

Ultra Wide Band Communications

MATLAB Problems

Graduate course in Telecommunications

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Rome, Italy

2021-2022

MATLAB practice
**Comparison between theory and
simulation results**

Problem

- ◆ **Goal of the practice work:** learn how to use MatLab to compare a theoretical equation describing the performance of a system of interest with simulation results
- ◆ The practice will focus on a BPSK system, comparing the Bit Error Rate (BER) expected from the theory with the results obtained by simulations
- ◆ **Expected outputs:** MATLAB/Octave script (and supporting scripts and functions) as well as a figure comparing theory and simulation
- ◆ **Main steps:**
 1. Draw a flow diagram of the algorithm used to generate simulation results
 2. Implement the algorithm and generate simulation results
 3. Implement the formula for the evaluation of the BER for a BPSK system as a function of the Signal-to-Noise Ratio (SNR)
 4. Compare graphically theory and simulation using the plot command

Problem - Hints

1. Generate SNR values between SNR_{MIN} and SNR_{MAX} dB with step 1
2. Hints for simulation:
 1. Generate N_{bits} random binary values, with the generic element x taking values in $\{-1,1\}$
 2. The output y for a BPSK system corresponding to x can be simulated by evaluating:

$$y = \sqrt{SNR} \cdot x + n$$

where n is the outcome of a Gaussian (a.k.a. Normal) random variable with mean 0 and variance 1

3. Hints for theory:
 1. The Bit Error Probability for a BPSK system working at a given SNR is given by:

$$BEP = \frac{1}{2} \operatorname{erfc} \left(\sqrt{\frac{SNR}{2}} \right) = Q \left(\sqrt{SNR} \right)$$

Problem

Parameter	Value
N_{bits}	10^6
SNR_{MIN}	1 dB
SNR_{MAX}	12 dB

Table 1 - values of the parameters to be considered

◆ Hint:

- Check the *randn* function on MATLAB help for the generation of Gaussian random values