Dcom

Spring – 2022

1/a:

10011001 | 11100010 | 00100100 | 10000100 | 00000000

8 bits | 8 bits | 8 bits | 8 bits

$K = 4 \quad m = 8$

```
  10011001
  11100010
  00100100
+ 10000100
------------
  1000100011
+        1
------------
  1000100100
```

extra at MSB

checksum = 01101101 (cbw)

10011001
11100010
00100100
10000100

1000100011
10

1000100101
1's compliment: 0111011010
checksum=111011010

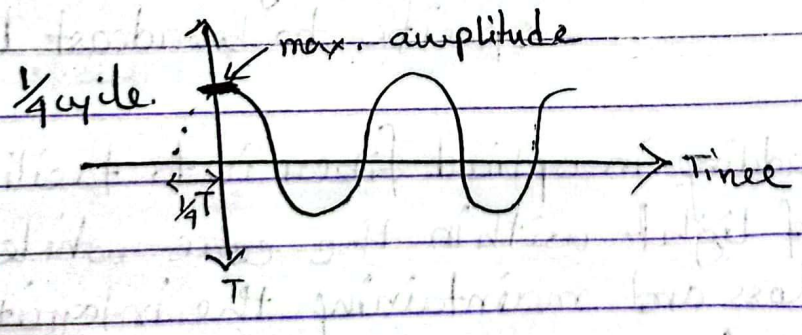
1/b: Data rate = $\frac{\text{amount of data}}{\text{time}}$.

a character = 8 bits. and data rate = 1000 bps (given).

So, $1000^{bps} = \frac{8 \text{ bits}}{\text{time}}$

$\Rightarrow$ time = $\frac{8 \text{ bits}}{1000 \text{ bps}}$ = 0.008 s.

Phase shift for a sine wave with max. amplitude after 1/4 cycle is 90° to the left or right depending on the direction of the shift.



Ans-2

2/a: polynomial representation of 1010111

$(1 \times x^5) + (0 \times x^4) + (1 \times x^3) + (0 \times x^2) + (1 \times x^1) + (1 \times x^0)$

$= x^5 + x^3 + x + 1$

after right-shift of 1010110 upto 3 bits = 0001010

thus converting into polynomial $= (1 \times x^2) + (0 \times x^1) + (1 \times x^0)$

$= x^2 + 1$ (Ans).

2/b: $N = 100$; $N/n = 10$ crossbars (both from 1st + 3rd stage)

$K = 6$ (crossbars no. in middle stage).

We know,

total crossbars $= 2kN + k\left(\frac{N}{n}\right)^2$

$= 2 \times 6 \times 100 + 6\,(10)^2$

$= 1800$ crossbars.

3/a: Data link layer has 2 sublayers:

DLC (Data link Control): Deals with all issues common to both point to point and broadcast links.

MAC (Media Access Control): Deals only with issues specific to broadcast links.

The purpose of cladding in optical fiber is to facilitate the propagation of light within the core while minimizing signal loss and maintaining the integrity of signal. As optical fiber use the reflection

method to transmit signals in the form of light, cladding is needed to prevent light from refracting.
It surrounds the core and the difference in density of the two materials helps in reflection

Sky vs line of sight propagation:
Sky propagation is radiation of higher frequency radio wave upward into the ionosphere where they are reflected back to earth. And it is used for greater distances with lower ~~oupth~~ outputs.
Whereas, line of sight prop. is transmission of very high freq. signals from one antenna to other in a straight line where antennas are directional, facing eachother, tall and close enough not being affected by the earth's curvature. Radio transmissions cannot be completely focused by this one.

3/b: Broadcast Address is one to all communication. for an example : FF:FF:FF:FF:FF:FF

Using ARP, system A needs to send only one broadcast frame. Each of other 18 systems need to recieve the frames, decapsulate & and remove the ARP message and pass the message to their ARP protocol to find that the frame must be discarded. This means processing and discarding only 18 broadcast frames.
After system B responds with its own data link address

system A can store the link layer address in it's cache memory. The rest of the nine frames are only unicast.

4/b: Pure ALOHA vulnerable time $= 2 \times T_{fr}$

$T_{fr} = 1000 / 1 \times 10^6 = 1$ ms.

So, vulnerable time $= 2 \times 1 = 2$ ms (Ans).

5/a: 4 fundamental characteristics of effective d. communication:-

① Delivery: The system must deliver data to the correct destination and data must be received by the intended device or user and only by that device or user.

② Accuracy: System must deliver the data accurately. Data that have been altered in transmission and left uncorrected are unusable.

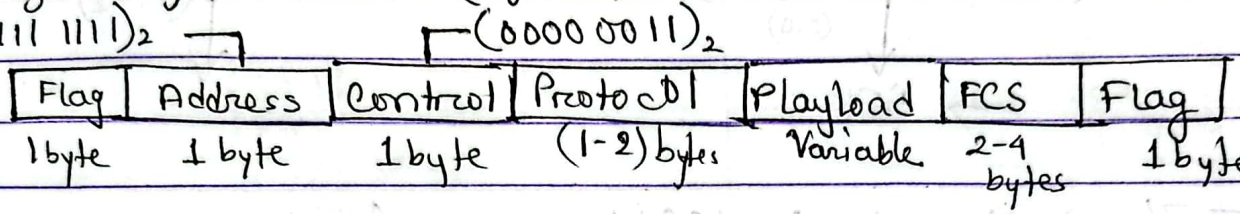
③ Timeliness: Data must be delivered timely. Data delivered is useless data. In the case of video and audio, timely delivery means delivering data as they are produced, in the same order that they are produced, and without significant delay. This type of delivery is called real time transmission.

