OVERVIEW OF DATA COMMUNICATION AND NETWORKING

Multiple Choice Type Questions

1. Match the following A with B: [WBUT 2013]

A	B
a) Format and code conversion services	m) Session layer
b) Establishes, manages and terminates sessions	n) Application
c) Ensures reliable transmission of data	o) Transport layer
d) Log –in and log – out procedures	p) Presentation layer

	(a)	(b)	(c)	(d)
a)	p	m	o	n
b)	m	o	p	n
c)	n	p	m	o
d)	p	o	n	m

Answer: (a)

2. Repeater functions in _____ layer(s). [WBUT 2013]

a) Physical (MAC) b) Data link c) network d) both (a) and (b)

Answer: (a)

3. Match the following: [WBUT 2013]

I) Datalink layer	P) POP3
II) Network layer	Q) UDP
III) Transport layer	R) RARP
IV) Application layer	S) PPP

	I	II	III	IV
a)	P	Q	R	S
b)	P	R	Q	S
c)	S	Q	R	P
d)	S	R	Q	P

Answer: (a)

4. The position of SSL in TCP / IP protocol suite is [WBUT 2013]

a) between transport and internet layer
b) between data link and physical layer
c) between application and transport layer
d) none of these

Answer: (c)

5. How many link required for a fully connected ring topology? [WBUT 2014]

a) n(n-) b) n c) n(n-1) d) n-1

Answer: (b)

6. Which one is a DCE device? [WBUT 2014]
a) modem b) computer c) network card d) none of this
Answer: (a)

7. Transmission media are closest to the layer [WBUT 2014]
a) Physical b) network c) datalink d) transport
Answer: (a)

8. BNC connectors are used by cables [WBUT 2014]
a) UTP b) STP c) coaxial d) fibre-optic
Answer: (c)

9. The process of converting analog signals into digital signals so they can be processed by a receiving computer is referred to as [WBUT 2014]
a) modulation b) demodulation c) synchronizing d) digitizing
Answer: (b)

10. Which of the following can be determined from a frequency-domain Graph of signal? [WBUT 2014]
a) frequency b) phase c) power
d) all of these e) none of these
Answer: (d)

11. Which of the following is considered a broadband communication channel?
a) Coaxial cable b) fiber optic cable [WBUT 2014]
c) microwave circuits d) all of these
Answer: (d)

12. The transmission signal coding method of TI carrier is called [WBUT 2014]
a) Bipolar b) NRZ c) Manchester d) binary
Answer: (a)

13. A protocol is a set of rules governing a time sequence of events that must take place [WBUT 2014]
a) between peers b) between an interface
c) between modems d) across an interface
Answer: (a)

14. In OSI network model, the dialogue control and token management are responsibility of [WBUT 2015]
a) session layer b) network layer
c) transport layer d) data link layer
Answer: (a)

15. Which of the following performs modulation and demodulation? [WBUT 2015]
a) fiber optics b) satellite c) coaxial cable d) modem
Answer: (d)

16. RZ encoding involves ..... Level(s) of signal amplitude. [WBUT 2016]
a) 1 b) 3 c) 4 d) 5

Answer: (b)

17. PCM is an example of ..... conversion. [WBUT 2016]
a) digital to analog b) analog to analog
c) digital to digital d) analog to digital

Answer: (d)

18. The four basic elements of any communication system include [WBUT 2018]
a) peer-to-peer, videoconferencing, online photo-conferencing, net optical
b) sending and receiving devices, communication channel, connection device and data transmission specifications
c) telephone lines, coaxial cables fiber-optics cables and communication channel
d) software, hardware, communication channel, network

Answer: (b)

19. Automatic repeat request error management mechanism is provided by [WBUT 2018]
a) Media access control
b) Logical link control sublayer
c) Network interface control sublayer
d) None of these

Answer: (a)

Short Answer Type Questions

1. How fiber – optic works? Explain. [WBUT 2013]

Answer:

Optical fiber (or "fiber optic") refers to the medium and the technology associated with the transmission of information as light pulses along a glass or plastic strand or fiber. Optical fiber carries much more information than conventional copper wire and is in general not subject to electromagnetic interference and the need to retransmit signals. Most telephone company long-distance lines are now made of optical fiber. Transmission over an optical fiber cable requires repeaters at distance intervals. The glass fiber requires more protection within an outer cable than copper. For these reasons and because the installation of any new cabling is labor-intensive, few communities have installed optical fiber cables from the phone company's branch office to local customers (known as local loops). A type of fiber known as single mode fiber is used for longer distances; multimode fiber is used for shorter distances.

2. Explain about the various modes of data transfer. [WBUT 2013]

Answer:

Network devices use three transmission modes (methods) to exchange data, ***simplex, half duplex***, and ***full duplex***.

- **Simplex transmission** is like a one-way street where traffic moves in only one direction. Simplex mode is a one-way-only transmission, which means that data can flow only in one direction from the sending device to the receiving device. Figure 1-7 illustrates simplex transmission.
- **Half-duplex transmission** is like the center lane on some three-lane roads. It is a single lane in which traffic can move in one direction or the other, but not in both directions at the same time. Half-duplex mode limits data transmission because each device must take turns using the line. Therefore, data can flow from A to B and from B to A, but not at the same time. Figure 1-8 illustrates half-duplex transmission.
- **Full-duplex transmission** is like a major highway with two lanes of traffic, each lane accommodating traffic going in opposite directions. Full-duplex mode accommodates two-way simultaneous transmission, which means that both sides can send and receive at the same time. In full-duplex mode, data can flow from A to B and B to A at the same time.

3. Explain the function of various layer in TCP/IP. **[WBUT 2013]**

Answer:

TCP/IP is based on a four-layer reference model. All protocols that belong to the TCP/IP protocol suite are located in the top three layers of this model.

Application Layer: Defines TCP/IP application protocols and how host programs interface with transport layer services to use the network.

Transport Layer: Provides communication session management between host computers. Defines the level of service and status of the connection used when transporting data.

Internet: Packages data into IP datagrams, which contain source and destination address information that is used to forward the datagrams between hosts and across networks. Performs routing of IP datagrams.

