PRINT LAST NAME:_____

Examination 1

CEN 4500C Computer Network Fundamentals
February 13, 1995

Instructions

1. This is a closed-book, 50-minute examination.
2. You may use one 8.5" by 11" sheet of notes for reference.
3. Answer any four (4) questions, and no more.
4. Each question is worth fifteen (15) points.
5. Start the answer to each question on a new page (i.e., do **not** put the answer to more than one question on the same page).
6. Show your work. No work, no credit.
7. Assemble your answers in numerical order of the questions when you submit them.
8. **Do not turn the page and start until the proctor tells you to start.**
9. **Leave a 1" square in the upper left corner for a staple.**
10. **Read and sign the following statement.** You may write this on your exam and sign it there if you wish to take the exam questions home with you today. Do not discuss this exam with anyone in this course who has not yet taken this exam.

On my honor, I have neither given nor received unauthorized aid on this examination, and I will not discuss the contents of this examination with any student who has not yet taken this examination.

Signed:

1. (a) (6) Name and describe three distinct forms of transmission impairment.

   (b) (3) For each form of transmission impairment you describe, give a practical means of reducing or eliminating its effect. How well does this method work?

   (c) (4) In what ways does digitization of an analog signal introduce noise? Be specific and provide illustrations.

   (d) (2) In light of the previous question, why are analog signals digitized?

2. (a) (5) Describe and compare Biphase encoding with Bipolar encoding. Be quantitative where possible.

   (b) (3) Consider a spectral band between 20.001 GHz and 20.021 GHz with an SNR of 21.7 dB. What is the theoretical maximum data rate for this channel?

   (c) (3) Assuming the data rate for the previous part was 320 MHz (it isn't), how many signal elements must be used to achieve that data rate?

   (d) (4) Give PSK and ASK phase-amplitude constellations for a channel whose baud rate is one half its data rate. Label the signal elements with their digital values in a way that minimizes errors and state why your labeling does this.

3. (a) (4) Draw the signal forms for NRZ-M, RZ, Bipolar AMI and Manchester coding for the digital data: 10110000000000000000011101.

   (b) (3) Apply B8ZS scrambling to the data above and show the signal form.

   (c) (6) What problems can occur with single bit errors when B8ZS encoding is used? Give examples for each and state the effect the error has.

   (d) (2) Distinguish pulse stuffing from bit stuffing.

4. (a) (4) Give the (15,11) 1-bit error correcting Hamming Code word for the data 11001111001 (assume numbering with LSB to the right). Indicate which bits are parity.

   (b) (2) Corrupt bit 7 and show how the code can find and correct the error.

   (c) (3) What would the decoder do if bits 7 and 9 were corrupted? Why?

   (d) (3) Given the polynomial $P(X) = X^5 + X^2 + X + 1$, compute the CRC for the data from above. Show the transmitted quantity, indicating data and parity bits.

   (e) (3) Corrupt bits 7 and 9 andshow that the CRC detects the error.

5. Consider a system in which Sliding Window ARQ is to be used, with a data rate of $R = 64$ Mbps, frame length $L = 1000$ bits/frame, and propagation delay $\tau = 4$ msec. Assume the frames include 2 octets for frame synchronization, 2 octets for addressing, 2 octets for data length, type, and control information (not including sequence numbers), 2 octets for CRC, and use piggybacking.

   (a) (4) What should the sequence number size be to maximize utilization if GBN ARQ is used?

   (b) (4) What is the net data rate achieved (including framing overhead)? Assume no errors, but include calculations for framing overhead in addition to protocol overhead.

   (c) (4) What would be the effect on utilization of using SR-ARQ instead with the same sequence number length?

   (d) (3) Discuss the tradeoffs of using piggybacked acknowledgements - what additional complexity/overhead is incurred, and what benefits are gained?

6. (a) (6) Compare and contrast TDM and FDM - what are their relative advantages and disadvantages?

   (b) (2) Consider a multiplexor with 24 incoming lines, each with a maximum data rate of 56 kbps, with each line actually transmitting data one quarter of the time. Assuming synchronous TDM with octet interleaving, what must the outgoing line's data rate be?

   (c) (4) Now suppose that the same multiplexor uses asynchronous TDM instead, with minimum addressing overhead. If the outgoing line is designed to have 80% utilization, what should its raw data rate be?

   (d) (3) Given the asynchronous TDM mux from above, what is the mean delay incurred for the data going through the mux, assuming an exponential interarrival distribution?