1) MULTIPLE CHOICE (12 POINTS)

Which describes the correct order of the OSI model layers from top to bottom?

- Physical, data link, network, transport, session, presentation, application
- Data link, physical, network, transport, session, presentation, application
- Physical, data link, network, transport, presentation, session, application
- Application, presentation, session, transport, network, data link, physical

Which layer of the OSI model determines the route from the source computer to the destination computer?

- The transport layer
- The data link layer
- The physical layer
- The network layer

Which layer of the OSI model packages raw data bits into data *frames*?

- The physical layer
- The presentation layer
- The network layer
- The data link layer

The Session layer of the OSI is responsible for what tasks?

- Creating, maintaining, and ending sessions;
- Reliable delivery of data and error control
- Transferring and routing of packets on the network
- Addressing and reassembling frames

Which of the following allows for two devices to communicate at the same time?

- Simplex
- Half duplex
- Full duplex
- Complex

What is the order in which information blocks are created when **decapsulation** with TCP/IP is used? (Select the best answer).

- Segments, packets or datagrams, frames, data bits
- Data, segments, packets or datagrams, frames, bits
- Bits, frames, packets or datagrams, segments, data
- Packets or datagrams, frames, segments, bits, data

2) FILL IN THE BLANK (6 POINTS)

Identify the name of the OSI layer next to its description.

a. Network layer 3 This layer is responsible for forwarding data inside a router to the right interface for retransmission

b. (2) link This layer accepts data from IP for framing and then transmission.

c. transfer Layer 4 This layer transmits the data and handles error notification and flow control end-to-end.

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3) SYNCHRONOUS/ ASYNCHRONOUS TRANSMISSION (8 POINTS)

Fill in the following table with the appropriate item(s) listed below:

1. The clock information is embedded into the transmitted signal.
2. Start-of-text (STX), end-of-text (ETX) characters.
3. *Start* bit and one or two *stop* bits.
4. *Synchronous idle* or *SYN* characters.
5. Faster receiver clock.
6. Start-of-frame byte, then "length" byte.
7. *Opening-closing flag bytes.*
8. 10-bits *preamble* which precedes the frame contents.

Any (1) for (1)

6

	Asynchronous Transmission	*Synchronous Transmission*	
		Character oriented	*Bit oriented*
Bit synchron.	(5)	the clock information (1)	(1)
Character synch.	(3)	Synchronous idle or SYN character (4)	opening flag & closing (7)
Frame synchron.	Start of Text ETX (2)	start of frame byte (6)	10 bit preamble which --- (8)

4) APPLICATION LAYER Protocols (6 POINTS)

What Application Layer protocols are used by the following services

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- E-mail SMTP Simple mail transfer protocol
- Remote Terminal protocol TELNET
- File Transfer FTP file transfer protocol
- WWW ~~TCP transfer Control protocol~~

http

5) Probability Calculation **(10 POINTS)**

Assume that a frame consists of 100 characters and that a character has 8 bits. The bit error rate is $BER = 10^{-6}$. What is the probability that the frame gets transmitted with errors?

$N = 100 \times 8 = 800$ bits　　$P = BER = 10^{-6}$

$NP \ll 1$

10

$P(\text{with Error}) = 1 - (1-P)^N$

$= 1 - (1 - NP)$

$= 1 - (1 - 800 \times 10^{-6})$

$= 8 \times 10^{-4}$

6) Modem Bit Rate **(8 POINTS)**

Assume a modem packs 4 bits into each signal change and operates at 2400 baud.

- How many voltage levels it is using?
- What is its operating Bit Rate?

8

0000

$2^4 = 16$

$\log_2 M$

16 voltage levels = M

m = 4

$R_s = 2400$ Signal/sec.

4 bits/signal.

2400 → 4 bits → sec

$R_b = m R_s = 2400 \times 4$

$= 9600$ bps

7) Frequency Division Multiplexing FDM **(10 POINTS)**

Calculate the Bandwidth required to send 24 digitized voice channels by FDM on an international satellite system? Assume a Noiseless channel Transmission.

