Code :

```
%Simulation of OFDM system in an AWGN environment
clc;
clear all;

%--------Simulation parameters----------------
nSym=10^4; %Number of OFDM Symbols to transmit
EbN0dB = -20:2:8; % bit to noise ratio
%--------OFDM Parameters - Given in IEEE Spec--
N=64; %FFT size or total number of subcarriers (used + unused) 64
Nsd = 48; %Number of data subcarriers 48
Nsp = 4 ; %Number of pilot subcarriers 4
ofdmBW = 20 * 10^6 ; % OFDM bandwidth

% Derived Parameters
deltaF = ofdmBW/N; %=20 MHz/64 = 0.3125 MHz
Tfft = 1/deltaF; % IFFT/FFT period = 3.2us
Tgi = Tfft/4;%Guard interval duration - duration of cyclic prefix
Tsignal = Tgi+Tfft; %duration of BPSK-OFDM symbol
Ncp = N*Tgi/Tfft; %Number of symbols allocated to cyclic prefix
Nst = Nsd + Nsp; %Number of total used subcarriers
%For BPSK the number of Bits per Symbol is same as num of subcarriers
nBitsPerSym=Nst;
% converting to symbol to noise ratio
EsN0dB = EbN0dB + 10*log10(Nst/N) + 10*log10(N/(Ncp+N));
errors= zeros(1,length(EsN0dB));
theoreticalBER = zeros(1,length(EsN0dB));

%Monte Carlo Simulation
for i=1:length(EsN0dB),
for j=1:nSym
```

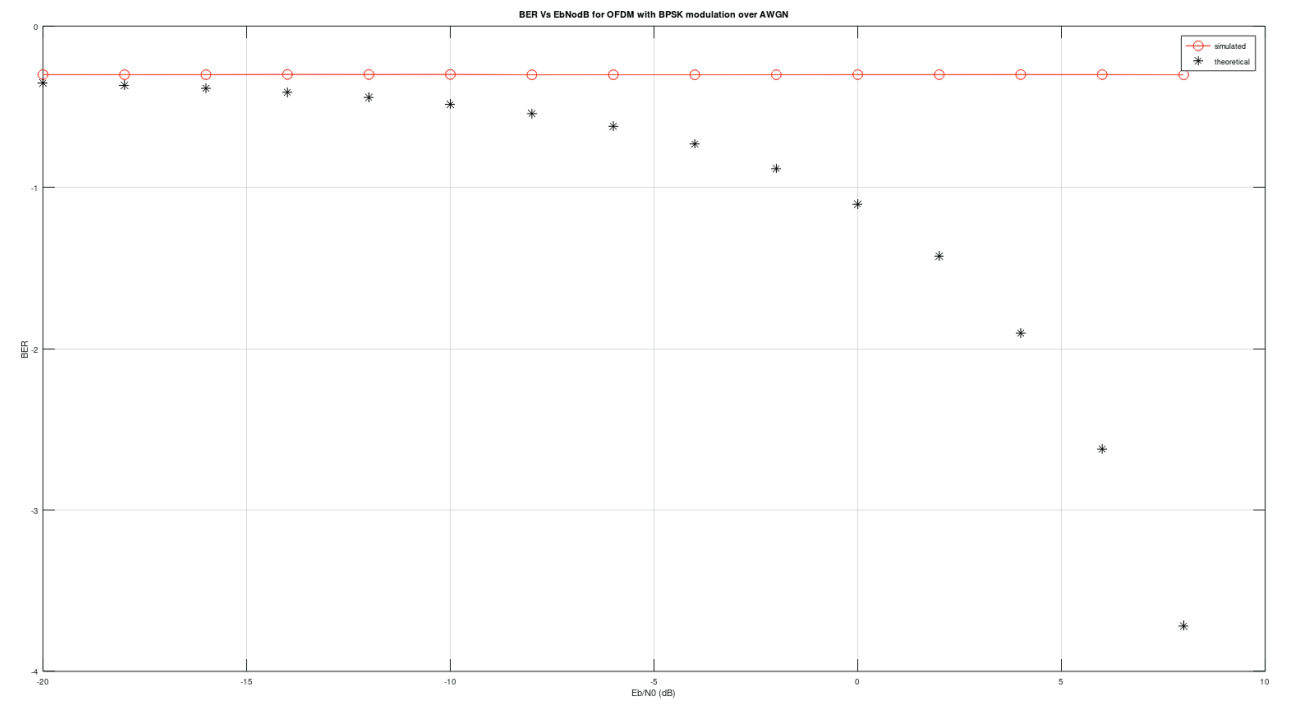
```
% Transmitter
s=2*round(rand(1,Nst))-1; %Generating Random Data with BPSK modulation
%IFFT block
%Assigning subcarriers from 1 to 26 (mapped to 1-26 of IFFT input)
%and -26 to -1 (mapped to 38 to 63 of IFFT input); Nulls from 27 to 37
%and at 0 position
X_Freq=[zeros(1,1) s(1:Nst/2) zeros(1,11) s(Nst/2+1:end)];
% Pretending the data to be in frequency domain and converting to time domain
x_Time=N/sqrt(Nst)*ifft(X_Freq);
%Adding Cyclic Prefix
ofdm_signal=[x_Time(N-Ncp+1:N) x_Time];
% Channel Modeling
noise=1/sqrt(2)*(randn(1,length(ofdm_signal))+1i*randn(1,length(ofdm_signal)));
r= sqrt((N+Ncp)/N)*ofdm_signal + 10^(-EsN0dB(i)/20)*noise;

% Receiver
%Removing cyclic prefix
r_Parallel=r(Ncp+1:(N+Ncp));
%FFT Block
r_Time=sqrt(Nst)/N*(fft(r_Parallel));
%Extracting the data carriers from the FFT output
R_Freq=r_Time([(2:Nst/2+1) (Nst/2+13:Nst+12)]);
%BPSK demodulation / Constellation Demapper.Force +ve value --> 1, -ve value --> -1
R_Freq(R_Freq>0) = +1;
R_Freq(R_Freq<0) = -1;
s_cap=R_Freq;

numErrors = sum(abs(s_cap-s)/2); %Count number of errors
%Accumulate bit errors for all symbols transmitted
errors(i)=errors(i)+numErrors;
end
theoreticalBER(i)=(1/2)*erfc(sqrt(10.^(EbN0dB(i)/10))); %Same as BER for BPSK over
AWGN
end
```

```
simulatedBER = errors/(nSym*Nst);
plot(EbN0dB,log10(simulatedBER),'r-o');
hold on;
plot(EbN0dB,log10(theoreticalBER),'k*');
grid on;
title('BER Vs EbNodB for OFDM with BPSK modulation over AWGN');
xlabel('Eb/N0 (dB)');ylabel('BER');legend('simulated','theoretical');
```