Network interface: Specifies details of how data is physically sent through the network, including how bits are electrically signaled by hardware devices that interface directly with a network medium, such as coaxial cable, optical fiber, or twisted-pair copper wire.

4. We have a channel with 1MHz bandwidth. The SNR for this channel is 63; what is the appropriate bit rate and signal level? **[WBUT 2014, 2015]**

Answer:

First we use the Shannon formula to find upper limit.

$C = B \log_2 (1 + SNR)$

C = capacity of the channel in bps

B = Bandwidth

SNR = signal to noise ratio

$C = B \log_2 (1 + SNR) = 10^6 \log_2 (1 + 63) = 10^6 \log_2 64 = 6$ Mbps

Then we use the Nyquist formula to find the number of signal levels.

$4 \text{ Mbps} = 2 \times 1 \text{ MHZ} \times \log_2 L \rightarrow L = 4$

5. What is the difference between OSI model and TCP/IP model? [WBUT 2014, 2015]

Answer:

Both, TCP/IP model and OSI model, work in very similar fashions. But they do have very subtle differences.

OSI Model	TCP/IP Model
1. More of reference model created by ARPA. There are no real implementations.	1. Implemented by almost all equipments used in the context of Internet/Intrenet – computers, routers, cell-phones, etc.
2. Defines seven layers.	2. Defines four layers (Application, Transport, Network and Data-Link) with an abstract physical layer.
3. No clear distinction specified with respect to connection-less and connection-oriented scenarios.	3. Clearly defined connectionless (UDP) and connection-oriented (TCP) Transport layers.
4. Have Session layer and Presentation layer with defined semantics.	4. Transport layer "links-up" with the physical layer directly.

6. a) A signal is sampled. Each sample represents one of four levels. How many bits are needed to represent the each sample? If the sampling rate is 8000 samples per second. What is the bit rate?

b) If the baud rate is 400 for a 4-psk signal, what is bit rate? [WBUT 2014]

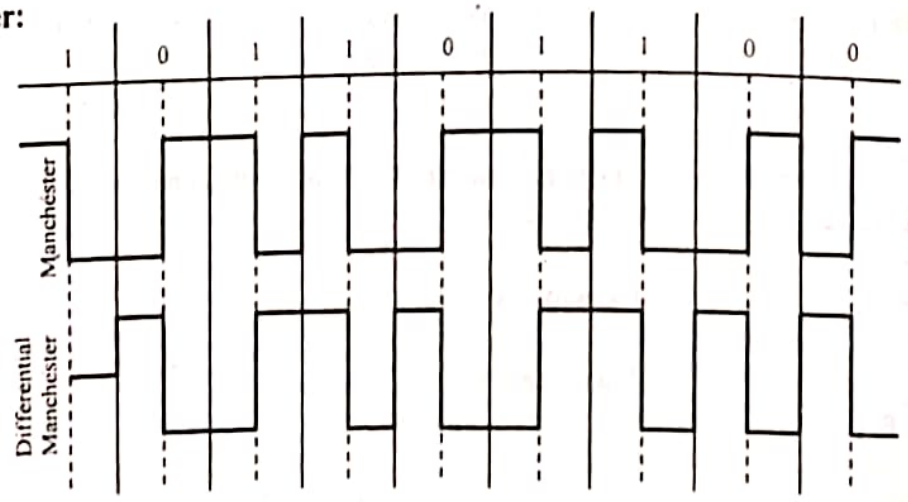
Answer:

a) Quantization 2 bits/sample; Bit rate = 8000 * 2 = 16,000 bps;

b) 800

7. Sketch the waveform for the bit stream 101101100 in Manchester and Differential Manchester encoding scheme. [WBUT 2015]

Answer:



8. What is Bit Rate? What is Baud Rate? An analog signal carries 4 bits in each signal unit. If 1000 signal units are sent per second, find the Baud rate and Bit rate. [WBUT 2016]

Answer:

1st Part:

Bit rate is a measure of the number of data bits (that's 0's and 1's) transmitted in one second. A figure of 2400 bits per second means 2400 zeros or ones can be transmitted in one second, hence the abbreviation 'bps'.

2nd Part:

Baud rate by definition means the number of times a signal in a communications channel changes state. For example, a 2400 baud rate means that the channel can change states up to 2400 times per second.

3rd Part:

There are 1000 signal units are sent per second.

And each signal carries 4 bits, as we know

Bit rate = No. of bits per second = $4 \times 1000\,\text{bit/sec.} = 4000\,\text{bit/sec.} = 4\,\text{kbps.}$

Where **Baud rate** = No. of signal units per second = $1000\,\text{bits/sec.} = 1\,\text{kbps.}$

9. Briefly discuss about the different guided media that are used in computer networks and make a comparison among them. **[WBUT 2016]**

Answer:

There are four basic types of Guided Media:

- Open Wire
- Twisted Pair
- Coaxial Cable
- Optical Fiber

Open Wire: Open Wire is traditionally used to describe the electrical wire strung along power poles. There is a single wire strung between poles. No shielding or protection from noise interference is used. This media is susceptible to a large degree of noise and interference and consequently not acceptable for data transmission except for short distances under 20 ft.

Twisted Pair: The wires in Twisted Pair cabling are twisted together in pairs. Each pair would consist of a wire used for the positive data signal and a wire used for the negative data signal. Any noise that appears on one wire of the pair would occur on the other wire. Because the wires are opposite polarities, they are 180 degrees out of phase and the noise appearing on the wires cancels itself out. Twisted Pair cables are most effectively used in systems that use a balanced line method of transmission

The degree of reduction in noise interference is determined specifically by the number of turns per foot. Increasing the number of turns per foot reduces the noise interference.

To further improve noise rejection, a foil or wire braid shield is woven around the twisted pairs.

Coaxial Cable: Coaxial Cable consists of two conductors. The inner conductor is held inside an insulator with the other conductor woven around it providing a shield. An insulating protective coating called a jacket covers the outer conductor. The outer shield protects the inner conductor from outside electrical signals. The distance between the outer conductor (shield) and inner conductor plus the type of material used for insulating the inner conductor determine the cable properties or impedance. Typical impedances for coaxial cables are 75 ohms for Cable TV, 50 ohms for Ethernet Thinnet and Thicknet. The excellent control of the impedance characteristics of the cable allows higher data rates to be transferred than Twisted Pair cable.

