COE 768: Mid-Term Test

2019

- There are **Five** questions. Answer **ALL** of them. The points assigned to the questions are indicated at the beginning of the questions. The total points of this paper are 100.
- If doubt exists as to the interpretation of any question, the student is urged to submit with the answer paper, a clear statement of any assumption made.
- Time limit: 1 hour 50 minutes.

Student Name:

Student ID:

Question	Marks
Question 1 (15%)	
Question 2 (15%)	
Question 3 (25%)	
Question 4 (20%)	
Question 5 (25%)	
Total (100%)	

Question 1

A transmission system has the following parameters:

- NRZ encoding (binary 1 and 0 are represented by positive and negative rectangular pulses, respectively)
- Start delimiter (SD) is represented by 01111110.
- End delimiter (ED) is represented by 00000001.

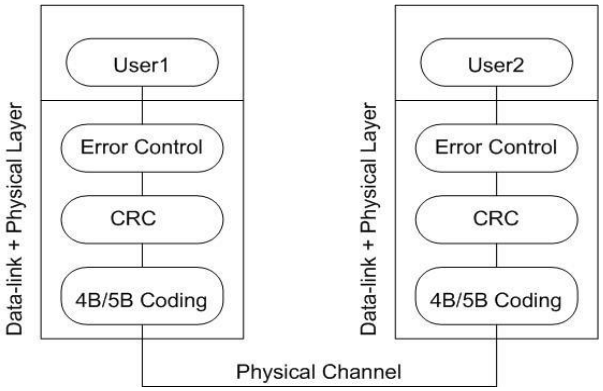
a) **(10 points)** Based on the above information, design the most efficient bit-stuffing strategy to provide data transparency. Your design should specify at what situation a stuffed bit should be inserted in the data stream and the value of the stuffed bit (1 or 0).

b) **(5 points)** Based on your answer in part (a), sketch the NRZ waveform that represents the following binary data: 11110000 00001111.

Note 2: Do not include SD and ED in your sketch.

Question 2

Figure 1 shows the processing stages implemented in the physical and data-link layers for a point-to-point communication over a physical link. The error control stage uses a connection-oriented protocol to handle the recovery of the corrupted frame; the CRC stage uses the polynomial $G(x) = x^4 + x^2 + 1$ for error checking; the 4B/5B coding performs framing and signal transmission. The data rate of the physical channel is 1Mbps.



a. **(8 points)** If the output of the error control stage (i.e. the input of the CRC stage) on the User1 side (the transmitter side) is "01010110", determine the corresponding output of the CRC stage.

b. **(7 points)** Sketch the output time waveform based on NRZI line code that represents the data (01010110) and the corresponding CRC in part (b). The 4B/5B encoding table is given below, assuming that the first pulse is negative. **Note:** Do not include SD and ED in your sketch.

4B-5B Encoding table

4-bit data	5-bit symbol	4-bit data	5-bit symbol
0000	11110	1000	10010
0001	01001	1001	10011
0010	10100	1010	10110
0011	10101	1011	10111
0100	01010	1100	11010
0101	01011	1101	11011
0110	01110	1110	11100
0111	01111	1111	11101

Question 3

Stations A and B are connected by a physical link. The two stations use a connection-oriented protocol at the data-link layer to exchange data. The protocol has the following parameters:

- 3-bit sequence field and 3-bit acknowledgement (next) field;
- Selective-Repeat is adopted as the sliding window mechanism;
- Each data frame carries a sequence number (Ns) and an Ack number (Nr).

At $t = 0$, the window pointers S_f, S_n (for the sending window) and R_n (for the receiving window) had the values of 7, 3, and 5, respectively. Subsequently, the following events occurred:

- At $t = 1$ msec, station A received a data frame from station B with Ns=5 and Nr=2. The frame passed the CRC test.
- At $t = 10$ msec, station A received the second data frame with Ns=7, Nr=2. The frame passed the CRC test.
- At $t = 15$ msec, station A received the third frame with Ns=2, Nr=2. The frame passed the CRC test.
- At $t = 17$ msec, station A sent a data frame to station B.

a. **(5 points)** Based on the information provided above, what is the maximum sending window size that can be used by the protocol?

b. **(5 points)** Based on your answer in (a), explain if any of the data frames received by station A would be rejected by the data-link layer of station A.

c. **(10 points)** Based on your answer in (a), determine the values of S_f, S_n and R_n at $t = 17$ msec.

d. **(5 points)** Based on your answer in (c), determine the values of Ns and Nr of the data frame sent by station A.

Question 4

A data-link layer that supports the communication between two computers over a physical link has the following parameters:

- Link distance =500 km;
- Channel data rate = 100 Mbps;
- Error Control Protocol: Go-back-n
- Maximum Frame size = 10000 bits
- Signal propagation speed = 2×10^5km/sec

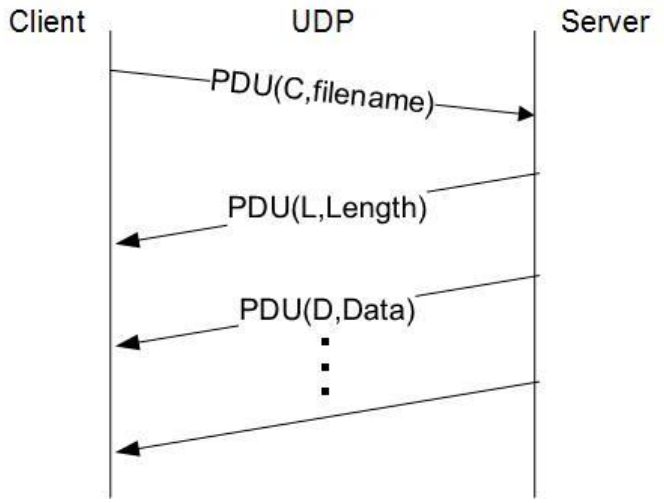
a) **(12 points)** Determine the minimum number of bits required to represent the sequence number of the frame in order to achieve maximum efficiency.

b) **(8 points)** Determine the optimal time-out period for retransmission. Answer the question based on the following assumptions:

- The retransmission timer starts when the transmission of the data frame is completed.
- The receiver sends an ACK for every correctly received frame.
- Time to process a data frame = 0.5 msec.
- Time to generate and transmit an ACK frame = 0.1 msec.

Question 5

(25 points) This question is related to labs 3, 4 and 5. In lab 5, the server sends a "F" PDU to inform the client the completion of a file download. In this question, you are asked to use a "L" PDU instead of a "F" PDU to achieve the same effect. More specifically, before the start of the file transfer, the server will send the "L" PDU whose data field contains the size of the file in bytes (a 4-byte integer is used to hold the file size, assuming that the size of the file to be transferred is less than 2^{32} bytes). The client uses this information to keep track of the number of bytes received and thus knows when the file transfer is completed. Note that the server only uses the "data" PDU to transport all the file data. No "F" PDU is used. The following diagram illustrates the PDU exchanges based on the use of "L" PDU.



You only need to show the portions of the client program that are modified, assuming the server program is implemented correctly.

Hints:
To copy the integer value stored in the character array "data" to the integer variable "size":

```
int     size;
char    data[4];

size = *data;
```