STAT/ELEC 331 HW 8

Problems in addition to those from the book

1. **Report your HW 5 score** (1 point)

   Due to a clerical error, we failed to record some of your scores for homework 5. Please write down your homework five score (raw score, not a percentage).

2. **Bivariate Normal PDF** (5 points)

   Use your favorite software package such as Matlab, Mathematica, Maple, or SPlus for this problem. Let $\mu_1 = \mu_2 = 0$, $\sigma_1 = 2\sigma_2 = 1$. Graph the pdf of the bivariate normal with $\rho = 0, .3, -.6$, and .9. Describe the effect of each of the five parameters on the pdf. Hand in your clearly labeled plots, but not your scripts. If you use Matlab, you may find the following functions useful: `meshgrid, mesh, subplot`.

3. **Detecting a constant signal: Controlling the false alarm rate** (10 points)

   Recall the problem discussed in class where $A > 0$, and a transmitter transmits a constant length n signal of amplitude either 0 or A. The receiver observes the transmitted signal corrupted by i.i.d. (independent and identically distributed) Gaussian noise with zero mean and variance σ^2. In class we considered the detector that computes the sample average of the received samples and makes a decision by comparing that average to a threshold γ. We also saw that the optimal γ depends on the *a priori* probability θ of a zero-amplitude signal being transmitted.

   In many practical settings θ is unknown. For example, suppose you are designing an incoming ballistic missile detection system. What is the a priori probability of such an event? Hard to say.

   In such a scenario, we cannot set γ to minimize the probability of error. An alternative is to choose some level $\alpha \in (0, 1)$ and set γ so that the probability of a false alarm is α. A false alarm is when you say there was something there when there really wasn't.

   a. Determine γ as a function of α

   b. What is the *miss probability* for this detector as a function of α? A *miss* is when something was there but you didn't see it.

   c. The quantity nA^2/σ^2 is sometimes called the signal-to-noise ratio (SNR). Why is this name appropriate?