

3.1.2.

An error detecting code uses a parity bit for the odd bits and another for the even bits. What is the Hamming distance?

The hamming distance is 2 (same as regular parity)

3.1.3.

If we ~~use~~ use 1000 bit blocks of data, What is the max error rate under which error detection and retransmission ~~with no error~~ (1 parity bit per block) is better than using Hamming code? Assume independent bit errors and error-free retransmission. ($\epsilon = < 0.009$)

$$1000 \text{ bit block} \Rightarrow n = 1000$$

$$\text{Hamming code: } n = 2^r - 1 \Rightarrow r = \lceil \log_2(n+1) \rceil = \lceil \log_2(1001) \rceil = 10$$

$$\text{Eff}_H = \frac{k}{n} = \frac{2^r - 1}{2^r} = 0.9902$$

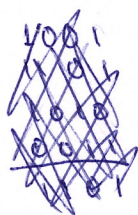
$$\text{Eff}_p = \frac{1}{1 - p_s^n + 2(1 - p_s^n)} \Rightarrow p_s^n + 2 - 2p_s^n = \frac{1}{\text{Eff}_p} \Rightarrow p_s = \sqrt[n]{2 - \frac{1}{\text{Eff}_p}} \Rightarrow p_e = 1 - \sqrt[n]{2 - \frac{1}{\text{Eff}_p}}$$

$$\text{Eff}_p \geq \text{Eff}_H \Leftrightarrow p_e \leq 1 - \sqrt[n]{2 - \frac{1}{\text{Eff}_H}} = 1 - \sqrt[1000]{2 - \frac{1}{0.9902}} = \boxed{9.92 \cdot 10^{-6} \geq p_e}$$

3.1.4

What is the 4-bit-word ~~Checksum~~ for 1001 1100 1010 0011 ?

(1011)



$$\begin{array}{r} 1001 \\ + 1101 \\ + 1010 \\ + 0011 \\ \hline 100011 \\ 10 \\ \hline 0101 \\ \hline \sim 11010 \end{array}$$