④ Jitter: It refers to the variation in the packet arrival time. It is the uneven delay in the delivery of audio or video packets. For example, let us assume that video packet are sent every 30 ms. If some packets delay 30ms and others 40ms., the result of video quality will be uneven.

[Book - chap - 1 → Pg 4]

PPP: It is the format of the frame to be exchanged between devices. It also defines how two devices can negotiate the establishment of the link and the exchange of data.

Diagram of PPP Frame: (Pg - 311)



5/b: Given, B = 5 MHz.

i) NRZ-L → B = N/2 so, N = 2 x 5 MHz = 10 Mbps.

ii) AMI → B = N/2 so, N = 10 Mbps.

iii) Manchester → B = N so, N = 5 Mbps.

iv) 8B6T → B = 3N/4 so N = 6.67 Mbps.

v) MLT-3 → B = N/3 so N = 15 Mbps.

vi) 2B1Q → B = N/4 so N = 20 Mbps

vii) 4D-PAM-5 → B = N/8 so N = 40 Mbps.

6/a: Sending a voice signal from a microphone to a recorder is baseband transmission as no modulation is involved. TDM is a digital Multiplexing technique for combining several low-rate channels into one high rate one.

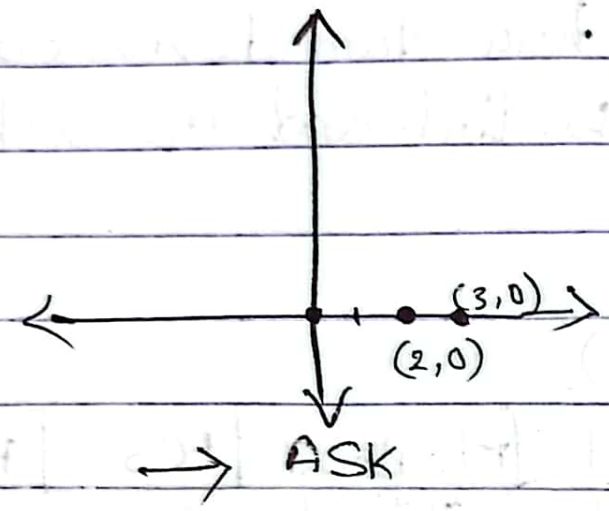
i) SMTP: Simple Mail Transfer Protocol

ii) SNMP: Simple Network Management Protocol

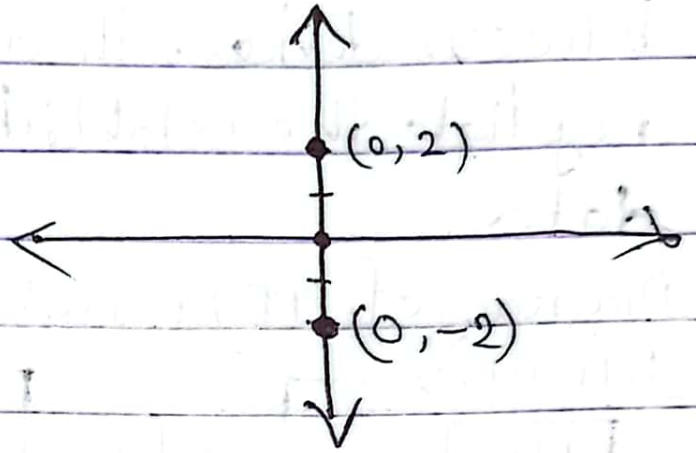
→ Main protocol used in electronic mail service

→ Used by an administrator to manage the Internet at global and local levels.

6/b: i) (2,0) and (3,0)

