Assignment 3

Due Thursday, November 28, 2019 (with no deadline extension possible). Submit your assignment using the appropriate Assignment folder on the course web site. Assignments submitted after the solutions are made available will be given a mark of zero. **Show how you obtained your answers.**

Question 1

One way to build an error-correcting code is to place the data bits in a matrix and compute one parity bit (even or odd) for each row and one parity bit for each column. If one of the data bits is received in error then the parity check for that column and that row will be wrong. The receiver can determine which bit was received in error by computing the row and column parity bits and inverting the bit in the row and column combination indicated by the failed parity checks.

(a) What is the rate of this code if there are 4×4 = 16 data bits?

(b) Will the code detect an error in one of the parity bits?

(c) Can this code correct more than one error? If so, when?

Question 2

A CRC uses the generator polynomial $1x^1 + 1x^0$.

(a) What is the length of the CRC (in bits)?

(b) What is the remainder of dividing the message $1, 0, 1, 0, 1, 1$, represented as a polynomial, by the above generator polynomial?

(c) How many bits are in the partial remainder at each step of the division?

(d) Derive an expression for the next partial remainder as a function of an input bit and the previous partial remainder. *Hint: If the two bits being considered in a step of the long division are **ab**, what is the value of the next partial remainder (the next value of **a**) when **a**=0? When **a**=1?*

(e) What operation does this represent?

(f) If we use the final partial remainder as the CRC, are we adding an even or an odd parity bit?

Question 3

A channel has a flat frequency response, a bandwidth of 1 MHz and adds Gaussian noise to the signal. The SNR at the output of the channel is 3 dB.

(a) What is the maximum symbol rate (in Hz) that can be transmitted over this channel without ISI?

(b) What is the maximum data rate (in bits per second) that can be transmitted over this channel without ISI?

(c) What is the maximum information rate can be transmitted over this channel at an error rate of 10^{-15}.