CS 5480: Sample Midterm Exam Questions: Sample answers

Print Name: ________________________________

This is an open book, open note exam. Answer the problems in the space provided. The total number of points allocated to each problem is indicated; the entire exam will be graded out of a maximum of 100 points. Write all of your answers directly on this paper. Make your answers as concise as possible. **You needn't cover every available nano-acre with writing.**

You have **75 minutes** in which to complete the exam. Pay attention to the time remaining. If you get stuck on a particular problem, I suggest that you skip it and come back to it.

Good luck!

1. Explain how a single router can employ line cards that support ethernet, token ring, and a SONET point-to-point connection, despite their very different link-level protocols. **(5 points)**

   Routers (typically) work at the network (IP) layer, so they do not care what link layer protocol is being run by the line cards.

2. XXX

3. What is the difference between time division multiplexing and statistical multiplexing. Give an example network protocol that employs each multiplexing mechanism. **(5 points)**

   In TDM, the resource is divided into pieces by time (slots) and each client gets a £xed slot (or set of slots) for which it does not need to contend with other clients. SONET is a good example of TDM. In contrast, in SDM a resource is shared statistically, where data is transmitted on-demand, when a client needs to send it. If multiple clients need to transmit simultaneously, they arbitrate for the resource. Thus, bandwidth is shared over time, with each client getting a statistical "fair share" rather than a guaranteed "fair share." Ethernet is a good example of statistical multiplexing.

4. XXX

5. Considering the normal IP address convention for indicating a network, how many hosts can be addresses on the following networks? **(6 points)**

   (a) 128.110.0.0? '128" indicates that this is a class B network, therefore it supports 64K hosts.

   (b) 155.99.108.0? This is also a class B network (the leading bits of "155" are still 100), therefore it supports 64K hosts. However, since it is not unreasonable to assume that the "108" constrains those 8 bits, an answer of 256 hosts was acceptable.

   (c) 166.70.89.48, netmask 255.255.255.248? The netmask speci£es that there are 8 hosts (or 7 hosts and a broadcast address).

6. Although uncommon, bit errors occur on physical connections. As a result, link layer protocols typically employ various forms of error correction. **(16 points)**

   (a) Explain the principle of operation of a CRC error detection mechanism. **(5 points)**

   Treat the message as a polynomial over x. Multiply it by some known x^k. Add a remainder polynomial that makes the resulting code evenly divisible by a known polynomial of degree k (the CRC code). Transmit the resulting CRC-enhanced message, including the extra k bits of CRC. The receiver determines if the message divided by the known polynomial (CRC code) has a remainder. If so, there was an error. If not, the likelihood of an error is very small, and with carefully selected polynomials, requires that the error bits be at least k bits apart.

   (b) Using the 3-bit CRC $x^3 + x^2 + 1$, derive the three check bits for the message 0000. **(6 points)**

   In mod-2 arithmetic, $0000...$ divided by anything has no remainder naturally, so the three check bits are 000. (The message sent is 0000000.)

   (c) For the 7-bit CRC-protected message you derived for 0000, give an example of a message with an error that will *not* be detected. **(5 points)**

   The CRC-protected message from (b) is 0000000. If the error is a multiple of the CRC code (1101), then it will not be detected. One example of an erroneous message that would not be detected is 1101000. (*This message would appear to the receiver to be a correctly transmitted message with* 1101 *as the payload, not* 0000).

In retrospect, I don't really like questions 4b and 4c.

7. Token rings and ethernets are two common forms of LAN technology. (20 points)

   (a) The media access control (MAC) mechanism for token rings, where a station must remove the token from the network before it is allowed to transmit, ensures that under periods of high network load, the network is utilized ef£ciently. What mechanism(s) do ethernets employ to attempt to achieve high performance even under heavy load? How does this mechanism work (*in reasonable detail*)? **(7 points)**

      The key mechanism that gives Ethernet good high load behavior is *binary exponential back-off* . Using this mechanism, a node that detects a collision backs off (delays trying to resend) for a random interval between (0, $2^{collisions} - 1$) delay intervals, up to some upper limit of the number of collisions that it will tolerate. Doing this reduces the chance of nodes continuing to collide with one another, which increases the chance that *some* node will transmit successfully, which is what utilization is all about.

   (b) XXX

   (c) XXX

8. Suppose a 100-Mbps point-to-point link is being set up between the Earth and a new lunar colony. The distance from the earth to moon is approximately 385,000 km, and data travels over that link at the speed of light, $3 * 10^8$ m/second. Suppose you are designing a sliding window protocol for this link. Further assume that the maximum packet size for this networking technology is 1-kilobyte. **(20 points)**

   (a) Calculate the minimum roundtrip time for this link. **(2 points)**

      Time = distance/velocity = 385,000,000m / 380,000,000 m/s
      Time $\approx$ 1 second (one way).
      Roundtrip = 2 * one-way latency = 2 seconds

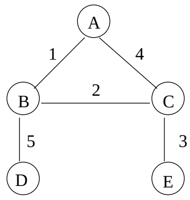
   (b) Using the RTT as the delay, calculate the delay * bandwidth product for this link. **(3 points)**

      DBP = 2s * 100Mbps = 200 megabits

   (c) XXX

   (d) XXX

9. Forwarding, routing, and bridges. **(22 points)**



(a) For the small network shown in Figure 9, give the datagram forwarding table for each node. The links are labelled with their relative costs; your tables should forward each packet via the lower cost path to its destination. **(6 points)**

Since the "ports" were not labelled on the diagram, there are a lot of different schemes for designing the table. A common way to label port numbers is with the name of the node at the other end of that connection, which results in the following table:

-	A	B	C	D	E
A	0,-	1,B	3,B	6,B	6,B
B	1,A	0,-	2,C	5,D	5,C
C	3,B	2,B	0,-	7,B	3,E
D	6,B	5,B	7,B	0,-	10,B
E	6,C	5,C	3,C	10,C	0,-

(b) Suppose this network represented a collection of ATM switches, describe how a virtual circuit is established between node A and node E, assuming the forwarding table that you calculated in the previous sub-problem. **(8 points)**

A picks VC id and forwards the VC create request to B.
B picks VC id and forwards the VC create request to C.
C picks VC id and forwards the VC create request to E.
Hosts gets request and responds to E with a VC id.
E responds to C with the VCI it selected. C responds to B, and B to A in similar fashion. Each node creates a table entry mapping incoming VCI number (the one it selected during VC creation) to an outgoing VCI number (the one it received from its downstream neighbor when the creation was being acknowledged).

(c) Describe, compare, and contrast the mechanisms used to build forwarding tables for bridges and routers. **(8 points)**

Bridges observe traf£c on the network and use this to infer what nodes are where. To eliminate loops, bridges in large con£gurations typically run a spanning tree algorithm, with one of the bridges designated as the root.
Routers run an explicit routing protocol between the routers, who exchange information about what *networks* are located where in the network. Routers do *not* examine the random user traf£c ¤owing through or past them to infer routing information.