



SCHOOL OF COMPUTER SCIENCE AND ENGINEERING
CONTINUOUS ASSESSMENT TEST - I
FALL SEMESTER 2026-2027

Programme Name & Branch : B. Tech Computer Science and Engineering
Course Code and Course Name : BACSE203 Computer Networks
Faculty Name(s) :
Class Number(s) :
Date of Examination : 10.08.2026 AN
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:
CO1. Interpret the different building blocks of networks.
CO2. Analyze the error and flow control mechanisms for connecting a network.

Q. No	Question	M	CO	BL
1.	A university campus network connects hostel LANs to a central data centre, which accesses the Internet through an ISP. A student sends an HTTPS request to a web server in another country. a) Explain how network topology, encapsulation, and multiplexing/demultiplexing enable reliable end-to-end communication. Include the role of the router in forwarding the request and how the destination server identifies the correct application. b) Explain how the OSI model, TCP/IP model, and Internet architecture support this communication. Map the OSI layers to the TCP/IP model and justify the merging of layers in the TCP/IP architecture.	10	CO1	BL2
2.	A 512 kbps microwave link connects a weather monitoring station on a remote mountain peak to a regional data center. The one-way distance between the two is 45,000 km, and signals travel through the medium at 2.5×10^8 m/s. The station periodically captures atmospheric sensor data and transmits it as a single file of size 6 Mb to the data center. a) Calculate the one-way propagation delay and the minimum Round-Trip Time (RTT) of the link. Also determine the Bandwidth Delay Product (BDP). b) Calculate the minimum time required for the 6 Mb file to reach the data center, assuming negligible processing and queuing delays.	10	CO1	BL4
3.	a) Explain encoding and state the rules for NRZ-L, NRZ-I, Manchester, and Differential Manchester encoding schemes. Assuming an initial high signal level prior to transmission, sketch the signal waveforms for the bit stream 1011001 for each scheme	5	CO2	BL4
	b) Compare the framing mechanisms of PPP and HDLC. Illustrate the stuffing process for PPP with an example, and apply the appropriate stuffing technique to the following HDLC payload: 01111110 11111100	5		



SCHOOL OF COMPUTER SCIENCE AND ENGINEERING
CONTINUOUS ASSESSMENT TEST - I
FALL SEMESTER 2026-2027

4.	A sender transmits the 8-bit data 10110011 using CRC with the generator polynomial $G(x) = x^4 + x^3 + 1$. Determine the CRC remainder and the transmitted codeword using modulo-2 division. Then demonstrate how the receiver verifies the received codeword and explain why a zero remainder indicates successful error detection.	10	CO2	BL3									
5.	Hosts A and B use Stop-and-Wait ARQ with 1-bit sequence numbers (0/1). $RTT = 6$ ms, timeout = $2 \times RTT$. A sends 3 frames to B. Frame 0 is sent and acknowledged with no incident (t = 0 ms to t = 6 ms). The remaining frames behave as follows: <table><tr><td>Frame</td><td>Attempt 1</td><td>Attempt 2</td></tr><tr><td>1</td><td>Lost in transit</td><td>Delivered and ACKed</td></tr><tr><td>2</td><td>Delivered; ACK lost</td><td>Retransmitted and ACKed</td></tr></table> a) Draw the complete timing diagram for Frames 0, 1, and 2, clearly marking the timeout expirations and retransmissions. b) Explain how B avoids delivering the duplicate Frame 2 to the upper layer, and calculate the total time (in ms) from t = 0 until A receives the final ACK for Frame 2.	Frame	Attempt 1	Attempt 2	1	Lost in transit	Delivered and ACKed	2	Delivered; ACK lost	Retransmitted and ACKed	10	CO2	BL4
Frame	Attempt 1	Attempt 2											
1	Lost in transit	Delivered and ACKed											
2	Delivered; ACK lost	Retransmitted and ACKed											



SCHOOL OF COMPUTER SCIENCE AND ENGINEERING
CONTINUOUS ASSESSMENT TEST - I
FALL SEMESTER 2026-2027

ANSWER KEY

Question 1 Answer

Topology: Hierarchical (star-of-stars) — hostel LANs connect to a central data centre, which connects to the ISP/Internet. This layered structure lets traffic be aggregated and routed efficiently instead of requiring direct links between every pair of hosts.

