School of Engineering and Applied Science (SEAS)
Ahmedabad University

BTech(ICT) Semester V: Wireless Communication (ECE311)

Laboratory Assignment-3

Enrollment No: AU1841131 **Name: Mansi Dobariya**

1. Solution Problem-1

   (a) Matlab Script:

```
close all;
clear all;
clc;

%step1: Analytical plot
Eb_No_db= [0:35] ;

%convert into linear
Eb_No_Lin=10.^ (Eb_No_db/10);

%mu for theoretical part
mu=sqrt(Eb_No_Lin ./ (Eb_No_Lin + 1 ));
theoryBer=0.25*(2 - (3.* mu) + (mu.^(3)));

%step2 :simulation
N=700000;
ip = rand(1,N)>0.5;          % Generating 0,1 with equal probability
s = 2*ip-1;                  % BPSK modulation 0 -> -1; 1 -> 1
index=1;

for ii = 1:length(Eb_No_db)
   p=sqrt(1/Eb_No_Lin(ii))
   % white Gaussian noise, 0dB variance
   n1= 1/sqrt(2)*[randn(1,N) + j*randn(1,N)];
   %Rayleigh channel
   h1=1/sqrt(2)*[randn(1,N) + j*randn(1,N)];
   % Noise addition
   y1 = h1.* s + p*n1 ;

   % white Gaussian noise, 0dB variance
   n2= 1/sqrt(2)*[randn(1,N) + j*randn(1,N)];
   %Rayleigh channel
   h2=1/sqrt(2)*[randn(1,N) + j*randn(1,N)];
   % Noise addition
   y2 = h2.* s + p*n2 ;

   % white Gaussian noise, 0dB variance
   n3= 1/sqrt(2)*[randn(1,N) + j*randn(1,N)];
   %Rayleigh channel
   h3=1/sqrt(2)*[randn(1,N) + j*randn(1,N)];
   % Noise addition
   y3 = h3.* s + p*n3 ;

   % white Gaussian noise, 0dB variance
   n4= 1/sqrt(2)*[randn(1,N) + j*randn(1,N)];
   %Rayleigh channel
   h4=1/sqrt(2)*[randn(1,N) + j*randn(1,N)];
   % Noise addition
   y4 = h4.* s + p*n4 ;

```

```
   %Error detection for 1x2 SIMO
   for ll=1:N
   d2(ll)=conj(h1(ll)) * y1(ll) + conj (h2 (ll)) * y2(ll) ;
     if (real(d2(ll))>0)
       dataDetect_2(ll)=1;
     else
       dataDetect_2(ll)=0;
     end
   end

   error_2=xor(ip,dataDetect_2);
   bers_2(index)=sum(error_2)/N;
   snr_2(index)=ii;
   [snr_2(index) bers_2(index)]
   %N=N+10000;

   %Error detection for 1x4 SIMO
   for kk=1:N
   d(kk)=conj(h1(kk)) * y1(kk) + conj (h2 (kk)) * y2(kk) + conj(h3(kk)) * y3(kk) + conj (h4 (kk)) * y4(kk);
     if (real(d(kk))>0)
       dataDetect(kk)=1;
     else
       dataDetect(kk)=0;
     end
   end

   error=xor(ip,dataDetect);
   bers(index)=sum(error)/N;
   snr(index)=ii;
   [snr(index) bers(index)]
   %N=N+10000;
   index=index+1;

end

%SISO theoretical
theoryBer_siso=0.5.*(1-sqrt(Eb_No_Lin./(Eb_No_Lin+1)));

%for SISO Simulation
for ii = 1:length(Eb_No_db)
   % white Gaussian noise, 0dB variance
   n = 1/sqrt(2)*[randn(1,N) + j*randn(1,N)];
   %Rayleigh channel
   h=1/sqrt(2)*[randn(1,N) + j*randn(1,N)];
   % Noise addition
   y = h.* s + 10^(-Eb_No_db(ii)/20)*n ;

   %equalization
   yHat=y./h;

   % receiver - hard decision decoding
   ipHat = real(yHat)>0;

   % counting the errors
   nErr(ii) = size(find([ip- ipHat]),2);
end

simBer=nErr/N;
semilogy(Eb_No_db,theoryBer_siso,"m^",'LineWidth',3);
hold on;
semilogy(Eb_No_db,simBer,"-bo",'LineWidth',3);
hold on;
semilogy(Eb_No_db,theoryBer,"-k^",'LineWidth',2);
hold on
semilogy(Eb_No_db,bers_2,'-c+','LineWidth',2);
hold on
semilogy(Eb_No_db,bers,'dr-','LineWidth',2);
axis([0 35 10^-5 10^0])
grid on
```

```
legend(' nRx 1 Analytical ',' nRx 1 simulation',' nRx 2 Analytical ',' nRx 2
    simulation','nRx 4 simulation');
xlabel('Eb/No, dB');
ylabel('Bit Error Rate');
title('Bit error probability curve for BPSK modulation over SIMO (1*4) Wireless');
```

