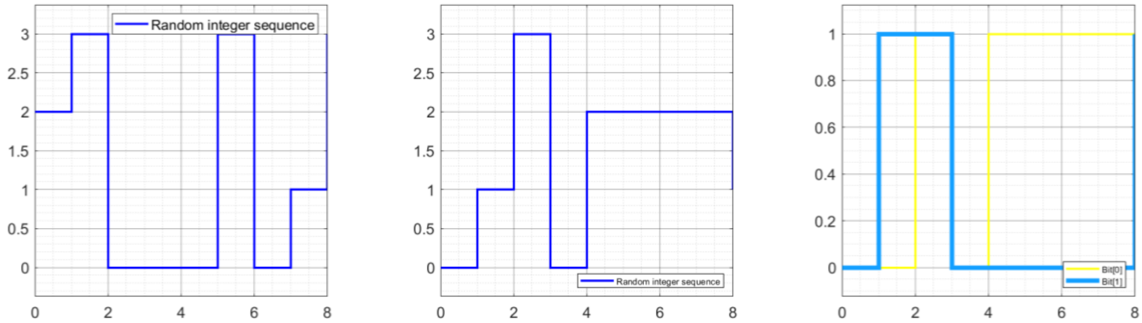
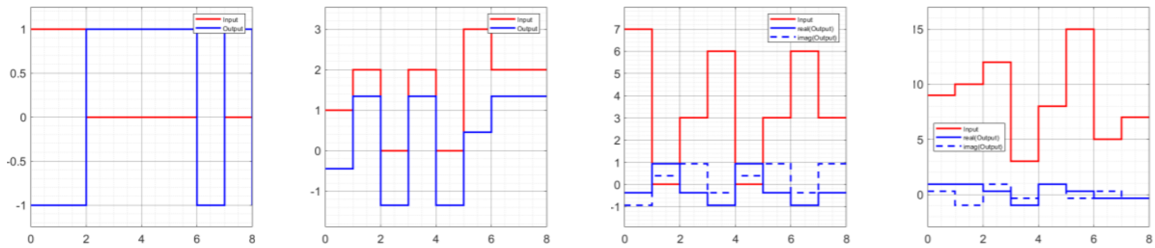
**Ömer Alperen Katı**
**2017401069**

# PROJECT 4: DIGITAL BANDPASS COMMUNICATION

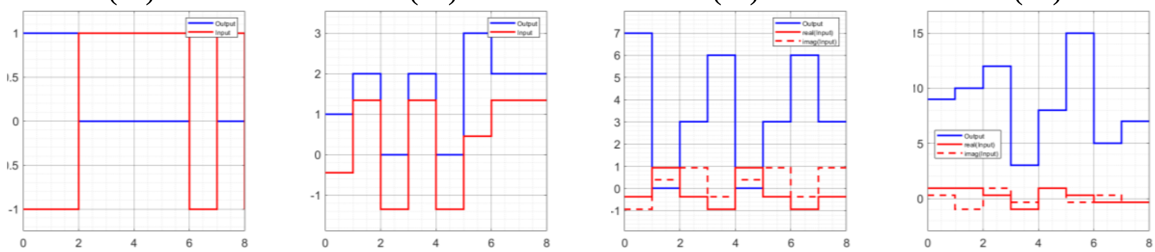



(a) (b1) (b2)

Fig. 1: The plot of (a) a random sequence, (b1) another random sequence and (b2) its corresponding bit sequence for N = 4 and of length 8.

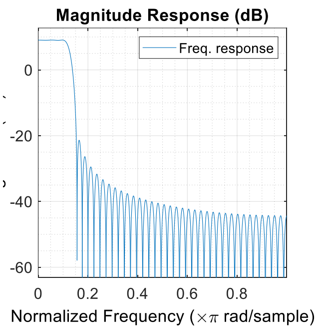



(a1) (b1) (c1) (d1)

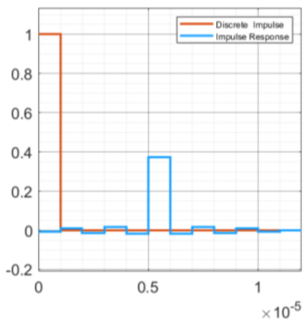



(a2) (b2) (c2) (d2)

Fig. 2: The input of the modulator and the output of the demodulator for (a1-a2) BPSK, (b1-b2) 4-PAM, (c1-c2) 8-PSK, (d1-d2) 16-QAM.



