REG.NO.:

SLOT: E2+TE2

SCHOOL OF COMPUTER SCIENCE AND ENGINEERING
CONTINUOUS ASSESSMENT TEST - II
WINTER SEMESTER 2025-2026

Programme Name & Branch	**: M. Tech Computer Science and Engineering (Integrated)**
Course Code and Course Name	**: CSI2007 ; Data Communication and Networks**
Faculty Name(s)	**: Dr. Anindita Kundu, Dr. S. Sudha, Dr. A. Krishnamoorthy, Dr. K. Rajakumar**
Class Number(s)	**: VL2025260501491, 1494, 1496, 1497**
Date of Examination	**: 20-03-2026**
Exam Duration	**: 90 minutes Maximum Marks: 50**

General instruction(s):

- Answer All Questions
- M - Max mark; CO – Course Outcome; BL – Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)
- Course Outcomes
  2. Identify and analyze the different types of network topologies, error and flow control mechanisms
  3. Design sub-netting and enhance the performance of routing mechanisms.

Q. No	Question	Module	Marks	CO	BL

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1	A sender transmits data frames of 500 bytes over a link with a bandwidth of 1 Mbps. The propagation delay between sender and receiver is 10 ms. The ACK size is negligible. a) Calculate the transmission time of one frame. b) If Stop-and-Wait protocol is used over a noiseless channel, calculate the total time required to send one frame and receive its ACK. c) Using the result from part (b), calculate the channel utilization of Stop-and-Wait protocol. d) If the channel becomes noisy and one frame out of every 5 frames is lost, how many total transmissions are required to successfully send 10 frames? Solution **a) Transmission time of one frame** Frame size = 500 bytes = 500 × 8 = **4000 bits** Bandwidth = 1 Mbps = 10^6 bps $$T_{tx} = \frac{4000}{10^6} = 0.004 \text{ s} = \mathbf{4\ ms}$$ **b) Total time (Stop-and-Wait)** Propagation delay (one way) = 10 ms Round-trip propagation delay = $2 \times 10 = 20$ ms ACK size negligible ⇒ ignore ACK transmission time $$T_{total} = T_{tx} + 2T_p = 4 + 20 = \mathbf{24}\text{ ms}$$ **c) Channel Utilization** $$U = \frac{T_{tx}}{T_{total}} = \frac{4}{24} = \frac{1}{6} \approx \mathbf{0.167}$$ $$\Rightarrow \mathbf{16.67\%}$$ **d) Total transmissions (with losses)** Given: 1 frame lost out of every 5 ⇒ Success probability = $\frac{4}{5}$ Expected transmissions per successful frame: $$\frac{1}{4/5} = \frac{5}{4} = 1.25$$ For 10 successful frames: $$10 \times 1.25 = 12.5 \approx \mathbf{13} \text{ transmissions}$$	3	2+3+3 +2	2	3

2.	In a shared Ethernet LAN using CSMA/CD, four computers A, B, C, and D are connected through a common bus cable as shown below. The signal propagation speed in the cable is 2×10^8 m/s. All computers follow the CSMA/CD protocol. A——100m——B——100m——C——100m——D At time t = 0, Computer A senses the channel idle and begins transmitting a frame. Before A's signal reaches the far end of the network, Computer D also senses the channel idle and begins transmitting. a) Calculate the propagation delay for a signal to travel from A to D. b) Explain why a collision occurs even though both computers sensed the channel to be idle before transmitting. c) Describe how CSMA/CD detects the collision and what actions the computers take immediately after detecting it. d) After detecting the collision, both computers apply the binary exponential backoff algorithm. Explain how this algorithm reduces the probability of repeated collisions. Solution: **a) Propagation delay from A to D** Distance from A to D: $$100 + 100 + 100 = 300 \text{ m}$$ Propagation speed: $$2 \times 10^8 \text{ m/s}$$ $$T_p = \frac{\text{Distance}}{\text{Speed}} = \frac{300}{2 \times 10^8}$$ $$T_p = 1.5 \times 10^{-6} \text{ s} = \mathbf{1.5\ \mu s}$$ **b) Why collision occurs** Even though both A and D sensed the channel as idle, a collision occurs due to **propagation delay:** • At **t = 0**, A starts transmitting. • A's signal takes **1.5 µs** to reach D. • Before A's signal arrives, **D still senses the channel as idle** (because the signal hasn't reached yet). • D starts transmitting within this **time window**. • When the signals from A and D meet on the cable, they **interfere**, causing a **collision**. **Key Insight (CSMA/CD Limitation)** CSMA/CD cannot prevent collisions because: • **Carrier sensing is local**, not instantaneous across the network. • Due to finite propagation delay, **two distant nodes may both think the channel is idle**.	3	10	2	4

c) Collision Detection and Immediate Actions in CSMA/CD

Collision Detection

In **CSMA/CD (Carrier Sense Multiple Access with Collision Detection)**:

- While transmitting, each computer **continuously monitors the channel**.
- It compares the signal on the medium with the signal it is transmitting.
- If there is a mismatch (abnormal voltage / signal distortion), a **collision is detected**.

Immediate Actions after Collision

Once a collision is detected, the computers:

1. **Abort Transmission Immediately**
   - Stop sending the current frame.
2. **Send a Jam Signal**
   - A short signal is transmitted to ensure all nodes recognize the collision.
3. **Invoke Backoff Algorithm**
   - Each computer waits for a random time before retransmitting.

d) Binary Exponential Backoff Algorithm

After a collision, each computer delays retransmission using this algorithm:

Working

- Let **k = number of collisions experienced (for that frame)**
- Choose a random number:

$$r \in [0, 2^k - 1]$$

- Wait time:

$$\text{Backoff Time} = r \times \text{slot time}$$

How It Reduces Repeated Collisions

1. **Randomization**
   - Each node picks a **different random delay**, reducing the chance of simultaneous retransmission.
2. **Exponential Increase**
   - After each collision, the range doubles:
     - 1st collision: [0,1]
     - 2nd: [0,3]
     - 3rd: [0,7]
   - This spreads transmissions over a larger time window.
3. **Adaptive Behavior**
   - Light traffic → small delay → faster recovery
   - Heavy collisions → larger delay → avoids congestion
4. **Reduced Synchronization**
   - Prevents nodes from repeatedly colliding in lockstep

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<table>
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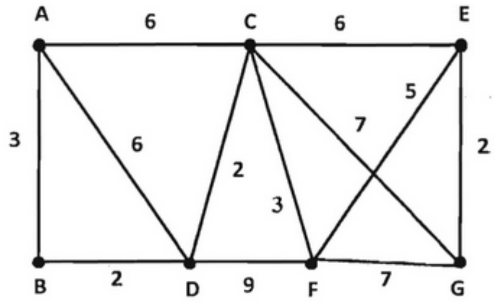
<td>
Consider the following network graph:


Apply a suitable routing algorithm to find the shortest path from Node A to Node G.

Solution:
We apply Dijkstra’s Algorithm since all edge weights are positive.

Step 1: Initialize
• Distance from A = 0
• Others = ∞
Step 2: Iterative Updates
From A:
• A → B = 3
• A → C = 6
• A → D = 6

Pick B (3):
• B → D = 3 + 2 = 5 (better than 6 → update D)

Pick D (5):
• D → C = 5 + 2 = 7 (no improvement over 6)
• D → F = 5 + 9 = 14

Pick C (6):
• C → F = 6 + 3 = 9 (update F)
• C → E = 6 + 6 = 12
• C → G = 6 + 7 = 13

Pick F (9):
• F → G = 9 + 7 = 16 (no improvement over 13)
• F → E = 9 + 5 = 14 (no improvement over 12)

Pick E (12):
• E → G = 12 + 2 = 14 (no improvement over 13)

Pick G (13) → Destination reached
Shortest Path: A →C→G
Total Cost: 6+7 = 13
</td>
<td>4</td>
<td>10</td>
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4. A university campus has been assigned the IP address block 192.168.32.0/19. This address space must be divided among three departments: CSE, ECE, and MECH. The requirements are as follows:

- CSE has 12 labs, each containing 80 machines.
- ECE has 18 labs, each containing 60 machines.
- MECH has 10 labs, each containing 50 machines.

Determine the subnet mask required for each lab based on the number of machines. Identify the range of IP addresses assigned to each lab in every department. Allocate the required address blocks to CSE, ECE, and MECH from the main network. Identify the Unallocated IP addresses (which can still be used later) and Wasted IP addresses (unused inside allocated subnets that cannot be reassigned). Calculate the total number of addresses wasted and remaining for the entire university network.

