w);
```

```
The original code is:     1     0     0     0     1     0
The value of ht matrix is

ht =

     1     1     0
     0     1     1
     0     0     1
     1     0     0
     0     1     0
     0     0     1

The syndrome is:     1     0     0
The error is in the position 4
corrected code is:
     1     0     0     1     1     0
```

**PROGRAM: 3**

```
clc;
clear;
w=[1 0 1 0 1 1 1];
fprintf('The original code is:');
disp(w);
P=[1 1 1;1 1 0 ;1 0 1; 0 1 1];
I=[1 0 0 ;0 1 0 ;0 0 1 ];
pt=P';
H=[pt,I];
ht=H';
disp('The value of ht matrix is');ht
for(i=1:3)
  s1=0;
for(j=1:7)
   s1=xor(s1,ht(j,i).*w(j));
end
s(i)=s1;
end
fprintf('The syndrome is:');
disp(s);
for(k=1:7)
   if(s==ht(k,:))
      temp=k;
   end
end
fprintf('The error is in the position %d\n',temp);
w(temp)=xor(w(temp),1);
disp('corrected code is:');
disp(w);
```

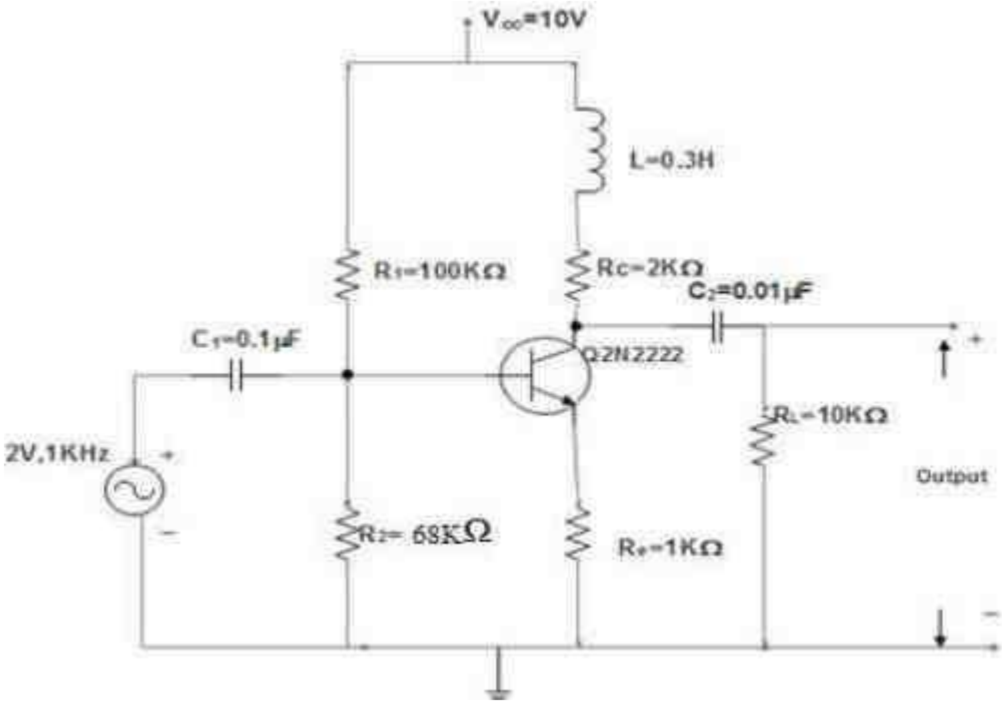
```
The original code is:    1    0    1    0    1    1    1
The value of ht matrix is
ht =