Optical Fibre: Optical Fibre consists of thin glass fibres that can carry information at frequencies in the visible light spectrum and beyond. The typical optical fibre consists of a very narrow strand of glass called the Core. Around the Core is a concentric layer of glass called the Cladding. A typical Core diameter is 62.5 microns (1 micron = 10^{-6} meters). Typically Cladding has a diameter of 125 microns. Coating the cladding is a protective coating consisting of plastic, it is called the Jacket. Data is transmitted as light waves which undergo continuous total internal reflection.

The cost of optical fibre is a trade-off between capacity and cost. At higher transmission capacity, it is cheaper than copper. At lower transmission capacity, it is more expensive.

Topic	Twisted Pair	Co-Axial Cable	Optical Fiber
Number of Cable	One pair of cables are required	Single cable is required	Single Cable is required
Medium	Electrical medium is used	Electrical medium is used	Illumination medium is used
Noise	Noise immunity is low	Noise immunity is moderate.	Noise immunity is high
Speed	Communication speed is low, nearly 4 Mbps	Communication speed is moderate, nearly 500 Mbps	Communication speed is high, nearly 2 Gbps
Bandwidth	Low Bandwidth, 3 MHz	Comparatively high bandwidth, 350MHz	Very High bandwidth, 2 GHz
Distance	Cover small distance, 2 to 10 km	Cover small distance, 1 to 10 km	Cover large distance, 10 to 100km
Usage	Used in LAN, TI Lines	Used in Cable TV, Ethernet Channel	Used in WAN,MAN etc.

10. Physical address operates in local domain whereas logical/IP address-operates in global domain explain. **[WBUT 2016]**

Answer:

i) A Physical address is a 48-bit flat address burned into the ROM of the NIC card which is a Layer1 device of the OSI model. This is divided into 24-bit vendor code and 24-bit serial address. This is unique for each system and cannot be changed.

A Logical address is a 32- bit address assigned to each system in a network. This works in Layer-3 of OSI Model. This would be generally the IP address.

ii) Physical address also called MAC address. It is present on Network interface cad. It won't change.
Logical addressing is used when a packet passes n/w boundary.

11. Explain Mesh, Bus, Ring, Star, Hybrid topology. **[WBUT 2017]**

Answer:

Mesh Topology

Mesh topology is a group of nodes which are all connected to each other and many types of connections are possible in a mesh topology. Every single node is connected to the other nodes in a mesh topology and the chances of connection break downs are very minimal in a mesh topology. Mesh topology is mostly used on a WAN.

Bus Topology

The bus topology is a series of nodes which are all connected to a backbone. Bus networks typically work well for smaller networks and use Ethernet cables for networking. It is easy to maintain and troubleshoot in a bus network. All the nodes in a bus network are dependant on the backbone and even if one node fails the remaining nodes work.

Ring Topology

A ring network is circular in shape and every node will have one node on either side of it. The ring topology is rare to come across because of its limitations. If there is damaged cable or breakdown in any one of the nodes then the entire network stops functioning.

Star Topology

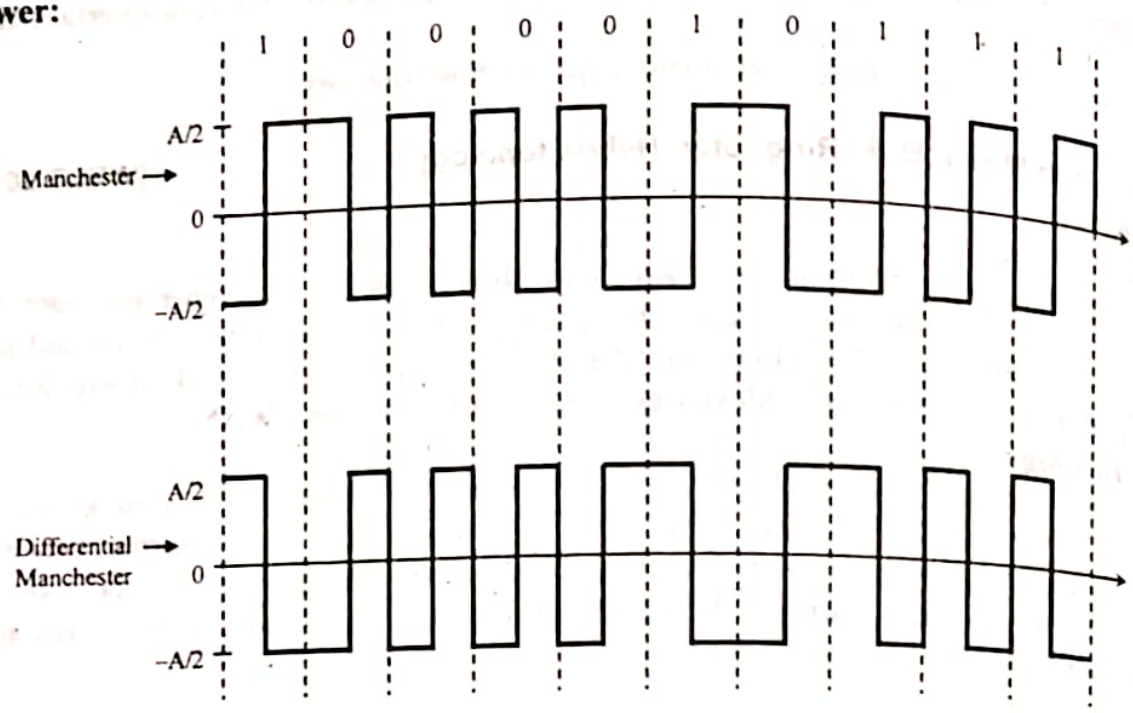
A star topology is based on a central node which acts as a hub. A star topology is common in homes networks where all the computers connect to the single central computer using it as a hub. The medium used to connect is the UTP or the untwisted pair cable. In case one node stops functioning or if there is cable damage the rest of the network would still work.

