Homework 4

ELEC 540: Advanced Wireless Communications

3 Problems, 60 points

Problems are taken from *Fundamentals of Wireless Communications,* by David Tse and Pramod Viswanath.

1. (Book Problem 6.1, 20 points)
The sum constraint in (6.6) applies because the two users send independent information and cannot cooperate in the encoding. If they could cooperate, what is the maximum sum rate they can achieve, assuming still individual power constraints P_1 and P_2 on the two users? In the case $P_1 = P_2$, quantify the cooperation gain at low and at high SNR. In which regime is the gain more significant?

2. (Book Problem 6.2, 20 points)
Consider the basic uplink AWGN channel in (6.1) with power constraints P_k on user k (for $k = 1, 2$). In Section 6.1.3, we stated that orthogonal multiple access is optimal when the degrees of freedom are split in direct proportion to the powers of the users. Verify this. Show also that any other split of degrees of freedom is strictly suboptimal, i.e., the corresponding rate pair lies strictly inside the capacity region given by the pentagon in Figure 6.2. Hint: Think of the sum rate as the performance of a point-to-point channel and apply the insight from Exercise 5.6.

3. (Book Problem 6.3, 20 points)
Calculate the symmetric capacity, (6.2), for the two-user uplink channel. Identify scenarios where there are definitely superior operating points.