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:	180 Minutes	Total Marks:	85
	Paper Date:	02-January-2024	Weight	45%
	Section:	ALL	Page(s):	11 + 1 (Rough Page)
	Exam Type:	Final		

Name: [redacted] **Roll No.** [redacted] **Section:** [redacted]

Instruction/Notes:
- Attempt all questions on the provided space in the 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.
- If you find any ambiguity in a question, you can make your own assumption and answer the question accordingly by stating your assumption.

Question #	1	2	3	4	5	6	7	8	
Total Marks	10	8	6	6	9	10	20	16	85
Obtained Marks	7	8	0	5	9	7	17	14.5	67.5
CLO #	1	2	2	2	3	3	3	~~4~~ 3	

Question 1: Answer the following multiple-choice questions by **filling the following table**. Cutting and overwriting is not allowed. Any answer outside the table will be awarded **zero marks**. [1+1+1+1+1+1+1+1+1+1 = 10] (CLO 1)

Any answers outside the table will NOT be marked.

1.1	B	✓
1.2	B	✓
1.3	C	✗
1.4	A	✗
1.5	C	✓
1.6	D	✓
1.7	D	✗
1.8	B	✓
1.9	D	✓
1.10	B	✓

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1.1. Time needed to perform an integrity check, lookup packet information in a local table and move the packet from an input link to an output link in a router.

A. Queueing delay
B. Processing delay
C. Transmission delay
D. Propagation delay

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1.2. True or False? The fraction of lost packets increases as the traffic intensity decreases.
A. True
B. False
1.3. Urg data pointer field in TCP segment consists of __________ bits:
A. 8
B. 16
C. 32
D. 64
1.4. The sending rate in TCP is adjusted according to the:
A. Congestion Window (cwnd)
B. Receive Window (rwnd)
C. Minimum of (cwnd , rwnd)
D. Urgent Data Pointer
1.5. What is the maximum length of IPv4 Header?
A. 20 Bytes
B. 40 Bytes
C. 60 Bytes
D. 80 Bytes
1.6. How does a host get it's own IP address & get the IP address of another host across the internet?
A. via DHCP & ARP respectively
B. via DNS & ARP respectively
C. via DNS & DHCP respectively
D. via DHCP & DNS respectively
1.7. The notification message in BGP can indicate:
A. Error in previous message
B. Close connection
C. Both A and B
D. None of the above
1.8. Ethernet's MAC protocol is based on:
A. Token Passing
B. CSMA / CD
C. CSMA / CA
D. Both B and C
1.9. To maintain cookies, what components are needed other than the cookie file on the user's host:
A. Cookie header line of the HTTP response message
B. Backend database at the website
C. Cookie header line in the next HTTP request message
D. All of the above
1.10. HTTP 2 mitigates __________ by interleaving frame transmission:
A. Performance
B. Head Of Line (HOL) blocking
C. Total Transfer Time
D. Transfer Time for Large Objects

Question 2: In packet-switched networks, like the Internet, the source host segments long, application-layer messages (e.g. an image or a music file) into smaller packets and sends the packets into the network. The receiver reassembles the packets back into the original message. This process is known as message segmentation. The below figure illustrates the end-to-end transport of a message with and without message segmentation. Consider a message that is 10^6 bits long that is to be sent from source to destination. Suppose each link in the figure is 5 Mbps. Ignore propagation, queuing, and processing delays. Each switch uses store-and-forward. [4 + 4 = 8] (CLO 2)

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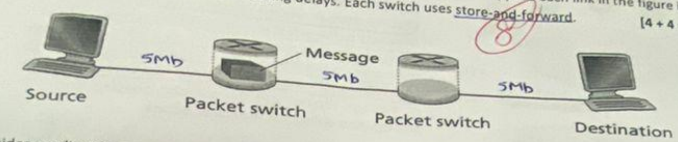
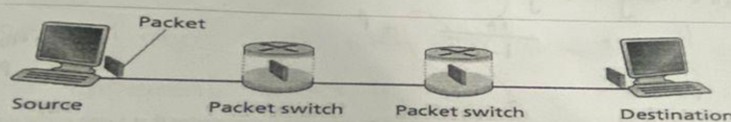
a.



