Roll No. _____ Name _____ Group _____

Thapar Institute of Engineering & Technology
Computer Science & Engineering Department
MID SEMESTER EXAMINATION

UCS414: Computer Network Date:08 March 2025 Time: 2 hours MM:30
Faculty: Dr. Lokendra Vishwakarma

Instructions:
1. Attempt all questions.
2. Attempt all the subparts of a question at one place.
3. Assume data if required.
4. Illustrate your answers with neat sketches wherever necessary.

1. a) **What is framing? Explain bit stuffing in framing.** [**2 marks** | CO2 | BL1]
Answer: Framing is a technique used in the Data Link Layer of the OSI model to break data into smaller, manageable units called frames. These frames are transmitted over the network and reassembled at the destination. Framing ensures proper synchronization, error detection, and efficient data transmission.
Bit stuffing is a method used in character-oriented and bit-oriented protocols to prevent accidental misinterpretation of control sequences (like frame delimiters). A special pattern (e.g., 01111110) is used to mark the beginning and end of a frame. If the sender's data contains the same bit pattern as the delimiter, the protocol inserts an extra bit (0 or 1) at predefined positions to avoid confusion. At the receiver's end, the extra bit is removed to reconstruct the original data.
Example: Suppose the frame delimiter is 01111110. If the actual data contains 011111, the transmitter inserts an extra 0 after every sequence of five consecutive 1s, making it 0111110. The receiver removes the stuffed 0 to get the original data.

b) **Differentiate the OSI and TCP/IP reference models based on at least 4 features.** [**2 marks** | CO1 | BL1] **Answer:**

Feature	**OSI**	**TCP/IP**
Number of Layers	7 Layers: Application, Presentation, Session, Transport, Network, Data Link, Physical	4 Layers: Application, Transport, Internet, Network Access
Protocol Dependency	Protocol-independent; works as a conceptual framework.	Protocol-oriented; based on TCP, IP, UDP, etc.
Layer Merging	Separate layers for Presentation, Session, and Data Link.	Merges Presentation & Session into Application; Data Link & Physical into Network Access.
Usage & Implementation	Primarily a theoretical model used for understanding networking concepts.	A practical, widely used model for real-world networking (e.g., the Internet).

c) **Explain the following:**
1. Bridges **2. Routers** [**2 marks** | CO1 | BL1]
Answer:
Bridges:
- It Acts on the data link layer (MAC address level).

- Used to divide (segment) the LAN into smaller LANs segments, or to connect LANs that use identical physical and data link layers protocol.
- Each LAN segment is a separate collision domain.
- Bridge does not send the received frame to all other interfaces like hubs and repeaters, but it performs filtering .
- Bridge uses a bridge table (forwarding table) that contains entries for the nodes on the LAN for packet forwarding.
- A bridge runs CSMA/CD before sending a frame onto the link not like the hub or repeater

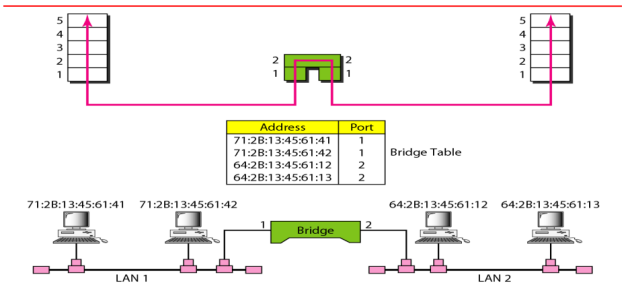

Figure 1: A bridge connecting two LAN

Routers:

- Operates at network layer and deals with packets not frames.
- Connect LANs and WANs with similar or different protocols together.
- Routers isolate both collision domains and broadcast domains.
- Acts like normal stations on a network, but have more than one network address (an address to each connected network).
- Deals with global address (network layer address (IP)) not local address (MAC address).
- Routers Communicate with each other and exchange routing information.
- Determine best route using routing algorithm by special software installed on them.
- Forward traffic if information on destination is available otherwise discard it (not like a switch or bridge).

