SRI SAIRAM ENGINEERING COLLEGE

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PROSPERITY THROUGH TECHNOLOGY

LAB MANUAL

20ECPL501 - COMMUNICATION SYSTEMS LABORATORY

V Semester ECE

Academic year: 2023-2024

Department

of

Electronics and Communication Engineering

PREFACE

"THE TRUE METHOD OF KNOWLEDGE IS EXPERIMENT"

The true transmission of knowledge really occurs when the student is open to and engaged in the information. With this in mind, this manual is compiled as a preparatory note for the Communication Systems laboratory experiments. Sufficient details have been included to impart self-learning.

Communication laboratory experiments mainly focuses on the study of different digital modulation techniques and encoding schemes and also to study sampling and Time division and multiplexing techniques. This laboratory also focuses on MATLAB simulation of digital modulation schemes such as ASK, FSK, PSK, DPSK, its signal constellation and also error control techniques as well as communication link simulation. Knowledge of communication systems laboratory is essential as they are the basics for most of the communication systems.

This manual is intended for the V semester ECE students. Each experiment is provided with introductory information and procedure to perform the experiment.

The manual has been compiled by Ms. S. Rajalakshmi, Assistant Professor/ECE and Ms. V. Remya, Assistant Professor/ECE Department. It is expected that this will be well received by the students.

Head of the Department **Principal**

INSTITUTION VISION

To emerge as a ”Centre of excellence “ offering Technical Education and Research opportunities of very high standards to students, develop the total personality of the individual and instill high levels of disciple and strive to set global standards, making our students technologically superior and ethically stronger, who in turn shall contribute to the advancement of society and humankind.

INSTITUTION MISSION

We dedicate and commit ourselves to achieve, sustain and foster unmatched excellence in Technical Education. To this end, we will pursue continuous development of infra-structure and enhance state-of-art equipment to provide our students a technologically up-to date and intellectually inspiring environment of learning, research, creativity, innovation and professional activity and inculcate in them ethical and moral values.

INSTITUTION POLICY

We at Sri Sai Ram Engineering College are committed to build a better Nation through Quality Education with team spirit. Our students are enabled to excel in all values of Life and become Good Citizens. We continually improve the System, Infrastructure and Service to satisfy the Students, Parents, Industry and Society.

DEPARTMENT VISION

To emerge as a "centre of excellence" in the field of Electronics and Communication Engineering and to mould our students to become technically and ethically strong to meet the global challenges. The Students in turn contribute to the advancement and welfare of the society.

DEPARTMENT MISSION

M1: To achieve, sustain and foster excellence in the field of Electronics and Communication Engineering.

M2: To adopt proper pedagogical methods to maximize the knowledge transfer.

M3: To enhance the understanding of theoretical concepts through professional society activities

M4: To improve the infrastructure and provide conducive environment of learning and research following ethical and moral values

Program Educational Objectives (PEOs)

To prepare the graduates to:

1. Acquire strong foundation in Engineering, Science and Technology for a successful career in Electronics and Communication Engineering.
2. Apply their knowledge and skills acquired to solve the issues in real world Electronics and Communication sectors and to develop feasible and viable systems.
3. Be receptive to new technologies and attain professional competence through professional society activities.
4. Participate in lifelong learning, higher education efforts to emerge as expert researchers and technologists.
5. Practice the profession with ethics, integrity, leadership and social responsibilities.

Program Specific Outcomes PSO

Electronics and Communication Engineering graduates will be able to:

1. Design, implement and test Electronics and Communication systems using analytical knowledge and applying modern hardware and software tools
2. Develop their skills to solve problems and assess social, environmental issues with ethics and manage different projects in multidisciplinary areas.

COURSE OUTCOMES

On completion of this laboratory course, the student should be able:

1 To demonstrate signal sampling and multiplexing schemes (K3)

2 To generate and detect amplitude and frequency modulation (K3)

3 To Implement encoding schemes using PCM and DM techniques (K3)

4 To demonstrate baseband transmission schemes such as ASK, BFSK, BPSK, QPSK, QAM and DPSK (K3)

5 To apply various channel coding schemes and demonstrate the improvement of noise performance (K3)

6 To simulate and evaluate the various functional modulus of communication system (K4)

SYLLABUS

20ECPL501 – COMMUNICATION SYSTEMS LABORATORY

L	T	P	C
0	0	3	1.5

OBJECTIVES: The student should be made :

- To visualize the effects of sampling and TDM .
- To Implement AM & FM modulation and demodulation .
- To implement PCM & DM
- To simulate Digital Modulation schemes
- To simulate Error control coding schemes

LIST OF EXPERIMENTS

1. Signal Sampling and reconstruction
2. Time Division Multiplexing
3. AM Modulator and Demodulator
4. FM Modulator and Demodulator
5. Pulse Code Modulation and Demodulation
6. Delta Modulation and Demodulation
7. Line coding schemes
8. Simulation of ASK, FSK and BPSK generation schemes
9. Simulation of DPSK, QPSK and QAM generation schemes
10. Simulation of signal constellations of BPSK, QPSK and QAM
11. Simulation of ASK , FSK and BPSK detection schemes
12. Simulation of Linear Block and Cyclic error control coding schemes
13. Simulation of Convolutional coding scheme
14. Communication link simulation

TOTAL: 45 PERIODS

TABLE OF CONTENTS

continuous assessment

Description	Maximum Marks
Aim / Procedure	**2**
Observation / Tabulation	**2**
Calculation	**2**
Graph & Result	**2**
Viva	**2**
Total	**10**

EXP. NO:1	**SIGNAL SAMPLING AND RECONSTRUCTION**
DATE:	

AIM:

To sample a signal with different sampling frequencies and to reconstruct the same..

APPARATUS REQUIRED:

S.No.	Name of the Equipment /Component	Range	Quantity
1.	Sampling trainer kit	-	1
2.	Connecting Plugs	-	-
3.	CRO	20 MHz	1

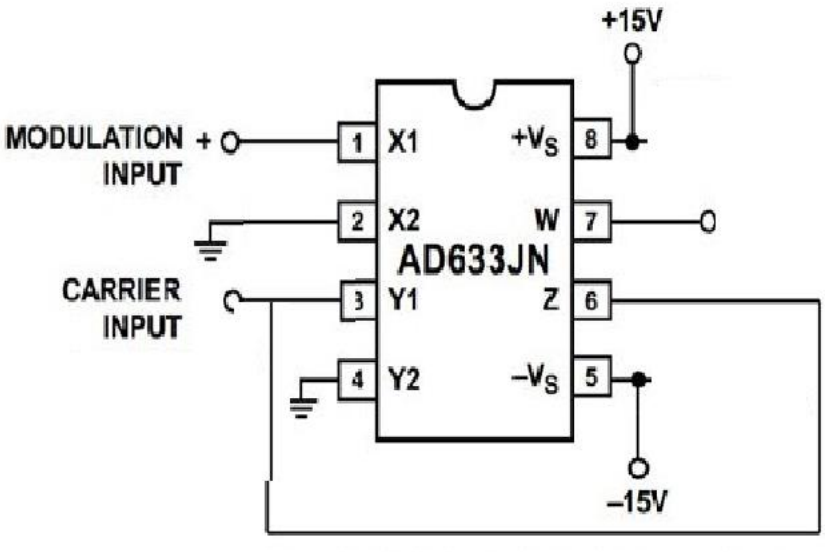
THEORY:

1. Sampling is the process by which an analog signal is converted into a corresponding sequence of samples that spaced uniformly in time (i.e. equally spaced in time).
2. It is necessary to choose the sampling rate property, so that the sequence of samples uniquely defines or recovers the original analog signal.
3. A band limited signal, which has no spectral components above the frequency fm Hz, is uniquely determined by its values at uniform intervals less than 1/2fm seconds apart.
4. The reciprocal of sampling period is called the sampling frequency or sampling rate (i.e) fs= 1/Ts. This ideal from of sampling is called “Instantaneous Sampling”.
5. If the signal is sampled at an equal or uniform intervals it is known as “uniform sampling”

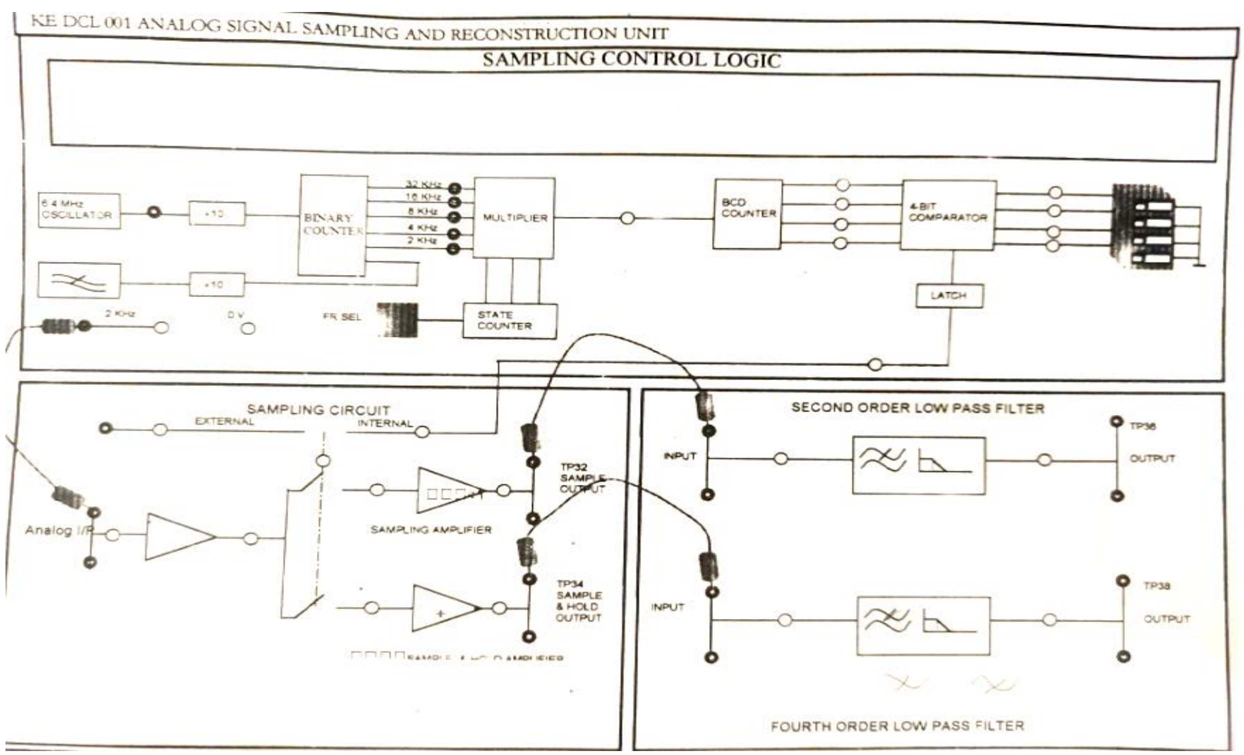
PROCEDURE:

1. The connections are given as per the circuit diagram.
2. Apply the modulating signal and measure its amplitude and time period.
3. Set the sampling frequency to 80 KHz and note down the amplitude and time period of the sampled signal.
4. Give the sampled signal to the reconstruction circuit and observe the reconstructed signal.
5. Repeat the same procedure for different sampling frequencies.
6. Plot the above waveforms in the graph.

SAMPING & RECONSTRUCTION CIRCUIT DIAGRAM:



SAMPING & RECONSTRUCTION BLOCK DIAGRAM:



TABULAR COLUMN:

SIGNAL	AMPLITUDE (V)	TIME PERIOD (ms)	FREQUENCY (KHz)
MODULATING SIGNAL			
CARRIER SIGNAL			
SAMPLED OUTPUT (using circuit)			

SAMPLED SIGNAL (USING BLOCK DIAGRAM)

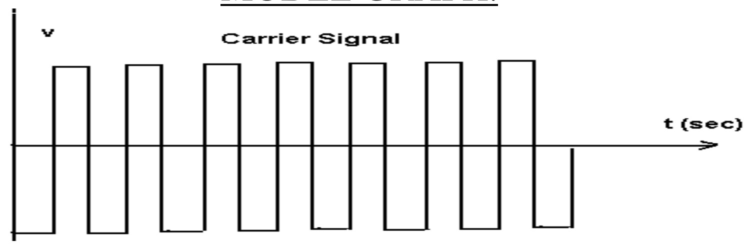
SIGNAL	AMPLITUDE (V)	TIME PERIOD(ms)		FREQUENCY (KHz)
		T_{ON}	T_{OFF}	
a)Sampled o/p b)Sample hold c)Flat top sample				

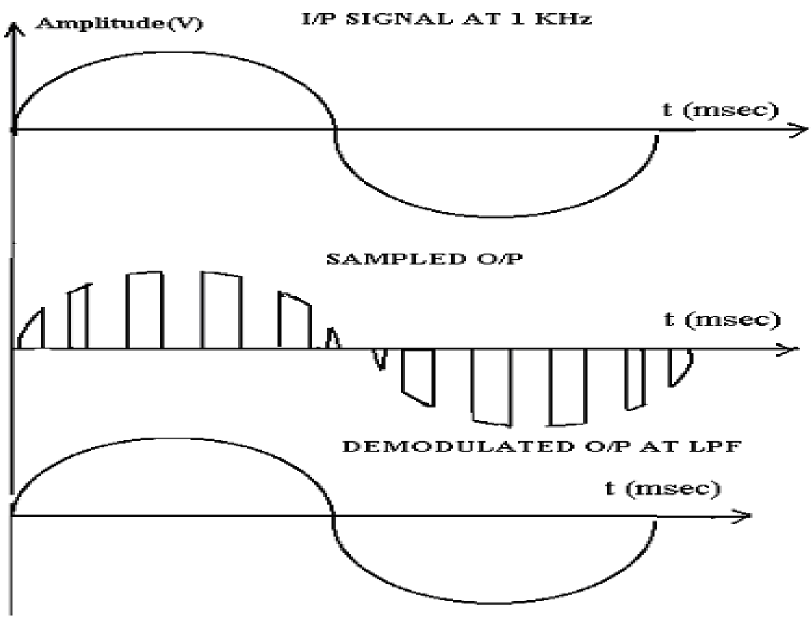
RECONSTRUCTED SIGNAL:

AMPLITUDE (V)	TIME PERIOD (ms)	FREQUENCY (KHz)

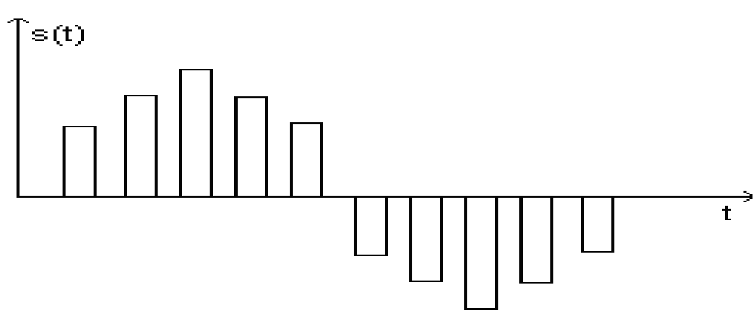
Duty cycle calculation: D = Ton / (Ton + Toff) = ---------- %

MODEL GRAPH:





Flot top:



RESULT:

Thus the given signal is sampled with different sampling frequencies and the waveforms are plotted.

