Boston University **Spring 2021**

ECE Department

Software Radios (EC 415)

Homework #5

Due on Blackboard by Friday 04/23/2021, 6:00PM

Solve the following exercises from the class textbook ("Software Receiver Design" by Johnson, Sethares, Klein):

1. 8.1
2. 8.2 (call your file `graycode.m` and upload it on Blackboard)
3. 8.5 (call your file `betterpulseshape.m` and upload it on Blackboard)
4. 8.8 (run the code 5 times for each case) [You will be able to answer this question after the lecture of 04/20/2021]

Homework 5 - Extra Question

In this question, you will implement a functional QPSK transmitter in Matlab. We recall that the QPSK alphabet contains $M = 4$ symbols: $\{\alpha_1, \alpha_2, \alpha_3, \alpha_4\}$ where

$$\alpha_m = e^{j2\pi(m-1)/M}, \qquad \text{for } m = 1, 2, 3, 4.$$

Assume that QPSK encodes each pair of bits according to a Gray code, i.e.,

Bits	Symbol
00	α_1
01	α_2
11	α_3
10	α_4

1. Create a Matlab function `letters2QPSK.m` that receives an arbitrary ASCII string and converts it into an array of QPSK symbols. Since an ASCII character only contains 7 bits, you should add a leading "0" bit to produce an 8-bit representation for each character. As an example, running `letters2QPSK('AB')` should produce the following result:

```
Columns 1 through 4

 0.0000 + 1.0000i   1.0000 + 0.0000i   1.0000 + 0.0000i   0.0000 + 1.0000i

Columns 5 through 8

 0.0000 + 1.0000i   1.0000 + 0.0000i   1.0000 + 0.0000i   0.0000 - 1.0000i
```

2. Write a Matlab script `QPSK_modulation.m` that converts an arbitrary string into a QPSK modulated passband signal. The script must use the `letters2QPSK` function to produce the symbols. Consider a carrier signal $e^{j2\pi f_c t}$ with frequency of $f_c = 10$ Hz, a baud rate of 1 Hz, a sampling frequency of 1 kHz (that is the sampling period is 1/1000 s), and a rectangular pulse function.

   The Matlab script should also plot the modulated signal. Show your result for the string `EC415`.

Deliverables

1. 2 Matlab files: `letters2QPSK.m` and `QPSK_modulation.m`.
2. An explanation of how the files work as part of your PDF submission.