Consider sending the message from source to destination without message segmentation [4]

How long does it take to move the message from the source host to the first packet switch?
$5mb = \frac{10^6}{5 \times 10^6} = 0.2sec$ 4
What is the total time to move the message from source host to destination host?
We have to go through 3 hops so $3(0.2) \Rightarrow 0.6sec$

b.



Now suppose that the message is segmented into 100 packets, with each packet being 10,000 bits long. [4]

How long does it take to move the first packet from source host to the first switch?
$Now \Rightarrow \frac{10{,}000}{5 \times 10^6} = 0.002$ sec (ignoring all other delays)   4
At what time will the second packet be fully received at the first switch?
Since its store & forward, second packet will be sent after the first packet is reached the first switch so The Time will be = $\boxed{0.004sec}$

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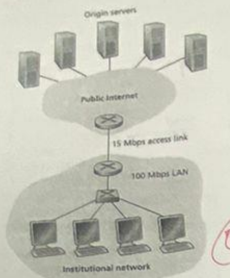
Question 3:



Consider this figure on the left.

There is an institutional network connected to the Internet. Suppose that the average object size is 850,000 bits and that the average request rate from the institutions' browsers to the origin servers is 16 requests per second. Also suppose that the amount of time it takes from when the router on the Internet side of the access link forwards an HTTP request until it receives the response is 3 seconds on average. *You can ignore processing, queuing, and propagation delays for your calculations.*

Note that the total average response time (delay) as the sum of the average LAN delay, average access delay (that is, the delay from the Internet router to the institutional router) and the average Internet delay. For the average access delay, use $\Delta/(1-\Delta\beta)$, where Δ is the average time required to send an object over the access link and β is the request rate per second.

0

[3]

a) Find the average response time ignoring LAN and access link propagation delays.

Avg obj size = 850,000 bits = 0.8 Mb
β = 16 req per second
Δ = 3 sec

= LAN delay + Avg Access delay + Internet Delay

$= \; ss \; + \; \frac{\Delta}{1-\Delta\beta} + \beta$ $\qquad \approx 0.18$ sec per 1 req.

= 15.93

b) Find the total response time for all 16 objects (requests per second) considering that a web cache is installed in the institutional LAN (**with a miss rate of 0.4**). Ignore LAN and access link propagation delays and assume that there is no cache penalty. [3]

miss rate = 0.4

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Question 4: [2 + 2 + 2 = 6] (CLO 2)

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i. Within the distributed database of resource records, DNS stores a four-tuple, each record has a ***name*** field, ***value*** field and ***type*** field. What is the other field, and describe its use?

Answer:

TTL → Time to Live, it is the 4th field which is stored at DNS. It shows us the time after which that particular (info about domain) will be dropped

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ii. For records with ***type***=NS, we know the ***name*** field stores the domain, whereas the ***value*** field stores the authoritative name server for that domain. What is stored in the ***name*** and ***value*** fields for records with ***type***=CNAME?

Answer:

In CNAME type,
name = Original Name (Domain)
value = Alias, Canonical Name

1

iii. If we want to implement DNS in a way that decreases the load at the upper levels of the hierarchy, we would prefer to use recursive DNS. Do you agree with this statement, explain your answer?

Answer:

No, I dont agree with this statement. If we want to implement DNS in a way that decreases the load on upper level of hierarchy, We should use Iterative Approach since it involves local domain iteratively asking at every level whereas recursion would put pressure on upper hierarchy.