EXP.NO:2	**TIME DIVISION MULTIPLEXING**
DATE:	

AIM:

To construct and study the TDM Circuit and draw its waveforms.

APPARATUS REQUIRED:

S.No.	Name of the Equipment /Component	Range	Quantity
1.	TDM Trainer Kit	-	1
2.	Connecting Plugs	-	-
3.	CRO	20 MHz	1

THEORY:

Multiplexing is the process of transmitting several separate information channels over the same communication circuit simultaneously without interference.

In PAM, PPM the pulse is present for a short duration and for most of the time between the two pulses no signal is present. This free space between the pulses can be occupied by pulses from other channels. This is known as Time Division Multiplexing. Thus, time division multiplexing makes maximum utilization of the transmission channel.

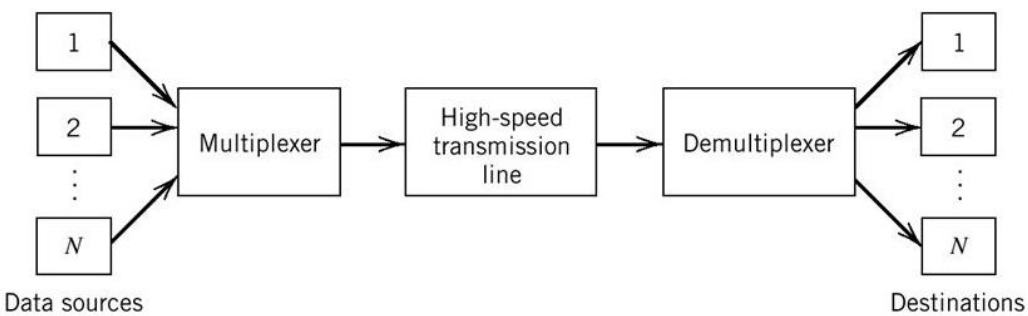
In TDM several information channels are transmitted over the same communication circuit simultaneously using a time sharing technique. As an example PAM waveforms can be generated, that have a very low duty cycle. This means the single channel is transmitted. Most of the transmission time would be wasted. Instead this time is fully utilized by transmitting pulse other than PAM signals during the intervals.

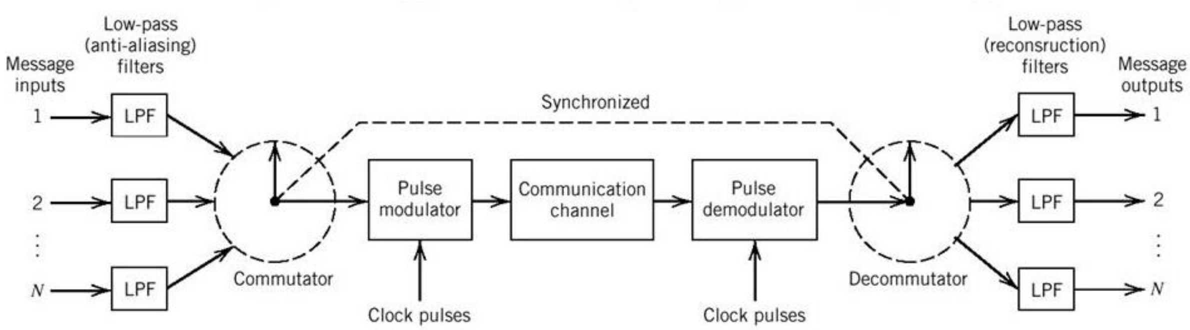
The first pulse is a synchronizing pulse with is used at the receiver in demultiplexing. The second pulse in amplitude modulated by channel 1.The third by channel 2 and the fourth by channel 3. This set up impulse is called a frame. The primary advantage of TDM is that several channels of information can be transmitted over a single cable of a single radio transmitter as any other communication circuit. Also any type of pulse modulator may be used in the TDM. In fact, many telephone systems are PCM-TDM

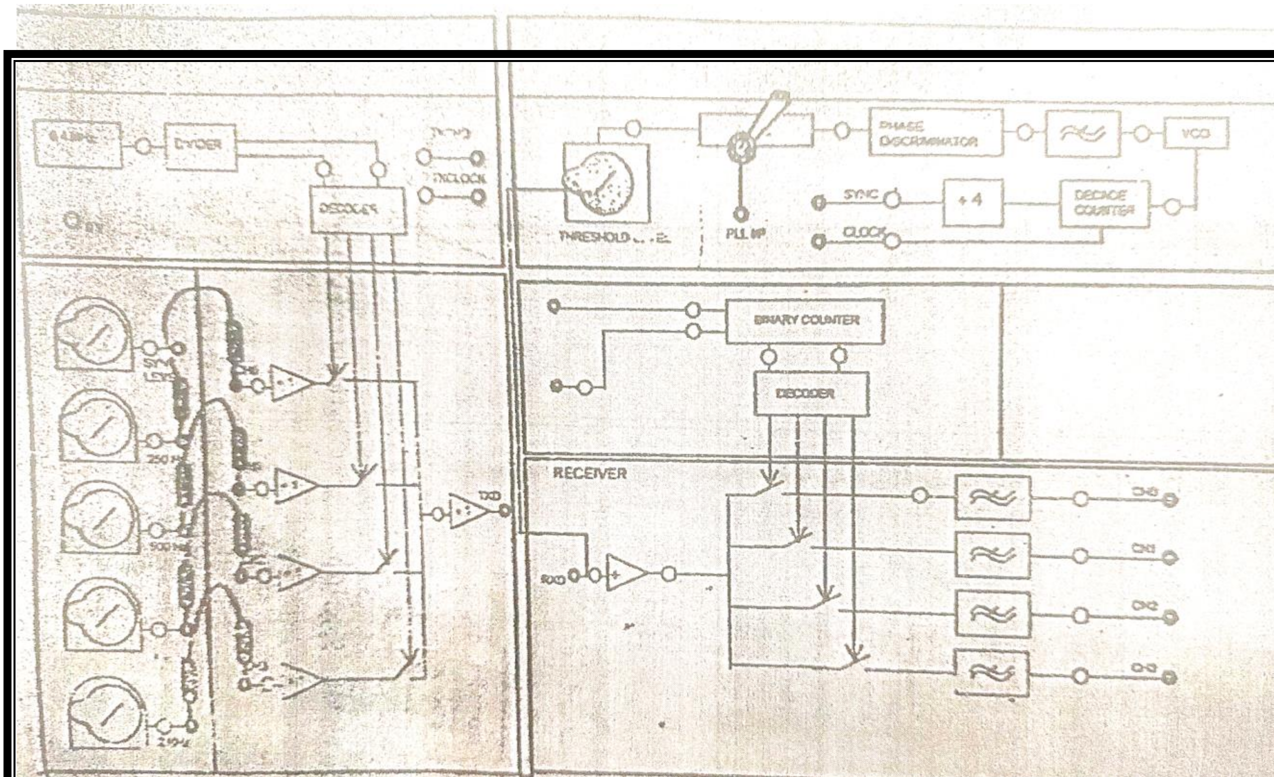
PROCEDURE:

1. Give the connections as per the block diagram.
2. Apply the four input sinusoidal signals of different frequency to four channels and measure the amplitude and time period of each signal.
3. Observe and measure the amplitude and frequency of the sampled signal for each channel individually.
4. Then observe the multiplexed waveform in the CRO.
5. Apply the multiplexed signal to the demultiplexer circuit and observe the original signals transmitted.
6. Measure the amplitude and time period of demultiplexed signal for each channel individually.
7. Plot all the waveforms in the graph.

BLOCK DIAGRAM:






DIVIDER
DECODER
BINARY COUNTER
DECODER
RECEIVER
PHASE DISCRIMINATOR
VCO
DECADE COUNTER
THRESHOLD
PLL I/P
SYNC
CLOCK
TXD
RXD

TABULAR COLUMN

1. Transmitted signals

Channel	Amplitude (V)	No. of Samples	Time Period (ms) (for each sample)		Total Time Period (ms)	Frequency (KHz)
			T_{ON}	T_{OFF}		

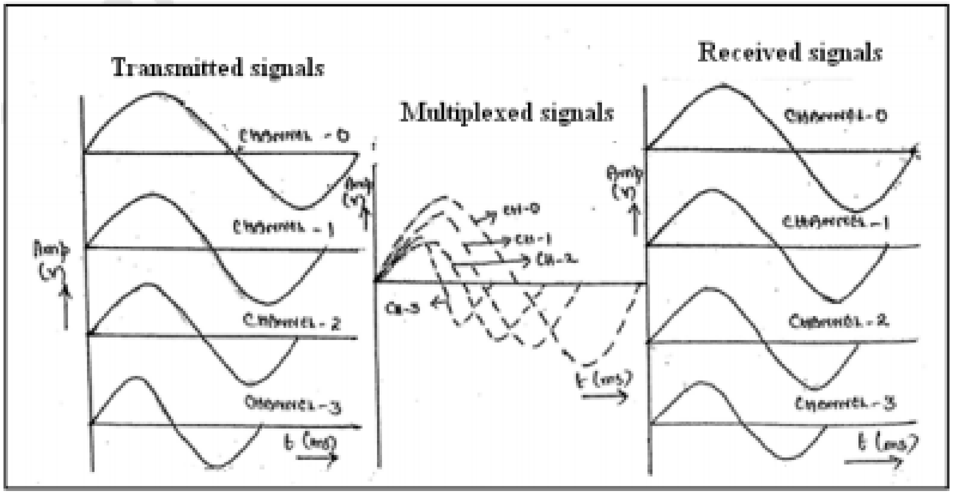
2. Sampled Signal

Channel	Amplitude (V)	Time Period (ms)	Frequency (KHz)

3. Received Signals

Channel	Amplitude (V)	Time Period (ms)	Frequency (KHz)

MODEL GRAPH:


Transmitted signals
Multiplexed signals
Received signals

RESULT:

Thus the Time division multiplexing and demultiplexing waveforms are obtained.

EXP. NO:3	GENERATION AND DETECTION OF AMPLITUDE MODULATION
DATE:	

AIM:

To construct amplitude modulator and demodulator circuit and plot the waveforms

Apparatus Required:

S.No.	Name of the Equipment /Component	Range	Quantity
1.	Diode	OA79	2
2.	Capacitor	0.1µF,0.01µF	2,1
3.	Resistors	1kΩ,100kΩ	2 ,1 each
4.	Decade Inductance Box	10 mH	1
5.	Function Generators	1 MHz	2
6.	CRO	20MHz	1
7.	Bread board		1
8.	Regulated power supply	0-30 V	1

Theory:

Modulation is the process of changing the amplitude of a relatively high frequency carrier signal in proportion with the instantaneous value of the modulating signal. The output waveform contains all the frequencies that make up the AM signal and is used to transport the information through the system. Therefore the shape of the modulated wave is called the AM envelope. With no modulating signal the output waveform is simply the carrier signal.

Modulation Index:

The ratio of maximum of modulating signal to maximum amplitude of carrier signal is called modulation index .

M=Em/Ec .If modulation index expressed in percentage it is also called as percentage modulation. Coefficient of modulation is a term used to describe the amount of amplitude change present in an AM waveform. There are three degrees of modulation available based on value of modulation index.

1) Under modulation : m< 1=Em < Ec

2) Critical modulation: m=1, Em = Ec

3) Over modulation: m>1, Em > Ec

Need for modulation is as follows:

- Avoid mixing of signals
- Reduction in antenna height
- long distance communication
- Multiplexing
- Improve the quality of reception
- Ease of radiation

<u>Advantages</u>

Modulator operates at low voltage level

Power efficiency is practically higher than 80%

All the preceding linear amplifier operates at low power level.

