

City University of Hong Kong
Department of Electrical Engineering

EE3009 Data Communications and Networking

Solution to Assignment 3

1. The receiver makes a decoding error if two or more out of the three bits are in error.

The probability of a data bit equal to 0 is $\frac{1}{2}$.

Therefore, $\Pr[\text{data bit}=0 \text{ and receiver makes a decoding error}] =$

$$P_{error}^0 = \frac{1}{2} [C_2^3 p^2 (1-p) + p^3]$$

Similarly, $\Pr[\text{data bit}=1 \text{ and receiver makes a decoding error}] =$

$$P_{error}^1 = \frac{1}{2} [C_2^3 p^2 (1-p) + p^3]$$

$$P_{error} = P_{error}^0 + P_{error}^1 = C_2^3 p^2 (1-p) + p^3 = 3(10^{-3})^2 (1 - 10^{-3}) + (10^{-3})^3 \\ \approx 3(10^{-6})$$

2. $b_0 = 11111111 \ 11111111 = 2^{16} - 1 = 65535$

$$b_1 = 11111111 \ 00000000 = 65280$$

$$b_2 = 11111111 \ 11110001 = 61681$$

$$b_3 = 11000000 \ 11000000 = 49344$$

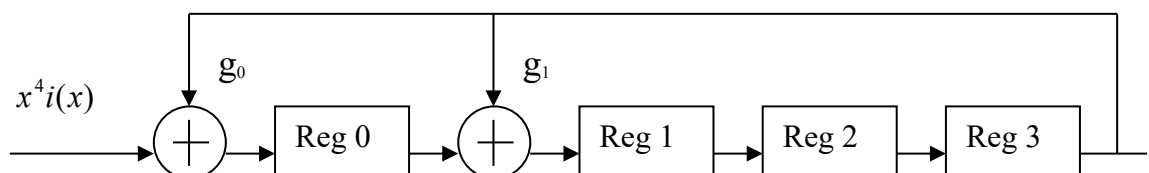
$$x = b_0 + b_1 + b_2 + b_3 \text{ modulo } 65535 = 241840 \text{ modulo } 65535 = 45235$$

$$b_4 = -x \text{ modulo } 65535 = 20300$$

so the internet checksum = 01001111 01001100

- 3.

i)



- ii) The encoding can be done either by polynomial division, or the more compact way of doing the division without explicitly writing the power of x .

$$\begin{array}{r}
 \begin{array}{r}
 x^9 + x^8 \qquad \qquad \qquad + x^3 + x \\
 x^4 + x + 1 \overline{) x^{13} + x^{12} + x^{10} + x^8 + x^7 + x^5 + x^4} \\
 \underline{x^{13} \qquad + x^{10} + x^9} \\
 x^{12} \qquad + x^9 + x^8 + x^7 + x^5 + x^4 \\
 \underline{x^{12} \qquad + x^9 + x^8} \\
 x^7 + x^5 + x^4 \\
 \underline{x^7 \qquad + x^4 + x^3} \\
 x^5 \qquad + x^3 \\
 \underline{x^5 \qquad + x^2 + x} \\
 x^3 + x^2 + x \leftarrow \text{remainder}
 \end{array}
 \end{array}$$

codeword = 11010110111110

or,

$$\begin{array}{r}
 \begin{array}{r}
 1100001010 \\
 10011 \overline{) 11010110110000} \\
 \underline{10011} \\
 10011 \\
 \underline{10011} \\
 10110 \\
 \underline{10011} \\
 10100 \\
 \underline{10011} \\
 1110 \leftarrow \text{remainder}
 \end{array}
 \end{array}$$

codeword = 11010110111110