# GATE 2019

# COMPUTER NETWORK

## COMPUTER SCIENCE & INFORMATION TECHNOLOGY

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# CONTENTS

# CHAPTER - 1
# *BASIC CONCEPTS*

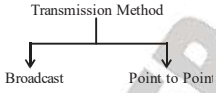
## 1.1 COMPUTER NETWORK
It is connection of computer used for exchanging data such as text, audio, video etc.

### 1.1.1 Network
It is set of devices/nodes connected by communication link. Its basic structure is as follows:


**C1, C2 are Machine-1, Machine-2**

Server is not visible to anyone but everyone request or respond through server. For example, we can download through youtube only when youtube server has uploaded data on website.

## 1.2 TRANSMISSION METHODS
It is the way of exchanging data on network. It is also called transmission technology.




### 1.2.1 Broadcast
1. Whenever any message is sent, it is broadcast to all machines on the network. But finally received by the intended recipient, whose address gets matched with the address field of the message and all other machines whose address does not match, they just ignore the message.
2. It has single communication channel among all the machines on the network.
3. Smaller network usually uses broadcast transmission method.

**Example**
Dish TV provide us access of all channels at a time but we can access one channel at a time.

Ethernet (IEEE 802.3), Token ring (IEEE 802.05) LAN uses broadcast technology.

### 1.2.2 Point-to-Point
1. The message is passed through one or more intermediate machines when it is sent by sender to reach the destination.
2. It consists of many connections between individual pair of machines.
3. Entire capacity of link is shared between two communicating devices.
4. Point to point transmission is called as unicasting.
5. Larger network usually uses point to point transmission method.

**Example**
(i) Remote & TV uses point to point transmission technology.
(ii) Telephony communication

# ASSIGNMENT

**1.** Flow control is the responsibility of
(a) Data link layer
(b) Transport layer
(c) Both (a) and (b)
(d) Application layer

**2.** Which of the following address cannot be changed?
(a) Hardware address
(b) Logical address
(c) Both (a) and (b)
(d) None of these

**3.** What is the Protocol Data (PDU) employed at the Data Link Layer?
(a) Bits
(b) Frames
(c) Packets
(d) Segments

**4.** Host to Host or Hop to Hop delivery is related to
(a) Data link layer
(b) Network layer
(c) Transport layer
(d) All of these

**5.** Which one of the following OSI layers performs error checking of data?
(a) Network (b) Transport
(c) Data link (d) Physical

**6.** The following are names of data units in each layer, which choice is not a correct match?
(a) Frame: Data Link
(b) Packet: Network
(c) Segment: Transport
(d) Frame: Network

**7.** Which layer of the OSI model is responsible for routing packets from one network to another?

connectionless and connection-oriented communication in the transport layer.

**8.** In the TCP/IP protocol suite, the physical layer is responsible for
(a) Exchange of programs over the physical medium
(b) The movement of bits over the physical medium.
(c) Operations of protocol over the physical medium
(d) Addressing over physical medium

**9.** Which of the following layer is responsible for moving frames from one hop to the next?
(a) Transport layer (b) Network layer
(c) Data - link layer (d) Physical layer

**10.** In the TCP/IP protocol suite, which of the following is a network layer protocol?
(a) The Secure shell (SSH)
(b) The internet Protocol (IP)
(c) The Stream Control Transmission Protocol (SCTP)
(d) User Datagram Protocol (UDP)

**11.** In the TCP/IP protocol suite, at which of the following layer a logical address is an identifier?
(a) Data link layer (b) Application layer
(c) Network layer (d) Transport layer

**12.** The Internet Protocol (IP) is
(a) A connection-oriented protocol
(b) A reliable protocol
(c) An unreliable protocol
(d) A reliable and connection-oriented protocol

**13.** Consider the following two tasks:
$T_1$: Dividing the transmitted bit stream into frames
$T_2$: Determining which route through the subnet to use

# GATE QUESTIONS

**1.** In the following pairs of OSI protocol layer/sub-layer and its functionality, the incorrect pair is

**[GATE - 2014]**

(a) Network layer and Routing
(b) Data Link layer and Bit synchronization
(c) Transport layer and End - to - end process communication
(d) Medium Access Control sub-layer and Channel sharing

**2.** Assume that source S and destination D are connected through two intermediate routers labels R. Determine how many times each packet has to visit the network layer and the data link layer during a transmission from S to D.


**[GATE - 2013]**

(a) Network layer-4 times and Data link layer-4 times
(b) Network layer-4 times and Data link layer-3 times
(c) Network layer-4 times and Data link layer-6 times
(d) Network layer-2 times and Data link layer-6 times

**3.** The Protocol Data Unit (PDU) for the application layer in the Internet stack is

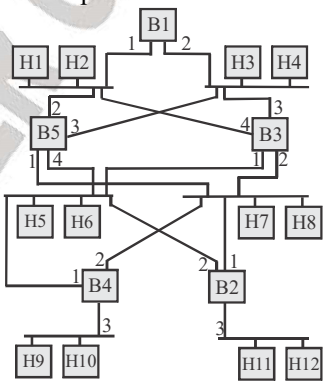
**[GATE - 2012]**

(a) Segment (d) Datagram
(c) Message (d) Frame

**Linked Statement for Q. 4 & Q.5**

Consider the diagram shown below where a number of LANs are connected by (transparent) bridges. In order to avoid packets looping through circuits in the graph, the bridges organize themselves in a spanning tree. First, the root bridge is identified as the bridge with the least serial number. Next, the root sends out (one or more) data units to enable the setting up of the spanning tree of shortest paths from the root bridge to each bridge.

Each bridge identifies a port (the root port) through which it will forward frames to the root bridge. Port conflicts are always resolved in favour of the port with the lower index value. When there is a possibility of multiple bridges forwarding to the same LAN (but not through the root port), ties are broken as follows: bridges closest to the root get preference and between such bridges, the one with the lowest serial number is preferred.




**4.** For the given connection of LAN by bridges, which one of the following choices represents the depth first traversal of the spanning tree of bridges

**[GATE - 2006]**

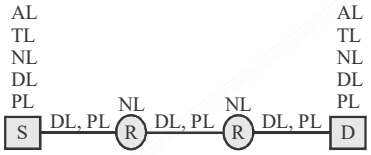
(a) B1, B5, B3, B4, B2
(b) B1, B3, B5, B2, B4
(c) B1, B5, B2, B3, B4
(d) B1, B3, B4, B5, B2

**5.** Consider the correct spanning tree for the previous question. Let host H1 send out a broadcast ping packet. Which of the following options represents the correct forwarding table on B3?

# SOLUTIONS

**Sol 1. (b)**
Bit synchronization is associated with physical layer because physical layer deals with bits.

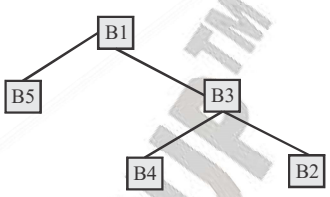
**Sol 2. (c)**
As the connectivity shown include router between source and destination. And router does processing up to the network layer.
So layers accessed by source, destination and router and links are shown below:




So data link layer is visited 6 times and network layer is visited 4 times.