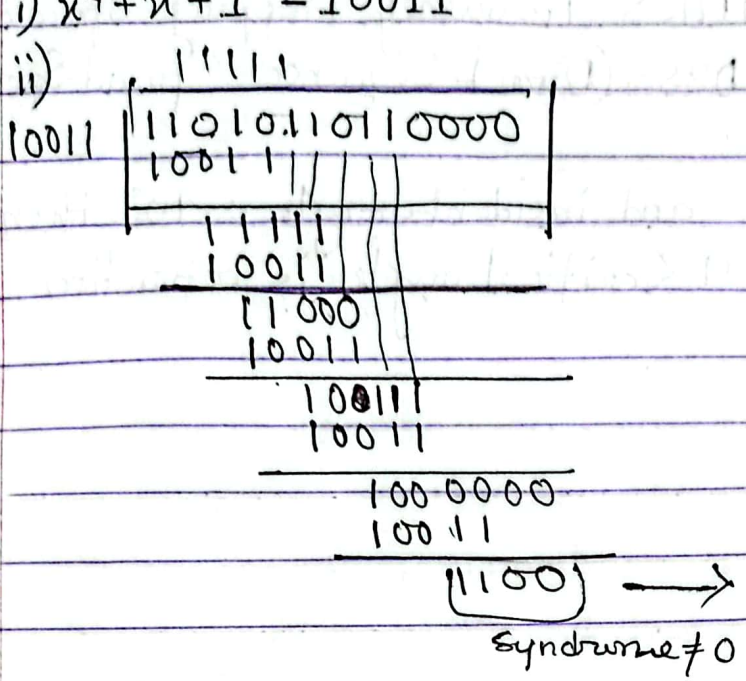


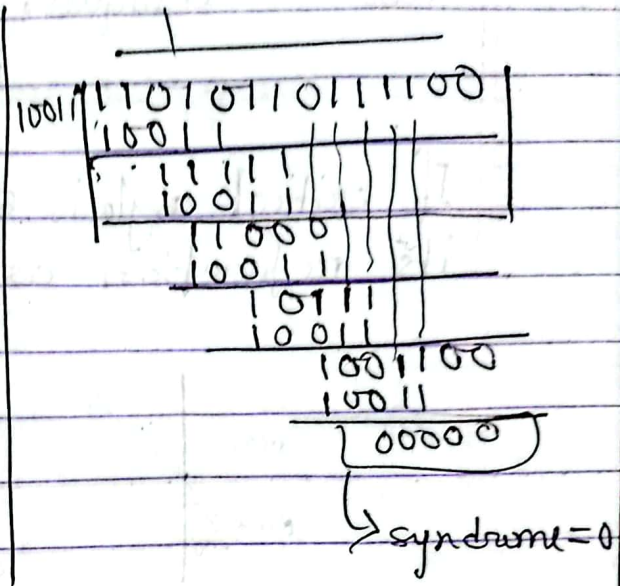
ii) (0,2) and (0,-2)



7/a: i) $x^4+x+1 = 10011$

ii)





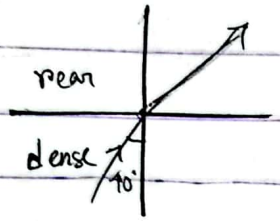
Final code word = $\overline{1101011011}\,\overline{1100}$. (Ans)

7/b: Spread Spectrum: We combine signals from different sources to fit into a larger bandwidth

Goals: In case of wireless applications likes LANS of WANs, air is the medium of communication. Stations must be able to share this medium without interception by an eavesdropper and without being subject to jamming from a malicious intruder. SS techniques add redundancy; they spread the original spectrum needed for each station. If the required bandwidth for each station is B, spread spectrum expands it to Bss, such that Bss >> B. The expanded bandwidth allows the source to wrap its message in a protective envelope, for a more secure transmission.

Two SS techniques: i) FHSS (Frequency Hopping Spread Spectrum)
ii) DSSS (Direct Sequence Spread Spectrum)

If critical angle is 60° and incident angle is 40°, then it's refraction as I < critical angle is refraction



Fall : 2021

1/a → same as sp-22 (7/a)

1/b:

Baseband	Broadband
① bidirectional	① unidirectional
② digital signal	② analog signal
③ signals can be sent for short distances	③ for long distances.
④ repeaters are used	④ Amplifiers are used
⑤ Capacity of fq less than 100kHz	⑤ higher than 100KHz
⑥ Suited for wired networks	⑥ wireless.
⑦ Supports TDM	⑦ Supports FDM.
⑧ Exple - ethernet	⑧ Exple - telephone

→ i) Application layer = messages.
ii) Transport " = segments / user datagrams.
iii) Network " = datagrams.
iv) Data link " = frames
v) Physical " = bits

2/a: Transmission Impairment : The signals travel through transmission media are not perfect and the imperfections causes signal impairment because of which the signal at the beginning and at the end of the medium are not same.

Causes of transmission impairment :

① Attenuation (means loss of energy due to overcoming the duty of energy)

② Distortion (means signal changes its form or shape due to difference in frequencies, phase, propagation speed etc)

③ Noise (Several types of noise is created due to random motion of electrons in wire, noise from motors and appliances etc can cause impairment)

3 types of link layer address :

① Unicast : one to one communication, A frame with a unicast address destination is destined only for one entity in the link. i.e. A3:34:45:11:92:F1

② Multicast: one to many communication. Jurisdiction is local.
example: A2:34:45:11:92:F1

③ Broadcast: one to all. A frame with a destination broadcast address is sent to all entities in the link. exple: FF:FF:FF:FF:FF:FF

2/b:

3/a: $B = 3MHz$

i) NRZ-L $\rightarrow B = N/2 \Rightarrow N = 2 \times B = 6$ Mbps.

ii) AMI $\rightarrow B = N/2 \Rightarrow N = 6$ Mbps.

iii) Manchester $\rightarrow B = N = 3$ Mbps.

iv) 8B6T $\rightarrow B = 3N/4 \rightarrow N = (4 \times 3)/3 = 4$ Mbps.

v) MLT-3 $\rightarrow B = N/3 \rightarrow N = 9$ Mbps.

vi) 2B1Q $\rightarrow B = N/4 \rightarrow N = 12$ Mbps

vii) 4D-PAM5 $\rightarrow B = N/8 \rightarrow N = 24$ Mbps.

3/b: 111 0000 0000 000.

$s = vt$

4/a: Five components of D.com:

1. Message : Info to be communicated.
2. Sender : Device that sends data.
3. Reciever : " " receives "
4. Transmission medium : The physical path through which a message travels.
5. Protocol : set of rules that gover D.com.

2 transmission media catagory: ① Guided (wired)
② Unguided (wireless)

4/b: i) Transmission time $= (100\,000 \times 8) / 10^6 = 0.8$ ms

Propagation

Q-1 (1, 2, 3)

12 marks

* Ways for accessing the internet:

1. Using Telephone networks: Internet is accessible by changing voice line between residences or business and the telephone center to point to point WAN.

2 ways: - Dial-up Service: Add a modem to the telephone line that converts data to voice. The software installed on the computer dials the ISP and initates making a telephone connection. But, as it is slow and cannot be used for internet and telephone at the same time due to slow speed, it is only used in small residences.

- DSL Service: This one allows line to be used simultaneously for voice and data com. and has higher speed.