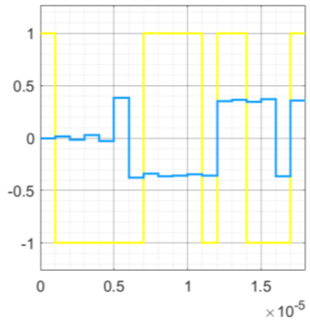

(a)



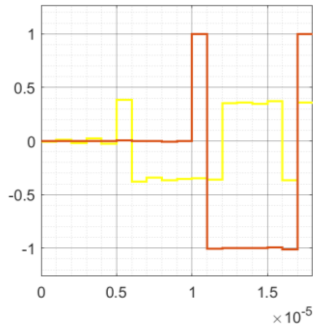

(b)

Fig. 3: (a) Frequency and (b) impulse response of the transmit filter.

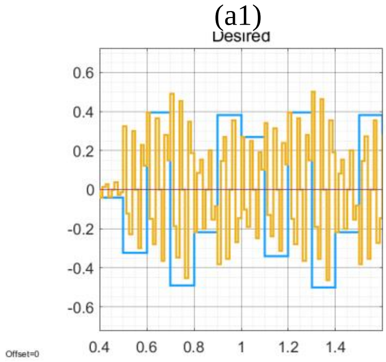
**Ömer Alperen Katı**
**2017401069**



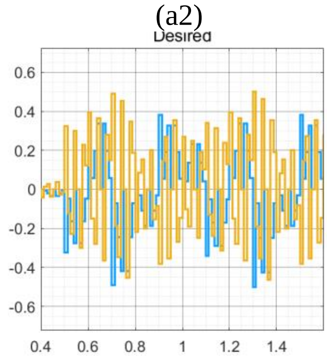

(a1)




(a2)




(b1)




(b2)

Fig. 4: The input/output pairs for (a1) transmit and (a2) receive raised cosine filters and (b1) up and (b2) down converters, respectively.

7. In Fig. 4(a1), by convolving with a raised cosine transmit filter, the signal energy is distributed to some time instances. In Fig. 4(a2), this distributed energy is recollected to its very first form but with a delay by again convolving with a raised cosine receive filter.

8. In Fig. 4(b1), we are upconverting the signal from baseband to passband, and in Fig. 4(b2), it is done vice versa.

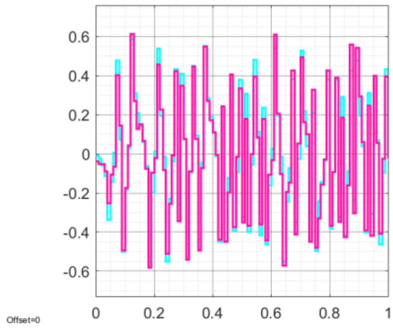



Fig. 5: The input/output of the AWGN channel when Es/N0 = 20.

**Ömer Alperen Katı**
**2017401069**

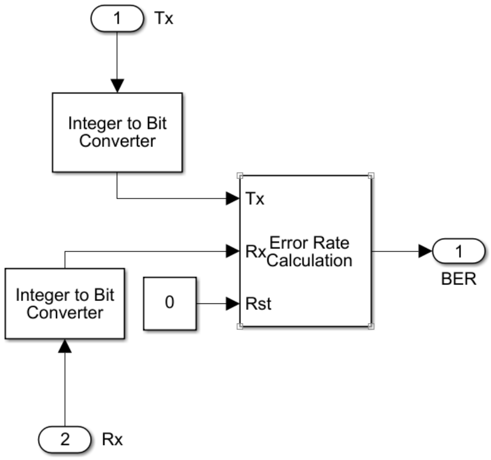



Fig. 6: BER calculator.

