Department of Electrical Engineering
Assignment
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Course Details

Course Title: Advance Computer Networks **Module:** 3rd
Instructor: Naeem Ahmad Jan **Total Marks:** 30

Student Details

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Q1.	(a)	Explain Physical layer services and Transmission Impairments?	Marks 6
	(b)	Express a period of 1 ms in microseconds, and express the corresponding frequency in kilohertzand A sine wave is offset one-fourth of a cycle with respect to time zero. What is its phase in degrees and radians?	Marks 4
Q2.	(a)	Explain the classification of digital to digital conversion? Difference between data element and signal element?	Marks 6
	(b)	We want to digitize the human voice. What is the bit rate, assuming 7 bits per sample?	Marks 4
Q3.	(a)	Explain the responsibilities of different layers of TCP/IP in detail?	Marks 6
	(b)	Convert the following data 01110010 to Manchester coding and Bipolar AMI?	Marks 4

Q1. (a) Explain Physical layer services and Transmission Impairments?

ANS: The physical layer is the first layer of the Open System Interconnection Model (OSI Model). The physical layer deals with bit-level transmission between different devices and supports electrical or mechanical interfaces connecting to the physical medium for synchronized communication.

This layer plays with most of the network's physical connections - wireless transmission, cabling, cabling standards and types, connectors and types, network interface cards, and more - as per network requirements. However, the physical layer does not deal with the actual physical medium (like copper, fiber).

The physical layer provides the following services:

- Modulates the process of converting a signal from one form to another so that it can be physically transmitted over a communication channel
- Bit-by-bit delivery
- Line coding, which allows data to be sent by hardware devices that are optimized for digital communications that may have discreet timing on the transmission link
- Bit synchronization for synchronous serial communications
- Start-stop signaling and flow control in asynchronous serial communication
- Circuit switching and multiplexing hardware control of multiplexed digital signals
- Carrier sensing and collision detection, whereby the physical layer detects carrier availability and avoids the congestion problems caused by undeliverable packets
- Signal equalization to ensure reliable connections and facilitate multiplexing
- Forward error correction/channel coding such as error correction code
- Bit interleaving to improve error correction
- Auto-negotiation
- Transmission mode control

Examples of protocols that use physical layers include:

- Digital Subscriber Line
- Integrated Services Digital Network
- Infrared Data Association
- Universal Serial Bus
- Bluetooth
- Controller Area Network
- Ethernet

<u>Transmission Impairment in Computer Network:</u>

In communication system, analog signals travel through transmission media, which tends to deteriorate the quality of analog signal. This imperfection causes signal impairment. This means that received signal is not same as the signal that was send. This imperfection cause signal impairment.

<u>Consequences:</u>

- For a digital signal, there may occur bit errors.
- For analog signals, these impairments degrade the quality of the signals.

Causes of impairment:

There are three main causes of impairment are,

1. Attenuation
2. Distortion
3. Noise

Attenuation – It means loss of energy. The strength of signal decreases with increasing distance which causes loss of energy in overcoming resistance of medium. This is also known as attenuated signal. Amplifiers are used to amplify the attenuated signal which gives the original signal back. Attenuation is measured in **decibels(dB)**. It measures the relative strengths of two signals or one signal at two different point.

ATTENUATION(DB) = 10LOG10(P2/P1)

Distortion – It means change in the shape of signal. This is generally seen in composite signals with different frequencies. Each frequency component has its own propagation speed travelling through a medium. Every component arrives at different time which leads to delay distortion. Therefore, they have different phases at receiver end from what they had at senders end.

Noise – The random or unwanted signal that mixes up with the original signal is called noise. There are several types of noise such as induced noise, crosstalk noise, thermal noise and impulse noise which may corrupt the signal.