2. Using Cable networks: Instead of antennas cable TV services are broadly used for TV broadcast as the cable companies are upgrading cable networks and connecting to internet. It provides a higher speed connection but varies depending on the number of neighbors using it.

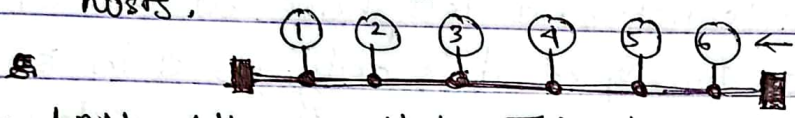
3. Using Wireless networks: It is the most popular one. With the help of growing wireless WAN access, we can get connected to the internet.

4. Direct connection to the internet: A large organization or a large corporation can itself become a local ISP and be connected to the internet by high

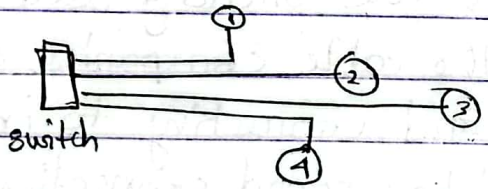
speed WAN from a carrier provider and connecting itself to a regional ISP. Example: A large university with several campuses can create an internetwork, then the internetwork can be connected to the Internet.

✱ Types of LAN networks:

1. LAN with a common cable: In the past, all hosts were connected through a common cable and a packet sent by one host was received by all hosts.

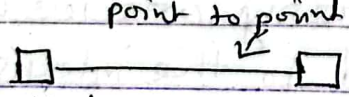


2. LAN with a switch: These days, ~~LAN hosts are~~ LANs use smart connecting switch, which recognizes the destination address of the packet and guide the packet to its destination without sending it to all the hosts.

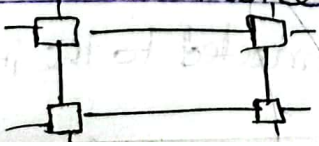


✱ Types of WAN networks:

1. Point to Point: connects two communicating ~~media~~ devices through a transmission media.



2. Switched WAN: Combination of several point to points WAN and has more than two ends



⊛ ISOC : Internet Society is an international, nonprofit organization that provides support for the internet standard process. They maintain and supports other administrative bodies such as IAB, IETF, IRTF and IANA. Promotes research and scholarly activities.

IETF: Internet Engineering Task Force is a forum of working groups managed by IESG. They are responsible for identifying operational problems and proposing solutions to these problems. Also develops and reviews specifications intended as Internet standards. The working grps are ~~collecting~~ collected into areas - and each area concentrates on a specific topic. Currently, there are 9: applications, protocols, routing, network management, next generation (IPng) and security.

⊛ IAB : Internet Architecture Board is the technical advisory to the ISOC. The main purpose of the IAB are to oversee the continuing development of the TCP/IP Protocol Suite and to serve in a technical advisory to ~~people~~ research members of the internet community. It has two primary components IETF and IRTF. Another responsibility of the IAB is editorial management of the RFCs. It is also the external liasion of internet and other standard organizations and forums.

IRTF: Internet Research Task Force is a forum of working groups managed by IRSG. IRTF focuses on long term research topics related to Internet protocols, applications, architecture and technology.

3marks:

* 3 Protocols used in Application layer:
  1. Hypertext Transfer Protocol (HTTP)
  2. Simple Mail Transfer Protocol (SMTP)
  3. File Transfer Protocol (FTP)

(আর 3 আছে — সব লাগবে)

* 3 Protocols used in Transport layer:
  1. Transmission Control Protocol (TCP)
  2. User Datagram Protocol (UDP)
  3. Stream Control Transmission Protocol (SCTP)

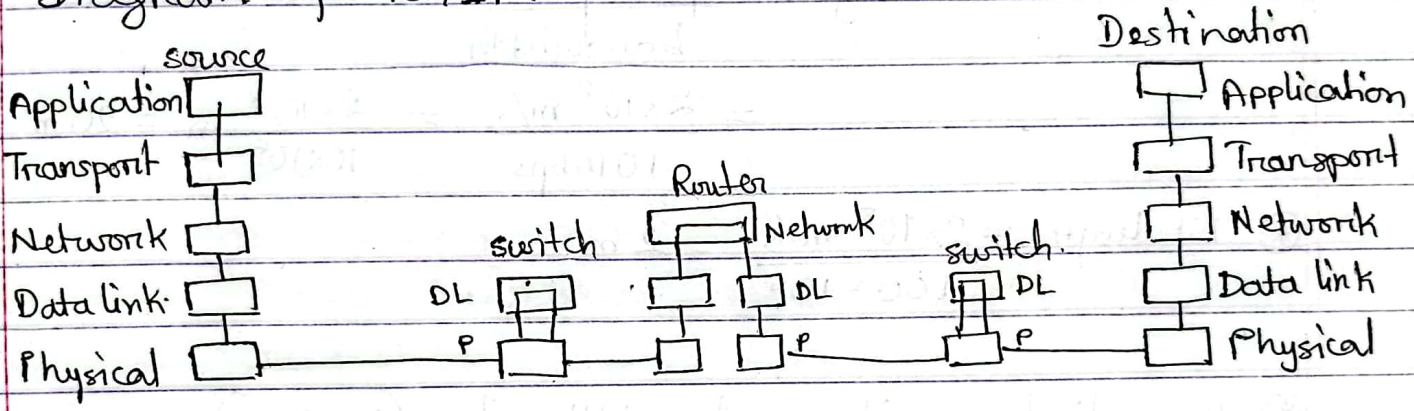
* 3 Protocols used in Network layer:
  1. Internet Control Message Protocol (ICMP)
  2. Internet Group Management Protocol (IGMP)
  3. Address Resolution Protocol (ARP)

* First principle of protocol layering states that to create bidirectional communication we need to make each layer so that it is able to perform two opposite tasks, one in each direction.

