Exam 1 (Midterm), Fall 1999
Computer Science 516
Computer Communication Networks
University at Albany

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1 Some Hints

Your professor suggests the following preparation strategies:

- This exam is open book and open notes (your own books and notes that is!). Calculators are premitted, networked devices are not.
- Write neat clean answers, since if the grader cannot understand you on the real exam, it will go badly for you.
- Show your work, if you are guessing the grader will not give much credit (even if you get lucky and guess right).
- Define your notation (you can use tables like the lecture notes if you like).
- Set up the solution symbolically and simplify before plugging numbers in, it is easier to follow for the grader.
- You can solve problems out of order, but keep the work for each problem in one place, and mark it clearly.

2 The Problems

1. Fourier Analysis (15 Points): Consider a Unipolar encoding of 8 bits, where the maximum voltage is $+V$ transmitted over a period of 1μsec. Also recall that all periodic functions, $g(t)$, can be described using a summation of sine and cosine functions:

$$g(t) = \frac{C}{2} + \left[\sum_{n=1}^{\infty} a_n \sin(2\pi n f t)\right] + \left[\sum_{n=1}^{\infty} b_n \cos(2\pi n f t)\right] \quad (1)$$

   (a) (5 Points) The ascii code for the letter 'a' (the grade you want!) is encoded `'\0x61'`. Show your derivation for the value of the term C in the Fourier series.

   (b) (10 Points) The ascii code for the letter 'b' is encoded `'\0x62'`. Show your derivation for b_n (hint it is a function of n) in the Fourier series.

2. Channel Performance Analysis (15 points): Suppose you are a developer and you want to upgrade a remote software installation as soon as possible, and it is now 2 p.m. The upgrade requires transferring 10 gigabytes of programs and data to your customer's machine. You can send the data over a 100 Mbps network, but you only get 1% of that bandwidth on average. Otherwise, you could transfer the data to a tape and have an overnight delivery arrive at the customer site by 10:00 A. M. tomorrow. It takes two additional hours to read the tape into the customer's machine after it arrives. You can assume you and your customer are in the same time zone. Which solution will get your customer up and running faster, the overnight delivery service, or sending the files over the wire.

3. Multiplexing and ATM (20 Points): Consider the network shown in Figure 1, and recall that ATM has 155 Mbps, and cells arrive in the configuration shown.

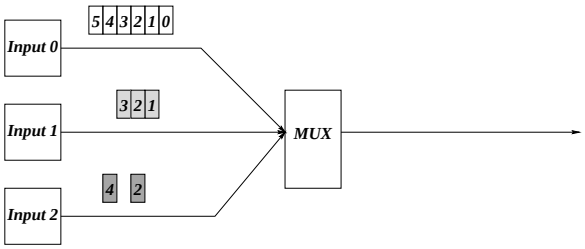

Figure 1: Multiplexing and ATM system from problem 3

   (a) (10 Points) Suppose that a time division multiplexer is used.

   - (5 Points) What is the minimum bandwidth of the multiplexed link?

- (5 Points) What is the utilization of the multiplexed link's bandwidth?

(b) (10 Points) Suppose that a statistical multiplexer is used and that the traffic rates shown are representative of the average rate of traffic, and that the multiplexed link has 80% of the bandwidth you computed in problem 3a.

- (5 Points) How fast must the link be to handle average traffic, and is the proposed link fast enough (derive, do not guess!)?
- (5 Points) What is the number of buffers (one buffer per 53 byte cell) required for a burst on all inputs lasting 0.5 seconds?

4. Protocol Layering (10 points):

   (a) (5 points) How is randomization used in ethernet protocols (at the data link layer), and how do token ring networks avoid randomization?

   (b) (5 Points) Show the PPP frame containing the following C literal as the data sent using the IP protocol

   ```
   "I deserve \0x7d an \0x7e A on \0xC0 this test!"
   ```

   Where `\0x7e`, `\0x7d` and `\0xC0` are the corresponding byte values injected into the stream of text.

5. Design principles and Queueing Theory (10 points): Suppose that a network interface card (NIC) implements the IP layer of the TCP/IP protocol in hardware (using a dedicated processor). Assume that when a packet is received it takes 5μsec (on average) to process the headers and trailers of received packets at the IP layer, and 12μsec (on average) for the software drivers to process the headers for the host to host layer.

   (a) (5 points) What is the maximum throughput of this system for received data if both the NIC hardware and host-to-host software can process packets in constant time?

   (b) If packets arrive every 20μsec on average (exponentially distributed), and the IP and host-to-host layers have an exponential distribution?

6. Network Systems programming (10 Points):

   (a) (5 points) Why do many flavors of unix support scatter/gather programming using readv and writev systems calls?

   (b) (5 points) What functionality does the connect system call provide?