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Question 5: Suppose that the three measured SampleRTT ... EstimatedRTT after each of these SampleRTT values is obtained, ... value of EstimatedRTT was 102 ms just before the first of these three samples ... DevRTT after each sample is obtained, assuming a value of β = 0.25 and assuming the value of DevRTT was 4 ms before the first of these three samples was obtained. Last, compute the TCP TimeoutInterval after each of these samples is obtained. **[3 + 3 + 3 = 9]**

Answer:

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Sample RTT = 105ms, 110, 115ms

$\alpha = 0.125$, Estimated RTT = 102ms

$\beta = 0.25$, Dev RTT = 4ms

Estimated RTT = (1-α) Estimated RTT + α Sample RTT

for 105

ERTT = (1-0.125) 102 + 0.125(105ms)

= 89.25 + 13.125

$\boxed{ERTT_1 = 102.375}$

for 110

$ERTT_2$ = (1-0.125)(102.375) + 0.125(110)

89.58 + 13.75

$\boxed{ERTT_2 = 103.328}$

for 115

$ERTT_3$ = (1-0.125)(103.328) + 0.125(115)

= 90.412 + 14.375

$\boxed{ERTT_2 = 104.787}$

Timeout = Est RTT + 4×D...

for 105 = 102.375 + 4(3.65...

$\boxed{1st = 117}$

for 110 = 103.328 + 4(4.4...

$\boxed{2^{nd} = 120.968 \approx 121}$

for 115 = 104.787 × 5.86(4...

$\boxed{3rd = 128.227}$

Dev RTT = (1-β) Dev RTT + β |estimated RTT - Sample RTT|

for 105

= (1-0.25) 4 + 0.25 |102.375 - 105|

= 3 + 0.65625

$\boxed{DevRTT_1 = 3.65625}$

for 110

$DevRTT_2$ = (1-0.25)(3.65625) + 0.25 |110 - 103.328|

= 2.74 + 1.668

$\boxed{DevRTT_2 = 4.41}$

for 115

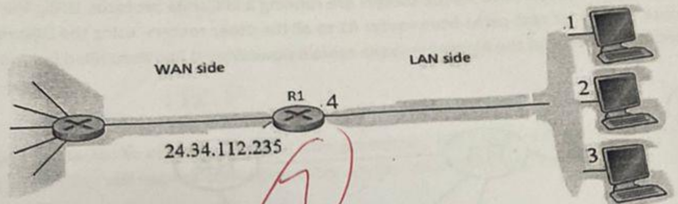
$DevRTT_3$ = (1-0.25)(4.41) + 0.25 |115 - 104.787|

= 3.3075 + 2.55325

$\boxed{DevRTT_3 = 5.86}$

Question 6: Consider the network setup in the following figure. Suppose that the ISP assigns the router R1 the address 24.34.112.235 on the WAN side. Also suppose that the subnet address of the home network is 192.168.1.0/24.

[4 + 6 = 10] (CLO 3)



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a) Assign addresses to all interfaces numbered 1 to 4 in the home network.

IP address of host at interface-1: 192.168.1.1/24

IP address of host at interface-2: 192.168.1.2/24

IP address of host at interface-3: 192.168.1.3/24

IP address of router R1 at interface-4: 192.168.1.0/24

3

b) Suppose each host has two ongoing TCP connections, all to port 80 at a host 128.119.40.86 residing somewhere in the WAN side (Internet). For that purpose, the host at interface-1 uses source ports 3345 and 3346; the host at interface-2 uses source ports 3355 and 3356; and the host at interface-3 uses source ports 3365 and 3366. Also suppose that the router R1 uses source port numbers greater than 4120 to establish TCP connections. Provide the six corresponding entries in the NAT translation table.

