UNIVERSITY OF TORONTO

FACULTY OF APPLIED SCIENCE AND ENGINEERING

FINAL EXAMINATION, APRIL 26, 2001 (THURSDAY)

Fourth Year – Electrical and Computer Engineering

ECE461S – INTERNETWORKING

Exam Type: A

Examiner – E. Law

Student Name: _____

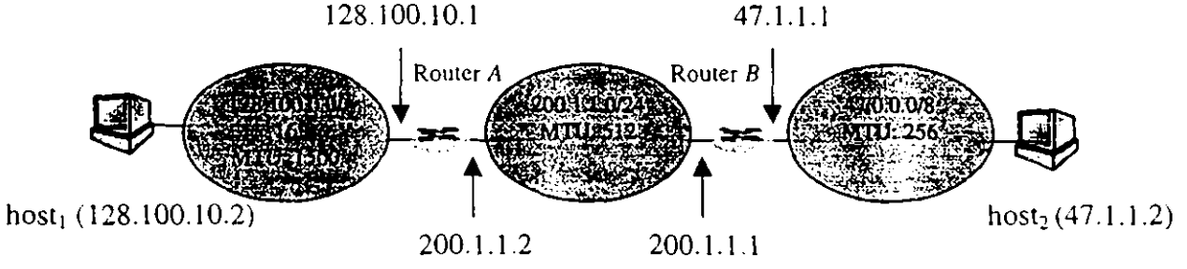
Student Number: _____

Rules:

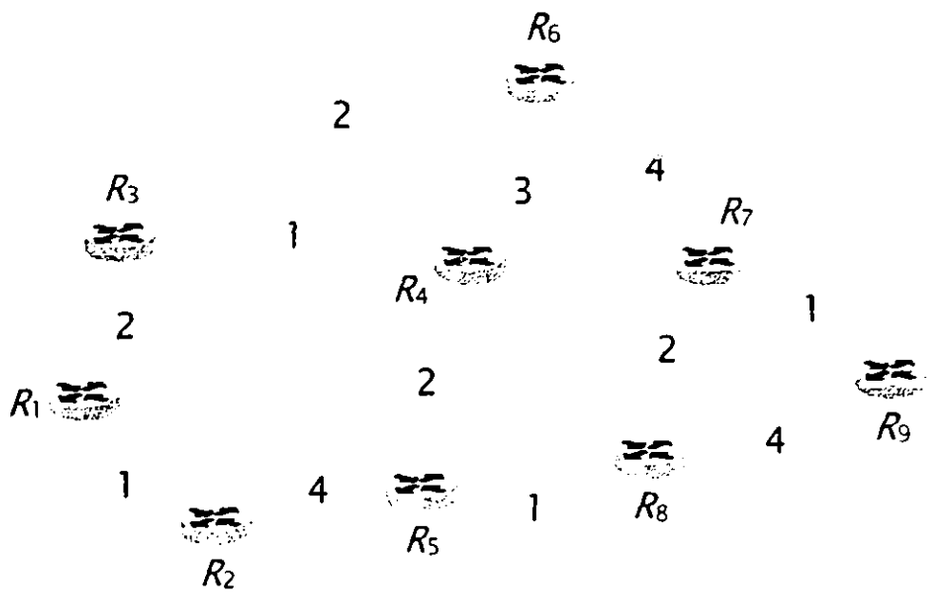
1. This is a Type A examination. You are not allowed to use aid-sheets, textbooks or any other materials.
2. You may only use non-programmable calculator.
3. Write your answer on the ruled side of the examination book provided with this examination. You may use the un-ruled sides for calculations or drafts.

Question	Score
1	/15
2	/12
3	/12
4	/4
5	/5
Total	**/48**

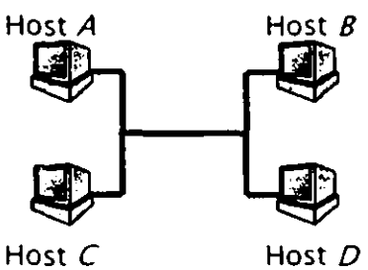
1. [15 points in total.] The path MTU (Maximum Transmission Unit) discovery process is to find the MTU along a path between a source and a destination in order to avoid fragmentation of the IP packets. In the following diagram. There are several subnets, each of them may have its MTU value. In this question for both parts (a) and (b), assume that the host 1 sends a TCP segment that carries data information, size 1460 octets (not including both the TCP and IP headers), to host 2. The size of the combined TCP and IP headers for this packet is 40 octets. The value of the identification field for the first packet to send from host 1 is 123. The TCP connection was set up properly before sending user's data. (a) (9 points) If the host 1 in the network does not use any Path MTU Discovery process, please show all the fragmented IP packets after they are passed through the routers *A* and *B*. In your answer, please show the following information: the values of the total length field, the IP identification field, the fragment offset, and its associated flags for each IP packet. (b) (3.5 points) If host 1 operates the Path MTU Discovery process, it then finds that the Path MTU is 256-byte on its way towards host 2. How many of TCP segments will be sent from host 1 for this sized 1460 octets data? Please show all information as indicated in part (a); moreover, please also show the sequence number in each TCP fragment, assuming the first byte of user's data is with sequence number "0". (c) (2.5 points) Please compare the traffic generated in host 2's subnet in these two parts. Moreover, please comment on their differences. Explain why more traffic is generated in terms of bytes after using the path MTU discovery process.



