(Affiliated to University of Mumbai)	*End Semester Examination (R-24/R-25) SH 2026*			
Branch: ECS	Course: Computer Network			
Year/ Semester: TE/ V	**Course code: ECC502 SOLUTION SK1**			
Time: 03 hours	Marks: 80			
Note: 1. All questions are compulsory. **2. Figures to right indicate full marks.** **3. Assume suitable data wherever necessary.**		Marks	CO	BL

Q.1 All questions are compulsory (30 Marks)

Q.1 A. Solution

TCP/IP architecture consists of four layers: Application Layer, Transport Layer, Internet Layer, and Network Access Layer.

1. Application Layer (1 Mark)

- **Provides services directly to end users.**
- **Supports protocols such as HTTP, FTP, SMTP, and DNS.**

Example: Accessing a webpage using HTTP.

2. Transport Layer (1 Mark)

- **Provides end-to-end communication between processes.**
- **Performs segmentation, flow control, and error control.**

Protocols: TCP and UDP.

3. Internet Layer (1 Mark)

- **Provides logical addressing using IP addresses.**
- **Performs routing of packets between networks.**

Protocol: IP.

4. Network Access Layer (1 Mark)

- **Handles framing and physical transmission of data.**
- **Transfers data over Ethernet, Wi-Fi, Fiber Optic, etc.**

Overall Working of TCP/IP Architecture (1 Mark)

Q.1(B)

Compare Radio Waves, Microwaves, Bluetooth and Infrared

Solution

Parameter	Radio Waves	Microwaves	Bluetooth	Infrared
Frequency Range	3 kHz-1 GHz	1 GHz-300 GHz	2.4 GHz ISM Band	300 GHz-400 THz
Communication Type	Omnidirectional	Directional	Short-range wireless	Line-of-sight
Range	Very High	High	Up to 100 m	Few meters
Penetration	Good	Moderate	Moderate	Poor
Applications	Radio Broadcasting	Satellite, Cellular	Headsets, PAN	Remote Controls
Cost	Low	Medium	Low	Low

Conclusion: Radio waves are suitable for long-distance broadcasting, microwaves for high-bandwidth communication, Bluetooth for PANs, and Infrared for short-range line-of-sight communication. (5 Marks)

Q.1(C)

Explain the need for HDLC at the Data Link Layer. Describe operational modes and station types.

Solution

Need of HDLC (2 Marks)

HDLC (High-Level Data Link Control) is a bit-oriented protocol used at the Data Link Layer.

Functions:

- **Provides framing mechanism. (0.5 Mark)**
- **Provides flow control. (0.5 Mark)**
- **Provides error detection and recovery. (0.5 Mark)**
- **Supports reliable communication. (0.5 Mark)**

Operational Modes of HDLC (2 Marks)
Normal Response Mode (NRM)

- **Secondary station can transmit only when permitted by Primary station.**

Asynchronous Response Mode (ARM)

- **Secondary station may transmit without explicit permission.**

Asynchronous Balanced Mode (ABM)

- **Both stations have equal authority.**
- **Most commonly used mode.**

(2 Marks)

Station Types (1 Mark)

Station	Description
Primary	Controls communication
Secondary	Operates under Primary station
Combined	Can act as Primary and Secondary

Q.1(D) Explain the Concept of Fragmentation and Reassembly with an Example. (5 Marks)
Solution
Fragmentation (2 Marks)
Fragmentation is the process of dividing a large IP packet into smaller packets called fragments when the packet size exceeds the network MTU (Maximum Transmission Unit).

- **Performed by routers or source host. (1 Mark)**
- **Each fragment carries its own IP header and is transmitted independently. (1 Mark)**

Reassembly (1 Mark)
Reassembly is the process of combining all fragments at the destination to reconstruct the original packet.

- **Performed only at the destination host. (1 Mark)**

Example (2 Marks)
Given:

- **Original IP Packet Size = 4000 Bytes**
- **MTU = 1500 Bytes**
- **IP Header Size = 20 Bytes**

Step 1: Calculate Maximum Data per Fragment (0.5 Mark)

$$1500 - 20 = 1480\ Bytes$$

Each fragment can carry 1480 Bytes of data.
Step 2: Divide Packet into Fragments (1 Mark)

Fragment	Data Size	Total Fragment Size
Fragment 1	1480 Bytes	1500 Bytes
Fragment 2	1480 Bytes	1500 Bytes
Fragment 3	1020 Bytes	1040 Bytes

Step 3: Reassembly at Destination (0.5 Mark)
The destination host collects Fragment 1, Fragment 2, and Fragment 3 and combines them to reconstruct the original 4000-byte packet.

