Digital Communication: Matlab Lab Report

Name: _____

Date: _____

1 Scatter plot of receive signal in constellation diagram

1.1 QPSK Modulation

Consider the QPSK modulation scheme:

$$\begin{bmatrix} s_1, & s_2, & s_3, & s_4 \end{bmatrix} = \begin{bmatrix} 1, & i, & -1, & -i \end{bmatrix}. \tag{1}$$

Plot the QPSK modulated signals in the complex plane.

1.2 QPSK in AWGN channel

Generate a random binary sequence of length 1000, modulate the data with the QPSK modulation scheme, and pass the modulated signal through the AWGN channel.

- Set SNR = 10 (dB), produce the scatter plot of the received signal in the complex plane;
- Set SNR = 20 (dB), again produce the scatter plot of the received signal, what do you observe?

1.3 8-PSK in AWGN channel

Repeat the exercise in 1.2 with the 8-PSK modulation scheme. Plot the modulated signal and the received signal for the cases SNR = 10 (dB) and SNR = 20 (dB).

1.4 QAM

Design customized QAM modulation schemes with M = 8 and M = 16. Scale your modulated signal such that the maximum symbol energy equals to 1. Plot the modulated signal and the received signal for the cases SNR = 10 (dB) and SNR = 20 (dB).

2 Bit error rate

In this exercise, we will implement a simulation of the modulation→channel→demodulation system, and estimate the bit error rate (BER) for different modulation schemes. A code skeleton of the simulation is provided blow, with some missing lines:

```
% Modulation order M

k = log2(M);              % Bits per symbol
EbNoVec = (5:15)';        % Eb/No values (dB)
numSymPerFrame = 100;     % Number of QAM symbols per frame

berEst = zeros(size(EbNoVec));
for n = 1:length(EbNoVec)
        % Convert Eb/No to SNR
        snrdB = EbNoVec(n) + 10*log10(k);
        % Reset the error and bit counters
```

```
        numErrs = 0;
        numBits = 0;

        while numErrs < 200 && numBits < 1e7
                % Generate binary data and convert to symbols
                dataIn = randi([0 1],numSymPerFrame,k);
                dataSym = bi2de(dataIn);

                % Your modulator here:

                % Pass through AWGN channel:

                % Your demodulator here:

                % Convert received symbols to bits
                dataOut = de2bi(rxSym,k);

                % Calculate the number of bit errors
                nErrors = biterr(dataIn,dataOut);

                % Increment the error and bit counters
                numErrs = numErrs + nErrors;
                numBits = numBits + numSymPerFrame*k;
        end

        % Estimate the BER
        berEst(n) = numErrs/numBits;
end
```

Your tasks are:

- Implement the simulation with 8-QPSK modulation/demodulation;
- Implement the simulation with 16-PSK modulation/demodulation;
- Implement the simulation with your customized 16-QAM modulation/demodulation.
- Plot the BER curves in one figure (using `semilogy`).
- Describe three difference you observe in the BER plot and explain why?