OSI model is a layered framework for the design of network systems that allows communication between

all types of computer systems. The purpose of OSI model is to show how to facilitate communication between different systems without requiring changes to the logic of the underlying hardware and software. It is flexible, robust and interoperable but ~~it is time consuming and~~ the model were never fully defined so TCP/IP was preferable.

Diagram of TCP/IP:



⊛ 2nd principle of protocol layering states that two objs under each layer at both sites should be identical. ISO is the International Organization for Standardization. It is a multinational body dedicated to worldwide agreement on international standards. Almost 3/4ths of the countries in the world are represented in the ISO. An ISO standard that covers all aspects of network communications is the OSI model.

OSI model :-

Application	Presentation	Session	Transport	Network	Data link	Physical

0.001s — 1 bit
1.5 — bit x

5marks.

(*) bit rate = $\frac{1}{\text{time}} = \frac{1}{0.001\,s} = 1\text{Kbps}$.

(*) bit rate = $\frac{10}{20\,\mu s} = \frac{10}{20\times10^{-6}\,s} =$ ~~50Kbps~~ 500 kbps

(*) We know, length of bit = prd. speed x bit duration

so, bit duration of 1 bit = .

(*) We know, bit length = $\frac{\text{pro speed}}{\text{bandwidth}}$

$= \frac{2\times10^8\ m/s}{10\,Mbps} = \frac{2\times10^8}{10\times10^6}\,m = 20\,m$

(*) bit length = $\frac{2\times10^8\ m/s}{100\times10^6} = 2\,m$.

(*) theoretical capacity = bandwidth x $\log_2(1+SNR)$

Here, bandwith = 20KHz

$SNR_{dB} = 40$

We know, $SNR = 10^{SNR_{dB}/10} = 10^4$.

∴ Capacity = $20\times10^3 \times \log_2(1+10^4) = 265757.1328$ bps

$= 265.7$ ~~Mbps~~ Kbps

(*) bandwith = 1 MHz = 1×10^6

$SNR_{dB} = 20$; $SNR = 10^2 = 100$

Capacity = $1\times10^6 \times \log_2(101) = 6658211.483$

$= 6$ Mbps.

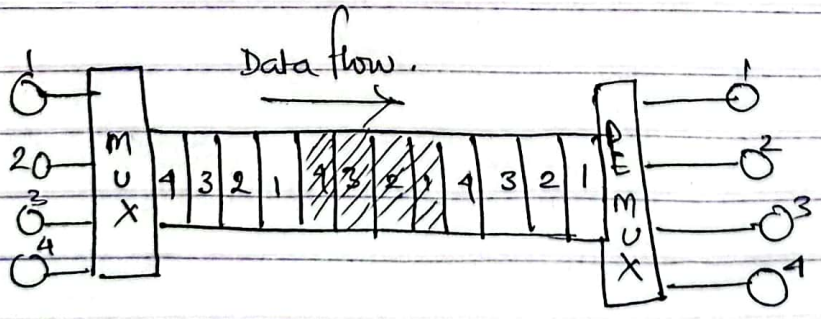
Quiz-9 ~~(10, 11, 12)~~ (4, 5, 6)

2 marks ⊛ Multiplexing techniques for analog signals:

1. FDM (Frequency-division Multiplexing): Applied when bandwidth of a link is greater than the combined bandwidths of the signals to be transmitted. Generated signals modulate different carrier freq. which are then combined into a ~~signal~~ composite signal that can be transported by the link. Also, to prevent overlaping channels are seperated by Guard bands
2. WDM (Wavelength division Multiplexing): Uses the high data rate capability of fiber optic cable. Conceptually same as FDM but multiplexing and demultiplexing involve optical signals transmitted through fiber optic channels. and the freq. are very high.

⊛ Multiplexing technique for Digital Signal:

Time Division Multiplexing: Digital process that combines several low rate channels into one high rate one. Instead of sharing a portion of the bandwidth as in FDM, time is shared and each connection occupies a portion of time in the link.



(*) Use of guard bands: In FDM, channels can be seperated by strips of unused bandwidth to prevent signals from overlapping, those strips are guard band.

Applications of FDM:

1. Combines analog signal
2. Used in AM and FM radio broadcasting
3. Used in first generation of cellular telephones.

(*) Interleaving: TDM can be visualized as two fast-rotating switches, one on the multiplexing side and the other on the demultiplexing side. The switches are synchronized and rotate at the same speed, but in opposite directions. On the multiplexing side, as the switch opens in front of a connection, that connection has the opportunity to send a unit onto the path. This process is called interleaving.

Application of WDM:

1. Combines optical signals
2. Used in SONET network in which multiple optical fiber lines are multiplexed and demultiplexed.

(*) Most susceptible to noise analog to analog conversion technique is AM because the amplitude is more affected by noise than phase or frequency.

(*) Most susceptible to noise digital to analog conversion technique is ASK because amplitude is more affected.

3 marks:

(*) bandwith = 4KHz. ; d = 0.

