TD2
Advanced digital communication

Exercise 1

A digital communication system operates with a signal power of 20mW, using two different modulation schemes: 4-QAM (QPSK) and 16-QAM. The system experiences Additive White Gaussian Noise (AWGN) with a noise power of 2 mW, and the bandwidth of the system is 10 MHz.

1- Calculate the SNR in linear terms and in db
2- Use the standard table to calculate the BER for 4-QAM and 16-QAM
3- Compare between BERs computed and justify the result

[**Table of Q-function values:** To find Q(1.36) look under column *x* to find 1.30. Then proceed on this row till you come to the column under 0.06. Read off the value as 8.692×10^{-2}]

If the signal power is increased to 40 mW**,**

4- Recalculate the SNR and determine the new BER for both 4-QAM and 16-QAM.
5- How does the BER change for each modulation scheme with the increase in signal power?

Exercice 2

A wireless communication system uses Quadrature Amplitude Modulation (QAM) over a channel with Additive White Gaussian Noise (AWGN). The system operates under the following conditions:

- Bandwidth (B): 10 MHz
- Thermal Noise Power Spectral Density (N_0): 10^{-9} W/Hz
- Signal Power (P_s): 100 mW
- Modulation Scheme: 16-QAM with a spectral efficiency of 4 bps/Hz
- Target BER: 10^{-5}
- SNR Values (dB): 10 dB, 15 dB, and 20 dB

1. Find the SNR (in linear form and dB) for the system.
2. Calculate the achievable data rate using the system's modulation scheme and SNR.
3. Determine the theoretical bit error rate (BER) for the 16-QAM modulation under the given SNR.
4. Calculate the maximum data rate in the presence of noise using the Shannon-Hartley theorem.