EE477 Homework 2b

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I.

In Figure 1 bit error probability(BER) and symbol error probability(SER) can be seen as a function of both Es/N0 and Es/N0 for QPSK. The simulation results match with the theory as one can see on the figure. But there exists also some differences between curves as expected because our computational method is just a simulation with some assumptions.

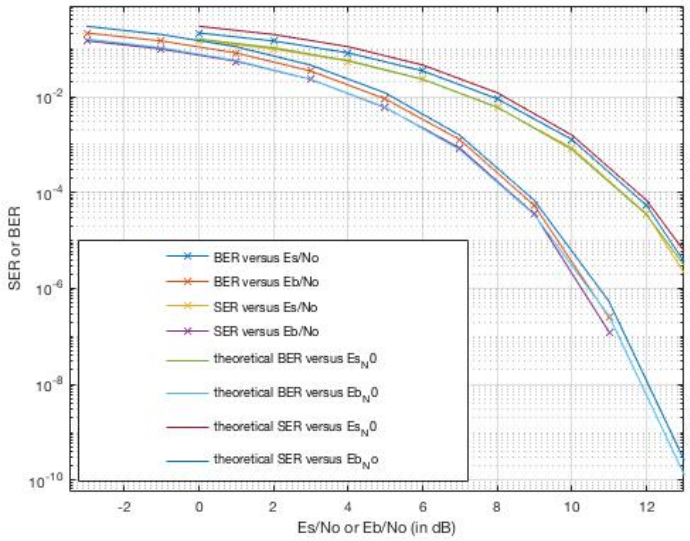


Fig. 1: QPSK - Theoretical and simulated BER and SER as a function of either Eb/N0 or Es/N0

II.

QPSK is basically two BPSK links operating on the same channel with their carriers in phase quadrature. Therefore the BER of a QPSK remains the same as BPSK. One can confirm this claim looking at Figure 2.
The advantage of BPSK is that it requires lower carrier to noise ratio. The drawback is that the data rate achieved using BPSK is lower. QPSK is basically two BPSK links operating on the same channel with their carriers in phase quadrature. Therefore the BER of a QPSK remains the same as BPSK. At QPSK data rate is doubled. The only penalty is in terms of carrier to noise ratio. QPSK requires 3 dB more carrier to noise ratio than BPSK.

III.

There are some differences between the theoretical and simulated results. As the SNR increases the gap between simulated and theoretical results increases too. Moreover the error probability of gray mapping is lower than the binary mapping as expected.

IV.

The theoretical result matches perfectly with the simulated result.

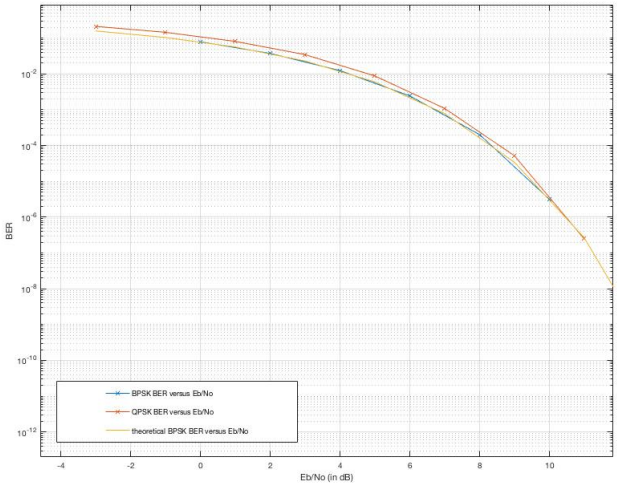


Fig. 2: BPSK and QQPSK- Theoretical and simulated BER as a function of Eb/N0

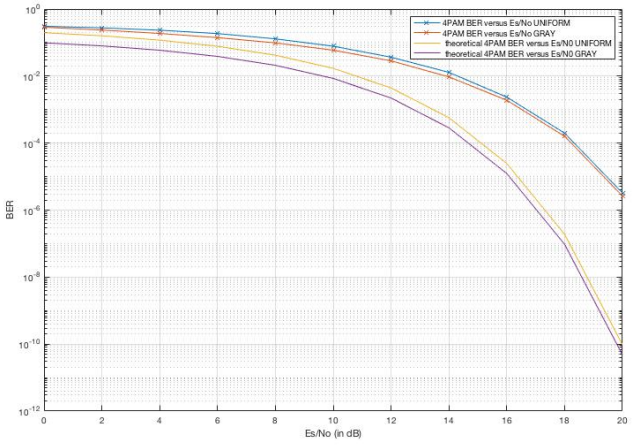


Fig. 3: 4-PAM- Theoretical and simulated BER as a function of Es/N0 with uniform and gray mapping

V.

BER versus Es/N0 graphic of 16-QAM with gray and binary mapping can be seen on Figure 5a and 5b. As expected, the error probability of gray mapped 16_QAM is lower than the uniform mapped 16_QAM. There exist some differences between simulated results and theoretical results. It's due to the fact that what we did is just a simulation.

VI.

