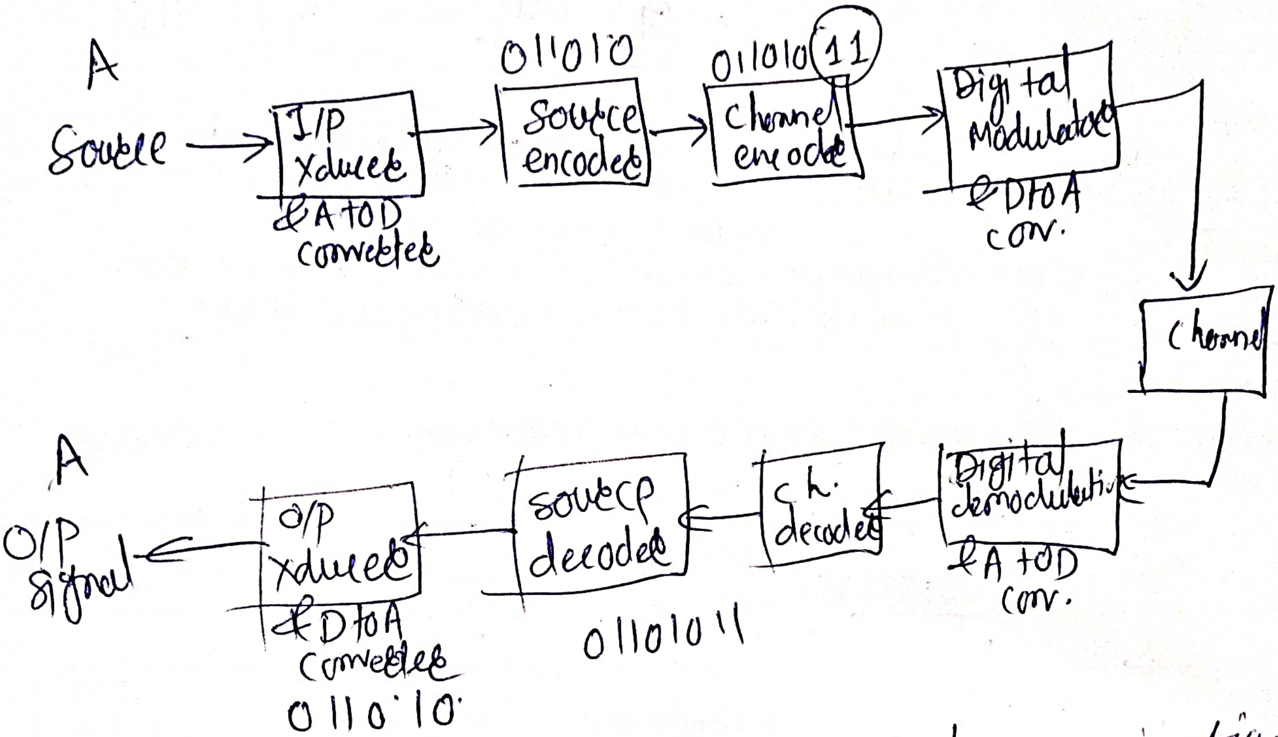
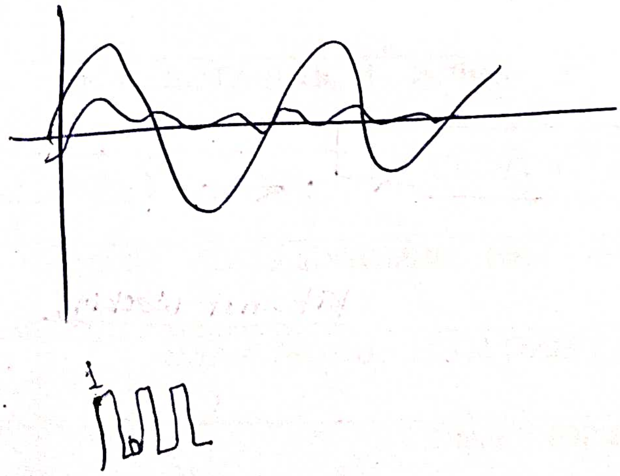


Basic elements of Digital communication



B4-PR ⇒ 48,51,54,56,57,58

Experiment No:1

Test the performance of the Amplitude shift keying(ASK) Modulator and demodulator circuits.

- Practical Significance
  Amplitude-shift keying (ASK) is type of digital modulation that represents digital data asvariations in the amplitude of a carrier wave. The amplitude of an analog carrier signal varies in accordance with the bit stream (modulating signal) where frequency and phase are keeping constant. This practical is designed to explain how change of amplitude in tolevel corresponds to logic 1 and logic 0.

- Relevant Program Outcomes (POs)
  - **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
  - **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
  - **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

- Relevant Course Outcomes
  - Maintain systems based on digital modulation techniques.

- Practical Outcome
  - Test the performance of the amplitude shift keying (ASK) Modulator/demodulator circuit.

- Relevant Affective domain unrelated Outcome(s)
  - Follow safe practices.
  - Handle instruments carefully.
  - Follow ethical practices.

- Minimum Theoretical Background
  Any digital modulation scheme uses a finite number of distinct signals to represent digitaldata. ASK uses a finite number of amplitudes, each assigned a unique pattern of binary digits. Each amplitude encodes an equal number of bits. Each pattern of bits forms the symbol that is represented by the particular amplitude. The demodulator is designed specifically for the symbol-set used by the modulator, determines the amplitude of the received signal and maps it back to the symbol it represents, thus recovering the original data. Frequency and phase of the carrier are kept constant in ASK.

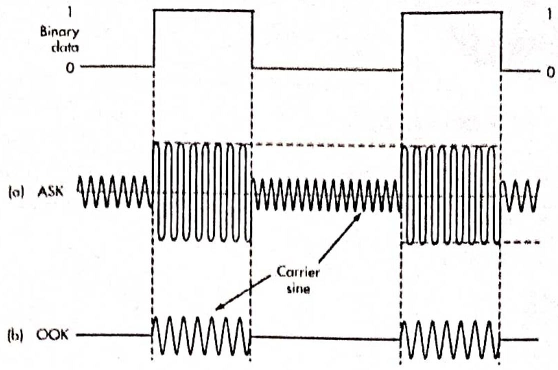


Figure 1.1: ASK Input output

- Practical Circuit Diagram

a) Sample Block Diagram

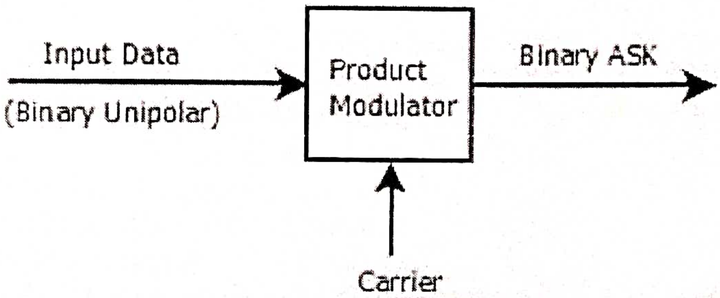


Figure 1.2 ASK modulator

[Courtesy:https://www.slideshare.net/aknigin/digital-communicationunit-3]

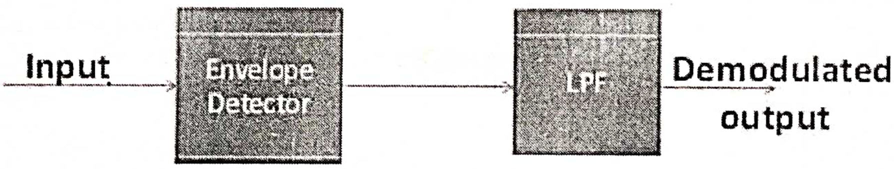


Figure 1.3 ASK demodulator

[Courtesy:http://www.evalidate.in/lab2/pages/Demod-ASK/DMASK/DMASK_I.html]

b) Actual block diagram / Circuit diagram

Actual Practical Setup (Students should draw practical set up used in their laboratory)

dsb AM :- Msg signal, carrier wave (H.F. radiowave 1 MHz), Modulations

A·C

$$s(t) = A_c\,[1 + m(t)]\cos(2\pi f_c t)$$

carrier Amplitude, msg s/g, carrier freq^n

Sr. No.	Instruments /Components	Specifications	Quantity
1.	Dual trace cathode rayoscilloscope / Digital storage oscilloscope	20MHz dual trace oscilloscope /25 MHz Dual Trace Digital Storage Oscilloscope	1
2.	Power supply	Variable DC power supply 0-30V,0-2A , SC protection , Digital meters	1
3.	ASK Trainer kit	Data clock frequency 2 KHz, 4 KHz, 8 KHz, 16 KHz, data 8 bit, 16 bit, 32 bit, 64 bit or equivalent trainer kit	1
4.	Connecting wires	CRO probes, patch chords	02

- **Precautions**

1. Do not switch ON the power supply unless you have checked the circuit connectionsas per the circuit diagram.

- **Procedure**

1. Make the connection as per circuit diagram.
2. Switch ON the power supply.
3. Connect digital input signal 1010110 on to the trainer kit of ASK modulator.
4. Observe the output of ASK modulator on CRO.
5. Connect output of ASK modulator to input of ASK demodulator.
6. Observe the output of ASK demodulator.
7. Draw the waveform on graph showing digital input signal, carrier signal, modulated signal and demodulated signal.
8. After completion of practical switch off the supply, remove the connection and submit the wires and equipment's.

- Resources used (with major specifications)

Sr. No.	Instruments /Components	Specifications	Quantity
1.			
2.			
3.			
4.			

- Observations and Calculations

Sr. No.	Output at	Amplitude	Time period	Frequency	Waveform
1	Input signal bit stream				
2	Carrier signal				
3	ASK modulator output				
4	ASK demodulator output				

- Results

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- Conclusions and Recommendation

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Experiment No:2

Test the performance of the Frequency shift keying(FSK) Modulator and demodulator circuits.

- Practical Significance
  FSK technology is used for communication systems such as amateur radio, caller ID and emergency broadcasts. This practical is designed to explain how modem converts the binary data from a computer to FSK for transmission over telephone lines, cables, optical fiber, or wireless media. The modem also converts incoming FSK signals to digital low and high states, which the computer can understand. In this practical student are able to view shifts in frequency as per the input digital data.

- Relevant Program Outcomes (POs)
  - **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
  - **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
  - **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

- Relevant Course Outcomes
  - Maintain systems based on digital modulation techniques.

- Practical Outcome
  - Test the performance of the Frequency shift keying (FSK) modulator and demodulator circuits.

- Relevant Affective domain unrelated Outcome(s)
  - Follow safe practices.
  - Handle instruments carefully.
  - Follow ethical practices.

- Minimum Theoretical Background
  Frequency-shift keying (FSK) is a method of transmitting digital signals. The two binary states, logic 0 (low) and 1 (high), are each represented by an analog waveform. Logic 0 is represented by a wave at a specific frequency, and logic1 is represented by a wave at a different frequency. 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 calledthe space frequency.

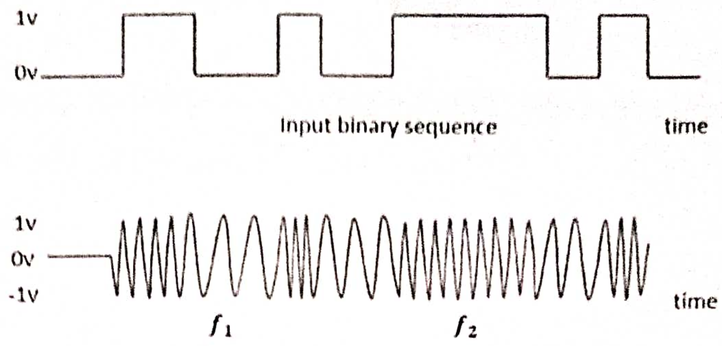

Figure 2.1: FSK Input –Output waveform

- Practical Circuit Diagram

a) Sample Block Diagram

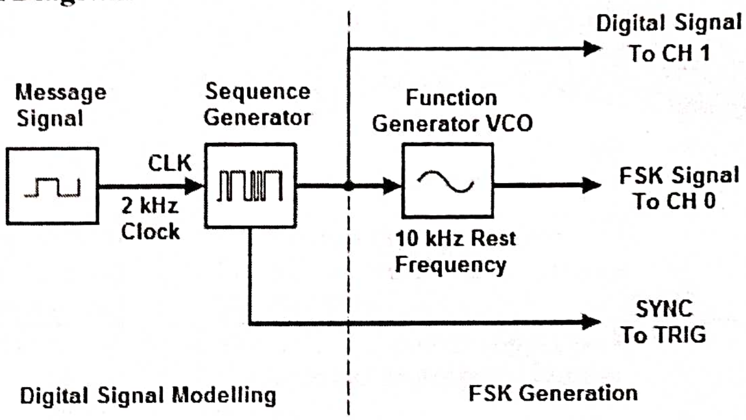

Figure 2.2: FSK Modulator
[Courtesy:http://www.evalidate.in/lab2/pages/FSKS/FSK/FSK_T.html]

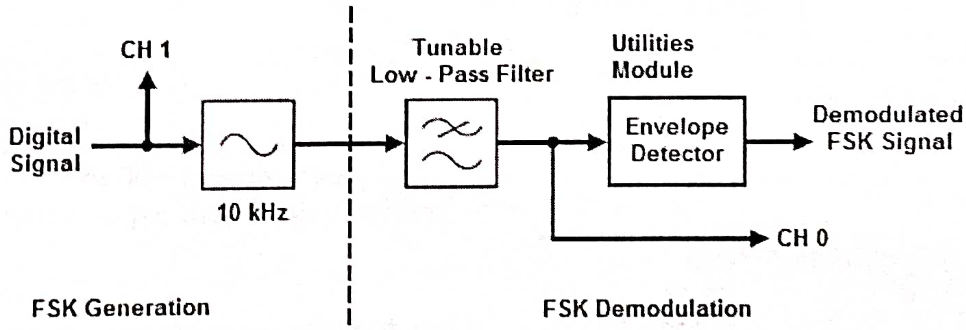

Figure 2.3: FSK demodulator
[Courtesy:http://www.evalidate.in/lab2/pages/Demod-FSK/DFSK/DFSK_T.html]

