Problem 1

Let $g(x) = x^3 + x + 1$. Consider the information sequence 1001.

(a) Find the codeword corresponding to the preceding information sequence.

(b) Suppose that the codeword has a transmission error in the first bit. What does the receiver obtain when it does its error checking?

Problem 2

ATM uses an eight-bit CRC on the information contained in the header. The header has six fields: GFC field (first 4 bits); VPI field (next 8 bits); VCI field (next 16 bits); Type field (next 3 bits); CLP field (next 1 bit); CRC (next 8 bits).

(a) The CRC is calculated using the following generator polynomial: $g(x) = x^8 + x^2 + x + 1$. Find the CRC bits if the GFC, VPI, Type, and CLP fields are all zero and the VCI field is 00000000 00001111. Assume the GFC bits correspond to the highest-order bits in the polynomial.

(b) Can this code detect single errors? Explain why.

Problem 3

A 1 Mbyte file is to be transmitted over a 1 Mbps communication line that has a bit error rate of $p = 10^{-6}$.

(a) What is the probability that the entire file is transmitted without errors? Note for n large and p very small, $(1-p)^n \approx e^{-np}$.

(b) The file is broken up into N equal-sized blocks that are transmitted separately. What is the probability that all the blocks arrive without error? Is dividing the file into blocks useful?

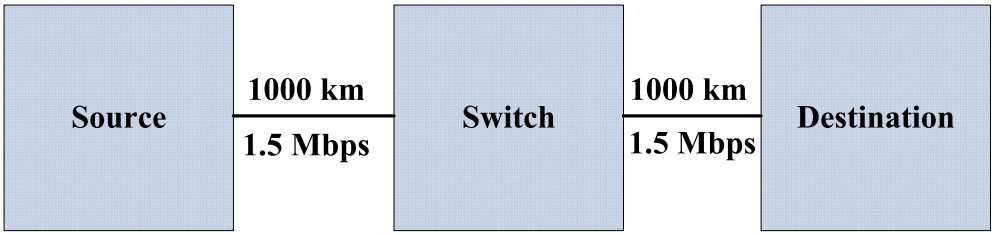
(c) Suppose the propagation delay is negligible, explain how Stop-and-Wait ARQ protocol can help deliver the file in error-free form. On the average how long does it take to deliver the file if the ARQ transmits the entire file each time?

(d) Now consider breaking up the file into N blocks. (Neglect the overhead for the header and CRC bits.) On the average how long does it take to deliver the file if the ARQ transmits the blocks one at a time? Evaluate your answer for $N = 80, 800$ and 8000.

(e) Explain qualitatively what happens to the answer in part (d) when the overhead is taken into account.

Problem 4

A 64-kilobyte message is to be transmitted from the source to the destination, as shown below. The network limits packets to a maximum size of two kilobytes, and each packet has a 32-byte header. The transmission lines in the network have a bit error rate of 10^{-6}, and Stop-and-Wait ARQ is used in each transmission line. How long does it take on the average to get the message from the source to the destination? Assume that the signal propagates at a speed of 2×10^5 km/second, and the ACK error, the ACK time, and processing time are negligible.



Problem 5

Consider a slotted ALOHA system with a large number of nodes. In a time slot, each backlogged packet (packet collided in previous transmission) is transmitted with probability p. And in each time slot, a new packet arrives to the system with probability ϵ. The new packet will attempt transmission in the next slot. All these transmissions are independent of one another.

- If there are N backlogged packets in the current time slot, find the probability distribution of the number of backlogged packets in the next time slot. (Hint: the number of backlogged packets in the next time slot can be N, $N-1$, or $N+1$).
- Calculate the average increase of the number of the backlogged packets in a time slot.
- If backlogged packets accumulate with the time, then the buffer will overflow and the system will be unstable. Is the given ALOHA system always a stable system? If not, under what condition the system becomes unstable?