National University of Computer and Emerging Sciences, Lahore Campus

	Course Name:	**Computer Networks**	**Course Code:**	**CS3001**
	Degree Program:	**BS (CS)**	**Semester:**	**Fall 2021**
	Exam Duration:	**60 Minutes**	**Total Marks:**	**40**
	Paper Date:	**21-Oct-2021**	**Weight**	**15%**
	Section:	**ALL**	**Page(s):**	**5 + 1 (Rough Page)**
	Exam Type:	**Mid-1**		

Name:_______________________________ **Roll No.**________________ **Section:**_______

Instruction/Notes:
- Attempt all questions on the provided question paper.
- Space for rough work is provided at the end of the paper.
- Even if you do use rough sheets, they should NOT be attached with final paper.

Problem 1: Answer the following multiple-choice questions by filling the following table. **[1+1+1+1+1 = 5 Marks]**

Any answers outside the table will NOT be marked.

1	A
2	B
3	C
4	C
5	B

1.1. A Server is part of the
- A. Edge Network
- B. Core Network
- C. Both Edge & Core Network
- D. None of the above

1.2. OSI/ISO & TCP/IP Service Models consists of ____ & ____ Layers respectively.
- A. 9 & 7
- B. 7 & 5
- C. 5 & 7
- D. 3 & 5

1.3. ________transfers messages from senders' mail servers to the recipients' mail servers.
- A. Simple Network Management Protocol
- B. Hyper Text Transfer Protocol
- C. Simple Mail Transfer Protocol
- D. Transmission Control Protocol

1.4. If traffic intensity is greater than 1, it means that.
- A. The average rate at which bits arrive at the queue is less than the rate at which the bits can be transmitted from the queue
- B. The queuing delay is within the bound and the network is not congested
- C. The average rate at which bits arrive at the queue exceeds the rate at which the bits can be transmitted from the queue
- D. The queuing delay is unbound however size of the queue does not exceed its maximum size

1.5. If the size of the packet is increased, the following delay will be increased.
- A. Propagation delay
- B. Transmission delay
- C. None of the above
- D. Both of the above

Problem 2: HTTP delays. A client is looking to get 11 objects from an HTTP server with which it maintains a round trip time (RTT) of α sec. The transmission time of each object is β sec. Assume that the IP addresses to acquire all objects are already known to the client i.e. no need for DNS queries. Assume that no TCP connection yet exists between the client and the server and the packet sizes in establishing any TCP connections are negligible. What is the minimum time it would take the client to get all the objects (via HTTP) from the server under each of the following conditions?

[2+2+2=6 Marks]

(a) Non-persistent HTTP (1.0) on a single TCP connection.

Solution: $11 \times (\alpha + \alpha + \beta)$ seconds $=(22\alpha + 11\beta)$ seconds

(b) Persistent (but not Pipelined) HTTP over a single TCP connection?

Solution: $(\alpha + 11\alpha + 11\beta)$ seconds $= (12\alpha + 11\beta)$ seconds

(c) Persistent and Pipelined HTTP (1.1) over a single TCP connection?

Solution: $(\alpha + \alpha + 11\beta)$ seconds $= (2\alpha + 11\beta)$ seconds

Problem 3: Consider a packet of length 3000 bytes, which starts at source end system and travels over four links to destination end system. Three packet switches connect these four links. Suppose that propagation speed on all four links is 2×10^8 m/s. The transmission rate of all four links is 2 Mbps and each packet switch incurs a processing delay of 5 msec. Moreover, suppose that the distance from source end system to packet switch 1 is 5,000 km, the distance from packet switch 1 to packet switch 2 is 4,000 km, the distance from packet switch 2 to packet switch 3 is 3,000 km, and the distance from packet switch 3 to destination end system is 1,000 km. What is the end-to-end delay for these values assuming no queuing delay exist? **[7 Marks]**

Solution:

Length of packet = L = 3000 x 8 = 24000 bits
Transmission rate of links: $R_1=R_2= R_3= R_4$ = 2 Mbps = 2×10^6 bps
Transmission delay of each link (L/R): $d_{trans1} = d_{trans2} = d_{trans3} = d_{trans4} = 24000/ 2 \times 10^6 = 12$ msec

Propagation speed of links: $s_1 = s_2 = s_3 = s_4 = 2 \times 10^8$ m/s
Distance between links: d_1 = 5000 km, d_2 = 4000 km, d_3 = 3000 km, and d_4 = 1000 km
$d_{prop1} = d_1/s_1 = 5000 \times 10^3 / 2 \times 10^8 = 25$ msec
$d_{prop2} = d_2/s_2 = 4000 \times 10^3 / 2 \times 10^8 = 20$ msec
$d_{prop3} = d_3/s_3 = 3000 \times 10^3 / 2 \times 10^8 = 15$ msec
$d_{prop4} = d_4/s_4 = 1000 \times 10^3 / 2 \times 10^8 = 5$ msec
$d_{prop} = d_{prop1} + d_{prop2} + d_{prop3} + d_{prop4} = 25 + 20 + 15 + 5 = 65$ msec

Processing delay of each packet switch: $d_{proc1} = d_{proc2} = d_{proc3} = 5$ msec

$d_{end\text{-}end} = 4 * d_{trans} + d_{prop} + 3 * d_{proc} = 4 \times 12 + 65 + 3 \times 5 = 48 + 65 + 15 = 128$ msec

