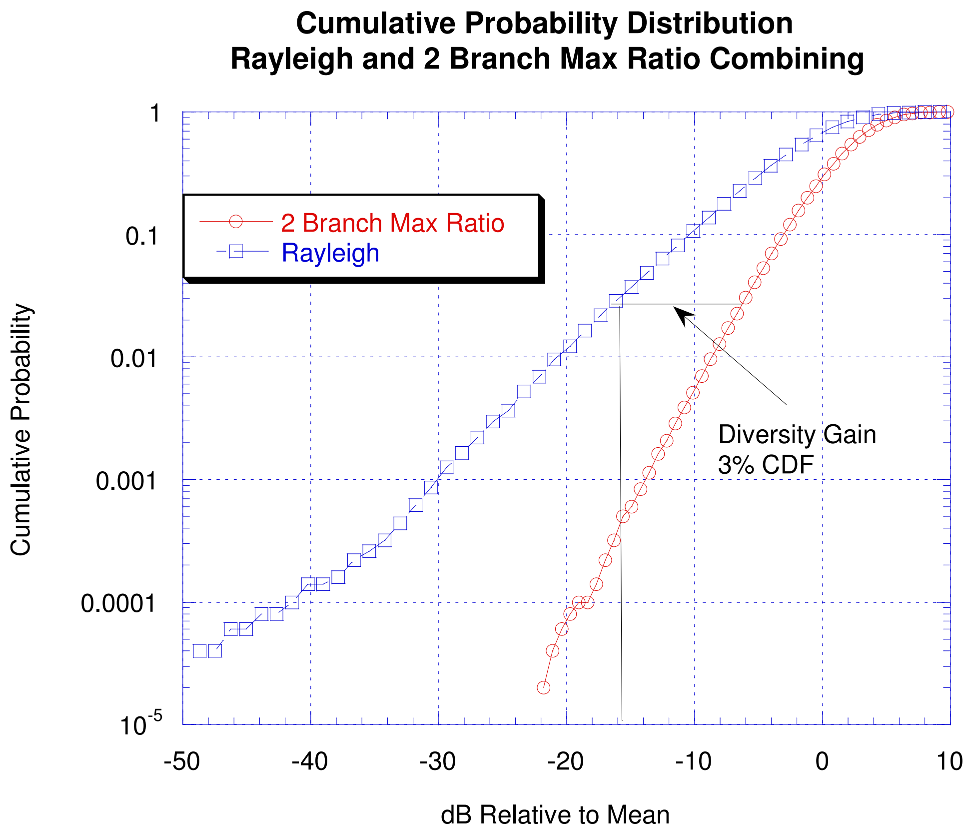
**University of Massachusetts Lowell**
**Department of Electrical and Computer Engineering**
**16.582/16.418 Wireless Communication**
**Diversity Combining:**

The purpose of this exercise is to help you to understand why diversity is so important in wireless systems.

1) Create a Rayleigh fading process the easy way.
    a. Take two independent arrays of Gaussian random numbers with mean 0 and variance 1. Assume a sampling rate of 1000 Hz. Design a low pass filter with bandwidth 10Hz which corresponds to a speed of approximately 3 MPH (5 kph, walking speed). Run each of the two processes through the filter and take the amplitude of the complex process. Let one function be real, and the other be complex.
    b. Verify using a histogram that each of the individual components are Gaussian.
    c. Plot about 1 second of the Rayleigh data but not the first second because the filter will have transitory behavior. On the x axis is time, and on the y axis is amplitude in dB. (remember amplitude is 20 log10.
    d. Create a normalized histogram (estimate of the pdf) of the amplitude (not in dB) and compare to a theoretical Rayleigh density function
    e. Create a histogram of the distribution of the phase formed from the inverse tangent of the I an Q terms.

2) Create a second instance of the Rayleigh fading using the technique outlined in step 1. Make sure that the two instances are independent. Calculate the correlation coefficient (average of P1.*P2(complex conjugate) of at least 100,000, preferably 500k to 1 Million samples of each process. Verify that the two processes are uncorrelated.
3) Now create a diversity combined signal by first doing A) selection diversity, and B) maximal ratio combining diversity on the amplitude of the two signals. In the time domain, plot a section of the combined signal (1 second) and look at the difference in terms of fade depth between parts 1) and 3). .
4) On the same plot, plot the CDF of the diversity combined signals and the uncombined signal as shown below.




5) Measure the diversity gain at the 1% level of significance.

5) Repeat 1-5 by creating 3 Rayleigh signals call them a, b and c. Let x=sqrt(1/3))(a+2b), y=sqrt(1/3)(c+2b). This is an example of partially correlated signals. See that the diversity gain is less.