<u>Disadvantages</u>

Requires high amplitude of modulating signal

Small operating range

<u>Application</u>

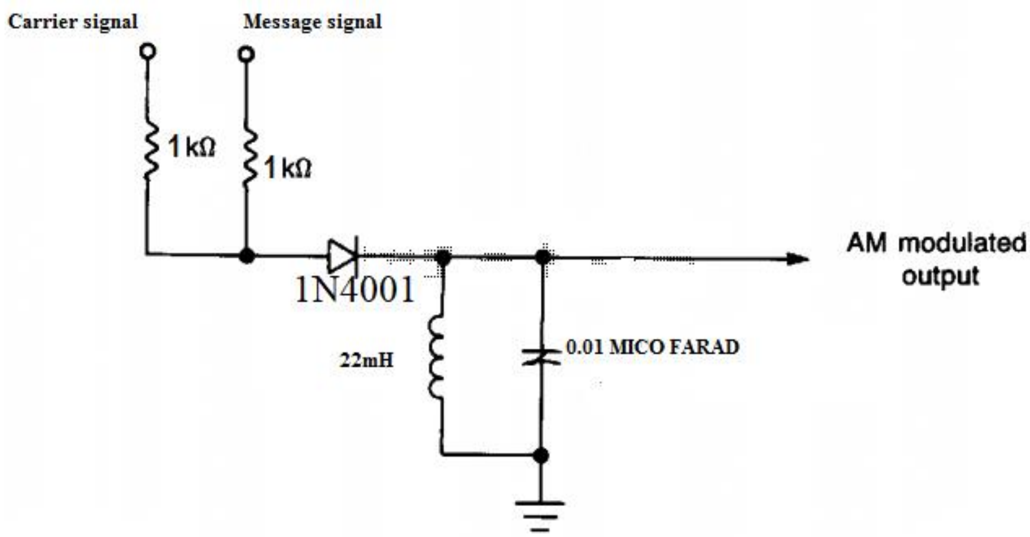
1) Commercial broadcasting of both audio and video signals

2) Two way mobile radio communication such as citizen band (CB) radio

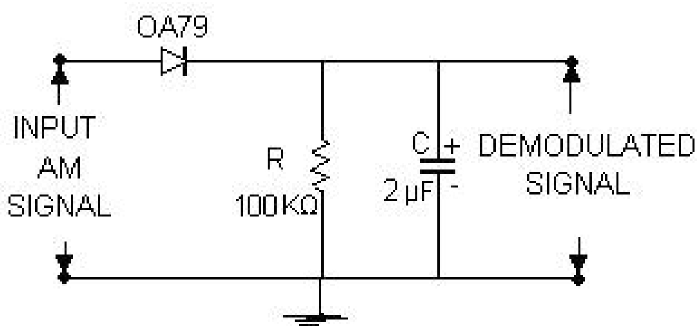
DEMODULATION

It is the process of separating message signal from the modulated wave carrier signal. The most commonly used AM detector is simple diode detector. The AM signal at fixed if is applied to the transformer primary. The signal at secondary is half wave rectified by diode .so that only it is called detector negative peak clipping is done using the detector circuit. This is the distortion occurs in the output of diode detector because of unequal ac and dc load impedances of the diode.

CIRCUIT DIAGRAM



DEMODULATION:



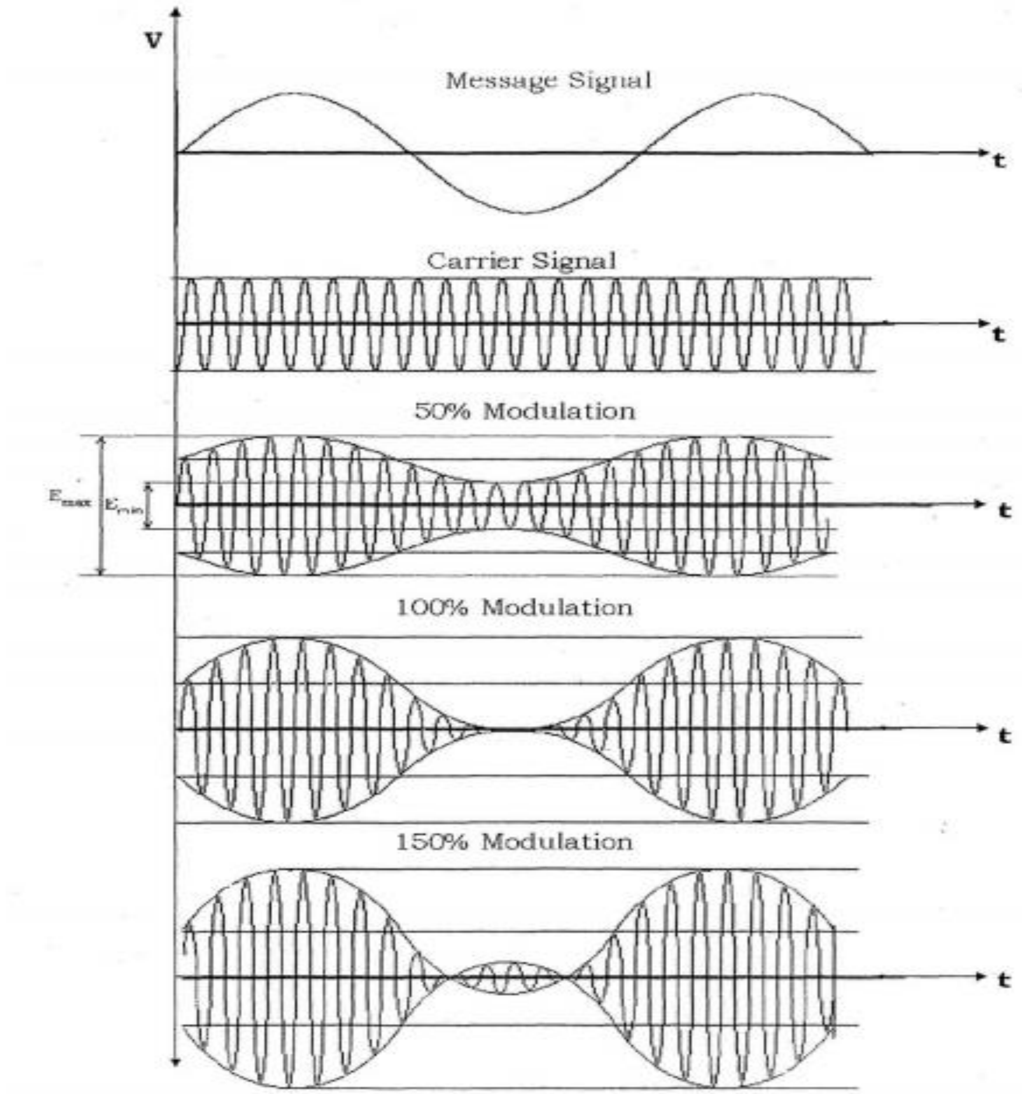
Tabulation

SIGNAL	AMPLITUDE(V)	TIME PERIOD(ms)	FREQUENCY(Hz)
Input signal			
Carrier signal			
AM signal	V max= V min=		
Demodulated signal			

PROCEDURE

1. Rig up the circuit as per the circuit diagram.
2. Modulating frequency is kept at 1 KHZ.
3. Carrier frequency is kept at 10KHZ
4. The output waveform is observed in CRO and measure Vmax&Vmin are calculated, modulation index calculated.
5. Output and input characteristics are plotted in graph.
6. Apply the AM signal to the detector circuit.
7. Observe the amplitude demodulated output on the CRO.
8. Compare the demodulated signal with the original modulating signal (Both must be same in all parameters). Plot the observed waveforms.

MODEL GRAPH:


V
Message Signal
t
Carrier Signal
t
50% Modulation
E_{max}
E_{min}
t
100% Modulation
t
150% Modulation
t

RESULT:

The amplitude modulation & demodulation circuit has been constructed and its characteristics are obtained.

EXP. NO:4	**GENERATION OF FREQUENCY MODULATION AND ITS DETECTION**
DATE:	

Aim:

To construct an Frequency modulation& demodulation circuit and to calculate modulation index of FM.

Apparatus Required:

s.no	components	Range	Qty
1	IC	XR 2206	
2	Resistor		
3	Capacitor		
4	Connecting wires		
5	Function generator	0-100 k HZ	
6	C.R.O	0-60 MHZ	
7	Regulated power supply	0-30 V	

Theory:

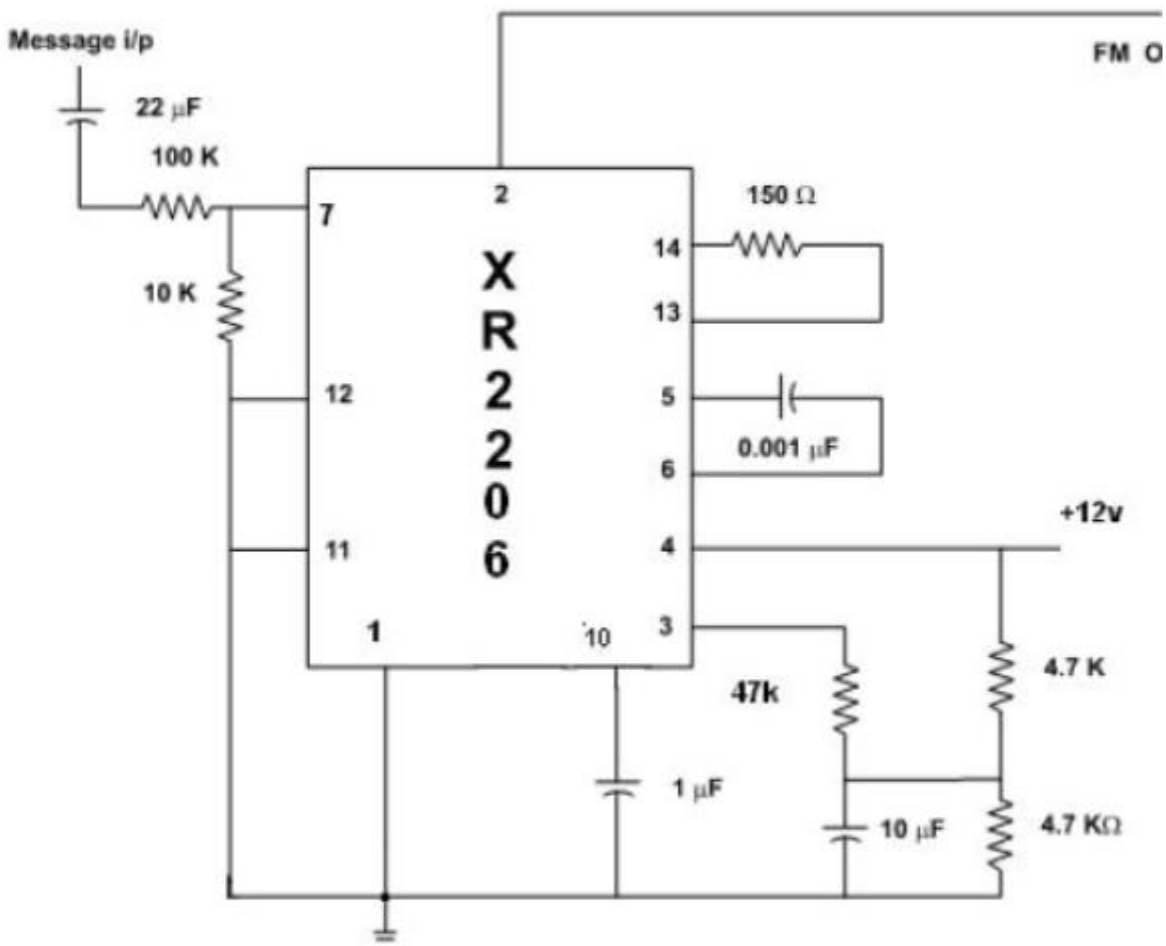
When frequency of the carrier varies as per amplitude variations of modulating signal then it is called frequency modulation .Amplitude of the modulated carrier remains constant the frequency modulated wave is given by $u(t) = A_c \cos(2\pi f_c t + \beta \sin(2\pi f_m t))$

FREQUENCY DEVIATION (Δf) and MODULATION INDEX (β): The frequency deviation Δf represents the maximum shift between the modulated signal frequency, over and under the frequency of the carrier.

$$\Delta f = \frac{f_{max} - f_{min}}{2}$$

DIAGRAM:

MODULATOR



We define modulation index m f the ratio between Δf and the modulating frequency f.

$$m_f = \frac{\Delta f}{f}$$

DIRECT METHOD:

An oscilloscope is used in which the reactance of one of the elements of the resonant circuit depends on the modulating voltage. The most common device with variable reactance is the Varactor or Varicap, which is a particular diode which capacity varies as function of the reverse bias voltage. The frequency of the carrier is established with AFC circuits (Automated frequency control) or PLL (Phase locked loop).

INDIRECT METHOD:

The FM is obtained in this case by a phase modulation, after the modulating signal has been integrated. In this phase modulator the carrier can be generated by a quartz oscillator, and so its frequency stabilization is easier. In the circuit used for the exercise, the frequency modulation is generated by a Hartley oscillator, which frequency is determined by a fixed inductance and by capacity (variable) supplied by varicap diodes.

ADVANTAGES:

1. Noise reduction
2. Improved system fidelity
3. Efficient use of power

DISADVANTAGE:

1. Requires a wider bandwidth
2. Utilizing more complex circuit in both transmitters and receivers.

APPLICATION:

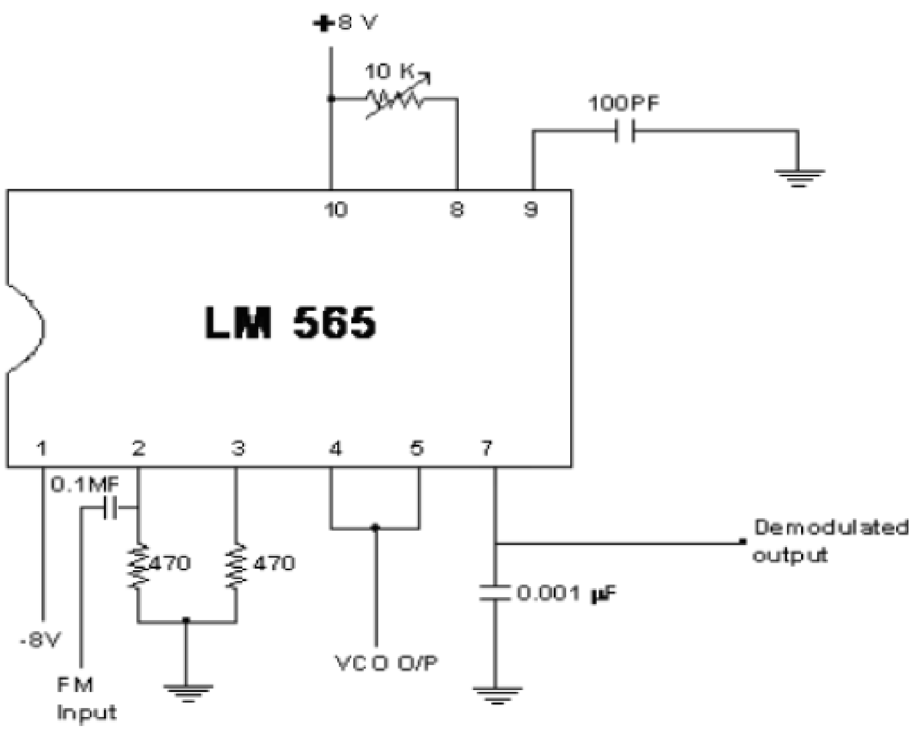
1. Television sound transmission
2. Two way mobile radio
3. Cellular Radio
4. Microwave
5. Satellite Communication System

PROCEDURE

- Connection are given as per circuit diagram For FM carrier is generated without giving input with RT & CT
- Note amplitude and frequency of carrier wave
- By giving input through function generator set a particular frequency
- The output modulated wave is traced and its amplitude and frequency are computed

The demodulation is done by given modulated output wave as input toi demodulator o/p is obtained.