These will be the local unique address of each host

This will be how they would be shown at other world

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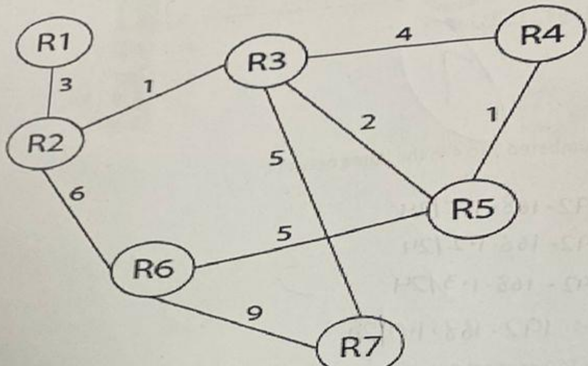
NAT Translation Table

WAN Side	LAN Side
192.168.1.0, 4121	192.168.1.1, 3345 → will be sending to 128.119...
192.168.1.0, 4122	192.168.1.1, 3346 → 128.119.40.8
192.168.1.0, 4123	192.168.1.2, 3355 → 128.119.40
192.168.1.0, 4124	192.168.1.2, 3356 → 128.119.4
192.168.1.0, 4125	192.168.1.3, 3365 → 128.119.40.
192.168.1.0, 4126	192.168.1.3, 3366 → 128.119.40

[13 + 7 = 20]

Question 7: Please answer both parts **(a)** & **(b)**

(a) Refer to the figure below, it contains a network topology containing routers R1 till R7 with the link cost mentioned against each link. All the routers are running a link state protocol. Using the table below, please compute the lowest cost paths from router R1 to all the other routers, using the Dijkstra's algorithm. List the iterations (steps) of the algorithm in the table below. (Step 0 has been filled for you.) [13] (CLO



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13

Step	N'	R2 D(R2), p(R2)	R3 D(R3), p(R3)	R4 D(R4), p(R4)	R5 D(R5), p(R5)	R6 D(R6), p(R6)	R7 D(R7), p(
0	R1	3 , R1	∞	∞	∞	∞	∞
1	R1, R2	3, R1	4, R2	∞	∞	9, R2	∞
2	R1, R2, R3	3, R1	4, R2	8, R3	6, R3	9, R2	9, R3
3	R1, R2, R3, R5	3, R1	4, R2	7, R5	6, R3	9, R2	9, R
4	R1, R2, R3, R5, R4	3, R1	4, R2	7, R5	6, R3	9, R2	9, R
5	R1, R2, R3, R5, R4, R6	3, R1	4, R2	7, R5	6, R3	9, R2	9, R
6	الكل	3, R1	4, R2	7, R5	6, R3	9, R2	9, R

R1, R2, R3, R5, R6, R7

(b) Answer all
i) Whic

4

(b) Answer all the parts below: (Please note IGP is the same as Intra-AS Routing Protocol) [7] (CLO 3)

i) Which of the three (IGP, iBGP, eBGP) carry intra-domain (or intra-AS) routing information?

Answer: 1 IGP

ii) Which of the three (IGP, iBGP, eBGP) carry inter-domain (or inter-AS) routing information?

Answer: 1 IBGP

iii) A host sends a packet to another within its own domain (or AS) but on a different LAN/subnet. Correctly sending this packet will require consulting table entries created by which of the three (IGP, iBGP, eBGP)?

Answer: 1 IGP

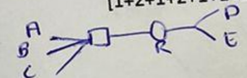
iv) A host sends a packet to another host in a different domain (or AS). Along the way, correctly sending this packet will require consulting table entries created by which of the three (IGP, iBGP, eBGP)?

Answer: eBGP 1

14.5

Question 8: Answer the following questions: **[10 + 6 = 16] (CLO 3)**

I) Consider three stations A, B, and C are on the same extended LAN. Two other stations D and E are part of a different LAN connected to the first LAN through a router R. Suppose that all stations know the IP addresses of each other (either on the same LAN or on different LAN) and ARP cache of A, B and C as well as D and E is empty. The following events happen in that order: **[1+2+1+2+1+1+2 = 10 Marks] (CLO 3)**



1. A sends an IP datagram to C.
2. B sends an IP datagram to D.
3. A sends a second IP datagram to C.
4. E sends an IP datagram to B.