**Sol 3. (c)**

**Sol 4. (a)**
Minimum spanning tree is formed by eliminating edges that will create loops/cycle. So, minimum spanning tree is




So by using depth first traversal of spanning tree of bridges gives traversal in order B1B5B3B4B2.

**Sol 5. (a)**
Based on above traversal
Forwarding table is correctly given in option (a).

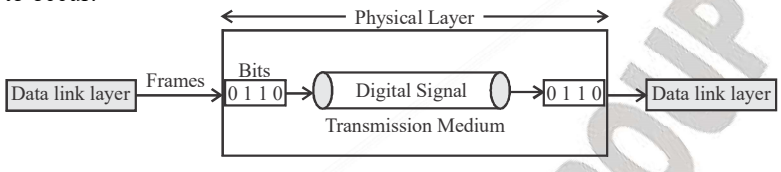
**Sol 6. (a)**

**Sol 7. (d)**
The transport protocol provides an end to end connectivity that shields network layer protocol from the details of the intervening network or networks. A transport protocol can be either connection oriented such as TCP, or connectionless such as UDP.

# CHAPTER - 2
# *PHYSICAL LAYER*

## 2.1 INTRODUCTION

Physical layer coordinates the functions required to carry a bit stream over a physical medium. It defines the procedures and functions that physical devices and interfaces have to perform for transmission to occur.




Physical layer is concerned with
1. Line coding
2. Transmission Impairment
3. Data Rate limits
4. Performance
5. Transmission Mode
6. Transmission Medium

## 2.2 LINE CODING

1. It is the process of converting digital data to digital signals.
2. Data, in the form of text, numbers, graphical images, audio or video are stored in computer memory as sequence of bits.
3. At the sender, digital data are encoded into digital signal and at the receiver, digital data are recreated by decoding the digital signal.

### 2.2.1 Characteristics

***1. Signal Element Versus Data Element***

***(i) Data Element***

It is the smallest entity that can represent a piece of information i.e. a bit. It means what we need to send is data element.

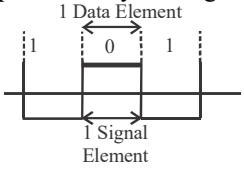
***(ii) Signal Element***

What we can send over communication line is signal element which carries our data element to be sent.

We define, ratio(r) = No. of data elements carried by each signal element.

Several situations with different value of r as follows

(a) r = 1 when one data element is represented by one signal element

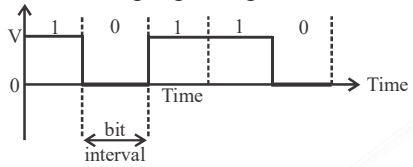


# WORKBOOK

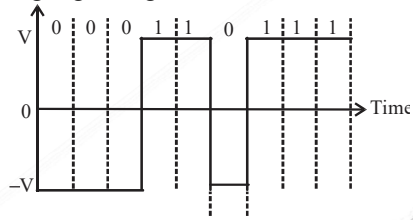
**1.** Draw the digital signal for the following data bit stream

**Solution.**

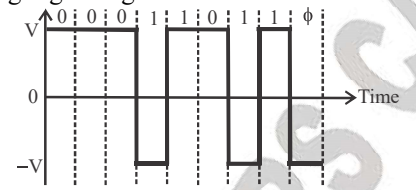
(a) If the data bit stream is 10110 then what will be its NRZ coding/digital signal.



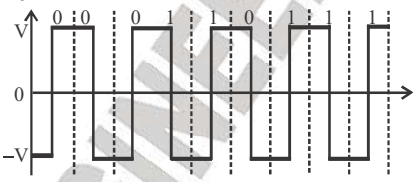

(b) If the data bit stream is 000110111 its NRZ-L coding/digital signal will be



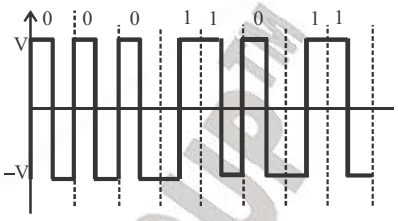

(c)If the data bit stream is 000110111 its NRZ-I coding/digital signal will be




(d)Manchester encoding of bits stream 000110111




(e)Differential Manchester encoding of bits stream 000110111




**2.** If a signal travels through an amplifier, and its power is increased 10 times. Calculate amplification of signal.

**Solution.**

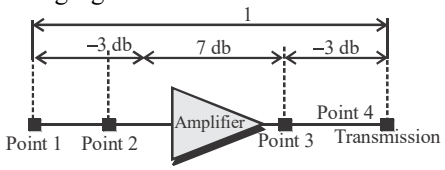
Let $P_1$ and $P_2$ are power of signals at the point 1 and point 2

$P_2 = 10P_1$ (given). The amplification (gain of power) can be calculated as

$$10\log_{10}\frac{P_2}{P_1} = 10\log_{10}\frac{10P_1}{P_1} C = 10$$

$\log_{10} 10 = 10(1) = 10$ dB

**3.** Calculate the resultant decibel value for the following figure.




**Solution.**

Here signal is suffering from attenuation and amplification.

During attenuation there are negative decibel values and during amplification there is positive decibel value.

The resultant dB = – 3 + 7 – 3 = + 1 it means the signal has gained in power

**4.** Calculate the power of a signal if its $dB_m = -30$.

**Solution.**

We can calculate the power in milliwatt of the signal as

# ASSIGNMENT

**1.** As the data packet moves from a lower layer to higher layer, the headers are
(a) Added (b) Removed
(c) Rearranged (d) Modified

**2.** Session layer is included in
(a) MAC layer
(b) Data link layer
(c) Transport layer
(d) Application layer

**3.** The upper layers of the OSI model are, in correct order:
(a) Session, application, presentation
(b) Session, Presentation, application
(c) Application, presentation, session
(d) None of these

**4.** The part of OSI where one most commonly finds data encryption, compression, and other encoding for network communication is:
(a) Application (layer seven)
(b) Session (layer five)
(c) Presentation (layer six)
(d) None of these

**5.** Which of these network devices belong at the OSI data link layer (layer two)?
(a) Router (b) Bridge
(c) TVPN (d) None of these

**6.** Which of these network devices belongs at the OSI physical layer (layer one)?
(a) Repeater (b) Router
(c) Switch (d) Bridge

**7.** What is the Protocol Data Unit (PDU) employed at the physical layer?
(a) Bits (b) Frames
(c) Packets (d) Segments

**8.** The bottom layer of the OSI model is about electrical and mechanical aspects networking. What is this layer known as?
(a) Transport (b) Data link
(c) Physical (d) Session

**9.** What network topology implements at least two paths to and from each node?
(a) Bus (b) Ring
(c) Star (d) Mesh

**10.** What type of network topology is depicted by a single cable where device connect using `T` connectors?
(a) Star (b) Bus
(c) Ring (d) 10 BaseT

**11.** The physical layer is responsible for the transmission of _____over the physical medium.
(a) Packets (b) Bits
(c) Message (d) All of these

**12.** Which of the following statements best describes a hub?
(a) All connected systems are in the same broadcast domain, but different collision domains.
(b) All connected systems are in the same collision domain, but different broadcast domains.
(c) All connected systems are in the same broadcast and collision domains
(d) All connected systems are in their own broadcast and collision domains

**13.** A hub is a
(a) Router (b) Bridge
(c) Repeater (d) All of these

# GATE QUESTION

**1.** How many 8-bit characters can be transmitted per second over a 9600 baud serial communication link using asynchronous mode of transmission with one start bit, eight data bits, and one parity bit?

