

## Baseband and Passband Modulation and Demodulation

### Introduction:

In this project, you will simulate two types of waveforms for digital communication systems, evaluate their AWGN performance, and find out what practical systems use those modulation schemes.

- 1) Baseband line codes: NRZ and Manchester code;
- 2) Passband modulation: OOK, BPSK, and QPSK.

This project will be performed by teams of two members. By the end of the module, your team shall submit a lab report, Matlab programs, and team evaluation form to canvas.

### Instructions:

1. Baseband Line Codes:
  - a. Generate independent random bits as the input;
  - b. Choose an up-sampling rate  $K$  and the appropriate pulse-shaping filter  $p(t)$  for the selected line code. Map the bits into symbols  $s(t)$ ;
  - c. Pass through the low-pass filter provided by the instructor, and add AWGN with specified SNR; plot and compare the eye diagrams.
  - d. Demodulate the received signal into bits by matched filtering and threshold detection;
  - e. Compute the bit error rate for the given SNR and plot the BER curves
2. Passband Modulation:
  - a. Generate independent random bits as the input;
  - b. Choose an up-sampling rate  $K$  and the NRZ pulse-shaping filter  $p(t)$  for the baseband signal. Map the bits into the complex symbols  $s(t)$  for the selected modulation scheme;
  - c. Pass  $s(t)$  through the low-pass filter provided by the instructor;
  - d. (optional) modulate the baseband signal to passband by a carrier frequency  $f_c$ ; denote it as  $u(t)$ ;
  - e. (optional) add a small random phase error to the carrier and create a received signal as  $v(t)$ ; demodulate the carrier to baseband by a Costas loop;
  - f. Add complex AWGN with specified SNR; denote this as the complex received signal  $r(t)$ ;
  - g. Demodulate the received signal  $r(t)$  into bits by matched filtering and threshold detection; Plot the BER curves.
3. Report:
  - a. discuss the eye diagrams of the baseband line codes;
  - b. discuss the scatter plots of the passband modulation schemes;
  - c. Discuss the energy efficiency and bandwidth efficiency of the passband modulation schemes.