# 6 Digital Communication - Modulation and Demodulation

In this labsheet you will study digital communication over ideal baseband and passband channels under the assumption of perfect frame and symbol (or bit) synchronization. For completing the tasks in this lab, you can use the Matlab files provided in bask_bpsk_moddemod.zip. The Matlab files are not solutions to the tasks in this labsheet. So you should use the Matlab files as a guide to complete the tasks.

**Baseband communication**

1. Generation of bits: In digital communications, the source is assumed to produce a stream of bits. The bits are usually modelled as an independent and identically distributed random process with the probability of a bit being 1 being 0.5. Generate a random sequence of bits of length $N$ (input) satisfying this property. See generate_frame_of_bits.m for hints to do this.

2. Obtaining the line code: In digital communications, the above bit sequence is then converted to a baseband signal according to the modulation scheme which is used. The baseband signal is obtained by converting 0 and 1 into appropriate pulses of duration $T_b$. For a bit sequence with $N = 10$, obtain a baseband signal for BASK and BPSK, with $T_b = 0.1$ seconds. See generate_bpsk_baseband_signal_for_frame.m for hints. Note that all continuous time signals have to be represented by their sampled counterparts.

3. Plot the power spectrum of the baseband signals for BASK and BPSK but with $N = 1000$. (Hint: carefully think about energy vs. power).

4. The rest of the tasks has to be done separately for both BASK and BPSK baseband signals.

5. Simulate sending the baseband signal through an ideal channel with zero propagation delay. See pass_through_ideal_channel.m from channel_modelling.zip for hints.

6. At the output of the ideal channel, implement a low pass receive filter followed by a matched filter for the baseband pulse shape that you have used. See rx_frontend_filter_baseband.m and matched_filter_rectangular.m for hints.

7. Obtain samples from the output of the matched filter; note that since an ideal channel is used, these samples can be taken at multiples of the bit times.

8. Implement a decision making device - a thresholder that will convert the samples to 0 or 1 based on whether your baseband signal is for BASK or BPSK.

**Passband communication**

1. Generate a sequence of bits with $N = 10$ as in Task 1 for baseband communication.

2. Generate the baseband signal for the above sequence of bits corresponding to both BASK and BPSK as in Task 2 for baseband communication.

3. The rest of the tasks have to be done for both BASK and BPSK if not explicitly mentioned.

4. Plot the power spectrum of the baseband signal.

5. Modulate the baseband signal using a carrier of frequency 50Hz. See modulate_baseband_signal.m for hints.

6. Plot the power spectrum of the modulated signal.

7. Simulate sending the modulated signal through an ideal passband channel with zero propagation delay.

8. At the output of a channel implement a passband receive filter with a passband corresponding to the bandwidth of the signal that you are sending through the channel. See rx_frontend_filter_passband.m.

9. Implement a coherent demodulator for both BASK and BPSK. Plot the spectrum of the output of the coherent demodulator for both cases. See demodulate_coherent_bpsk.m.

10. At the output of the demodulator, implement a matched filter for the pulse shape that you have used.

11. Obtain samples from the output of the matched filter; note that since an ideal channel is used, these samples can be taken at multiples of the bit times.

12. Implement a decision making device - a thresholder that will convert the samples to 0 or 1 based on whether your baseband signal is for BASK or BPSK.

13. (Optional): Implement a non-coherent demodulator for BASK.