**Digital Communication Systems Laboratory**

**Fall 2021**

**Laboratory 07: Quadrature Amplitude Modulation**

**Laboratory Goals:**

* How to implement Quadrature Amplitude Modulation?
* What is the most common demodulator and detector for QAM?
* What is the bandwidth of the QAM modulation?

**Description:**

In this experiment, we study the transmission and detection of signals in the passband. Most of the laboratory content can be found in the MATLAB live script. This document gives a brief description about every section, then states the laboratory tasks.

1. Parameter initialization.
2. This shows the several types of modulation.
3. The Quadrature Amplitude Modulation (QAM) is discussed here.
4. The received signal is decoded then detected.
5. The correlator decoder and detector are implemented.
6. The generation of noise and its impact are implemented and discussed.

**Tasks:**

1. Use these parameters for the following tasks:
   1. Message frequency (): TUID(8) + 1 Hz
   2. Carrier frequency (): (TUID(7) + 20) \*
2. Use the following constellation for 16-QAM. Plot the constellation with scatter plot command and constellation diagram in MATLAB.
   1. TUID=915614617
   2. TUID(5)=1
   3. TUID(6)=4

|  |  |  |
| --- | --- | --- |
| Symbol Index | In-Phase | Quadrature |
| 1 | 1 + ( TUID(5) / 10 ) | 1 + ( TUID(6) / 10 ) |
| 2 | -1 - ( TUID(5) / 10 ) | 1 + ( TUID(6) / 10 ) |
| 3 | -1 - ( TUID(5) / 10 ) | -1 - ( TUID(6) / 10 ) |
| 4 | 1 + ( TUID(5) / 10 ) | -1 - ( TUID(6) / 10 ) |
| 5 | 3 + ( TUID(5) / 10 ) | 1 + ( TUID(6) / 10 ) |
| 6 | 3 + ( TUID(5) / 10 ) | 3 + ( TUID(6) / 10 ) |
| 7 | 1 + ( TUID(5) / 10 ) | 3 + ( TUID(6) / 10 ) |
| 8 | -1 - ( TUID(5) / 10 ) | 3 + ( TUID(6) / 10 ) |
| 9 | -3 - ( TUID(5) / 10 ) | 3 + ( TUID(6) / 10 ) |
| 10 | -3 - ( TUID(5) / 10 ) | 1 + ( TUID(6) / 10 ) |
| 11 | -3 - ( TUID(5) / 10 ) | -1 - ( TUID(6) / 10 ) |
| 12 | -3 - ( TUID(5) / 10 ) | -3 - ( TUID(6) / 10 ) |
| 13 | -1 - ( TUID(5) / 10 ) | -3 - ( TUID(6) / 10 ) |
| 14 | 1 + ( TUID(5) / 10 ) | -3 - ( TUID(6) / 10 ) |
| 15 | 3 + ( TUID(5) / 10 ) | -3 - ( TUID(6) / 10 ) |
| 16 | 3 + ( TUID(5) / 10 ) | -1 - ( TUID(6) / 10 ) |

1. Find the appropriate thresholds for signal detection in the modified 16-QAM.
2. Transmit your TUID and plot the constellation with scatter plot and constellation diagram module. What is the error rate of transmission when the SNR = +inf?
3. Generate 1000 random samples for the modified 16-QAM and fill the following table

|  |  |
| --- | --- |
| 16-QAM | |
| SNR | Mean Absolute Error |
| 20 | 0 |
| 8 |  |
| 0 |  |
| -8 |  |
| -16 |  |
| -20 |  |
| -24 |  |

1. Plot the power spectrum of the baseband, carrier, modulated, and received signals for SNR = 0 dB.