Q.1(E)
Differentiate between TCP and UDP

Solution

Parameter	TCP	UDP
Connection	Connection-Oriented	Connectionless
Reliability	Reliable	Unreliable
Flow Control	Available	Not Available
Error Recovery	Available	Not Available
Acknowledgment	Used	Not Used
Speed	Slower	Faster
Header Size	20-60 Bytes	8 Bytes
Applications	Email, Banking	Streaming, VoIP

Conclusion: TCP emphasizes reliability while UDP emphasizes speed and low overhead. (5 Marks)

Q.1(F)
Compare HTTP and HTTPS
Solution

Parameter	HTTP	HTTPS
Full Form	HyperText Transfer Protocol	HyperText Transfer Protocol Secure
Security	No Encryption	Uses SSL/TLS Encryption
Port Number	80	443
Data Protection	Vulnerable to attacks	Secured communication
Authentication	Not Available	Available using Digital Certificates
Performance	Slightly Faster	Slightly Slower due to encryption
URL Prefix	http://	https://

Advantages of HTTPS

- **Provides Confidentiality. (1 Mark)**
- **Ensures Data Integrity. (1 Mark)**
- **Supports Authentication. (1 Mark)**

Conclusion: HTTPS is preferred for e-commerce, banking and secure websites because it protects transmitted data using SSL/TLS encryption. (5 Marks)
Q.2(A)
A university campus plans to upgrade its communication infrastructure.
Solution
a) Recommended Guided Transmission Medium (4 Marks)

Location	Recommended Medium	Justification
Laboratories with electrical equipment	STP	Shielding reduces EMI and interference. (1 Mark)
Hostels requiring multimedia applications	UTP Cat6/Cat6A	Cost-effective and supports high bandwidth. (1 Mark)
Existing CCTV System	Coaxial Cable	Compatible with old CCTV installations and reliable. (1 Mark)
Research Center 5 km away	Optical Fiber	High bandwidth and very low attenuation over long distances. (1 Mark)

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b) Advantages and Limitations of Each Medium (4 Marks)
UTP
Advantages

- **Low cost**
- **Easy installation**

Limitations

- **Susceptible to EMI**
- **Limited distance**

(1 Mark)

STP

Advantages

- **Excellent noise immunity**
- **Reduces signal interference**

Limitations

- **Higher cost**
- **Difficult installation**

(1 Mark)

Coaxial Cable

Advantages

- **Good shielding**
- **Reliable for CCTV**

Limitations

- **Lower bandwidth than fiber**
- **Bulky cable**

(1 Mark)

Optical Fiber

Advantages

- **Very high bandwidth**
- **Long-distance communication**
- **High security**
- **Low attenuation**

Limitations

- **Higher installation cost**
- **Fragile compared to copper**

(1 Mark)

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c) Best Solution for Research Center (2 Marks)

Recommended Medium: Optical Fiber Cable

Justification:

- **Supports Gbps transmission rates. (0.5 Mark)**
- **Very low attenuation over 5 km distance. (0.5 Mark)**
- **Immune to electromagnetic interference. (0.5 Mark)**
- **Easily scalable for future expansion. (0.5 Mark)**

Q.2(B)

Solution

a) Suitable Network Device for Each Requirement (5 Marks)

Requirement	Device	Justification
Signal regeneration after 100 m	Repeater	Regenerates weakened signals. (1 Mark)
Low-cost connection of 20 PCs	Hub	Economical LAN connectivity. (1 Mark)
Dedicated bandwidth	Switch	Creates separate collision domains. (1 Mark)
Connect LAN to Internet	Router	Connects multiple networks. (1 Mark)
Different network architectures	Gateway	Performs protocol conversion. (1 Mark)

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b) Compare Hub and Switch (2 Marks)

Parameter	Hub	Switch
Forwarding	Broadcasts to all ports	Sends to destination port only
Collision Domain	Single	Separate per port
Bandwidth	Shared	Dedicated
OSI Layer	Physical	Data Link

(2 Marks)

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c) Why Router for Internet Connectivity? (1 Mark)
Router performs:

- **Logical addressing using IP.**
- **Packet routing between networks.**
- **Path selection.**

Hence, routers are preferred over hubs and switches. (1 Mark)

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d) Device Supporting Different Protocols (2 Marks)
Gateway
Functions:

- **Protocol conversion.**
- **Data format translation.**
- **Application interoperability.**

(2 Marks)

Q.3(A)
Automatic Repeat Request (ARQ)
Solution
ARQ Concept (2 Marks)
ARQ is an error-control mechanism where:

