CS118
Spring 2023 Midterm Exam

1 hour 50 minutes
Close book and closed notes; NO use of any device except calculators.
One page of cheat sheet allowed; write your answer legibly.

- This exam has 5 pages including this cover page. Do all your work on these exam sheets, use the back side if needed.
- Cross out all the scratch work that you do not want to be counted as part of your answer before you submit the exam.
- Show ***all*** your work, including unfinished problems that you wish to be considered for partial credit.
- For all the problems except the multichoice ones: be *specific* and *clear* in your answers, and *explain all your answers*.
- When the answer to a problem is not immediately clear to you, do not dump on the paper anything and everything that comes to your mind, without knowing whether it is relevant or irrelevant. Irrelevant answers can lead to point-deduction because they show a lack of understanding of the problem.

Your name: _____

Student ID: _____

	Points	Your score
Problem 1	25	
Problem 2	25	
Problem 3	25	
Problem 4	25	
Total	100	

Problem 1 (24 points) For *all* the questions in Problem 1, please be careful in selecting your answers. For *each* of the 5 sub-questions below from (a) to (e), one can get partial credit by selecting a subset of correct answers, but will receive no credit if one selects any incorrect answer. **PLEASE WRITE YOUR ANSWER(S) IN THE BLANK BEFORE EACH QUESTION.**

a) _____ (4 points) If a protocol keeps no information after processing each packet/segment/request, it is called a stateless protocol. For the following protocols, please select the one(s) that is/are stateless.

A. HTTP/1.1
B. DNS (consider authoritative servers only)
C. TCP
D. UDP

b) _____ (6 points) As we have discussed in class, timer is a useful component in various protocol designs: because one communication end cannot see what is going on either inside the network or at the other end, when needed a data sender sets up an "alarm" (retransmission timer), and resends the data when the alarm goes off. For the following components, please select the one(s) that set(s) retransmission timer. Note that the questions are specific to the named protocols, without considering the protocol(s) running below the named ones.

A. HTTP client
B. HTTP server
C. DNS caching resolver
D. DNS authoritative server
E. TCP data sender
F. TCP data receiver

c) (4 points) A web browser sets up a TCP connection to fetch data from a web server. For the following statements, please answer True or False for each one:

- _____ Assuming HTTP/1.0 is in use: a single TCP segment sent by the browser can carry 2 HTTP requests
- _____ Assuming HTTP/1.1 is in use: a single TCP segment sent by the browser can carry 2 HTTP requests.

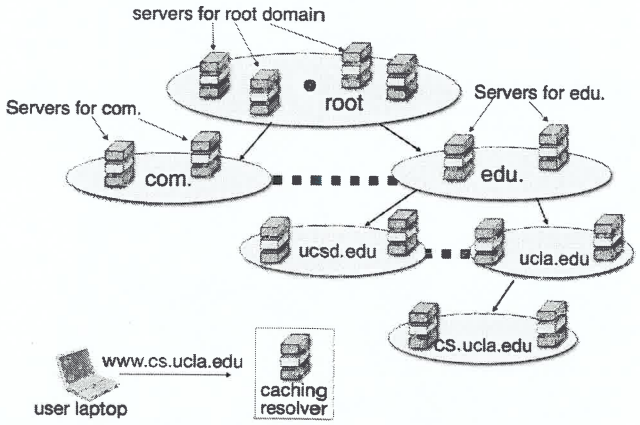
d) (4 points) Our department owns the DNS domain *cs.ucla.edu*, and the IP address block 131.179/16 (i.e all the IP addresses between 131.179.0.0 to 131.179.255.255). For the following statements, please answer True or False for each one:

- _____ Any host with a DNS name xxx.cs.ucla.edu can be reached by an IP address in the 131.179/16 block.
- _____ Any host with an IP address in the 131.179/16 block has a DNS name that is served by cs.ucla.edu domain's authoritative servers.

e) _____ (6 points) A TCP connection is established between nodes A and B, as such each of them holds multiple pieces of connection state information (such as the sequence number of latest acknowledgment sent/received, flow control window size, etc). Please select all the correct statement(s) below:

A. A and B hold identical connection state information all the time
B. A and B hold different connection state information all the time
C. The connection state information at A and B can be the same at some time, and different at some other time.

Problem 2 (26 points) In the figure to the right, DNS runs over UDP unless specified otherwise, the *one-way* delay between all local hosts and the caching resolver CR is 10 msec, and it takes 100 msec for the CR to get a reply from any of the authoritative DNS servers (i.e. the RTT=100msec). At time T=0, user laptop sends to CR a DNS request to get IP address for www.cs.ucla.edu. There is no packet loss unless specified otherwise.