Problem 4:

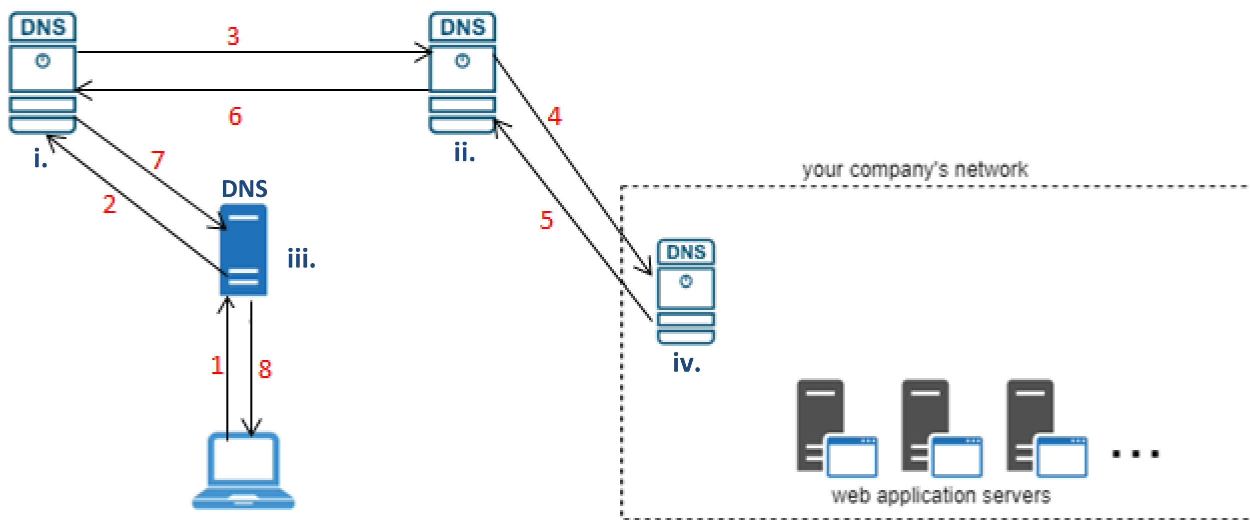
Suppose you would like to create a startup and register its domain name called www.MyCompany.com . In order to register a domain name, you will have to go to DNS registrar to enter Resource Records (RR) in the DNS distributed database. Below is a sketch that you will have to complete to show the connectivity between the end-systems to resolve the IP address of the startup you just initiated. Assume that you have 10,000 web servers and your own name-server called **dns1.mycompany.com** whose IP address is **172.16.5.1** **[2+1+5+4=12]**

(a) You are required to write the two RRs needed to make this whole system work by filling the table below (Ignore TTL in the table below):

NAME	VALUE	TYPE
www.MyCompany.com	dns1.mycompany.com	NS
dns1.mycompany.com	172.16.5.1	A

(b) In which DNS server will the two RRs be inserted that you filled in the table above? ___TLD___

(c) In the diagram below, draw the arrows (clearly indicating direction), and label each arrow with it's order / sequence number for a **recursive** DNS query.



(d) Refer to the above diagram, label the respective DNS servers numbered i., ii., iii. & iv. Below (i.e. write down the names of these different DNS servers against their respective numbers):

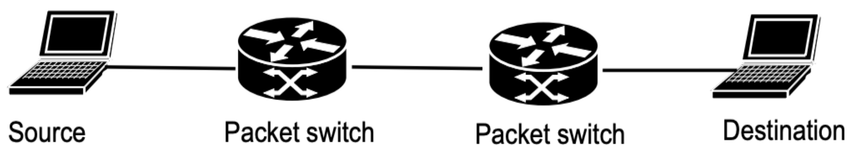
i. ___Root___

ii. ___TLD___

iii. ___Local / Default Name Server___

iv. ___Authoritative___

Problem 5: Long application-layer messages (for example, an image or a music file) are segmented into smaller packets and sent into packet-switched networks by the originating host. The packets are subsequently reassembled into the original message by the recipient. Message segmentation is the term we use to describe this process. A switched network is shown in the diagram below. Consider sending a message from the source to the destination that is 7.5×10^6 bits long. (Assume the header size is negligible in comparison to the overall message size.) Assume each link has a speed of 1.5 Mbps. Focus purely on transmission delays, assuming that all other delays are insignificant. **[5+5=10]**



(a) Consider sending the message without message segmentation from source to destination. How long does it take to move the message from the source host to the first packet switch? It's important to remember that each switch employs store-and-forward packet switching. What is the total time to move the message from source to the destination host?

Solution: $7.5 * 10^6 / 1.5 * 10^6 = 5$ sec.

Total delay = 5 sec × 3 hops = 15 sec.

(b) Now suppose that the message is segmented into 5000 packets, with each packet being 1500 bits long. How long does it take to move the first packet from source to the first switch? When the first packet is being sent from the first switch to the second switch, the second packet is being sent from the source host to the first switch. At what time will the second packet be fully received at the first switch?

Solution:

$1500/1.5 * 10^6$ = 1 msec.

Time at which the second packet is received at the first switch is the time at which the first packet is received at the second switch: 2×1 msec = 2 msec.

Rough Work: