3.1.2.

An error detecting code uses a parity bit for the add bits and another for the even bits. What is the ~~Hamm~~ Hamming distance? (=2)

$$\boxed{\text{The hamming distance is 2 (same as regular parity)}}$$

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 an error~~ (1 parity bit per block) is better than using Hamming Code? Assume independent bit errors and error-free retransmission. (="<0.009")

1000 bit block $\Rightarrow n = 1000$ b

Hamming code: $\left.\begin{array}{l} n = 2^r - 1 \\ r \in \mathbb{Z} \end{array}\right\} \Rightarrow r = \lceil \log_2 (n+1) \rceil = \lceil \log_2 (1001) \rceil = \lceil 9.97 \rceil = 10$

$$Eff_H = \frac{k}{n} = \frac{2^r - r - 1}{2^r - 1} = 0.9902$$

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

$$Eff_p \geq Eff_H \Leftrightarrow p_e \leq 1 - \sqrt[n]{2 - \frac{1}{Eff_H}} = 1 - \sqrt[1000]{2 - \frac{2^r - 1}{2^r - r - 1}} = \boxed{9.92 \cdot 10^{-6} \geq p_e}$$

3.1.4

What is the 4-bit-word ~~Checksum~~ ~~IP Checksum~~ IPv4 Checksum for 1001 1100 1010 0011 ? (1011)

$$\begin{array}{rr}
 & {\scriptstyle 1\,0\,1\,1\,1} \\
 & 1001 \\
 & 1101 \\
+ & 1010 \\
 & 0011 \\
\hline
10 \hookrightarrow & 0011 \\
 & 10 \\
\hline
 & 0101 \\
\sim & \\
\hline
 & \boxed{1010}
\end{array}$$