2.1 (6 points) Assume that CR has an empty caching at time T=0. Where will it send its first query to in order to get the final answer (IP address for www.cs.ucla.edu)back to the user?

2.2 (7 points) Assume that CR has a *non-empty* cache, although it does not have the final answer in its cache. To which domain's authoritative server that CR may send its first query to?

2.3 (6 points) Assume that CR sends its first query to an authoritative server of edu domain, when will the user laptop receive the final answer (IP address for www.cs.ucla.edu)? (here we make an assumption that there is no overlapping authoritative servers between ucla.edu and cs.ucla.edu domain)

2.4 (7 points) ucla.edu domain has 4 authoritative DNS servers as shown below (results from doing "dig ucla.edu ns"):

ucla.edu.	2224	IN	NS	ns4.dns.ucla.edu.
ucla.edu.	2224	IN	NS	ns2.dns.ucla.edu.
ucla.edu.	2224	IN	NS	ns3.dns.ucla.edu.
ucla.edu.	2224	IN	NS	ns1.dns.ucla.edu.
.....				
ns1.dns.ucla.edu.	28181	IN	A	192.35.225.7
ns4.dns.ucla.edu.	24543	IN	A	3.104.50.254
ns2.dns.ucla.edu.	25447	IN	A	54.201.38.106
ns3.dns.ucla.edu.	22164	IN	A	54.236.209.157

Assume that CR sends a query to 192.35.225.7 which is lost, will CR resend the query to the same authoritative server? Why or why not? Please explain.

Problem 3 (25 points) TCP's slow-start with congestion avoidance works in the following way:

- When starting a new TCP connection: Set cwnd = 1 segment, initialize ssthresh
- When cwnd < ssthresh (in Slow Start phase): upon receive an ack, cwnd = cwnd + 1 segment
- when cwnd ⩾ ssthresh (in Congestion Avoidance phase): increase cwnd by one segment per round-trip time

Host A opens up a TCP connection to send a large amount of data to host B using the above congestion control scheme, with the following parameter settings:

- Maximum Segment Size (MSS) = 1000 bytes
- A's initial Slow-Start threshold value (ssthresh) = 4000 bytes
- B's flow control window size is large enough so that it can be ignored in this problem.

Assume that the packet transmission time is much smaller than the round-trip propagation delay, so we consider that a "round trip" includes both transmission time and propagation delay. Host A sends the first 16 TCP segments and receives acknowledgments for all without any loss (TCP does not do delayed ACK). In answering the following questions, you may draw graphs to help explain your answers.

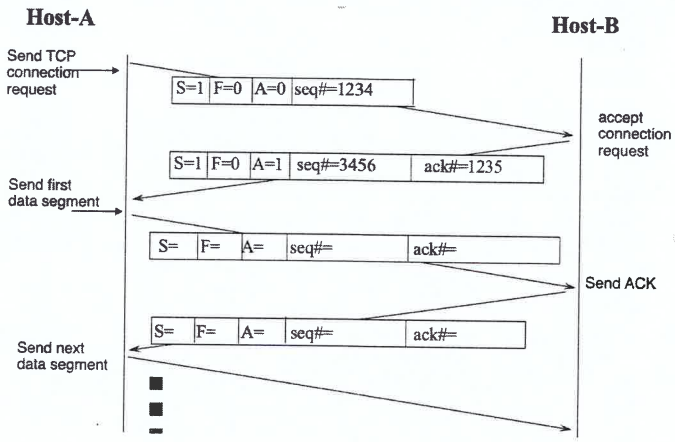
3.1 (12 points) Approximately how many round trips did it take A to get the 6th Acknowledgment?

3.2 (13 points) What is the size of the congestion control window after receiving the 16th ACK?

Problem 4 (25 points)

4.1 (10 points) Consider a data link between nodes A and B, with a bit rate of 8 Mbps and one-way propagation delay of 8 msec. If A uses a fixed window size of 10 packets for reliable data transfer, and B sends an Acknowledgment after every successfully received packet. Assuming all data packets have the same length, and ACK packet size is small enough so we ignore its transmission delay. What is the smallest possible packet size that can still achieve a link utilization of 50%? (that is, A should be busy transmitting at least 50% of the time)

4.2 (15 points) Node A sets up a TCP connection with B to send a big file. A's initial sequence number is 1234, B's initial sequence number is 3456. The figure to the right shows the exchange of packets in the absence of packet losses.



4.2.1 (5 points) Assume A's first data segment carries 1250 bytes of data, fill in the values for the 3rd and 4th packets in the exchange (S, F, A, seq#, ACK#)

4.2.2 (5 points) If the first SYN segment from A to B is lost, A will retransmit. What would be the sequence number in this retransmitted SYN segment?

4.2.3 (5 points) If B's first packet to A is lost, what happens next? Can A send its first data segment – why or why not?