**[GATE - 2004]**

(a) 600 (b) 800
(c) 876 (d) 1200

# SOLUTION

**Sol.1 (a)**
Total number of bits = 12
Modulation Rate= 9600 baud

Number of bit (8 bit character) transmitted = $\frac{9600}{12 \text{ bits}} = 800$

# CHAPTER - 3
# *DATA LINK LAYER*

## 3.1 INTRODUCTION

1. It attaches its own header to the packet delivered by network layer and makes it frame.
2. It moves frames over each of individual links in the end to end path.
3. t uses MAC address to deliver frames to recipient machine. MAC address is of 6 bytes (48 bits) and is represented in hexadecimal format such as 0E-E9-06-14-BB-4B .
4. Its protocol defines the format of the frames to be exchanged between the nodes at the ends of links and defines the action taken by these nodes on receiving and sending of frames.
5. Link layer protocols are Ethernet, Token Ring, 8.02.11 wireless LAN and PPP.
6. Data link layer is divided into two sub-layers named as Logical Link Control (LLC) and Medium Access Control (MAC)
7. LLC is responsible for Framing, Flow Control, Error Control and where as MAC is responsible for link access control i.e. coordinating the multiple users using shared channel.

### 3.1.1 FRAMING

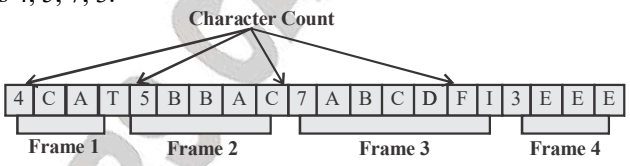
1.Data-link layer performs function of framing the packets that are received from network layer
2.It breaks the bit stream up into discrete frames and tells the size of each frame to the receiver.
It can be done using following methods.
(i) Character count
(ii) Character stuffing
(iii) Bit stuffing

#### *3.1.1.1 Character Count*

It specifies the number of characters to be in one frame in its one of the header field of frame.

**Example.**

Let 3 frames of sizes 4, 5, 7, 3.




***1. Limitation***

Any error in count field can change the boundaries of the frame and receiver will receive indifferent frames that are not of the sender.

#### *3.1.1.2 Character Stuffing*

1. It specifies the start and end of the frame using character sequence DLE STX and DLE ETX (DLE is Data link Escape, STX is start of Text, ETX is end of text)
2. If the characters for DLE STX and DLE ETX are itself present as part of the data, it inserts an ASCII character DLE before each incident DLE character in the data.

**Example.**

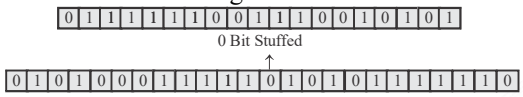
| Data sent by Network Layer | Data after being character stuffed |
|---|---|
| (a) A \| DLE \| B | (a) STX \| DLE \| A \| DLE \| DLE \| B \| DLE \| ETX |

# WORKBOOK

**1.** If flag byte is 01111110 and Original data is 011100101010101000111111101. Compute the new data after bit stuffing to be sent.

**Solution.**

Data after bits stuffing is




**2.** Find the hamming distance of codewords 000110 and 110010

**Solution.**

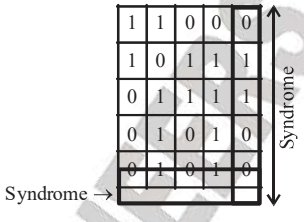
XOR of the two given codewords is calculated as

000110
110010
110100 ←result

The number of 1's in result 110100 are 3. So, their Hamming distance is 3 that implies the two codewords differ by 3 bits.

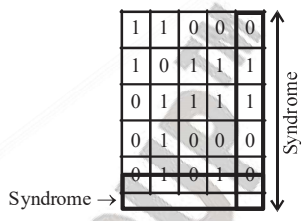
**3.** Find the syndrome for dataword 1100101101110101 using two-dimensional even parity-check code with column of 4 bits.

**Solution.**

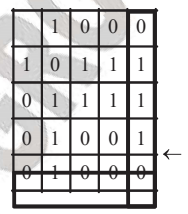



If an error occurred in of the 3rd digit from the left in 4th word.

Errored data received with syndrome calculated at Sender's is side




New syndrome for received data is




Paring the recalculated syndrome and received syndrome, we get error in 3rd digit of the 4th word. As It is binary data, changing 0 to 1.

**4.** If a CRC generator uses a divisor as polynomial $x^3 + x + 1$ and dataword is 1001010. Find the codeword to be send to the receiver.

**Solution.**

Divisor is $x^3 + x + 1$ (given) in Binary form, it can be written as 1011 and dataword is 1001010

At Sender's side

# ASSIGNMENT - I

**1.** A 10 Base 2 Ethernet network uses what type of cable?
(a) Thin coaxial (b) Twisted-Pair cable
(c) Thick coaxial (d) None of these

**2.** Which of the following is a product of LLC sub layer?
(a) 802.3 frame
(b) 802.5 frame
(c) PDU (Protocol data unit)
(d) Preamble

**3.** Consider building a CSMA/CD network running at 10 Mbps over a cable with no repeaters. If the signal speed in the cable is $10^6$ Km/sec and minimum frame size is 1500 bytes then what is the cable length?
(a) 600 km (b) 1200 Km
(c) 12 Km (d) 120 Km

**4.** How many bits a 550 meter ring cable containing 60 equally spaced stations (assuming each has one bit delay) can occupy? Assume 4 Mbps data rate and propagation speed of 250 meters per micro sec
(a) 60 bits (b) 69 bits
(c) 70 bits (d) 75 bits

**5.** One Gbps CSMA/CD LAN is to be designed over 1Km cable without repeater. The cable supports signal speed of 200, 000 Km/sec. What is the Minimum frame size that Data Link layer should consider?
(a) $10^9$ bits (b) 5000 bits
(c) 10000 bits (d) 10 bits