(b) Simulation Output:

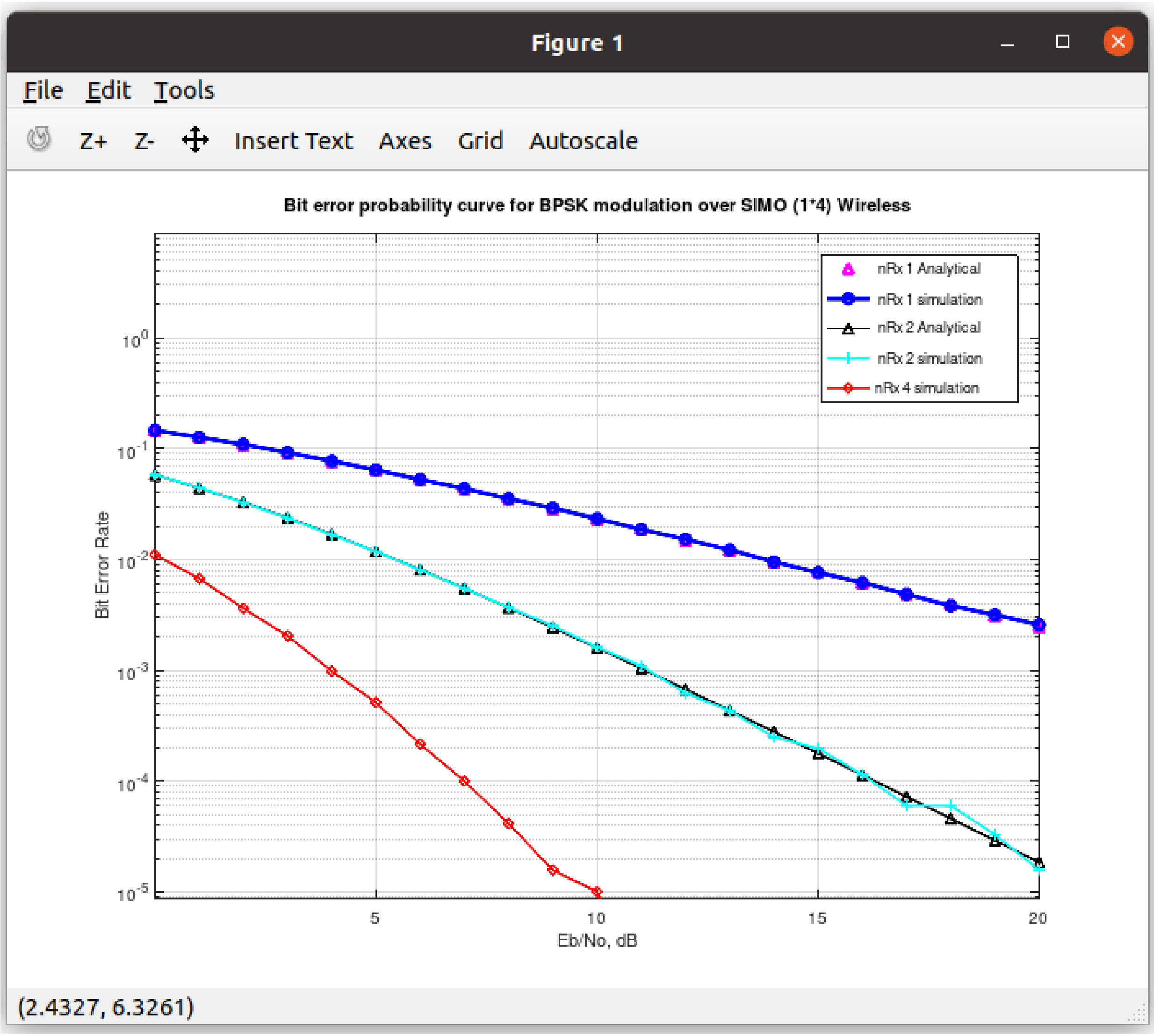

Fig 1.1 : BPSK modulation over SIMO (1*4)