We know, $N = [1/(1+d)] \times r \times B$.

a) ASK ; $r = \log_2 2 = 1$

$N = [1/(1+0)] \times 1 \times 4 \times 10^3$

$= 4$ Kbps.

b) 64-QAM ; $r = \log_2 64 = 6$

$N = [1/(1+0)] \times 6 \times 4 \times 10^3$.

$= 24$ Kbps.

(*) a) QPSK ; $r = \log_2 4 = 2$

$N = [1/(1+0)] \times 2 \times 4 \times 10^3$

$= 8$ Kbps.

b) 16-QAM ; $r = \log_2 16 = 4$.

$N = 4 \times 4 \times 10^3 = 16$ Kbps.

(*) We know, data rate $\Rightarrow N = [1/(1+d)] \times r \times B$

here, $B = 6$ MHz.

$r = \log_2 64 = 6$.

let $d = 0$.

so, $N = 6 \times 6 \times 10^6 = 36$ Mbps.

(*) B (for each channel) $= 1\text{MHz}/10 = 100$KHz ; d = 0 (Given)

We know, $N = \frac{1}{(1+d)} \times r \times B$.

$\Rightarrow r = \frac{(1+d) \times N}{B}$

$\Rightarrow r = \frac{1\text{Mbps}}{100\text{KHz}}$ [for each channel] $= 10$.

Calculating level, $L = 2^n = 2^{10} = 1024$

so 1024-QAM is needed.

(*) $B_{ss} = 100\,KHz$; $B = 4\,KHz$

number of hops $= \frac{100\,K\,Hz}{4\,K} = 25\,Hz$.

∴ minimum number of bits $= \log_2 25 = 4.64 \approx 5$ bits.

(*) Barker chip is 11 bits.

1 voice channel of 64 Kbps needs $= 11 \times 64\,Kbps = 704\,Kbps$

~~Total voice channels = (10 Mbps / 704 Kbps)~~

if 704 Kbps for 1 voice channel

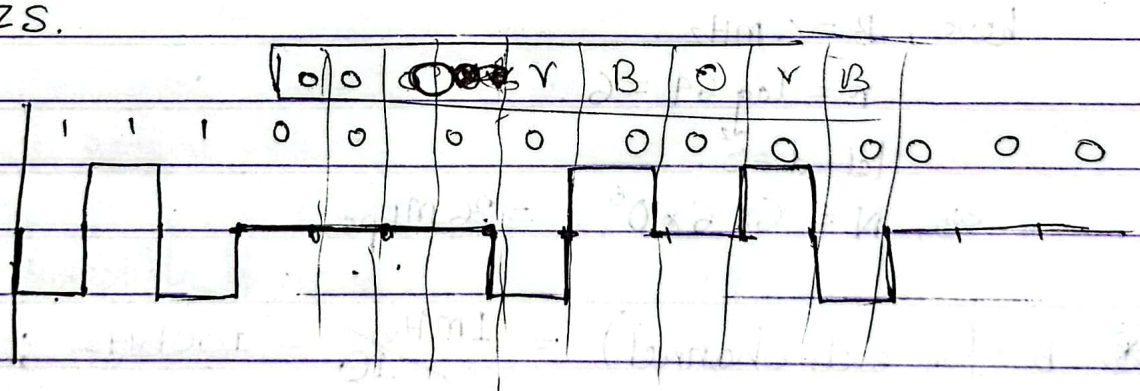
then 10 Mbps " $\frac{10\,Mbps}{704\,Kbps}$ "

$= 14.2$ channels.

≈ 14 channels (Ans).

(*) 111 000 000 000 00

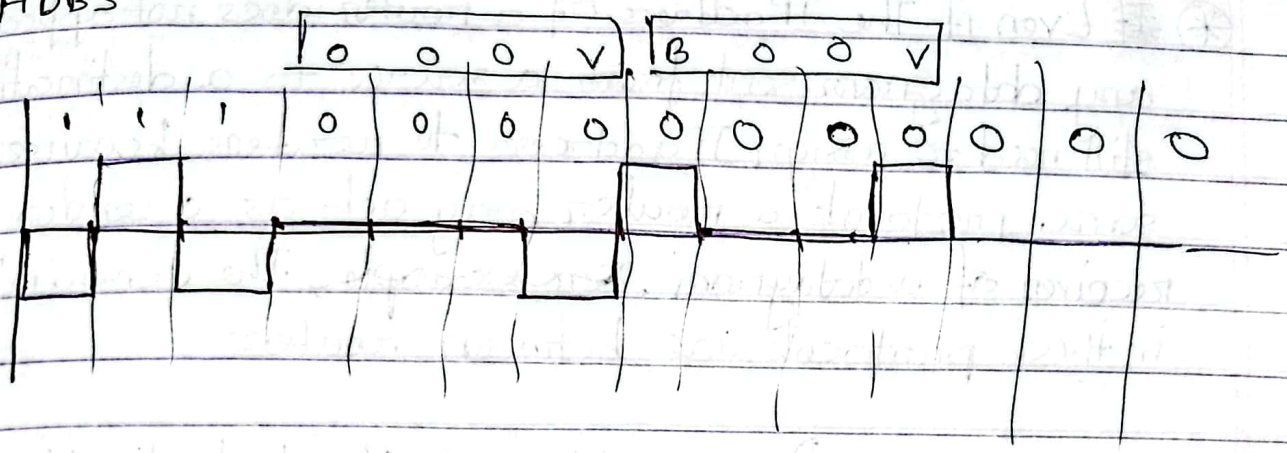
a) B8ZS.



V = non zero voltage that breaks AMI rule of encoding

B = " " " " supports " " " "

b) HDB3



Quiz-3 (ch-7,8,9).

