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Your Roll No.....

Sr. No. of Question Paper : 2032 **L**
Unique Paper Code : 2342012403
Name of the Paper : Computer Networks
Name of the Course : **B.Sc. (H) Computer Science – DSC (NEP-UGCF-2022)**
Semester : IV
Duration : 3 Hours Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. The paper has **two** sections. **All** questions in **Section A** are compulsory.
3. Attempt any **four** questions from **Section B**.
4. Parts of a question must be attempted together.

Section A

- 1 (a) What is the sliding window protocol? How does it improve efficiency over Stop-and-Wait protocol? If the sequence number field is 3 bits long, what is the maximum window size for Selective Repeat protocol? 3
- (b) A synchronous TDM system transmits 4000 frames per second. Each frame consists of 12 slots, and each slot carries 8 bits. Additionally, 2 extra bits are added to each frame for synchronization. 3
 - (i) What is the size of each frame (in bits)?
 - (ii) Give the transmission rate (in bps).
 - (iii) What is the duration of each output frame?
- (c) Explain the significance of "signal levels" in the Nyquist formula. How does increasing the number of levels affect the data rate? 3
A channel uses four signal levels and has a bandwidth of 150 KHz. What is the maximum data rate achievable using the Nyquist formula?
- (d) In a bus topology, the total bandwidth is 10 Mbps. 3
Due to collisions and retransmissions, only 70% of the bandwidth is effectively utilized. Calculate the effective data rate of the network.
If 4 devices share the channel equally, what is the average data rate per device?
Explain why collisions are common in bus topology.
- (e) A satellite communication system is used to provide connectivity across remote and geographically dispersed regions. 3
 - (i) Explain how satellite communication enables wide-area or global coverage.
 - (ii) Write any two limitations associated with satellite communication.
- (f) A TCP connection is established over a communication link with a bandwidth of 5 Mbps, a round trip time (RTT) of 40 ms, and a TCP window size of 20,000 bits. 3
Calculate the actual throughput of the connection and comment on whether the link is fully utilized or not based on the result.

P.T.O.

- (g) A noiseless channel has bandwidth 4 kHz and uses 8 signal levels. A noisy channel has the same bandwidth with SNR = 20 dB. Which channel has a higher maximum data rate? Justify. 3
- (h) A communication channel has a bandwidth of 10 Mbps between Device A and Device B. 3
- (i) In Half-Duplex mode, A and B alternately transmit for 2 seconds each. Calculate the effective data rate experienced by each device over time.
 - (ii) In Full-Duplex mode, both devices transmit simultaneously using the same 10 Mbps link. Explain how the bandwidth is utilized and determine the effective data rate for each device?
- (i) Modern computer networks rely on different devices operating at various layers of the OSI model. 3
- Compare Hub, Switch and Router in terms of:
- (i) Layer of operation
 - (ii) Functionality
- (j) In a computer network, a host needs to send data to another host. It knows the destination IP but not the MAC address. Write the name of the protocol and explain its working. 3

Section B

- 2 a) TCP is considered a reliable protocol, while UDP is called an unreliable and connectionless protocol. Justify the above statement by comparing the mechanisms such as handshaking, error control, reliability, ordering of segments and congestion control. Provide examples of applications that benefit from each protocol. 7
- b) Answer the following questions with respect to the Stop and Wait Protocol: 8
- (i) How does the Stop-and-Wait protocol handle duplicate frames?
 - (ii) Why is a timer necessary at the sender side in the Stop-and-Wait protocol? What could happen if there's no timer?
 - (iii) What is the significance of sequence numbers being only 1 bit in Stop-and-Wait ARQ?
 - (iv) What happens if the sender sends a frame and the receiver receives it correctly, but the ACK frame is lost? Illustrate the complete flow with the help of a sequence diagram.
- 3 a) Consider a network of six routers labelled A, B, C, D, E, and F. The cost of the links between the routers is as follows: 8
- A-B: 3
 - A-C: 1
 - B-C: 7
 - B-D: 5
 - C-D: 2

D-E: 7

C-F: 8

E-F: 2

Using Dijkstra's algorithm, determine the shortest path from router A to router E and show all intermediate steps.

Also, State the Optimality Principle.

- b) Discuss the advantages and disadvantages of allowing browsers to be extended using plug-ins and helper applications. 7
- Can a single-threaded web server handle multiple client requests at the same time? Justify your answer with reasons related to server architecture and performance. Describe the role of multithreading in improving Web server throughput.
- 4 a) Why must a station in CSMA/CD transmit for a minimum duration of 2τ before it can assume the channel has been seized? Illustrate using a diagram. 7
- In a CSMA/CD network, a station experiences a collision after transmitting a frame. If this is the third collision, calculate the maximum wait time before the next transmission attempt. Assume a slot time of $50 \mu s$.
- What is the significance of the "backoff time" in CSMA/CD?
- b) An organization is assigned the IP address 192.168.10.0/24. The network administrator needs to create two subnets to accommodate 120 and 30 hosts respectively. 8
- For each subnet:
- (i) Provide the subnet mask in dotted-decimal notation
 - (ii) List the first and last valid host IPs
 - (iii) Indicate the broadcast address
- 5 a) Explain the purpose of the following ICMP messages: 7
- (i) Destination Unreachable
 - (ii) Time Exceeded
 - (iii) Echo and Echo Reply
 - (iv) Timestamp Request and Timestamp Reply
 - (v) Source Quench
 - (vi) Redirect
 - (vii) Router Advertisement/ Solicitation
- b) What is Cyclic Redundancy Check (CRC)? A bit stream 10011101 is transmitted using the standard CRC method. The generator polynomial is $x^3 + 1$. Show the actual bit string transmitted. Suppose that the third bit from the left is inverted during transmission. Show that this error is detected at the receiver's end. 8

- 6 a) A data frame of 600 bits is transmitted using both bit stuffing and byte stuffing. 8
In bit stuffing, there are 50 occurrences of five consecutive 1s.
In byte stuffing, 10 flag bytes appear in data.
- i. Calculate the overhead in both techniques. Which technique is better for this case?
 - ii. Consider that during transmission over a noisy channel, 2 stuffed bits are flipped in the bit-stuffed frame.
Explain how this affects frame synchronization. Can the receiver correctly recover the original data? Suggest a method to detect such errors.
- b) What are the different categories of UTP cables defined by the EIA? Explain each with its specifications and applications. 7
- 7 a) Compress the 128 bit (16 bytes) IPv6 address written as eight groups of four hexadecimal digits 8000:0000:0000:0000:0123:4567:89AB:CDEF. 3
- b) A file transfer application requires reliable delivery, while a live video streaming application prioritizes speed over accuracy. Explain the types of communication services suitable for each case. 4
- c) A TCP connection has a bandwidth of 10 Mbps and RTT of 20 ms. 4
- (i) Calculate the minimum window size required to fully utilize the bandwidth.
 - (ii) Explain the significance of this result in terms of network performance.
- d) Discuss how propagation characteristics in terms of reflection, refraction and diffraction affect the performance of radio wave and microwave communication. 4