**6.** Consider a token ring LAN in which time on the ring will alternate between data frame transmission and token. In a single instance of data frame followed by a token as a cycle and defined as follows
t is average time for one cycle
$t_1$ is average time to transmit a data frame
$t_2$ is average time to pass a token
If u is the maximum utilization of the channel then the value of u is

(a) $\frac{t}{t_1 + t_2}$ (b) $\frac{t_1}{t_1 + t_2}$
(c) $\frac{t-1}{t_1 + t_2}$ (d) $\frac{1}{t-(t_1 + t_2)}$

**7.** MTU stands for
(a) Minimum Transfer Unit
(b) Minimum Transmission Unit
(c) Maximum Transmission Unit
(d) Maximum Transfer Unit

**8.** Synchronization of bits is done by
(a) Data link layer (b) Network layer
(c) Transport layer (d) All of these

**9.** Bridges operate at the _____of the OSI model.
(a) The Data-Link Layer
(b) Top Layer
(c) The Transport Layer
(d) The Network Layer

**10.** Which of the following options is not an useful property of Manchester line code for an Ethernet?
(a) Continuous Energy
(b) Continuous Clock transition
(c) No DC component
(d) No signal change at a 1 to 0 transition

**11.** At which layer of the OSI model does a switch exist?
(a) Physical (b) Data link
(c) Network (d) Session

**12.** If a frame enters a bridge and the MAC address is not found in the MAC address table, what will the bridge do with the frame?
(a) Drop it

# GATE QUESTIONS

**1.** A computer network uses polynomials over GF(2) for error checking with 8 bits as information bits and uses $x^3 + x + 1$ as the generator polynomial to generate the check bits. In this network, the message 01011011 is transmitted as

**[GATE - 2017]**

(a) 01011011010 (b) 01011011011
(c) 01011011101 (d) 01011011100

**1.** The values of parameters for the Stop-and Wait ARQ protocol are as given below:
Bit rate of the transmission channel = 1 Mbps.
Propagation delay from sender to receiver = 0.75 ms.
Time to process a frame = 0.25 ms.
Number of bytes in the information frame = 1980
Number of bytes in the acknowledge frame = 20
Number of overhead bytes in the information frame = 20
Assume that there are no transmission errors. Then, the transmission efficiency (expressed in percentage) of the Stop-and-Wait ARQ protocol for the above parameters is _____ (correct to 2 decimal places).

**[GATE - 2017]**

**2.** Consider two hosts X and Y, connected by a single direct link of rate $10^6$ bits/sec. The distance between the two hosts is 10,000 km and the propagation speed along the link is $2 \times 10^8$ m/sec. Host X send a file of 50,000 bytes as one large message to host Y continuously. Let the transmission and propagation delays be p milliseconds and q milliseconds, respectively. Then the values of p and q are

**[GATE - 2017]**

(a) p=50 and q=100 (b) p=50 and q=400
(c) p=100 and q=50 (d) p=400 and q=50

**3.** Consider a binary code that consists of only four valid code words as given below:
00000, 01011, 10101, 11110
Let the minimum Humming distance of the code be p and the maximum number of erroneous bits that can be corrected by the code by q. Then the values of p and q are

**[GATE - 2017]**

(a) p=3 and q=1 (b) p=3 and q=2
(c) p=4 and q=1 (d) p=4 and q=2

**4.** A sender uses the Stop-and-Wait ARQ protocol for reliable transmission of frames. Frames are of size 1000 bytes and the transmission rate at the sender is 80 Kbps (1Kbps = 1000 bits/second). Size of an acknowledgement is 100 bytes and the transmission rate at the receiver is 8 Kbps. The one-way propagation delay is 100 milliseconds. Assuming no frame is lost, the sender throughput is _____ bytes/second.

**[GATE - 2016]**

**5.** In an Ethernet local area network, which one of the following statements is TRUE?

**[GATE - 2016]**

(a) A station stops to sense the channel once it starts transmitting a frame.
(b) The purpose of the jamming signal is to pad the frames that are smaller than the minimum frame size.
(c) A station continues to transmit the packet even after the collision is detected.
(d) The exponential backoff mechanism reduces the probability of collision on retransmissions.

**6.** A network has a data transmission bandwidth of 20 × 106 bits per second. It uses CSMA/CD in the MAC layer. The maximum signal propagation time from one node to another node is 40 microseconds. The minimum size of a frame in the network is_____bytes.

# SOLUTIONS

**Sol 1. (c)**

```
1011)01011011000(01000011
     1011
     ----
      1100
      1011
      ----
       1110
       1011
       ----
        101
        ---
        CRC
```

**Sol 2. (89.33)**

B = 1 Mbps

$T_p$ = 0.75 ms

$T_{proc}$ = 0.25 ms

Payload = 1980 B

Ack = 20 B

OH = 20 B

L = Payload + OH = 1980 + 20 = 2000 Bytes

$$T_x = \frac{L}{B} = \frac{2000 \times 8}{1 \times 10^6} = 16 \text{ ms}$$

$$T_{ax} = \frac{20 \times 8}{1 \times 10^6}$$

= 160 μsec

= 0.16 msec

Total time = $T_x + T_p + T_{proc} + T_{ax} + T_p + T_{aproc}$

= 16 ms + 0.75 ms + 0.25 ms + 0.16 ms + 0.75 ms

= 17.91 ms

$$\eta = \frac{T_x}{\text{Total Time}} = \frac{16}{17.91} = 89.33\%$$

**Sol 3. (d)**

Given

B = $10^6$ bps

Distance = 10000 km

$T_p = 2 \times 10^8$ m/s

L = 50000 B

$$p = T_x = \frac{L}{B} = \frac{50000 \times 8}{100 \times 10^4} = \frac{4}{10} \times \frac{10^3}{10^3} = \frac{4000}{10} = 400 \text{ msec}$$

$$q = \frac{d}{v} = \frac{10000 \times 10^3}{2 \times 10^8} = \frac{1}{20} = \frac{1}{20} \times \frac{10^3}{10^3} = \frac{1000}{20} \text{ ms} = 50\text{ms}$$

**Sol 4. (a)**

The number of bit positions in which two code words differ is called Hamming Distance.