Hybrid topology

Hybrid topology is an integration of two or more different topologies to form a resultant topology. When different topologies are connected to one another, they do not display characteristics of any one specific topology. This is when it becomes a hybrid topology. It is chosen when there are more than two basic working topologies in place already, and these have to be connected to one another. When there is a star topology connected to another star topology, it still remains a star topology. However, when a star topology and bus topology are connected to one another, it gives rise to the creation of a hybrid topology. Often when the topologies are connected to one another, the layout of the resultant topology is difficult to comprehend, however, the new topology works without any problems.

12. Sketch the waveform for the bit stream 1000010111 in Manchester and Differential Manchester encoding techniques. **[WBUT 2018]**

Answer:



13. a) Define protocol. [MODEL QUESTION]
b) Why multilayered reference model is preferred over single layered structure?
c) Make a comparative study between serial and parallel communication.

Answer:

a) A protocol is a set of rules which governs how data is sent from one point to another. In data communications, there are widely accepted protocols for sending data. Both the sender and receiver must use the same protocol when communicating.

b) Multi-layered reference model is preferred over single layered structure, because each layer has to take care of a limited number of objectives. Hence the design an implementation can be streamlined and made very robust because the number of abnormal conditions to be handled is limited.

Every layer is assumed to be autonomous. This means that a portion of a stack from one manufacturer can easily inter-operate with a portion of the stack from another manufacturer. The user thus gets the advantage of competition among stack vendors at every layer.

c)

Parallel communication	Serial communication
Carries multiple (8, 16, 32, etc.) data bits simultaneously.	Carries data one bit at a time
Can provide very high throughput	Limited throughput
Difficult to achieve "multiple access", hence used mostly for point-to-point communication	Possible to achieve multiple access, hence used in shared communication channels
Needs much more cabling	Needs less cabling

Parallel communication	Serial communication
Modulation rarely applied	Modulation applied in most cases except very simple ones.
Channel must necessarily be wired	Wireless channel is possible

14. a) Twisted pair cable offers better bandwidth than untwisted pair. How?
b) For a 4 kHz voice channel, What should be the minimum bit rate of the digitized channel considering 128 different quantization levels? State clearly Shanon's capacity formula. **[MODEL QUESTION]**

Answer:

a) Twisted pair cabling is a type of wiring in which two conductors (the forward and return conductors of a single circuit) are twisted together for the purposes of canceling out electromagnetic interference (EMI) from external sources; for instance, electromagnetic radiation from unshielded twisted pair (UTP) cables, and crosstalk between neighboring pairs.

b) Voice channel = 4KHz. Hence, Nyquist rate (i.e., minimum sampling rate) 8KHz = 8000 Hz
No. of Quantization levels = $128 = 2^7$
So, it takes 7 bits to code 1 sample.
Minimum bit rate of the digitized channel = Minimum No. of samples per second X No. of bits per sample = 8000 * 7 = 56000 **Bps.**

Shannon's Capacity Formula:

Considering all possible multi-level and multi-phase encoding techniques, the Shannon–Hartley theorem states that the channel capacity C, meaning the theoretical tightest upper bound on the rate of clean (or arbitrarily low bit error rate) data that can be sent with a given average signal power S through an analog communication channel subject to additive white Gaussian noise of power N, is: $C = B\log_2(1+S/N)$

where
C is the channel capacity in bits per second;
B is the bandwidth of the channel in hertz;
S is the total signal power over the bandwidth, measured in watt or volt2;
N is the total noise power over the bandwidth, measured in watt or volt2; and
S/N is the signal-to-noise ratio (SNR) or the carrier-to-noise ratio (CNR) of the communication signal to the Gaussian noise interference expressed as a linear power ratio (not as logarithmic decibels).

15. State Shanon capacity formula for Noisy Channel. **[MODEL QUESTION]**

Answer:

If C is the channel capacity of a noisy channel, then the Shannon formula states that if p is the acceptable bit-error rate, then the achievable bit-rate R is given by:
$R = C / (1 - H(p))$, where, $H(p) = - [p \log p + (1 - p) \log(1 - p)]$

For additive Gaussian noise channel of B/W = B and signal to noise ratio = S/N, C is given by:

$C = B \log (1 + S/N)$

16. a) What is the purpose of multiplexing? FDM is for analog signals, TDM is for digital signals. Explain why.
b) What should be the link capacity to multiplex 3 input signals each of 300 bits per sec speed using 2 bits/sec framing rate? **[MODEL QUESTION]**

Answer:

a) Multiplexing is needed so that the available channel can be used efficiently and also to save costs. There is too much to know about multiplexing, here is just a short overview. One thing that one has to know is multiple access.

Time-domain concept

With respect to time, a signal can be either continuous or discrete. In a continuous signal, the signal intensity varies smoothly over a period of time, i.e., there are no breaks in the signal, e.g., human speech. The familiar sine wave ($y = \sin(x)$) is an example of a continuous signal. On the other hand, in a discrete signal, the signal intensity is maintained at a constant level for some period of time and then changes to another constant level, e.g., binary 1 and 0.

Frequency-domain concept

Practically speaking, an electromagnetic signal is made up of many frequencies, for example, the human speech uses a frequency range between 20 Hz – 200,000 Hz. This frequency range is called as the spectrum of the signal.

b) 3 input signals, each of 300 bps + 2bps framing rate means no. of bits arrives per second = (300 + 2) * 3= 906 bps.
Therefore, Link Capacity = 906bps

17. a) What is the purpose of providing two separate protocols UDP and TCP in the transport layer of TCP/ IP architecture?
b) Define bandwidth of a media. **[MODEL QUESTION]**

Answer:

a) TCP is a connection oriented protocol. So it offers a reliable transmission of data. But UDP is connectionless protocol. Which produce an unreliable service but it is faster than connection oriented protocol.

b) ***Band Width:***

Bandwidth (computing) or digital bandwidth: a rate of data transfer, throughput or bit rate, measured in bits per second

Bandwidth (signal processing) or analog bandwidth: a measure of the width of a range of frequencies, measured in hertz

18. a) Define baseband and broadband transmission? [MODEL QUESTION]
b) What is the application of TDM Switching? What is multiplexing?

Answer:

a) Baseband: Electronic data prior to any modification. It refers to analog or digital data before they are merged with other signals (multiplexed) or intermixed into a carrier wave (modulated).

