EE 224B: Fundamentals of Wireless Communication

Problem Set 1

Due: January 29 in class

1. Exercise 2.2 in notes.

2. Exercise 2.3.

3. Exercise 2.5.

4. A mobile receiver is moving at speed v and is receiving signals arriving along two reflected paths which are at angles θ_1 and θ_2 from the direction of motion. The transmitted signal is a sinusoid at frequency f.

a) Is the above information enough for estimating i) the coherence time T_c; ii) the coherence bandwidth W_c? If so express in terms of the given parameters. If not, specify what additional information would be needed.

b) Consider an environment in which there are reflectors and scatterers in all directions from the receiver and an environment in which they are clustered within a small angular range. Using part (a), explain how the channel would diff in these two environments.

5. Exercise 2.10 parts 1), 2) and 3).

6. Let x be a random variable equally likely to be $+1$ or -1 and

$$\mathbf{y} = \mathbf{h}x + \mathbf{z}$$

where $\mathbf{h} \in \Re^n$ is a fixed vector. We want to perform maximum likelihood (ML) detection of x from observing $\mathbf{y}$, but before hand we have the freedom to choose $\mathbf{h}$ to make the error probability as small as possible. The constraint on $\mathbf{h}$ is:

$$\sum_{i=1}^{n} h_i^2 \leq 1.$$

a) Suppose $\mathbf{z} \sim N(0, \sigma^2 I)$. What should we choose $\mathbf{h}$ to be? What is the ML detection rule and what is the probability of error?

b) Suppose $\mathbf{h} \sim N(0, K_z)$, where K_z is non-singular. Repeat part (a). Express your answer in terms of K_z.

c) Repeat part (b) if K_z is singular.