LAKSHMI NARAIN COLLEGE OF TECHNOLOGY, BHOPAL

Name of Student: ____________________________

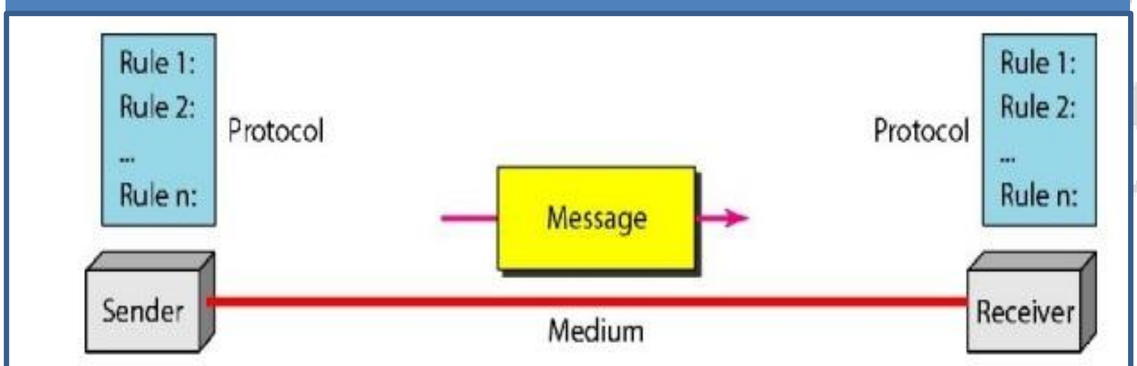
Enrollment No.: ____________________________

Class: ____________________________

Section: ____________________________

Session: ____________________________

Data Communication [EC-605] Lab manual



Department of Electronics & Communication Engineering

Kalchuri Nagar, Raisen Road, Bhopal (MP) - 462023

Vision of the Department:

To be recognized as Centre of Academic Excellence by imparting quality teaching and strengthening research and development activities with world class infrastructure in the field of Electronics and Communication Engineering.

Mission of the Department

- **M1** To establish a quality teaching learning process to provide application oriented, in-depth knowledge consistently.
- **M2** To establish state-of-the-art laboratories for academic excellence and to develop infrastructure through collaboration for quality research.
- **M3** To equip the students by blending theoretical knowledge and practical skills with employability and entrepreneurship traits for a bright successful career.
- **M4** To inculcate team spirit and leadership qualities to produce socially acceptable, eco-friendly and responsible citizens.

Program Educational Objectives (PEO's)

Students will be able to

- **PEO1** Apply knowledge of mathematics, science and engineering as appropriate in the field of Electronics & Communication Engineering as proficient learners in the domains such as Electronic Circuits, Embedded Systems, Communication Systems, Digital Signal Processing, VLSI Design, Data Networks, IOT, and Simulation etc.
- **PEO2** Seek admissions at Institutes of repute for higher education in Engineering & Technology and Management to the tune of 10%, seek employment in core and IT domains to the extent of 80% with remaining 10% opting for entrepreneurship.
- **PEO3** Use the skills, latest techniques, tools for modern engineering and ICT which are necessary to analyze industrial problems related to Electronics & Communication Engineering with focus to Global, Economical and Environmental Issues.
- **PEO4** Understand engineering solutions, exhibit professionalism, ethical attitude, team work, effective written and oral communication skills to practice in their profession with high regards to societal issues and responsibilities.

Program Specific Outcomes (PSO's)

Student will be able to:

- **PSO1** Apply basic concepts of science and engineering, to undertake theoretical learning of Electronic Devices and Circuits, Analog & Digital Communication, Signals & Systems, Embedded Systems, VLSI Design etc.
- **PSO2** Develop the ability to acquire hands-on skills such as Circuit Simulation, MATLAB, HDL Programming, Embedded Systems, DSP and PCB Designing etc.
- **PSO3** Develop team spirit and professional ethics to undertake research oriented projects, especially developmental projects and a few industry sponsored projects.
- **PSO4** Learn extra-curricular courses such as soft-skills, personality development, and groom them as responsible citizen with professional ethics blended with human values, engineering economics and ability to handle real life issues.

Course Outcomes (CO's)

Student will be able to

CO1 Connect computers in local area network.

CO2 Encode given signal in various line encoding technique using MATLAB.

CO3 Generate CRC code for the given data bit and the divisor using MATLAB.

CO4 Plot Efficiency of Pure Aloha and slotted Aloha using MATLAB.

CO5 Plot Channel Efficiency for Ethernet in MATLAB.

Do's and Don'ts

1. Data network connections should not be altered. Personal equipment may not be connected to the data network without first obtaining permission.
2. Do not unplug the cable while the power is switched on.
3. All the connections made as per the circuit diagram of a particular experiment should be quite tight.
4. Read carefully all the instructions in the lab manual before conducting any experiment.

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Rubrics for Assessment of student performance during Experiments

Area of Direct Assessment	Poor (0-2 Marks)	Fair (3-4 Marks)	Average (5-6 Marks)	Good (7-8 Marks)	Excellent (9-10 Marks)
Aim & Theory	Aim is not clear and irrelevant theory written Concept was not explained.	Aim is clear and Incomplete theory written. Concept could not be explained.	Aim is clear and Theory written but is unorganised Concept is explained.	Aim is clear and Theory written properly. Concept is explained.	Aim is clear and Theory written properly. Concept is explained with neat diagrams.
Performance and Working with Others	Did not conduct the experiment and none of the member recorded the observations.	Followed few steps to conduct the experiment. But few members recorded the observations.	Followed few steps to conduct the experiment. Few members recorded the observations.	Followed step by step method to conduct the experiment. Sufficient observations recorded by all team members.	Followed step by step method to conduct the experiment. Many observations recorded by all team members.
Safety Measures	None of the team member knew safety measures and did not followed.	Team members had knowledge of safety measures and followed few of them.	Team members had fair knowledge of safety measures and followed them.	Team members were well acquainted with safety measures and followed.	Team members were well acquainted with safety measures and followed all of them.
Result and Conclusion	No data recorded. Conclusion can not be drawn.	Analysis does not follow data the data. Conclusion can not be drawn.	Analysis as recorded somewhat lacks in insight. Results is poorly recorded to make sense. Conclusion can not be drawn.	Analysis as recorded somewhat lacks in insight. But clearly recorded as Results. Conclusion is properly drawn.	Observations are analysed accurately and clearly recorded as Results. Conclusion is properly drawn.
Observations and Calculations	No observations recorded and no calculation done.	Insufficient number of observations recorded. So calculations are Inaccurate.	Sufficient number of observations recorded but calculations are Inaccurate.	Almost all observations recorded. Calculations are accurate and well organised.	Many observations recorded in the table. Calculations are accurate and well organised.
Internal Viva	Student does not have grasp on the experiment and could not answer the questions about the experiment.	Student mumbles incorrectly, pronouns terms and speak too quietly for teachers to hear.	Student is uncomfortable but is able to answer basic questions about the experiment.	Student is at ease and able to answer expected questions, but fails to elaborate.	Student demonstrated full knowledge by answering all questions with explanations and elaboration.