Broadband: A type of data transmission in which a single medium (wire) can carry several channels at once, cable TV, for example. In contrast, baseband transmission allows only one signal at a time.

b) Time Division Multiplexing (TDM) Switching is a type of digital multiplexing where two or more channels are derived from a selected frequency spectrum.
There are some apparent key benefits to using Time Division Multiplexing Switching as opposed to one of the other multiplexing switching techniques, such as:
TDM switching enables service providers to use both their legacy services and the new services simultaneously.
TDM can reduce costs by enabling service providers to move to Signalling System 7 (SS7).
TDM switching can positively impact investment and cost for service providers.
Multiplexing is sending multiple signals or streams of information on a carrier at the same time in the form of a single, complex signal and then recovering the separate signals at the receiving end.

19. a) Find the bandwidth for a QPSK signal transmitting at 2kbps. The transmission is in full duplex mode.
b) A digital signaling system is required to operate at 9600 bps. If a signal element encodes 16 bit word, what is the minimum bandwidth required for this channel?
[MODEL QUESTION]

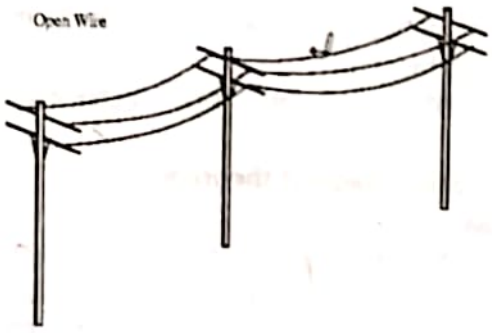
Answer:

a) Each signal element in QPSK carries four bits. Hence, baud rate is 2Kbps/4 = 500 bps.
b) Required bandwidth is 9600/16 = 600 Hz.

20. a) Describe any one guided and one unguided media with diagram.
b) Explain at least three reasons why the TCP/IP model came out as winner in the battle of the internet over ISO-OSI. [MODEL QUESTION]

Answer:

a) Guided Transmission Media uses a "cabling" system that guides the data signals along a specific path. The data signals are bound by the "cabling" system. Guided Media is also known as Bound Media. Cabling is meant in a generic sense in the previous sentences and is not meant to be interpreted as copper wire cabling only.



Open Wire is traditionally used to describe the electrical wire strung along power poles. There is a single wire strung between poles. No shielding or protection from noise interference is used. We are going to extend the traditional definition of Open Wire to include any data signal path without shielding or protection from noise interference. This can include multiconductor cables or single wires. This media is susceptible to a large degree of noise and interference and consequently not acceptable for data transmission except for short distances under 20 ft.

Unguided Transmission Media consists of a means for the data signals to travel but nothing to guide them along a specific path. The data signals are not bound to a cabling media and as such are often called Unbound Media.

Microwave transmission is line of sight transmission. The transmit station must be in visible contact with the receive station. This sets a limit on the distance between stations depending on the local geography. Typically the line of sight due to the Earth's curvature is only 50 km to the horizon! Repeater stations must be placed so the data signal can hop, skip and jump across the country.

Microwaves operate at high operating frequencies of 3 to 10 GHz. This allows them to carry large quantities of data due to their large bandwidth.

Advantages:

a. They require no right of way acquisition between towers.
b. They can carry high quantities of information due to their high operating frequencies.
c. Low cost land purchase: each tower occupies only a small area.
d. High frequency/short wavelength signals require small antennae.

Disadvantages:

a. Attenuation by solid objects: birds, rain, snow and fog.
b. Reflected from flat surfaces like water and metal.
c. Diffracted (split) around solid objects.
d. Refracted by atmosphere, thus causing beam to be projected away from receiver.

b) TCP/IP Protocols are considered to be standards around which the internet has developed. The OSI model however is a "generic, protocol- independent standard."

TCP/IP combines the presentation and session layer issues into its application layer.

TCP/IP combines the OSI data link and physical layers into the network access layer.

TCP/IP appears to be a more simpler model and this is mainly due to the fact that it has fewer layers.

The OSI model consists of 7 architectural layers whereas the TCP/IP only has 4 layers.

21. State Nyquist theorem. **[MODEL QUESTION]**

Answer:

The Nyquist theorem states that a signal must be sampled at least twice as fast as the bandwidth of the signal to accurately reconstruct the waveform; otherwise, the high-frequency content will alias at a frequency inside the spectrum of interest (passband). An

alias is a false lower frequency component that appears in sampled data acquired at too low a sampling rate.

22. What is the purpose of Guard bands? In FDM, suppose there are three signal sources each having bandwidth 300 MHz. Find the minimum bandwidth of the path if 10MHz. Find the minimum bandwidth of the path if 10 MHz guard bands are used. **[MODEL QUESTION]**

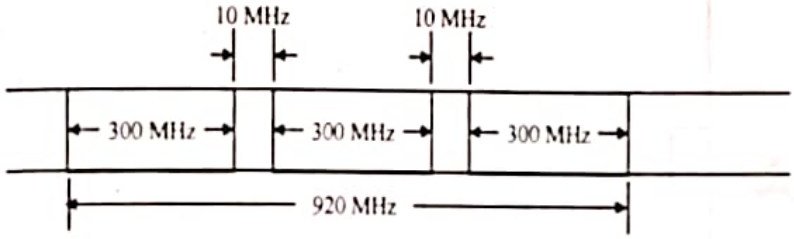
Answer:

In radio, a guard band is an unused part of the radio spectrum between radio bands, for the purpose of preventing interference.

It is a narrow frequency range used to separate two wider frequency ranges to ensure that both can transmit simultaneously without interfering each other. It is used in frequency division multiplexing.

With 3 signals, there are minimum 2 guard bands.

So minimum band width = $3 \times 300 + 2 \times 10 = 920$ MHz.