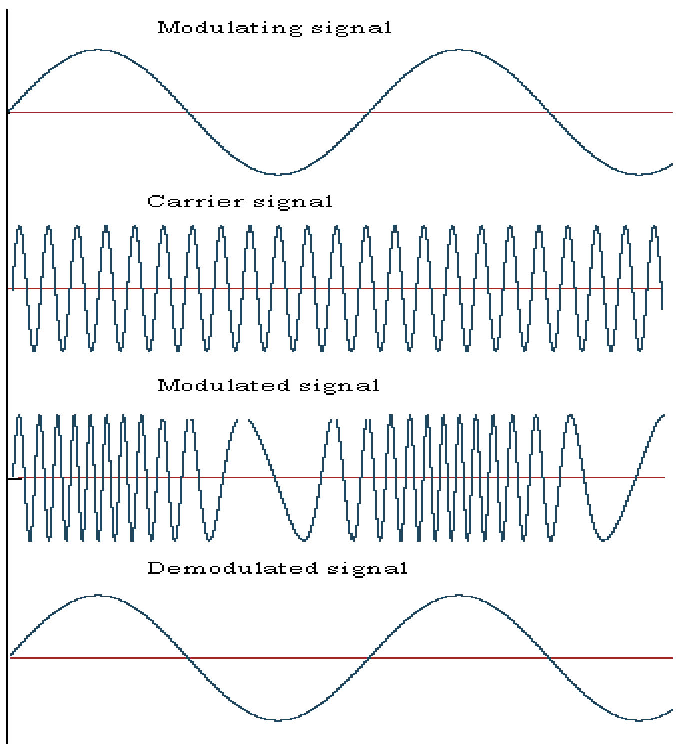
DEMODULATOR



TABULATION

Signal	Amplitude (V)	Time Period (s)	Frequency (Hz)
Message			
Carrier			
Modulated			
Demodulated			

MODEL GRAPH:



RESULT:

The frequency modulation & demodulation circuit has been constructed and its characteristics are obtained.

EXP. NO:5	**PULSE CODE MODULATION**
DATE:	

Aim:

To construct and study a PCM transmitter and receiver kit

Apparatus Required:

1. PCM Transmitter and Receiver Kit
2. Connecting Plugs
3. CRO

THEORY:

Pulse code modulation is known as digital pulse modulation technique. It is the process in which the message signal is sampled and the amplitude of each sample is rounded off to the nearest one of the finite set of allowable values. It consists of three main parts transmitter, transmitter path and receiver. The essential operation in the transmitter of a PCM system are sampling, Quantizing and encoding. The band pass filter limits the frequency of the analog input signal. The sample and hold circuit periodically samples the analog input signal and converts those to a multi-level PAM signal. The ADC converts PAM samples to parallel PCM codes which are converted to serial binary data in parallel to serial converter and then outputted on the transmission line as serial digital pulse. The transmission line repeaters are placed at prescribed distance to regenerate the digital pulse.

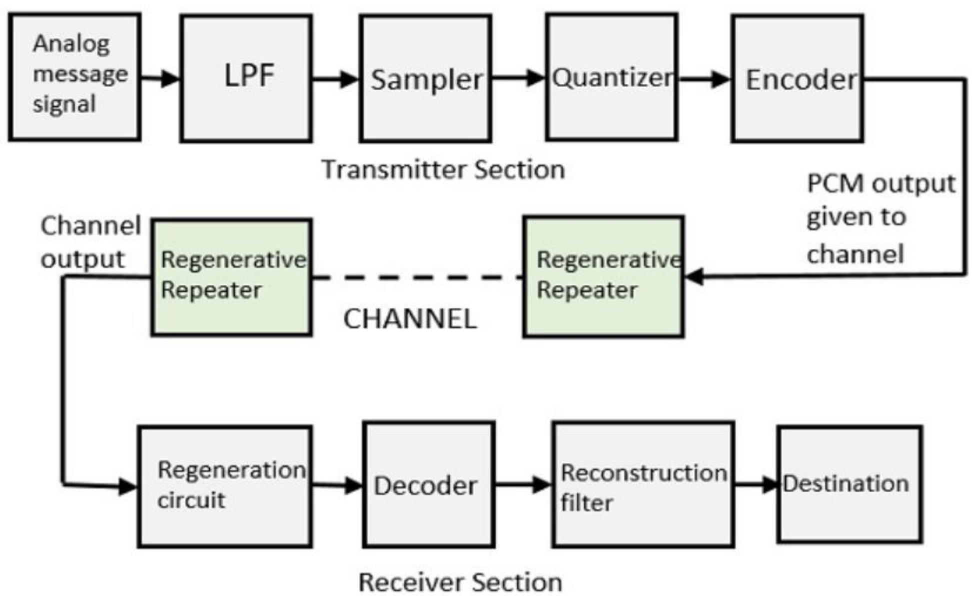
In the receiver serial to parallel converter converts serial pulse received from the transmission line to parallel PCM codes. The DAC converts the parallel PCM codes to multi-level PAM signals. The hold circuit is basically a Low Pass Filter that converts the PAM signal back to its original analog form.

1. The kit diagram shows the method of PCM generation system.
2. In this transmitter circuit, two message inputs are sampled and multiplexed and then it is pass over to the A/D converter to circuit to get digital messages as encoder.
3. The PCM system has an error check code generator to make a distortion less transmission.
4. Then to a shift register to get the regenerated signals without any error.
5. The timing circuit / logic provides a periodic pulse train, derived from receiver sampling the equalized pulses at the instants of time where the signal to noise ration is minimum.
6. If the measured value is larger than threshold or reference value, a '1' was transmitted.
7. If the comparison value is below the threshold value a zero was transmitted.
8. The reverse steps are used in the receiver process.

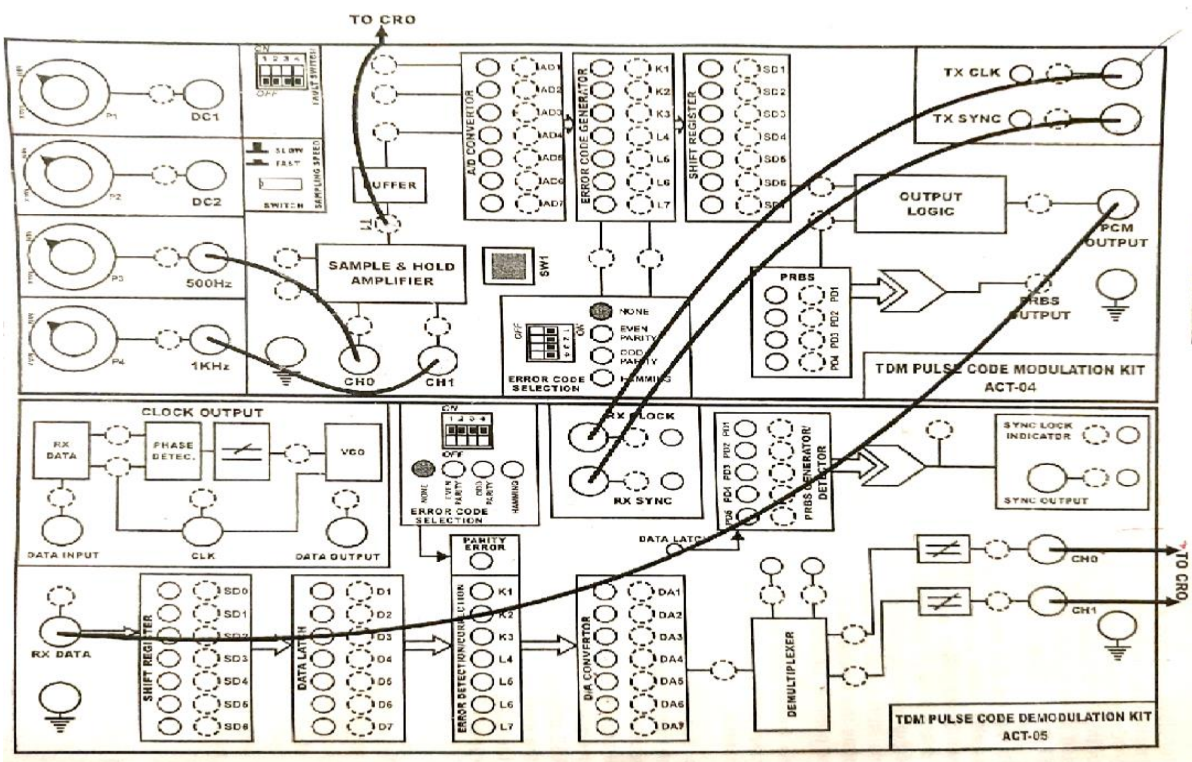
ADVANTAGES:

1. Secrecy
2. Noise resistant and hence free from channel interference

Block Diagram of PCM



PCM TRANSMITTER& RECEIVER



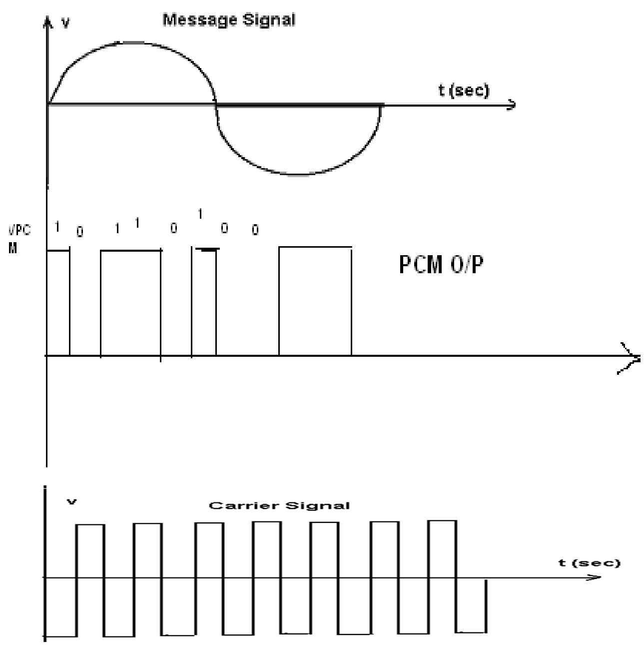
PROCEDURE:

1. Give the connections as per the block diagram.
2. Measure the amplitude and time period of the input signal.
3. Measure the amplitude and time period of the sampled signal.
4. Apply the input signal to the PCM kit and observe and measure the PCM output.
5. Plot the waveforms in the graph..

Tabular Column:

SIGNAL	AMPLITUDE (V)	TIME PERIOD (ms)	FREQUENCY (KHz)
MODULATING SIGNAL			
SAMPLING SIGNAL			
PCM CODE			

Model Graph :



Result:

The PCM output waveforms are studied and obtained.

EXP. NO:6	DELTA MODULATION AND DEMODULATION
DATE:	

Aim:

To construct and study the characteristics of Delta modulation and demodulation kit.

Apparatus Required:

1. DELTA Modulation and demodulation kit
2. Connecting Plugs
3. CRO

THEORY

Delta modulation is a form of pulse modulation width a sample value is represented as a signal bit. This is almost similar to differential PCM,as the transmitted bit is only, one per sample first to indicate whether the present sample is larger or smaller than previous one. The encoding decoding, and quantizing process become extremely simple bit this system cannot handle rapidly varying samples. This increases the quantizing noise. The trainer is a self sustained and well organized kit.

ADVANTAGES:

- Simple system/circuitry
- Cheap
- Single bit encoding allows us to increase the sampling rate or to transmit more information at some sampling rate for the given system BW.

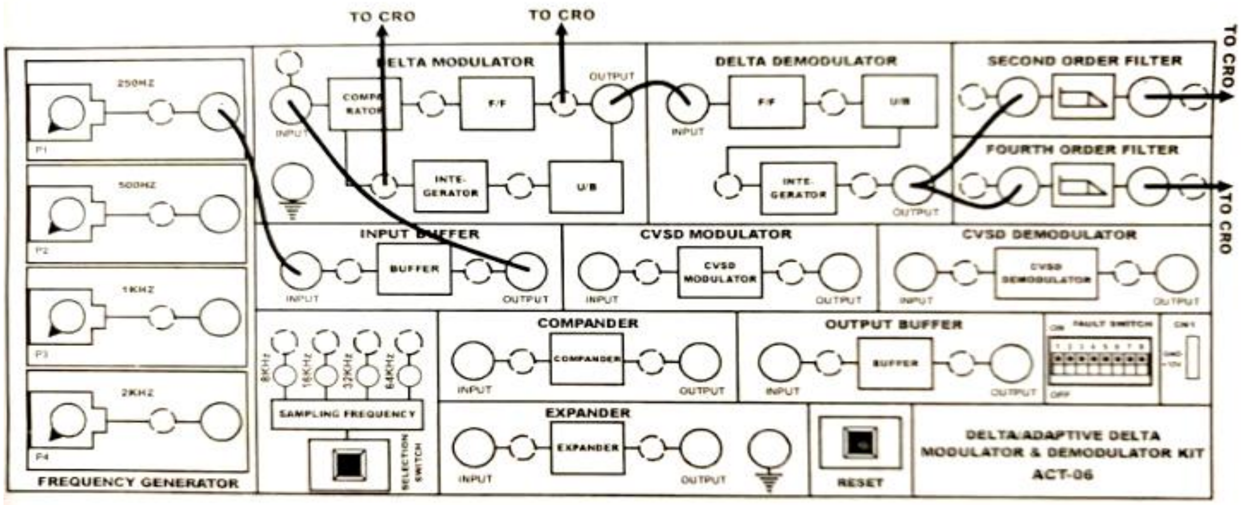
DISADVANTAGES :

- Noise and distortion.
- Major drawback is that it is unable to pass DC information.