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INDEX

Name of Student: ____________________ Enrollment No.: _______________

Sr. No	Title of the Experiment	Date of Experiment	Date of Submission	Remark
1	To study the physical components of Data Communication.			
2	To Study OSI reference model.			
3	To Study the various network topologies with their advantages & disadvantages.			
4	To Connect the computers in Local Area Network.			
5	Write MATLAB codes to generate Uni-Polar NRZ Signal for given sequence.			
6	Write MATLAB Codes to generate Polar RZ signal for given sequence.			
7	Write MATLAB codes to generate signal using Manchester code for given sequence.			
8	Write MATLAB codes to generate CRC code for the given data bit and the divisor.			
9	Write MATLAB codes to Plot Efficiency of Pure Aloha and slotted Aloha.			
10	Write MATLAB codes to plot Channel Efficiency of Ethernet.			

Date of Experiment: ____________

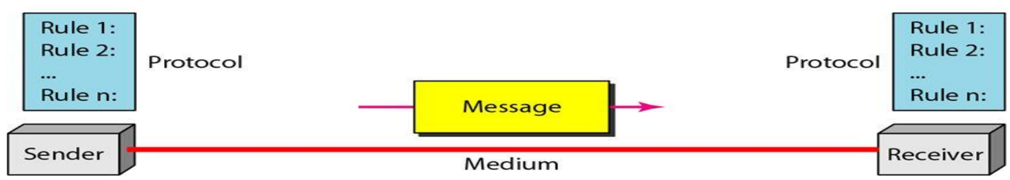
Experiment No. : 1

AIM: To study the physical components of Data Communication.

Introduction

In Data Communications, *data* generally are defined as information that is stored in digital form. *Data communications* is the process of transferring digital information between two or more points. *Information* is defined as the knowledge or intelligence. Data communications can be summarized as the transmission, reception, and processing of digital information. For data communications to occur, the communicating devices must be part of a communication system made up of a combination of hardware (physical equipment) and software (programs). The effectiveness of a data communications system depends on four fundamental characteristics: delivery, accuracy, timeliness, and jitter.

A data communications system has five components:



- **Message**

In a data communication system, the message is the information sent out through the system. The message may include numbers, words, photos, other graphics, sounds, video or a combination of any of these. Messages in a data communication system are put together in analog or digital form and broken into groups or segments of data called packets. Each packet has a payload -- the actual data being sent -- and a header -- information about the type of data in the payload, where it came from where it is going, and how it should be reassembled so the message is clear and in order when it arrives at the destination.

- **Sender**

The sender in a data communication sequence is the device that generates the messages. Sometimes these devices are called sources or transmitters instead of senders. Some sending devices are desktop and laptop computers, netbooks, smartphones, video cameras, workstations, telephones, fax machines and tablets. Television stations, radio stations, short wave radios and walkie talkies are also considered senders -- or transmitters -- in a data communication system.

- **Receiver**

The receiver is the device on the other end of the data communication transmission that gets the message and reassembles it. Many of the same devices that function as receivers also function as senders, such as computers, smart phones and telephone handsets. Some, however, are only receivers, such as radios, printers, or televisions.

- **Medium**

The medium is the means by which the message travels from the sender to the receiver. In a data communication system this includes the wire, twisted wire, local area network (LAN) cable, fiber optic cable, microwave signal, satellite signal or any other transmission medium used in a network. A point to point connection is comprised of only two devices connected by a dedicated medium. On the other hand, multiple devices may be connected through mediums into networks. The Internet is a collection of many different networks creating a distributed network. Other networks include LANs, Metropolitan Area Networks (MANs) and Wide Area Networks (WANs).

- **Protocol**

A protocol is a set of rules that guides how data communication is carried out. Every device that wants to communicate with each other must use the same protocol in order to exchange messages. Every device on the Internet, for example, uses the TCP/IP protocol. AppleTalk is another protocol. The keys to protocol are syntax, semantics and timing. All the rules and standards are necessary so that devices manufactured by many different companies can still communicate with each other.

Result: Various physical components of data communication are studied.

Signature of Faculty

Date of Experiment: ____________

Experiment No. : 2

AIM: To Study OSI reference model.

THEORY:

Introduction: Here, we will discuss two important network architectures - the OSI reference model and the TCP/IP reference model. Although the protocols associated with the OSI model are rarely used any more, the model itself is actually quite general and still valid, and the features discussed at each layer are still very important. The TCP/IP model has the opposite properties: the model itself is not of much use but the protocols are widely used.

OSI reference model: Virtually all networks in use today are based in some fashion on the Open Systems Interconnection (OSI) standard. OSI was developed in 1984 by the International Organization for Standardization (ISO), a global federation of national standards organizations representing approximately 130 countries. The core of this standard is the OSI Reference Model, a set of seven layers that define the different stages that data must go through to travel from one device to another over a network. The principles that were applied to arrive at the seven layers can be briefly summarized as follows:

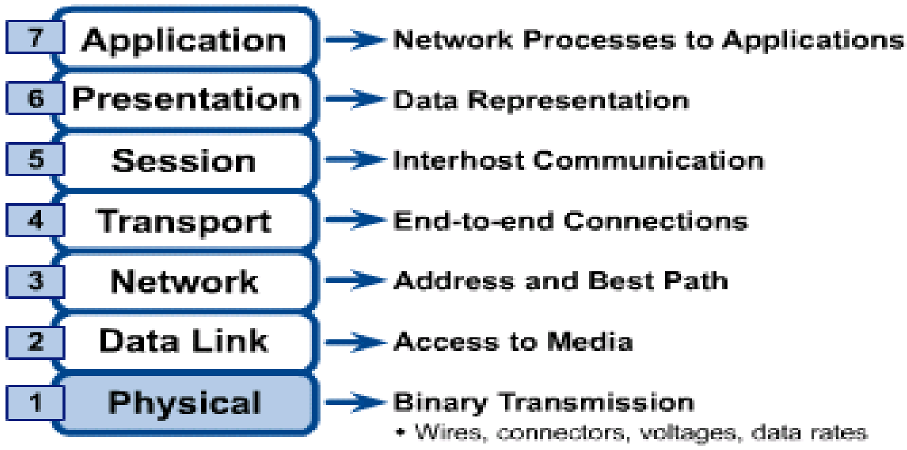
1. A layer should be created where a different abstraction is needed.

2. Each layer should perform a well-defined function.

3. The function of each layer should be chosen with an eye toward defining internationally standardized protocols.

4. The layer boundaries should be chosen to minimize the information flow across the interfaces.

5. The number of layers should be large enough that distinct functions need not be thrown together in the same layer out of necessity and small enough that the architecture does not become unwieldy.



Layer 1: Physical - This is the level of the actual hardware. It defines the physical characteristics of the network such as connections, voltage levels and timing.

Layer 2: Data - In this layer, the appropriate physical protocol is assigned to the data. Also, the type of network and the packet sequencing is defined. The main task of the data link layer is to transform a raw transmission facility into a line that appears free of undetected transmission errors to the network layer. It accomplishes this task by having the sender break up the input data into data frames (typically a few hundred or a few thousand bytes) and transmits the frames sequentially. If the service is reliable, the receiver confirms correct receipt of each frame by sending back an acknowledgement frame.

