# CSC/ECE 570 Section 001

# Spring 2021

# Homework #3

**Keywords:** Data Link Layer, Framing, Error Correction, Error Detection

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## Instructions

* You can do this homework in groups of two (at most). Only one submission per group.
* The total number of points is 48.
* You must answer all questions for full credit.
* Use only this paper for your answers, in the space provided.
* The due date is as posted on the web page (please submit your answers through Wolfware).

# Questions: Answer the following questions. Justify your answers and be as precise as possible. Do not make unnecessary assumptions.

**[1]** **[4 points]** 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 is used:

(a) Byte count.

(b) Flag bytes with byte stuffing.

(c) Starting and ending flag bytes with bit stuffing.

**[2]** **[4 points]** The following data fragment occurs in the middle of a data stream for which the byte-stuffing algorithm described in the text is used: A B ESC C ESC ESC ESC FLAG FLAG D. What is the output after stuffing?

**[3] [4 points]** Calculate the 16-bit Checksum for the text of 8 characters (“Network”) at the sender. Also show how it be decoded in receiver if there are no transmission errors. USE ASCII (refer ASCII table ) to change each byte to a 2 digit hexadecimal number.

**[4] [4 points]** A bit string, 011110111110110110, needs to be transmitted at the data link layer. What is the string transmitted after bit stuffing?

**[5] [4 points]** To provide more reliability than a single parity bit can give, an error-detecting coding scheme uses one parity bit for checking all the odd-numbered bits and a second parity bit for all the even-numbered bits. What is the Hamming distance of this code?

**[6] [4 points]** Sixteen-bit messages are transmitted using a Hamming code. How many check bits are needed to ensure that the receiver can detect and correct single-bit errors? Show the bit pattern transmitted for the message 1111001100110101. Assume that even parity is used in the Hamming code.

**[7] [4 points]** One way of detecting errors is to transmit data as a block of n rows of k bits per row and add parity bits to each row and each column. The bit in 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? Show that this scheme cannot detect some four-bit errors.

**[8] [4 points]** Suppose that data are transmitted in blocks of sizes 1000 bits. What is the maximum error rate under which error detection and retransmission mechanism (1 parity bit per block) is better than using Hamming code? Assume that bit errors are independent of one another and no bit error occurs during retransmission.

**[9] [4 points]** Suppose that a message 1000 1100 1010 0011 is transmitted using Internet Checksum (4-bit word). What is the value of the checksum?

**[10] [4 points]** What is the remainder obtained by dividing x7 + x4 + 1 by the generator polynomial x2+1?

**[11] [4 points]** Find the status of the following generators related to two isolated, single-bit errors

1. x+1
2. x4 +1
3. x7 + x6 + 1
4. x15 + x14+ 1

**[12] [4 points]** A 1024-bit message is sent that contains 992 data bits and 32 CRC bits. CRC is computed using the IEEE 802 standardized, 32-degree CRC polynomial. For each of the following, explain whether the errors during message transmission will be detected by the receiver:

(a) There was a single-bit error.

(b) There were two isolated bit errors.

(c) There were 18 isolated bit errors.

(d) There were 47 isolated bit errors.

(e) There was a 24-bit long burst error.

(f) There was a 35-bit long burst error.