# EE/CSE 461 Midterm Exam

**July 27, 1998**

**Your Name: Sample Solution**

Every problem carries an equal number of points. Your solutions must contain the derivation of your answers.

Write all your answers directly on this paper. Make your answers as concise as possible. If there is something in a question that you believe is open to interpretation, then please go ahead and interpret **but** state your assumptions in your answer.

## Problems:

1. If a binary signal is sent over a 3-kHz channel whose signal-to-noise ratio is 20dB, what is the maximum achievable data rate?

*The Shannon limit is 19.5 kbps. The Nyquist limit is 6kbps. The bottleneck is therefore the Nyquist limit, giving a maximum channel capacity of 6kbps.*

2. Compare the delay in sending an x-bit message over a k-hop path in a circuit-switched network and in a (lightly-loaded) packet-switched network. The circuit setup time is s sec, the propagation delay is d sec per hop, the packet size is p bits, and the data rate is b bps. Under what conditions does the packet network have a lower delay?

*With circuit switching, at t=s the circuit is set up; at t=s+x/b the last bit is sent; at t=s+x/b + kd the message arrives.*

*With packet switching, the last bit is sent at t=x/b. To get to the final destination, the last packet must be retransmitted K-1 times by the intermediate nodes, each transmission taking p/b sec, so the total delay is*

*x/b + (K-1)p/b + kd.*

*Packet switching is faster if s> (K-1)p/b.*

3. A major issue in the design and analysis of any ring network is the "physical length" of a bit. If the data rate of the ring is 1 Mbps, and a typical signal propagation speed is about 200 m per microsecond, how many bits can a ring whose circumference is 1000 meters contain on it at once?

For calculation and discussion see Tanenbaum pg. 293.

4. Suppose that a framing scheme for use over a point-to-point link uses a two byte length prepended to each packet to recover packet boundaries. The receiver reconstructs packet boundaries by reading the length, and then that many bytes of packet data. Suppose an error in the underlying layer causes one bit to be changed. In the worst case, how many packets could be destroyed by this error? Mention a better framing scheme and the corresponding number (of packets that could be destroyed) for that scheme.

*In the worst case, the bit changed is in the length field. All subsequent packets could be lost. The receiver will never find the length bytes after the error unless it is a very lucky user.*

5. Consider an ARQ algorithm running over a 20-km point-to-point fiber link.

(a) Compute the propagation delay for this link, assuming that the speed of light is 2*10^8 meters per second in the fiber.
(b) Suggest a suitable timeout value for the ARQ algorithm to use.
(c) Why might it still be possible for the ARQ algorithm to timeout and retransmit a frame, given this timeout value?

*(a) Propagation delay = 20*10^3/2*10^8 sec = 0.1 ms*
*(b) The round trip time would be around 0.2 ms. A suitable timeout time would be double this round trip time = 0.4 ms*
*(c) The timeout calculation does not consider delays that may be induced by the remote node; e.g. when it has to process for a long period of time before sending an ACK.*