Layer 3: Network - The way that the data will be sent to the recipient device is determined in this layer. Logical protocols, routing and addressing are handled here. The network layer controls the operation of the subnet. A key design issue is determining how packets are routed from source to destination. Routes can be based on static tables that are "wired into" the network and rarely changed. They can also be determined at the start of each conversation, for example, a terminal session (e.g., a login to a remote machine). Finally, they can be highly dynamic, being determined anew for each packet, to reflect the current network load.

Layer 4: Transport - This layer maintains flow control of data and provides for error checking and recovery of data between the devices. Flow control means that the Transport layer looks to see if data is coming from more than one application and integrates each application's data into a single stream for the physical network.

Layer 5: Session - Layer 5 establishes, maintains and ends communication with the receiving device. The session layer allows users on different machines to establish sessions between them. Sessions offer various services, including dialog control (keeping track of whose turn it is to transmit), token management (preventing two parties from attempting the same critical operation at the same time), and synchronization pointing long transmissions to allow them to continue from where they were after a crash).

Layer 6: Presentation - Layer 6 takes the data provided by the Application layer and converts it into a standard format that the other layers can understand. Unlike lower layers, which are mostly concerned with moving bits around, the presentation layer is concerned with the syntax and semantics of the information transmitted. In order to make it possible for computers with different data representations to communicate, the data structures to be exchanged can be defined in an abstract way, along with a standard encoding to be used "on the wire." The presentation layer manages these abstract data structures and allows higher-level data structures (e.g., banking records), to be defined and exchanged.

Layer 7: Application - This is the layer that actually interacts with the operating system or application whenever the user chooses to transfer files, read messages or performs other network-related activities. The application layer contains a variety of protocols that are commonly needed by users. One widely-used application protocol is HTTP (Hypertext Transfer Protocol), which is the basis for the World Wide Web. When a browser wants a Web page, it sends the name of the page it wants to the server using HTTP. The server then sends the page back. Other application protocols are used for file transfer, electronic mail, and network news.

RESULT – Study of OSI reference model is done successfully.

Signature of Faculty

Date of Experiment: ____________

Experiment No. : 3

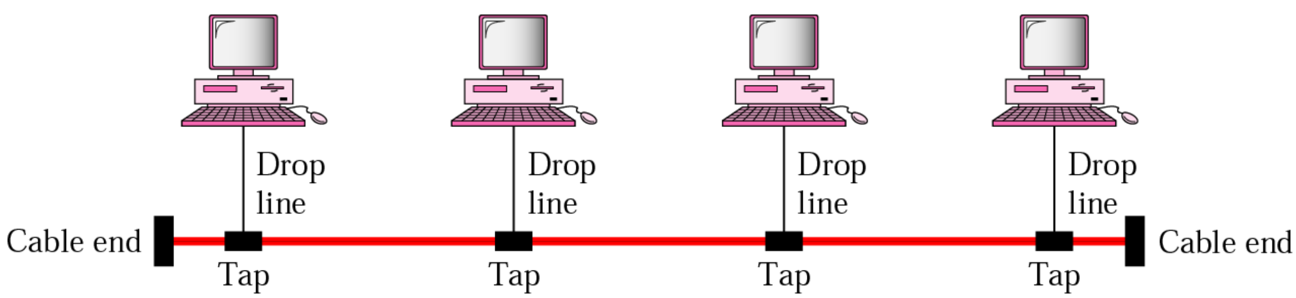
AIM: To Study the various network topologies with advantages & disadvantages.

THEORY: **Network topology** is the arrangement of the various elements (links, nodes, etc.) of a computer **network**. Essentially, it is the **topological** structure of a **network** and may be depicted physically or logically.

Types

- **Bus Topology:**

Commonly referred to as a linear bus, all the devices on a bus topology are connected by one single cable.



Advantages:

• Easy to use & inexpensive simple network

• Easy to extend thus allowing long distance traveling of signal

• Requires less cable length than a star topology

Disadvantages:

• Becomes slow by heavy network traffic with a lot of computer

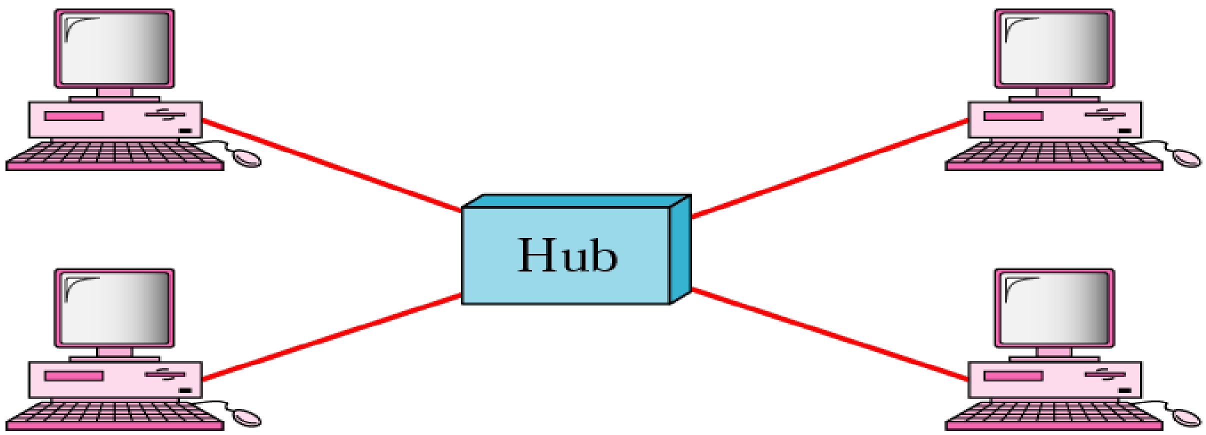
• Difficult to troubleshoot & difficult to identify the problem if the entire network shut down

• Terminator is required at both ends of the backbone cable

• Not meant to be used as a standalone solution in a large building.

- **Star Topology**

The star topology is the most commonly used architecture in Ethernet LANs. When installed, the star topology resembles spokes in a bicycle wheel. Larger networks use the extended star topology. When used with network devices that filter frames or packets, like bridges, switches, and routers, this topology significantly reduces the traffic on the wires by sending packets only to the wires of the destination host.



