Experiment 2 :BPSK System and Bit Error (BER) performance

EC4091D Communication Engineering Lab II

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AIM

- To simulate a digital communication system in the presence of noise using coherent binary phase shift keying (BPSK) with antipodal signaling and evaluate it's performance.

Theory

- For BPSK modulation method, the symbols are $s_1(t) = \sqrt{\frac{2E}{T}} cos(\omega_0 t)$ and $s_2(t) = -\sqrt{\frac{2E}{T}} cos(\omega_0 t)$
- They are also represented as simply +E and -E or +1 and -1 in the constellation diagram.

Theory

- In coherent detection, the decision criteria is $s_1(t)$ if $z(T) \geq 0$ and $s_2(t)$ if $z(T) \leq 0$, where z is the correlation of received vector with basis function.
- Bit error rate is computed as number of bits correctly demodulated/ total number of bits, analytically, this is given by $Q(\sqrt{\frac{2E}{N}})(1 - Q(\sqrt{\frac{2E}{N}}))$

Algorithm

Modulation of BPSK

1. Generate random integers from choices [+1,-1].
2. Add additive white Gaussian noise with required variance and mean 0. These represent symbols received from awgn channel.
3. For of each received symbols, decode them as -1 if less than 0, else decode as $+1$.
4. Compute BER rate as ratio of symbols correctly detected to total number of symbols.
5. Compute BER analytically using expression.

Observations

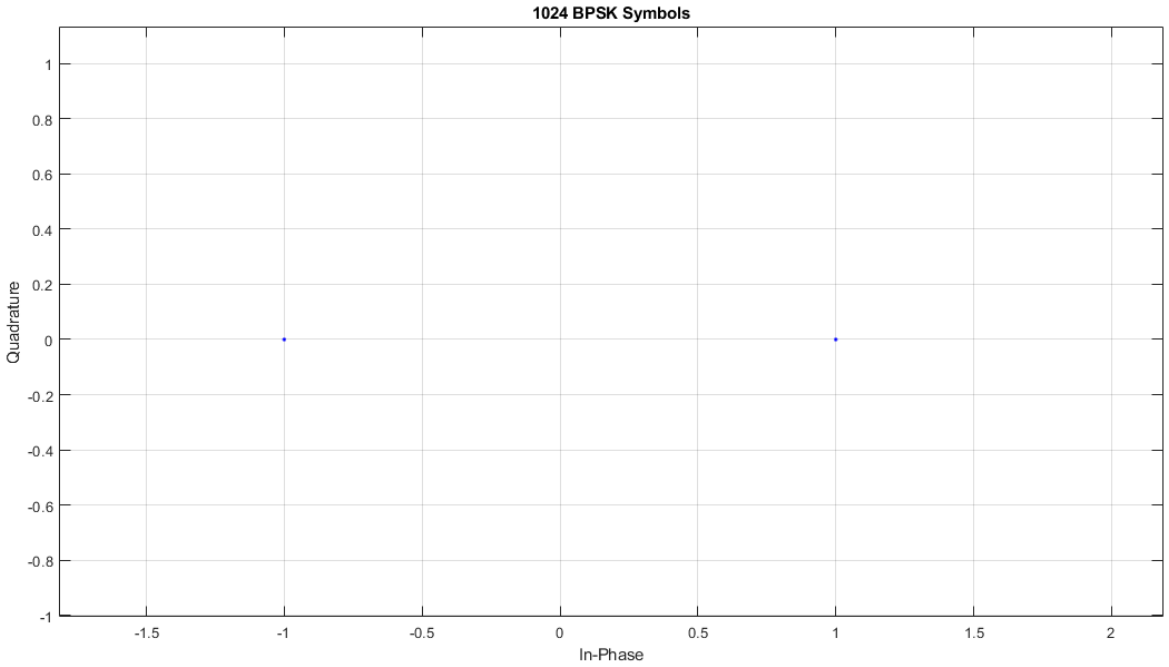
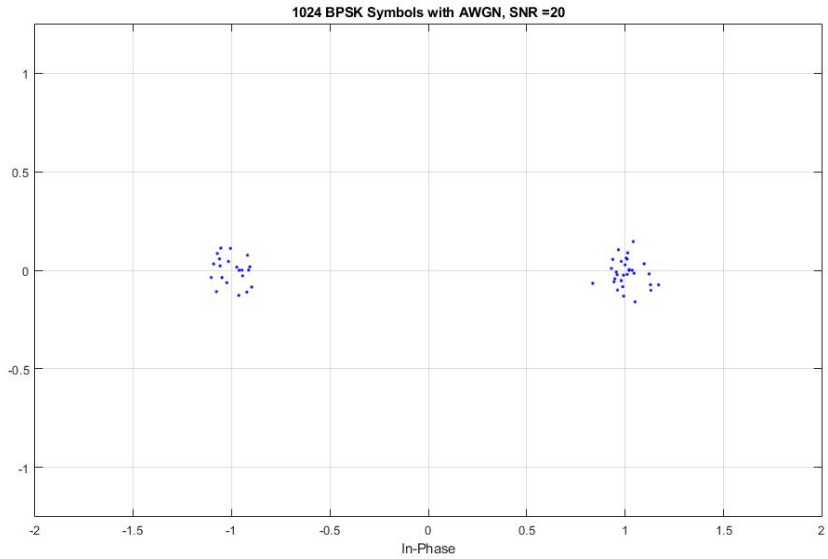
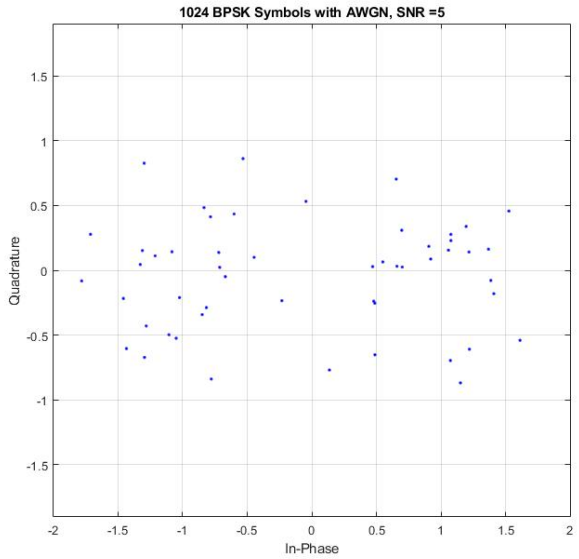