Output :



Code :

```
pkg load communications;
clc;
clear all;
N=64; %No. of bits
M=4; %No. of channels
data=randsrc(1,N,0:1:M-1); %To take random data from user in digital signal format
display(data);
%To achieve modulation
Mary_output=pskmod(data,M); %M_ary modulation of signal
figure(1);
stem(Mary_output);
title("Modulated output of signal");
%Serial to parallel conversion
s2p=reshape(data,[N/M,M]);
%To divide 16*4 matrix of s2p into 16*1 matrix
subcarrier1=s2p(:,1);
subcarrier2=s2p(:,2);
subcarrier3=s2p(:,3);
subcarrier4=s2p(:,4);
%Taking inverse fourier transform of signal
ifft1=ifft(subcarrier1);
ifft2=ifft(subcarrier2);
ifft3=ifft(subcarrier3);
ifft4=ifft(subcarrier4);
%To plot real part of signal to achieve orthogonality
figure(2);
plot(real(ifft1),'r');
hold on;
plot(real(ifft2),'b');
```

```
hold on;
plot(real(ifft3),'g');
hold on;
plot(real(ifft4),'y');
hold on;
for i=1:M;
 ifft_signal(:,i)=ifft((s2p(:,i)),16) %16 is the ifft point
end
%To plot ifft of whole signal of dimensions 16*4
figure(3);
plot(ifft_signal);
title('IFFT of Integrated Signal');
%parallel to serial conversion
p2s=reshape(ifft_signal, 1,N);
figure(4);
plot(real(p2s));
xlabel('time');
ylabel('amplitude');
title('OFDM signal to be transmitted')
```

