B1. Networks (25 points)

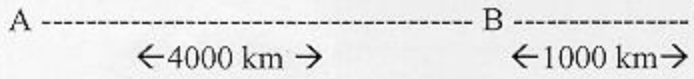
1. (In answering this question, you may discuss specific details of TCP's mechanisms, or you may present the answers in terms of a generic reliable transport layer protocol.)

Most reliable transport layer protocols specify that a sender should retransmit transport layer protocol data units (T-PDUs) that are not acked by the receiver within a 'reasonable' time. The reasonable time is often implemented with a retransmission timer being set to an RTO (retransmission timeout) value when a T-PDU is transmitted. If an ack has not been received before the RTO timer expires, the T-PDU is retransmitted.

- (15pts) Explain in detail a good approach for a transport sender to determine an appropriate RTO value. Discuss the positive and negative aspects of your suggested approach.
- (5pts) Some receivers use "delayed acks." What are they, and how might they affect determining an appropriate RTO value?
- (5pts) Discuss with examples the negative and positive aspects of a sender using an RTO value that is
    - too short
    - too long

B2. Networks (25 points)

2. In the following store&forward topology, protocol data units (PDUs) (i.e., frames) are generated at node A and sent to node C via node B.



Both links A-B, and B-C are full duplex.
The data rate on link A-B is 100 kbps in each direction.
The propagation delay is 5 microseconds/km for both lines.

All PDUs with data are 1000 bits; ACKs are separate PDUs of negligible length.
A sliding window protocol with a window size = 3 is used between A and B.
A stop-and-wait protocol is used between B and C.
There are no errors.

(20pts) (a) Determine the minimum data rate between B and C so that the average number of frames entering and leaving B is the same over a long interval. (Suggestion: draw a timing diagram showing traffic between A-B, and B-C.)

(5pts) (b) True/False (and defend your answer): By increasing both A's sending window size and the transmission rate over the link B-C, the rate of PDUs into and out of B can be made arbitrarily large. (Assume all other parameters remain unchanged.)

B3. Networks (25 points)

3. Consider the following statement: "Loops are an unavoidable fact-of-life in all distributed routing algorithms."

(8pts) (a) Explain what is meant by a loop in a routing algorithm. What are some of the causes of loops in distributed algorithms?

(5pts) (b) Provide a concrete example of how loops may arise in the distributed Bellman-Ford algorithm.

(5pts) (c) Describe any one technique that has been proposed to eliminate loops from the distributed Bellman-Ford algorithm. Does this technique succeed in its objective? Why or why not?

(7pts) (d) Do you agree or disagree with the above statement? Give cogent and well-reasoned arguments to support your case. Clearly discuss the applicability of the statement to each of the two main categories of distributed routing algorithms, namely distance vector and link state.

B4. Networks (25 points)

4. (18pts) (a) Reliable data transfer protocols exist at both the link layer (e.g., HDLC) and the transport layer (e.g., TCP). Compare and contrast the inherent similarities and differences between these two layers, and how those differences impact the design of reliable data transfer protocols at the two layers.

(7pts) (b) In some environments, such as communicating with distant satellites traveling to other planets, attaining reliability using timeouts and retransmissions at either the link or transport layer results in unacceptably poor performance. Discuss how a reliable data transfer protocol might otherwise provide reliability in such an environment (at either the link or transport layer)?