Advantages:

- Easy to modify and add new computer to a star network without disturbing the rest of the network
- Ease of diagnosis of network faults through the central computer
- Single computer failure do not necessarily bring down the whole star network
- Use of several cable types in the same network

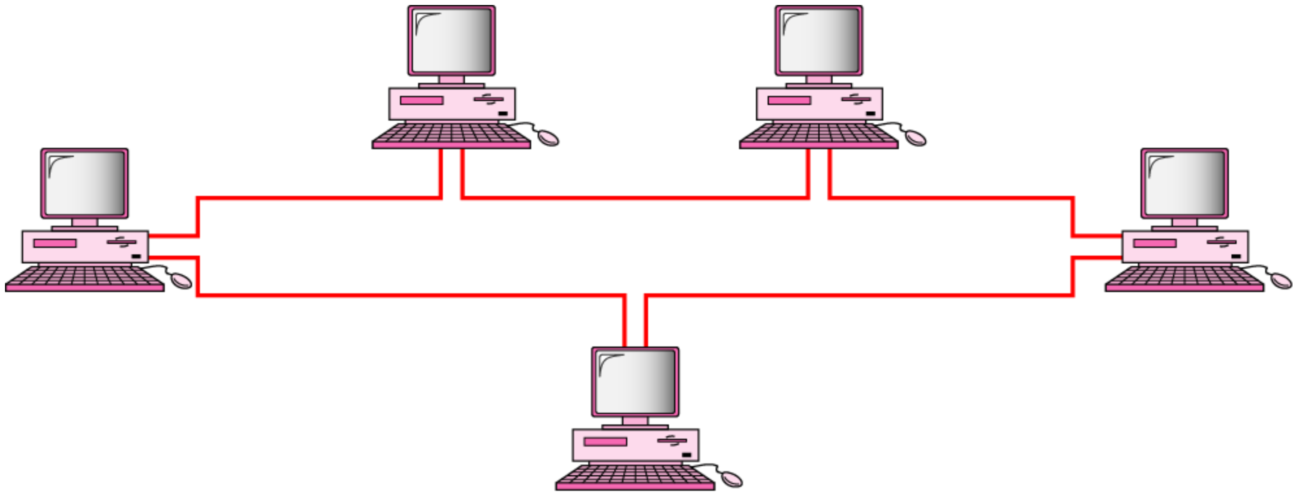
Disadvantages:

- Requires more cable length than a linear topology.
- If the hub or concentrator fails, nodes attached are disabled.
- More expensive than linear bus topologies because of the cost of the concentrators

- **Ring Topology:**

A frame travels around the ring, stopping at each node. If a node wants to transmit data, it adds the data as well as the destination address to the frame. The frame then continues around the ring until it finds the destination node, which takes the data out of the frame.

- Single ring – All the devices on the network share a single cable
- Dual ring – The dual ring topology allows data to be sent in both directions although only one ring is used at a time.



Advantages:

- Every computer is given equal access to the token; no one computer can monopolize the network
- Fair sharing of the network allows the network to degrade gracefully as more users are added

Disadvantages:

- Failure to one network can affect the whole network
- Difficult to troubleshoot a ring network
- Adding or removing computer disrupts the network

Ring network layout ring network is a topology of computer network where each node is connected to two other nodes, so as to create a ring. Ring networks tend to be inefficient when compared to Star networks because data must travel through less number of points before reaching its destination. For example , if a given ring network has eight computers on it, to get from computer one to computer four, data must be travel from computer one, through computers two and three, and to it's destination at computer four. It could also go from computer one through eight, seven, six, and five until reaching four, but this method is slower because it travels through more computers. Ring network also carry the disadvantage that if one of the nodes in the network breaks then the entire network will break down with it as it requires a full circle in order to function.

RESULT – Study of network topologies with advantages & disadvantages is done successfully.

Signature of Faculty

Date of Experiment: ____________

Experiment No. : 4

AIM: To Connect the computers in Local Area Network.

THEORY: A **local area network** (**LAN**) is a computer network that interconnects computers within a limited area such as a home, school, computer laboratory, or office building, using network media. The defining characteristics of LANs, in contrast to wide area networks (WANs), include their smaller geographic area, and non-inclusion of leased telecommunication lines.

ARCNET, Token Ring and other technology standards have been used in the past, but Ethernet over twisted pair cabling, and Wi-Fi are the two most common technologies currently used to build LANs.

PROCEDURE:

On the host computer On the host computer, follow these steps to share the Internet connection:

1. Log on to the host computer as Administrator or as Owner.

2. Click **Start**, and then click **Control Panel**.

3. Click **Network and Internet Connections**.

4. Click **Network Connections**.

5. Right-click the connection that you use to connect to the Internet. For example, if you connect to the Internet by using a modem, right-click the connection that you want under Dial-up / other network available.

6. Click **Properties**.

7. Click the **Advanced** tab.

8. Under **Internet Connection Sharing**, select the **Allow other network users to connect through this computer's Internet connection** check box.

9. If you are sharing a dial-up Internet connection, select the **Establish a dial-up connection whenever a computer on my network attempts to access the Internet** check box if you want to permit your computer to automatically connect to the Internet.

10. Click **OK**. You receive the following message: “When Internet Connection Sharing is enabled, your LAN adapter will be set to use IP address 192.168.0.1. Your computer may lose connectivity with other computers on your network. If these other computers have static IP addresses, it is a good idea to set them to obtain their IP addresses automatically. Are you sure you want to enable Internet Connection Sharing?”

11. Click **Yes**.

The connection to the Internet is shared to other computers on the local area network (LAN). Network adapter that is connected to the LAN is configured with a static IP address of 192.168.0.1 and a subnet mask of 255.255.255.

On the client computer

To connect to the Internet by using the shared connection, you must confirm the LAN adapter IP configuration, and then configure the client computer. To confirm the LAN adapter IP Configuration, follow these steps:

1. Log on to the client computer as Administrator or as Owner.
2. Click **Start**, and then click **Control Panel**.
3. Click **Network and Internet Connections**.
4. Click **Network Connections**.
5. Right-click **Local Area Connection** and then click **Properties**.
6. Click the **General** tab, click **Internet Protocol (TCP/IP)** in the **connection uses the Following items** list, and then click **Properties**.
7. In the **Internet Protocol (TCP/IP) Properties** dialog box, click **Obtain an IP address automatically** (if it is not already selected), and then click **OK**.

Note: You can also assign a unique static IP address in the range of 192.168.0.2 to 192.168.0.254. For example, you can assign the following static IP address, subnet mask, and default gateway:

8. IP Address 192.168.31.202
9. Subnet mask 255.255.255.0
10. Default gateway 192.168.31.1
11. In the **Local Area Connection Properties** dialog box, click OK
12. Quit Control Panel.

RESULT: Computer is successfully connected with Local Area Network.

Signature of Faculty

Date of Experiment: ____________

Experiment No. : 5

AIM: Write MATLAB codes to generate Uni-Polar NRZ Signal for given sequence.

TOOLS REQUIRED: MATLAB v 7.8

THEORY:

- **Unipolar Encoding**

It is a line code. A positive voltage represents a binary 1, and zero volts indicate a binary 0. It is the simplest line code, directly encoding the bit stream, and is analogous to on-off keying in modulation.

Its drawbacks are that it is not self-clocking and it has a significant DC component, which can be halved by using return-to-zero, where the signal returns to zero in the middle of the bit period. With a 50% duty cycle each rectangular pulse is only at a positive voltage for half of the bit period. This is ideal if one symbol is sent much more often than the other and power considerations are necessary, and also makes the signal self-clocking.

