Homework 1

ELEC 540: Advanced Wireless Communications

Problems are from *Fundamentals of Wireless Communications,* by David Tse and Pramod Viswanath. The equation number in the problems refer to the ones in Chapter 3 of the book.

1. (Book Problem 3.1, 20 points)
Verify (3.19) and the high SNR approximation (3.21).
Hint: Write the expression as a double integral and interchange the order of integration.

2. (Book Problem 3.7, 30 points)
In this exercise, we study the performance of the rotated QAM code in Section 3.2.2.

1. Give an explicit expression for the *exact* pairwise error probability $\mathbb{P}\{x_A \to x_B\}$ in (3.49). Hint: The techniques from Exercise 1 will be useful here.
2. This pairwise error probability was upper bounded in (3.54). Show that the product of SNR and the difference between the upper bound and the actual pairwise error probability goes to zero with increasing SNR. In other words, the upper bound in (3.54) is tight up to the leading term in 1/SNR.

3. (Book Problem 3.10, 50 points)
In Section 3.2.2, we looked at the example of the rotation code to achieve time diversity (with the number of branches, L, equal to 2). Another coding scheme is the permutation code. Shown in Figure 1 are two 16-QAM constellations. Each codeword in the permutation code for $L = 2$ is obtained by picking a pair of points, one from each constellation, which are represented by the same icon. The codeword is transmitted over two (complex) symbol times.

1. Why do you think this is called a permutation code?
2. What is the data rate of this code?
3. Compute the diversity gain and the minimum product distance for this code.

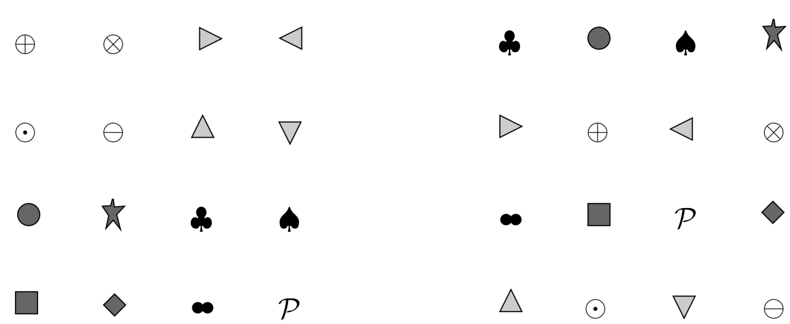

Figure 1: A permutation code.