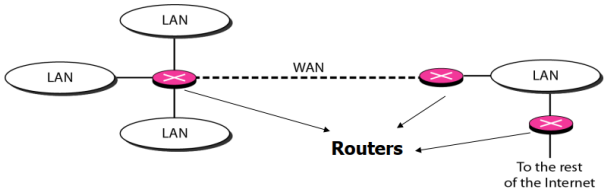

Figure 2: Routers connecting independent LANs and WANs

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2. a) Differentiate between single bit and burst error with example? [**1 marks** | CO2 | BL2]

Answer:

Single bit Error: It is nothing but a special type of transmission error. During transmission of data packets from one networking device to another, if only one bit from this whole data packet is being changed/corrupted/altered then Single-bit transmission error occurs. This single bit corruption can be occurred due to induced noise in data transmission cable or presence of electromagnetic interference. For example say one sender sent a data packet to a receiver and the data packet is 0111. And during transmission single-bit error occurred and receiver receives 0011 instead 0111 i.e. only one bit is flipped.

Burst Error: Similarly it is one kind of Transmission error and very likely to single bit error. But in Burst error, multiple data bits of a data packets are being changed/corrupted/ altered during transmission. And these multibit corruption occurs in a very short period so it is called 'Burst'. Communication line interference, impulsive noise are the main factors which lead to burst error. As multiple bit are being corrupted so it can fully corrupt a data

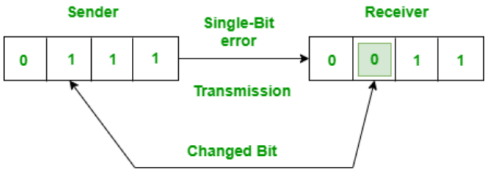

Figure 3: Single bit error depiction

packet and making it fully valueless. Burst errors can be rectified by retransmission but it consumes additional network resources and burst error can occur in that also. For example the sender sends a data block of 110001 and receiver receives 101101. Here, we can see that in a single instance total 3bits of data corrupted i.e. burst error occurred.

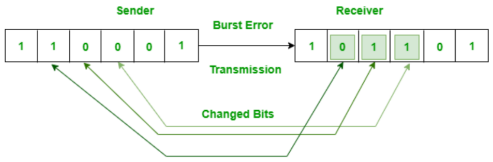

Figure 4: Burst error depiction

b) Suppose a dataword 110010100 is to be transmitted from Sender A to Receiver B. CRC method with generator 10101 is used to track errors in the transmitted packet. Find:
1. The Redundancy bits to be added to the dataword and the codeword generated for transmission. [**2.5 marks** | CO2 | BL2]
2. If the fourth bit from right in the given datawod is corrupted to 1 and received dataword is 11001***1***100, show the steps to detect the error at Receiver B. [**2.5 marks** | CO2 | BL3]
Solution:

```
10101)11001 0100 0000(111110111
      10101
      11000
      10101
       11011
       10101
        11100
        10101
         10010
         10101
          11100
          10101
           10010
           10101
            1110
```

Hence, the codeword is 110010100**1110**
Divide the codeword **110011100 1110** with 10101 to get syndrome. If it is non zero, means error.

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3. a) Define the "looping" problem with suitable diagram that arises due to interconnection of switches / bridges when creating a LAN. Describe the method to solve this problem in detail. [**3 marks** | CO2 | BL4]
Answer: Transparent bridges work fine as long as there are no redundant bridges in the system. Systems administrators, however, like to have redundant bridges (more than one bridge between a pair of LANs) to make the system more reliable. If a bridge fails, another

bridge takes over until the failed one is repaired or replaced. Redundancy can create loops in the system, which is very undesirable. The following figure shows a very simple example of a loop created in a system with two LANs connected by two bridges.

