| Communications & Networks<br>EEE2040 - Spring 2017 | University of Surrey<br>Department of Electronic Engineering |
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**Objective:**

The purpose of this assignment is to use simulation of a vector model DCS in order to estimate and plot the probability of error as a function of SNR per bit for a digital communication system that employs a four-level PAM, i.e. 4-PAM. The receiver is assumed to consist of a single correlation-type detector in this system.

**Procedure:**

The simulations MUST be written in **plain MATLAB code**, i.e., **use of communication library for modulator and demodulator will not be accepted**. Your simulation should follow the following steps in each transmission round:

1. A random bit generator is implemented to simulate an information source that generates two bits with probability of input bit 0 and input bit 1 equal to 0.5 at each transmission round.
2. A constellation mapping function that maps two bits from the source, generated in Step 1, into four signal levels as shown in the following:

00 to -3d
01 to -d
11 to +d
10 to +3d

3. Then the modulated signals will be transmitted through an AWGN channel which simply adds a zero mean Gaussian real random number with a variance $\sigma^2$ to the transmitted level in Step 2. This noisy signal will be delivered to the receiver.

4. Then, the received signal will be processed by the detector at the receiver side, which implements an optimum reception algorithm for 4-PAM.

5. The output of the detector is compared to the input of the constellation modulator to record bit errors.

**Questions:**

Your report must answer the following questions. Please number the sections of your report according the following numbers.

1. Block diagram of the transmitter and receiver.

2. Constellation diagram of the system.

3. Describe the function of the optimum detectors this system. Your description must explain the decision criterion for this particular system.

4. Obtain the average SNR per bit as a function of $d\ and\ \sigma$.

5. Obtain the theoretical formula for probability of bit error for this system as the function of the average SNR per bit. This must be a closed form equation.

6. Run your simulations for 10,000 transmissions for the average SNR per bit equal to the following values (0, 2, 4, 6, 8, 10, 12, 15) dB. Hint: you can assume d=1 and change the value of $\sigma$ to vary average SNR. For each value of the average SNR, compute the probability of error from the equation that you obtained in Question 3 and the simulations. Then, plot both results on a single plot using MATLAB's plot function. Use a solid line for the theoretical values and markers 'o' for the simulation values.

7. Print and attach the source code as the last section of your report.

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| **Submission** | **- Through SurreyLearn**<br><br>**- Submission Date: 1st of May 2017** |
| **Questions** | Please contact Ao at a.lei@surrey.ac.uk if you have questions. |
| **Important Notes** | 1. Each student is expected to individually complete the project (**no group submission**).<br>2. If the evaluations of the submitted materials indicate any kind of plagiarism, the result will be a **zero mark** for the entire assignment part of the module.<br>3. Some students may be randomly asked to explain their results and implementations in personal interviews. |