APPLICATION:

- Digital voice storage
- Voice transmission
- Radio communication devices such TV remotes

BLOCK DIAGRAM FOR DELTA MODULATION AND DEMODULATION



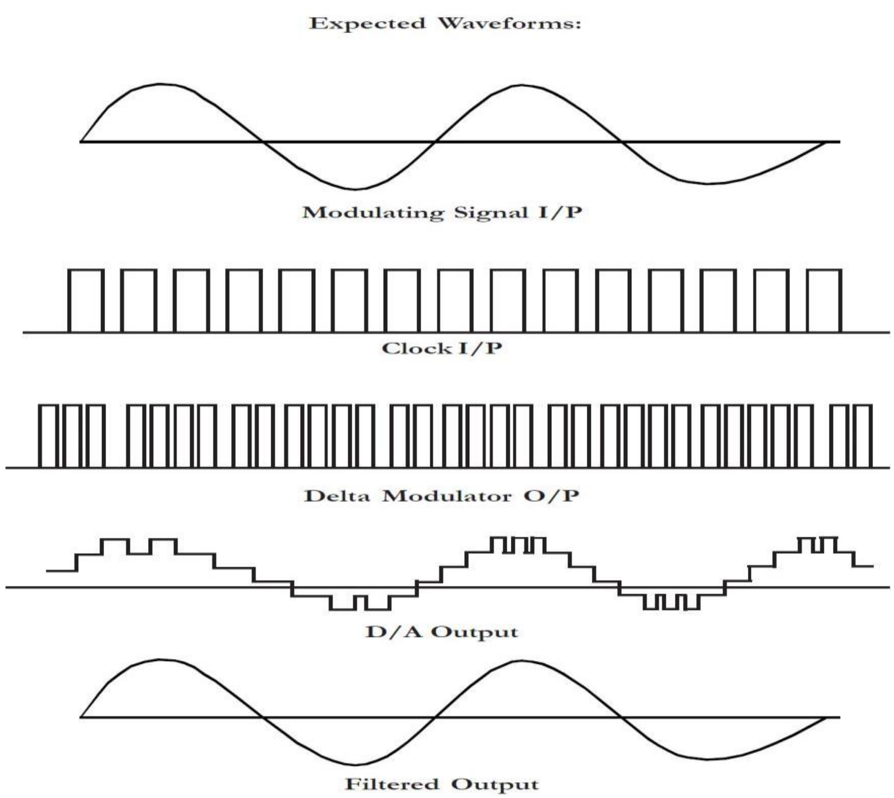
PROCEDURE:

1. Connections are to be given as per the block diagram.
2. Observe the modulated waveforms.
3. Measure the amplitude and time period of both the waveforms.
4. Plot the graph.
5. Repeat the above procedure for delta modulation also

TABULATION

WAVE	AMPLITUDE	TIME PERIOD	FREQUENCY
INPUT			
LPF OUTPUT			
COMPARATOR O/P			
ONE BIT QUANTISERO/P			
BIPOLAR NRZ ENCODER O/P			
DEMODULATED			

MODELGRAPH



RESULT

The delta modulation demodulation circuit is constructed and its output waveform is plotted.

EXP. NO:7 a	**LINE CODING SCHEMES**
DATE:	

AIM;

To obtain the standard digital codes from the source coded signals using various techniques.

Apparatus Required:

1. Line coding Kit
2. Power supply
3. DSO
4. Patch chord

Theory:

Binary 1's and 0's such as in CPM signaling, may be represented in various serial – bit signaling formats called line codes. The most commonly used PCM popular data formats are given.

There are 2 major categories: Return to zero (RZ) and Non return to zero. With RZ coding, the waveform return to a zero volt level for a portion of the bit interval. The waveforms for the line code may be further classified according to the rule that is used to assign voltage level to represent the binary data.

Unipolar signaling:

In positive logic unipolar signaling, the binary 1 is represented by a high level and binary 0 by a zero level. This type of signaling is also called on-off keying.

Polar signaling:

Binary 1's and 0's represented by equal positive and negative levels.

Bipolar Signaling:

Binary 1's are represented by alternating positive or negative values. The binary 0 is represented by a zero level. The term pseudo ternary refers to the use of 3 encoded signal levels to represent two level data. This is called alternate mark inversion signaling.

Manchester Signaling:

Each binary 1 is represented by a positive half bit period pulse. Similarly, a binary 0 is represented by a negative half bit period pulse followed by appositive half bit period pulse. This is also called as Split Phase Encoding.

The line codes shown above are also known by other names:

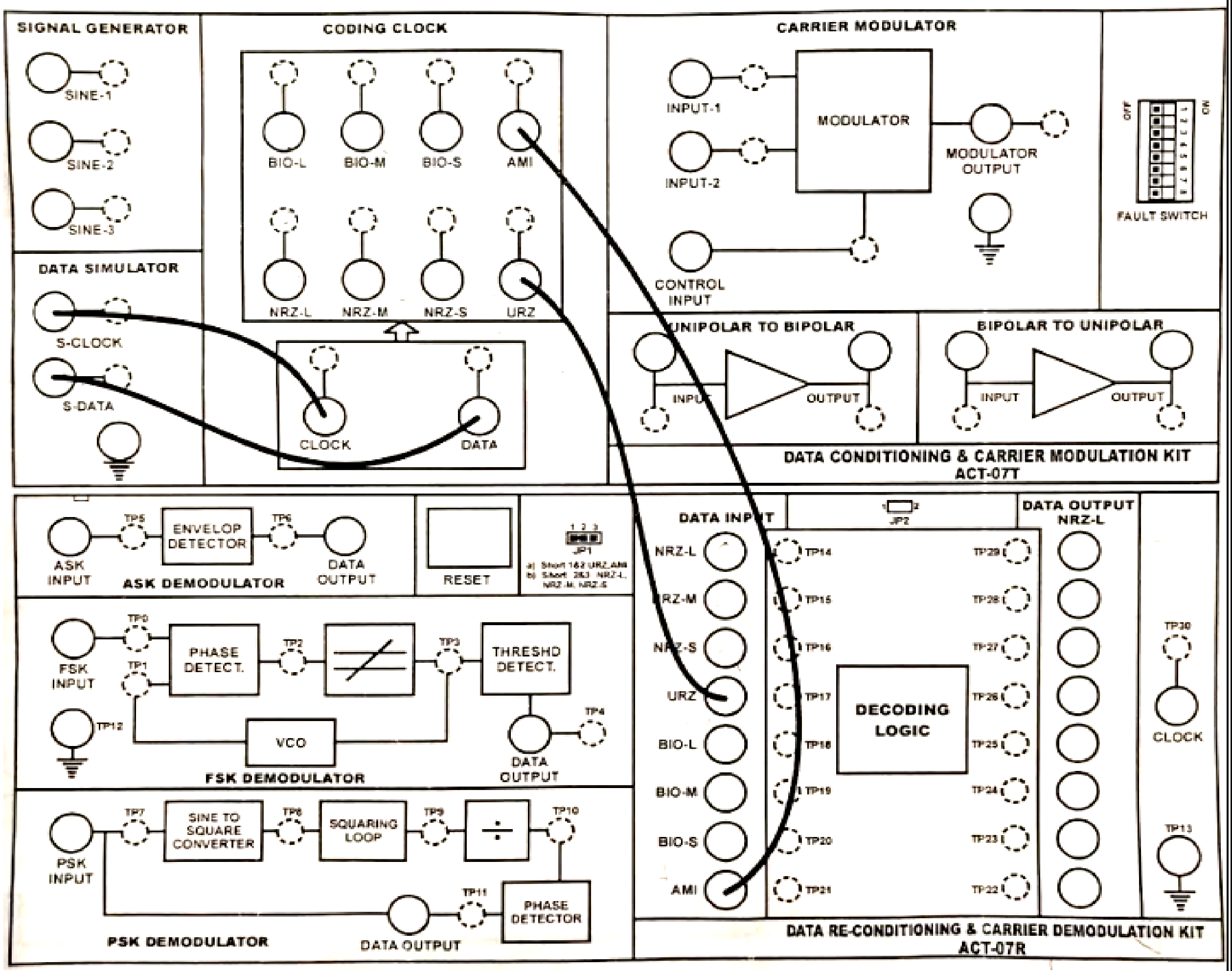
- **Polar NRZ:** Also called as **NRZ – L** Where L denotes the normal logic level assignment.
- **Bipolar RZ:** Also called **RZ-AMI**, where AMI denotes alternate mark inversion.
- **Bipolar NRZ:** Also called **NRZ – M** where M denotes inversion on mark

Procedure:

Coding and Decoding

1. Set up the trainer kit in standalone mode and prepare a list of waveform that are to be observed in trainer kit.
2. Connect the unit with the given power supply.
3. Connect S-Clock to the coding clock.
4. Connect S -Data to the input data
5. Connect one channel of the scope to the S data and other to the coded data to be observed.
6. Power ON the unit
7. Observe the waveform at CRO and plot the input and output the waveforms.
8. Connect the coded output to the data input of the decoding logic and observe the original data

Block diagram:



Result:

Thus various line coding and decoding techniques are studied and verified using hardware kit.

EXP. NO:7 b	SIMULATION OF LINE CODING
DATE:	

Aim:

To simulate and study the line coding sequence using MATLAB

SOFTWARE REQUIRED:

MATLAB

ALGORITHM:

STEP 1: Start the program.

STEP 2: GET the input sequence

STEP 3: Assign correct amplitude for binary 1 and 0 based on type of line coding scheme

STEP 4: Plot the time along x-axis and amplitude along y-axis.

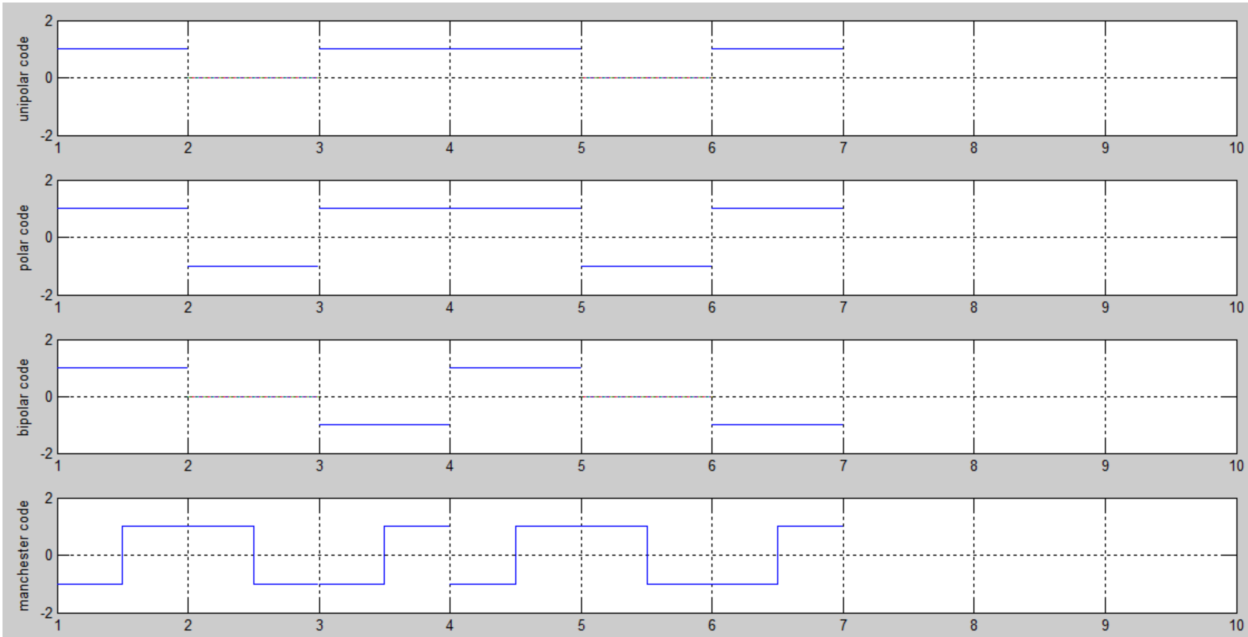
STEP 5: Stop the program.

PROGRAM:

```
clc;
close all;
clear all;
N=6;
x=[1 0 1 1 0 1];
nx=size(x,2);
sign=1;
i=1;
while i<nx+1
   t = i:0.001:i+1-0.001;
   if x(i)==1
      unipolar_code=square(t*2*pi,100);
      polar_code=square(t*2*pi,100);
      bipolar_code=sign*square(t*2*pi,100);
      sign=sign*-1;
      manchester_code=-square(t*2*pi,50);
   else
      unipolar_code=0;
      polar_code=-square(t*2*pi,100);
      bipolar_code=0;
      manchester_code=square(t*2*pi,50);
   end
   subplot(4,1,1);
```

```
    plot(t,unipolar_code);
    ylabel('unipolar code');
    hold on;
    grid on;
    axis([1 10 -2 2]);

    subplot(4,1,2);
    plot(t,polar_code);
    ylabel('polar code');
    hold on;
    grid on;
    axis([1 10 -2 2]);

    subplot(4,1,3);
    plot(t,bipolar_code);
    ylabel('bipolar code');
    hold on;
    grid on;
    axis([1 10 -2 2]);

    subplot(4,1,4);
    plot(t,manchester_code);
    ylabel('manchester code');
    hold on;
    grid on;
    axis([1 10 -2 2]);

    i=i+1;
end
```

OUTPUT:


unipolar code
polar code
bipolar code
manchester code
2
0
-2
1
2
3
4
5
6
7
8
9
10

Result:

The various line coding schemes are simulated using MATLAB

EXP. NO:8	SIMULATION OF ASK MODULATION
DATE:	

AIM:

To perform ASK generation using MATLAB program.

SOFTWARE REQUIRED:

MATLAB

ALGORITHM:

STEP 1: Start the program.

STEP 2: GET the two signals; message and carrier

STEP 3: Perform ASK

STEP 4: Plot the time along x-axis and amplitude along y-axis.

STEP 5: Stop the program.

