Carleton University
Department of Systems and Computer Engineering
SYSC5606 Introduction to Mobile Communications
Summer 2015
Question Set 3
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Question 1

(a) In a DS-CDMA multiple user system, how many simultaneous users can be supported such that an average bit error rate less than 10^{-3} is maintained for each user? Assume all users employ power control such that the received power of each user is maintained at an average $E_b/N_0 = 10$ dB, and assume each user has a PN code that is produced from an 7-bit shift register. Mention any other assumptions that you make.

(b) How many users can be supported if each uses a different orthogonal spreading code of length 64?

Question 2

The output of a channel, sampled at time kT is

$$y_k = h_0 a_k + h_1 a_{k-1} + v_k$$

where the date symbols $a_k = \pm 1$ with equal probability, and are uncorrelated, and the v_k are independent, zero-mean sampled of noise with variance of σ^2. A linear equalizer with 3 tap coefficients is used to process the channel's output (equalizer output at time k is $z_k = \sum_{n=0}^{2} w_n * y_{k-n}$). Its 3 tap coefficients are required to minimize the mean squared value of the error between the kth equalizer output sample and the $k-1$ st data symbols a_{k-1}.

a) Derive expressions for the optimum tap coefficients and minimum mean squared error as functions of the above parameters.

b) Determined the coefficients and minimum MSE for $h_0 = 1+j$, $h_1 = 0.3-0.1j$, and $\sigma^2 = 0.01$.

Question 3

In an omnidirectional (single-cell, single-sector) CDMA cellular system, $E_b/N_0 = 20$ dB is required for each user. If 100 users, each with a baseband data rate of 13 kbps, are to be accommodated, determine the minimum channel bit rate of the spread spectrum chip sequence. Ignore voice activity considerations.

Question 4 (Bonus)

Compare $\bar{\gamma}/\Gamma$ (selection diversity) with $\bar{\gamma_M}/\Gamma$ (maximal ratio combining) for one to six branches. Specifically, compare how the average SNR increases for each diversity scheme as a new branch is added. Does this make sense? What is the average SNR improvement offered by 6-branch maximal ratio combining as compared to 6-branch selection diversity? If $\gamma/\Gamma = 0.01$, determine the probability that the received signal will be below this threshold for maximal ratio combining and selection diversity (assume 6 branch are used). How does this compare with a single Rayleigh fading channel with the same threshold?