    1    1    1
    1    1    0
    1    0    1
    0    1    1
    1    0    0
    0    1    0
    0    0    1
The syndrome is:    1    0    1
The error is in the position 3
corrected code is: 1    0    0    0    1    1    1
```

**Result:**

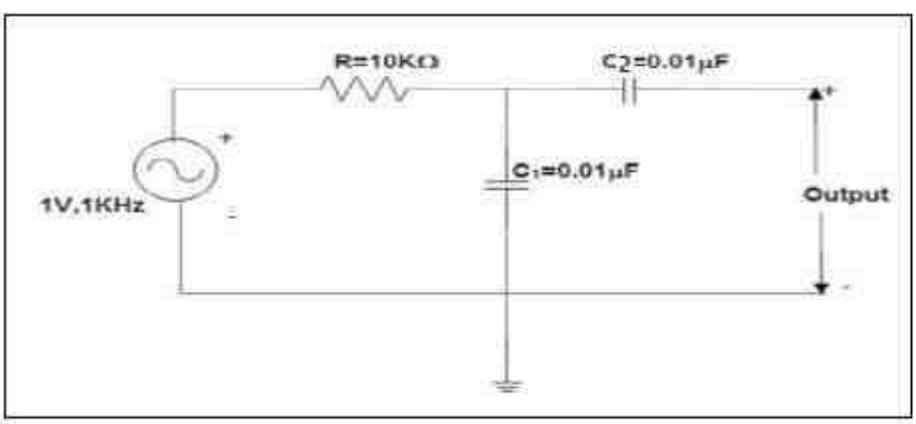
The Linear and cyclic coding scheme is simulated and the output is obtained.

## CIRCUIT DIAGRAM:

### PRE EMPHASIS CIRCUIT DIAGRAM:




### DE EMPHASIS DIAGRAM :



# EX.NO. 12 PRE –EMPHASIS AND DE-EMPHASIS

**AIM:**

To design a pre emphasis circuit to boost the input signal level for a FM transmitter for a cut off frequency of 1KHz. Attenuate the boosted high frequency signals at the receiver side using a deemphasis circuit with a cutoff frequency of 1.6KHz. Analyze t he frequency response characteristics of pre emphasis and de emphasis circuits.

**COMPONENTS REQUIRED:**

| S.NO. | NAME OF THE EQUIPMENT / COMPONENT | RANGE | QUANTITY |
|---|---|---|---|
| 1 | Cathode Ray Oscilloscope | (0 – 20MHz) | 1 |
| 2 | Audio Frequency Oscillator | (0-2) MHz | 1 |
| 3 | Regulated power supply | (0 -30V), 1A | 1 |
| 4 | Resistors | 1K Ω 2K Ω 10K Ω 68K Ω 100K Ω | 1, 1, 2, 1, 1 |
| 5 | capacitors | 0.1 µF 0.001 µF | 2 3 |
| 6 | Semiconductor Device(Transistor) | Q2N2222 | 1 |
| 7 | Decade Inductance Box | 0.3H | 1 |

## THEORY :

During the transmission over a channel, the received signal contains interference (high frequency noise).

For demodulated FM signals, the interference power increases as the frequency goes up. Thus, De-emphasis is applied to the demodulated signal to decrease the power of the int erference in high frequency. However, in order to keep the high frequency component of the demodulated message, preemphasis must be applied to the message before going through the FM modulator.

**PRE-EMPHASIS**

Pre-emphasis refers to boosting the relative amplitudes of the modulating voltage for higher audio frequencies. Pre-emphasis is done at the transmitting side of the frequency modulator. Signals with higher modulation frequencies have lower SNR. In order to compensate this, the high frequency signals are emphasised or boosted in amplitude at the transmitter section of a communication.

system prior to the modulation process. That is, the pre- emphasis network allows the high frequency
modulating signal to modulate the carrier at higher level, this causes more frequency deviation. The circuit consist of a transistor, resistor and an inductor. It is basically a high pass filter or Differentiator. A pre-emphasis circuit produces a constant increase in the amplitude of the modulating signal with an increase in frequency.

**MODEL GRAPH**

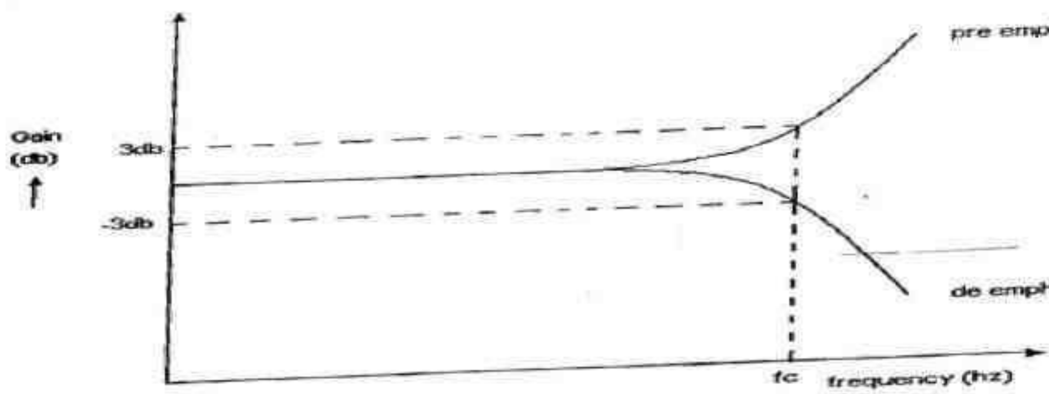



**Fig. Frequency Response of Pre-Emphasis and De Emphasis**

The cut off frequency is determined by the RC or L/R time constant of the network. Normally, the cut off frequency occurs at the frequency where capacitive reactance or inductive reactance equals R. The cut off frequency is given by the formula

By the use of an active pre-emphasis network we can reduce the signal loss and distortion with the increase of SNR. Also the output amplitude of the network increases with frequencies above cut off frequency.

**DE-EMPHASIS**

De-emphasis is the complement of pre-emphasis, in the anti-noise system called emphasis. This circuit is used to attenuate the high frequency signal that is boosted at the transmitter section. The circuit is placed at the receiving side. It acts as a low pass filter. The cut off frequency is given by the formula The cut off frequency is given by the formula

The circuit consists of a passive network consisting of a resistor and a capacitor. It is basically a low pass filter or integrator. The pre- emphasis network in front of the FM modulator and a de-emphasis network at the output of the FM demodulator improves the Signal to Noise Ratio

**Result:** The characteristics of pre-emphasis and de-emphasis circuits were studied

**EX.NO: 13 SIMULATION OF CONVOLUTIONAL CODING SCHEME**

**Aim:**

To simulate convolutional coding scheme.

**Apparatus required:**

Personal computer with Matlab Simulink

**Theory**

In block coding, the encoder ***accepts a k-bit message block*** and ***generates an n-bit codeword***, which contains ***n – k parity-check bits***. Thus, codewords are produced on a block-by-block basis. Buffer must be provided in the encoder to buffer an entire message block, before generating the associated codeword. In some applications the message bits come in serially rather than in large blocks, in which case the use of a buffer may be unwanted. In such situations, the use of convolutional coding may be the preferred method. A convolutional coder generates redundant bits by using modulo-2 convolutions; hence the name convolutional codes.

**PROGRAM:**