PROGRAM:

```
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);
%Plot the input binary data
 subplot(5,1,1);stem(m);
 title('binary data bits');xlabel('n--->');ylabel('b(n)');grid on
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;
    %plot the message (unipolar)
     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
     %Plot the carrier signal
      subplot(5,1,3);plot(t,c);
      title('carrier signal');xlabel('t--->');ylabel('c(t)');grid on

    %product of carrier and message
    ask_sig(i,:)=c.*m_s;
    t1=t1+(Tb+.01);
    t2=t2+(Tb+.01);
    %Plot the ASK signal
    subplot(5,1,4);plot(t,ask_sig(i,:));
    title('ASK signal');xlabel('t--->');ylabel('s(t)');grid on
    hold on
    end
   hold off
   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
```

OUTPUT:

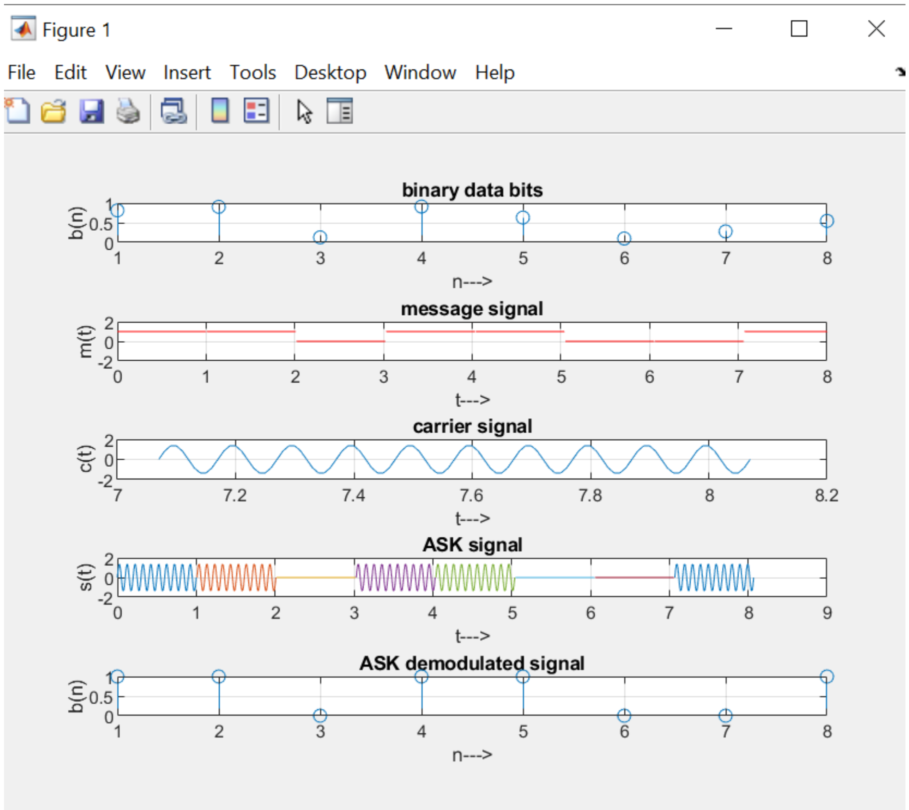


Figure 1
File Edit View Insert Tools Desktop Window Help
binary data bits
b(n)
n--->
message signal
m(t)
t--->
carrier signal
c(t)
t--->
ASK signal
s(t)
t--->
ASK demodulated signal
b(n)
n--->

RESULT:

Thus ASK modulation was simulated using MATLAB

EXP. NO:9	SIMULATION OF BFSK MODULATION AND DEMODULATION
DATE:	

AIM:

To simulate BFSK modulation and demodulation using MATLAB program.

SOFTWARE REQUIRED:

MATLAB

ALGORITHM:

STEP 1: Start the program.
STEP 2: GET the two signals
STEP 3: Perform BFSK
STEP 4: Plot the time along x-axis and amplitude along y-axis.
STEP 5: Stop the program.

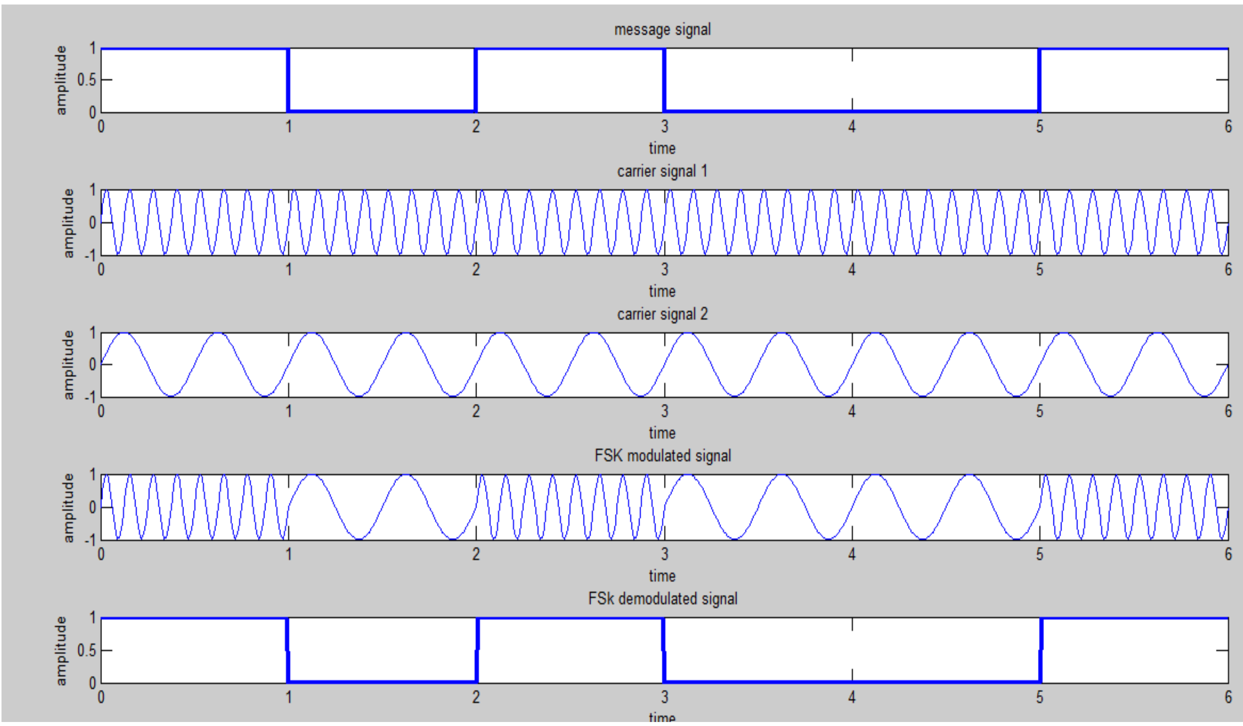
PROGRAM:

```
clc;
clear all;
close all;
%carrier freq
f1=8;
f2=2;
a=1;
%6 bit are used
n=[1 0 1 1 0 0];
L=length(n);
if n(L)==1
   n(L+1)=1
else
   n(L+1)=0
end
tn=0:L;
%plot message
subplot(5,1,1);
stairs(tn,n ,'linewidth',3);
title('message signal');
xlabel('time');
ylabel('amplitude');
```

```
%plot carrier sig
t=0:0.01:6;
y1=a*sin(2*pi*f1*t);
y2=a*sin(2*pi*f2*t);
subplot(5,1,2);
plot(t,y1);
title('carrier signal 1');
xlabel('time');
ylabel('amplitude');
subplot(5,1,3);
plot(t,y2);
title('carrier signal 2');
xlabel('time');
ylabel('amplitude');
%modulation process
for  i=1:6
for j=(i-1)*100:i*100
if (n(i)==1)
        s(j+1)=y1(j+1);
else
        s(j+1)=y2(j+1);
end
end
end
%plot fsk signal
subplot(5,1,4);
plot(t,s);
title('FSK modulated signal');
xlabel('time');
ylabel('amplitude');
%demodulation process
for i=1:6
for j=(i-1)*100:i*100
if(s(j+1)==y1(j+1))
        s(j+1)=1;
else
        s(j+1)=0;
end
end
end
```

```
%plot demodul
subplot(5,1,5);
plot(t,s,'linewidth',3);
title('FSk demodulated signal');
xlabel('time');
ylabel('amplitude');
```

OUTPUT:



RESULT:

Thus BFSK was simulated using MATLAB

EXP. NO:10	SIMULATION OF BPSK MODULATION AND DEMODULATION
DATE:	

AIM:

To perform BPSK generation and detection using MATLAB program.

SOFTWARE REQUIRED:

MATLAB

ALGORITHM:

STEP 1: Start the program.
STEP 2: GET the two signals
STEP 3: Perform BPSK
STEP 4: Plot the time along x-axis and amplitude along y-axis.
STEP 5: Stop the program.

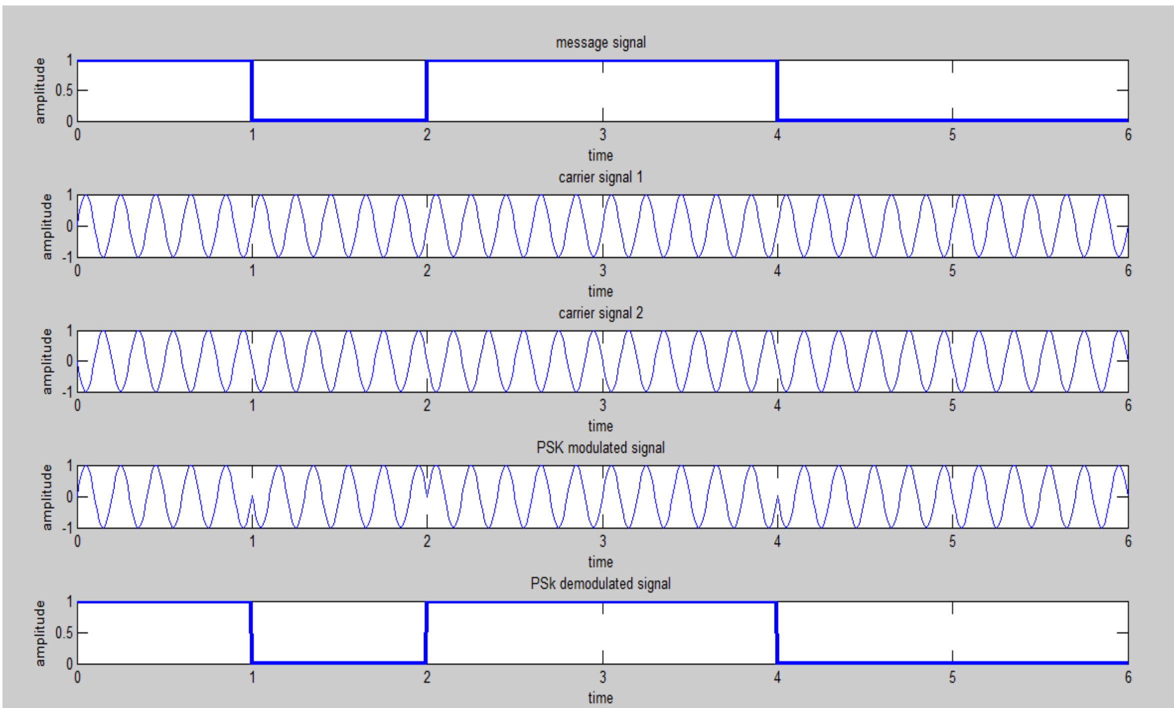
PROGRAM:

```
clc;
clear all;
close all;
%carrier freq
f=5;
a=1;
%6 bit are used
n=[1 0 1 1 0 0];
l=length(n);
if n(l)==1
   n(l+1)=1
else
   n(l+1)=0
end
L1=length(n);
t2=0:L1-1;
%plot message
subplot(5,1,1);
stairs(t2,n,'linewidth',3);
title('message signal');
xlabel('time');
ylabel('amplitude');
```

```
%plot carrier sig
t=0:0.01:6;
y1=a*sin(2*pi*f*t);
y2=-a*sin(2*pi*f*t);
subplot(5,1,2);
plot(t,y1);
title('carrier signal 1');
xlabel('time');
ylabel('amplitude');
subplot(5,1,3);
plot(t,y2);
title('carrier signal 2');
xlabel('time');
ylabel('amplitude');
%modulation process
for  i=1:6
for j=(i-1)*100:i*100
if (n(i)==1)
        s(j+1)=y1(j+1);
else
        s(j+1)=y2(j+1);
end
end
end
%plot psk signal
subplot(5,1,4);
plot(t,s);
title('PSK modulated signal');
xlabel('time');
ylabel('amplitude');
%demodulation process
for i=1:6
for j=(i-1)*100:i*100
if(s(j+1)==y1(j+1))
        x(j+1)=1;
else
        x(j+1)=0;
end
end
end
```

```
%plot demodulated sig
subplot(5,1,5);
plot(t,x,'linewidth',3);
title('PSk demodulated signal');
xlabel('time');
ylabel('amplitude');
```

OUTPUT:



RESULT:

Thus BPSK was simulated using MATLAB

EXP. NO:11	SIMULATION OF DPSK MODULATION
DATE:	

AIM:

To perform DPSK generation using MATLAB program.

SOFTWARE REQUIRED:
MATLAB

ALGORITHM:

STEP 1: Start the program.

STEP 2: GET the two signals

STEP 4: Perform DPSK

STEP 5: Plot the time along x-axis and amplitude along y-axis.

