National University of Computer and Emerging Sciences, Lahore Campus

	Course Name:	**Computer Networks**	**Course Code:**	**CS3001**
	Degree Program:	**BS (CS), BS (SE), BS (DS), BS (Robotics)**	**Semester:**	**Fall 2023**
	Exam Duration:	**60 Minutes**	**Total Marks:**	**30**
	Paper Date:	**28-September-2023**	**Weight**	**15%**
	Section:	**ALL**	**Page(s):**	**6**
	Exam Type:	**Mid-1**		

Name:_____ **Roll No.**_____ **Section:**_____

Instruction/Notes:
- Attempt all questions on the provided question paper.
- You can ask the invigilator for rough sheets.
- In case, you have used rough sheets, they should NOT be attached with final paper.

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

Any answers outside the table will NOT be marked. Moreover, Cutting and overwriting is not allowed.

1	A
2	B
3	C
4	B
5	C

1.1. Which of the following statement(s) is / are correct

A. SMTP uses handshake at the application layer level, while HTTP does not
B. SMTP uses handshake at both the application and the transport layer level, just like HTTP
C. SMTP doesn't use handshake unlike HTTP
D. None of the above

1.2. The issue of stale copy of an object in a Web Cache may be resolved via.

A. Cookies
B. Conditional Get
C. Pipelining
D. Can't be resolved

1.3. Suppose a client sends an HTTP request message with the ***If-modified-since:*** header. Suppose the object in a server has not changed since the last time a client retrieved the object. Then the server will send a response message with the status code:

A. 200 OK
B. 404 Not Found
C. 304 Not Modified
D. none of the above

1.4. Choose the statement which is wrong in case of SMTP?

A. It requires message to be in 7bit ASCII format
B. It is a pull protocol
C. It transfers files from one mail server to another mail server
D. SMTP is responsible for the transmission of the mail through the internet

1.5. Suppose a packet is L = 1500 bytes long, and link transmits at R = 1 Gbps. Transmission delay for this packet is:

A. 0.0000015 secs
B. 666,666 secs
C. 0.000012 secs
D. 0.000015

Problem 2: Answer the following questions: **[2+1+1+1+1 = 6 Marks] (CLO 1)**

A. A system has an *n-layer* protocol hierarchy. Applications generate messages of length *M* bytes. At each of the layers, an *h-byte* header is added. What fraction of the network bandwidth is filled with headers? **[2]**

Answer: With *n* layers and *h* bytes added per layer, the total number of header bytes per message is *hn*, so the space wasted on headers is *hn*. The total message size is *M+nh*, so the fraction of bandwidth wasted on headers is *hn / (M+hn)*.

B. Suppose the algorithms used to implement the operations at layer *k* is changed. How does this impact operations at layers *k – 1 (lower layer)* and *k + 1 (upper layer)*? **[1]**

Answer: This has no impact on the operations at layers k-1 or k+1

C. Suppose there is a change in the service (set of operations) provided by layer *k*. How does this impact services at layers *k-1 (lower layer)* and *k+1 (upper layer)*? **[1]**

Answer: There is no impact at layer k-1, but operations in k+1 have to be re-implemented.

D. Write the name of protocol being used between sender's mail server and receiver's mail server? **[1]**
Answer: SMTP

E. Write the name of protocol being used between mail server and user agent of the receiver? **[1]**
Answer: IMAP or HTTP

Problem 3: Solve and answer the following questions: **[3+3+3 = 9 Marks] (CLO 2)**

A. Hosts A and B are connected to each other via router R. R is a store-and-forward router. The bandwidth from A to R is 10 Mbps, and the bandwidth from R to B is 5 Mbps. The propagation delay of each link is 22 milliseconds. Assume host A sends a 30KB file to host B. Assume the file is divided into two packets, p1 and p2, where p1 has a length of 10KB, and assume the packets are sent back-to-back. What is the difference between the arrival times of the first and the second packet at host B? **[3]**

Answer:

Size of packet p1 = 10 KB

Transmission time of p1 (on link from A to R) = packet Size / link rate= (8*10) / 10000 = 80 / 10000 = 8 msec

Transmission time of p1 (on link from R to B) = packet Size / link rate= (8*10) / 5000 = 80 / 10000 = 16 msec

Size of packet p2 = 30 -10 = 20 KB

Transmission time of p2 (on link from A to R) = packet Size / link rate= (8*20) / 10000 = 160 / 10000 = 16 msec

Transmission time of p2 (on link from R to B) = packet Size / link rate= (8*20) / 5000 = 160 / 5000 = 32 msec