Actual Practical Setup (Students should draw practical set up used in their laboratory)

- Resources required

Sr. No.	Instruments /Components	Specifications	Quantity
1	Dual trace cathode ray oscilloscope / Digital storage oscilloscope	20MHz dual trace oscilloscope /25 MHz Dual Trace Digital Storage Oscilloscope	1
2	Power supply	Variable D C power supply 0 -30 V ,2A with SC protection , Digital meters	1
3	FSK Trainer kit	Four type selectable data clock frequency 2 KHz, 4 KHz, 8 KHz, 16 KHz, and four selectable types bit data 8 bit, 16 bit, 32 bit, 64 bit or equivalent trainer kit	1
4	Connecting wires	CRO probes, patch chords	2

- **Precautions**

1. Do not switch ON the power supply unless you have checked the circuit connectionsas per the circuit diagram.

- Procedure

1. Make the connection as per circuit diagram.
2. Switch ON the power supply.
3. Select the input bit stream of 1010110 and connect it to input terminals of FSK modulator.
4. Observe the output of FSK modulator on CRO.
5. Connect output of FSK modulator to input of FSK demodulator.
6. Observe the output of FSK demodulator.
7. Draw the waveform on graph showing digital input signal, carrier signal, modulated signal and demodulated signal.
8. After completion of practical switch off the supply, remove the connection and submit the wires and equipment's.

- Resources used (with major specifications)

Sr. No.	Instruments /Components	Specifications	Quantity
1.			
2.			
3.			
4.			
5.			

- Observations and Calculations

Table 17.1: Waveforms at Various stages of FSK

Sr. No.	Input signal	Modulated output signal Frequency	Waveform
1	Logic "1"		
2	Logic "0"		

- Results
  Modulated signal frequency for Logic"1" =
  Modulated signal frequency for Logic"0" =

- Conclusions and Recommendation
  ....
  ....
  ....
  ....

Experiment No:3

Test the performance of the Binary Phase Shift Keying(BPSK) Modulator and Demodulator circuits.

- Practical Significance
  PSK technique is widely used for wireless LANs, bio-metric, contactless operations, along with RFID and Bluetooth communications. BPSK has a bandwidth which is lower than that of BFSK signal. It has a very good noise immunity .This practical enable the students to generate and decode BPSK signal.

- Relevant Program Outcomes (POs)
  - **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
  - **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
  - **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

- Relevant Course Outcomes
  - Maintain systems based on digital modulation techniques.

- Practical Outcome
  - Test the performance of the Binary Phase Shift Keying (BPSK) Modulator and Demodulator circuits.

- Relevant Affective domain related Outcome(s)
  - Follow safe practices.
  - Handle instruments carefully.
  - Follow ethical practices.

- Minimum Theoretical Background
  Phase Shift Keying ((PSK) is the digital modulation technique in which the phase of the carrier signal is changed by varying the sine and cosine inputs at a particular time with respect to the given digital input Figure 3.1 shows BPSK modulator)

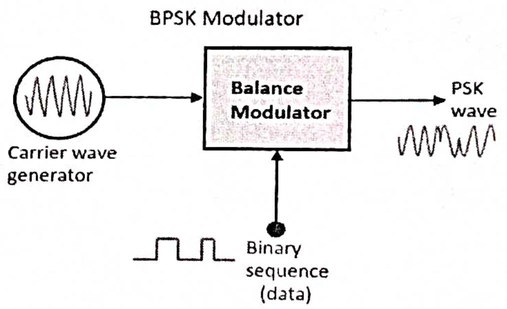

Figure 3.1: Generation of PSK/ BPSK Modulator

[Courstey:https://www.tutorialspoint.com/digital_communication/digital_communication_phase_shift_keying.htm]

In BPSK modulation, phase of the carrier signal is changed according to the data bit to betransmitted. Keeping its frequency and amplitude constant as shown in Figure 3.2

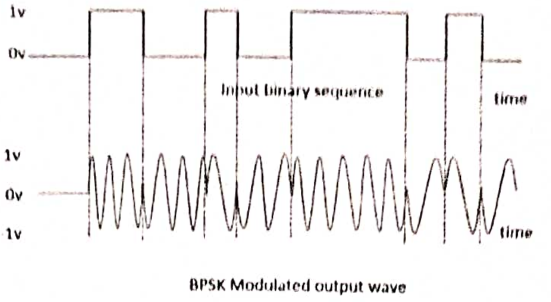

Figure 3.2: Waveform of BPSK modulation
[Courstey:https://www.tutorialspoint.com/digital_communication/digital_communication_phase_shift_keying.htm]

BPSK demodulator

Figure 16.3 shows BPSK demodulator. The BPSK modulating signal is demodulated with a synchronous detection system. The synchronous detection system uses a modulator to multiply the received signal and regenerated carrier wave. The frequency and phase ofthe regenerated carrier wave must match (synchronize with) the carrier wave used on the transmitting end.

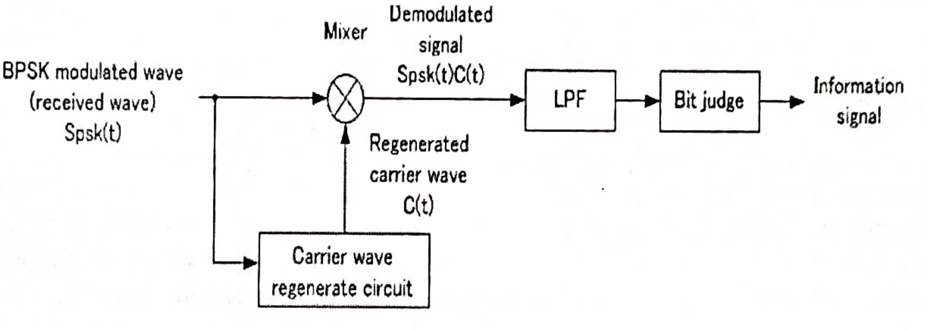

Figure 3.3: BPSK demodulator
[Courstey:https://www.tutorialspoint.com/digital_communication/digital_communication_phase_shift_keying.htm]

