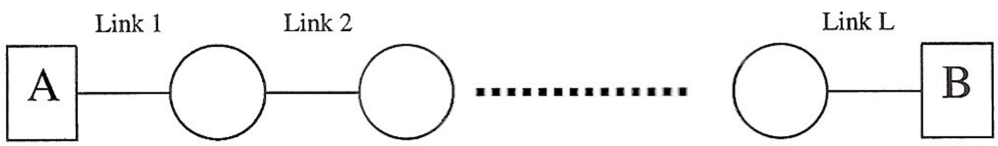
Name:______________________ **Student ID:**_______________

EECS 122 Midterm Exam

March 6, 2007

- **Please write your name on top of each page.**
- **If required, use the blank side of each page.**

Problem 1:



Consider 2 hosts A and B are connected via L links between them. Host A wants to send a file of length X bits divided into N packets of equal length (assume N divides X evenly). All the intermediate nodes do "**store and forward**", i.e., they download each packet fully before forwarding it ahead. Let R bits/second be the transmission rate and T sec be the propagation delay on each of the links on the path from A to B. Make the following assumptions:

(A1) Processing delay at each node is negligible. I.e., you can neglect any delay between downloading and forwarding any packet (data or ACK) at any node on the path.
(A2) ACK packets are small. Their transmission time is negligible compared to their propagation delay on the links.
(A3) There are no errors on any links or at any nodes.

Find the length of time it takes between transmission of the first bit of the file at A and the time when there is no more transmission of packets in the network when

1. No ACKs are required anywhere in the network and packets may be pipelined by A and by all nodes in the network.**(6 points)**

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2. At each link on the network, an ACK is required per packet. Hence, the next packet is not transmitted till the previous packet has been ACKed on the link. **(6 points)**

3. A requires B to ACK every packet and does not send the next packet until the previous one is ACKed. **(6 points)**

4. A requires B to send one ACK for every k packets sent (assume N = kM). A does not send the next batch of k packets unless the previous batch has been ACKed. **(6 points)**

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Problem 2: Starting from a message m1m2m3m4, the Hamming-(7, 4) code is obtained by appending 3 control bits $c_1c_2c_3$:

$$c_1=m_1+m_2+m_4$$
$$c_2=m_1+m_3+m_4$$
$$c_3=m_2+m_3+m_4$$

Note: "+" denotes the exclusive-or operation.

1. Prove that the minimum Hamming distance of this code is 3. (Hint: consider the cases of two messages differing in 1 or 2 bits.) **(10 points)**

2. How many bit errors can it detect? How many can it correct? **(6 points)**

3. Station A sends an encoded message to station B. There is exactly 1 bit error during the transmission and B receives 1010011. Correct the error. **(10 points)**

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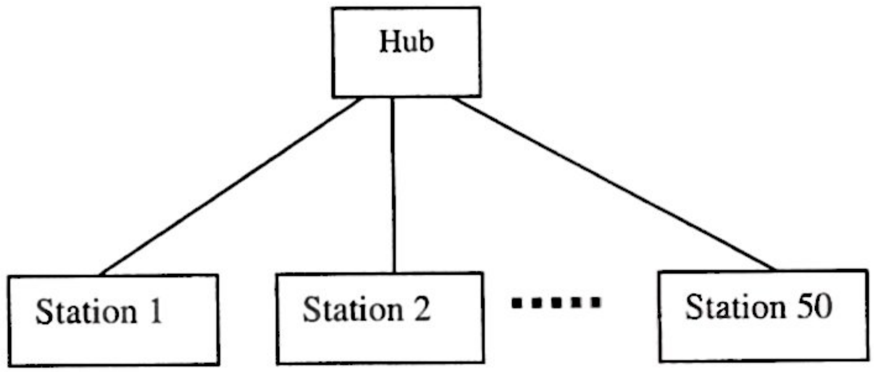
Problem 3: Consider the scenario where 50 stations are connected using a 10 Mbps Ethernet and a hub. Each station is located equidistant from the hub, has an unlimited supply of 125 byte frames (including 18 bytes of MAC header), and the destination for each frame is uniformly chosen.



1. Test measurements reveal that on average 100 microseconds is used by collisions, preambles, and Inter-Frame Gap (IFG) per successful frame transmission. What is the total throughput provided by the stations to the network layer? **(8 points)**

2. The test measurements also showed that the stations achieved quite disproportionate throughput over successive 100ms intervals. What might be the reasons for this behavior? **(7 points)**

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3. It is suggested that replacing the hub by a switch would improve the network throughput and fairness. Do you agree? Provide reasons. **(7 points)**

Problem 4: Answer the following questions briefly. At most 2-3 sentences should suffice for each part.

1. According to Nyquist, over a channel with bandwidth B (Hz) and M signal levels, we can get a bitrate of $2B\log_2 M$. Why can't we increase M to reach arbitrarily high bitrates? **(4 points)**

2. What does the word “transparent in transparent bridges signify? Provide all reasons. **(4 points)**

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3. Explain how you would change the length of the CRC field as the length of the payload covered by this CRC increases. **(4 points)**

Problem 5: Multiple Choice Questions (Circle one or more choices).

1. Packets arrive from sources A and B to a switch, each at 10 Mbps. A's packets spend 10 microseconds inside the switch while B's packets spend 20 microseconds. Assume that there are no packet losses in the switch. What is the average amount of buffer (to store both A and B's packets) required to be maintained in the switch. **(4 points)**

    a. 100 bits

    b. 200 bits

    c. 300 bits

    d. 400 bits

2. Suppose Bob decides to maintain his window size (W) inversely proportional to the round trip time (RTT) that he sees when transmitting to Alice, what throughput will he observe? **(4 points)**

    a. Inversely proportional to RTT^2

    b. Inversely proportional to RTT^4

    c. Proportional to RTT^2

    d. Proportional to RTT^4

3. Mark all the statements that are NOT true for an infrastructure mode 802.11 network. **(4 points)**

    a. RTS/CTS messages help with the hidden terminal problem.

    b. The exposed node problem is a big issue for such networks.

    c. Access Point can the be the bottleneck for the overall throughput performance.

    d. An Extended Service Set is created by using a Distribution System.

4. CSMA/CA functionalities in an 802.11 network are provided by: **(4 points)**

    a. Monitoring whether the radio interface is busy or idle.

    b. Using appropriate inter-frame gaps.

    c. By implementing virtual sensing using Network Allocation Vectors.

    d. All of above.