23. Write down the advantages of fibre-optic cable over twisted pair and coaxial cable. **[MODEL QUESTION]**

Answer:

Optical fibre is a cable with numerous advantages:

Light-weight

Immune to noise

Low attenuation

Tolerates data rates on the order of 100 Mbps

Bandwidth from tens of megahertz to several gigahertz (monomode fibre)

24. a) How does Manchester encoding differ from differential Manchester encoding?

b) Draw the following encoding scheme for the bit stream: 0001110101

(i) NRZ-I

(ii) Manchester coding

(iii) Differential Manchester coding. **[MODEL QUESTION]**

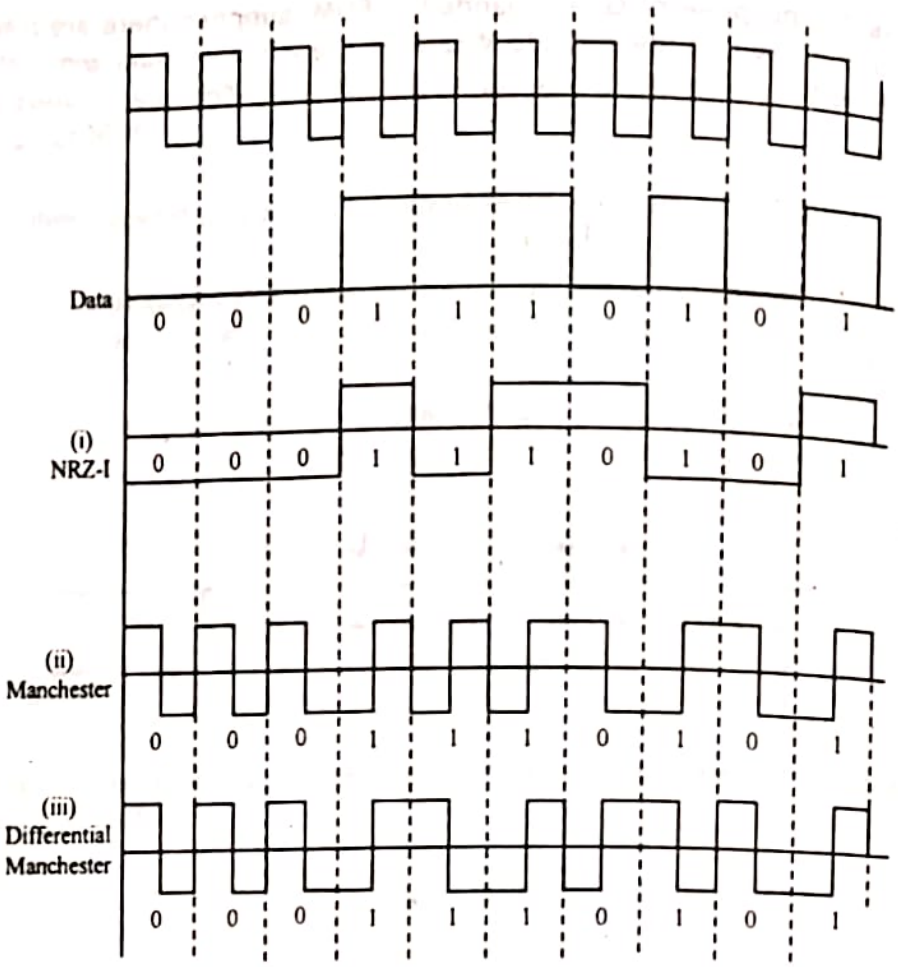
Answer:

a) Manchester code is a form of data communications line code in which each bit of data is signified by at least one transition. Manchester encoding is therefore considered to be self-clocking, which means that accurate synchronization of a data stream is possible. Each bit is transmitted over a predefined time period.

On the other hand, Differential Manchester encoding is a method of encoding data in which data and clock signals are combined to form a single self-synchronizing data

stream. It is a differential encoding, using the presence or absence of transitions to indicate logical value.

b)



25. Differentiate between datagram and virtual circuit packet switching schemes. [MODEL QUESTION]

Answer:

Datagram packet switching introduces the idea of cutting data on a flow into packets which are transmitted over a network without any resource being allocated. If no data is available at the sender at some point during a communication, then no packet is transmitted over the network and no resources are wasted.

In this scheme each packet is processed individually by a router, all packets sent by a host to another host are not guaranteed to use the same physical links.

Virtual circuit packet switching (VC-switching) is a packet switching technique which merges datagram packet switching and circuit switching to extract both of their advantages. VC **switching is a variation of datagram packet switching where packets flow on so-called logical circuits for which** no physical resources like frequencies or time slots are allocated.

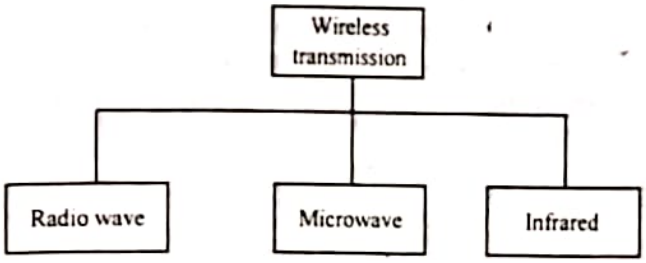
Long Answer Type Questions

1. a) What are the advantages of optical fiber over twisted-pair and coaxial cable?
b) Give an example for each class of unguided media.
c) What is the disadvantage ADSL technology? **[WBUT 2014]**

Answer:

a) The biggest is less attenuation (degradation) of signal, so that a message can travel significantly further over an optical fibre than over a copper (twisted pair of coax) cable before it becomes too garbled to understand. In addition, fibre optic cables are generally immune to electromagnetic interference (such as strong electrical or magnetic fields) nearby, while copper cables can have such interference reduce or completely destroy their ability to carry signals. Finally, it is much easier to transmit on multiple channels (frequencies) over fibre than over copper, so a fibre optic cable can handle many more simultaneous message streams than twisted pair or coax.

b)



For example,
Application of radio wave is in communication with mobile phones, MRI scans, scientific experiments and cosmic observations.
The radar gun that the police use in one of the local speed traps usually operates in the frequency range of, 10,500 to 34,700 Mhz. i.e. microwave.
The heat we feel at a distance from an element on an electric stove is infrared or thermal radiation.

c) Some disadvantages that we can find:

- A DSL connection works better the closer you are to the telephone exchange in your location.
- The connection is faster to download (receive data) to send information.
- This service is not available in all locations.

