COMP5621 Computer Networks

Fall Semester 2016

Final Examination

Date: 10 Dec. 2016 Time: 12:30 - 14:30 pm (2.00 hours)

Name:_____ Student ID:
_____Email:_____

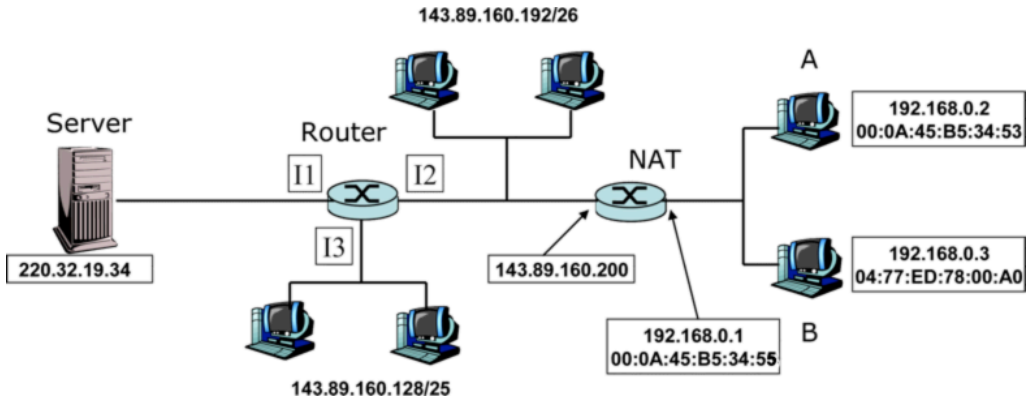
Instructions

1. Please type in your name, student ID and email address on this page.
2. Please answer all the questions within the space provided on the examination paper. You may use back of the pages for your rough work.
3. This paper consists of 6 questions and 7 pages.
4. You have total **120** minutes to complete the exam, apportion on average **20** minutes per question, and manage your time wisely.
5. Please read each question very carefully and answer the questions clearly in the space provided. Make sure your answers are neatly written, legible and to the point.
6. Show all the steps used in deriving your answer, wherever appropriate.
7. The only documents allowed are the textbook and the lecture notes, without any solutions to any exercises annotated on either.
8. Calculators and electronic devices are not allowed. You can use the back of the paper for draft paper

Question	Points	Score
1	10	
2	20	
3	20	
4	10	
5	20	
6	20	
Total	**100**	

Problem 1 (10 points): ARP

Consider the network setting in the figure below. Node A and node B are both in a LAN behind the NAT.



a) (5pts) Assume the ARP table of node A is initially empty. Suppose node A wants to send an IP datagram to node B. Fill in the following boxes which represent the corresponding headers of the messages. Use N/A if not applicable.

Messages	Source MAC	Destination MAC	Source IP	Destination IP
ARP request				
ARP reply				
IP in Ethernet frame				

b) (5pts) Show the routing table at Router with entries related to this figure only.

Subnet number	Subnet Mask	Next Hop

Problem 2 (20 points): TCP Congestion Control

a) (2pts) In what situation is an ACK not used to estimate the RTT in TCP?

b) (2pts) Since triple duplicate acknowledgements enable us to quickly detect packet losses in TCP, can we completely eliminate the use of timeout to detect packet loss? Justify your answer with a brief explanation of two or three sentences.

c) (3pts) Explain briefly how the fast recovery works in TCP Reno.

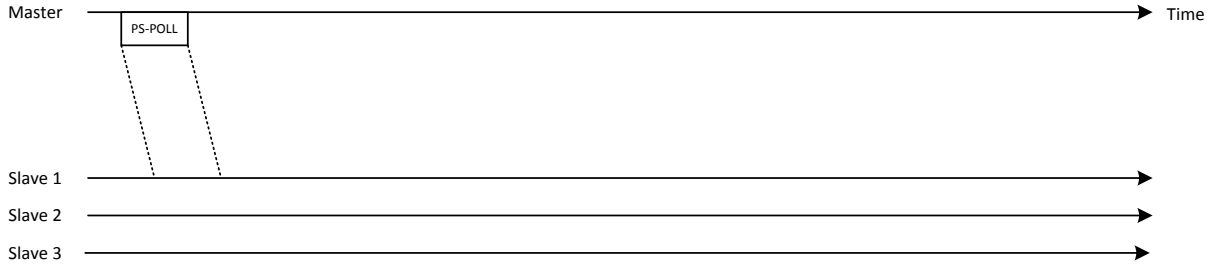
d) (6pts) Consider a TCP sender that sends a large amount of data and then goes idle at t_1 (since it has no more data to send). It remains idle for a relatively long period of time and then wants to send more data at t_2. What are the advantages and disadvantages of having TCP use the `CongWin` and `ssthreshold` values from t_1 when starting to send data at t_2?

