

# EE 121: Introduction to Digital Communication Systems

## Problem Set for Discussion Section 4

Wed 2/20/2007 and Mon 2/25/2007

1. A satellite broadcasts a digital television signal by sending two raw data bits  $x_1$  and  $x_2$  at a time, to  $K$  dishes on the ground. Each dish receives the bitstream through independent erasure channels with probability  $p$ .

(a) In order to improve reliability, a feedback system is introduced. If a ground user loses one or both of the bits, it sends a feedback message to the satellite, requesting retransmission of the lost data. The satellite receives all feedback messages errorfree and retransmits the appropriate bits. What is the probability  $p_1$ , that there exists a user that cannot decode both the bits, even after a possible retransmission? What is the expected rate  $R_1$ , of this code. What happens for  $K = 1$ . What happens for large  $K$ ?

(b) Suppose instead that the satellite uses a code with the following generator matrix

$$\mathbf{G} = \begin{pmatrix} 1 & 0 \\ 0 & 1 \\ 1 & 1 \end{pmatrix}.$$

What is the rate  $R_2$ , of this code? Write out all the codeword vectors. Explain how the decoder works. What is the minimum distance of the code? What is the probability  $p_2$ , that there exists a user who cannot decode both the bits?

(c) Comment on the ratios  $p_1/p_2$  and  $R_1/R_2$ , when  $p$  is a small fixed number, and  $K$  grows.