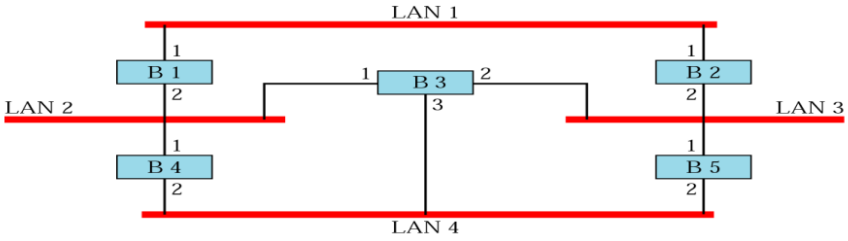

Figure 5: Looping problem in the LAN

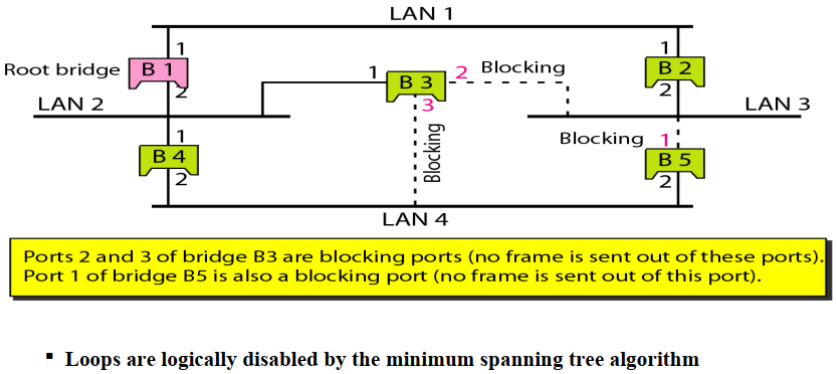

Figure 6: Looping solution in the LAN

b) Frames of 100 bits are transmitted over a 1 Mbps satellite channel using a Sliding Window Protocol. Acknowledgments (ACKs) are piggybacked, and the header size is negligible. A 3-bit sequence number is used. Given that the one-way propagation delay is 250 ms, determine the maximum achievable channel utilization for this sliding window protocol.

[**3 marks** | CO2 | BL4]

Answer:

Given Data:

Channel Capacity= 1 Mbps = $1\text{x}10^6$bps
Frame Size (D+H) = 1000 bits
Header (H) = Negligible so, D = D+H = 1000
Propagation Delay (I) = 250ms = $250\text{x}10^{-3}$ sec
3 bit sequence, i.e., w = 8

Utlilization in Sliding window protocol:

$$U = \frac{D}{D+H} \cdot \frac{w}{1+2IC/F}$$

$$= \frac{1000}{1000} \cdot \frac{8}{1+\frac{2\text{x}250\text{x}10^{-3}\text{x}10^6}{1000}} = 0.015$$

That is 1.5% is the maximum channel utilization.

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4. a) What is Network Topology? Explain different types of topologies in Network.

[**3 marks** | CO2 | BL1]

Answer: The topology of a network is the geometric representation of the relationship of all the links and linking devices/nodes to one another. 1. Physical Topology and 2. Logical Topology.

Different types of topologies are shown in the figure 7.

b) Consider a token ring network with a length of 2km having 10 stations including a monitoring station. The propagation speed of the signal is 2 x 10^8 m/s and token transmission time is ignored. If each station is allowed to hold the token for 2μsec, what is the minimum

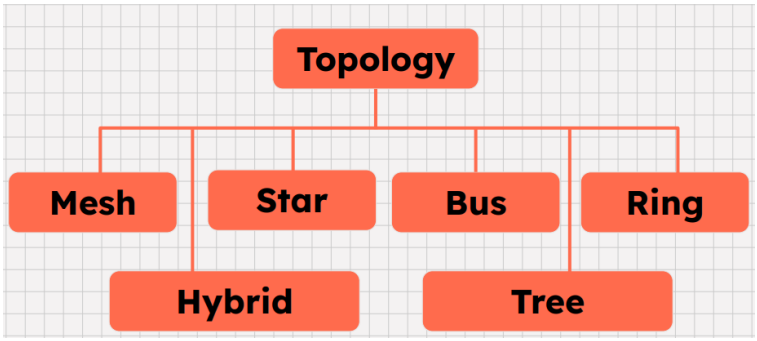

Figure 7: Classification of topology

time for which the monitoring station should wait (in μ sec) before assuming that the token is lost?
Note: A monitoring station assume that the token is lost if it is not return back to it in fixed amount of time. [**3 marks** | CO2 | BL4] **Solution:**
Given Data:
Propagation speed: 2 x 10^8 m/s
Token holding time (THT): 2μsec
Token Ring network length: 2 km = 2 x 10^3