NRZ (Non-Return-Zero) - Traditionally, a unipolar scheme was designed as a non-return-to-zero (NRZ) scheme, in which the positive voltage defines bit 1 and the negative voltage defines bit 0. It is called NRZ because the signal does not return to zero at the middle of the bit.

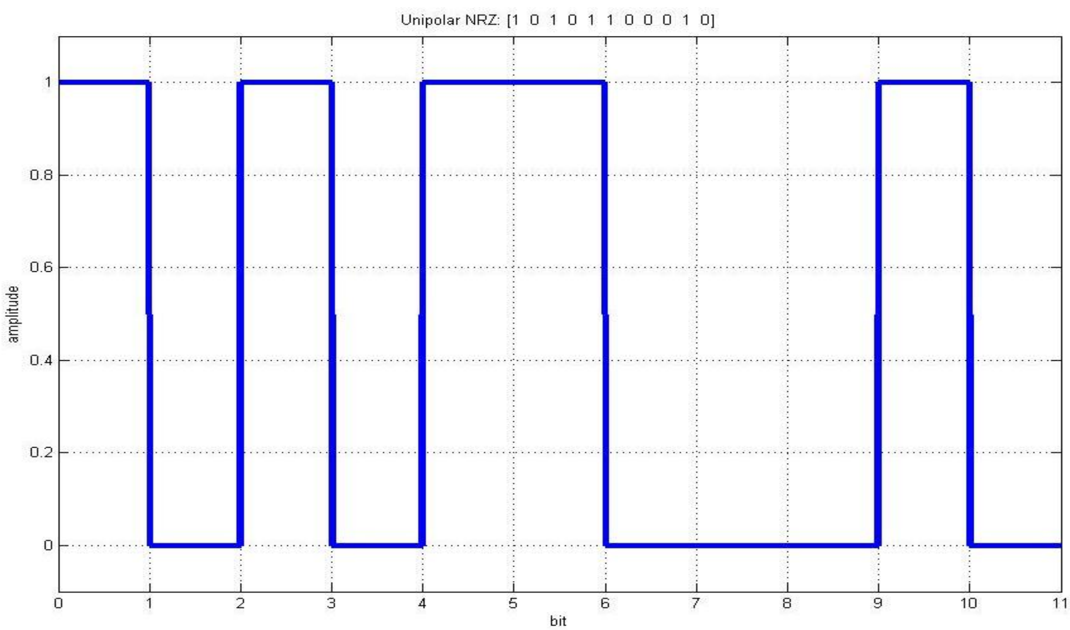
Compared with its polar counterpart, Uni Polar NRZ, this scheme is very expensive. The normalized power (power required to send 1 bit per unit line resistance) is double that for polar NRZ. For this reason, this scheme is not normally used in data communications today.

CODES:

```
% Write MATLAB codes to generate Uni-Polar NRZ Signal for given sequence
    bits = input('Enter bit sequence=');
    bitrate = 1; % bits per second
    T = length(bits)/bitrate; % full time of bit sequence
    n = 200;
    N = n*length(bits);
    dt = T/N;
    t = 0:dt:T;
    x = zeros(1,length(t)); % output signal
```

```
   for i = 0:length(bits)-1
if bits(i+1) == 1
      x(i*n+1:(i+1)*n) = 1;
     else
      x(i*n+1:(i+1)*n) = 0;
end
   end
   plot(t,x,'LineWidth',4);
   axis([0 t(end) -0.1 1.1])
   grid on;
   xlabel('bit');
   ylabel('amplitude');
   title(['Unipolar NRZ: [' num2str(bits) ']']);
```

WAVEFORM :



RESULT –Unipolar NRZ signal is generated successfully.

Signature of Faculty

Date of Experiment: ____________

Experiment No. : 6

AIM: Write MATLAB Codes to generate Polar RZ signal for given sequence.

TOOLS REQUIRED: MATLAB v 7.8

THEORY:

Polar encoding- is a line code. A positive voltage represents a binary 1, and zero volts indicate a binary -1. It is the simplest line code, directly encoding the bit stream, and is analogous to on-off keying in modulation.

Its drawbacks are that it is not self-clocking and it has a significant DC component, which can be halved by using return-to-zero, where the signal returns to zero in the middle of the bit period. With a 50% duty cycle each rectangular pulse is only at a positive voltage for half of the bit period. This is ideal if one symbol is sent much more often than the other and power considerations are necessary, and also makes the signal self-clocking.

Return to Zero (RZ)

Return-to-zero (RZ) describes a line code used in telecommunications signals in which the signal drops (returns) to zero between each pulse. This takes place even if a number of consecutive 0s or 1s occur in the signal. The signal is self-clocking. This means that a separate clock does not need to be sent alongside the signal, but suffers from using twice the bandwidth to achieve the same data-rate as compared to non-return-to-zero format.

The "zero" between each bit is a neutral or rest condition, such as zero amplitude in pulse amplitude modulation (PAM), zero phase shift in phase-shift keying (PSK), or mid-frequency in frequency-shift keying (FSK). That "zero" condition is typically halfway between the significant condition representing a 1 bit and the other significant condition representing a 0 bit.

Although return-to-zero (RZ) contains a provision for synchronization, it still has a DC component resulting in “baseline wander” during long strings of 0 or 1 bits, just like the line code non-return-to-zero.

Codes:

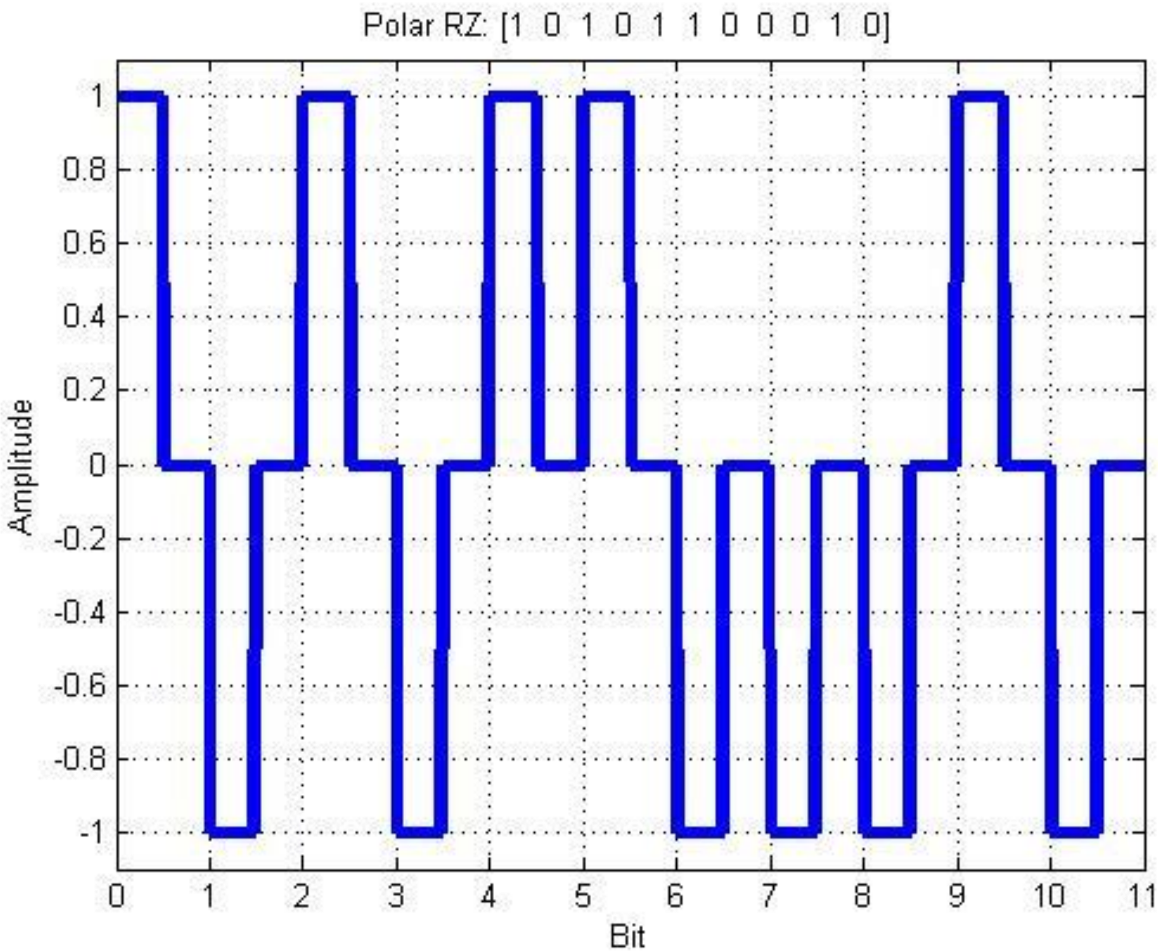
```
%Write MATLAB Codes to generate Polar RZ signal for given
sequence.
    bits = input('Enter bit sequence=');
    bitrate = 1; % bits per second

    T = length(bits)/bitrate; % full time of bit sequence
    n = 200;
    N = n*length(bits);
    dt = T/N;
    t = 0:dt:T;
    x = zeros(1,length(t)); % output signal

    for i = 0:length(bits)-1
          if bits(i+1) == 1
           x(i*n+1:(i+0.5)*n) = 1;
           x((i+0.5)*n+1:(i+1)*n) = 0;
          else
           x(i*n+1:(i+0.5)*n) = -1;
           x((i+0.5)*n+1:(i+1)*n) = 0;
          end
    end

    plot(t,x,'LineWidth',4);
    axis([0 t(end) -1.1 1.1]);
    xlabel('Bit');
    ylabel('Amplitude');
    grid on;
    title(['Polar RZ: [' num2str(bits) ']']);
```

Waveform:



Result: Polar RZ signal is generated successfully.

Signature of Faculty

Date of Experiment: ____________

Experiment No. : 7

AIM: Write MATLAB codes to generate signal using Manchester code for given sequence.

TOOLS REQUIRED: MATLAB v 7.8

THEORY: In telecommunication and data storage, **Manchester coding** (also known as **phase encoding**, or **PE**) is a line code in which the encoding of each data bit has at least one transition and occupies the same time. It therefore has no DC component, and is self-clocking, which means that it may be inductively or capacitive coupled, and that a clock signal can be recovered from the encoded data. As a result, electrical connections using a Manchester code are easily galvanically isolated using a network isolator a simple one-to-one isolation transformer.

The name comes from its development at the University of Manchester, where the coding was used to store data on the magnetic drum of the Manchester Mark 1 computer.

Manchester coding is widely used (e.g., in 10BASE-T Ethernet (IEEE 802.3); consumer IR protocols; see also RFID or near field communication). There are more complex codes, such as 8B/10B encoding, that use less bandwidth to achieve the same data rate but may be less tolerant of frequency errors and jitter in the transmitter and receiver reference clocks.

Codes:

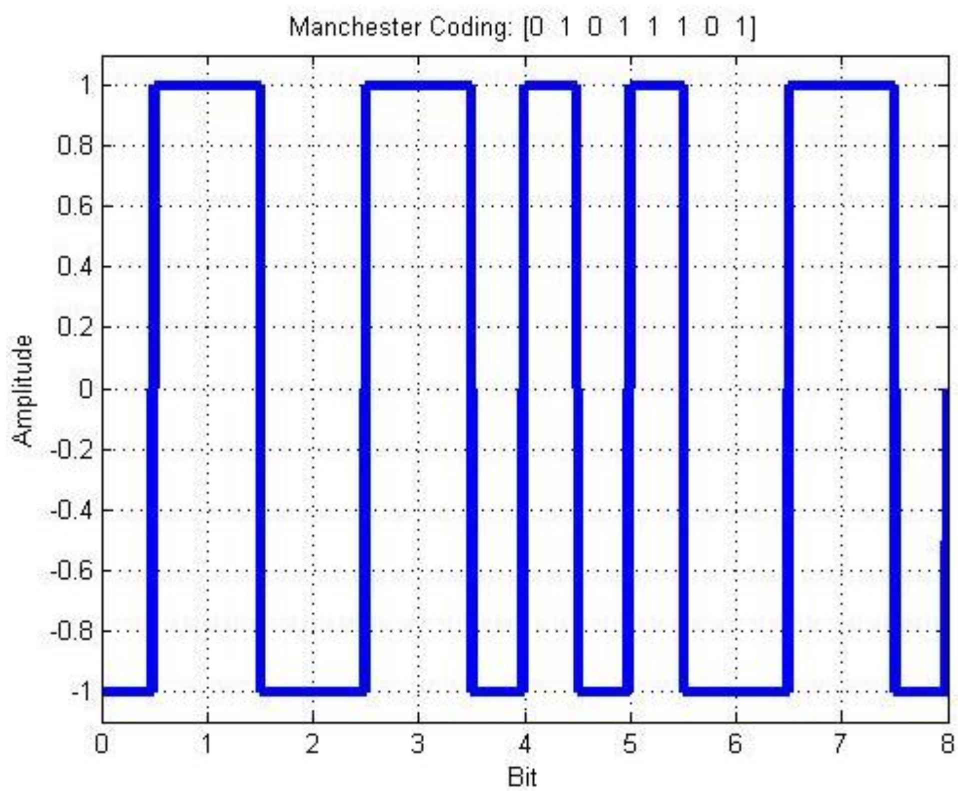
```
%To generate signal using Manchester code for given sequence.
bits = input('Enter bit sequence=');
bitrate = 1; % bits per second
T = length(bits)/bitrate; % full time of bit sequence
n = 200;
N = n*length(bits);
dt = T/N;
t = 0:dt:T;
x = zeros(1,length(t)); % output signal

for i = 0:length(bits)-1
      if bits(i+1) == 1
       x(i*n+1:(i+0.5)*n) = 1;
```

```
            x((i+0.5)*n+1:(i+1)*n) = -1;
           else
            x(i*n+1:(i+0.5)*n) = -1;
            x((i+0.5)*n+1:(i+1)*n) = 1;
           end
      end

      plot(t,x,'LineWidth',4);
      axis([0 t(end) -1.1 1.1]);
      xlabel('Bit');
      ylabel('Amplitude');
      grid on;
      title(['Manchester Ciding: [' num2str(bits) ']']);
```

Waveform:



Result: Manchester coded signal is generated successfully.