* Even if the IP address of a router does not appear in any datagram sent from a source to a destination, we still need to assign IP addresses to routers because in some protocols a router may act as a sender or receiver of a datagram. For example, the communications in these protocols are between routers.

* Determination of IP address: The host should know its own IP address, which becomes the source IP address in the packet. The application layer uses the services of DNS to find the destination address of the packet and passes it to the network layer to be inserted in the packet.

* Framing: It is the first service provided by data link layer. The DLL at each node needs to encapsulate the datagram in a frame before sending it to the next node and the next node needs to decapsulate it. Different data link layers have different formats for framing.

2 categories of links:

1. Point to point link: The link is dedicated to the two devices.
2. Broadcast link: The link is shared between several pairs of devices.

* Flow control: Whenever we have a producer and a consumer, we need to think about flow control. We cannot have an unlimited buffer size at the receiving side. So we either let the receiving data link layer drop the frames if its buffer is full or let the it send a feedback to the sending data link layer to ask it to stop or slow down. Different data link layer protocols use different strategies for flow control.

2 sublayers: 1. DLC (Data link control): Deals with all issues common to both point to point and broadcast links.
2. MAC (Media Access Control): Deals with only broadcast links.

* Error Control: After receiving nodes receive the electromagnetic signals sent by the sending nodes and then transformed to bits to put together for creating a frame. Since electromagnetic signals are susceptible to error, a frame is susceptible to error too. The error needs to be detected and afterwards it needs to be either corrected or discarded and retransmitted by the sending node.

3 types of addresses in link layer:

1. Unicast: A frame with a unicast address destination is destined only for one entity in the link. i.e. A3:34:45:11:92:F1

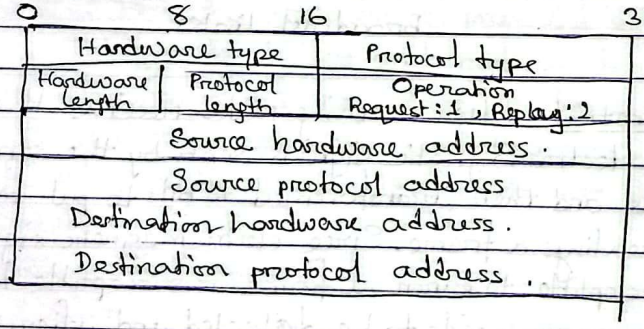
2. Multicast : One to many communication.
exple: A3:34:45:11:92:F1

3. Broadcast : One to all communication.
exple: FF:FF:FF:FF:FF:FF

⊛ Congestion Control: A link may be congested with frames, which may result in frame loss, most data link layer protocols do not directly use a congestion control to alleviate congestion, although some wide area networks do. This is considered an issue in the network layer or transport layer because of its end to end nature.

1 -> 2 -> 3

ARP Packet:



3 marks:

⊛ delay times: 3, 10, 20, 7, 20 ms (Given).

for 1 datagram: $\frac{3200\ km}{2\times10^8\ m/s} + (3+20+20) = 59.0$ ms.

for 2 " : $\frac{11700\ km}{2\times10^8\ m/s} + (3+10+20) = 58.5+3+10+20 = 91.5$ ms.

for 3 " : $\frac{12200\ km}{2\times10^8\ m/s} + (3+10+20+20) = 61+53 = 114$ ms

order of arrival: 3 -> 2 -> 1 (Ans).

⊛ (same delay times given)

for 1 datagram : $\frac{12200\ km}{2\times10^8\ m/s} + (3+10+20+20) = 114$ ms

for 2 datagram : $\frac{10200\ km}{2\times10^8\ m/s} + (3+7+20) = 51+30 = 81$ ms

for 3 datagram : $\frac{10700\ km}{2\times10^8\ m/s} + (3+7+20+20) = 53.5+50 = 103.5$ ms.

order of arrival: 1 -> 3 -> 2 (1->3->2)

⊛ for datagram -> Path length = 11700 km, switches = 1, 2, 5.

Delay = $\frac{11700\ km}{2\times10^8\ m/s} + (3+10+20) = 58.5+33 = 91.5$ ---

(বাকি গুলা প্রশ্ন ই)

5 marks:

* Given, propagation speed $= 2\times10^8$ m/s
  ranges $= 1000$ to 1200 nm.
  Bandwidth $= \left(\frac{2\times10^8 \text{ m/s}}{1000\times10^{-9}\text{ m}}\right) - \left(\frac{2\times10^8 \text{ m/s}}{1200\times10^{-9}\text{ m}}\right)$
  $= 33.33\times10^{-6}$ Hz

* ranges $= 1000$ to 1400 nm.
  Bandwidth $= \left(\frac{2\times10^8 \text{ m/s}}{1000\times10^{-9}}\right) - \left(\frac{2\times10^8 \text{ m/s}}{1400\times10^{-9}}\right)$
  $= 57.14\times10^{-6}$ Hz

* Given, prop. speed $= 2\times10^8$ m/s
  length $= 10$m
  so, delay $= \frac{\text{length}}{\text{speed}} = \frac{10\text{ m}}{2\times10^8\text{ m/s}} = 5\times10^{-8}$ s
  $= 0.05$ µs

* length $= 1$ km
  delay $= \frac{1000\text{ m}}{2\times10^8\text{ m}} = 5$ µs.