Concept:
Minimum waiting time: propagation delay or ring lateny + token holding time for each station
Minimum waiting time: $T_P + n$ x THT

Propagation delay (T_P): $\frac{\text{Network Length}}{\text{Propagation Speed}} = \frac{2 \text{ x } 10^3}{2 \text{ x } 10^8} = 10^{-5} . \frac{10}{10} = 10\mu$sec.
Minimum waiting time: 10 + 10 x 2 = 30 μ sec.

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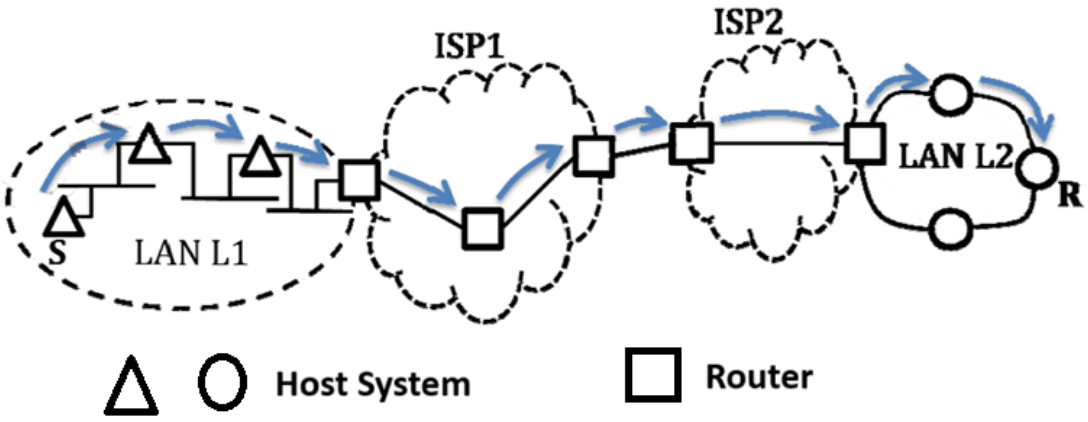
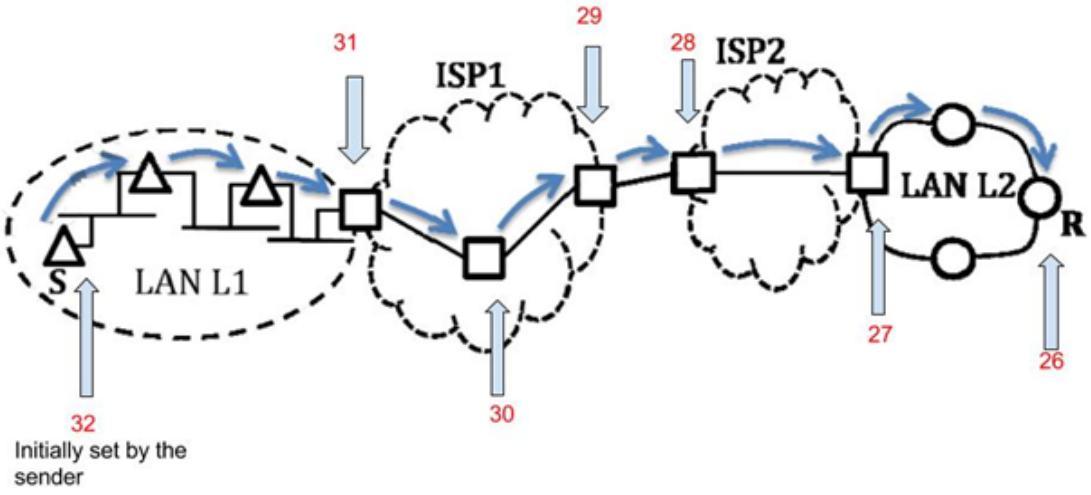
5. a) The Time-to-Live (TTL) field is an 8-bit field in the IPv4 header that specifies the maximum number of hops (routers) a packet can pass through before being discarded. Its primary purpose is to prevent packets from looping indefinitely in case of routing errors. If packets are only within the same subnet, they do not pass through routers, so TTL remains unchanged. In the diagram shown below L1 is an Ethernet LAN and L2 is a Token-Ring LAN. An IP packet originates from sender S and traverses to R, as shown. The link within each ISP, and across two ISPs, are all point to point optical links. The initial value of TTL is 32. What is the maximum possible value of TTL field when R receives the datagram. Justify your answer with all clear steps according to the diagram given below. [**3 marks** | CO3 | BL4]



