CS 4380 Data Communications **Winter Quarter, 1997**

Midterm Examination

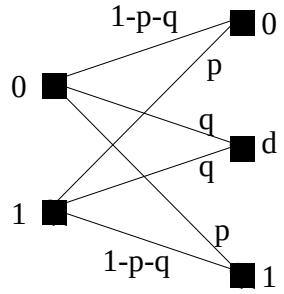
February 6

Be neat and concise. You may use your calculator and one page cheat sheet. Show your work. Good luck!

Name: _____

Problem	Points	Score
1	15	
2	20	
3	15	
4	15	
5	15	
6	20	
Total	100	

1. **Channel Modeling.** Consider a variation on the Binary Symmetric Channel model that includes the possibility of an error that converts a 0 or a 1 into an indeterminate value (i.e., a value that the receiver cannot conclusively decode as 0 or 1). Let d denote this value. The following diagram indicates the probabilities of receiving a 0, 1 or d, when sending a 0 or a 1.



(a) Give the probability of receiving $00d1d$ when sending 01100.

(b) Give the probability of receiving no d's when sending 0111.

(c) Is it easier or more difficult to design a code that detects errors for this sort of channel (as opposed to the traditional BSC channel)? Explain your answer.

2. **Coding.** Consider a code with two parity bits for frames of eight bits. The first parity bit provides an even parity check over the *even* positions in the codeword (i.e., bits $0, 2, 4, 6$). The second parity bit provides an even parity check over the *odd* positions in the codeword (i.e., bits $1, 3, 5, 7$).

   (a) Give the codeword for the frame 01110101, clearly indicating the parity bits.

   (b) What is the Hamming distance of this code?

   (c) What are the error detection properties of this code? (i.e., characterize all types of errors that this code can detect)

3. **ARQ.** Consider the Stop-and-Wait ARQ protocol. Assume a channel that operates at 10 Mbps and has propagation delay of 50 msec. Suppose the link level frames are 1000 bits and the ACKs are 10 bits. Assume the time to process an I-frame (before ACKing) and the time to process an ACK (before sending the next I-frame) are both negligible.

   (a) Fill in the timing diagram below with all times labeled, for the error-free transmission of three I-frames.

Sender ———————————————————————————————

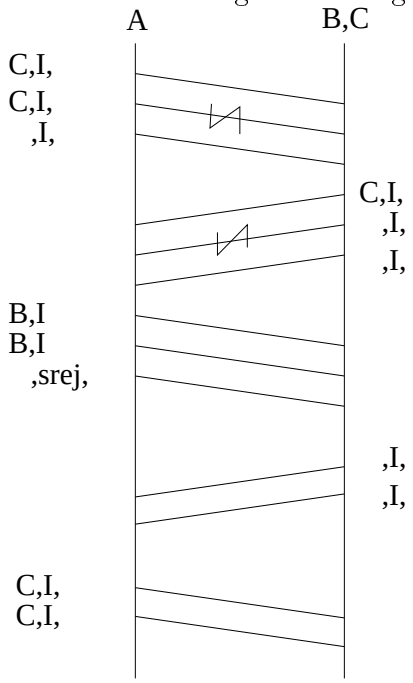
Receiver ———————————————————————————————

   (b) What is the maximum throughput possible (measured in frames per second) with Stop-and-Wait ARQ on this channel?

   (c) What is the minimum throughput possible?

4. **High Level Data Link Control (HDLC).**

Fill in the missing information in the following HDLC diagram.



5. **Short answer.** Give short answers for the following questions.

(a) What is a peer-to-peer protocol?

(b) Give an example of a type of application that is well suited to TDMA medium access control. Explain.

(c) What is the difference between forward error control and backward error control?

6. **ARQ and Sequence Numbers.** Suppose the Go-Back-N protocol has been enhanced for a receiver that can do a small amount of resequencing. Specifically, the receiver has two buffers available for incoming packets.

   (a) If the sequence number in the packets is three bits long, how large can the sender's window be?

   (b) Demonstrate that a problem can occur if the sender's window is any larger than your answer to part (a).

   (c) What types of ACKs and NACKs are needed to take advantage of the enhanced capabilities? Explain.