CS 421: COMPUTER NETWORKS **SPRING 2014**

FINAL
May 23, 2014
150 minutes

Name: _____

Student No: _____

Show all your work very clearly. Partial credits will only be given if you carefully state your answer with a reasonable justification.

Q1	
Q2	
Q3	
TOT	

1)

a) (5 pts) Consider a modification in SMTP such that the sender's user agent directly contacts with the receiver's mail server instead of using his/her own mail server as the intermediate server. What might be a possible problem with this modified SMTP?

b) (5 pts) If an HTTP client wants to get a Web page, but knows only the URL of the HTTP server, what application-layer and transport-layer protocols are needed to download the page?

c) (5 pts) Why does an application using UDP have more control of when a segment is sent compared to an application using TCP?

d) Consider a home network which is connected to the Internet with an ADSL link that has a download rate of 10 Mbps ($10x10^6$ bps). Assume that there are three file downloads from servers A, B and C sharing the link and the ADSL link is the only bottleneck link for all three downloads. The round-trip delays between the home network and servers A, B and C are 6 ms, 15 ms and 30 ms, respectively.

   i) (6 pts) Suppose TCP is used as the transport layer protocol for all three downloads. Calculate the throughput achieved by each download.

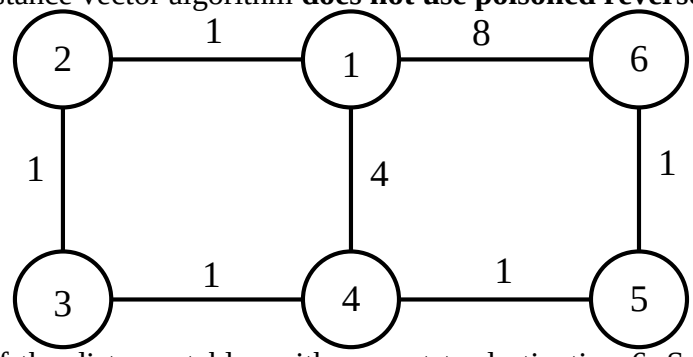
   ii) (6 pts) Now assume that ADSL link is replaced by a fiber optic link running at 1 Gbps ($1x10^9$ bps). Calculate the throughput achieved by each download.

e) (8 pts) Suppose that a file composed of 40 segments, each with a size of 1250Bytes, will be transferred over a TCP connection with a round-trip delay of 10 ms and bandwidth of 10 Mbps, i.e., $10x10^6$ bps. Assume that no loss event occurs during the entire file transfer. Further assume that the slow start threshold (ssthresh) at the beginning of the TCP connection is infinitely large. Ignore all processing and queueing delays and assume that ACK messages have a negligibly small transmission time. How long does it take to transmit the entire file and receive the final ACK?

2)

a) (12 pts) The network below uses the distance-vector routing algorithm. Assume the following:

- Links have the same cost in both directions.
- Nodes exchange their routing info once every second, in perfect synchrony and with negligible transmission delays. Specifically, at every t = i, i = 0, 1, 2, 3,..., each node sends and receives routing info instantaneously, and updates its routing table; the update is completed by time t=i+0.1.
- At time t = 0, the link costs are as shown below and the routing tables have been stabilized. At time t = 0.5, the cost of the link (3,4) becomes 10. There are no further link cost changes.
- Route advertisements are **only exchanged periodically**, i.e., there are no immediate route advertisements after a link cost change. Hence the first route advertisement after the link cost change at t = 0.5 sec occurs at t = 1.0 sec. *Note:* However, whenever a link cost change occurs, the two nodes at the endpoints of this link immediately make corresponding changes in their distance tables.
- Assume that the distance vector algorithm **does not use poisoned reverse**.



Give the evolution of the distance tables with respect to destination 6. Specifically, give the distance table entries for destination 6 at nodes 1-5, for t = 0.1, 0.5, 1.1, 2.1, ..., **until** all distance vectors stabilize. Present your final answer in the table given below where $D^i(j)$ is the distance vector element denoting the distance from *i* to *j*.

Time, t	$D^1(6)$ via			$D^2(6)$ via		$D^3(6)$ via		$D^4(6)$ via			$D^5(6)$ via	
	2	4	6	1	3	2	4	1	3	5	4	6
0.1												
0.5												
1.1												
2.1												
3.1												
4.1												
5.1												
6.1												
7.1												
8.1												
9.1												
10.1												
11.1												

b) (8 pts) Suppose host A transmits a 4000 Byte IP packet (including the 20 Byte IP header) over a 2-hop path to host B. The MTU of the first link (A to router) is 1500 Bytes (IP header plus data), and the MTU of the second link (router to B) is 1100 Bytes (IP header plus data). Assuming that IP header does not contain any options, indicate the length (in Bytes), more flag, and offset field values **(specify the offset values in units of 8 bytes)** of the fragment(s) transmitted over each link in the tables below.

First link

Fragment	Length	Offset	Flag
1			
2			
3			
4			
5			
6			
7			
8			

Second link

Fragment	Length	Offset	Flag
1			
2			
3			
4			
5			
6			
7			
8			

c) (5 pts) You are given the assignment of setting subnet addresses for 5 departments of your company. The number of Internet connected PCs in each department is given in the following table. Assume that the 139.179.128.0/18 address block is given to you for this purpose. Use the following table to show the addresses of the five subnets that you created.

Campus	**# of PCs**	**Subnet address (CIDR format)**
1	5000	
2	3500	
3	1800	
4	1000	
5	900	

d) (6 pts) Suppose that you are asked to develop the routing algorithm for a network represented by a graph $G = (N,E)$, where N is the set of nodes and E is the set of links. Assume that link $l, l \in E,$ in the network has a transmission capacity C_l in bps. You decided to use the Dijkstra's algorithm in order to compute the shortest paths between node pairs. Propose a path cost metric for a path p in terms of $\{C_l, l \in p\}$ so that the shortest paths computed by the Dijkstra's algorithm will have small delays. Justify your proposed metric.

3)

a) (6 pts) Suppose the data sequence 11001101 is transmitted using the generator sequence 1100101. Compute the CRC bits and the transmitted bit sequence.

b) (5 pts) Consider an Ethernet LAN using CSMA/CD running at 10 Mbits/sec. The propagation speed for the signal over the cable is $2x10^8$ m/sec. The distances between the nodes in this Ethernet are given in the following table. Compute the minimum frame size in bytes so that the CSMA/CD algorithm will work properly.

Distance (m)	A	B	C	D
A	-	100	350	600
B	100	-	250	500
C	350	250	-	250
D	600	500	250	-

c) (4 pts) Why does the collision probability in Ethernet increase as the propagation delay increases?

d) (5 pts) Why is it necessary for network layer protocols running on top of Ethernet, e.g., IP, to have a packet length field in its header?

e) Assume that there are five active nodes competing for access to a channel using the Slotted-Aloha protocol. Assume that each node has one packet to transmit. Each node attempts to transmit in each time slot with probability *p* as long as it has a packet to send.

i. (4 pts) Calculate the probability that any one of the five nodes makes a successful transmission in the first time slot.

ii. (4 pts) Calculate the probability of a collision in the first time slot.

iii. (6 pts) Calculate the probability that there are successful transmissions in each of the first three time slots.