Step 1: Given Block

Network: **192.168.32.0/19**

Total IPs:

$$2^{32-19} = 2^{13} = 8192 \text{ IPs}$$

Department	Labs	Machines/Lab	Total Hosts
CSE	12	80	960
ECE	18	60	1080
MECH	10	50	500

CSE (80 hosts)

Need ≥ 80 → next power = 128

Subnet = **/25** (126 usable)

ECE (60 hosts)

Need ≥ 60 → 64

Subnet = **/26** (62 usable)

MECH (50 hosts)

Need ≥ 50 → 64

Subnet = **/26** (62 usable)

🔷 CSE Allocation (12 × /25)

Each /25 = 128 IPs

Total = 12 × 128 = **1536 IPs**

Range:

- Start: **192.168.32.0**
- End: **192.168.37.255**

Example lab ranges:

- Lab1: 192.168.32.0 – 192.168.32.127
- Lab2: 192.168.32.128 – 192.168.32.255
- ...
- Lab12 ends at **192.168.37.255**

🔷 ECE Allocation (18 × /26)

Each /26 = 64 IPs

Total = 18 × 64 = **1152 IPs**

Range:

- Start: **192.168.38.0**
- End: **192.168.42.255**

Example lab ranges:

- Lab1: 192.168.38.0 – 192.168.38.63
- Lab2: 192.168.38.64 – 192.168.38.127
- ...

🔷 MECH Allocation (10 × /26)

Each /26 = 64 IPs

Total = 10 × 64 = **640 IPs**

Range:

- Start: **192.168.43.0**
- End: **192.168.45.255**

4	10	3	3

	Step 5: Unallocated IPs Used so far: $$1536 + 1152 + 640 = 3328$$ Remaining: $$8192 - 3328 = \mathbf{4864} \text{ IPs (Unallocated)}$$ **Step 6: Wasted IPs (Inside Subnets)** **CSE:** • Usable = 126, Needed = 80 • Waste per lab = 46 $$12 \times 46 = 552$$ **ECE:** • Usable = 62, Needed = 60 • Waste per lab = 2 $$18 \times 2 = 36$$ **MECH:** • Usable = 62, Needed = 50 • Waste per lab = 12 $$10 \times 12 = 120$$				

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5.	An IPv4 packet header begins with the following hexadecimal values: 46 00 00 3C 1A 2B 20 00 40 06 7C 91 AC 10 02 0F AC 10 02 01 Answer the following questions based on the IPv4 header format: a) Identify the Version and Header Length (IHL) fields from the first byte. b) Determine the Total Length of the IP packet in decimal number system. c) Check whether the packet is fragmented or not using the Flags and Fragment Offset fields. d) Convert the Source IP address from hexadecimal to dotted decimal notation. e) Identify the protocol used in the packet based on the Protocol field.	4	10	3	3

🔷 a) Version and IHL

First byte = **46 (hex)**

Convert to binary:

$$4 = 0100, \quad 6 = 0110 \Rightarrow 01000110$$

- **Version (first 4 bits):** 0100 = **4** → IPv4
- **IHL (last 4 bits):** 0110 = **6**

👉 Header length:

$$6 \times 4 = \mathbf{24} \text{ bytes}$$

🔷 b) Total Length

Bytes: **00 3C (hex)**

$$0x003C = \mathbf{60} \text{ bytes}$$

🔷 c) Fragmentation Check

Bytes: **20 00**

Convert:

$$0x2000 = 0010\ 0000\ 0000\ 0000$$

- First 3 bits = **Flags**
  - Bit 1 (Reserved) = 0
  - Bit 2 (DF) = 1
  - Bit 3 (MF) = 0
- Fragment Offset = **0**

👉 **Interpretation:**

- DF = 1 → **Do Not Fragment**
- MF = 0 → No more fragments
- Offset = 0

✅ **Packet is NOT fragmented**

	🔷 **d) Source IP Address** Bytes: **AC 10 02 0F** Convert each to decimal: • AC = 172 • 10 = 16 • 02 = 2 • 0F = 15 👉 **Source IP = 172.16.2.15** 🔷 **e) Protocol Field** Byte: **06 (hex)** $0x06 = \mathbf{6}$ 👉 Protocol = **TCP**				

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