```
data = randi([0 1],10,1);
trellis1 = poly2trellis([5 4],[23 35 0; 0 5 13]);
code1 = convenc(data,poly2trellis([5 4],[23 35 0; 0 5 13]));
ans = 15

trellis = poly2trellis(7,{'1 + x^3 + x^4 + x^5 + x^6', ...
    '1 + x + x^3 + x^4 + x^6'})
trellis = struct with fields:
    numInputSymbols: 2
    numOutputSymbols: 4
          numStates: 64
         nextStates: [64x2 double]
            outputs: [64x2 double]
data = randi([0 1],70,1);
codedData = convenc(data,trellis);
decodedData = vitdec(codedData,trellis,34,'trunc','hard');
biterr(data,decodedData)
for n = 1:length(EbNoVec)
    % Convert Eb/No to SNR
    snrdB = EbNoVec(n) + 10*log10(k*rate);
    % Noise variance calculation for unity average signal power.
    noiseVar = 10.^(-snrdB/10);
    % Reset the error and bit counters
    [numErrsSoft,numErrsHard,numBits] = deal(0);

    while numErrsSoft < 100 && numBits < 1e7
        % Generate binary data and convert to symbols
        dataIn = randi([0 1],numSymPerFrame*k,1);
```

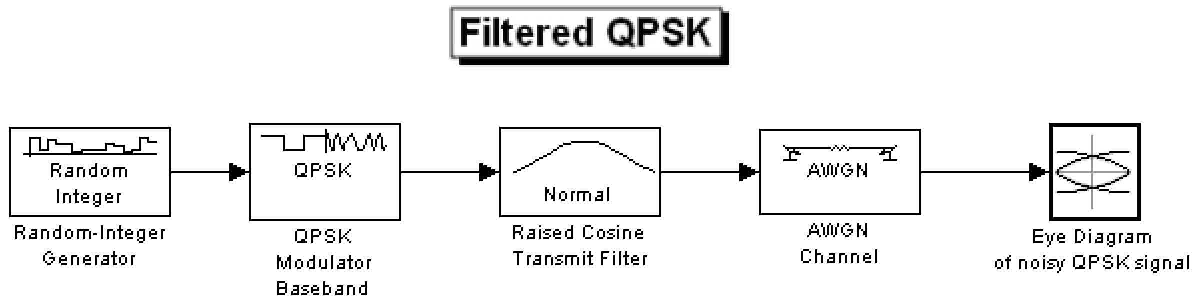
```
        % Convolutionally encode the data
        dataEnc = convenc(dataIn,trellis);