Practical Circuit Diagram

a) Sample Practical Setup

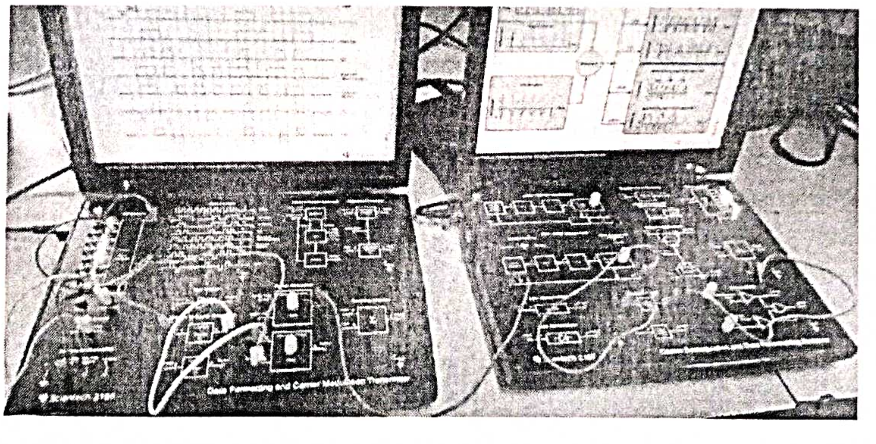

Figure3.4: Practical set up for BPSK modulation and demodulation

b) **Actual Practical Setup** (Students should draw practical set up used in their laboratory)

- Resources required

Sr. No.	Instruments /Components	Specifications	Quantity
1	BPSK modulator and demodulator trainer kit	Four type selectable data clock frequency 2 KHz, 4 KHz, 8 KHz, 16 KHz, And four selectable types bit data 8 bit, 16 bit, 32 bit, 64 bit or equivalent trainer kit	1
2	CRO / DSO	25 MHz, dual Trace / Bandwidth 30MHz – 200MHz	1
3	Connecting wires	Single strand Teflon coating (0.6mm diameter)	As per requirement

- Precautions
  1. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.
  2. While doing the experiment adjust proper volt/div and times/div selection on CRO/DSO.

- Procedure
  1. Make connections as shown in figure 16.4
  2. Select input data 11001011 from data generator using switches and connect it to bipolar convertor.
  3. Connect bipolar data to signal input of balanced modulator (BPSK modulator).
  4. Select carrier signal from carrier generator and connect it to carrier input of balanced modulator (BPSK modulator).
  5. Switch on the power supply.
  6. Connect DSO/CRO probe at output of balanced modulator (BPSK modulator).
  7. Observe output waveforms of balanced modulator (BPSK modulator) on CRO.
  8. Write output signal phase shift with respect to carrier for input signal (logic 1 and logic 0) in observation table16.1.
  9. For BPSK demodulation connect output of balanced modulator (BPSK modulator) to input of BPSK demodulator kit as shown in figure 16.4
  10. Observe output of low pass filter on DSO/CRO.
  11. Draw the waveform of input data, carrier signal, BPSK signal and output of low pass filter on graph paper for observed value.
  12. After completion of practical switch off the supply, remove the connection and submit the wires and equipment's.

- Actual Resources used (with major specifications)

Sr. No.	Instruments /Components	Specifications	Quantity
1			
2			
3			
4			

- Observations

Table 16.1: Measurement of phase shift of given carrier

Sr. No.	Input Signal	Modulated output signal phase shift w.r.t. carrier
1	Logic 0	
2	Logic 1	

- Result

As input signal is at logic 1 output signal phase shift with respect to carrier is .... (180^0 / No Change).

- Conclusions

....

....

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....

Experiment No:4

Test the performance of the Differential Phase shift keying(DPSK) modulator / demodulator circuits.

- Practical Significance
  DBPSK (Differential Binary Phase Shift Keying) is a common form of phase modulation used in analog modems. DBPSK does not require complex demodulation circuitry and is less susceptible to random phase changes in the transmitted waveform. This practical is designed to explain how with differential Phase Shift Keying technique. We can read the data stream. DBPSK is widely used for wireless LANs, bio-metric, contactless operations, along with RFID and Bluetooth communications.

- Relevant Program Outcomes (POs)
  - **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
  - **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
  - **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

- Relevant Course Outcomes
  - Maintain systems based on digital modulation techniques.

- Practical Outcome
  - Test the performance of the Differential Binary Phase shift keying (DBPSK) modulator / demodulator circuits.

- Relevant Affective domain unrelated Outcome(s)
  - Follow safe practices.
  - Handle instruments carefully.
  - Follow ethical practices.

- Minimum Theoretical Background
  DPSK is the combination of differential encoding and BPSK. Binary bit b (t) and its previous bit b ($t-T_b$) are used to generate differential encoding with the help of EX-OR gate. The differential encoding signal is converted to bipolar non return zero signal. The signal is multiplied with carrier to produce required DPSK. The DPSK input and one bit delayed output are added and given to where be integrator.

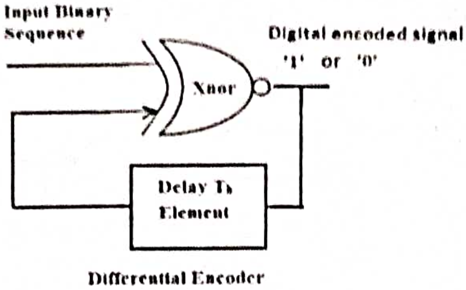

Figure 4.1: Differential encoding process

The output of integrator is given to decision device will generate logic "1" if intégrator output is greater than 0 and generate logic "0" if integrator output is less than 0, in the demodulation.

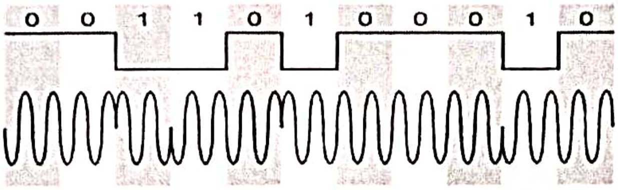

Figure 4.2: DPSK output waveforms

- Practical Circuit Diagram

a) Sample block diagram

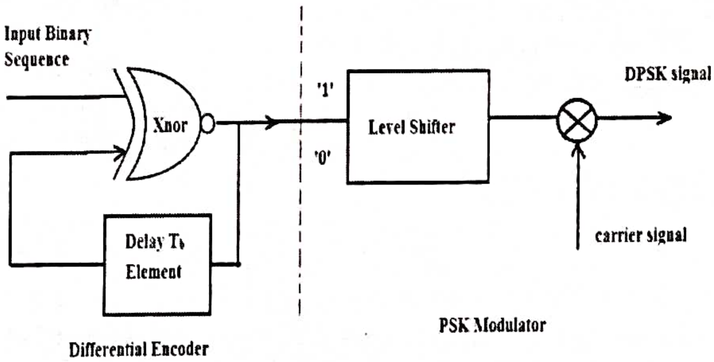

Figure 4.3: DBPSK transmitter

[Courtesy: https://ece4uplp.com/2018/06/09/differential-phase-shift-keying-dpsk/]