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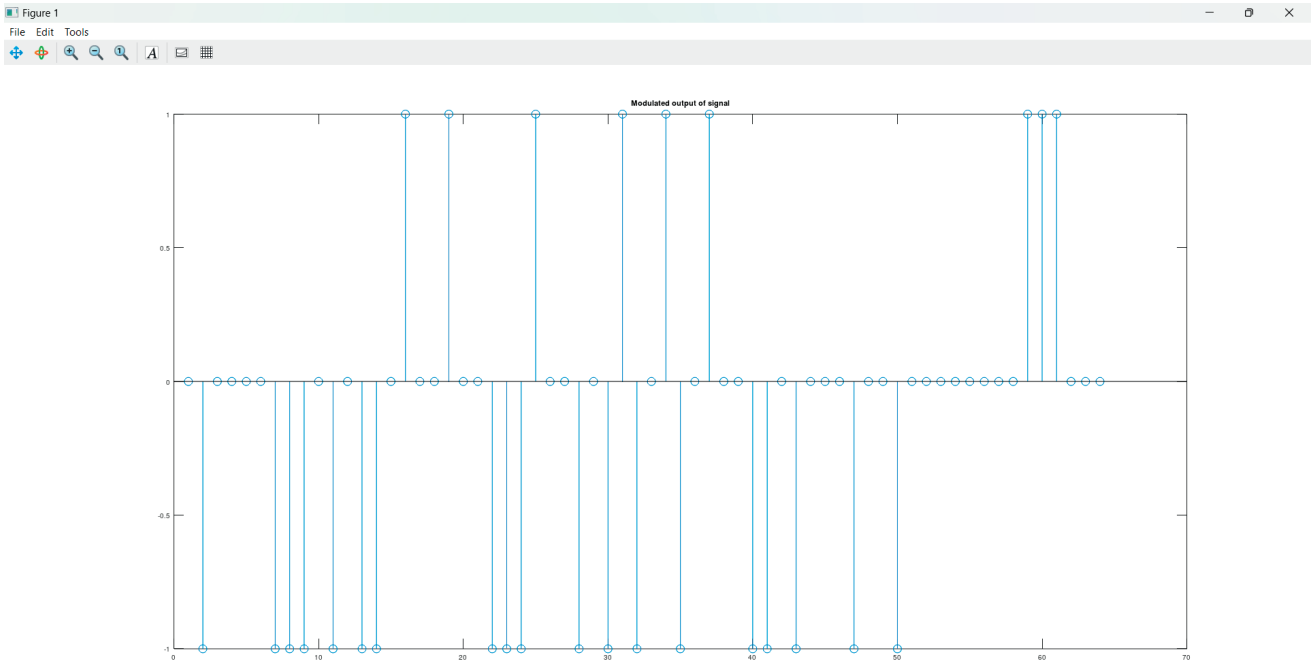
Output :



