Assignment 1 - Simulation of an 8-ary Digital Communication System

Digital Communications (EEEN40060), 2020/2021

You are required to write, in MATLAB, a simulation of a digital communication system which uses 8-ary modulation (there are $M = 8$ equiprobable transmit symbols). The system model is shown on the left-hand side of Figure 1. Transmission is over the additive white Gaussian noise (AWGN) channel. The signal space diagram for the modulation scheme is shown on the right-hand side of Figure 1. Note that **it is sufficient to simulate the equivalent vector channel** (you do not need to simulate the waveforms).

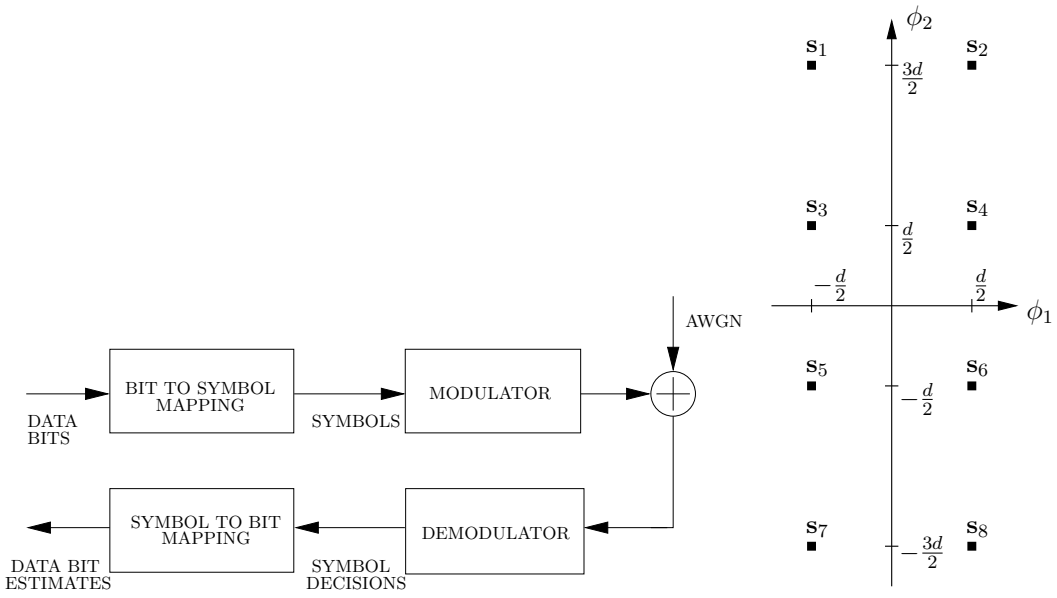

Figure 1: Left: Block diagram of the 8-ary digital communication system to be simulated. Right: Signal-space diagram for the 8-ary modulation scheme.

The following are the requirements:

- Use your simulation to plot the symbol error rate (SER) versus E_s/N_0 curve for the system. Plot SER on a log scale and E_s/N_0 in dB.

- Then, on the same graph, plot the *theoretical* SER curve for the system. To do this, you will need to derive an expression for the probability of symbol error for this system as a function of E_s/N_0.
- Choose a bit to symbol mapping for the transmitter. Describe your mapping clearly, and explain why you chose this particular mapping.
- On a new graph, plot the bit error rate (BER) versus E_b/N_0 curve for the system. Plot BER on a log scale and E_b/N_0 in dB.
- From this curve, estimate the value of E_b/N_0 above which the system BER lies below 10^{-4} (or, if this takes too long a time, 10^{-3}).
- Your program should consist of a single m-file script, and should be appropriately annotated with comments. You should not use any procedures from the MATLAB communications toolbox.
- Your assignment should be submitted via Brightspace, and should contain two files:
  (a) Your MATLAB simulation m-file, and
  (b) A short report (**in PDF format**) containing the derivation of the theoretical SER as well as the two system performance graphs mentioned above. A brief commentary about the methods you used and the results you obtained should also be included in this report. The answers to the specific questions asked above should also be stated clearly in your report.
- You should spend approximately **4 hours** on this assignment.
- The deadline is **9pm on Sunday 14 March 2021**.
- **And most importantly:** The program you submit should be **your own work**. Programs will be scrutinized for evidence of copying. Programs in which copying is found will NOT be awarded a pass grade.

You may find the following MATLAB tips useful:

- The function `rand` generates a random number which is uniformly distributed between 0 and 1. Thus for example, `b = rand < 0.5` generates a random bit `b`.
- The function `randn` generates a Gaussian-distributed random number with mean 0 and variance 1. Thus, multiplying this number by σ produces a Gaussian-distributed random number with mean 0 and variance σ^2.
- The function `semilogy(x,y)` plots x against y, rather like `plot(x,y)`, except that it uses a log scale for the y-axis.