| | | | |
|---|---|---|---|
| 00000 | 00000 | 00000 | 00000 |
| 01011 | 10101 | 11110 | 10101 |
| ⊕––– | ⊕––– | ⊕––– | ⊕––– |
| = 3 | 3 | 4 | 4 |

| | |
|---|---|
| 01011 | 10101 |
| 11110 | 11110 |
| ⊕––– | ⊕––– |
| = 3 | 3 |

So minimum distance = 3 ⇐ p

To connect d errors, you need a distance 2d + 1 code

So 3 = 2d + 1

Hence, d = 1 ⇐ q

p = 3, q = 1

**Sol 5. (2500)**

Bandwidth(R) = 80 kbps

Frame size = 1000 bytes

Propagation Time(PT) = 100 ms

Acknowledgement size = 100byte

Transmission Rate at receiver = 8kbps

$$\text{Transmission Time (TT)} = \frac{\text{Framesize}}{\text{Bandwidth}}$$

= 100 ms

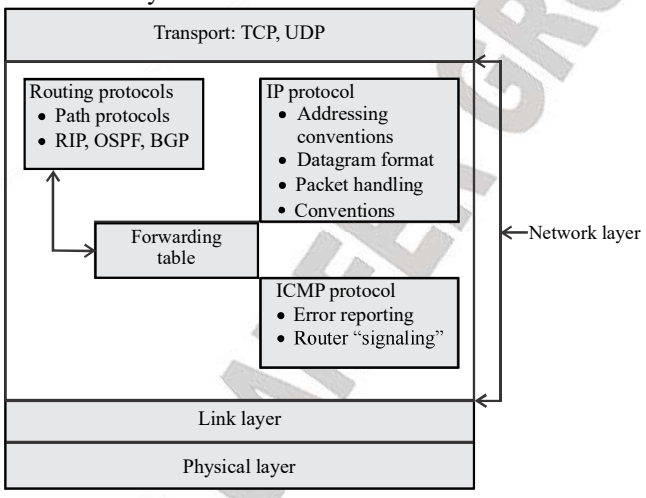
Transmission Time of acknowledgement $(TT_{Ack}) = \frac{\text{Acknowledgement size}}{\text{Bandwidth}}$ =100 ms

$$\text{Efficiency} = \frac{TT}{TT + 2PT + TT_{Ack}}$$

# CHAPTER - 4
# *NETWORK LAYER*

## 4.1 INTRODUCTION

1. Network layer provides host to host communication. It receives data from transport layer and forms the packets of received data.
2. It works on IP address of host to route the packets to receipt network
3. It has three major components: IP protocol, Routing, ICMP.
4. IP protocol includes Addressing convention, Datagram format and Packet handling conventions
5. Routing determines the path a datagram should follow from source to destination. It includes path selection and RIP, OSPF, BGP protocols.
6. ICMP (Internet control message protocol) is a facility to report errors in a datagram and respond to requests for certain network layer information




## 4.2 IP ADDRESSING

1.IP address is technically associated with the interface rather than with the host or router containing that interface.
2.Each IP address is 32 bits long which contains the network and host identifier on that particular network.
3.It is written in dotted decimal notation. For example 193.32.216.164
4.They are logical addresses.
5.They are assigned by Internet Corporation for Assigned Names and Numbers (ICANN). It assigns IP addresses to ISPs (Internet Service Provider) and ISP handles allocation or management of addresses within their regions. This address 255.255.255.255 is Broadcast IP address.
6.Each IP address has two parts network id and host id. Network id has all host bits 0's.
7. There are two types of Addressing:-
(i) Classful Addressing
(ii) Classless Addressing

# WORKBOOK

**1.** Determine the netid and direct broadcast address for IP address 201.16.139.149.

**Solution.**

IP address = 201.16.139.149

(Netid is calculated by taking ANP of IP address and m/w mask)

So, Network address is as follows.

201.16.139.149

AND 255.255.255.0

201.16.139.0

Netid: 201.16.139.0

Direct Broadcast address of 201.16.139.0 is 201.16.139.255.

**2.** Determine the netid and direct broadcast for IP address 144.16.19.159.

**Solution.**

IP address = 144.16.19.159

It is class B

So its network mask is 255.255.0.0

Network address will be as

144.16.19.159

AND 255.255.255.0

144.16.0.0

Net ID: 144.16.0.0

Direct Broadcast → 144.16.255.255

**3.** Determine netid and Broadcast address for IP address 37.159.87.120.

**Solution.**

IP address = 37.159.87.120

It Belongs to class A

So its network mask is 255.0.0.0

37.159.87.120

AND 255. 0. 0. 0

Netid → 37.0.0.0

Direct Broadcast Address → 37.255.255.255

**4.** In class C, if subnet mask is 255.255.255.224 Calculate number of subnets and no. of host in each subnet

**Solution.**

Subnet mask is 255.255.255.224

In class C, Network mask is 255.255.255.0

In creating subnets, we use fewer bits of hosted and in this subnet mark last byte is 224 (11100000).

So it uses 3 bits to create subnet.

Total no. of subnets = $2^3 - 2 = 6$

Here 2 subnets are created, one of which gives network mask address and other gives subnets mask.

Here, 3 bits of host are used to create subnet and so 5 bits are used to define host.

$\therefore$ No. of hosts per subnet = $2^5 - 2 = 30$ hosts

**5.** In the class C if subnet mask is 255.255.255.240. Calculate the no. of subnets and no. of hosts in each subnet.

**Solution.**

Subnet mask = 255.255.255.240

240 = 11110000

Here 4 bits of host id bytes are used to define subnets.

So no. of subnets = $2^4 - 2 = 14$

No. of hosts in each subnet = $2^4 - 2 = 14$

Because 4 bits of host id bytes are left to define host.

**6.** IP address 203.16.17.119 and subnet mask is 255.255.255.224 is given. Calculate subnet IP subnet number first, lost host and direct broadcast address of that subnet.

**Solution.**

IP address = 203.16.17.119

It belongs to class C

IP: 203.16.17.119

AND 255.255.255.224

First 3 bytes of subnetid is same as IP address because they are AND with 255. Last byte is calculated as follows

119 01110111

224 11100000

# ASSIGNMENT - I

**1.** Network layer activities are:
(a) Logical addressing
(b) Port addressing
(c) Access control
(d) All of these

**2.** Consider the following statements
S1: Protocols define how corresponding layers on separate machines communicate,
S2: Services are used by adjacent layers on the same machine to communicate. Which one of the following is true?
(a) S1 is true, S2 is false
(b) S2 is true, S1 is false
(c) Both are true
(d) Both are false

**3.** Routing is done in
(a) Network layer (b) Physical layer
(c) Data link layer (d) Transport layer

**4.** What types of routing connection would typically fragment data packets?
(a) Connection Oriented (b) Cut-Through
(c) Reliable (d) Connectionless

**5.** The Internet Protocol (IP) generally corresponds to which OSI layer?
(a) Network (layer three)
(b) Transport (layer four)
(c) Data Link (layer two)
(d) Session (layer five)

**6.** Which of these network devices primarily functions at the OSI network layer (layer 3)?
(a) Switch (b) Gateway
(c) Router (d) All of these

**7.** Which Protocol Data Unit (PDU) is employed at Network Layer?
(a) Bits (b) Frames
(c) Packets (d) Segments

**8.** Consider the following statements
S1:Network layer dividing the transmitted bit steam into frames.
S2:Network layer determining which route through the subnet to use.
Which one of the following is true?
(a) S1 is true, S2 is false
(b) S2 is true, S1 is false
(c) Both are true
(d) Both are false