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Answer the following considering the given scenario and sequence of events:

(a) In step (1) above, does station A need to use ARP? (A YES/NO answer is sufficient.)

Answer: NO 0

(b) In step (1), if A launches an ARP request, what should be the target IP address in that request?

Answer: Local address of C

(c) In step (2) above, does station B need to use ARP? (A YES/NO answer is sufficient.)

Answer: YES

(d) In step (2), if B launches an ARP request, what should be the target IP address in that request?

Answer: D's local IP address & E's too

(e) In step (3) above, does station A need to use ARP? (A YES/NO answer with justification.)

Answer: NO, since its in its own LAN & the IP is already known

(f) In step (4) above, does station E need to use ARP? (A YES/NO answer is sufficient.)

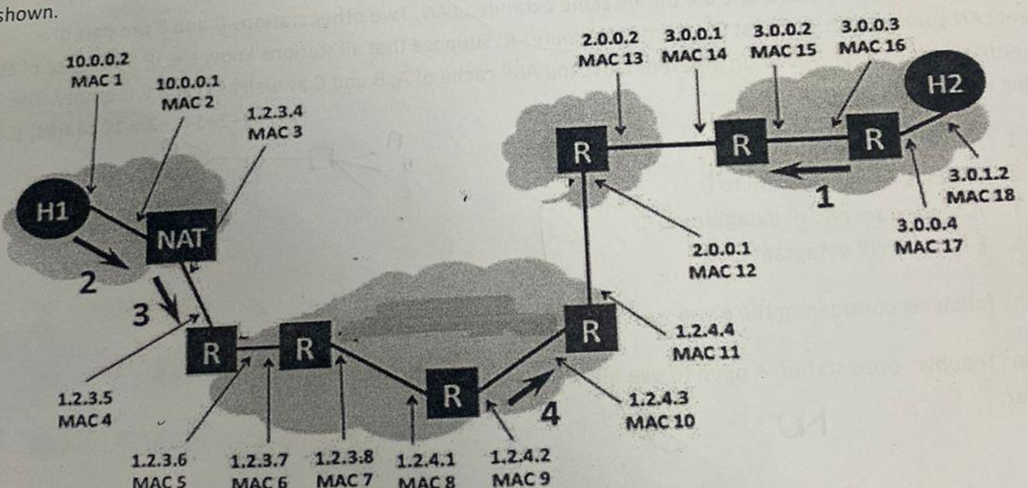
Answer: YES

(g) In step (4), if E launches an ARP request, what should be the target IP address in that request?

Answer: B's local IP address

II) The figure below shows a network topology. The LAN on the left uses a NAT to connect to the Internet and includes a client host H1. The LAN on the right includes a webserver H2. Packets between the two endpoints are routed along the path shown by heavy dark lines. The various network interfaces have IP and MAC addresses as shown.

[2+2+2=6] (CLO 3)



H1 has established an HTTP session with web server H2 and data packets are flowing between the two machine an example, headers for packet 1 have been filled (traveling from the server H2 to the client H1). Note that you should order your headers from "outermost" in, as shown: Ethernet should be listed before IP, because the Eth packet exists first on the wire.

You have to fill in the header type and the source and destination address for the network and datalink layer headers for packets 2, 3, and 4 (these packets are all traveling from the client H1 to the server H2, as marked on the figure with heavy black arrows and numbers).

5.5

A. Header for packet 1

Header Type	Source	Destination
Ethernet	MAC 16	MAC 15
IP	3.0.1.2	1.2.3.4

B. Header for packet 2

Header Type	Source	Destination
Ethernet	MAC 1	MAC 2
IP	10.0.0.2	3.0.1.2

C. Header for packet 3

Header Type	Source	Destination
Ethernet	MAC 3	MAC 4
IP	1.2.3.4	3.0.1.2

D. Header for packet 4

Header Type	Source	Destination
Ethernet	MAC 9	MAC 10
IP	1.2.4.2	3.0.1.2