Induced noise comes from sources such as motors and appliances. These devices act as sending antenna and transmission medium act as receiving antenna. Thermal noise is movement of electrons in wire which creates an extra signal. Crosstalk noise is when one wire affects the other wire. Impulse noise is a signal with high energy that comes from lightning or power lines

SNR = AVG SIGNAL POWER / AVG NOISE POWER

Ans#1 : (B)

$1 \text{ ms} = 1 * 10^{-3} \text{ s}$

1 milli Second = 10^{-3} s

1 second = 10^{6} µs

We can also write

$= 1 * 10^{-3} * 10^{6}$

$= 10^{3}$ µs

⇨ $1\text{ms} = 10^{3}$ µs

As, $1 \text{ ms} = 10^{-3} \text{ s}$

And $f = 1 / t$

$f = 1 / 10^{-3}$ Hz

$f = 10^{3}$Hz

f= 1000 Hz

or **, f=1 KHz**

As Complete cycle is 360°

Therefore ¼ cycles is

¼ * 360° = 90°

a sin wave is offset one forth of a cycle with respect to time zero its phase in radian is :

$$90° * \frac{2\pi}{360} = \frac{\pi}{2} = \textbf{1.5708 radian}$$

Q2. (a) Explain the classification of digital to digital conversion? Difference between data element and signal element?

ANS: Data or information can be stored in two ways, analog and digital. For a computer to use the data, it must be in discrete digital form. Similar to data, signals can also be in analog and digital form. To transmit data digitally, it needs to be first converted to digital form.

Digital-to-Digital Conversion:

This section explains how to convert digital data into digital signals. It can be done in two ways, line coding and block coding. The conversion involves three techniques: line coding, block coding, and scrambling. Line coding is always needed; block coding and scrambling may or may not be needed.

Line Coding:

Line coding is the process of converting digital data to digital signals. We assume that data, in the form of text, numbers, graphical images, audio, or video, are stored in computer memory as sequences of bits. Line coding converts a sequence of bits to a digital signal. At the sender, digital data are encoded into a digital signal; at the receiver, the digital data are recreated by decoding the digital signal. Figure shows the process.

Digital signal is denoted by discreet signal, which represents digital data. There are three types of line coding schemes available:

Uni-polar Encoding:

Unipolar encoding schemes use single voltage level to represent data. In this case, to represent binary 1, high voltage is transmitted and to represent 0, no voltage is transmitted. It is also called Unipolar-Non-return-to-zero, because there is no rest condition i.e. it either represents 1 or 0.

Polar Encoding

Polar encoding scheme uses multiple voltage levels to represent binary values. Polar encodings is available in four types:

- **Polar Non-Return to Zero (Polar NRZ)**

  It uses two different voltage levels to represent binary values. Generally, positive voltage represents 1 and negative value represents 0. It is also NRZ because there is no rest condition.

  NRZ scheme has two variants: NRZ-L and NRZ-I.

  NRZ-L changes voltage level at when a different bit is encountered whereas NRZ-I changes voltage when a 1 is encountered.

- **Return to Zero (RZ)**

  Problem with NRZ is that the receiver cannot conclude when a bit ended and when the next bit is started, in case when sender and receiver's clock are not synchronized.

  RZ uses three voltage levels, positive voltage to represent 1, negative voltage to represent 0 and zero voltage for none. Signals change during bits not between bits.

- **Manchester**

  This encoding scheme is a combination of RZ and NRZ-L. Bit time is divided into two halves. It transits in the middle of the bit and changes phase when a different bit is encountered.

- **Differential Manchester**

  This encoding scheme is a combination of RZ and NRZ-I. It also transit at the middle of the bit but changes phase only when 1 is encountered.

Bipolar Encoding

Bipolar encoding uses three voltage levels, positive, negative and zero. Zero voltage represents binary 0 and bit 1 is represented by altering positive and negative voltages.

Block Coding

We need redundancy to ensure synchronization and to provide some kind of inherent error detecting. Block coding can give us this redundancy and improve the performance of line coding. In general, block coding changes a block of m bits into a block of n bits, where n is larger than m. Block coding is referred to as an mBlnB encoding technique.

To ensure accuracy of the received data frame redundant bits are used. For example, in even-parity, one parity bit is added to make the count of 1s in the frame even. This way the original number of bits is increased. It is called Block Coding.

Block coding is represented by slash notation, mB/nB.Means, m-bit block is substituted with n-bit block where n > m. Block coding involves three steps:

- Division,
- Substitution
- Combination.

After block coding is done, it is line coded for transmission.

Scrambling

Biphase schemes that are suitable for dedicated links between stations in a LAN are not suitable for long-distance communication because of their wide bandwidth requirement. The combination of block coding and NRZ line coding is not suitable for long-distance encoding either, because of the DC component. Bipolar AMI encoding, on the other hand, has a narrow bandwidth and does not create a DC component. However, a long sequence of Os upsets the synchronization. If we can find a way to avoid a long sequence of Os in the original stream, we can use bipolar AMI for long distances. We are looking for a technique that does not increase the number of bits and does provide synchronization. We are looking for a solution that substitutes long zero-level pulses with a combination of other levels to provide synchronization. One solution is called scrambling. We modify part of the AMI rule to include scrambling, as shown in Figure 4.18. Note that scrambling, as opposed to block coding, is done at the same time as encoding. The system needs to insert the required pulses based on the defined scrambling rules. Two common scrambling techniques are B8ZS and HDB

Signal Element versus Data Element:

Let us distinguish between a data element and a signal element. In data communications, our goal is to send data elements. A data element is the smallest entity that can represent a piece of information: this is the bit. In digital data communications, a signal element carries data elements. A signal element is the shortest unit (time wise) of a digital signal. In other words, data elements are what we need to send; signal elements are what we can send. Data elements are being carried; signal elements are the carriers. We define a ratio r which is the number of data elements carried by each signal element.

(b) We want to digitize the human voice. What is the bit rate, assuming 7 bits per sample?

ANS: The human voice normally contains frequencies from 0 to 4000 Hz. So the sampling rate and bit rate are calculated as follows:

Sampling rate= 4000 X 2 = **8000 samples/s**

Bit rate = 8000X 7 = 56000 bps = **56 kbps**

Q3. (a) Explain the responsibilities of different layers of TCP/IP in detail?

ANS: While TCP/IP is the newer model, the Open Systems Interconnection (OSI) model is still referenced a lot to describe network layers. The OSI model was developed by the International Organization for Standardization. There are 7 layers:

1. Physical (e.g. cable, RJ45)
2. Data Link (e.g. MAC, switches)
3. Network (e.g. IP, routers)
4. Transport (e.g. TCP, UDP, port numbers)
5. Session (e.g. Syn/Ack)
6. Presentation (e.g. encryption, ASCII, PNG, MIDI)
7. Application (e.g. SNMP, HTTP, FTP)

People have come up with tons of mnemonic devices to memorize the OSI network layers. One popular mnemonic, starting with Layer 7, is "All People Seem To Need Data Processing." But one that I'm partial to, which starts with Layer 1, is "Please Do Not Throw Sausage Pizza Away."

The TCP/IP model is a more concise framework, with only 4 layers:

1. Network Access (or Link)
2. Internet
3. Transport (or Host-to-Host)
4. Application (or Process)

One mnemonic device for the TCP/IP model is "Armadillos Take In New Ants."

Network Layers and Functions

For the OSI model, let's start at the top layer and work our way down.

- Layer 7 (Application): Most of what the user actually interacts with is at this layer. Web browsers and other internet-connected applications (like Skype or Outlook) use Layer 7 application protocols.
- Layer 6 (Presentation): This layer converts data to and from the Application layer. In other words, it translates application formatting to network formatting and vice versa. This allows the different layers to understand each other.
- Layer 5 (Session): This layer establishes and terminates connections between devices. It also determines which packets belong to which text and image files.
- Layer 4 (Transport): This layer coordinates data transfer between system and hosts, including error-checking and data recovery.
- Layer 3 (Network): This layer determines how data is sent to the receiving device. It's responsible for packet forwarding, routing, and addressing.
- Layer 2 (Data Link): Translates binary (or BITs) into signals and allows upper layers to access media.
- Layer 1 (Physical): Actual hardware sits at this layer. It transmits signals over media.

The TCP/IP model, sometimes referred to as a protocol stack, can be considered a condensed version of the OSI model.

- Layer 1 (Network Access): Also called the Link or Network Interface layer. This layer combines the OSI model's L1 and L2.
- Layer 2 (Internet): This layer is similar to the OSI model's L3.
- Layer 3 (Transport): Also called the Host-to-Host layer. This layer is similar to the OSI model's L4.
- Layer 4 (Application): Also called the Process layer, this layer combines the OSI model's L5, L6, and L7.

How Network Layers Work

As we walk through an example, keep in mind that the network layers models are not strictly linear. One layer doesn't finish its processes before the next one begins. Rather, they work in tandem.

Application, Presentation, and Session Layers

Let's suppose you're using Skype on a laptop. You're messaging your friend, who's using Skype on their phone from a different network.

Skype, as a network-connected application, uses **Layer 7 (Application)** protocols like Telnet. If you send your friend a picture of your cat, Skype would be using the File Transfer Protocol (FTP).

Layer 6 (Presentation) receives application data from Layer 7, translates it into binary, and compresses it. When you send a message, Layer 6 encrypts that data as it leaves your network. Then it decrypts the data when your friend receives it.

Applications like Skype consist of text files and image files. When you download these files, **Layer 5 (Session)** determines which data packets belong to which files, as well as where these packets go. Layer 5 also establishes, maintains, and ends communication between devices.

Transport and Network Layers

Layer 4 (Transport) receives data from Layer 5 and segments it. Each segment, or data unit, has a source and destination port number, as well as a sequence number. The port number ensures that the segment reaches the correct application. The sequence number ensures that the segments arrive in the correct order.

This layer also controls the amount of data transmitted. For example, your laptop may be able to handle 100 Mbps, whereas your friend's phone can only process 10 Mbps. Layer 4 can dictate that the server slow down the data transmission, so nothing is lost by the time your friend receives it. But when your friend sends a message back, the server can increase the transmission rate to improve performance.

Lastly, Layer 4 performs error-checking. If a segment of data is missing, Layer 4 will re-transmit that segment.

TCP and UDP are both very well-known protocols, and they exist at Layer 4. TCP favors data quality over speed, whereas UDP favors speed over data quality.

Layer 3 (Network) transmits data segments between networks in the form of packets. When you message your friend, this layer assigns source and destination IP addresses to the data segments. Your IP address is the source, and your friend's is the destination. Layer 3 also determines the best paths for data delivery.

Data Link and Physical Layers

Layer 2 (Data Link) receives packets from Layer 3. Whereas Layer 4 performs logical addressing (IPv4, IPv6), Layer 2 performs physical addressing. It adds sender and receiver MAC addresses to the data packet to form a data unit called a frame. Layer 2 enables frames to be transported via local media (e.g. copper wire, optical fiber, or air). This layer is embedded as software in your computer's Network Interface Card (NIC).

In short, Layer 2 allows the upper network layers to access media, and controls how data is placed and received from media.

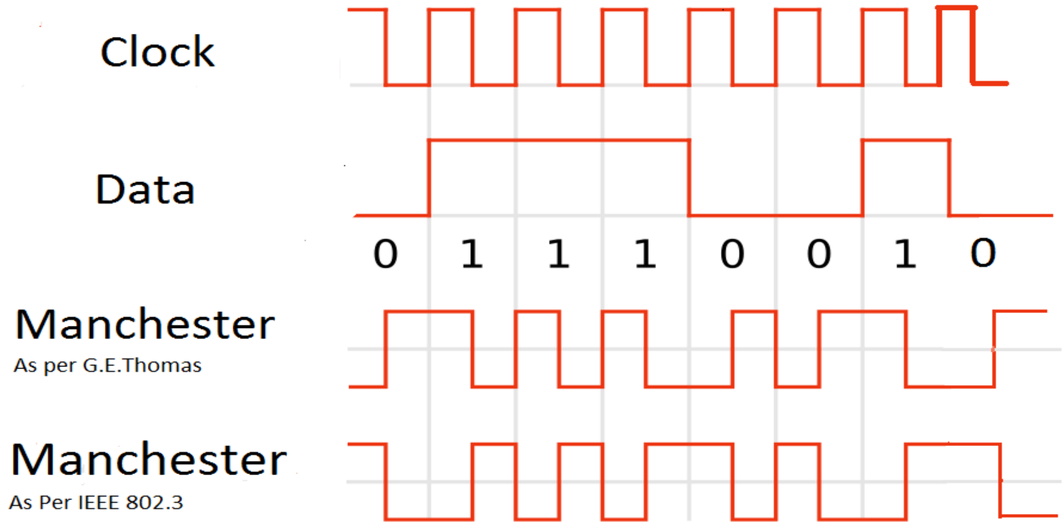
Hardware—the things you can actually physically touch—exist at **Layer 1 (Physical).** This layer converts the binary from the upper layers into signals and transmits them over local media. These can be electrical, light, or radio signals; it depends on the type of media used. When your friend receives the signals, they're decapsulated, or translated back into binary and then into application data so your friend can see your message.