- **Receiver detects errors.**
- **ACK is sent for correct frame.**
- **NAK or timeout causes retransmission.**
- **Ensures reliable transmission.**

(2 Marks)

Stop-and-Wait ARQ (2 Marks)
Sender transmits one frame and waits for ACK.
Sender Receiver
Frame 0 ---------->
ACK 0 <---
Frame 1 ---------->
ACK 1 <---
Advantages:

- **Simple implementation.**

Limitation:

- **Low efficiency.**

(2 Marks)

Go-Back-N ARQ (2 Marks)
Multiple frames can be transmitted.
0 1 2 3 4
X
Retransmit 2,3,4

Advantages:

- **Better utilization.**

Limitations:

- **Multiple retransmissions.**

(2 Marks)

Selective Repeat ARQ (2 Marks)
Only erroneous frames are retransmitted.
0 1 2 3 4
X
Retransmit only 2
Advantages:

- **High efficiency.**

Limitations:

- **High buffer requirements.**

(2 Marks)

Comparison (2 Marks)

Feature	Stop-Wait	Go-Back-N	Selective Repeat
Efficiency	Low	Medium	High
Window Size	1	N	N
Buffer Need	Low	Medium	High
Retransmission	Single Frame	Error and following frames	Only error frame

(2 Marks)

Q.3(B)
CSMA Protocol
Solution
CSMA Concept (2 Marks)
Carrier Sense Multiple Access:

- **Node listens before transmitting.**
- **If medium is free, transmission begins.**
- **Reduces collisions.**

(2 Marks)

1-Persistent CSMA (2 Marks)
Channel Idle?
Yes
|
Transmit Immediately
Advantages:

- **High utilization**

Limitation:

- **High collision probability**

(2 Marks)

Non-Persistent CSMA (2 Marks)
Channel Busy?
Yes
|
Wait Random Time
Advantages:

- **Lower collisions**

Limitation:

- **Increased delay**

(2 Marks)

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p-Persistent CSMA (2 Marks)
Used in slotted channels.
Probability p → transmit.
Probability (1-p) → wait one slot.
(2 Marks)

Comparison (2 Marks)

Parameter	1-Persistent	Non-Persistent	p-Persistent
Collision Probability	High	Low	Moderate
Delay	Low	High	Moderate
Utilization	Good	Moderate	Good
Performance	Moderate	Better	Best balance

(2 Marks)

Q.4(A)
Solution
Given IPv4 Header:
45 00 00 54 A6 F2 40 00
40 01 00 00
C0 A8 01 0A
C0 A8 01 14

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a) IPv4 Header Decoding (5 Marks)
Version (1 Mark)
First Hex Digit = 4
Version = IPv4

Header Length (1 Mark)
Second Hex Digit = 5

$$IHL = 5 \times 4 = 20 \text{ bytes}$$

Answer = 20 Bytes

Total Length (1 Mark)
0054H

$$84_{10}$$

Answer = 84 Bytes

TTL (0.5 Mark)
40H = 64
TTL = 64

Protocol (0.5 Mark)
01H = ICMP
Protocol = ICMP

Source Address (0.5 Mark)

C0 A8 01 0A
192.168.1.10

Destination Address (0.5 Mark)
C0 A8 01 14
192.168.1.20

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b) IPv4 vs IPv6 (5 Marks)

Feature	IPv4	IPv6
Address Size	32-bit	128-bit
Address Space	4.3 Billion	Vast
Header Size	Variable	Fixed 40B
Security	Optional IPsec	Built-in IPsec
Configuration	Manual/DHCP	Auto Configuration
NAT	Required	Not Required
Representation	Decimal	Hexadecimal

Q.4(B)
Solution
Given:
Network = 172.16.0.0/16
Required Subnets = 50

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a) Bits Borrowed (2 Marks)

$$2^5 = 32$$

Not enough

$$2^6 = 64$$

Bits borrowed = 6
(2 Marks)

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b) New Subnet Mask (2 Marks)
Original Prefix = /16

$$16 + 6 = 22$$

Slash Notation =/22
Binary mask:
255.255.252.0
(2 Marks)

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c) Total Subnets (1 Mark)

$$2^6 = 64$$

Answer = 64 Subnets
(1 Mark)

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d) Usable Hosts/Subnet (2 Marks)
Host bits:

$$32 - 22 = 10$$

Total Hosts:

$$2^{10} = 1024$$

Usable Hosts:

$$1024 - 2 = 1022$$

Answer = 1022 Hosts
(2 Marks)