Encapsulation: At the client, HTTPS (app data) → TLS record → TCP segment (adds src/dst port) → IP packet (adds src/dst IP) → Ethernet/Wi-Fi frame (adds MAC addresses + trailer) → bits. Each router strips down to the IP header, decides the next hop, and re-encapsulates in a new frame; the destination server decapsulates back up the stack.

Multiplexing / Demultiplexing: The transport layer (TCP) uses port numbers to multiplex several application streams from one host onto the network layer, and to demultiplex incoming segments to the correct process at the destination (destination port 443 → HTTPS/web-server process). The 5-tuple (srcIP, srcPort, dstIP, dstPort, protocol) identifies the exact socket/connection.

Router's role: Operates at the Network layer; on receiving a packet it checks the destination IP, performs a longest-prefix-match lookup in its routing table, decrements TTL, and forwards the packet to the next hop — repeated hop-by-hop until the destination network is reached.

How the server identifies the correct application: Not by IP alone — the TCP/UDP port number in the transport header maps the incoming segment to the specific listening process (e.g. port 443 → web server).

Internet architecture: The Internet is a packet-switched network of interconnected, independently-administered networks (Autonomous Systems/ISPs). It offers connectionless, best-effort delivery — each router forwards packets hop-by-hop based purely on the destination IP address, with no dedicated end-to-end circuit reserved in advance; TCP at the end hosts layers reliability (retransmission, ordering) on top of this best-effort service.

OSI ↔ TCP/IP mapping:

OSI (7 layers)	TCP/IP (4 layers)
Application, Presentation, Session	Application
Transport	Transport
Network	Internet
Data Link, Physical	Network Access (Link)

Justification for merging layers:

- Presentation and Session merge into Application because TCP/IP is implementation-driven — functions like encryption, compression and session handling are left to the application/library (e.g. TLS) rather than mandated as separate protocol layers.



SCHOOL OF COMPUTER SCIENCE AND ENGINEERING
CONTINUOUS ASSESSMENT TEST - I
FALL SEMESTER 2026-2027

- Data Link and Physical merge into one Network-Access layer because TCP/IP treats the underlying LAN/WAN technology (Ethernet, Wi-Fi, PPP) as a pre-existing black box it doesn't standardize itself.

Question 2 Answer

Given: Bandwidth $B = 512$ kbps, distance = 45,000 km, propagation speed $v = 2.5 \times 10^8$ m/s, file size = 6 Mb

Propagation delay: $T_p = \text{distance} / v = (45,000 \times 10^3 \text{ m}) / (2.5 \times 10^8 \text{ m/s}) = 0.18 \text{ s} = 180 \text{ ms}$

Minimum RTT: $RTT = 2 \times T_p = 360 \text{ ms}$

Bandwidth-Delay Product (BDP): $BDP = \text{Bandwidth} \times RTT = 512 \times 10^3 \text{ bps} \times 0.36 \text{ s} = 184,320 \text{ bits} (\approx 23,040 \text{ bytes} \approx 22.5 \text{ KB})$

Transmission delay: $T_t = \text{file size} / B = (6 \times 10^6 \text{ bits}) / (512 \times 10^3 \text{ bps}) = 11.71875 \text{ s}$

Minimum time for the file to reach the data centre: $T_t + T_p = 11.71875 + 0.18 = 11.89875 \text{ s} \approx 11.9 \text{ s}$
(one-way: transmission + propagation only, since processing/queuing are negligible)

Question 3 Answer

Q3a

What is encoding: Line (digital-to-digital) encoding is the process of converting a stream of binary data (1s and 0s) into a digital signal — a sequence of discrete voltage levels/pulses — suitable for transmission over a physical medium. A good encoding scheme must allow the receiver to correctly recover both the data and the clock (synchronization), and ideally have no DC component and built-in error-detection capability.

