Homework 3 (EE7600 MIMO Systems for Wireless Communications)

1. Consider the following MIMO channel with a random constant-channel-matrix

$$X_k = \sqrt{\rho} S_k H + W_k, \qquad k = 0, 1, 2, 3, \ldots .$$

We have two cases: the realization of H known for the receiver but unknown for transmitter (*coherent* case) and the realization of H unknown for both transmitter and receiver (*noncoherent* case). Assume that $M = 2$, $T = 2$, and $N = 1$.

Alamouti's scheme is based on the following 2×2 orthogonal space-time block code:

$$\mathcal{O}_z = \begin{pmatrix} z_1 & z_2 \\ -z_2^* & z_1^* \end{pmatrix}.$$

Assume that the two information symbols z_1, z_2 are both from the Q-PSK constellation.

(a) Simulate and plot the uncoded bit error rates of Alamouti's scheme for *coherent* modulation for two transmit antennas and conventional PSK scheme for single transmit antenna in the *coherent* case for SNR ρ of 0dB–30dB with increment 2dB (or 3dB, or 5dB).

(b) Simulate and plot the uncoded bit error rates of Alamouti's scheme for *differential* modulation for two transmit antennas and conventional differential PSK scheme for single transmit antenna in the *noncoherent* case for SNR ρ of 0dB–30dB with increment 2dB (or 3dB, or 5dB).

(c) Draw some conclusions from the obtained results in (a) and (b).

2. Describe the matrices of the *real* and *complex* orthogonal space-time block codes for $M = 1, 2, 3, 4$ transmit antennas and their code rates.

Note:

M, N denote the numbers of transmit and receive antennas, respectively. T is the length of block of channel uses. Random variables in H, H_k and W_k are i.i.d. $\mathcal{CN}(0, 1)$.