BER for binary signals in AWGN channel

Signal tx and rx

$$z = \begin{cases} a_1 + n_0 & \text{if } \mathrm{s}_1(t) \text{ (bit} = \text{ '1') is transmitted,} \\ a_2 + n_0 & \text{if } \mathrm{s}_2(t) \text{ (bit} = \text{ '0') is transmitted,} \end{cases}$$

BER expression

$$p_b = Q\left(\frac{a_1 - a_2}{2\sigma_0}\right)$$

Task 1: Theoretical BER

Consider the antipodal signaling, that is, a2 =−a1.

Let a1 =[0.25, 0.5, 0.75, 1, 1.25, 1.5, 1.75, 2, 2.5, 3, 3.5].

Noise variance =1.

a) Using matlab function erfc, calculate theoretical BER for each value of a1.
b) Plot the theoretical BER as a function of SNR. While plotting use loglog function instead of plot

Monte carlo simulation

$$z = \begin{cases} a_1 + n_0 & \text{if } s_1(t) \text{ (bit } = \text{ '1') is transmitted,} \\ a_2 + n_0 & \text{if } s_2(t) \text{ (bit } = \text{ '0') is transmitted,} \end{cases}$$

Consider a1=- a2

Generate signal a randomly from [a1, a2]. USe rand or randi matlab function

Generate noise using randn function.

Generate z using signal a and noise.

If z> (a1+a2)/2, declare the received signal as bit 1 else as bit 0.

Repeat the above process 10000 times. count number of times bit 1 is tx. count number of times z = bit 1.

Sim BER = 1-(z=bit 1)/(#times bit 1 tx)

Task 2: Simulated BER

Let a1 =[0.25, 0.5, 0.75, 1, 1.25, 1.5, 1.75, 2, 2.5, 3, 3.5].

Noise variance =1.

a) Calculate BER from monte carlo simulation for each value of a1.
b) Plot the simulated BER as a function of SNR. While plotting use loglog function instead of plot. Plot it in the same plot as theoretical BER. Use matlab function hold on
c) Insert labels for axis and legend in the plot

Result