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:

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

Problem

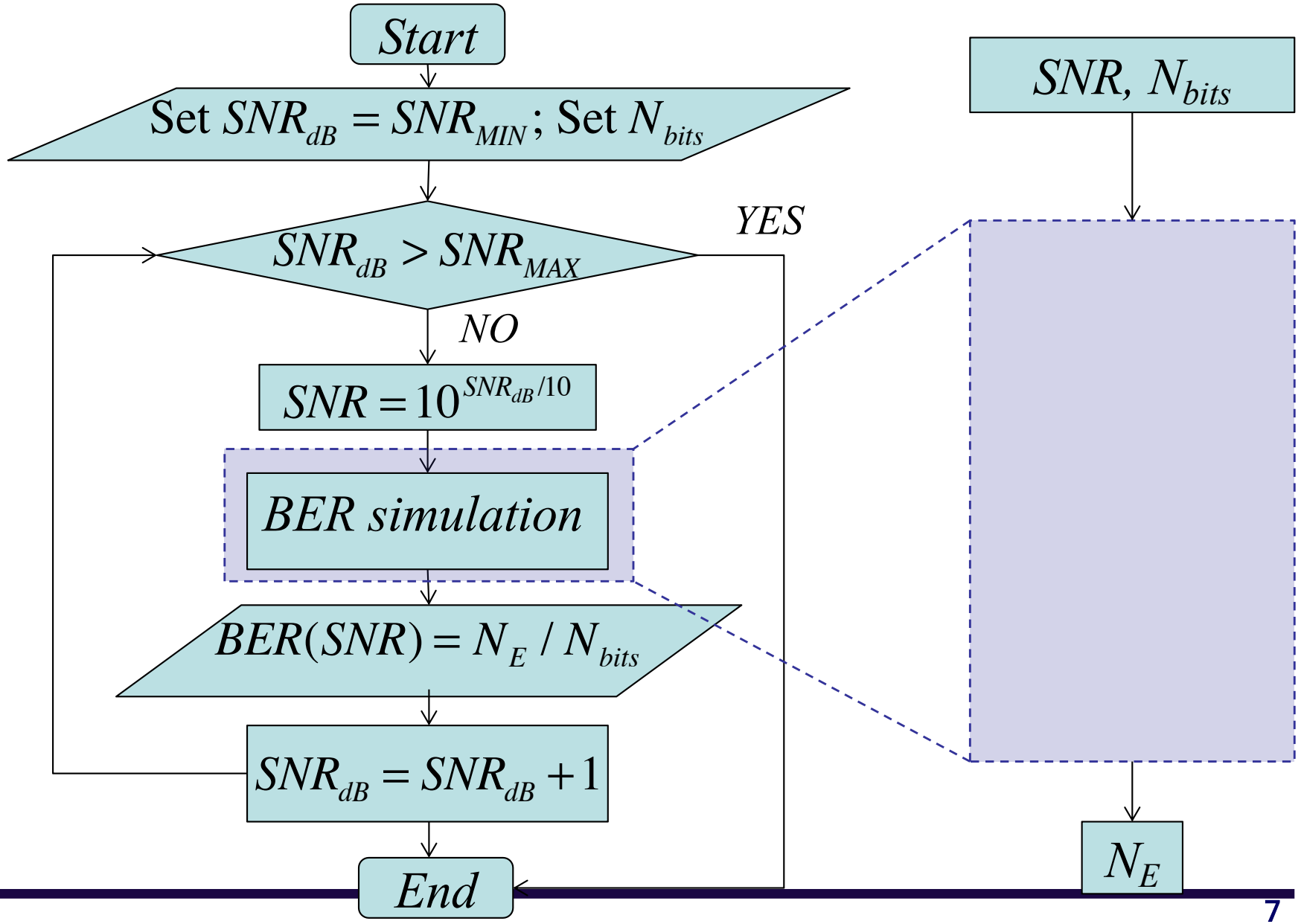
Parameter	Value
N_{bits}	10^6
SNR_{MIN}	1 dB
SNR_{MAX}	12 dB

Table 1 - values of the parameters to be considered

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

Solution

Solution - Flow diagram (1/2)



Solution – Flow diagram (2/2)