Signature of Faculty

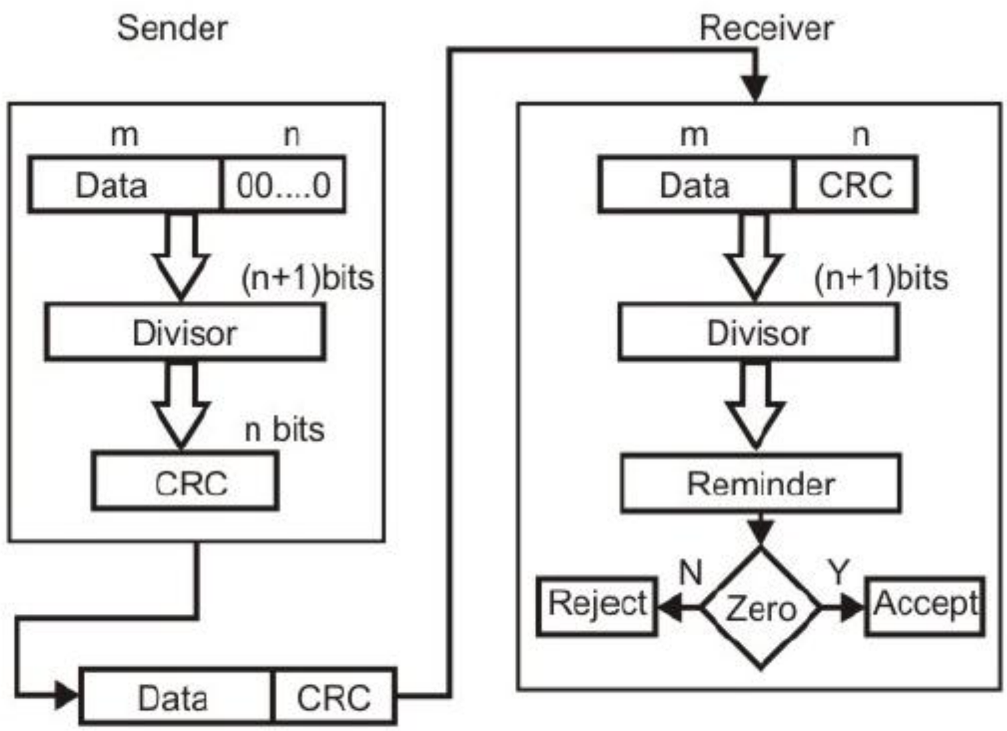
Date of Experiment: ____________

Experiment No. : 8

AIM: Write MATLAB codes to generate CRC code for the given data bit and the divisor.

TOOLS REQUIRED: MATLAB v 7.8

THEORY: This Cyclic Redundancy Check is the most powerful and easy to implement technique. Unlike checksum scheme, which is based on addition, CRC is based on binary division. In CRC, a sequence of redundant bits, called **cyclic redundancy check bits**, are appended to the end of data unit so that the resulting data unit becomes exactly divisible by a second, predetermined binary number. At the destination, the incoming data unit is divided by the same number. If at this step there is no remainder, the data unit is assumed to be correct and is therefore accepted. A remainder indicates that the data unit has been damaged in transit and therefore must be rejected. The generalized technique can be explained as follows.



If a k bit message is to be transmitted, the transmitter generates an r-bit sequence, known as *Frame Check Sequence* (FCS) so that the $(k+r)$ bits are actually being transmitted. Now this r-bit FCS is generated by dividing the original number, appended by r zeros, by *a* predetermined number. This number, which is $(r+1)$ bit in length, can also be considered as the coefficients of a polynomial, called G*enerator Polynomial.* The remainder of this division process generates the *r*-bit FCS. On receiving the packet, the receiver divides the *(k+r)* bit frame by the same predetermined number and if it produces no remainder, it can be assumed that no error has occurred during the transmission. Operations at both the sender and receiver end are shown in Fig.

CODES:

```
%CRC Generator
x = input('enter data word = ');
y = input('enter divisor = ');
p = length(y);
k = length(x);
n = p+k-1;
dw = x;
for  z=1:(n-k)
     dw(k+z) = 0;
end
for  z=1:p
     td(z)= dw(z);
     tr2(z)=0;
     tr3(z)=1;
end
     tr = xor(td,y);
while(1)
     z=z+1;
if(z>n)
break;
end

tr(p+1)=dw(z);
for  l=2:(p+1)
     tr1(l-1)=tr(l);
end

tr = tr1;
```

```
if   (tr(1)==0)
     tr=xor(tr,tr2);
     else
     tr=xor(tr,y);
     end
end
cd=x;
for  z=2:p
     cd(k+z-1)=tr(z);
end
disp(cd);
```

Result: The CRC code for given data is generated successfully.

enter data word = [1 0 0 1 0 0]

enter divisor = [1 1 0 1]

CRC Codeword 1 0 0 1 0 0 0 0 1

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Date of Experiment: ____________

Experiment No. : 9

AIM: Write MATLAB codes to Plot Efficiency of Pure Aloha and slotted Aloha.

TOOLS REQUIRED: MATLAB v 7.8

THEORY: **ALOHAnet**, also known as the **ALOHA System**, or simply **ALOHA**, was a pioneering computer networking system developed at the University of Hawaii. ALOHAnet became operational in June, 1971, providing the first public demonstration of a wireless packet data network.

Pure ALOHA

In pure ALOHA, the stations transmit frames whenever they have data to send. When two or more stations transmit simultaneously, there is collision and the frames are destroyed. In pure ALOHA, whenever any station transmits a frame, it expects the acknowledgement from the receiver. If acknowledgement is not received within specified time, the station assumes that the frame (or acknowledgement) has been destroyed. If the frame is destroyed because of collision the station waits for a random amount of time and sends it again. This waiting time must be random otherwise same frames will collide again and again. Therefore pure ALOHA dictates that when time-out period passes, each station must wait for a random amount of time before resending its frame. This randomness will help avoid more collisions.