BER versus Es/N0 graphic of 8-PSK with gray and binary mapping can be seen on Figure 6a and 6b. As expected, the error probability of gray mapped 8-PSK is lower than the uniform mapped 8-PSK. There exist some differences between simulated results and theoretical results. It's due to the fact that what we did is just a simulation.

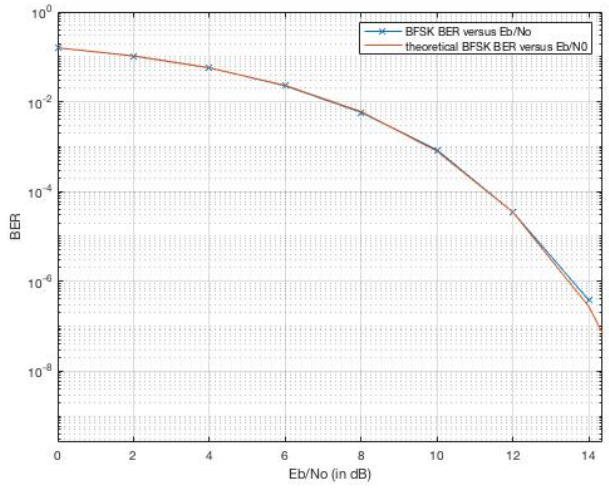
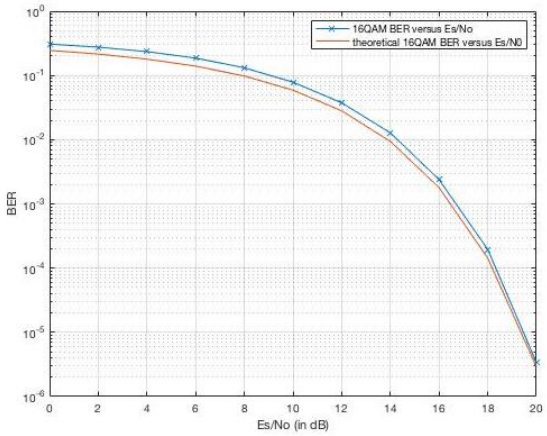
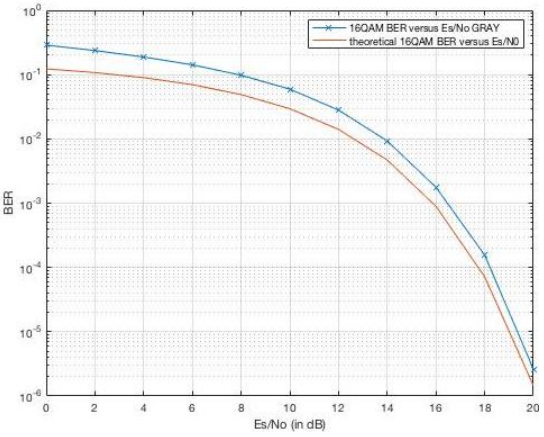


Fig. 4: BFSK-BER performance as a function of Eb/N0

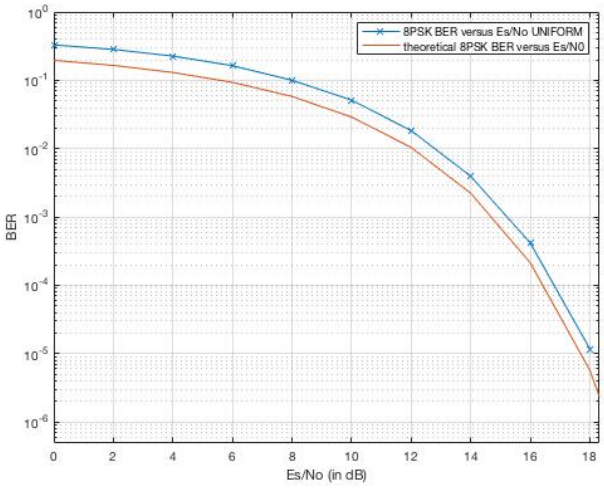


(a) uniform

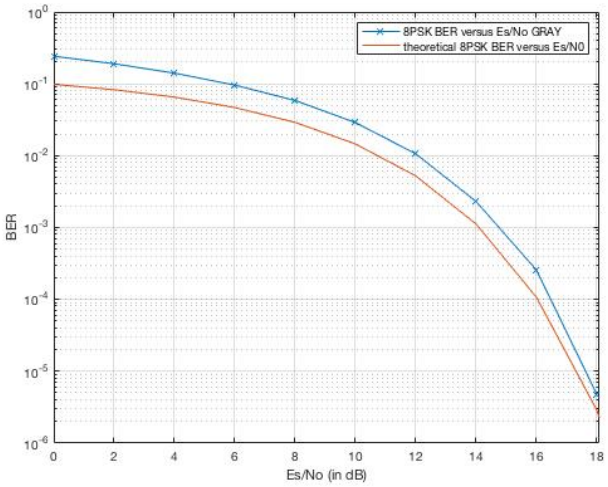


(b) Gray

Fig. 5: 16QAM theoretical and simulated BERs with uniform and gray mapping



(a) uniform



(b) Gray

Fig. 6: 8PSK theoretical and simulated BERs with uniform and gray mapping

VII.

The matlab code for this part can be seen between the files.