2. [12 points in total.] (a) (2 points) Please describe the operations of the Steiner tree approach in a real physical network? (b) (8 points) Given the following network topology, please use the Steiner-tree approach to find the lowest cost multicast tree with one-core node given that there are both senders and receivers connected to the routers: (R_3, R_4, R_7, R_9). If there are multiple identical lowest cost multicast trees, then list all of them. (c) (2 points) From the calculation in part (a), what is the next best multicast tree from this Steiner tree calculation? Which is the core node? What is the cost for this tree? [For this question, you are allowed to visually find out the lowest cost tree without using the Dijkstra's or Ford-Fulkerson algorithm. The costs for all the links between any two nodes are marked in the graph.]



3. [12 points in total.] (a) (3 points) What are the goals of the "Slow Start" (SS)? Please describe in-details the operations of the SS in the TCP flow control mechanism. (b) (1 point) In the latest TCP flow control RFC, the starting value of a host's congestion window (*cwnd*) for the SS is set to be either 1 MSS or 2 MSSs. Before this RFC, the starting *cwnd* was set to 1 MSS only. From your understanding, can you try to explain the reason behind the increase from 1 MSS to 2 MSSs? (c) (1 point) A protocol designer develops a new mechanism known as the Fast Start (FS) at the receiver side. The operation of the FS is to split an acknowledgement into multiple acknowledgements within one round trip time (RTT). Can you interpret the goal of this design? [The following network setup is for parts (d) and (e).] Suppose in a network topology as shown in the following diagram, we have the following system parameters and environment:

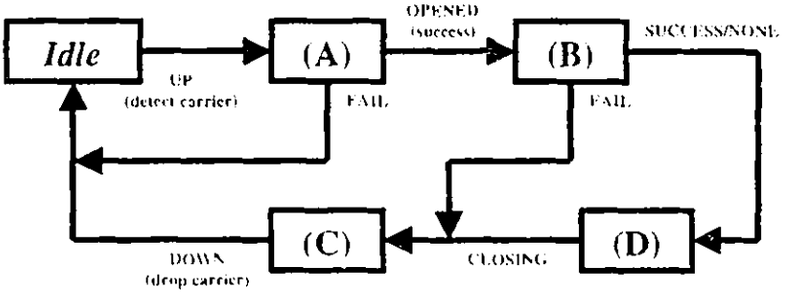


- infinite channel capacity for the TCP connection in any directions;
- host *A* establishes one TCP connection to host *B*; and host *C* establishes one TCP connection to host *D*; both connections are setup at the same time, say, time=0;
- the round trip delay between hosts *A* and *B* (similarly for hosts *C* and *D*) is fixed at *a* seconds;
- host *A* and host *C* use the SS mechanism with parameters *ssthresh* = 64Kbytes, *IW*=2Kbytes, *MSS*=1Kbytes;
- host *B* replies an ACK whenever it receives a TCP packet from host *A*;
- host *D* uses 2-segment delayed ACK, and the FS mechanism that generates 2 ACKs evenly distributed in one RTT, i.e., when the host *D* is triggered to send ACKs at time *T*, it sends the first ACK at time *T*, and the second ACK at time *T*+(*a*/2);
- assume that both hosts *A* and *C* have continuous backlogged infinite information to send for their TCP connections;