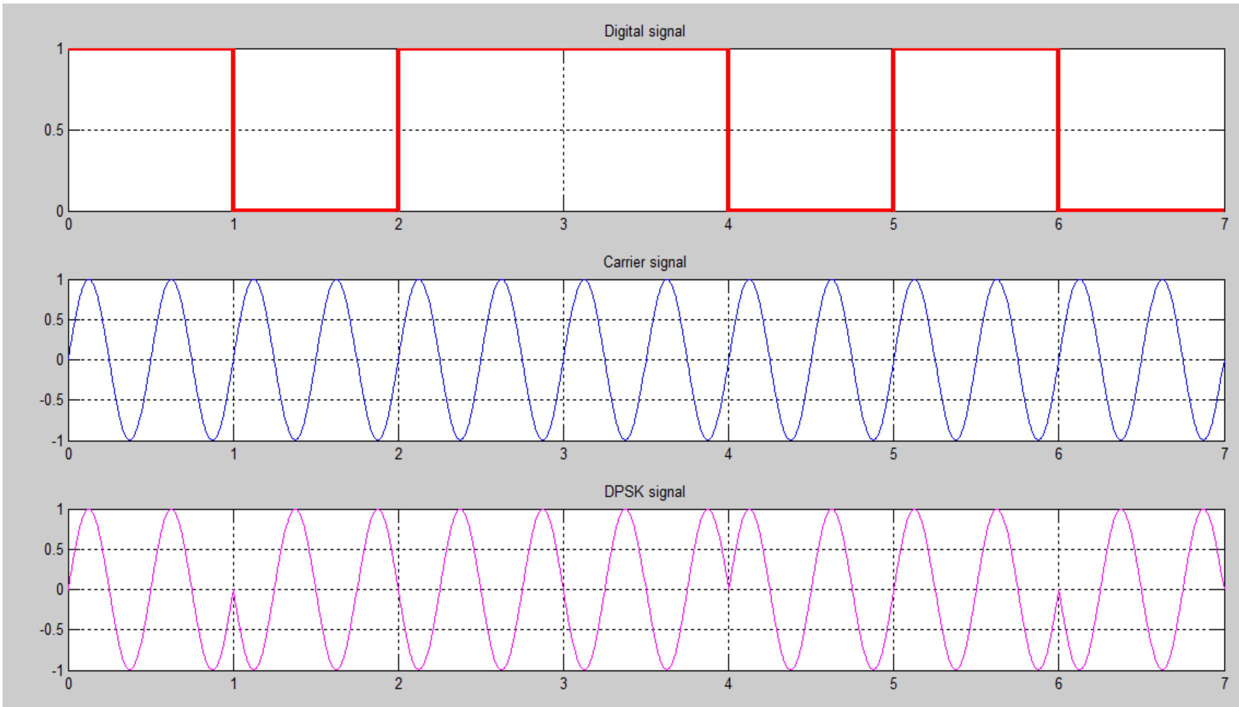
STEP 6: Stop the program.

PROGRAM:

```
clc;
clear all;
close all;
t=0:.01:1;
fc = 2;
M = [1 0 1 1 0 1 0]
codedM=1;
for i=1:1:length(M)
    bit = not(xor(codedM(i),M(i)));
    codedM = [codedM bit];
end
codedM = codedM(2:length(codedM));

messageLength=length(M);
time=[];
digitalSignal=[];
dpskSignal=[];
carrierSignal=[];
for i=1:1:messageLength
    carrier = sin(2*pi*fc*t);
    carrierSignal = [carrierSignal carrier];
    if M(i) == 1
```

```
        bit = ones(1,length(t));
    else
        bit = zeros(1,length(t));
    end

    digitalSignal = [digitalSignal bit];

    if codedM(i) == 1
        DPSK = sin(2*pi*fc*t+0);
    else
        DPSK = sin(2*pi*fc*t+pi);
    end

    dpskSignal = [dpskSignal DPSK];
    time=[time t];
    t=t+1;
end

subplot(3,1,1);
plot(time,digitalSignal,'r','linewidth',3);
grid on;
title('Digital signal');

subplot(3,1,2);
plot(time,carrierSignal);
grid on;
title('Carrier signal');

subplot(3,1,3);
plot(time,dpskSignal,'m');
grid on;
title('DPSK signal');
```

OUTPUT:



RESULT:

Thus DPSK was simulated using MATLAB

EXP. NO:12	SIMULATION OF QPSK MODULATION AND CONSTELLATION
DATE:	

AIM:

To perform QPSK modulation using MATLAB program and to plot its constellation.

SOFTWARE REQUIRED:

MATLAB

ALGORITHM:

STEP 1: Start the program.

STEP 2: GET the two signals

STEP 3: Perform QPSK

STEP 4: Plot the time along x-axis and amplitude along y-axis.

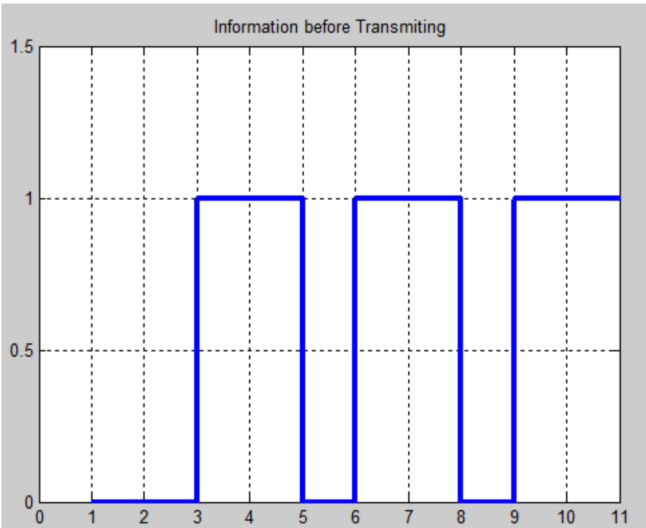
STEP 5: Stop the program.

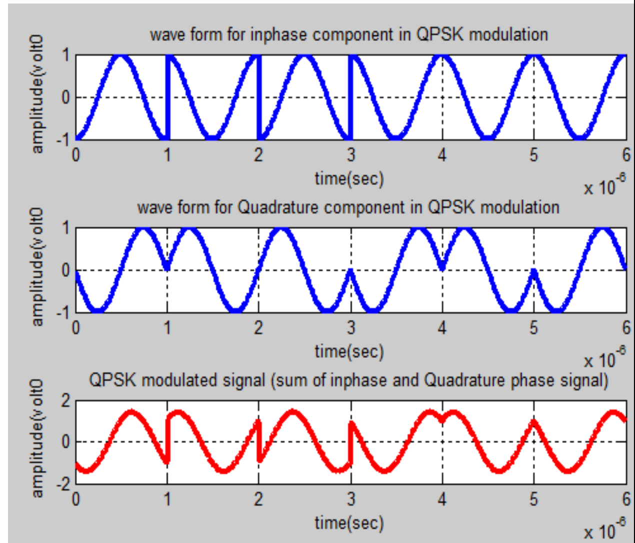
PROGRAM:

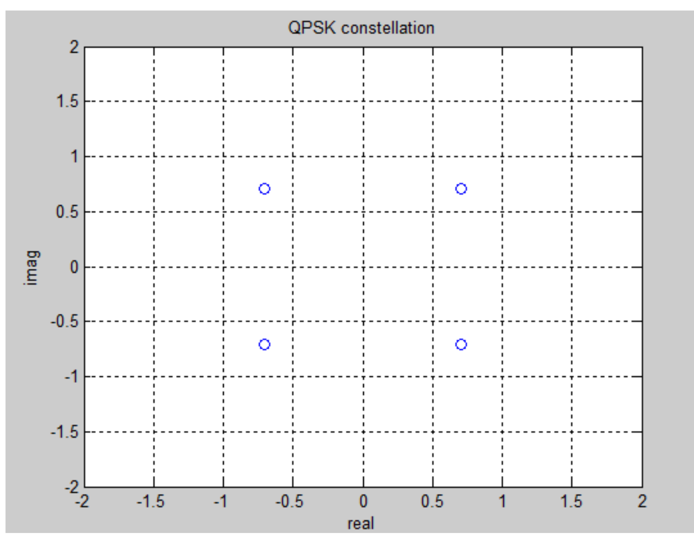
```
clc;
clear all;
close all;
data=[0 0 1 1 0 1 1 0 1 1 1 0]; % information
figure(1)
stairs(data, 'linewidth',3), grid on;
title('  Information before Transmiting ');
axis([ 0 11 0 1.5]);
data_NZR=2*data-1; % Data Represented at NZR form for QPSK modulation
s_p_data=reshape(data_NZR,2,length(data)/2);  % S/P convertion of data
br=10.^6; %Let us transmission bit rate  1000000
f=br; % minimum carrier frequency
T=1/br; % bit duration
t=T/99:T/99:T; % Time vector for one bit information
y=[];
y_in=[];
y_qd=[];
d=zeros(1,length(data)/2);
for i=1:length(data)/2
   p=data(2*i);
   imp=data(2*i - 1);
```

```
        y1=s_p_data(1,i)*cos(2*pi*f*t); % inphase component
        y2=s_p_data(2,i)*sin(2*pi*f*t) ;% Quadrature component
        y_in=[y_in y1]; % inphase signal vector
        y_qd=[y_qd y2]; %quadrature signal vector
        y=[y y1+y2]; % modulated signal vector
        if (imp == 0) && (p == 0)
          d(i)=exp(j*pi/4);%45 degrees
        end
        if (imp == 1)&&(p == 0)
           d(i)=exp(j*3*pi/4);%135 degrees
        end
        if (imp == 1)&&(p == 1)
           d(i)=exp(j*5*pi/4);%225 degrees
        end
        if (imp == 0)&&(p == 1)
           d(i)=exp(j*7*pi/4);%315 degrees
        end
    end
    Tx_sig=y; % transmitting signal after modulation
    qpsk=d;
    tt=T/99:T/99:(T*length(data))/2;
    figure(2)
    subplot(3,1,1);
    plot(tt,y_in,'linewidth',3), grid on;
    title(' wave form for inphase component in QPSK modulation ');
    xlabel('time(sec)');
    ylabel(' amplitude(volt0');
    subplot(3,1,2);
    plot(tt,y_qd,'linewidth',3), grid on;
    title(' wave form for Quadrature component in QPSK modulation ');
    xlabel('time(sec)');
    ylabel(' amplitude(volt0');
    subplot(3,1,3);
    plot(tt,Tx_sig,'r','linewidth',3), grid on;
    title('QPSK modulated signal (sum of inphase and Quadrature phase signal)');
    xlabel('time(sec)');
    ylabel(' amplitude(volt0');
    figure(3);
    plot(d,'o');%plot constellation without noise
    axis([-2 2 -2 2]);
    grid on;
    xlabel('real'); ylabel('imag');
    title('QPSK constellation');
```

OUTPUT:


Information before Transmiting
1.5
1
0.5
0
0 1 2 3 4 5 6 7 8 9 10 11


wave form for inphase component in QPSK modulation
amplitude(volt0
time(sec)
x 10^-6
wave form for Quadrature component in QPSK modulation
amplitude(volt0
time(sec)
x 10^-6
QPSK modulated signal (sum of inphase and Quadrature phase signal)
amplitude(volt0
time(sec)
x 10^-6


QPSK constellation
imag
real
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2 -1.5 -1 -0.5 0 0.5 1 1.5 2

RESULT:

Thus QPSK was simulated using MATLAB

EXP. NO:13	SIMULATION OF SIGNAL CONSTELLATIONS OF BPSK & QAM
DATE:	

AIM:
To plot the constellation diagram of digital modulation system BPSK, QAM using MATLAB.

SOFTWARE USED:
MATLAB

THEORY:
A constellation diagram is a representation of a signal modulated by an arbitrary digital modulation scheme. It displays the signal as a two dimensional scatter diagram in the complex plane at symbol sampling instants. It can also be viewed as the possible symbols that may be selected by a given modulation scheme as points in the complex plane.

ALGORITHM:

STEP 1: Start the program.

STEP 2: GET the two signals

STEP 4: Scatter plot the constellation points

STEP 5: Plot the In-Phase component along x-axis and Quadrature component along y-axis.

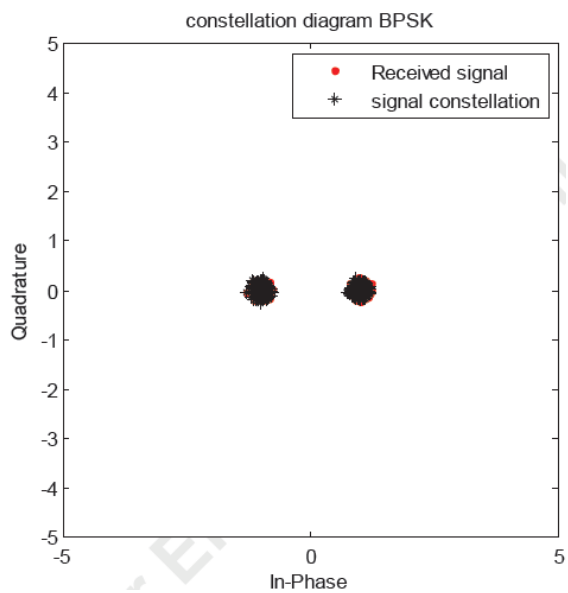
STEP 6: Stop the program

PROGRAM: BPSK

```
clc;
clear all;
close all;
M=2;
k=log2(M);
n=3*1e5;
nsamp=8;
X=randint(n,1);
xsym = bi2de(reshape(X,k,length(X)/k).','left-msb');
Y_psk= modulate(modem.pskmod(M),xsym);
Ytx_psk = Y_psk;
EbNo=30;
SNR=EbNo+10*log10(k)-10*log10(nsamp);
Ynoisy_psk = awgn(Ytx_psk,SNR,'measured');
```

```
Yrx_psk = Ynoisy_psk;
h1=scatterplot(Yrx_psk(1:nsamp*5e3),nsamp,0,'r.');
hold on;
scatterplot(Yrx_psk(1:5e3),1,0,'k*',h1);
title('constellation diagram BPSK');
legend('Received signal' ,'signal constellation');
axis([-5 5 -5 5]);
hold off;
```

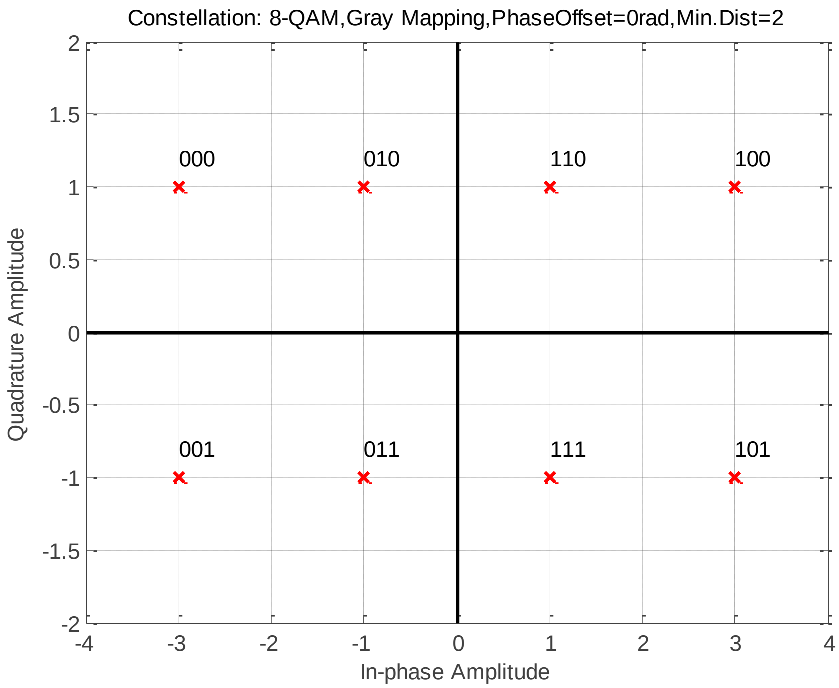
OUTPUT:



SIGNAL CONSTELLATION FOR 8-QAM

```
data=randi([0 1],96,1);
hModulator=comm.RectangularQAMModulator(8,'BitInput',true);
hModulator.PhaseOffset=0;
modData=step(hModulator,data);
constellation(hModulator)
```

SIMULATED OUTPUT:



RESULT:

Thus the constellation diagrams of digital modulation system BPSK & QAM are simulated & plotted in MATLAB.

