1 Triple Modular Redundancy

A sender uses triple modular redundancy to send a packet. The receiver receives the following 3 versions of the packet:

1: 10**0**11001
2: 10**1**11001
3: 10**0**11001

What can be said about the original packet?

2 (7,4)-Hamming Code

Consider a (7,4)-Hamming Code with the generator matrix G and the parity check matrix H.

$$\mathbf{G} = \begin{pmatrix} 1 & 1 & 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 1 & 0 & 0 \\ 1 & 1 & 1 & 0 & 0 & 1 & 0 \\ 1 & 0 & 1 & 0 & 0 & 0 & 1 \end{pmatrix} \qquad \mathbf{H} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 1 & 0 \\ 0 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 0 & 1 \end{pmatrix}$$

1. What is the codeword for the data word $\begin{pmatrix} 1 & 0 & 1 & 0 \end{pmatrix}$?

2. What is the syndrome of the codeword $\begin{pmatrix}0 & 0 & 1 & 0 & 1 & 0 & 1\end{pmatrix}$?

3. Assuming only 1 bit error occured in $\begin{pmatrix}0 & 0 & 1 & 0 & 1 & 0 & 1\end{pmatrix}$, how can it be corrected?

4. If we decode a codeword and get the syndrome $\begin{pmatrix}0 & 0 & 0\end{pmatrix}$, does it mean that there is no error in the received codeword?

3 Internet Checksum

1. What is the checksum of the frame 010000111101 (if the frame is divided in 4 bit words)?

2. How would the receiver check whether there were any bit errors in a received frame?

3. What kind of error can/cannot be detected using the Internet checksum?

4 Cyclic Redundancy Check

1. Given the CRC-4 generator polynomial $G(x) = x^4 + x^1 + x^0$ and the data frame represented by the polynomial $M(x) = x^7 + x^6 + x^5 + x^3 + x^0$

   What does the transmitted polynomial $T(x)$ look like?

2. Assume you received the polynomial
   $T(x) \oplus E(x) = x^{11} + x^{10} + x^9 + x^7 + x^4 + x^1$.
   Given the CRC-4 generator polynomial $G(x) = x^4 + x^1 + x^0$, is $E(x) = 0$?

3. If the remainder obtained after dividing the received frame by the generator polynominal is zero, does it mean that there is no error in the received frame?