2. a) What is a multiplexing? Discuss one analog multiplexing technique. **[WBUT 2017]**

Answer:

1st part:

A process of combining multiple signals or data into one. They can be of different types viz.

- Time division multiplexing
- Frequency division multiplexing
- Code division multiplexing

In telecommunications and computer networks, multiplexing (also known as muxing) is a process where multiple analog message signals or digital data streams are combined into one signal over a shared medium. The aim is to share an expensive resource. For example, in telecommunications, several phone calls may be transferred using one wire. It originated in telegraphy, and is now widely applied in communications.
The multiplexed signal is transmitted over a communication channel, which may be a physical transmission medium. The multiplexing divides the capacity of the low-level communication channel into several higher-level logical channels, one for each message signal or data stream to be transferred. A reverse process, known as demultiplexing, can extract the original channels on the receiver side.

2nd part:
At the source end, for each frequency channel, an electronic oscillator generates a carrier signal at a single frequency that carries information, which has higher frequency than the baseband signal. The carrier signal and the baseband signal are applied to a modulator circuit. The modulator alters some aspect of the carrier signal, such as its amplitude, frequency, or phase, with the baseband signal, "piggybacking" the data onto the carrier. Multiple modulated sub-bands at different frequencies are sent through the transmission medium, such as a RF, cable, or optical fiber, on this main carrier. The information from the modulated signal is carried in the sidebands each side of the carrier frequency. This band of frequencies is called the passband of the channel. As long as the sub-band frequencies of the channel are spaced far enough apart, so they do not overlap, the sub-bands will not interfere with each another. Thus the available channel bandwidth is divided into "slots" or sub-bands, each of which can carry a separate or parallel modulated signal. At the destination end of the RF, cable, or fiber, a local oscillator mixes with the carrier frequency, and the resulting baseband signal is filtered to produce each sub-band to a separate output, or a single serial output from parallel sub-bands.

b) Briefly explain the parallel transmission and serial transmission with diagram.
[WBUT 2017]

Answer:
Parallel Transmission
Here bits are sent along several individual wires at a time to the destination, bits are transferred simultaneously. This method is evidently faster as several bits are transferred at a time however this method is suitable when transferring data along short distances only as over long distances the bits tend to muddle up resulting in a failed transfer. Parallel transmission is usually used to transfer data within a computer system (short distance) or maybe to an external device which is at a relatively short distance away.
In a network both methods are effectively utilized to provide maximum efficiency and speed with data transfer, their use is based on the average distance of data transfer, also at certain points along the network, a serial-to-parallel (and vice versa) conversion may occur.

Parallel Transmission

Big advantage of parallel transmission is the factor of speed. All else being equal, parallel transmission can increase the transfer speed by a factor of n over a serial transmission. But there is also a very significant disadvantage of parallel transmission. And that is the factor of cost. It can be proved from the fact that the parallel transmission requires 'n'.

Serial Transmission

This is a relatively simple method, where bits are transferred along a single wire to the destination one bit at a time. This method is commonly used where transmission is over long distances, this is a slower method however more efficient relatively. They are usually used to transfer data along different computer systems or to an external device some distance away.

3. Write short notes on the following:

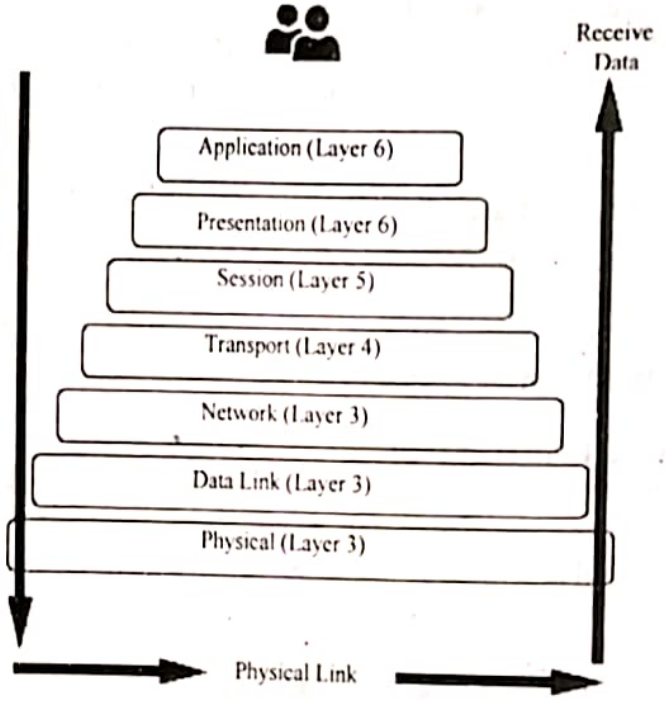
a) OSI model **[WBUT 2017]**
b) Optical fiber **[MODEL QUESTION]**
c) Microwave transmission **[MODEL QUESTION]**

Answer:

a) OSI model –

The Open System Interconnection (OSI) model defines a networking framework to implement protocols in seven layers. The Open System Interco nnection (OSI) model defines a networking framework to implement protocols in seven layers. There is really nothing to the OSI model. In fact, it's not even tangible. The OSI model doesn't perform any functions in the networking process. It is a conceptual framework so we can better understand complex interactions that are happening. In the OSI model, control is passed from one layer to the next, starting at the application layer (Layer 7) in one station, and proceeding to the bottom layer, over the channel to the next station and back up the hierarchy. The OSI model takes the task of inter-networking and divides that up into what is referred to as a vertical stack that consists of the following 7 layers.

The 7 Layers of OSI



Application (Layer 7)
OSI Model, Layer 7, supports application and end-user processes. Communication partners are identified, quality of service is identified, user authentication and privacy are considered, and any constraints on data syntax are identified. Everything at this layer is application-specific. This layer provides application services for file transfers, e-mail, and other network software services. Telnet and FTP are applications that exist entirely in the application level. Tiered application architectures are part of this layer.

Presentation (Layer 6)
This layer provides independence from differences in data representation (e.g., encryption) by translating from application to network format, and vice versa. The presentation layer works to transform data into the form that the application layer can accept. This layer formats and encrypts data to be sent across a network, providing freedom from compatibility problems. It is sometimes called the syntax layer.