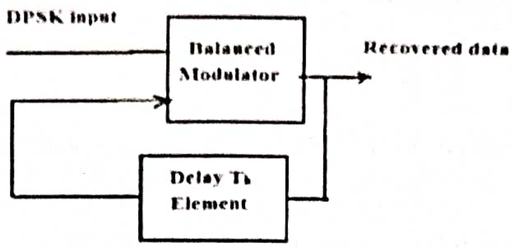

Figure 4.4: DBPSK receiver
[Courtesy: https://ece4uplp.com/2018/06/09/differential-phase-shift-keying-dpsk/]

b) Actual Block Diagram / Circuit diagram

- Resources required

Sr. No.	Instruments /Components	Specifications	Quantity
1.	Dual trace cathode ray oscilloscope / Digital storage oscilloscope	20 MHz dual trace oscilloscope /25 MHz Dual Trace Digital Storage Oscilloscope	1
2.	Power supply	Variable D C Power supply 0-30V,0-2A , SC protection Digital meters	1
3.	DBPSK Trainer kit	Four type selectable data clock frequency 2 KHz, 4 KHz, 8 KHz, 16 KHz, And four selectable types bit data 8 bit, 16 bit, 32 bit, 64 bit or equivalent trainer kit	1
4.	Connecting wires	CRO probes, attenuation probes, patch chords	2

- **Precautions**

1. Do not switch ON the power supply unless you have checked the circuit connectionsas per the circuit diagram.

- Procedure
  1. Make the connection as per circuit diagram.
  2. Switch ON the power supply.
  3. Set the input bit stream as 10110010
  4. Observe the output waveform at the output of DBPSK modulator.
  5. Connect the output of DBPSK modulator to DBPSK demodulator input.
  6. Observe the waveforms at various test points using CRO.
  7. Sketch the waveforms of DBPSK modulator output and demodulator output on graphpaper.
  8. After completion of practical switch off the supply, remove the connection and submit the wires and equipments.
- Resources used (with major specifications)

Sr. No.	Instruments /Components	Specifications	Quantity
1.			
2.			
3.			

- Observations and Calculations

Table 4.1: Waveforms at Various stages of DBPSK

Sr. No.	Output at	Waveform
1	**Input signal bit stream**	
2	**Clock**	
3	**Differential encoded output**	
4	**DBPSK modulator output**	
5	**DBPSK demodulator output**	

- Results

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Experiment No:5

Generate a TDM signal using MATLAB simulation software.

- Practical Significance

  Time division multiplexing (TDM) is a communications process that transmits two or more streaming digital signals over a common channel. In TDM, incoming signals are divided into equal fixed-length time slots. After multiplexing, these signals are transmitted over a shared medium and reassembled into their original format after de-multiplexing. Time slot selection is directly proportional to overall system efficiency. Time division multiplexing (TDM) is also known as a digital circuit switched.

  Time division multiplexing (TDM) has many applications in ISDN telephone lines, PSTN. In this practical, students will generate TDM signal and reconstruct it using simulation software.

- Relevant Program Outcomes (POs)
  - **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
  - **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
  - **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

- Relevant Course Outcomes
  - Multiplex and demultiplex digital signals.

- Practical Outcome
  - Generate a TDM signal using MATLAB software.

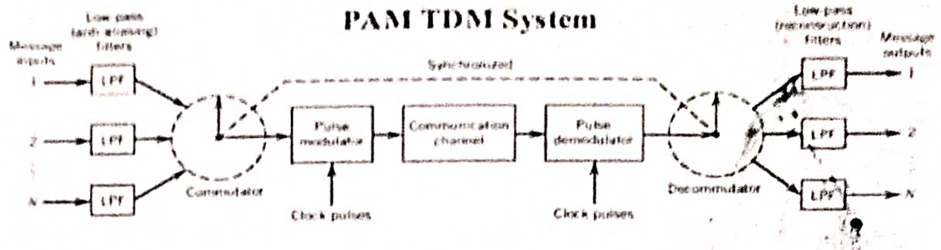
- Relevant Affective domain related Outcome(s)
  - Select proper programming environment.
  - Follow ethical practices

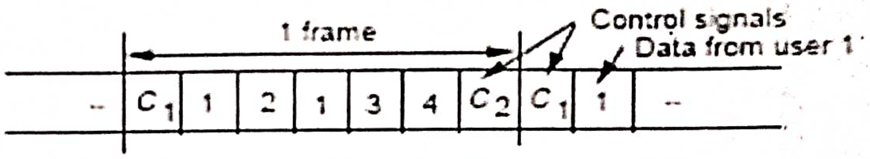
- Minimum Theoretical Background

  Multiplexing is used to increase the channel capacity. Time division multiplexing (TDM)is a method in which different information signals transmitted over a common carrier oneafter other. Each information signal transmitted over short interval of time. TDM is suitable for transmission of digital signal. Figure 5.1 shows working of TDM transmitter and receiver.

Block diagram of TDM system

PAM TDM System





A Typical Framing Structure for TDM

Figure 5.1: TDM transmitter and receiver

[Courtesy: https://www.google.co.in/search?q=TDM+transmitter+and+receiver+block+diagram&tbm=isch&source=iu&ictx=1&fir=Lh2PEUjQ1_A_LM%253A%252CWgOhhICgRZjvvM%252C_&usg=_fAo6avhHHzF5JHfYfWpUI7JbTNA%3D&sa=X&ved=0ahUKEwjF0KDep6_cAhXKMY8KHWraDnYQ9QEINDAG&biw=1366&bih=613#imgrc=Lh2PEUjQ1_A_LM:]

- Sample Simulation Code

a) Sample code for TDM signal Generation using MATLAB -code

```
clc;
close all;
clear all;
% Signal generation
x=0:.5:4*pi;                         % signal taken upto 4pi
sig1=8*sin(x);                       % generate 1st
sinusoidal signal
l=length(sig1);
sig2=8*triang(l);                    % Generate 2nd
triangular Signal

% Display of Both Signal
subplot(2,2,1);
plot(sig1);
title('Sinusoidal Signal');
ylabel('Amplitude--->');
xlabel('Time--->');
subplot(2,2,2); plot(sig2);
title('Triangular Signal');
ylabel('Amplitude--->');
xlabel('Time--->');

% Display of Both Sampled Signal
subplot(2,2,3);
stem(sig1);
title('Sampled Sinusoidal Signal');



ylabel('Amplitude--->');
xlabel('Time--->');
subplot(2,2,4);
stem(sig2);
```

```
title('Sampled Triangular Signal');
ylabel('Amplitude--->');
xlabel('Time--->');


l1=length(sig1);
l2=length(sig2);
for i=1:l1
sig(1,i)=sig1(i);                          % Making Both row vector
to a matrix
sig(2,i)=sig2(i);
end

% TDM of both quantize signal
tdmsig=reshape(sig,1,2*l1);
% Display of TDM Signal
figure
stem(tdmsig);
title('TDM Signal');
ylabel('Amplitude--->');
xlabel('Time--->');

% Demultiplexing of TDM Signal
demux=reshape(tdmsig,2,l1);
for i=1:l1
sig3(i)=demux(1,i);                       % Converting The matrix
into row vectors
sig4(i)=demux(2,i);
end

 % display of demultiplexed signal
figure
subplot(2,1,1)
plot(sig3);
title('Recovered Sinusoidal Signal');
ylabel('Amplitude--->');
xlabel('Time--->');
subplot(2,1,2)
plot(sig4);
title('Recovered Triangular Signal');
ylabel('Amplitude--->');
xlabel('Time--->');
```