**9.** State true (T) and false (F) of the following statements
1. A straight-through cable should be used to connect a router to a switch.
2. A switch builds its MAC table based on Destination MAC addresses
3. Routers separate broadcast domains.
4. A bridge will always forward all broadcast traffic to all ports.
(a) TFTT (b) FTTF
(c) TFFT (d) FTFT

**10.** In a networking system, a session must be established before data may be transmitted. What OSI layer is responsible for this function?
(a) Presentation (b) Session
(c) Transport (d) Data Link

**11.** To establish a session between network communicators, Session layer protocols are required. Choose two protocols that work in this layer.
(i) RPC (ii) PICT
(iii) ASP (iv) JPEG
(a) (i) and (iii)
(b) (ii) and (iii)
(c) (ii) and (iii)
(d) (iii) and (iv)

**12.** What kind of device might you need if you wanted to connect your corporate LAN to the internet?

# GATE QUESTIONS

**1.** For a host machine that uses the token bucket algorithm for congestion control, the token bucket has a capacity of 1 megabyte and the maximum output rate is 20 megabytes per second. Tokens arrive at a rate to sustain output at a rate of 10 megabytes per second. The token bucket is currently full and the machine needs to send 12 megabytes of data. The minimum time required to transmit the data is _____seconds.

**[GATE - 2016]**

**2.** An IP datagram of size 1000 bytes arrives at a router. The router has to forward this packet on a link whose MTU (maximum transmission unit) is 100 bytes. Assume that the size of the IP header is 20 bytes. The number of fragments that the IP datagram will be divided into for transmission is_____.

**[GATE - 2016]**

**3.** Which one of the following protocols is **NOT** used to resolve one form of address to another one?

**[GATE - 2016]**

(a) DNS (b) ARP
(c) DHCP (d) RARP

**4.** Which one of the following fields of an IP header is NOT modified by a typical IP router?

**[GATE- 2015]**

(a) Checksum (b) Source address
(c) Time to Live (TTL) (d) Length

**5.** Consider the following routing table at an IP router:

**[GATE- 2015]**

| Network No. | Net Mask | Next Hop |
|---|---|---|
| 128.96.170.0 | 255.255.254.0 | Interface 0 |
| 128.96.1680 | 255.255.254.0 | Interface 1 |
| 128.96.166.0 | 255.255.254.0 | R2 |
| 128.96.164.0 | 255.255.252.0 | R3 |
| 0.0.0.0 | Default | R4 |

For each IP address in Group-I identify the correct choice of the next hop from Group-II using the entries from the routing table above.

**List-I**
A. 128.96.171.92
B. 128.96.167.151
C. 128.96.163.151
D. 128.96.165.121

**Group-II**
(i) Interface 0
(ii) Interface 1
(iii) R2
(iv) R3
(v) R4

**Codes:**
(a) A-i, B-iii, C-v, D-iv
(b) A-i, B-iv, C-ii, D-v
(c) A-ii, B-iii, C-iv, D-v
(d) A-ii, B-iii,C-v, D-iv

**6.** Host A sends a UDP datagram containing 8880 bytes of user data to host B over an Ethernet LAN. Ethernet frames may carry data up to 1500 bytes (i.e. MTU = 1500 bytes). Size of UDP header is 8 bytes and size of IP header is 20 bytes. There is no option field in IP header. How may total number of IP fragments will be transmitted and what will be the contents of offset field in the last fragment?

**[GATE - 2015]**

(a) 6 and 925 (b) 6 and 7400
(c) 7 and 1110 (d) 7 and 8880

**7.** Two hosts are connected via a packet switch with 107 bits per second links. Each link has a propagation delay of 20 microseconds. The switch begins forwarding a packet 35 microseconds after it receives the same. If 10000 bits of data are to be transmitted between the two hosts using a packet size of 5000 bits, the time elapsed between the transmission of the first bit of data and the

# SOLUTIONS

**Sol 1. (1.2)**
Given
Maximum burst rate, M = 20 MB
Token arrival rate, P = 10 MB
Constant rate (bucket o/p), P = 10 MB
Bucket capacity, C = 1 MB

Time for 1 MB, $S = \frac{C}{M-P} = \frac{1}{20-10} = 0.1\text{sec}$

For the total message of 12 MB is 1.2 sec

**Sol 2. (13)**
L =1000 bytes
MTU = 100 bytes
IP header = 20 bytes
So MTU payload is 100–20 = 80 bytes
Data=1000-20=980
Number of fragments = 980/80 = 13

**Sol 3. (c)**
DHCP is dynamic host configuration protocol: allocates one of the unused IP address.

**Sol 4. (a)**
Router cannot change the source address because it is the IP address of sender.

**Sol 5. (a)**
To find the interface for IP address, we have to AND IP address and Netmask, if the answer matches with the network address then its corresponding interface is chosen for next hop.

**A:**
IP address 128.96.171.92
AND Netmask 255.255.254.0
= 128.96.10101011.01011100
AND 255.255.11111110.00000000
128.96.170.0
Therefore, A select interface 0

**B:**
IP address 128.96.167.151
AND Netmask 255.255.254.0
= 128.96.10100111.10010111
AND 255.255.11111110.00000000
128.96.166.0
Therefore, B select interface $R_2$

**C:**
IP address 128.96.163.121
AND Netmask 255.255.254.0
= 128.96.10100001.01111001
AND 255.255.11111110.00000000
128.96.162.0
Therefore, C select interface $R_4$

**D:**
IP address 128.96.165.121
AND Netmask 255.255.254.0
= 128.96.10100011.01111001
AND 255.255.11111110.00000000
128.96.164.0
Therefore, D select interface $R_3$
So, option (a) is correct.

**Sol 6. (c)**
UDP datagram = 8880byte
UDP header = 8 bytes
IP header = 20 bytes
MTU = 1500 bytes
Actual data in MTU = 1500 – 20=14 80 bytes
Actual data in IP packet = 8880 + 8
= 8888 bytes
So, size of first fragment = (1480 +20) bytes
size of 2nd fragment =(1480 +20) bytes
size of 3rd fragment = (1480 +20) byte
size of 4th fragment = (1480 +20) bytes
size of 5th fragment = (1480 +20) bytes
size of 6th fragment = (1480 +20) bytes
size of 7th fragment =(56 + 20) bytes
offset of 7 fragment is 1110

**Sol 7. (1575 μ sec)**
Bandwidth = $10^7$ bps
Propagation delay = 20 μ sec
Forward time by switch = 35 μ sec
Packet size = 5000 bits

# CHAPTER - 5
# *TRANSPORT LAYER*

## 5.1 INTRODUCTION

1.A transport layer provides logical communication between application processes running on different hosts. Logical communication means hosts running the process are directly connected.
2.Transport layer protocols are implemented in the end system but not in network routers.
3.It provides data to the network layer.
4.Services that transport protocol can provide are often constrained by the services model of network–layer protocol. But there are also certain services that are offered by transport protocol but not by network layer protocol.
5.Transport layer has 16 bit port number to identify a process to which data is to be delivered (destination port number) and by which data is sent(source Port number) .
6.The port number ranging from 0 to 1023 are well known such as HTTP's port no. 80, FTP's port no. 21.