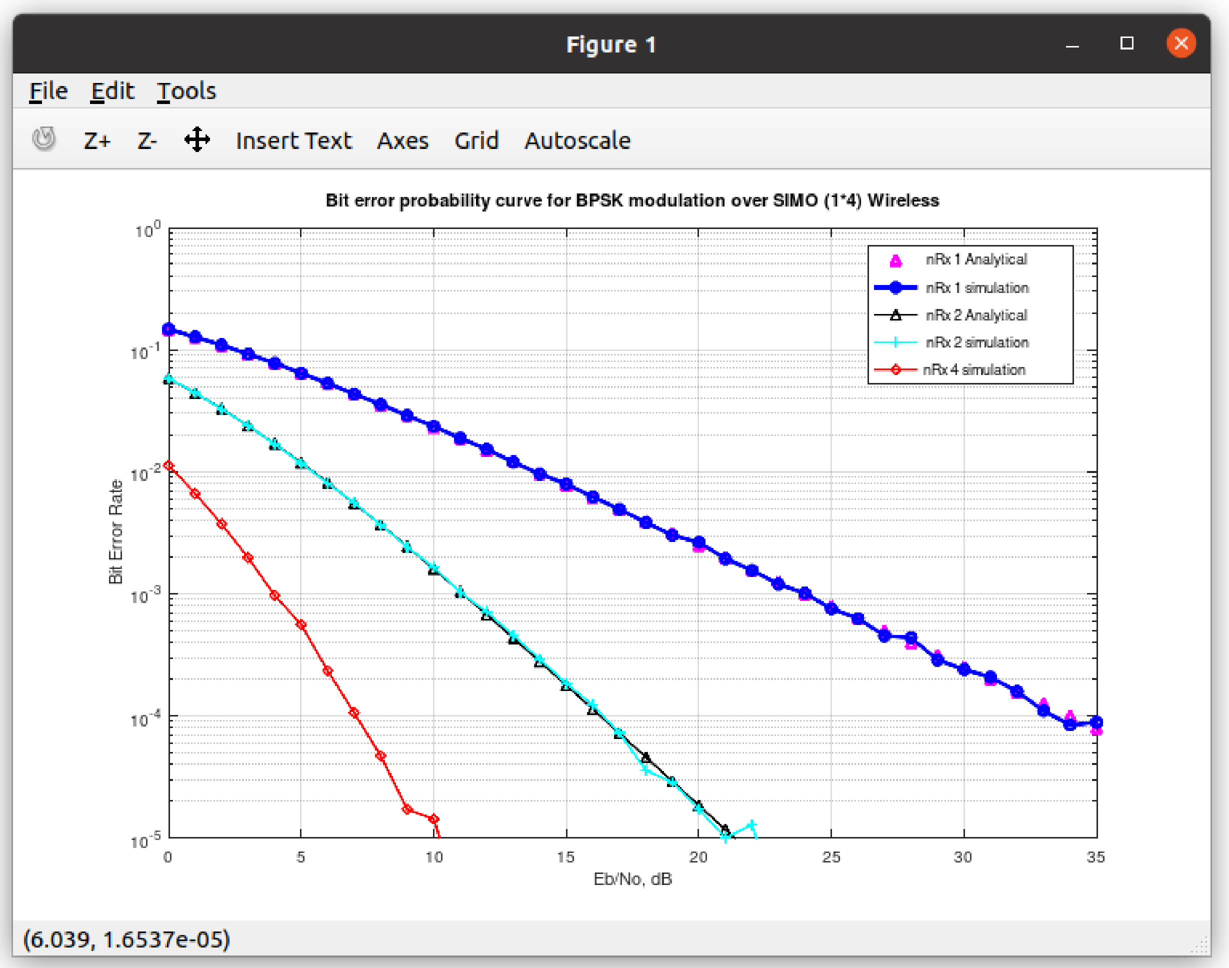

Fig 1.2: BPSK modulation over SIMO (1*4)

(c) Inference:

1) Rayleigh fading channel which is a more realistic representation of a wireless communication channel.In fact, for Rayleigh fading, the statistics has a steady slope in its BER curve for SISO(1 tx and 1 Rx). With increasing the Signal power, the Bit error in received signal reduces steadily . In Simulation over AWGN in QPSK , BER rate is much higher for Small value of SNR .Improves rapidly and offers a better performance than Rayleigh fading channel also low bit error rate (BER) and low SNR.This is because Rayleigh fading channel is characterized by multipath signal and it is computed by average BER .

2) Here(SIMO),The receivers are receiving data with high data rate, so that necessary for reducing errors and delimit from BER value to give the best performance of the system with less noise. Therefore, necessary to choose the better channel with better BER performance when building the transceiver in order to produce less noise and high performance. In SIMO(1*2), if at one Rx signal is in deep fading then 2nd Rx can receive the signal and we can improve performance over 1 Rx, 1 Tx.

3) Instead of SIMO(1*2), we choose SIMO(1*4) as 4 Rx antenna ,it gives better performance due to at receiver side if 1 antenna don't get any signal(in deep fade)

another antenna can receive and solve the problem of diversity. It's clearly visible more Rx antenna gives better performance.The deviation can be assumed as a result of the randomness of large numbers of iterated value employed in the program, since the model is taking into account infinite arrival paths.