(b) Convert the following data 01110010 to Manchester coding and Bipolar AMI?

ANS:

Manchester Coding :

Manchester encoding is a synchronous clock encoding technique used by the physical layer of the Open System Interconnection [OSI] to encode the clock and data of a synchronous bit stream. In data transmission, Manchester encoding is a form of digital encoding in which data bits are represented by transitions from one logical state to the other. This is different from the more common method of encoding, in which a bit is represented by either a high state such as +5 volts or a low state such as 0 volts. The chief advantage of Manchester encoding is the fact that the signal synchronizes itself. This minimizes the error rate and optimizes reliability. The main disadvantage is the fact that a Manchester-encoded signal requires that more bits be transmitted than those in the original signal.



So data encodes to **<u>1001010110100110</u>**

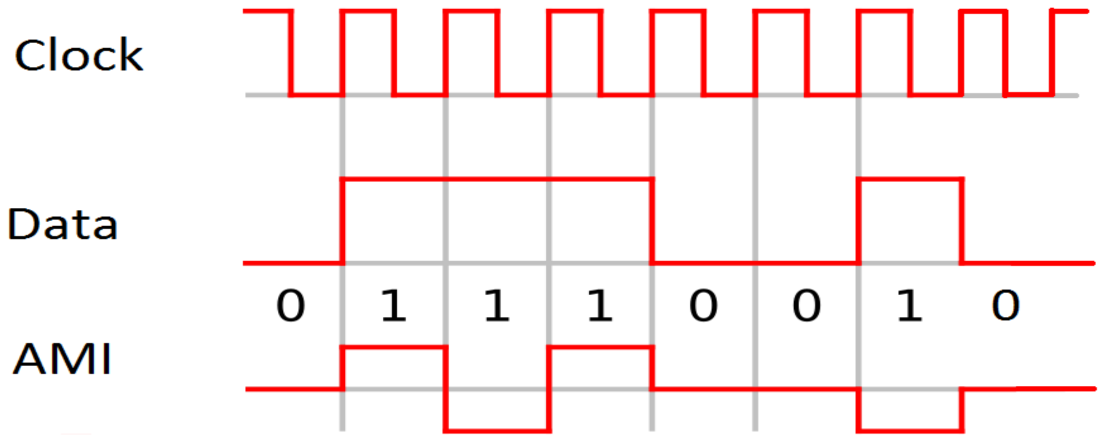
<u>Bipolar AMI :</u>

AMI (Alternate Mark Inversion)

AMI (Alternate Mark Inversion) is a synchronous clock encoding technique which uses bipolar pulses to represent logical 1 values. It is therefore a three level system. A logical 0 is represented by no symbol, and a logical 1 by pulses of alternating polarity. The alternating coding prevents the build-up of a d.c. voltage level down the cable. This is considered an advantage since the cable may be used to carry a small d.c. current to power intermediate equipment such as line repeaters.

AMI coding was used extensively in first generation PCM networks, but suffers the drawback that a long run of 0's produces no transitions in the data stream (and therefore does not contain sufficient transitions to guarantee lock of a DPLL). Successful transmission therefore relies on the user not wishing to send long runs of 0's and this type of encoding is not therefore transparent to the sequence of bits being sent.

The HDB3 encoding scheme is one of many which have been developed to provide regular transitions irrespective of the pattern of data being carried.



So data encodes to **<u>0 +1 -1 +1 0 0 -1 0</u>**