Network Architectures 3329 **Name:** _____
Spring 2018 **Midterm**
03/14/2018 **Time Limit: 80 minutes**

- **Print** your name.
- Close-book policy: You may not use the text, my class notes and/or any notes and study guides you have created. You may use a calculator. You may not use a cell phone or computer.

Problem	Points	Score
1	30	
2	30	
3	6	
4	6	
5	10	
6	9	
7	9	
Total:	100	

---

1. **True or False**

   (a) (2 points) PCs, workstations, Web servers, mail servers, PDAs, Internet-connected game consoles are all devices that fall under the category of hosts.

   A. true B. false

   (b) (2 points) The golden rule in traffic engineering is: *Design your system so that the traffic intensity is no greater than 1.* (Traffic intensity is the ratio La/R where Ra is the traffic arrival rate, R is the transmission rate.)

   A. true B. false

   (c) (2 points) For an application to enjoy reliable data transfer, it must run over TCP.

   A. true **B. false**

   (d) (2 points) Packet-switching is not always "better" than circuit-switching, the (design of the) later is simpler and offers guarantees such as bandwidth.

   A. true B. false

   (e) (2 points) Content providers, by creating their private networks, bypasses the upper tiers of the Internet, reduce their payment, and achieve greater control of how their servies are delivered.

   A. true B. false

   (f) (2 points) Both virus and worm are self-replicating malwares that can enter a users device, but only virus requires some form of user interaction to infect.

   A. true B. false

   (g) (2 points) In the layered network protocol stack, it is generally easier to make changes to protocols at a high layer than those in the lower layers.

   A. true B. false

   (h) (2 points) The Internet does not provide any of the services guarantee that are offered by TCP and/or applications.

   A. true B. false

   (i) (2 points) In the context of any given communication session between a pair of processes, we will label one process as the client and the other process as the server only if in a server client architecture.

   A. true **B. false**

   (j) (2 points) HTTP protocol is not concerned with data loss or data reordering in the network.

   A. true B. false

   (k) (2 points) TCP congestion control and flow control take similar actions that treating different symptoms.

   A. true **B. false**

   (l) (2 points) In TCP congestion control, a timeout event will always trigger a transition to the slow start state.

   A. true B. false

   (m) (2 points) We studied two protocols, namely GBN (Go-Back-N) and Selective Repeat (SR), that achieve reliable data transfer. TCP is simply a realization of the GBN protocol because it is more efficient compared to SR.

   A. true **B. false**

(n) (2 points) When multiple applications running over TCP share a common bottleneck, TCP congestion control will ensure fair share among those applications.
A. true **B. false**

(o) (2 points) When multiple TCP connections share a common bottleneck, TCP congestion control will ensure fair share among those connections.
A. true **B. false**

2. **Multiple choice questions**

(a) (3 points) Which of the following devices can *not* run an application-layer protocol?
A. laptop B. smartphone **C. router** D. traffic control system

(b) (3 points) The benefits of the Internet's layered architecture does *not* include
A. the implementation of TCP can be changed without affecting other components as long as the new implementation provides the same TCP service
B. new applications can be added without changing the underlying TCP/UDP protocols
C. some functionalities are implemented in more than one layer
D. a modularity mechanism for the complex Internet system

(c) (3 points) The mechanisms enabling reliable data transfer do *not* include
A. socket programming B. timeout C. error detection D. retransmission

(d) (3 points) Which of the following service(s) is (are) provided by UDP?
A. reliable data transfer
B. throughput
C. multiplexing and demultiplexing
D. none of the above

(e) (3 points) Suppose you wanted to implement a transaction from a remote client to a server in TCP, what is the minimum delay to complete one transaction? Describe it in terms of round trip time (RTT).
A. 1RTT **B. 2RTT** C. 2.5RTT D. 3RTT

(f) (3 points) Which of the following protocol(s) run(s) over UDP not TCP?
A. HTTP B. POP3 (for email) **C. DNS** D. FTP (for file transfer)

(g) (3 points) If a TCP server was to simultaneously support `N` clients, how many sockets would the TCP server need? A. 1 B. 2 C. `N` **D.** `N+1`

(h) (3 points) If a UDP server were to simultaneously support `N` clients, how many sockets would the UDP server need? **A. 1** B. 2 C. `N` D. `N+1`

(i) (3 points) For a client-server application running over TCP or UDP, which of the following is true
A. the server program must be executed before the client program
B. the client program must be executed before the server program
C. the server program can be executed before or after the client program
D. none of the above

(j) (3 points) In reliable data transfer, sequence number is introduced to address
A. losses in the network
B. duplicate packets after retransmission
C. detect error
D. packet reordering in the network

3. **Written questions (short answer)** Consider how UDP receiver computes the Internet checksum

   (a) (3 points) Suppose you have the following 2 bytes: 01011101 and 01100101. What is the 1s complement of the sum of these 2 bytes?

   Solution: Adding the two bytes gives 11000010. Taking the ones complement gives 00111111.

   (b) (3 points) Suppose that the UDP receiver computes the Internet checksum for the received UDP segment and finds that it matches the value carried in the checksum field. Can the receiver be absolutely certain that no bit errors have occurred? Explain.

