Acoustic Modem Project Milestone 2

# Exercise 3-1: Quadrature amplitude modulation (QAM)

4. Max distance ( example: 16-QAM: sqrt((4-1)^2 +(4-1)^2) peak power  
Average distance: average of distances to point.  
Normalization factors are the average distances.

5. Trade-off between higher bitrate vs accuracy  
 We can send more bits at a time but the distances decrease. When noise ‘corrupts’ the   
 channel, more errors will happen with higher QAM due to smaller distances between QAM points.

## Exercise 3-2: Orthogonal frequency-division multiplexing (OFDM)

5. product van

* Number of encoded bits per QAM symbol = log2(M)
* QAM symbols per OFDM frame = (N-L)/2-1
* Number of OFDM frames transmitted per second = fs/DFT
* R=fs /N \* log2(M)\* ( (N-L)/2-1)

6. b. BER increases with higher order QAM

c. BER increases with decreasing SNR

# Exercise 4-2: OFDM modulation over acoustic channel

6. Check the BER. Explain what you observe. : compensating for the exact channel, gives a ber of 0

7. Prefix has to be longer than impulse response h. without awgn => still zero since we compensate for the ‘exact’ channel

8. Higher SNR = lower BER

Higher order of QAM = higher BER

Different channel transfer functions? => the channels are attenuated, the worse higher the BER since the awgn has more impact there.

# Exercise 4-3: Reducing the BER with ON-OFF bit loading

The error is dependant of the channel frequency response. High frequency response means a better  
 channel, so we have better data transmission. If we only use these channels we have less errors. => lower bitrate!

Large attenuation on very high and very low frequency of channel.

# Exercise 4-4: Adaptive bit loading

Using the following relation: Y = H\*X + N 🡪 for Psd: Py = |H|2\*Px + Pn

Here follows : Pn = Py - |H|2\*Px

Using different Gamma’s give other results 10 is for a BER of 10-6