

**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. 01010111110101110111110 ...
  
8. Bit stuff the following bit sequences (which contain no flags):
  - a. 0001111110111110011111001
  - 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.