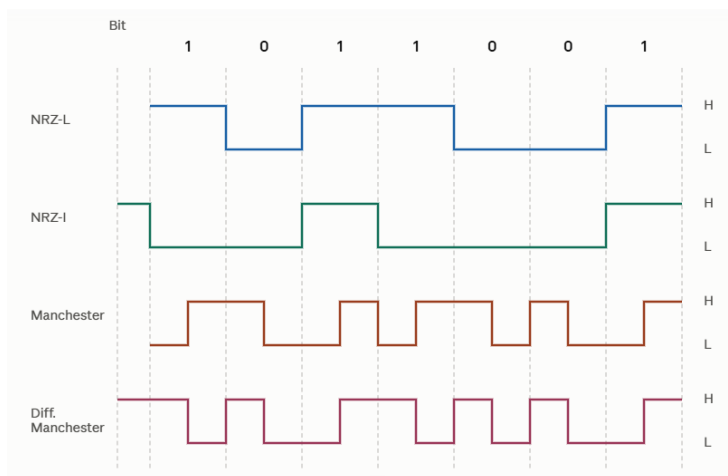
Rules:

- NRZ-L: level = bit value directly (1 → High, 0 → Low); no dependence on history.
- NRZ-I: transition (level inversion) at the START of the interval if bit = 1; no change if bit = 0.
- Manchester: always a transition at the MIDDLE of every bit (self-clocking) = NRZ-L XOR clock. Convention used: 0 → high-to-low mid-bit transition, 1 → low-to-high mid-bit transition.
- Differential Manchester: always a mid-bit transition (for clocking); additionally a transition at the START of the interval if bit = 0, no start transition if bit = 1 (relative to the previous ending level).

Waveforms for bit stream 1 0 1 1 0 0 1, initial level = High:



SCHOOL OF COMPUTER SCIENCE AND ENGINEERING
CONTINUOUS ASSESSMENT TEST - I
FALL SEMESTER 2026-2027



Q3(b).

	PPP	HDLC
Flag	01111110 (byte)	01111110 (bit pattern)
Stuffing	Byte (character) stuffing — escapes the flag/escape byte inside data using an escape byte (0x7D) + XOR 0x20	Bit stuffing — inserts a 0 after every five consecutive 1s in data
Addressing	Point-to-point (no addressing usually needed)	Supports multipoint (address field present)
Error control	Simpler, relies on higher layers	Built-in sequence numbers, sliding window

PPP byte-stuffing example: if data contains the flag byte 0x7E, it is transmitted as 0x7D 0x5E (escape byte 0x7D followed by 0x7E XOR 0x20 = 0x5E). Similarly, if data contains the escape byte 0x7D itself, it is sent as 0x7D 0x5D.

HDLC bit-stuffing on payload 01111110 11111100:

Combined bitstream = 0111111011111100 (16 bits). It contains two runs of six consecutive 1s (positions 2–7 and 9–14), so a 0 is inserted after each run's 5th one:

Stuffed output: 0 1 1 1 1 1 [0] 1 0 1 1 1 1 1 [0] 1 0 0 → 011111010111110100 (18 bits)



SCHOOL OF COMPUTER SCIENCE AND ENGINEERING
CONTINUOUS ASSESSMENT TEST - I
FALL SEMESTER 2026-2027

Question 4 Answer

Data $M = 10110011$, $G(x) = x^4 + x^3 + 1 \rightarrow$ generator = 11001 ($r = 4$)

Append 4 zeros to the data $\rightarrow 101100110000$, then perform modulo-2 (XOR) division by 11001:

CRC remainder = 0100

Transmitted codeword = 101100110100 (data + remainder)

Receiver verification: The receiver divides the full received codeword by the same generator (11001) using modulo-2 division. If no errors occurred, the remainder is all zeros — confirming the data is (very likely) error-free; a non-zero remainder indicates a detected transmission error. (Verified computationally: dividing 101100110100 by 11001 gives remainder 0000.)

