PRINT FAMILY NAME:_____

Examination 1

CEN 4500C Computer Network Fundamentals
October 5, 1999

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 three (3) 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:
Printed name:

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

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

   (c) (4) Why is IR used for remote controls, while RF is used for cordless phones?

   (d) (2) Why was GWEN designed to use very low frequencies (ground waves)?

2. (a) (4) Describe and compare balanced and unbalanced transmission.

   (b) (3) What signal-to-noise ratio (in dB) is needed to transmit data at 1 Mbps over a conventional phone line (bandlimited to 4 kHz).

   (c) (3) Assuming the SNR for the previous part was 40 dB (it isn't), how many signal elements must be used to achieve that data rate? Comment.

   (d) (4) What is PAM? Why was it developed? What are the critical elements in design of a PAM system?

   (e) (1) How did PAM lead to the technology used on compact disks?

3. (a) (4) What are the two fundamental approaches to error handling and how do they differ?

   (b) (3) Suppose you had to design a communication system for a space probe to Neptune. What type of error handling would you use? Why?

   (c) (3) What is the Hamming Distance of the following code?

   $$C = \{010010, 101101, 000111, 111000\}$$

   Can another code word be added to C without decreasing its Hamming Distance? If so, provide the word, if not, argue why not.

   (d) (2) If a code has a Hamming Distance of 6, what is the maximum number of errors it is guaranteed to detect? What is the maximum number of errors it is guaranteed to correct?

   (e) (3) Suppose that the code from the previous part is only used to correct 1-bit errors, with the remaining redundancy used to detect errors. What is the maximum number of bit errors it is guaranteed to detect under these circumstances? Why?

4. Consider a system in which Sliding Window ARQ is to be used, with a data rate of $R = 55$ Mbps, frame length $L = 220$ bits/frame, and propagation delay $\tau = 1$ 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) (3) What is the maximize protocol utilization if GBN ARQ is used with 7-bit sequence numbers?

   (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) (3) How many bits of sequence number should be used to achieve maximum utilization if SR-ARQ is used instead?

   (d) (4) Compare individual ACKs with cumulative ACKs. Which form is better for GBN-ARQ, and why?

   (e) (1) What is the benefit of using NAKs?

5. (a) (3) What is MF/TDM and why is it used?

   (b) (2) Consider a synchronous multiplexor the has a raw output data rate of 1 Mbps and two of its input lines have a data rate of 196 Kbps. How many additional input lines with a maximum data rate of 124 Kbps each can it support? Assume that synchronous transmission is used for the date lines.

   (c) (4) Assuming that byte interleaving is used in the transmitted frames, give a frame format for transmission and indicate pulse stuffing as appropriate.

   (d) (3) 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 is the maximum average utilization possible for the input lines?

   (e) (3) What complications could arise if FDM were used instead of TDM for multiplexing in this system?