        % QAM modulate
        txSig = qammod(dataEnc,M,'InputType','bit','UnitAveragePower',true);

        % Pass through AWGN channel
        rxSig = awgn(txSig,snrdB,'measured');

        % Demodulate the noisy signal using hard decision (bit) and
        % soft decision (approximate LLR) approaches.
        rxDataHard = qamdemod(rxSig,M,'OutputType','bit','UnitAveragePower',true);
        rxDataSoft = qamdemod(rxSig,M,'OutputType','approxllr', ...
            'UnitAveragePower',true,'NoiseVariance',noiseVar);

        % Viterbi decode the demodulated data
        dataHard = vitdec(rxDataHard,trellis,tbl,'cont','hard');
        dataSoft = vitdec(rxDataSoft,trellis,tbl,'cont','unquant');

        % Calculate the number of bit errors in the frame. Adjust for the
        % decoding delay, which is equal to the traceback depth.
        numErrsInFrameHard = biterr(dataIn(1:end-tbl),dataHard(tbl+1:end));
        numErrsInFrameSoft = biterr(dataIn(1:end-tbl),dataSoft(tbl+1:end));

        % Increment the error and bit counters
        numErrsHard = numErrsHard + numErrsInFrameHard;
        numErrsSoft = numErrsSoft + numErrsInFrameSoft;
        numBits = numBits + numSymPerFrame*k;

