Homework 3 (EE7600 MIMO Systems for Wireless Communications)

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

\[ X_k = \sqrt{\rho} S_k H + W_k, \quad k = 0, 1, 2, 3, \ldots \]

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

Alamouti's scheme is based on the following \( 2 \times 2 \) 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 \( \rho \) 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 \( \rho \) 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. \( \mathcal{CN}(0, 1) \).