

## Sample Midterm Exam

**Directions:** Write your name on the exam. Write something for every question. You will get some points if you attempt a solution but nothing for a blank sheet of paper. Write something down, even wild guesses. Problems take long to read but can be answered concisely.

| Question | Maximum | Score |
|----------|---------|-------|
| 1        | 30      |       |
| 2        | 20      |       |
| 3        | 15      |       |
| 4        | 15      |       |
| 5        | 20      |       |

**1, Overview, 30 points:** Give the most important reason you can think of for each of the following. Each answer should be 1 line. Only one reason please!

- **Layering and Interfaces:** Many of today's routers implement firewalls. Thus the routers at the boundaries of DEC networks will allow email from the outside world but not other applications such as Telnet. Why is Peter Protocol unhappy about firewalls?
- **Clock Recovery:** Why eye patterns are often used by real communication engineers in a lab?
- **Shannon Limit:** Hugh Hopeful is working with a transmitter that can only send at two amplitude levels. Hugh assumes that he can never send faster than the Nyquist rate. Why is Hugh wrong?
- **Media:** Why lasers and single-mode fibre, though more expensive, are sometimes used to send light over a fibre link?
- **Coding, Preambles and Transitions:** Why 11111111 is a reasonable preamble for AMI coding but not for Ethernet.
- **CRCs and Hamming Distance:** Why frames, after adding CRC-32, have a Hamming Distance of at least 4 for reasonable frame sizes. (this is easier than it may appear).
- **Data Link:** Why undetected error rates on Data Links should be several orders of magnitude lower than the lost frame rate.

- **Data Link:** Why it is sometimes not worth doing error recovery at the Data Link.
- **LANs and multiplexing:** Why most LANs do statistical multiplexing instead of strict multiplexing.
- **LANs and wide area networks:** Why its reasonable to have high bandwidths for Local Area Networks and lower bandwidths for wide area networks.

**2. Data Link Protocols on Half-Duplex Links, 20 points:** So far in all our Data Link protocols we have assumed the links to be full-duplex so data and acks can be sent at the same time. In this problem, we examine the problems of running Data Links over half-duplex links where only one person can send at a time, either sender or receiver.

Consider a satellite link where the one-way propagation delay between sender and receiver is  $P = 250$  msec. Assume that the link is half-duplex; data can flow only in one direction at a time. The sender and receiver share the link using Time Division Multiplexing: the sender is allowed to send for  $T_s$  time and then the receiver sends for  $T_r$  time, and so on. We wish to implement a reliable data link protocol over this link. Assume that sender sends data in frames of size  $F$  bits and the receiver sends acks of size  $A$  bits. The speed of the link is  $B$  bits per second.

We start by implementing an alternating bit protocol between sender and receiver. Let  $T_s = P + F/B$  (i.e., sender gets to send for long enough to send a frame and have it be received by the receiver) and  $T_r = P + A/B$  (i.e., receiver gets to send for long enough to send an ack and have it be received by the sender)

- What is a natural value of the sender timeout for retransmissions?
- What is the efficiency of this system in terms of link usage (ignore link errors)?
- To improve the efficiency, we change the implementation to a sliding window system. If the sender window size is limited to  $X$  frames, how would you set  $T_s$  and  $T_r$  to get maximum link usage efficiency. What is the resulting link efficiency (ignore link errors)?
- After using the system we notice that link errors are frequent and so we change to a selective reject protocol. How would you modify the information returned in an ack to improve the efficiency of the selective reject system? Explain how the sender would use this information.

**3. CRCs and Error Polynomials, 15 points:** Consider the CRC generator polynomial  $x + 1$  used to generate CRC checksums just as we studied in class.

- How many bits do we have in the checksum?
- Consider a message 101. What is the checksum value? Show your division
- Consider a message 111. What is the checksum value? Show your division?
- Prove that this CRC polynomial catches all odd bit errors.
- You have seen this CRC called by a different name. What is it?

**4. HDLC Framing, 15 points:** Hugh Hopeful has invented a new flag for HDLC (Hopeful Data Link Control) protocol. He uses the flag 01010101.

- In order to prevent data bits from being confused with flags, the sender stuffs a one after receiving a sequence 010101. Does this work? Justify your answer with a short proof or counterexample. (8 points)
- To reduce the overhead, Hugh tries to stuff a zero after receiving 0101010. Will this work? Justify your answer with a short proof or counterexample. (7 points)