e) (7pts) Suppose that instead of a multiplicative decrease, TCP decreased the window size by a constant value. Would the resulting additive increase additive decrease be fair, i.e., would it converge to an equal share of bandwidth? Justify your answer using diagrams similar to the figure used in the notes.

Problem 3 (20 points) Polling MAC Protocol:

Consider a network with a bandwidth of *R* bps accessed using a polling-based MAC protocol with one master node and *N* slave nodes. To poll a slave node, the master sends to that node a PS-POLL frame of *p* bits. A slave node that receives a PS-POLL responds with an Ack (if it has data) or a Nack (otherwise) of *a* bits. A node that has data to transmit is allowed to transmit only *Q* bits per round immediately following the Ack. The one-way propagation delay in this network is denoted *d*.

c) (4pts) Complete the time-space diagram below to illustrate the operation of this protocol with three slave nodes, where nodes 1 and 2 have data to transmit while node 3 does not.



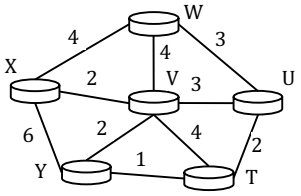
d) (6pts) Suppose two nodes are ready to transmit among the *N* nodes. Give an expression for the network throughput in this case in terms of *N, p, a, d, Q* and *R*

e) (6pts) Give an expression for the maximum possible throughput of this network?

f) (4pts) Assuming the propagation delay is negligibly small, and that both *p* and *a* are equal to 10 bytes, give an expression of the minimum value of Q to be able to achieve at least 99% efficiency. Calculate this minimum value.

Problem 4 (10 points) Link State Routing:

a) (7pts) Derive the shortest paths from node X to all the remaining nodes in the following network using Dijkstra's shortest path algorithm. (Break the ties between nodes by choosing the rightmost entry in the table.)

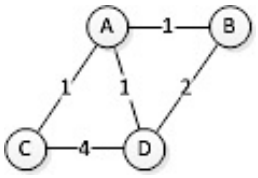


Step	*N'*	*D(T),p(T)*	*D(U),p(U)*	*D(V),p(V)*	*D(W),p(W)*	*D(Y),p(Y)*

b) (3pts) Draw the resulting routing graph from X to all other nodes.

Problem 5 (20 points) Distance Vector Routing

Consider the following network.



a) (8pts) Give the distance vector tables at nodes A, B, C, and D at the start of the DV algorithm, then at the end when the algorithm converges, by filling up the tables below.

At the start

@A	A	B	C	D

@B	A	B	C	D

@C	A	B	C	D

@D	A	B	C	D

At the end

@A	A	B	C	D

@B	A	B	C	D

@C	A	B	C	D

@D	A	B	C	D

b) (8pts) Would the final tables be different if we initially used DV with poisoned reverse? If yes, show the final tables of nodes A and D and explain briefly, and if no, explain briefly why not.

@A	**A**	**B**	**C**	**D**

@D	**A**	**B**	**C**	**D**

c) (4pts) Assuming the cost of link C-D goes up from 4 to 60, can the count to infinity problem happen in this situation if we use distance vector without poisoned reverse? Explain briefly why or why not?

Problem 6 (20 points) Ethernet LANs:

a) (6pts) The efficiency of an Ethernet LAN is given by $E = 1 / (1 + 5t_{prop}/t_{trans})$. We wish to operate a 1 Gbps Ethernet LAN at 50% efficiency. The speed of light in the transmission medium is 2×10^8 m/s. Suppose the frame length to be transmitted is 2500 bits. Calculate the maximum distance between any two nodes in this network.

b) (6pts) Will the transmitting node A be able to detect a collision in this LAN before it completes transmission? Briefly justify your answer.

c) (4pts) Repeat the same for a 100 Mbps LAN.

d) (4pts) Based on your results above what can you comment on the effect of the LAN speed on the performance of the LAN.