**Example.**

Consider two houses one in the East Delhi and other in West Delhi having four kids in each. The kids in the two houses write letters to each other. Let kids A1 and A2 are responsible for letter collection from their respective house kids and their distribution to postal service mail carrier. Now, it can be understood about the transport layer of computer network by the following analogy

| | |
|---|---|
| Letter in envelopes | Application layer Message |
| Kids | Process |
| Houses | Hosts (end systems) |
| Kids A1, A2 | Transport Layer Protocol |
| Postal Service | Network layer Protocol |

### 5.1.1 Multiplexing and De-Multiplexing

1.A process can have one or more sockets for communication between the network and processes.
2.The transport layer in the receiving host delivers data to an intermediate socket. Because at any given time, there can be more than one socket in the receiving host, each socket has a unique identifier.
3.The job of gathering data chunks from different sockets and encapsulating header information with them to create segment and passing segments to the network layer is called multiplexing.
4.The job of delivering the data in the transport layer segment to the correct socket is called De-multiplexing.

## 5.2 USER DATAGRAM PROTOCOL (UDP)

1. UDP takes message from the application process, attaches source and destination port number field for the multiplexing/ de-multiplexing service and passes the resulting segment to the network layer.
2. When segment arrives at the receiving host, UDP uses the destination port number to deliver the segment's data to the correct application process.
3. UDP is connectionless as there is no handshake between sender and receiver.
4. DNS (Domain Name Server), RIP (Routing Information Protocol), and SNMP (Simple Network management Protocol) uses UDP.

# ASSIGNMENT - I

**1.** The transport layer provides
(a) Node-to-node communication
(b) Host- to-host communication
(c) Process-to-process communication
(d) All of the above

**2.** Why some transport-layer packets may be lost in the Internet?
(a) Because a valid destination address is not known to these packets
(b) A socket address is not defined for these packets.
(c) The router through which the datagram need To pass to reach their destination may be congested
(d) Because the time has been cleared out.

**3.** Which of the following features is not common in both data link layer and transport layer?
(a) Recovery from transmission errors
(b) Flow control
(c) Multiplexing
(d) Framing

**4.** Choose the correct statement
(a)A client program normally uses a well-known port number. A server program normally uses an ephemeral port number.
(b)A client program normally uses an ephemeral port number. A server program normally uses a well-known port number.
(c)A client program normally uses an private port number. A server program normally uses a well-known port number.
(d) None of these

**5.** Match List-I (Range of Port numbers) with List-II (corresponding port) and choose the correct answer using the codes given below.
**List-I**
A. 0 to 1023
B. 1024 to 49, 151
C. 49, 152 to 65, 353
**List-II**
(i) Registered ports
(ii) Well-known ports
(iii) Dynamic ports
**Codes**
(a) A-ii, B-i, C-iii
(b) A-i, B-ii, C-iii
(c) A-iii, B-ii, C-i
(d) A-ii, B-iii, C-i

**6.** A port number is
(a) 8 bits long (b) 16 bits long
(c) 32 bits long (d) 64 bits long

**7.** In DHCP, the ports used by the client and server are respectively
(a) An ephemeral; a well-known
(b) A well-known; a well-known
(c) A well-known; an ephemeral
(d) An ephemeral; an ephemeral

**8.** Suppose that a new organization needs to create a new server process and allows its customers to access the organization site using that process. How should the port number for the server process be selected?
(a)The organization can choose any real number as a port number.
(b)The organization can choose a port number from 0 to 1023.
(c)This will depend on the IP address of the organization.
(d)The organization needs to select a port number from the registered range. 1024 to 49,151and register that port number with ICANN.

**9.** A client residing on a host with IP address 122.45.12.7 sends a message to the corresponding server residing on a host with IP

# GATE QUESTIONS

**1.** Consider socket API on a Linux machine that supports connected UDP sockets. A connected UDP socket is a UDP socket on which connect function has already been called. Which of the following statements is/are CORRECT?
I. A connected UDP socket can be used to communicate with multiple peers simultaneously.
II. A process can successfully call connect function again for an already connected UDP socket.

**[GATE - 2017]**

(a) I only (b) II only
(c) Both I and II (d) Neither I nor II

**2.** Consider the following statement about the routing protocols. Routing Information Protocol (RIP) and Open Shortest Path First (OSPF) in a IPv4 network.
I. RIP uses distance vector routing
II. RIP packets are sent using UDP
III. OSPF packets are sent using TCP
IV. OSPF operation is based on link-state routing
Which of the statements above are CORRECT?

**[GATE - 2017]**

(a) I and IV only
(b) I, II and III only
(c) I, II and IV only
(d) II, III and IV only

**3.** Suppose two hosts use a TCP connection to transfer a large file. Which of the following statements is/are False with respect to the TCP connection?
1. If the sequence number of a segment is m, then the sequence number of the subsequent segment is always m + 1
2. If the estimated round trip time at any point of time is t sec, the value of the retransmission timeout is always set to greater than or equal to t sec.
3. The size of the advertised window never changes during the course of the TCP connection.
4. The number of unacknowledged bytes at the sender is always less than or equal to the advertised window.

**[GATE - 2015]**

(a) 3 only (b) 1 and 3 only
(c) 1 and 4 only (d) 2 and 4 only

**4.** Assume that the bandwidth for a TCP connection is 1048560 bits/sec. Let $\alpha$ be the value of RTT in milliseconds (rounded off to the nearest integer) after which the TCP window scale option is needed. Let $\beta$ be the maximum possible window size with window scale option. Then the values of $\alpha$ and $\beta$ are

**[GATE - 2015]**

(a) 63 milliseconds $65535 \times 2^{14}$
(b) 63 milliseconds $65535 \times 2^{16}$
(c) 500 milliseconds $65535 \times 2^{14}$
(d) 500 milliseconds $65535 \times 2^{16}$

**5.** Consider the following statements.
(i) TCP connections are full duplex.
(ii) TCP has no option for selective acknowledgment
(iii)TCP connections are message streams.

**[GATE - 2015]**

(a) Only i is correct
(b) Only i and ii are correct
(c) Only ii and iii are correct
(d) All of i, ii and iii are correct.