EXP. NO:14	ERROR CONTROL CODING USING MATLAB
DATE:	

AIM:

To perform error control coding (linear block code)using MATLAB program.

ALGORITHM

STEP 1: Start the program.
STEP 2: GET the two signals
STEP 3: perform the operation by generate matrix finding hamming code
STEP 4: display the o/p sequence
STEP 5: display the possible code
STEP 6: Stop the program.

PROGRAM:

CYCLIC BLOCK CODE

```
clc;
clear all;

%%%%code can take values (7,4),(7,3),(8,3),(8,4),....
codeLength=input('Enter the length of the code :');            %Length of the output code word
messageLength=input('Enter the length of the message:'); %Length of the input message bits
if (messageLength<codeLength)
   Message = input('Enter the message bits:');
   disp(Message);

   disp ('Cyclic polynomial');
   cyclicPolynomial=cyclpoly(codeLength,messageLength,'min'); %Creates a polynomials
for cyclic codes
   disp(cyclicPolynomial);

   disp('Encoded word');
   %Encodes the message bits using cyclic code
   code=encode(Message,codeLength,messageLength,'cyclic/fmt',cyclicPolynomial);
   disp(code);

   disp('Error pattern generation');
```

```
    error=randerr(1,codeLength);              %Introduces a random one bit error
    disp(error);

    disp('Received vector');
    receivedCode = xor(code,error);   %Xor the error with the code word
    disp(receivedCode);

    disp('Decode message bits');
   %Decodes the received code word and recovers the original message
    msg=decode(receivedCode,codeLength,messageLength,'cyclic');
    disp(msg);
else
    disp('k value should be less than n');
end
```

SAMPLE OUTPUT

```
Enter the length of the code :7

Enter the length of the message:4

Enter the message bits:[1 0 1 0]

     1     0     1     0

Cyclic polynomial

     1     0     1     1

Encoded word

     0     1     1     1     0     1     0

Error pattern generation

     0     0     0     0     1     0     0

Received vector

     0     1     1     1     1     1     0

Decode message bits

     1     0     1     0
```

LINEAR BLOCK CODE

```
clc;
clear all;
n=input('Enter the code size(n):');        %Length of the output code word
k=input('Enter the message size(k):');    %Length of the input message bits

if(k<n)
   m=input('Enter the message:');
   p=[1 1 0;0 1 1;1 1 1;1 0 1];  %Parity matrix
   g=[eye(k),p];                           %Generator matrix
   disp('Generator matrix:');
   disp (g);

   % encode
   c=rem(m*g,2);  %Create the code by multiplying the message and generator polynomial
   disp('coded message at transmission side:');
   disp (c);

   % noise
   e=randerr(1,n);
   r=xor(c,e);          %Introduce a random one bit error in the message
   disp('Received code at received side:');
   disp(r);
    %Parity matrix
   h=[eye(n-k),[p]'];      %Creates a parity check matrix
   disp('Parity matrix:');
   disp(h);
   %Syndrome
   disp('Syndrome');
   ht=h';                    % Transpose of the parity check matrix
   s=mod(r*ht,2);    % Calculates the syndrome value from the received code and parity
matrix
   disp(s);
   %Find the error bit from the transpose of the parity check matrix
   for j=1:n
      t=n-k;
      for i=1:n-k
         if(s(1,i)==ht(j,i))
         t=t-1;
         end
      end
      if(t==0)
      break;
      end
```

```
    end

    disp('Position of errorbit is');
    disp(j);

    %Error pattern
    r(j)=-r(j); %Correct the error
    disp('Corrected code:');
    disp(r);

    for i=1:k
      dm(i)=r(i); %The first k bits of the corrected code word is the message
    end
    disp('Decoded message:');
    disp(dm);

else
    disp('k should be less than n');
end
```

SAMPLE OUTPUT

Enter the code size(n):7

Enter the message size(k):4

Enter the message:[1 0 1 1]

Generator matrix:

```
1    0    0    0    1    1    0
0    1    0    0    0    1    1
0    0    1    0    1    1    1
0    0    0    1    1    0    1
```

coded message at transmission side:

```
1    0    1    1    1    0    0
```

Random one bit error

```
0    1    0    0    0    0    0
```

Received code at received side:

```
1    1    1    1    1    0    0
```

Parity matrix:

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

Syndrome

0 1 0

Position of errorbit is

2

Corrected code:

1 0 1 1 1 0 0

Decoded message:

1 0 1 1

RESULT:

Thus encoding and decoding of block codes are performed using MATLAB.

EXP. NO:15	CONVOLUTION CODING SCHEME
DATE:	

AIM:

To simulate a communication link using MATLAB

APPARATUS REQUIRED:

- Matlab software
- PC

ALGORITHM

STEP 1: Start the program.
STEP 2: Enter the message sequence
STEP 3: Assign the number of flipflops
STEP 4: perform convolution
STEP 4: Display the states
STEP 5: Display the o/p code sequence
STEP 6: Stop the program.

CONVOLUTION CODING

```
clc;
clear all;
close all;
m=[1 0 1 1];
p=2  %Number of flipflops
z=zeros(1,p);
mm=horzcat(m,z); %Additional zeros added with message sequence
x=[]; % flipflop states
c=[]; %code vector
for i = 1:1:length(mm)
        d1(i+1) = mm(i);
        d2(i+1) = d1(i);
        x=[x; d1(i) d2(i)]; % states of shift register
        u(i) = xor(x(i,1),x(i,2));
        c1(i) = xor(u(i), mm(i));
        c2(i)=xor(mm(i), x(i,2));
        c= [c c1(i) c2(i)]
end
 disp (‘ States of the shift register:’)
x
```

```
disp('Code Vector')
c
```

OUTPUT

States of the shift register:

x =

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

Code Vector
c =
1 1 1 0 0 0 0 1 0 1 1 1

RESULT:

Thus the code vector is generated using convolutional coding

EXP. NO:16	COMMUNICATION LINK SIMULATION
DATE:	

AIM:

To simulate a communication link using MATLAB

APPARATUS REQUIRED:

- Matlab software
- PC

ALGORITHM

STEP 1: Start the program.
STEP 2: GET the two signals
STEP 3: perform the operation of BPSK
STEP 4: add noise
STEP 4: Remove noise and demodulate
STEP 5: display the o/p sequence
STEP 6: Stop the program.

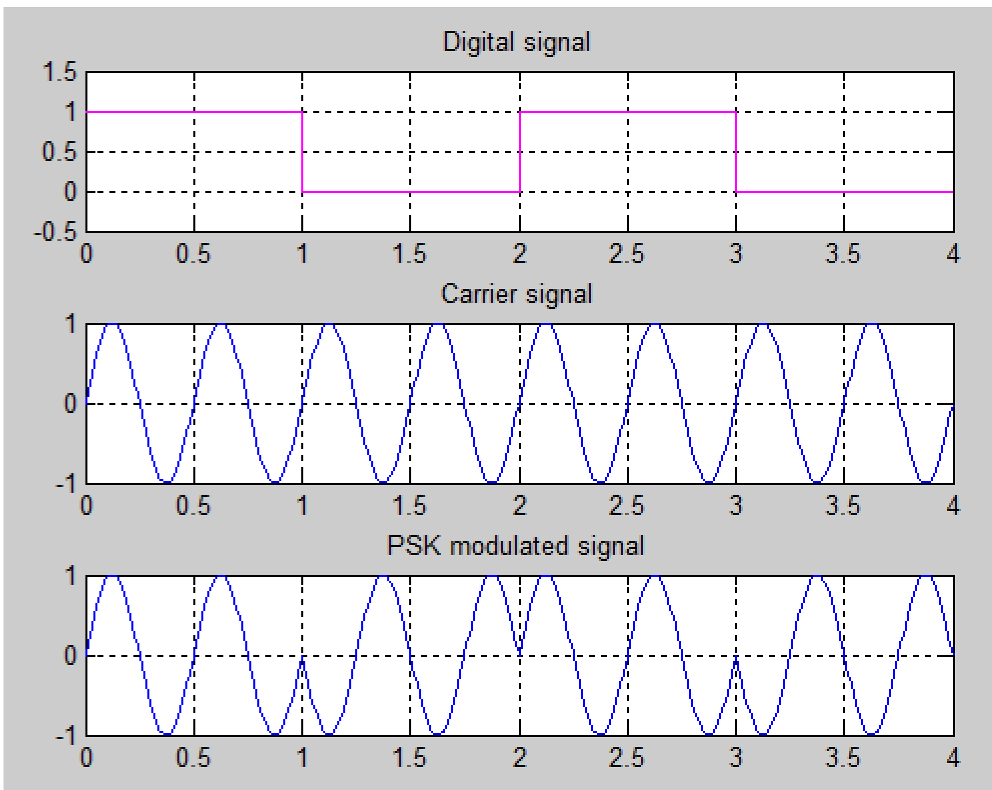
COMMUNICATION LINK SIMULATION

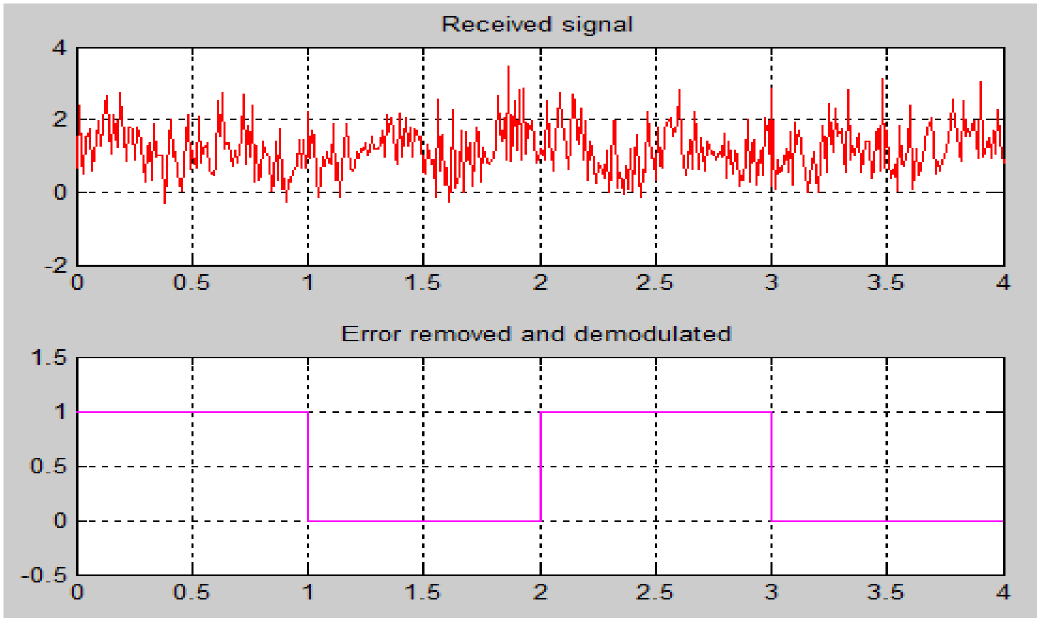
```
clc;
clear all;
close all;
t=0:.01:1;
fc = 2;
M = input('Enter the message bits: ');
messageLength=length(M);
time=[];
digitalSignal=[];
pskSignal=[];
carrierSignal=[];
fori=1:1:messageLength

carrier = sin(2*pi*fc*t);
carrierSignal = [carrierSignal carrier];

if M(i) == 1
bit = ones(1,length(t));
else
```

```
bit = zeros(1,length(t));
end
digitalSignal = [digitalSignal bit];
if M(i) == 1
       PSK = sin(2*pi*fc*t+0);
else
       PSK = sin(2*pi*fc*t+pi);
end
pskSignal = [pskSignal PSK];
time=[time t];
   t=t+1;
end

% Add Rayleigh fading to the transmitted signal
ray=sqrt(randn(1,length(t)*messageLength).^2+randn(1,length(t)*messageLength).^2);
pskSignalRay= pskSignal*mod(rand(1,1),1)+ray;
demodMsgSignal=[];

fori=1:1:messageLength
rx(i)=sum(pskSignalRay(length(t)*(i-1)+1:length(t)*i).*carrier);
ifrx(i)< 0
demodMsgSignal=[demodMsgSignal zeros(1,length(t))];
else
demodMsgSignal=[demodMsgSignal ones(1,length(t))];
end
end


subplot(3,1,1);
plot(time,digitalSignal,'m');
grid on;
axis([0 messageLength -0.5 1.5]);
title('Digital signal');

subplot(3,1,2);
plot(time,carrierSignal);
grid on;
title('Carrier signal');

subplot(3,1,3);
plot(time,pskSignal);
grid on;
title('PSK modulated signal');
figure,
subplot(2,1,1);
```

```
plot(time,pskSignalRay,'r');
grid on;
title('Received signal');
subplot(2,1,2);
plot(time,demodMsgSignal,'m');
grid on;
axis([0 messageLength -0.5 1.5]);
title('Error removed and demodulated');
```

OUTPUT




Received signal
4
2
0
-2
0
0.5
1
1.5
2
2.5
3
3.5
4
Error removed and demodulated
1.5
1
0.5
0
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
4

RESULT:

Thus simulation of communication link was performed using MATLAB.