Simulation Output:

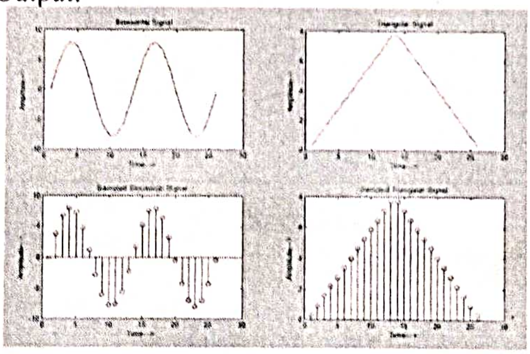


Figure 5.2: Input for TDM system

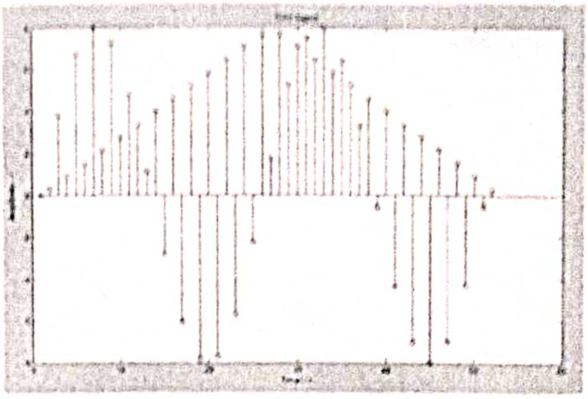


Figure 5.3: Output of TDM transmitter

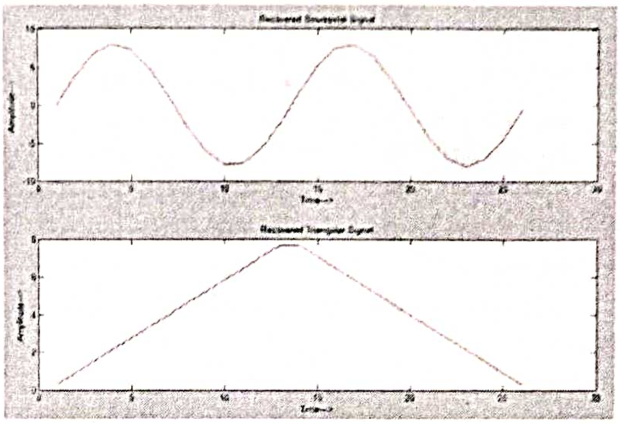


Figure 5.4: Output of TDM receiver

b) Actual Simulation Code

- **Resources required**

Sr. No.	Instruments/ Components	Specifications	Quantity
1.	Computer	Latest Specifications with high end Processor suitable for simulation software	1
2.	Simulation Software	Lab view/ MATLAB /SCILAB/P Spice /HS Spice / Multisim/ Proteus or any other relevant open source software	1

- Precautions
  1. Ensure proper earthling to the computer system.
  2. Ensure compatibility of computer system with software.
  3. Ensure proper installation of simulation software.

- Procedure
  1. Open MATLAB
  2. Go to file and create a new (.m) file.
  3. Type the above code in the code window.
  4. Save the file.
  5. Define the path directory.
  6. Run the program using F5 key or run command.
  7. Observe the output TDM signal in command window.
  8. Paste the print out under observations heading.

- Resources used (with major specifications)

Sr. No.	Instruments /Components	Specifications	Quantity
1.			
2.			
3.			

- Observations

Actual TDM signal observed (Student should paste TDM signal waveform)

- Conclusions and Recommendation

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Experiment No:6

To Study of the delta modulator/ demodulator using MATLAB

- Practical Significance
  In PCM the signaling rate and transmission channel bandwidth are quite large since it transmits all the bits which are used to code a sample. To overcome this problem, Delta modulation is used. A delta modulation is an analog-to-digital and digital-to-analog signal conversion technique used for transmission of voice information. DM is the simplest form of differential pulse-code modulation (DPCM) where the difference between successive samples is encoded into n-bit data streams. In delta modulation, the transmitted data are reduced to a 1-bit data stream. This practical is designed to explain how different types of information signals which are analog in nature can be converted todigital form.

- Relevant Program Outcomes (POs)
  - **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
  - **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
  - **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

- Relevant Course Outcomes
  - Use various pulse code modulation techniques.

- Practical Outcome
  - Test the performance of the delta modulator/ demodulator circuit.

- Relevant Affective domain unrelated Outcome(s)
  - Follow safe practices.
  - Handle instruments carefully.
  - Follow ethical practices.

- Minimum Theoretical Background
  Delta modulation is a Differential Pulse Code modulation (DPCM) technique in which the difference signal is encoded into a single bit .Delta modulation provides a staircase approximation of the input sampled signal where only one bit per sample is transmitted. This one bit is sent by comparing the present sample value with the previous samplevalue and the result whether the amplitude is to be increased or decreased is transmitted. If the step is reduced, 0 is transmitted and if the step is increased then 1 is transmitted.

The Fig 6.1 illustrates the block diagram of Delta modulation transmitter.

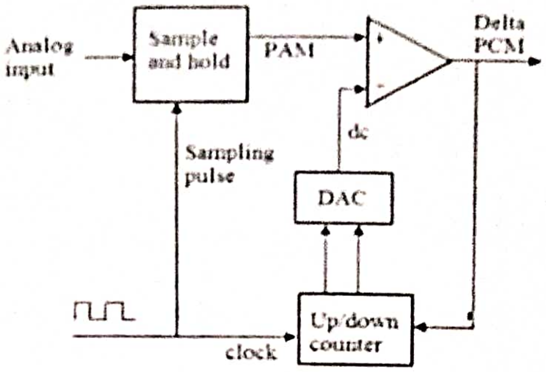

Figure 6.1: Delta modulation Transmitter

Sample and hold circuit will sample the analog input signal into Pulse amplitude modulated (PAM) signal. The Up-down counter stores the magnitude of the previous sample in the binary value. This binary number is converted into equivalent voltage in the Digital-to-analog converter (DAC).The PAM signal and the DAC output are compared inthe comparator. The Up-down counter is incremented or decremented depending on whether the previous sample is larger or smaller than the current sample. The output of the comparator generates the Delta pulse code modulated signal.
The Figure 6.2 illustrates the block diagram of Delta modulation receiver.

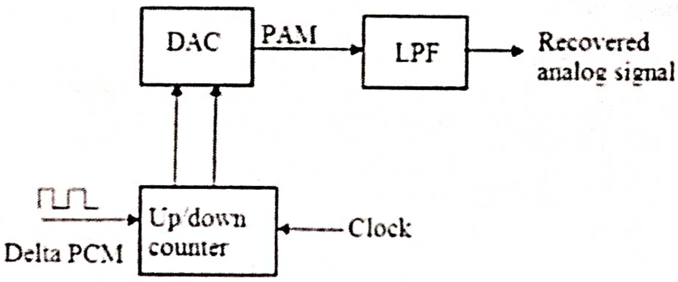

Figure 6.2: Delta modulation Receiver

The receiver of the delta modulator consists of DAC, up/down counter and LPF. The Delta PCM signal is fed to the up/down counter. Based on the input received from the up/down counter, DAC will generate the output PAM signal. The output of DAC is givenLPF which will filter out high frequency component Thus the output signal of DAC in the transmitter and receiver is identical to the original information signal. There are two distortions; slope overhead error and granular noise are present in DM.

