University of Moratuwa
Department of Electronic & Telecommunication Engineering

EN3053 Digital Communications I

Lab Assignment – Eye diagrams and Equalization

In this Lab Assignment, students are expected to work in groups of two (maximum). Each task needs to be completed using MATLAB or Octave. (Please state in the report which software you have used.)

Task 1

In Task I, you are expected to generate eye diagrams for baseband binary phase shift keying (BPSK) signaling with different pulse shaping filters. An example can be found at
http://www.dsplog.com/2008/05/01/eye-diagram-plot-matlab-raised-cosine-filter/

1. Generate an impulse train representing BPSK symbols.
2. Obtain transmit signal by convolving the impulse train with a pulse shaping filter where the impulse response is a sinc function.
3. Generate the eye diagram of the transmit signal.
4. Repeat 1-3 for raised cosine pulse shaping filters with roll-off factor 0.5 and 1.
5. Compare the robustness of the system with respect to noise, sampling tine and synchronization errors.

Task 2

In Task 2, you are required to repeat Task 1, in the presence of additive white Gaussian noise (AWGN). To generate noise, use 'randn' function. Set the variance of noise such that $\frac{E_b}{N_0} = 10$ dB, where E_b is the average bit energy and N_0 is the noise power spectral density.

Task 3

For Task 3, you will design a zero-forcing (ZF) equalizer for a 3-tap multipath channel. Please follow the following steps for Task 4.

1. Generate a random binary sequence.
2. BPSK modulation - bit 0 represented as -1 and bit 1 represented as +1. You can ignore pulse shaping here. Assume you are transmitting impulses.
3. Generate the received signal samples by convolving the symbols with a 3-tap multipath channel with impulse response h = [0.2 0.9 0.3].
4. Add White Gaussian noise such that $\frac{E_b}{N_0}$=0 dB.
5. Computing the ZF equalization filters at the receiver for 3, 5, 7, and 9 taps in length.
6. Demodulation and conversion to bits
7. Calculate the bit error rate (BER) by counting the number of bit errors.
8. Repeat steps 1-7 for $\frac{E_b}{N_0}$ values 0 -10 dB.
9. Plot the BER for all tap settings and $\frac{E_b}{N_0}$ values in the same figure.
10. Plot the BER for an additive white Gaussian noise (AWGN) channel in the same figure.

11. Why there is a discrepancy between the AWGN channel BER and the ZF equalized multipath channel. Explain your results referring to the design of the ZF equalizer.

Compile your results as a report and submit with the source codes (in a .zip file) on or before 11.59 PM, December 12th, 2021.