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[data bit=0 and receiver makes a decoding error] =

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

   Similarly, Pr[data bit=1 and receiver makes a decoding error] =

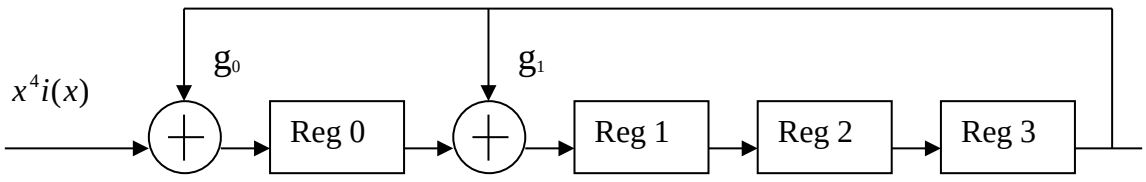
   $P_{error}^{1} = \frac{1}{2}[C_2^3 p^2(1-p) + p^3]$

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

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 modulo 65535 = 241840 modulo 65535 = 45235
   b_4= -x 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.

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

codeword = 11010110111110

or,

$$
\begin{array}{r}
1100001010 \\
\hline
10011 \;\big)\; 11010110110000 \\
10011 \\
\hline
10011 \\
10011 \\
\hline
10110 \\
10011 \\
\hline
10100 \\
10011 \\
\hline
1110 \quad \leftarrow \text{remainder}
\end{array}
$$

codeword = 11010110111110