**6.** Which one of the following socket API functions converts an unconnected active TCP socket into a passive socket

**[GATE - 2014]**

(a) Connect (b) Bind
(c) Listen (d) Accept

**7.** Let the size of congestion window of a TCP connection be 32 KB when a timeout occurs.

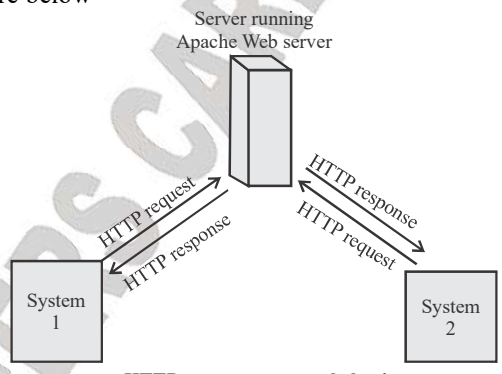
# CHAPTER - 6
# *APPLICATION LAYER*

## 6.1 INTRODUCTION

1. It is related to client and server architecture, there is an always one host called the server, which services requests from many other hosts, called clients. A client host can be either sometimes on or always on.
2. No two clients can directly communicate with each other. It is only possible having in between server/ servers for their communication.
3. Web Application, file transfer, Remote Login, and e-mail all are application layers application.
4. An application-layer protocol defines how an each application's processes, running on different end systems, pass messages to each other.
5. Its different protocols are HTTP, FTP, SMTP, POP, DNS etc.

### 6.1.1 HTTP (Hyper Text Transfer Protocol) (Web page Display)

1. It is the web's application layer protocol and is the heart of the web.
2. It is implemented in both client and server program, executing on different end systems, by exchanging HTTP messages.
3. HTTP uses TCP as its underlying transport protocols.
4. It runs on port number 80.
5. A browser is a user agent for the web; it displays the requested web page to the user.
6. Thus, when a user requests a web page the browser sends HTTP request message for the objects in the page to server. The server receives the requested message and responds with HTTP response message as shown in figure below




**HTTP request-response behavior**

7. HTTP is said to be stateless protocol, as HTTP server maintains no information about the client.
8. HTTP is pull protocol i.e., someone loads information on a web server and users use HTTP to pull the information from the server at their convenience.

It uses both non persistent and persistent connection (in default mode).

***(i) Non-persistent connection***

(a) Here, TCP connection transports exactly one request message and one response message.
(b) TCP connection is closed after the server sends the requested data.

# ASSIGNMENT

**1.** Match List-I(internet application) with List-II (application-layer protocol that the application uses) and choose the correct answer using the codes given below

**List-I (Application)**

A. Web
B. File Transfer
C. Remote Login
D. Email

**List-II (Protocol used in the application)**

(i) FTP
(ii) HTTP
(iii) SMTP
(iv) Telnet

**Codes:**

(a) A-ii, B-iv, C-i, D-iii
(b) A-ii, B-ii, C-i, D-iv
(c) A-ii, B-i, C-iv, D-iii
(d) A-iv, B-i, C-ii, D-iii

**2. Assertion (A):** HTTP, FTP, SMTP, POP3, and IMAP run on top of TCP rather than UDP.
**Reason (R):** TCP provides a reliable data transfer service.
(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R true but R is not the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.

**3.** In a centralized P2P network,
(a) The directory system uses the client-server paradigm; the storing and downloading of the files are also done using client-server paradigm.
(b) The directory system uses the peer-to-peer paradigm: the storing and downloading of the files are done using client-server paradigm.
(c) The directory system uses the client-server paradigm; the storing and downloading of the files are done using peer-to-peer paradigm.
(d) The directory system uses the peer-to-peer paradigm; he storing and downloading of the files are also done using peer-to-peer paradigm.

**4.** In a client-server network architecture
(a) The server provides service and the client receives service
(b) The client provides service and the server receives service
(c) Both the client and server can provide and receive service
(d) None of these

**5.** Which of the following application is not based on client-server network architecture?
(a) Web
(b) File transfer
(c) Remote-login
(d) Instant messaging

**6.** For a communication session between a pair of processes, which process is the client and which is the server?
(a) The process which requests to establish the connection is client; the process which requests to terminate the connection is the server.
(b) The process which sends the first packet into the network is the client and the process which sends the last packet into the network is server.
(c) The process which sends first three packets consecutively is the client and the process which receives last two packets consecutively is the server.
(d) The process which initiates the communication is the client; the process that waits to be contacted is the server.

**7.** What information is used by a process running on one host to identify a process running on another host?
(a) The IP address of the destination host and the port number of the destination

# GATE QUESTIONS

**1.** Consider a TCP client and a TCP server running on two different machines. After completing data transfer, the TCP client calls close to terminate the connection and a FIN segment is sent to the TCP server. Server-side TCP responds by sending an ACK, which is received by the client-side TCP. As per the TCP connection state diagram (RFC 793), in which state does the client-side TCP connection wait for the FIN from the server-side TCP?

**[GATE - 2017]**

(a) LAST-ACK (b) TIME-WAIT
(c) FIN-WAIT-1 (d) FIN-WAIT-2

**2.** Which of the following is/are example(s) of stateful application layer protocols?

(i) HTTP (ii) FTP
(iii) TCP (iv) POP3

**[GATE - 2016]**

(a) (i) and (ii) only
(b) (ii) and (iii) only
(c) (ii) and (iv) only
(d) (iv) only

**3.** Identify the correct sequence in which the following packets are transmitted on the network by a host when a browser requests a webpage from a remote server, assuming that the host has just been restarted.

**[GATE - 2016]**

(a) HTTP GET request, DNS query, TCP SYN
(b) DNS query, HTTP GET request, TCP SYN
(c) DNS query, TCP SYN, HTTP GET request
(d) TCP SYN, DNS query, HTTP GET request

**4.** In one of the pairs of protocols given below, both the protocols can use multiple TCP connections between the same client and the server. Which one is that?

**[GATE - 2015]**

(a) HTTP, FTP
(b) HTTP, TELNET
(c) FTP, SMTP
(d) HTTP, SMTP

**5.** Which one of the following statements is NOT correct about HTTP cookies?

**[GATE - 2015]**

(a) A cookie is a piece of code that has the potential to compromise the security of an Internet user
(b) A cookie gains entry to the user's work area through an HTTP header
(c) A cookie has an expiry date and time
(d) Cookies can be used to track the browsing pattern of a user at a particular site

**6.** Which of the following transport layer protocols is used to support electronic mail?

**[GATE - 2012]**

(a) SMTP (b) IP
(c) TCP (d) UDP

**7.** Consider different activities related to email
m1 : Sends an email from a mail client to a mail server
m2: Download an e-mail from mailbox server to a mail client
m3: Checking e- mail in a web browser
Which is the application layer protocol used in each activity?

**[GATE - 2011]**

(a) m1 : HTTP m2: SMTP m3 POP
(b) m1:SMTP m2:FTP m3:HTTP
(c) m1 : SMTP m2:POP m3:HTTP
(d) m1:POP m2:SMTP m3:IMAP

**8.** A layer-4 firewall (a device that can look at all protocol headers up to the transport layer) CANNOT

**[GATE - 2011]**

(a) Block entire HTTP traffic during 9 : 00 pm and 5:00am
(b) Block all ICMP traffic