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$C = 64\text{kbps} \times 24$

$= 1536$ kbps

$4k \times 2 \times 8$

(64kbps)

$C = 2W \log_2 M$

max bit data rate

$W = \dfrac{C}{2\log_2 M} = \dfrac{1536 \text{ kbps}}{2}$

Bandwidth

take M = 2

$16 = 4^2$

8) Information Theory **(10 POINTS)**

Consider a spectral band between 20.001 GHz and 20.021 GHz with a signal to noise ratio (S/N) of 15. What is the theoretical maximum data rate for this channel?

$C = W \log_2(1 + \frac{S}{N})$

$W = 20.021 - 20.001 = 20 \times 10^6$ Hz

Max data rate

$C = 20 \times 10^6 \times \log_2(1 + 15)$

$C = 20 \times 10^6 \times 4 = 80$ Mbps

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9) Time Division Multiplexing **(14 POINTS)**

Assume that 2 computers are using Time Division Multiplexing (TDM) to take turns sending 10^3 bytes packets over a shared channel that operates at 64 Kbps. If the hardware takes 100 microseconds after one computer stops sending before the other can begin, how long it take for each of the computers to send a 10^6 Bytes data file?

$10^3 \times 8 = 8 \times 10^3$ b

(packet = 8 Kb)

100 μs

$\frac{10^6}{10^3} = 1000$ packet

64 kp → 1 s

8 Kp → T_1

$T_2 = T_1 = \frac{8}{64} = 0.125$ s

T_1 + delay

T_2

$T_t = (2N-1)T_x + (2N-2)T_G$

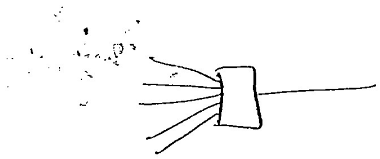
$\simeq 2N(T_x + T_G)$

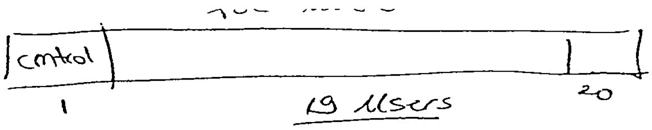
$T_x = \frac{8 \times 10^3}{64 \times 10^3}$

$2(0.125) + 100 \times 10^{-6} =$

$0.25 + 100 \times 10^{-6} = 0.25$ s

Time for 1 pack





10) USEFUL BIT RATE (16 POINTS)

A 1.28 Mbps link is serving several DTEs using TDM. Every frame trasmitted on that link is made of 20 bytes. Answer the following after taking the following assumptions:

20-1 = 19 Users

- Each byte is made of 8 bits including one framing bit and one handshaking bit. (8 bits)
- Byte number 1 in every frame is used for control information.

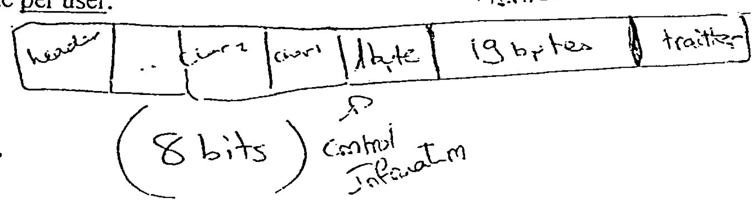
a) How many users can be multiplexed on that link. Sketch the frame.

b) What is the useful bit rate per user.

rate $= \frac{1.28 \times 10^6}{20} = 64$ kbps

rate $= \frac{1.28 \times 10^6}{20} \times \frac{6}{8} = 48$ kbps

20 bytes

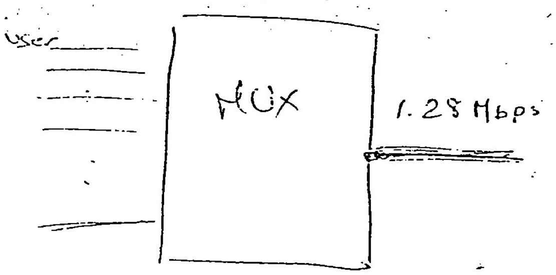


frame = 20 bytes.

⇒ 19 effective bytes

20 × 8 = 160 bits/frame

(b)



1.28 Mbps is the total load

$\frac{1280 \text{ kbps}}{160}$ = 8 k frames = 8000 frames

frame = 20 byte

19 bytes.

useful

19 × 6 = 114 useful bits/frame

useful bit

~~8000 frames can be sent together ⇒ 8000 users if each sends 1 frame~~

20 − 1 = 19 users.