Arrival time of packet p1 from A to B = 8 + 22+ 16 +22 = 68 msec

Arrival time of packet p2 from A to B = 8 + 16 + 22+ 32 +22 = 100 msec

Difference in arrival time of packets (p2-p1) = 100 – 68 = 32 msec

B. Kaka Munna's home network connection can upload at 125 kilobytes per second. His router has a 100 kilobyte FIFO buffer for packets awaiting transmission. At time 0, Kaka's client starts sending 1 kilobyte packets at 150 packets per second. Sheeda, Kaka's friend, says the buffer will never discard a packet in this case, whereas Jaadu, Kaka's other friend, says the first packet will be dropped after 2 seconds. Kaka's third friend, Beeba, says the first packet will be dropped after 4 seconds. Would you agree with any one of them? **[3]**

Answer: Beeba is right. Each second, Kaka is sending 1000*150 = 150,000 bytes. The network connection can consume 125,000 bytes in the first second, and the remaining 25,000 bytes will be buffered. In the next second, the next 150,000 bytes will be sent by Kaka, of which, 125,000 bytes can be consumed by the network connection (100,000 of the new data, and 25,000 from the buffer contents), so 50,000 bytes must be buffered. After 4 seconds, the buffer will be full (25,000 bytes added to the buffer after every second).

C. Consider sending over HTTP/2 a Web page that consists of one video clip, and five images. Suppose that the video clip is transported as 2000 frames, each of the first, second and third image have 5 frames, fourth image has 4 frames while fifth image has 3 frames. Note that "frame time" is the time needed to send out a frame. If frames are interleaved, then how many frame times are needed until all five images are sent? **[3]**

Answer:

3 x 6 + 1 x 5 + 1 x 4 = 27 frame times needed

First when frames are interleaved, then 1 frame is taken from video clip and each of the images. Therefore, 27 frame times are needed until all five images are sent. The fifth image will be sent till 18^{th} frame, fourth till 23^{rd} frame while first three images will be sent till 27^{th} frame. So only 27 frame time are needed. All remaining frames from frame 28^{th} till frame 2022 belong to video clip.

Problem 4: **[3 + 2 = 5 Marks] (CLO 2)**

During the unfortunate 9/11 physical attacks in New York City, the top-level domain (TLD) server for South Africa was physically located in the same building which was attacked in New York City. After the physical destruction of that building on 9/11, local internet communication within South Africa was disrupted (i.e. for a Web user in South Africa, accessing a local website in South Africa became inaccessible, for example cricket.co.za, where "za" is the country domain for South Africa)? Answer the following:

(i) What could be the reason for this local internet websites inaccessibility within South Africa? **[3]**

Answer:

Web browsing within South Africa requires DNS to resolve domain names for local South African Websites names (e.g., cricket.co.za). For this purpose, the client or their local (default) DNS server need to contact (indirectly or directly) the TLD server responsible for the local "za" domain. Since this "za" TLD server was located in New York City and went down during the physical destruction on 9/11, thus local domain names could not be resolved to their IP addresses, making them inaccessible.

(ii) Why did this disruption **not** occur immediately after the physical destruction on 9/11 for many local websites, but occurred gradually taking many hours, (or even days) after the physical event? (In other words, many local websites continued to be available for quite some time after the physical 9/11 attack but became unavailable quite slowly and gradually after the physical 9/11 attack.) **Why?** **[2]**

Answer:

The local (default) DNS servers in South Africa must have had many local websites (domains) name-to-address mappings (RRs) cached already, particularly for popular local websites, thus allowing them to be reachable after the attack. However, these cached entries had a time-to-live field that eventually expired, causing the local DNS servers to purge these RRs from the cache, thus any future DNS queries for these would fail due to the inability to contact the TLD server.

Problem 5: **[2+3 = 5 Marks] (CLO 2)**

A large e-commerce website, "ShopifyMart.com," experiences heavy traffic, especially during peak hours. The website has two data centers: Data Center A and Data Center B. Data Center A is the primary data center where the original server is located. Data Center B is a backup data center with a cache server. The average time taken to retrieve a product page from Data Center A is 6 seconds, while the average time to retrieve the same page from Data Center B (via the cache server) is 1 second. During a typical day, the website receives 50,000 requests for product pages. The cache hit rate at Data Center B is 70%.

i. Calculate the time saved per request using the cache server at Data Center B. **[2]**

Answer:

Time saved per request = Time without caching - Time with caching

= 6 seconds - 1 second

= 5 seconds

ii. Determine the total time saved in a day due to caching at Data Center B. **[3]**

Answer:

Total requests = 50,000

Cache hit rate = 70% = 0.7

Total time saved = Total requests × Cache hit rate × Time saved per request

= 50,000 × 0.7 × 5 seconds

= 175,000 seconds

= 48.61 hours

So, using the cache server at Data Center B saves approximately 48.61 hours in total over the course of a day.