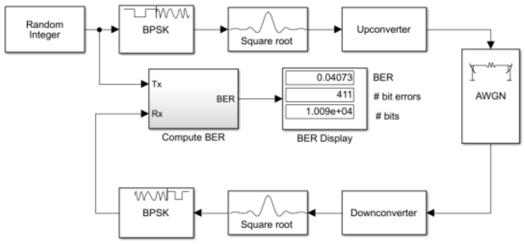



Fig. 7: Complete bandpass BPSK system.

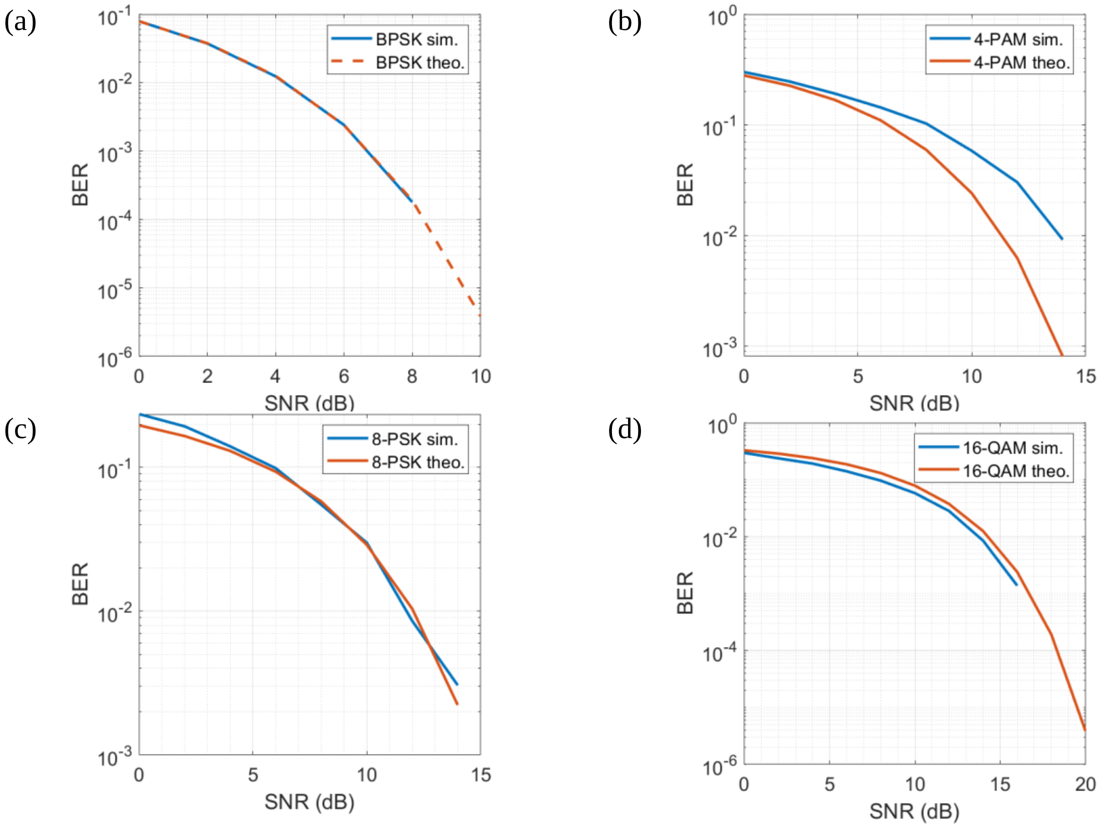



Fig. 8: Theoretical and simulated BER vs SNR plots for (a) BPSK, (b) 4-PAM, (c) 8-PSK, (d) 16-QAM.

12.-15. In Fig. 8, the theoretical and simulated BER curves for all keying methods except 4-PAM fit almost perfectly. One can observe that as we are going from subfigure (a) to (d), BPSK to 16-QAM, higher BER values are observed for the same SNR values. In other words, to get lower BER values, one should go for higher SNR values of 16-QAM. Due to the limitation of SIMULINK that it assumes very small BER values to be zero, the simulation curves cannot go higher SNR values as the theoretical curves do.