- Sample Simulation Code

c) Sample code for DM signal Generation using MATLAB -code

```
%delta modulation code
  clc;
clear all;
close all;
%define and plot the input signal
a=2
t=0:2*pi/50:2*pi;
x=a*sin(t)
l=length(x)
plot(x,'ro--')
%define and plot the delta modulation signal
delta=0.2
```

```
hold on
xn=0
for i=1:l
if x(i)>xn(i)
d(i)=1;
xn(i+1)=xn(i)+delta;
else d(i)=0;
xn(i+1)=xn(i)-delta;
end
end
stairs(xn)
hold on
%recover the original signal (apply  demodulation)
for i=1:d
if d(i).xn(i);
d(i)=0;
xn(i+1)=xn(i)-delta;
else d(i)=1;
xn(i+1)=xn(i)+delta;
end
end
plot(xn,'b*-');
legend('orignal signal','DM','DM demod');
```

- Resources required

Sr. No.	Instruments/ Components	Specifications	Quantity
1.	Computer	Latest Specifications with high end Processor suitable for simulation software	1
2.	Simulation Software	Lab view/ MATLAB /SCILAB/P Spice /HS Spice / Multisim/ Proteus or any other relevant open source software	1

- Precautions
  1. Ensure proper earthling to the computer system.
  2. Ensure compatibility of computer system with software.
  3. Ensure proper installation of simulation software.

- Procedure
  1. Open MATLAB
  2. Go to file and create a new (.m) file.
  3. Type the above code in the code window.
  4. Save the file.
  5. Define the path directory.
  6. Run the program using F5 key or run command.
  7. Observe the output DM signal in command window.
  8. Paste the print out under observations heading.

- Resources used (with major specifications)

Sr. No.	Instruments /Components	Specifications	Quantity
1.			
2.			
3.			

- Observations:

Actual DM signal observed (Student should paste DM signal waveform)Note: Draw waveforms on graph

- Results

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- Conclusions and Recommendation

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Experiment No:7

Test the performance of Amplitude Shift Keying (ASK)using relevant simulation software

- Practical Significance
  Amplitude Shift Keying (ASK) is a type of Amplitude Modulation which represents the binary data in the form of variations in the amplitude of a signal. Any modulated signal has a high frequency carrier. The binary signal when ASK modulated, gives a zero value for Low input while it gives the carrier output for High input. This practical is designed to explain how change of amplitude in to levbl corresponds to logic 1 and logic 0.

- Relevant Program Outcomes (POs)
  - **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
  - **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
  - **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

- Relevant Course Outcomes
  - Maintain systems based on digital modulation techniques.

- Practical Outcome
  - Test the performance of Amplitude Shift Keying (ASK) using relevant simulation software.

- Relevant Affective domain unrelated Outcome(s)
  - Follow safe practices.
  - Handle instruments carefully.
  - Follow ethical practices.

- Minimum Theoretical Background
  Amplitude Shift Keying (ASK) is the digital modulation technique. In amplitude shift keying, the amplitude of the carrier signal is varied to create signal elements. Both frequency and phase remain constant while the amplitude changes.
  In ASK, the amplitude of the carrier assumes one of the two amplitudes dependent on thelogic states of the input bit stream. This modulated signal can be expressed as: Amplitudeshift keying (ASK) in the context of digital signal communications 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. Thus the modulatedwaveform consists of bursts of a sinusoid.

Figure 7.1 illustrates a binary ASK signal (lower), together with the binary sequence which initiated it (upper). Neither signal has been band limited.

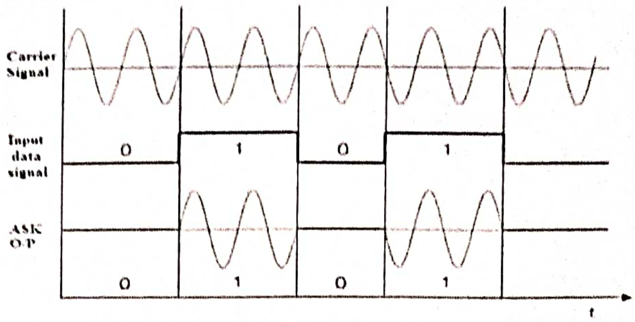

Figure 7.1: ASK I/P- O/P waveforms

- Sample Simulation Code

a) Generation of ASK waveform using MATLAB code

```
clc

t=0:0.001:30;

f1=input('carrier

frequency:');f2=input('pulse

frequency:'); a=3;

x=a.*sin(2*pi*f1*t);

u=(a/2).*square(t)+(a/2

);v=x.*u;

subplot(3,1,1);

plot(t,x);

subplot(3,1,2);

plot(t,u);

subplot(3,1,3);

plot(t,v);
```

Simulation Output:

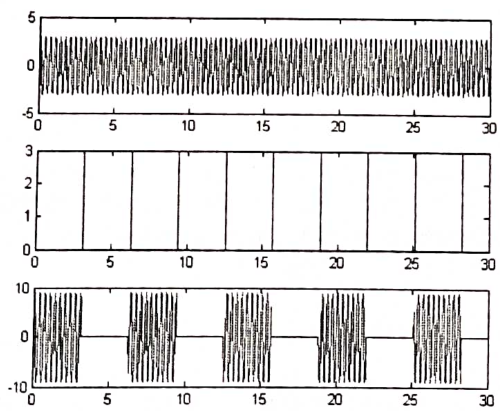

Figure7.2: ASK Output

b) Actual simulation code

(Paste / Write the coding sheet)

Resources required

Sr. No.	Instruments /Components	Specifications	Quantity
1.	Computer	Latest Specifications with high end Processor suitable for simulation software	1
2.	Simulation Software	Lab view/ MATLAB /SCILAB/P Spice /HS Spice / Multisim/ Proteus or any other relevant open source software/	1

- Precautions

1. Ensure proper earthing to the computer system.
2. Ensure compatibility of computer system with software.
3. Ensure proper installation of simulation software.

- Procedure

1. Open the MATLAB.
2. Go to file and create a new file with extension (.m file)
3. Write the MATLAB code in program window.
4. Save the file.
5. Define path directory.
6. Run the program using function key (F5) or use "RUN" command.
7. Observe the output of ASK in command window.
8. After completion of practical shut down the PC and switch off the supply

Resources used (with major specifications)

Sr. No.	Instruments /Components	Specifications	Quantity
1.			
2.			
3.			