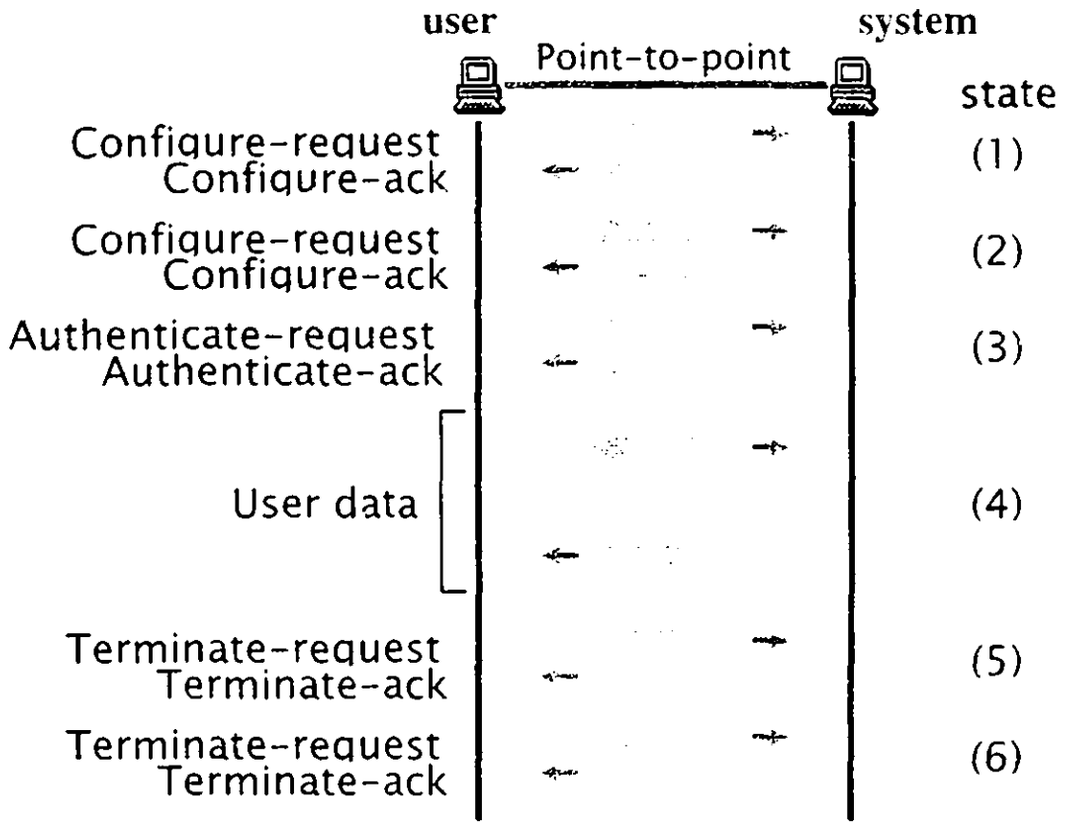
(d) (6 points) Assuming null packet transmission delay, please plot the *cwnd* against time in terms of *a* for the SS durations at both the hosts *A* and *C*. (e) (1 point) Which connection gets to the *ssthresh* earlier?

4. [4 points in total.] (a) (1 points) Please explain the roles and functions of the ICMP protocol. (b) (3 points) Amongst all the ICMP messages, there are messages which are known as "redirect," and "source quench." Please describe its operations in details.

5. [5 points in total.] (a) (1 point) The following diagram shows the finite state machine used in the point-to-point protocol (PPP). What are the machine states for (A), (B), (C) and (D)?



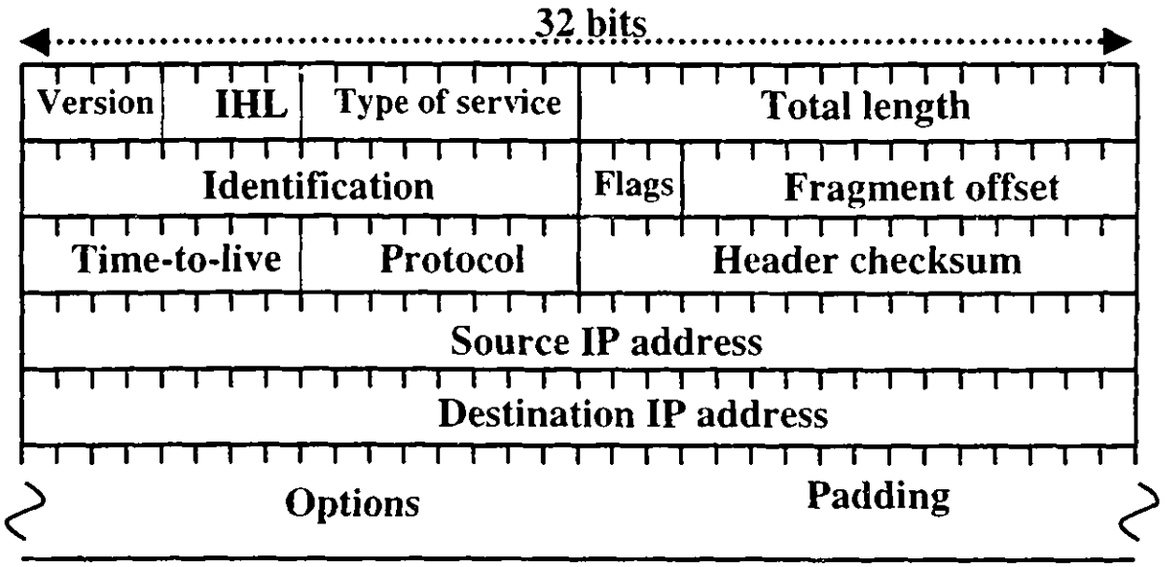
(b) (3 points) The following figure shows the PPP connection between a user and access provider. Some message types seem identical, but they actually belong to two sub-protocols in PPP. What are these two protocols? Moreover, there is an incorrect message ordering on the user side in the diagram, please indicate that particular incorrect message sequence, and show the proper message order.



On the left hand side, the PPP system states are unknown. Please interpret the states from the PPP finite state machine after you have properly rearranged the message order. (c) (1 point) To which layer of the OSI 7-layer model does PPP belong to? Please describe the network scenario under which PPP can be used.

Appendix:

- IP Header Format



- TCP Header Format