* Given, $P_s = 200$mW (at the start)
  attenuation $= -3$dB
  " in linear scale $= 10^{(-3/10)} = 0.5012$.
  length $= 1$ km

$P_{end} = 200\text{ mW} \times 0.5012 = 100.24$ mW

* $P_s = 200$ mW
  Attenuation $= -7$ dB for 100 KHz.
  " in linear $= 10^{(-7/10)} = 0.1995$

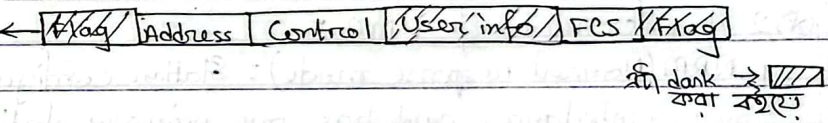
$P_{end} = 200\text{ mW} \times 0.1995 = 39.90$ mW.

Quiz-4 (ch-10, 11, 12)

2marks:

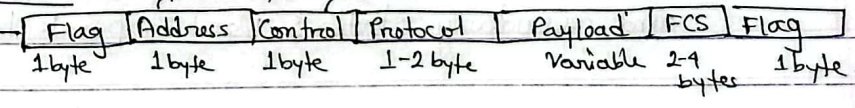
* HDLC Protocol :- High-Level Data Link Control (HDLC) is a bit oriented protocol for communication over point to point and multipoint links that implements the Stop and Wait protocols.

HDLC-I :



* PPP : The format of the frame to be exchanged between devices, it also defines how 2 devices can negotiate the establishment of the link and the exchange of data.

PPP frame: $\rightarrow (1111\,1111)_2$ $\rightarrow (0000\,0011)_2$



* HDLC-U Frame:

⊛ **Authentication Protocol**: Authentication means validating the identity of a user who needs to access a set of resources. PPP has created 2 authentication Protocol:
1. PAP (Password Authention Protocol)
2. CHAP (Challenge Handshake Authentication Protocol)

⊛ **Network Control Protocol**: PPP can carry a network layer data packet from protocols defined by the Internet, OST, Xerox, AppleTalk, DECnet etc. To do this, PPP has network Control Protocols for each protocols.
Exple:- IPCP (Internet Protocol Control Protocol), Xerox CP etc.

⊛ **2 transfer modes of HDLC**:
1. NRM (Normal response mode): Station configuration is unbalanced and has one primary station and multiple secondary stations which sends and response respectively. Used for both Point to point and multipoint links
2. ABM (Asynchronous Balanced mode): Configuration is balanced. Each station functions as both primary and secondary stations. Used in point to point.

3marks:

⊛ 3 random access protocols:
1. ALOHA
2. CSMA/CD (Carrier Sense multiple Access/Collision Detection)
3. CSMA/CA (" " " "/Collision Avoidance)

⊛ 3 random controlled-access protocols:
1. Reservation
2. Polling
3. Token passing.

⊛ 3 Channelization protocols:
1. FDMA (Freq-division multiple access)
2. TDMA (Time-division multiple access)
3. CDMA (Code-division multiple access).

5marks:

⊛ Generator = x^4+x+1. ; number of bits in generator = 5.
bit stream = 1101 0110 11
code word = 1101 0110 11 0000 [4 0's for 5 generator bits]
code word in polynomial = $x^{13}+x^{12}+x^{10}+x^8+x^7+x^5+x^4$

$$
\begin{array}{r|l}
x^4+x+1 & x^9+x^8+x^3+x \\
\hline
 & x^{13}+x^{12}+x^{10}+x^8+x^7+x^5+x^4 \\
 & x^{13}+x^{10}+x^9 \\
\hline
 & x^{12}+x^9+x^8+x^7+x^5+x^4 \\
 & x^{12}+x^9+x^8 \\
\hline
 & x^7+x^5+x^4 \\
 & x^7+x^4+x^3 \\
\hline
 & x^5+x^3 \\
 & x^5+x^2+x \\
\hline
 & x^3+x^2+x.
\end{array}
$$

Final codeword: $x^{13}+x^{12}+x^{10}+x^8+x^7+x^5+x^4+x^3+x^2+x$

1101011011111110.

⊛ Generator = x^3+1 so, $n=4$.

data word = 10011101

codeword = 10011101000 (left shifted thrice)

Polynomial = $x^{10}+x^7+x^6+x^5+x^3$

$$
\begin{array}{r|l}
x^3+1 & x^{10}+x^7+x^6+x^5+x^3 \\
 & x^{10}+x^7 \\
\hline
 & x^6+x^5+x^3 \\
 & x^6+x^3 \\
\hline
 & x^5 \\
 & x^5+x^2 \\
\hline
 & x^2
\end{array}
$$

$x^7+x^3+x^2$

So the actual codeword = $x^{10}+x^7+x^6+x^5+x^3+x^2$

= 10011101100

⊛ 1001 1001 | 1110 0010 | 0010 0100 | 1000 0100

$$
\begin{array}{r}
1001\ 1001 \\
1110\ 0010 \\
0010\ 0100 \\
+\ 1000\ 0100 \\
\hline
100\ 010\ 00\ 11 \\
+10 \\
\hline
0010\ 0101
\end{array}
$$

checksum = 11011010.

10
10
1
1011

10
10
100

⊛ Given, 01001100 | 0101 0101 | 1110 0001 | 1000 0011

$$
\begin{array}{r}
0100\ 1100 \\
1010\ 1010 \\
1110\ 0001 \\
\oplus\ 1100\ 0011 \\
\hline
1010\ 01\ 1010 \\
+10 \\
\hline
1001\ 1100
\end{array}
$$

checksum = 01100011