Question 5 Answer

RTT = 6 ms, Timeout = $2 \times \text{RTT} = 12$ ms

Time (ms)	Event
0	A sends Frame 0 (seq 0)
6	A receives ACK0 (given)
6	A sends Frame 1 (seq 1) — lost in transit
18	Timeout (6+12) fires; A retransmits Frame 1
24	Frame 1 retransmission delivered + ACK1 received (18+6)
24	A sends Frame 2 (seq 0) — delivered to B, but ACK lost
36	Timeout (24+12) fires; A retransmits Frame 2
42	Retransmitted Frame 2 delivered + final ACK2 received (36+6)

Complete timing diagram:



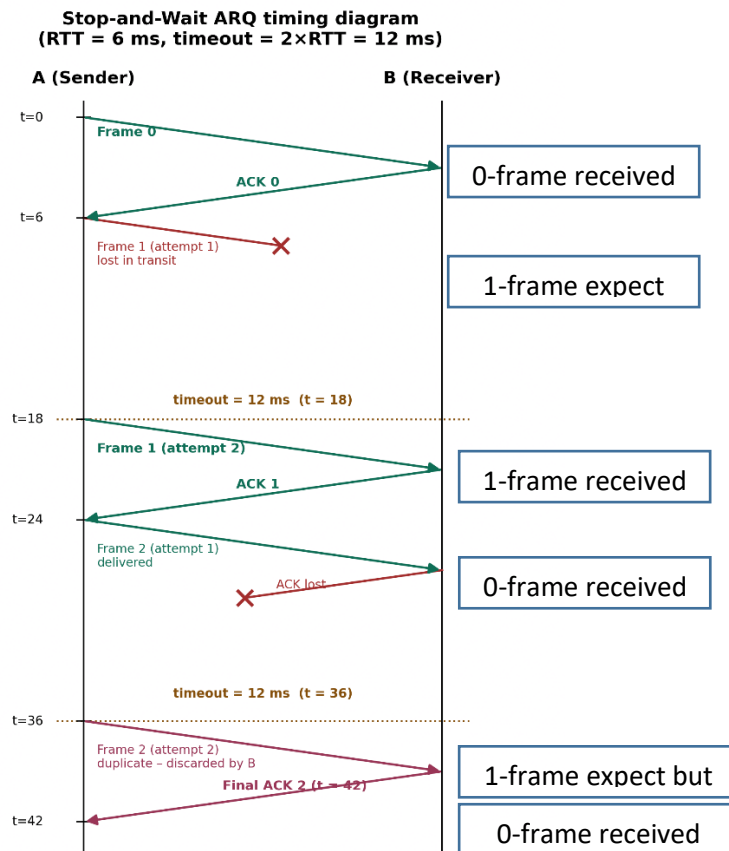
VIT[®]

Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

REG.NO.:

SLOT: B2+TB2

SCHOOL OF COMPUTER SCIENCE AND ENGINEERING
CONTINUOUS ASSESSMENT TEST - I
FALL SEMESTER 2026-2027



Avoiding duplicate delivery: B already delivered Frame 2 (seq 0) to the upper layer during Attempt 1 (only the ACK was lost, not the frame). When the retransmitted duplicate Frame 2 (same seq = 0) arrives in Attempt 2, B compares it against the sequence number it last accepted/delivered, recognizes it as a duplicate, discards its payload without re-delivering it, and simply re-sends the ACK — which finally reaches A.

Total time from t = 0 until A receives the final ACK for Frame 2 = 42 ms.