ECE158a Assignment 2

Due date Oct 20

1 Questions

1. We have seen in class that Hamming code is an error correction code that gives a simple way to add check bits and correct up to $(d_{min} - 1)/2$ errors, where d_{min} is the minimal Hamming distance between any two codewords in the code. In the following, we consider the Hamming $(7, 4)$ code, where $n = 7$ is the codeword length, and $k = 4$ is the message length.

   a) List all the codewords in the Hamming $(7, 4)$ code.

   b) Pick any two codewords from the Hamming $(7, 4)$ code, compute the sum of the two codewords. Is the result a codeword in the Hamming $(7, 4)$ code.

   c) Suppose you receive a block of bits 1010010. Use the syndrome decoding scheme introduced in class to decode the received block. Assuming that the decoding scheme does not make a mistake in this case, please identify the original message (4 bits) and the locations of error bits in the received block (if errors occur).

   d) What is the minimal Hamming distance d_{min} of the Hamming $(7, 4)$ code? How many error bits could be corrected by the Hamming $(7, 4)$ code?

   e) Now consider a channel that transmits one bit at a time with an error probability p, and each use of the channel is independent. Suppose you send a Hamming $(7, 4)$ codeword through this channel (use the channel 7 times to send the $7-bit$ codeword), and decode the received bits with the syndrome decoding. Derive the probability that you make a mistake in decoding (i.e. the probability that the decoded message is not the original message). Also, apply $p = 0.9$ in the expression to evaluate the probability.

2. Suppose you are transmitting a data message 1110011 using a cyclic redundancy check (CRC) code with generator 101 lets call it message A. If you send A with checksum method with blocks of size 3 what is the checksum that you would append to the message?

3. Consider the topology shown in Figure 1, where every device is in the same LAN. Suppose switches $1 - 4$ are learning switches. Answer the following questions:

   a) Suppose host 2 is going to send a frame to host 8, and the IP address of host 8 is known to host 2. Describe the procedure required to forward the frame from host 2 to host 8. In particular, explain how the switches determine the path to forward the frame.

   b) Suppose host 2 has sent the frame to host 8, and host 8 then sent another frame to host 2. Write down the switch table (or MAC address table) for each switch.

4. Suppose three nodes are communicating on a network that uses a random access protocol to mitigate collisions. Let the nodes transmit packets in slots as shown in the following diagram 2, where slot 1 begins at time t = 0. In the protocol, each node transmits a packet, and if there is a collision then the node waits for X time slots before transmitting again, where X is a random variable following the distribution $Unif\{0, 1, 2, \ldots, 2^N - 1\}$, $N = min\{m, 10\}$, and m is the number of previous collisions for that packet.

   a) How many packets has each node successfully transmitted after time slot 8 has completed?

   b) After slot 1, what was the probability that there was a collision in slot 2?

   c) What is the probability no node transmits in slot 9?

Figure 1: Tree topology

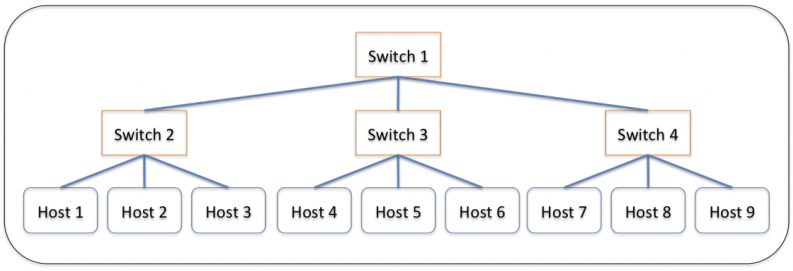

Figure 2: Q4 Diagram