    % Estimate the BER for both methods
    berEstSoft(n) = numErrsSoft/numBits;
    berEstHard(n) = numErrsHard/numBits;
end
```

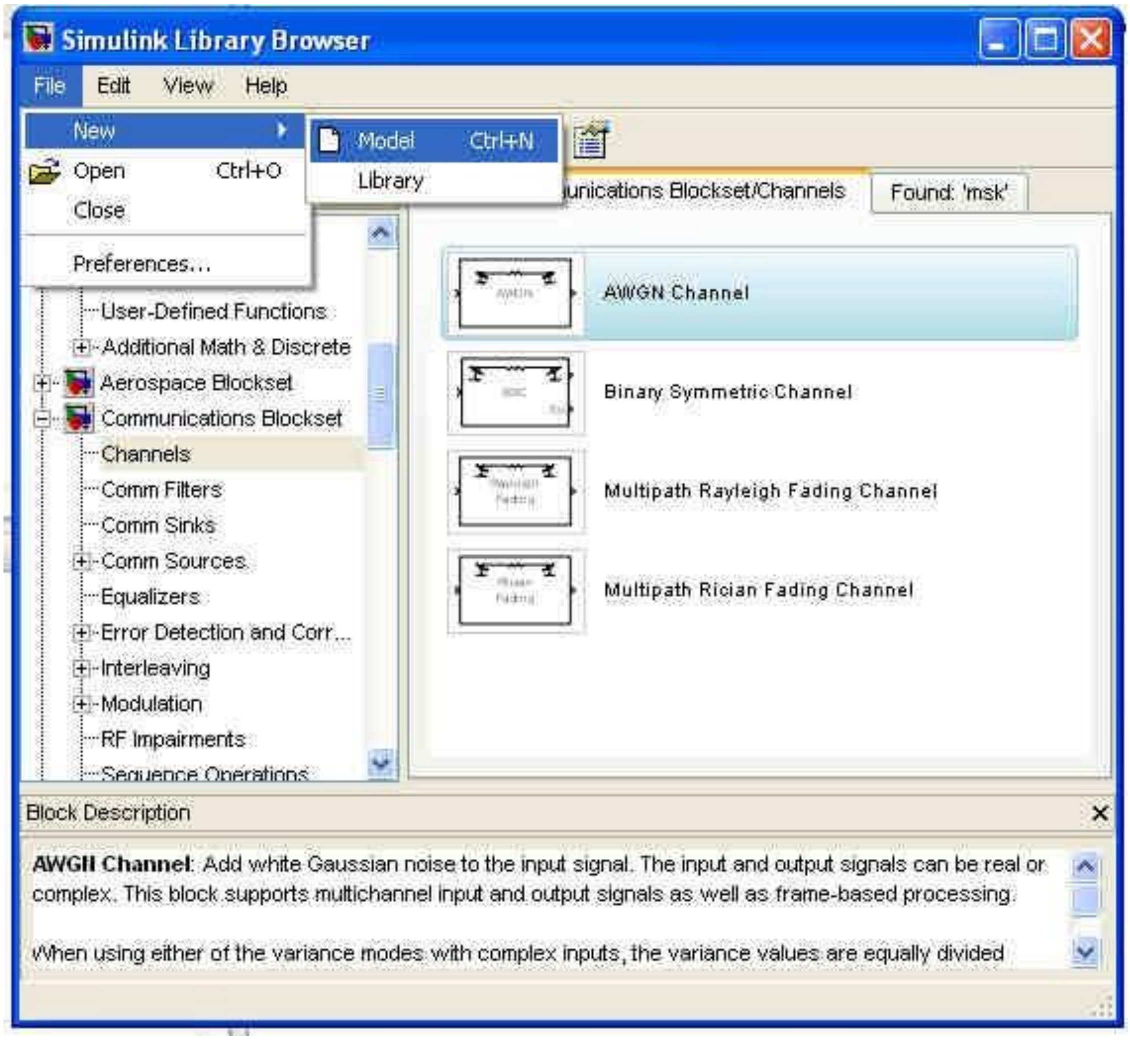
**Result:**

The convolutional coding scheme is simulated and the output is obtained.

**Block Diagram:**

Diagram:



**Ex. No.: 14** **COMMUNICATION LINK SIMULATION**

**Aim:**

To simulate a simple communication link by using the Matlab tool

**Apparatus required:**

Personal computer with Matlab Simulink

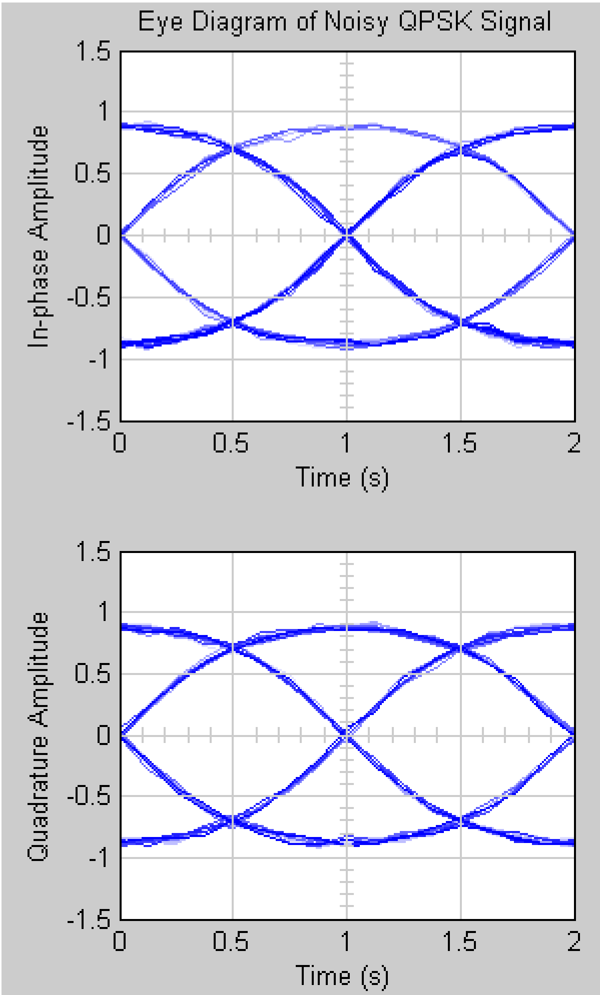
**Theory:**

In telecommunication, a communications system is a collection of individual communications networks, transmission systems, relay stations, tributary stations, and data terminal equipment (DTE) usually capable of interconnection and interoperation to form an integrated whole. The components of a communications system serve a common purpose, are technically compatible, use common procedures, respond to controls, and operate in union. Telecommunications is a method of communication (e.g., for sports broadcasting, mass media, journalism, etc.). A communications subsystem is a functional unit or operational assembly that is smaller than the larger assembly under consideration.

**Procedure:**

1. Open the Matlab simulink tool.
2. Drag the tools as per the block diagram.
3. Connect the blocks.
4. Run the simulation tool.
5. Observe the transmitted and receiving signals.
6. The plots were analyzed for the performance the communication link.

**Output Diagram:**



**Result:**

A simple communication link was designed using the Matlab Simulink tool and the performance of the link was studied.