clear

N = 10^6; % number of bits or symbols

rng(100); % initializing the random number generator

randn('state',200); % initializing the randn() function

% Transmitter

ip = rand(1,N)>0.5; % generating 0,1 with equal probability

s = 2\*ip-1; % BPSK modulation 0 -> -1; 1 -> 1

% AWGN Channel

n\_AWGN = 1/sqrt(2)\*[randn(1,N) + 1i\*randn(1,N)]; % white Gaussian noise, 0dB variance

Eb\_N0\_dB = (-3:10); % multiple Eb/N0 values

% AWGN Simulation

nErr\_AWGN = zeros(size(Eb\_N0\_dB));

for ii = 1:length(Eb\_N0\_dB)

% Noise addition

y\_AWGN = s + 10^(-Eb\_N0\_dB(ii)/20)\*n\_AWGN; % additive white Gaussian noise

% Receiver - hard decision decoding

ipHat\_AWGN = real(y\_AWGN)>0;

% Counting the errors

nErr\_AWGN(ii) = sum(ip ~= ipHat\_AWGN);

end

simBer\_AWGN = nErr\_AWGN/N; % simulated BER

theoryBer\_AWGN = 0.5\*erfc(sqrt(10.^(Eb\_N0\_dB/10))); % theoretical BER for AWGN

% Plot AWGN

figure

semilogy(Eb\_N0\_dB, theoryBer\_AWGN,'b.-');

hold on

semilogy(Eb\_N0\_dB, simBer\_AWGN,'mx-');

axis([-3 10 1e-5 0.5])

grid on

legend('AWGN Theory', 'AWGN Simulation');

xlabel('Eb/No, dB');

ylabel('Bit Error Rate');

title('Bit error probability curve for BPSK modulation in AWGN channel');

% Rayleigh Channel

h = 1/sqrt(2)\*[randn(1,N) + 1i\*randn(1,N)]; % Rayleigh fading channel

n\_AWGN = 1/sqrt(2)\*[randn(1,N) + 1i\*randn(1,N)]; % white Gaussian noise, 0dB variance

n\_Rayleigh = h.\*n\_AWGN; % multiply by Rayleigh fading coefficients

% Rayleigh Simulation

nErr\_Rayleigh = zeros(size(Eb\_N0\_dB));

for ii = 1:length(Eb\_N0\_dB)

% Noise addition

y\_Rayleigh = s + 10^(-Eb\_N0\_dB(ii)/20)\*n\_Rayleigh; % additive noise in Rayleigh channel

% Receiver - hard decision decoding

ipHat\_Rayleigh = real(y\_Rayleigh)>0;

% Counting the errors

nErr\_Rayleigh(ii) = sum(ip ~= ipHat\_Rayleigh);

end

simBer\_Rayleigh = nErr\_Rayleigh/N; % simulated BER

theoryBer\_Rayleigh = 0.5\*(1-sqrt(10.^(Eb\_N0\_dB/10)./(1+10.^(Eb\_N0\_dB/10)))); % theoretical BER for Rayleigh

% Plot Rayleigh

figure

semilogy(Eb\_N0\_dB, theoryBer\_AWGN,'b.-');

hold on

semilogy(Eb\_N0\_dB, theoryBer\_Rayleigh,'g--');

semilogy(Eb\_N0\_dB, simBer\_Rayleigh,'r.-','MarkerSize',4); % Reduce marker size

axis([-3 10 1e-5 0.5])

grid on

legend('AWGN Theory', 'Rayleigh Theory', 'Rayleigh Simulation');

xlabel('Eb/No, dB');

ylabel('Bit Error Rate');

title('Bit error probability curve for BPSK modulation in Rayleigh fading channel');