Univeristy of California at Berkeley
College of Engineering
Department of Electrical Engineering and Computer Science

EECS 122 I. Stoica
Fall 2005

MIDTERM EXAMINATION
Monday, 17 October 2005

INSTRUCTIONS—READ THEM NOW! This examination is CLOSED BOOK/CLOSED NOTES. There is no need for calculations, and so you will not need a calculator, Palm Pilot, laptop computer, or other calculation aid. Please put them away. You MAY use one 8.5" by 11" double-sided crib sheet, as densely packed with notes, formulas, and diagrams as you wish. The examination has been designed for 80 minutes/80 points= (1 point = 1 minute, so pace yourself accordingly). All work should be done on the attached pages.

In general, if something is unclear, write down your assumptions as part of your answer. If your assumptions are reasonable, we will endeavor to grade the question based on them. If necessary, of course, you may raise your hand, and a TA or the instructor will come to you. Please try not to disturb the students taking the examination around you.

We will post solutions to the examination as soon as possible, and we will grade the examination as soon as practical, usually within a week. Requests for regrades should be submitted IN WRITING, explaining why you believe your answer was incorrectly graded, within ONE WEEK of the return of the examination in class. We try to be fair, and do realize that mistakes can be made during the regarding process. However, we are not sympathetic to arguments of the form "I got half the problem right, why did I get a quarter of the points?"

_____________________________ SID: ___________________
(Name—Please Print!)

_____________________________ Instructional Account: ee122-______
(Discussion Section – Day and Time)

QUESTION	**POINTS ASSIGNED**	**POINTS OBTAINED**
1	10	
2	10	
3	20	
4	10	
5	15	
6	15	
TOTAL	80	

Student Name:__________________________ SID:__________________

Question 1: *General Networking Concepts (10 points)*
For each of the following statements, indicate whether the statement is True or False, and provide a very short explanation of your selection (2 points each).

a. In packet switching networks, packets between two hosts always follow the same route. T F
Rationale:

b. According to the End-to-End Argument the network should implement reliability. T F
Rationale:

c. Link state routing protocols is more robust than distance vector protocols. T F
Rationale:

d. Detecting packet loss via 3 UDP Acks is faster than waiting for a retransmission timeout. T F
Rationale:

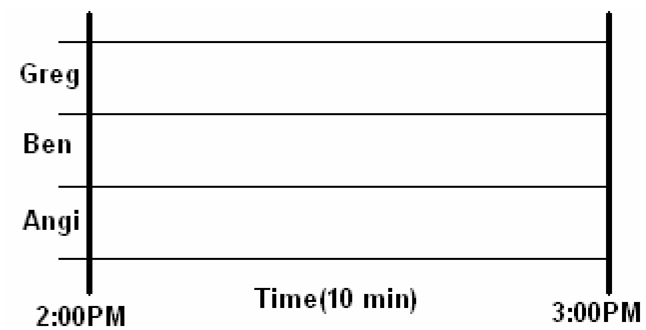
e. Shared bus routers have higher throughput than point-to-point routers. T F
Rationale:

Student Name:___________________________ SID:___________________

Question 1: *Little's theorem (10 points)*

Murali wants to find the average number of people in his office hours, which are from 2:00-3:00PM. He observes the following three people and the times that they arrive and leave: ***Angi:*** *2:00-2:20PM* ***Ben:*** *2:10-2:50PM* ***Greg:*** *2:40-3:00PM*

a.) Show this behavior on the following plot:



b.) What is the mean number of people in Murali's office hours?

Question 3: *Store-and-forward (20 points)*

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 10Mbps, and the bandwidth from R to B is 5Mbps. The one-way latency of each link is 22ms. Assume host A sends a 30KB file to host B.

a.) 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?

b.) What is the effective throughput between A and B in part (a)? (The transmission time is the time interval from the time the first bit is sent at A until the final bit is received at B).

c.) Does the throughput increase or decrease if we divide the file into smaller packets? Why?

d.) Now, assume each packet is acknowledged. The file is divided into 6 packets of the same size. How long would it take to send the entire file assuming that the sender cannot send a anew packet before it receives an acknowledgement for the previous packet? (The transfer time is the time interval measure at source A from the time the first segment is sent until the acknowledgement of the last segment is received). Ignore the transmission time of the acknowledgements.

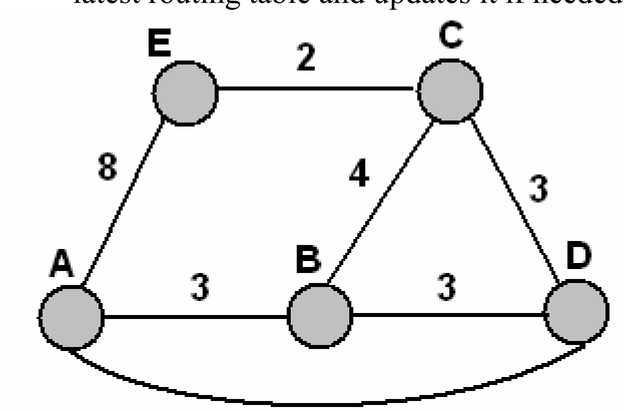
Question 4: *TCP* 1 (10 Points)

On any given Sunday, Sam initiates a connection with his girlfriend Alice in order to plan out what movie they're going to watch on Tuesdays with Morrie. This Sunday, immediately after Sam initiates the connection, Alice decides to send him a 60 KB picture using TCP. Assuming she sends the picture in 2500 byte segments including a 50-byte header over a 2 Mbps link with a propagation delay of 30 ms, what is the total time difference between when Sam initiates the connection to when Alice receives the last ACK? The TCP implements a slow-start mechanism with an initial congestion window of 1. Neglect queuing and processing delays at both the sender and receiver, and assume there are no losses.

