Read the following articles on BLAST and MIMO


These articles may be downloaded from the following website

http://www1.bell-labs.com/project/blast/
Problem #1
This problem concerns Maximal Ratio Combining (MRC) – SIMO techniques

a) The modulation technique is BPSK. Find the outage probability at the output of a maximal-ratio combining receiver (with two receiving antennas) as a function of the average received energy per bit per antenna, divided by the noise spectral density, $E_{b, \text{avg, ant}}/N_0$, and the required instantaneous, $E_{b, \text{req, ant}}/N_0$, for the required instantaneous probability of error. Assume that the receiving antennas receive independent signals of the same average power.

b) Now find the outage probability of a maximal-ratio combining receiver (with two receiving antennas) as a function of the total average received energy per bit at both antennas divided by the noise spectral density, $E_{b, \text{avg, total}}/N_0$. Assume that the antennas receive independent signals of the same average power.
c) For BPSK, compare the results of (a) and (b) with those for a single receiving antenna at an outage probabilities, of $10^{-3}$ and $10^{-1}$, if the desired instantaneous $Pr_b\{\varepsilon\}=10^{-5}$. How many dB have been gained in each case by using MRC-SIMO techniques?

**Problem #2**
This problem concerns MRC techniques when the number of receiving antennas is “L”.

For BPSK, show that the probability density function, $f(x)$, for the combined received signal for $L$ antennas, with maximal-ratio combining, is given by the equation below.

$$f(x)= \frac{1}{(L-1)! (2\sigma^2)^L} x^{L-1} \exp\{-x/2\sigma^2\}; \quad x \geq 0$$

(where $x = x_1 + x_2 + \ldots + x_L$; $x_i=r_i^2$.

The variable, $r_i$ represents the random Rayleigh variable at each receiving antenna.

**Hint:** This is similar to what we did in class for two receiving antennas.