Figure 1: Constellation diagram of transmitted BPSK symbols

Observations (cont.)



(a) Constellation diagram of BPSK symbols subject to awgn with a high SNR of $20dB$



(b) Constellation diagram of BPSK symbols subject to awgn with a low SNR of $5dB$

Figure 2: Constellation of BPSK under awgn

Observations (cont.)

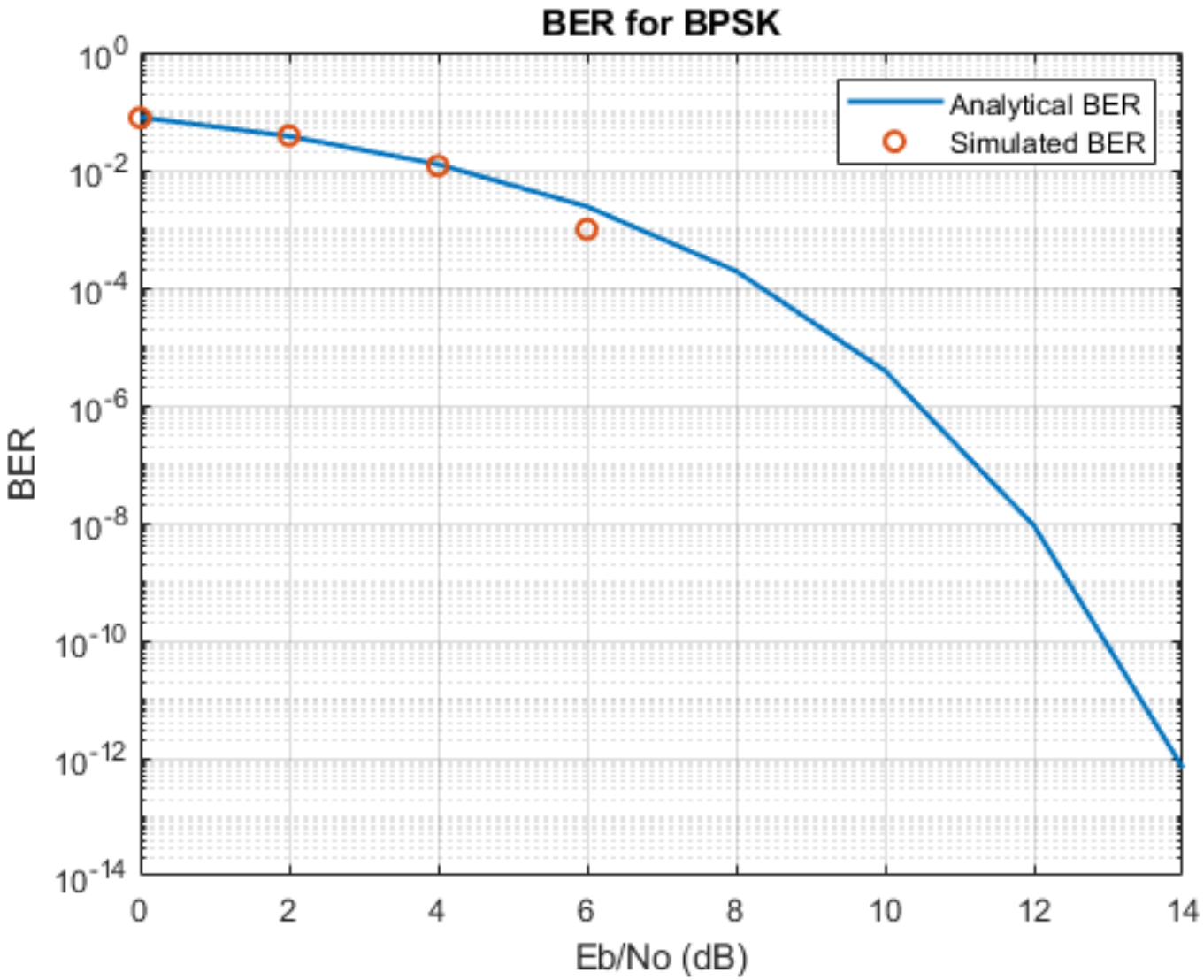


Figure 3: BER, simulated(red) and analytically computed(blue)

Inferences

- Figure 2 shows that higher SNR results in stronger noise as expected.
- Figure 3 shows that the analytical expression for BER is correct as both the plots show the same values of BER for the same values of SNR.