Observations and Calculations:

a) **Actual simulation output observed** **(Student should paste the simulation output)**

Results

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Conclusions and Recommendation

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Experiment No:8

Generate a FDM signal using MATLAB software

- Practical Significance

  In telecommunications, frequency-division multiplexing (FDM) is a technique by which the total bandwidth available in a communication medium is divided into a series of non-overlapping frequency sub-bands, each of which is used to carry a separate signal. This allows a single transmission medium such as the radio spectrum, a cable or optical fiber to be shared by multiple independent signals. In this practical, students will generate a FDM signal using simulation software and reconstruct the same.

- Relevant Program Outcomes (POs)
  - **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
  - **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
  - **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

s

- Relevant Course Outcomes
  - Multiplex and demultiplex digital signals.

- Practical Outcome
  - Generate a FDM signal using relevant simulation software.

- Relevant Affective domain related Outcome(s)
  - Select proper programming environment.
  - Follow ethical practices

- Minimum Theoretical Background

  The operation of frequency division multiplexing (FDM) is based on sharing the available bandwidth of a communication channel among the signals to be transmitted. Each signal to be transmitted modulates a different carrier. The modulation can be AM, SSB, FM or PM. The modulated signals are then added together to form a composite signal which is transmitted over a single channel. Generally, the FDM systems are used for multiplexing the analog signal.

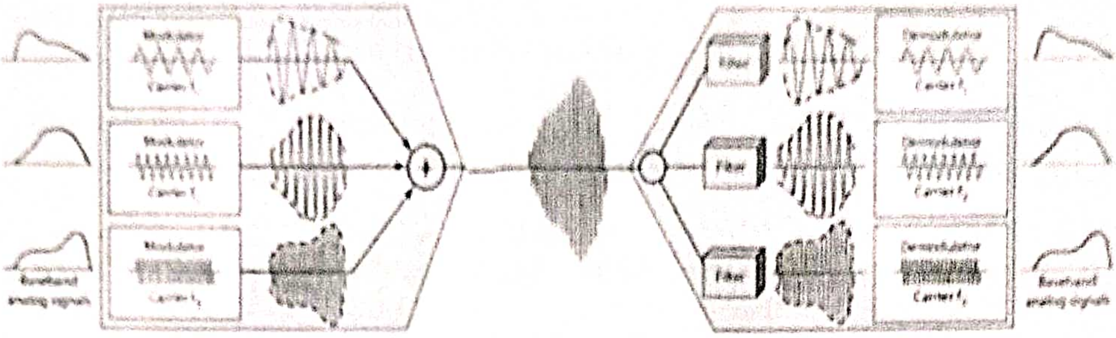


Figure 8.1 FDM transmitter and FDM receiver.

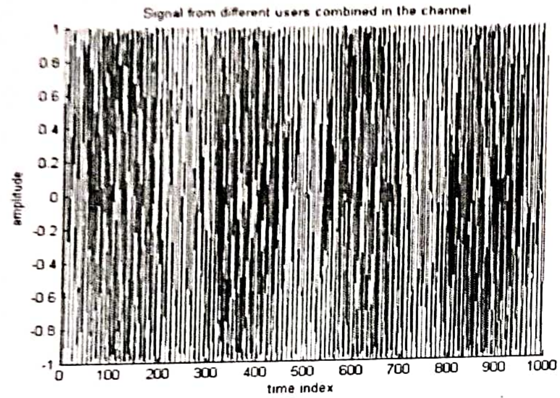
- Sample simulation code

a) Sample code for FDM signal Generation using MATLAB -code

```
clc;
clear
allclose
all
samples=1000;
% number of users
nos=8;
% modulating signal frequency in
Hzmfreq=[30 40 50 60 70 80 90
100];
% carrier frequency allocated to the different users in Hz
cfreq=[300 600 900 12000 1500 1800 2100 2400];
% choose frequency
deviationfreqdev=10;
% generate modulating
signal
t=linspace(0,1000,samples);
parfor i=1:nos
   m(i,:)=sin(2*pi*mfreq(1,i)*t)+2*sin(pi*8*t)
;end
% Generate the modulated signal
parfor i=1:nos
   y(i,:)=fmmod(m(i,:),cfreq(1,i),10*cfreq(1,i),freqdev);
end
% pass the modulated signal through the
channelch_op=awgn(sum(y),0,'measured');
% demodulate the received signal at the base
stationparfor i=1:nos
   z(i,:)=fmdemod(y(i,:),cfreq(1,i),10*cfreq(1,i),freqdev);
end
% display the transmitted signal  and received signal at the base station
% figure
C = {'k','b','r','g','y',[.5 .6 .7],[.8 .2 .6],[.3 .2 .2]}; % Cell array of
colros.for i=1:nos
figure(1)
hold on
```

```
plot(y(i,:),'color',C{i});
xlabel('time index'); ylabel('amplitude'); title('Signal from different users
combinedin the channel');figure subplot(3,1,1)
plot(m(i,:))            % modulating signal
xlabel('time index'); ylabel('amplitude'); title('modulating Signal from user');
subplot(3,1,2)
plot(y(i,:),'color',C{i}); % modulated signal
xlabel('time index'); ylabel('amplitude'); title('modulated Signal from user');
subplot(3,1,3)
plot(z(i,:),'color',C{i}); % demodulated signal
xlabel('time index'); ylabel('amplitude'); title('demodulated Signal from user at
thebase station');
end
figue
plot(ch_op) % combination of all modulated signals passed through the
channelxlabel('time index'); ylabel('amplitude'); title('Signal after passing
through the channel')
```

Simulation Output:



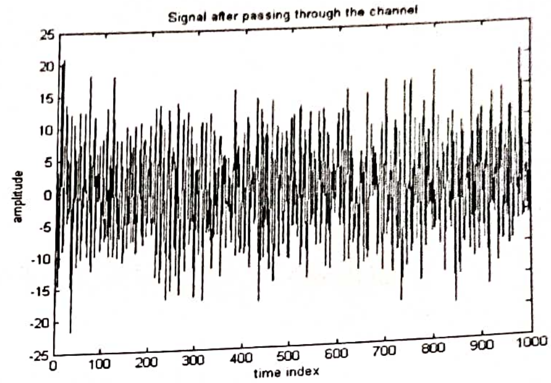


Figure 8.2 Output of FDM transmitter and FDM receiver.

b) Actual Simulation Code

- Resources required

Sr. No.	Instruments /Components	Specifications	Quantity
1.	Computer	Latest Specifications with high end Processor suitable for simulation software	1
2.	Simulation Software	Lab view/ MATLAB /SCILAB/P Spice /HS Spice / Multisim/ Proteus or any other relevant open source software	1

- Precautions
  1. Ensure proper earthing to the computer system.
  2. Ensure compatibility of computer system with software.
  3. Ensure proper installation of simulation software.

- Procedure
  1. Open MATLAB
  2. Go to file and create a new (.m) file.
  3. Write the above code.
  4. Save the file.
  5. Define the path directory.
  6. Run the program using F5 key or run command.
  7. Observe the output FDM signal in command window.
  8. Paste the print out under observations heading.

- Resources used (with major specifications)

Sr. No.	Instruments /Components	Specifications	Quantity
1.			
2.			
3.			

- Observations

Actual FDM signal observed (Student should paste the FDM waveform)