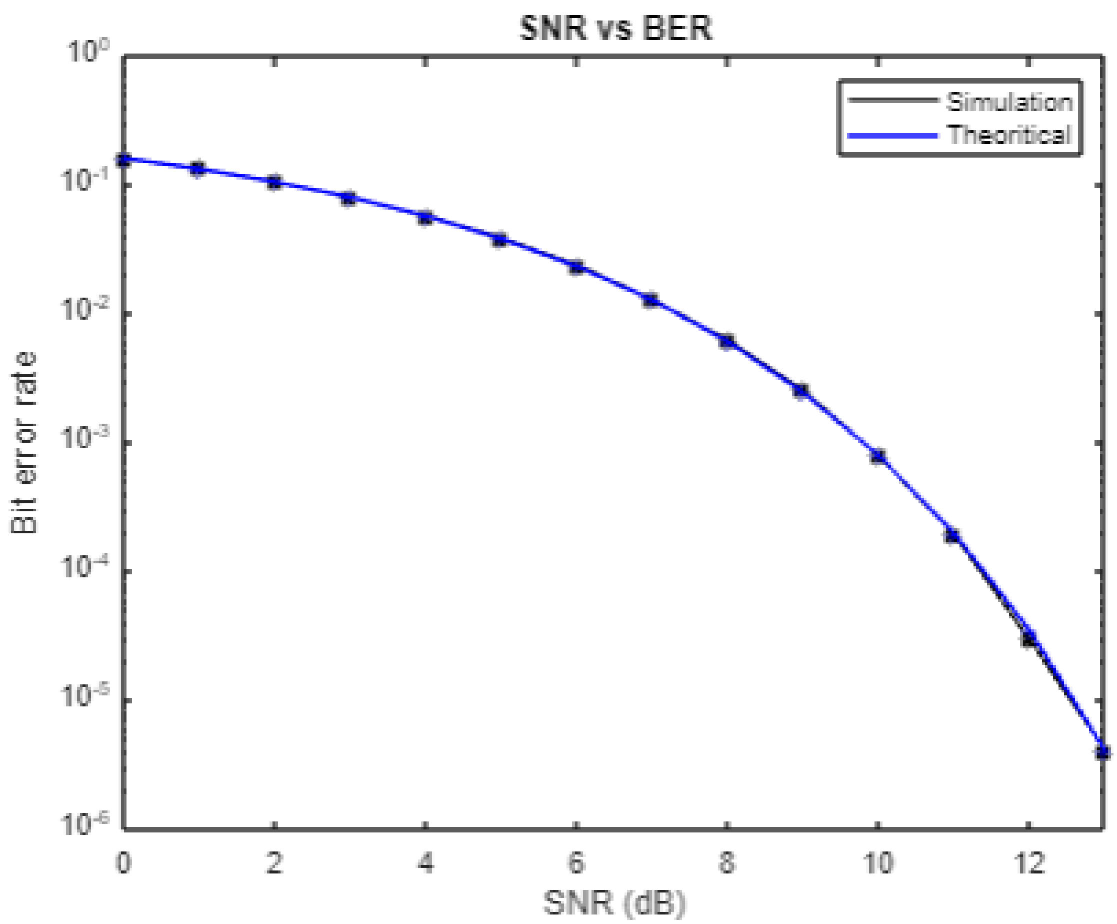
Assignment-3 (Part-B)

Q.1 Consider the transmission of BPSK modulated data over an AWGN channel. The observation element at the output of the correlation receiver is expressed as: x = si + w,where si ∈ {√Eb, −√Eb} and w~N(0,N0/2). Simulate this system in MATLAB, that is, generate a sequence of 106 samples of BPSK symbols, noise samples, and corresponding received samples. The detector is a maximum likelihood detector. Plot the probability of error curve as a function of Eb/N0 from 0 dB to 40 dB. Compare it with the analytical curve (obtained by directly implementing the mathematical relation of average BER derived in class in MATLAB). Compare and comment on the probability of error curve obtained by transmitting binary ASK over AWGN channel.State any assumptions you have made.

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SNR_dB = 0:1:40;                              % SNR

SNR = 10.^(SNR_dB/10);
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N = 10^6;

m_str = randi([0 1],1,N);              % message samples


% BPSK signals

% our signal space is one dimensional and signal vector we get is of the
form si = {+sqrtE, -sqrtE}

% so to generate our bpsk signals we will use a polar NRZ scheme where
bit 0 --> +1 and bit 1 --> -1


s_bpsk = 1 - 2*m_str;


% AWGN channel

% the noise is assumed to be additive white gaussian with zero mean and
power spectral density is N0/2.


noise = randn(1,N);                      % for our example we assume the
noise is N(0,1) such that noise power  = 1


% Transmitting our bpsk signals over the AWGN channel


for i=1:length(SNR)                      % we iterate for different SNR
values


   x = sqrt(SNR(i)) * s_bpsk + noise;  % recieved signal



   % we will keep a threshold of zero as we are using a maximum
likelihood

   % detector which in our case the threshold will be the perpendicular
bisector between our points.

   % i.e if x < 0 => bit 1 and if x > 0 => bit 0



   % we need to identify the bits that will be wrongly predicted due to
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   % the noise addition. To do this we need to identify which bits have
a
   % change in energy due to noise.

   error_bits = x.* s_bpsk;
   ind_error_bits = find(error_bits < 0);
   no_of_error_bits(i) = length(ind_error_bits);

end

ber = no_of_error_bits/N;                    % BER (simulation)

% BER (theoritical)

ber_theo = qfunc(sqrt(SNR));                 % the BER theoritically is
Q(sqrt(2E/No))

figure()
plt_ber_sim = semilogy(SNR_dB, ber, 'k*-', 'LineWidth',1);      %
plotting the SNR vs BER
hold on;

plt_ber_theo = semilogy(SNR_dB, ber_theo, 'b+-');

xlabel("SNR (dB)");
ylabel("Bit error rate");
xlim([0 13]);
legend([plt_ber_sim plt_ber_theo], {'Simulation','Theoritical'});
title('SNR vs BER');
```