Slotted ALOHA

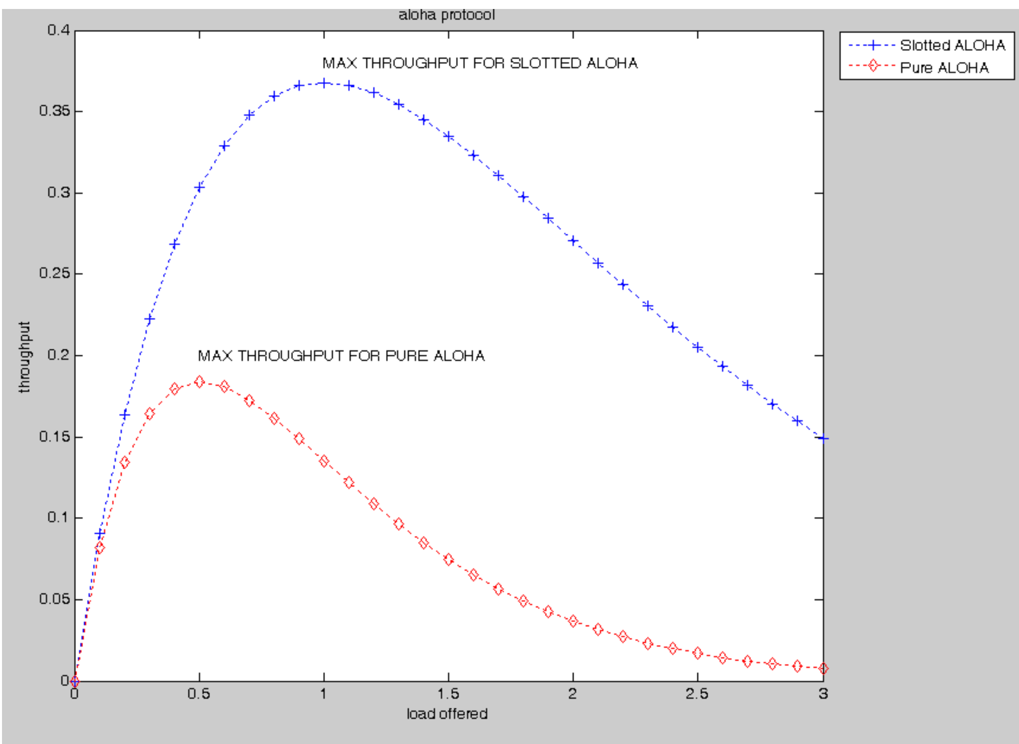
Slotted ALOHA was invented to improve the efficiency of pure ALOHA as chances of collision in pure ALOHA are very high. In slotted ALOHA, the time of the shared channel is divided into discrete intervals called slots. The stations can send a frame only at the beginning of the slot and only one frame is sent in each slot. In slotted ALOHA, if any station is not able to place the frame onto the channel at the beginning of the slot *i.e.* it misses the time slot then the station has to wait until the beginning of the next time slot. Slotted ALOHA still has an edge over pure ALOHA as chances of collision are reduced to one-half.

Codes:

```
%To Plot Efficiency of Pure Aloha and slotted Aloha.
G=0:0.1:3;
S=G.*exp(-G);
plot(G,S,'b+:');
text(1,.38,'MAX THROUGHPUT FOR SLOTTED ALOHA')
xlabel('load offered');
```

```
ylabel('throughput');
title('aloha protocol');
hold on;
S1=G.*exp(-2*G);
plot(G,S1,'rd:');
text(0.5,.2,'MAX THROUGHPUT FOR PURE ALOHA')
xlabel ('load offered');
ylabel ('throughput');
title ('aloha protocol');
legend ('Slotted ALOHA','Pure ALOHA', 'Location',
'NorthEastOutside')
```

Waveform:



Result: Efficiency of Pure and slotted ALOHA is successfully plotted.

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Date of Experiment: ____________

Experiment No. : 10

AIM: Write MATLAB codes to plot Channel Efficiency of Ethernet.

TOOLS REQUIRED: MATLAB v 7.8

THEORY: The formula for cellular radio capacity is modified to explicitly include channel efficiency. The effect of a varying carrier-to-interference ratio is considered. Higher carrier power can lead to higher bit-rates per hertz of bandwidth for individual channels, but it reduces the frequency reuse. The tradeoff between these two effects is made explicit. It is seen that there is a point of diminishing returns beyond which the advantage of higher channel efficiency is outweighed by reduced frequency reuse. There should be an optimum carrier-to-interference ratio that maximizes the capacity as measured in number of channels per cell.

CODES:

```
b=input('enter the b.w.');
l=input('enter the input length');
c=input('enter the input capacity');
k=1:256; f1=64*8;
f2=128*8; f3=256*8;
p=((k-1)/k).^(k-1);
x=(2*b*l)./(c.*p);
a1=x./f1;
a2=x./f2;
a3=x./f3;
n1=1./(1+a1);
n2=1./(1+a2);
n3=1./(1+a3);
plot(k,n1,'rd:');
hold on;
plot(k,n2,'gp:');
hold on;
```

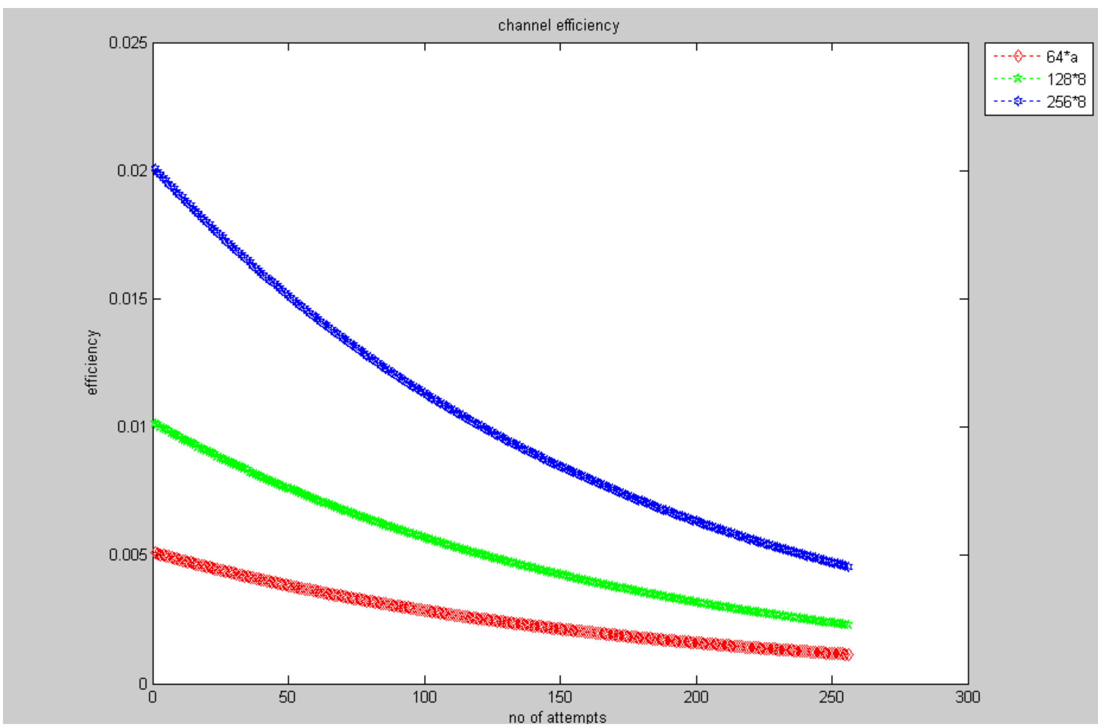
```
    plot(k,n3,'bh:');
    xlabel('no of attempts');
    ylabel('efficiency');
title('channel efficiency');
```

Plot of Channel Efficiency:

Enter the b.w. : 20000000

Enter the input length : 2500

Enter the input capacity : 1000000



RESULT – Channel Efficiency for Ethernet is plotted successfully.

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