Assignment 2

The following questions are taken from Chapters 5 and 6 of the Wireless Communications *texbook by Rappaport (first edition). Assignment is due Monday, March 25 at 11:30AM.*

Question 1

Plot the BER vs. E_b/N_0 performance for BPSK, DPSK, QPSK and noncoherent FSK in additive Gaussian white noise. List advantages and disadvantages of each modulation method from the mobile communications standpoint.

Question 2

If a mobile radio link operates with 30 dB SNR and uses a 200 kHz channel, find the theoretic maximum data capacity possible. How does your answer compare to what is offered by the GSM standard, which operates at a channel rate of 270.8333 kbps?

Question 3

Compare the BER and RF bandwidth of a GMSK signal operating in AWGN for the following BT values: (a) 0.25, (b) 0.5, (c) 1, (d) 5. Discuss the practical advantages and disadvantages of these cases.

Question 4

Determine the necessary E_b/N_0 in order to detect BPSK with an average BER of 10^{-5} for a Rayleigh fading channel

Question 5

Consider a single branch Rayleigh fading signal has a 20% chance of being 6 dB below some mean SNR threshold.

(a) Determine the mean of the Rayleigh fading signal as referenced to the threshold.

(b) Find the likelihood that a two branch selection diversity receiver will be 6 dB below the mean SNR threshold.

(c) Find the likelihood that a three branch selection diversity receiver will be 6 dB below the mean SNR threshold.

(d) Find the likelihood that a four branch selection diversity receiver will be 6 dB below the mean SNR threshold.

(e) Based on your answers above, is there a law of diminishing returns when diversity is used?

Question 6

Extending the diversity concepts in this chapter and using the flat fading BER analysis of Chapter 5, it is possible to determine the BER for a wide range of modulation techniques when selection diversity is applied.

Define γ_0 as the required E_b/N_0 to achieve a specific BER = y in a flat Rayleigh fading channel, and let γ denote the random *SNR* due to fading. Furthermore let $P(\gamma)$ denote a function that describes the BER for a particular modulation when the $SNR = \gamma$. It follows:

$$y = Pr[P(\gamma) > x] = Pr[\gamma < P^{-1}(x)] = 1 - e^{(-P^{-1}(x))/\gamma_0}$$

(a) Find an expression that solves γ_0 in terms of $P^{-1}(x)$ and y.

(b) When M uncorrelated fading branches are used for diversity selection, write a new expression for y.

(c) Determine the required average E_b/N_0 for BPSK in order to sustain a 10^{-3} BER in a Rayleigh fading channel.

(d) When 4 branch diversity is used, determine the required average E_b/N_0 for BPSK in order to sustain a 10^{-3} BER in a Rayleigh fading channel.