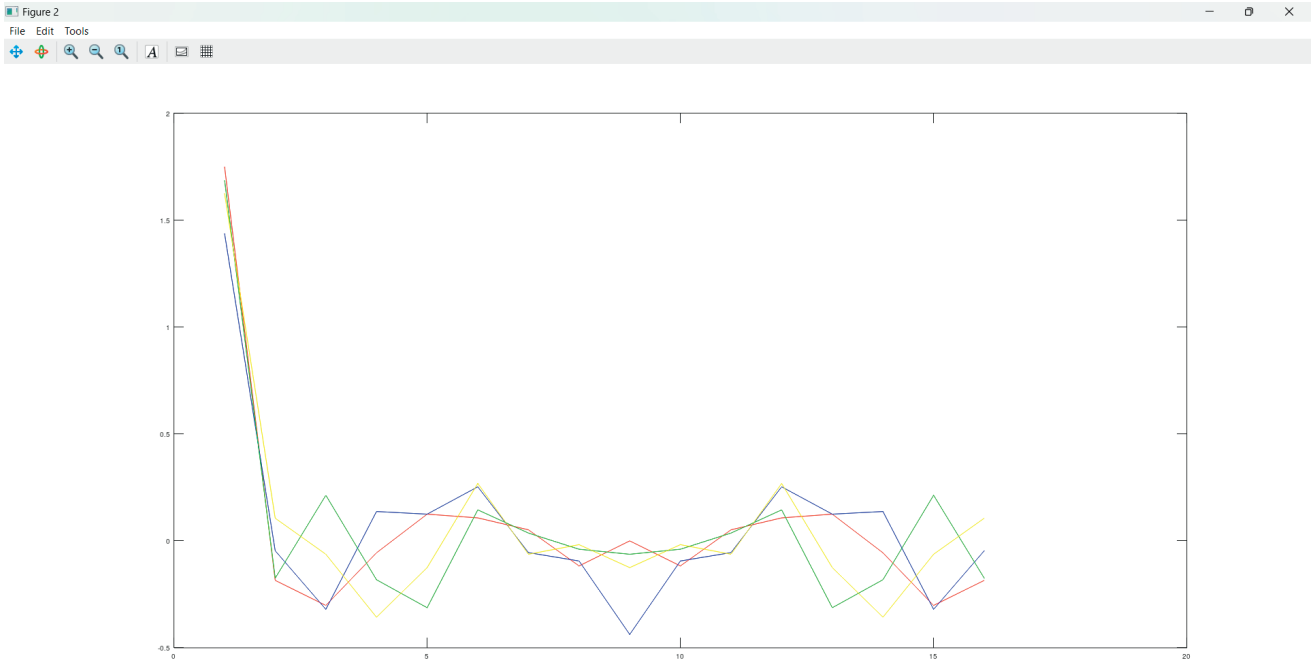
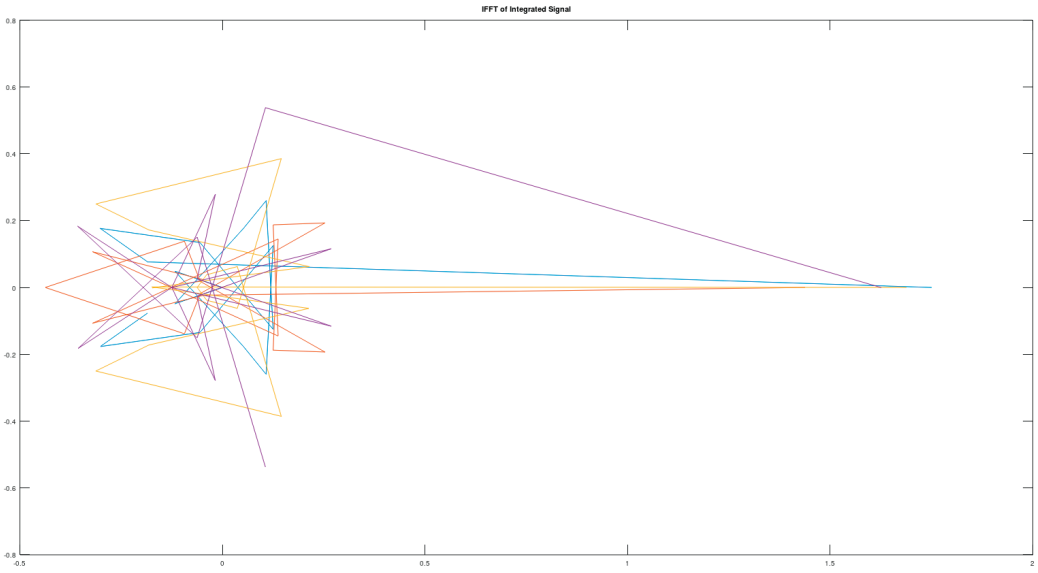


Figure 3

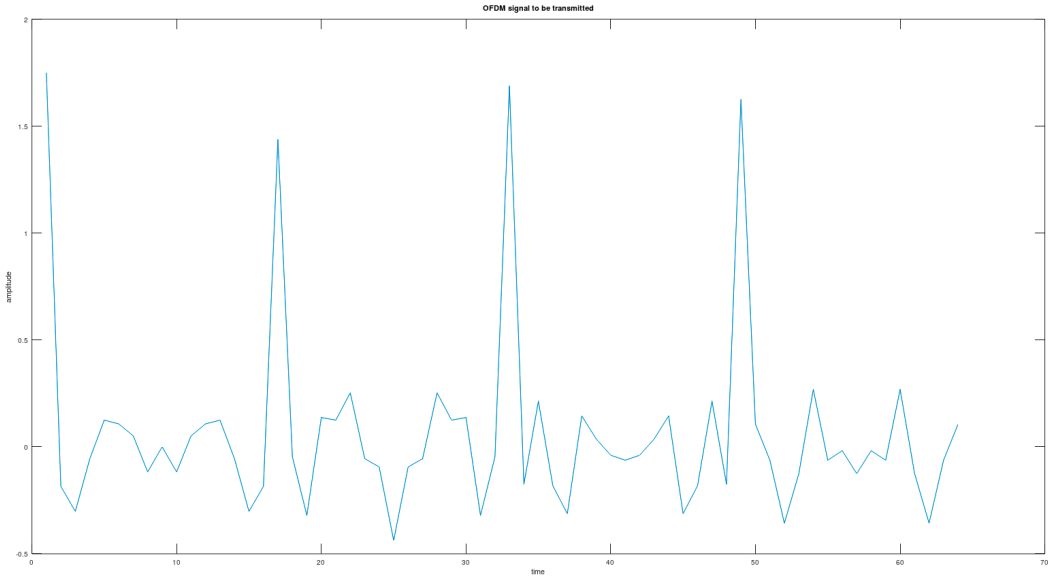
File Edit Tools



(1.9032, 0.28538)

Figure 4

File Edit Tools



(67.573, 0.8586)