Exercise 2: Error detection, Error control and Flow control

1. Assume that a data transfer is disturbed by a burst of noise during 2 milliseconds. How many bits may have been affected if the bit rate is
    a. 10 kbps?
    b. 100 kbps?
    c. 1 Mbps?

2. Assuming even parity, determine the value of the parity bit for each of the following bit sequences:
    a. 1001001
    b. 1100111
    c. 1001011
    d. 1110111

3. Calculate the CRC for the following messages if the generator polynomial is $C(x) = x^3+x^2+1$. Check your solution as well!
    a. 00111010
    b. 1010011110
    c. 111000111
    d. 1100110011

4. Assume that a 4-bits CRC with generator polynomial $C(x) = x^4+x^3+1$ has been used. Which of the following three messages have been accurately received?
    a. 11010111
    b. 10101101101
    c. 10001110111

5. Determine 8-bits checksums for the following bit sequences:
    a. 10010011 10010011
    b. 00011001 01010011
    c. 11000111 00001101

6. Assume that a receiver receives the following bit sequences. An 8-bit check sum is used. Have the bit sequences been received correctly?
    a. 10010011 10011011 11011001
    b. 00110011 10110111 00010101
    c. 01110000 00111000 01010111

7. Remove the bit stuffed 0:s from the following bit sequences, which have been detected on a link where the HDLC-protocol is used.
    a. 010101111101011101111100 ...
    b. 010101111110101110111110 ...

8. Bit stuff the following bit sequences (which contain no flags):
    a. 000111111011110011111001
    b. 000111111111111111111111111111110011111001

9. Assume that a Go-back-N ARQ uses a window of size 15. How many bits are needed to define the sequence number?

10. In Go-back-*N* ARQ, the size of the sender window must be less than 2^m, where *m* is the number of bits used for the representation of sequence numbers. Show in an example, by drawing a message sequence, why the size of the sender window must be less than 2^m.

11. A Selective Repeat ARQ is using 7 bits to represent the sequence numbers. What is the maximum size of the sliding window?

12. Assume that host A sends frames to host B and uses sequence numbers coded with 3 bits. A *Go-back-n*-ARQ is used with a sliding window of size 4. Show the content of the window in the following cases:
    a. ***Before*** A has sent any frames.
    b. ***After*** A has sent frames 0,1 och 2; B has sent ACK for frames 0 and 1; and these ACKs have been received by A.
    c. ***After*** A has sent 3,4,5 and 6; B has sent ACK for 4; and this ACK has received by A.

13. Host A uses *stop-and-wait*-ARQ when sending frames to host B. Assume that the distance att between A and B is 4 000 km. Answer the following questions:
    a. After how long time can A receive an ACK for a frame? Use the speed of light as propagation speed and assume that the time it takes for B to send an ACK after receiving a frame is zero.
    b. How long is the transmission time for a frame of 1000 bytes if the transmission rate is 100 000 kbps?
    c. Use the answers in a) and b) in order to determine percentage of time that A is idle.