ECE 360 – Computer Networks

Assignment 2

1. A noiseless 4-KHz channel is sampled every 1msec. What is the maximum data rate?
2. 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?
3. What signal-to-noise ratio is needed to put a T1 carrier on a 50-KHz line?
4. Multipath fading is maximized when the two beams arrive 180 degrees out of phase. How much of a path difference is required to maximize the fading for a 50-Km-long 1-GHz microwave link?
5. In a typical mobile phone system with hexagonal cells, it is forbidden to reuse a frequency band in an adjacent cell. If 840 frequencies are available, how many can be used in a given cell?
6. The following character encoding is used in a data link protocol: A: 01000111; B: 11100011; FLAG:01111110; ESC: 11100000. Show the bit sequence transmitted (in binary) for the four-character frame: A B ESC FLAG when each of the following framing methods are used:
    a. Character count.
    b. Flag bytes with byte stuffing.
    c. Starting and ending flag bytes, with bit stuffing.
7. One of your classmates, Scrooge, has pointed out that it is wasteful to end each frame with a flag byte and then begin the next one with a second flag byte. One flag byte could do the job as well, and a byte saved is a byte earned. Do you agree? Explain.
8. A bit string, 0111101111101111110, needs to be transmitted at the data link layer. What is the string actually transmitted after bit stuffing?
9. One way of detecting errors is to transmit data as a block of n rows of k bits per row and adding parity bits to each row and each column. The lower-right corner is a parity bit that checks its row and its column. Will this scheme detect all single errors? Double errors? Triple errors?
10. A bit stream 10011101 is transmitted using the standard CRC method described in the text. The generator polynomial is x^3+ 1. Show the actual bit string transmitted. Suppose the third bit from the left is inverted during transmission. Show that this error is detected at the receiver's end.
11. Consider the stop-and-wait protocol where A wants to send 1 KB frames to B. Packets that are overdue are presumed lost and are retransmitted.
    a. In the absence of any packet losses or duplications, explain why it is not necessary to include any "sequence number" data in the frame header.
    b. Suppose that the link can lose occasional packets, but that packets that do arrive always arrive in the order sent. Is a 2-bit sequence number (that is N mod 4) enough for A and B to detect and resent any lost packets? Is a 1-bit sequence number enough?
    c. Now suppose that the link can deliver out of order, and that sometimes a packet can be delivered as much as 1 minute after subsequent packets. How

does this change the sequence number requirements?

12. Suppose that a certain communications protocol involves a per-packet overhead of 100 bytes for header and framing. We want to send 1MB of data using this protocol, however, one data byte is corrupted and the entire frame containing it is lost and needs to be retransmitted. Give the total number of overhead plus loss bytes for frame sizes of 1,000, 5,000, 10,000, and 20,000 bytes. What size is the optimal one?