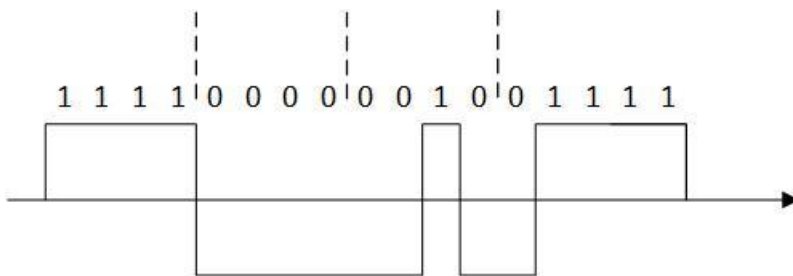# COE768: Computer Networks

2019 Mid-Term Test Answers

Question 1:

a) Since the ED is 00000001, the data portion should never contain this pattern. To achieve this, we can insert a "one" in the data stream after every **6 consecutive zeros**.

b) After the bit stuffing, the bit stream is 1111 0000 0010 01111.
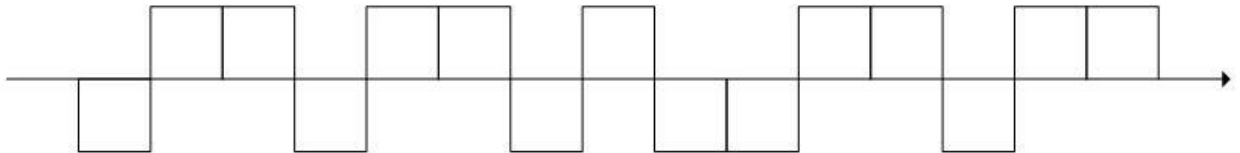
Question2:

(a) CRC:

$$x^{10} + x^8 + x^6 + x^5 \div x^4 + x^2 + 1 \xrightarrow{yields} \text{remainder} = x^3 + x$$

```
                        100 0 01
                    _____
10101    /    0101 0110 0000
                    101 01
                _____
                        10 000
                        10 101
                    _____
                        1010
```

Therefore the output of the CRC stage is: 0101 0110 1010

(b) Output at the 4B/5B transmitter: after 4B/5B mapping → 01011 01110 10110. The corresponding waveform is:

Question 3

a) Since the sequence space is 8 (2^3), the maximum window size is 8/2= 4.

b) The first frame was accepted because it passed the CRC test and the sequence number is inside the receiving window. The second frame was also accepted using the same argument above. The third frame was rejected because the sequence number, which is 2, is outside the receiving window, which is [6, 7, 0, 1]

c) $S_f = 2, S_n = 4 \ and \ R_n = 6$

d) Ns=3 and Nr=6

Question 4

a) Time to transmit a frame: $t_f = \dfrac{10000}{10^8} = 10^{-4} \, sec$

   Propagation delay: $t_{prop} = \dfrac{500}{2 \times 10^5} = 2.5 \times 10^{-3}$

   Normalized propagation delay: $a = \dfrac{t_{prop}}{t_f} = 25$

   For maximum efficiency, $W_s \geq 2a + 1 = 51$, where W_s is the sending window size.
   Since $2^n \geq W_s + 1 = 52$, where n is the number of bits required, therefore the minimum value of n is 6.

b) The optimal retransmission timeout is the time between the completion of the transmission of the data frame and the reception of the corresponding ack frame. This is the sum of the round trip delay, the time to process the data frame and the time to generate and transmit the ack frame:

   Round trip delay (2×2.5) + time to process a data frame (0.5) + time to generate and transmit an ack frame $(0.1) = 5.6$ msec

Client Program

```
n = read(s, &rpdu, 101);
if (rpdu.type == 'L'){
   bytes_to_read = *rpdu.data;
   while(n = read(s, &rpdu, 101)){
      if(rpdu.type == 'D'){
        write(fd, rpdu.data, n-1);
        bytes_to_read = --(n-1);
        if(bytes_to_read == 0)
          break;
      }
   }
}
```