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e) First Subnet Details (3 Marks)
Block Size:

$$256 - 252 = 4$$

First subnet:
Network Address:
172.16.0.0
First Host:
172.16.0.1
Last Host:
172.16.3.254
Broadcast:
172.16.3.255
(3 Marks)

Q.5(A)
Unicast Routing Protocols
Solution
Classification (2 Marks)

1. **Distance Vector Routing**
2. **Link State Routing**
3. **Path Vector Routing**

(2 Marks)

Distance Vector Routing (2 Marks)
Examples:

- **RIP**

Working:

- **Exchanges routing tables with neighbors.**
- **Uses hop count metric.**

Advantages:

- **Simple**

Limitation:

- **Slow convergence**

(2 Marks)

Link State Routing (2 Marks)
Examples:

- **OSPF**
- **IS-IS**

Working:

- **Builds network topology map.**
- **Uses Dijkstra algorithm.**

Advantages:

- **Fast convergence**

Limitation:

- **Complex**

(2 Marks)

Path Vector Routing (2 Marks)
Example:

- **BGP**

Working:

- **Advertises AS paths.**
- **Prevents loops.**

Advantages:

- **Highly scalable**

Limitation:

- **Complex configuration**

(2 Marks)

Comparison (2 Marks)

Feature	Distance Vector	Link State	Path Vector
Example	RIP	OSPF	BGP
Updates	Entire Table	LSA	Path Info
Convergence	Slow	Fast	Moderate
Scalability	Low	Medium	High
Metric	Hop Count	Cost	AS Path

Q.5(B)
ICMP Protocol
Solution
Protocol Used (1 Mark)
ICMP (Internet Control Message Protocol)
Used for:

- **Error reporting**
- **Diagnostics**

(1 Mark)

Working of ICMP (3 Marks)

- **Operates with IP.**
- **Sends control messages.**
- **Helps identify network problems.**

Example:
Ping → Echo Request
Reply → Echo Reply
(3 Marks)

Error Reporting Messages (3 Marks)

1. **Destination Unreachable**
2. **Time Exceeded**
3. **Redirect**
4. **Parameter Problem**

(3 Marks)

Query/Control Messages (3 Marks)

1. **Echo Request**
2. **Echo Reply**

3. **Timestamp Request**
4. **Timestamp Reply**
5. **Router Advertisement**

Examples:

- **Ping uses Echo.**
- **Traceroute uses Time Exceeded.**

(3 Marks)

Q.6(A)

a) TCP Three-Way Handshake (5 Marks)

Connection Establishment

Client Server

SYN ---------->

<---------- SYN+ACK

ACK ---------->

Steps:

1. **Client sends SYN. (1 Mark)**
2. **Server responds SYN+ACK. (2 Marks)**
3. **Client sends ACK. (2 Marks)**

Connection Termination

FIN -------->

<-------- ACK

<-------- FIN

ACK -------->

Four-way termination releases connection gracefully.

(5 Marks)

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b) TCP Header Decoding (5 Marks)

Header:

04 D2 00 50
00 00 00 64
00 00 00 C8
50 12 20 00
00 00 00 00

Source Port (1 Mark)

04D2H

1234

Source Port = 1234

Destination Port (1 Mark)

0050H

80

Destination Port = 80 (HTTP)

Sequence Number (1 Mark)
00000064H

$$100$$

Sequence Number = 100

Acknowledgement Number (1 Mark)
000000C8H

$$200$$

Acknowledgement Number = 200

Header Length and Flags (1 Mark)
50H
Header Length:

$$5 \times 4 = 20$$

Flags:
12H = 00010010
ACK = 1
SYN = 1
URG=0, PSH=0, RST=0, FIN=0

Q.6(B)
a) Functions of Transport Layer (5 Marks)
Solution

1. **Process-to-process delivery. (1 Mark)**
2. **Segmentation and Reassembly. (1 Mark)**
3. **Flow Control. (1 Mark)**
4. **Error Control. (1 Mark)**
5. **Multiplexing and Demultiplexing using Port Numbers. (1 Mark)**

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b) UDP Header Decoding (5 Marks)
Given Header:
15 B3 01 BB 00 18 A1 B2

Source Port Number (1 Mark)
15B3H

$$5555$$

Source Port = 5555

Destination Port Number (1 Mark)
01BBH

$$443$$

Destination Port = 443 (HTTPS)

Length Field (1.5 Marks)
0018H

$$24$$

Length = 24 Bytes

Checksum (1.5 Marks)
A1B2H
Checksum = A1B2

Final Answer

Field	Value
Source Port	5555
Destination Port	443
Length	24 Bytes
Checksum	A1B2