Session (Layer 5)
This layer establishes, manages and terminates connections between applications. The session layer sets up, coordinates, and terminates conversations, exchanges, and dialogues between the applications at each end. It deals with session and connection coordination.

Transport (Layer 4)
OSI Model, Layer 4, provides transparent transfer of data between end systems, or hosts, and is responsible for end-to-end error recovery and flow control. It ensures complete data transfer.

Network (Layer 3)
Layer 3 provides switching and routing technologies, creating logical paths, known as virtual circuits, for transmitting data from node to node. Routing and forwarding are functions of this layer, as well as addressing, internetworking, error handling, congestion control and packet sequencing.

Data Link (Layer 2)
At OSI Model, Layer 2, data packets are encoded and decoded into bits. It furnishes protocol knowledge and management and handles errors in the physical layer, flow control and frame synchronization. The data link layer is divided into two sub layers: The Media Access Control (MAC) layer and the Logical Link Control(LLC) layer. The MAC sub layer controls how a computer on the network gains access to the data and permission to transmit it. The LLC layer controls frame synchronization, flow control and error checking.

Physical (Layer 1)
OSI Model, Layer 1 conveys the bit stream - electrical impulse, light or radio signal — through the network at the electrical and mechanical level. It provides the hardware

means of sending and receiving data on a carrier, including defining cables, cards and physical aspects. Fast Ethernet, RS232 and ATM are protocols with physical layer components.

b) Optical fiber: ***Refer to Question No. 1 of Short Answer Type Questions.***

c) Microwave transmission:

Microwave transmission refers to the technology of transmitting information by the use of the radio waves whose wavelengths are conveniently measured in small numbers of centimeters, by using various electronic technologies. These are called microwaves. This part of the radio spectrum ranges across frequencies of roughly 1.0 gigahertz (GHz) to 30 GHz. Also by using the formula $\lambda = c/f$, these correspond to wavelengths from 30 centimeters down to 1.0 cm. [In the above equation, the Greek letter λ (lambda) is the wavelength in meters; c is the speed of light in meters per second; and f is the frequency in hertz (Hz).]

In the microwave frequency band, antennas are usually of convenient sizes and shapes, and also the use of metal waveguides for carrying the radio power works well. Furthermore, with the use of the modern solid-state electronics and traveling wave tube technologies that have been developed since the early 1960s, the electronics used by microwave radio transmission have been readily used by expert electronics engineers.

Microwave radio transmission is commonly used by communication systems on the surface of the Earth, in satellite communications, and in deep space radio communications. Other parts of the microwave radio band are used for radars, radio navigation systems, sensor systems, and radio astronomy.

The next higher part of the radio electromagnetic spectrum, where the frequencies are above 30 GHz and below 100 GHz, are called "millimeter waves" because their wavelengths are conveniently measured in millimeters, and their wavelengths range from 10 mm down to 3.0 mm. Radio waves in this band are usually strongly attenuated by the Earthly atmosphere and particles contained in it, especially during wet weather. Also, in wide band of frequencies around 60 GHz, the radio waves are strongly attenuated by molecular oxygen in the atmosphere. The electronic technologies needed in the millimeter wave band are also much more difficult to utilize than those of the microwave band.

4. a) What is the purpose of Guard Bands?
b) What is the relationship between FDM and WDM?
c) In FDM, suppose there are 3 signal sources each having bandwidth 300 MHz, find the minimum bandwidth of the path if 10 MHz guard bands are used.
d) What is the drawback of synchronous TDM that leads to the concept of asynchronous TDM? **[MODEL QUESTION]**

Answer:

a) Guard band is a narrow part of the radio spectrum between radio bands, for the purpose of preventing interference.

It is a narrow frequency range used to separate two wider frequency ranges to ensure that both can transmit simultaneously without interfering each other. It is used in TDM/TDMA/FDM/FDMA. It may be used in both wired and wireless communications so that adjacent frequency bands on the same media can avoid interference.

b) FDM: total frequency bands are divided into several users
e.g.: television broad casting
WDM: total wave length is divided in to number of users
e.g.: optical networking

c) For 3 signals we require at least 2 guard bands.
$\therefore$ maximum bandwidth = $3 \times 300 + 2 \times 10 = 920$ MHz.

d) Disadvantages:
One drawback of the TDM approach, as discussed earlier, is that many of the time slot in the frame are wasted. It is because, if a particular terminal has no data to transmit at particular instant of time, an empty time slot will be transmitted. An efficient alternative to this synchronous TDM is statistical TDM, also known as **asynchronous TDM**. It dynamically allocates the time slots on demand to separate input channels, thus saving the channel capacity. As with Synchronous TDM, statistical multiplexers also have many I/O lines with a buffer associated to each of them. During the input, the multiplexer scans the input buffers, collecting data until the frame is filled and send the frame. At the receiving end, the demultiplexer receives the frame and distributes the data to the appropriate buffers.

5. a) Explain the key characteristics of LAN, MAN and WAN. [MODEL QUESTION]
b) Make a comparative study of FDM, synchronous TDM and asynchronous TDM.
Answer:
a) LAN: (Local Area Network) A group of computers that share a common connection and are usually in a small area or even in the same building. For example an office or home network. They are usually connected by Ethernet cables and have high speed connections. If it was a wireless setup it would be called a WLAN, which would have a lower connection speed.
MAN: (Metropolitan Area Network) This is a larger network that connects computer users in a particular geographic area or region. For example a large university may have a network so large that it may be classified as a MAN. The MAN network usually exist to provide connectivity to local ISPs, cable tv, or large corporations. It is far larger than a LAN and smaller than a WAN. Also large cities like London and Sydney, Australia have metropolitan area networks.
WAN: (Wide Area Network) This is the largest network and can interconnect networks throughout the world and is not restricted to a geographical location. The Internet is an example of a worldwide public WAN. Most WANs exist to connect LANs that are not in the same geographical area. This technology is high speed and very expensive to setup.

b) Wave-division multiplexing (WDM) is conceptually the same as FDM, except that the multiplexing and demultiplexing involves light signals transmitted through optical fiber channel. The idea is the same basically we are combining the two different frequencies. However, the difference is that the frequencies are very high.