Student Name:__________________________ SID:__________________

Question 5: *Routing Protocols – Distance Vector* (10 Points)
Assume the following for this question:

- All nodes implement distance vector routing.
- All nodes have their time synchronized with each other.
- Route updates are exchanged in synchronized time step manner at fixed time intervals.
- Whenever an entry in the routing table of a node changes, that node sends its routing table to all of its immediate neighbors at the beginning of the next time step.
- Propagation time along all links takes a little less than 1 time step unit (ie. an update sent by a node at the beginning of a time step reaches its neighbors before the end of the time step).
- By the end of a time step every node if it received any routing updates from neighbors, computes its latest routing table and updates it if needed, before the end of the time step.



Consider the networks shown above. After all the nodes converge, the routing tables in the ndes will look like the following:

Node A

Dest	Cost	Hop
B	3	B
C	7	D
D	4	D
E	8	E

Node B

Dest	Cost	Hop
A	3	A
C	6	D
D	3	D
E	8	D

Node C

Dest	Cost	Hop
A	7	D
B	6	D
D	3	D
E	2	E

Node D

Dest	Cost	Hop
A	4	A
B	3	B
C	3	C
E	5	C

Node E

Dest	Cost	Hop
A	8	A
B	8	C
C	2	C
D	5	C

The link between node B and C gets upgraded to have a small link cost of 1. Both nodes B and C immediately update their routing tables to reflect this change. After several iterations the routing tables will eventually converge. Show step-by-step update propagation until all the tables converge.

Note: Start filling your step-by-step answer in the tables given below and in the next page. If you need additional tables, you can draw them yourselves in the next page. In your step-by-step answer, you should highlight the rows updated in each step by circling it.

Student Name:___________________________ SID:___________________

Time 1:

Node A

Dest	Cost	Hop
B		
C		
D		
E		

Node B

Dest	Cost	Hop
A		
C		
D		
E		

Node C

Dest	Cost	Hop
A		
B		
D		
E		

Node D

Dest	Cost	Hop
A		
B		
C		
E		

Node E

Dest	Cost	Hop
A		
B		
C		
D		

Time 2:

Node A

Dest	Cost	Hop
B		
C		
D		
E		

Node B

Dest	Cost	Hop
A		
C		
D		
E		

Node C

Dest	Cost	Hop
A		
B		
D		
E		

Node D

Dest	Cost	Hop
A		
B		
C		
E		

Node E

Dest	Cost	Hop
A		
B		
C		
D		

Time 3:

Node A

Dest	Cost	Hop
B		
C		
D		
E		

Node B

Dest	Cost	Hop
A		
C		
D		
E		

Node C

Dest	Cost	Hop
A		
B		
D		
E		

Node D

Dest	Cost	Hop
A		
B		
C		
E		

Node E

Dest	Cost	Hop
A		
B		
C		
D		

Time 4:

Node A

Dest	Cost	Hop
B		
C		
D		
E		

Node B

Dest	Cost	Hop
A		
C		
D		
E		

Node C

Dest	Cost	Hop
A		
B		
D		
E		

Node D

Dest	Cost	Hop
A		
B		
C		
E		

Node E

Dest	Cost	Hop
A		
B		
C		
D		

Question 6: *TCP 2* (15 Points)

Host A sends a file consisting of 9 segments to a host B using TCP. The particular version of TCP used by A and B does not implement fast recovery or fast retransmit. Assume that the 4^{th} segment in the transmission is lost. Assume the retransmission timeout is T and the one-way latency is d. Ignore the transmission time of the segments and of the acknowledgements. Also, ignore the three-way hand-shaking protocol.

a.) Draw the time diagram showing each segment and acknowledgement until the entire file is transferred. Indicate on the diagram all changes of the cwnd and sstresh. How long does it take to transfer the file?

b.) Answer part a) assuming TCP Reno, i.e., the TCP implements both fast retransmission and fast recovery.

c.) Answer part b) assuming that only the 6^{th} segment is dropped.

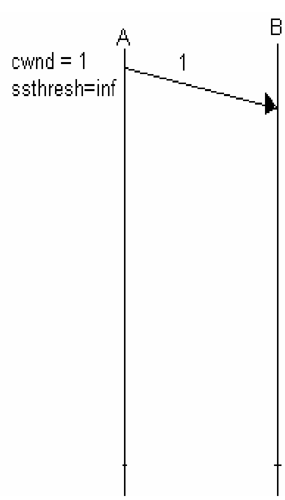
Notes:

- When using TCP Reno, cwnd does **not** increase upon receiving a DUP ack.
- If the value of cwnd is fractional, you should round it to the closest largest integer.
- The transfer time is the time interval at source A from the time the first segment is sent until the acknowledgement of the last segment is received.

Please use the following timing diagrams (which show the first packet) to answer this problem.

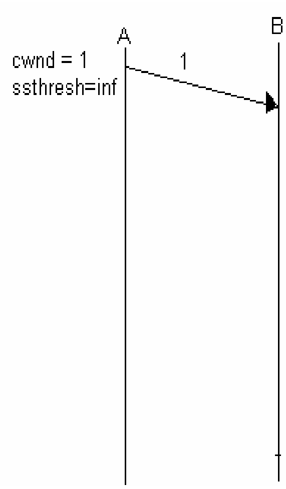
a.)

Transfer Time =



b.)

Transfer Time =



c.)

Transfer Time =