Solution:
TTL(Time to Live) - It is a mechanism that limits the lifespan of a packet in a computer network. It is implemented with the help of a counter or timestamp which is set by the

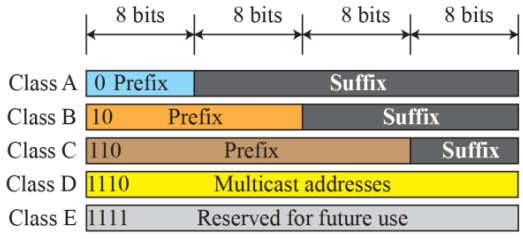
sender of the packet and embedded in the packet itself. It represents the maximum lifetime of a packet in the network. When a packet routes through a network, each router checks the current value of its TTL, if the TTL value is not zero then only the router accepts the packet, and decrements its value by 1. This process takes place at every router. If some router founds the TTL value of the incoming packet to be 0, then it simply discards/destroys the packet (because the lifetime of the packet is over, and hence the packet is not eligible to be in the network). One of the main purposes of setting the TTL value and doing all this process is to ensure that there is no undelivered packet in the network which is circulating indefinitely, and to avoid the problem of duplicate delivery of the same packet, which may arise in the case of network congestion. Now, routing decisions are taken place at the network layer. hence we have to see in the above question that when the packet is going through the network layer. LANs work at Data Link Layer only, hence the packet doesn't reach network layer in LANs. So in the question above, Except LANs, at all other points routing decisions have to be taken. Hence, TTL value will be checked and manipulated at those points/routers. At Receiver end also, the packet has to go through the network layer so as to reach to application layer, hence Receiver will also check and decrement the TTL value. So there are 6 routers in the above diagram. Initially TTL value was 32, so at the Receiver it will become 32 - 6 = 26.



b) Find the class of the following IP address and provide your justification.
1. 238.34.2.1
2. 129.14.6.8 [**1 marks** | CO3 | BL2]

Answer:

Classes of IP address is show below:



Class	Prefixes	First byte
A	$n = 8$ bits	0 to 127
B	$n = 16$ bits	128 to 191
C	$n = 24$ bits	192 to 223
D	Not applicable	224 to 239
E	Not applicable	240 to 255

Class of 238.34.2.1 is D and class of 129.14.6.8 is B.

c) A block of addresses is granted to a small organization. We know that one of the addresses is 205.16.37.39/28.
1. What is the first and last address in the block?
2. Find the number of addresses. [**2 marks** | CO3 | BL3]

Answer:

1. Determine the Subnet Mask: Given Prefix = /28
Subnet mask for /28:
Binary: 11111111.11111111.11111111.11110000
Decimal: 255.255.255.240
The last 4 bits are for host addresses, so each subnet has $2^4 = 16$ IP addresses.

2. Finding the first address:
Convert 205.16.37.39 to Binary: 11001101.00010000.00100101.00100111
Apply the Subnet Mask (AND operation):
11001101.00010000.00100101.00100111 (205.16.37.39)
11111111.11111111.11111111.11110000 (Subnet Mask: /28)
————————————————-
11001101.00010000.00100101.00100000 (205.16.37.32)

First Address (Network Address) = 205.16.37.32

3. Finding the last address:
Set all Host Bits to 1 (last 4 bits): 11001101.00010000.00100101.00101111 (205.16.37.47)
Last Address (Broadcast Address) = 205.16.37.47