   Solution: No, the receiver cannot be absolutely certain that no bit errors have occurred. This is because of the manner in which the checksum for the packet is calculated. If the corresponding bits (that would be added together) of two 16-bit words in the packet were 0 and 1 then even if these get flipped to 1 and 0 respectively, the sum still remains the same. Hence, the 1s complement the receiver calculates will also be the same. This means the checksum will verify even if there was transmission error.

4. **Written questions (essay, computational)** Suppose Host A wants to send a large file to Host B. The path from A to B has three links, of rates $R1 = 1Mbps$, $R2 = 200kbps$, $R = 500kbps$.

   (a) (2 points) Assuming no other traffic in the network, what is the throughout for the file transfer?

   Solution: R2, 200kbps

   (b) (4 points) Suppose the file is 8 million bytes. Dividing the file size by the throughout, roughly how long will it take the file to Host B?

   Solution: 8million byte = 8 X 8 million bits = 64 million bits
   64 million / 200k = 320 seconds

5. **Written questions (essay, computational)** Suppose users share a 10 Mbps link. Also suppose each user transmits continuously at 2 Mbps when transmitting, but each user transmits only 30 percent of the time.

   (a) (2 points) When circuit switching is used, how many users can be supported?

   Solution: 10 Mbps / 2Mbps = 5

   (b) (2 points) For the remainder of this problem, suppose packet switching is used. To prevent queuing delay, what is the maximum number of users that can transmit at the same time?

   Solution: 5

(c) (2 points) Find the probability that two given users are transmitting simultaneously.

Solution: $.3^2$

(d) (4 points) Suppose now there are 6 users. Find the fraction of time during which the queue grows.

Solution: $(.3)^6$

6. **Written questions (essay, computational)** Host A and B are communicating over a TCP connection, and Host B has already received from A all bytes up through byte 110. Suppose Host A then sends two segments to Host B back-to-back. The first and second segments contain 100 and 10 bytes of data, respectively. In the first segment, the sequence number is 111, the source port number is 400, and the destination port number is 80. Host B sends an acknowledgment whenever it receives a segment from Host A.

(a) (3 points) In the second segment sent from Host A to B, what are the sequence number, source port number, and destination port number?

Solution: In the second segment from Host A to B, the sequence number is 211, source port number is 400 and destination port number is 80.

(b) (3 points) If the first segment arrives before the second segment, in the acknowledgment of the first arriving segment, what is the acknowledgment number, the source port number, and the destination port number?

Solution: If the first segment arrives before the second, in the acknowledgment of the first arriving segment, the acknowledgment number is 211, source port number is 80 and destination port number is 400.

(c) (3 points) If the second segment arrives before the first segment, in the acknowledgment of the first arriving segment, what is the acknowledgment number?

Solution: If the second segment arrives before the first segment, in the acknowledgment of the first arriving segment, the acknowledgment number is 111, indicating that it is still waiting for bytes 111 and onwards.

7. **Written questions (essay, computational)** Consider the following Figure. Assuming TCP Reno is the protocol experiencing the behavior, answer the following questions. In all cases, you should provide a short discussion justifying your answer.

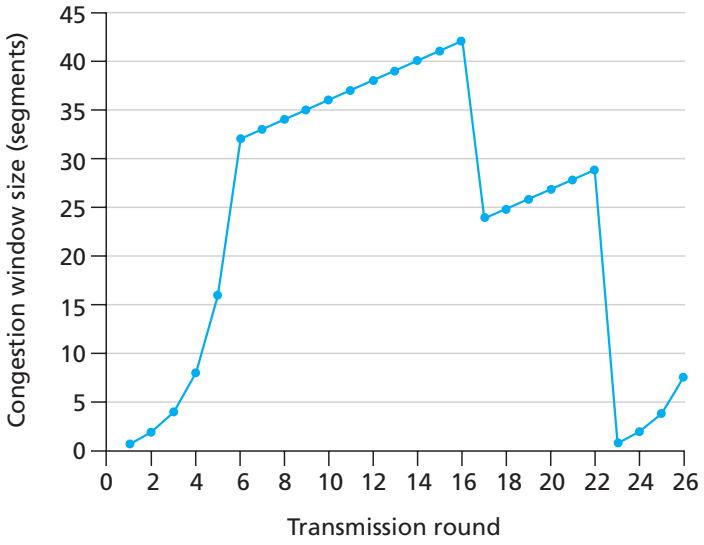

Figure 1: TCP window size as a funtion of time

(a) (2 points) What is the initial value of ssthresh

Solution: The threshold is initially 32, since it is at this window size that slow start stops and congestion avoidance begins.

(b) (2 points) Identify the intervals of time when TCP slow start is operating.

Solution: TCP congestion avoidance is operating in the intervals [1,6] and [23,26]

(c) (3 points) After the 16th transmission round, is segment loss detected by a triple duplicate ACK or by a timeout? Explain.

Solution: After the 16th transmission round, segment loss is detected due duplicate ACK. This is because the sender enters congestion avoidance rather than slow start.

(d) (2 points) Suppose TCP Tahoe is used (instead of TCP Reno), and assume that triple duplicate ACKs are received at the 14th round. What are the ssthresh and the congestion window

Solution: The threshold is set to half the value of the congestion window when packet loss is detected. When loss is detected during transmission round 16, the congestion windows size is 40. Therefore, the threshold is 20, and the congestion window size is reset to 1.