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Bit Error Rate Performance Evaluation of Different Digital Modulation and Coding Techniques with Varying Channels

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ABSTRACT

This paper focuses mainly on Bit Error Rate (BER), Signal to Noise Ratio and different Rayleigh channels. We have designed four Rayleigh channels. This paper describes the comparative analysis of different digital modulation techniques like BPSK, QPSK, 8PSK, 16PSK and 16QAM for four Rayleigh channels which are designed. We also compare the convolution coding with different code rates i.e. 1/2, 1/3 and 2/3 code rate for various channels. Here we use MATLAB2009b software.

KEYWORDS: *M-ARY Modulation, Quadrature Amplitude Modulation, Phase Shift Keying (PSK), Bit Error Rate (BER), Signal-to-Noise Ratio (SNR)*

I. INTRODUCTION

The concept of communication gives us insight into the way it influenced the development of modern civilization and still exerts an influence on modern societies. Communication is defined as 'the transmission of messages from one person to another person'. In telecommunication system, modulation is the method of varying one or more properties of a signal waveform which is called 'carrier signal' of high frequency along with a modulating signal which contains information to transmit [15]. With the modulating signal, the carrier signal is multiplied. Effective communication only takes place when the receiver understands the transmitter's exact message.

The communication system consists of different devices using one of two communication methods, i.e. wired or wireless, diff erent types of equipment (portable radios, mobile phones, base station radios and repeaters) and different accessories (speaker s, battery eliminators, etc.) and enhancements (encryption, sec urity measures, networking, etc.) to satisfy user needs.

In the communication methods, one of them is Wireless communications and other is wired communication. It has become one of the fastest growing areas in our modern life style and creates a large impact on our daily life also. A tremendous technological transformation during the last two decades has provided a potential growth in the area of digital communication System. In digital communications System, the industry uses the latest mathematical software's which are used to increase the performance of digital system with different digital modulation techniques. These techniques are Amplitude S hi ft Keying (ASK), Frequency Shift Keying (FSK), phase Shift Keying (PSK) and Quadrature Amplitude Modulation (QAM).

II. M- ARY MODULATION TECHNIQUES

In the communication System, The digital baseband data may be sent by varying the envelope, phase or frequency of a Radio frequency carrier signal as the envelope and phase offer two degrees of freedom and modulation techniques map baseband data into four or more possible RF Carrier signals. This type modulation techniques are known as M-ary modulation techniques, since they can represent more signals than if just the amplitude or phase were varied alone [13]. In this modulation technique, we send one of M possible signals s1 (t), s2 (t)…sm (t), during each signaling interval of duration Ts. In almost all applications, the numbers of possible signals are M=2n, where n is an integer.

The duration of the symbol is Ts=nTb, where Tb is the duration of the bit. In pass-band data transmission these signals are generated by changing the amplitude, phase, frequency of a sinusoidal carrier in M discrete steps thus we have M-ary ASK, Mary PSK and M-ary FSK digital modulation schemes [12][13] [14]. Using M-ary modulation technique, different types of bandwidth efficiency can be achieved at the expense of power efficiency.

III. CONVOLUTION CODE

The convolution codes offer a technique to error control coding substantially different from that of block codes. These codes are widely used in many applications to ensure reli able data transfer, including digital video, radio and mobile co mmunications, as well as satellite communication

[9]. Convolution coding is done by combining the fixed number of input bits. The input bits are stored in a fixed length shift register. They are combined with the help of modulo-two adders. An input sequence and the contents of shift registers perform modulo-2 addition after information sequence is sent to the registers, so that an output sequence is obtained. This operation is equivalent to binary convolution and hence it is called convolution coding [10] [11]. The ratio

of R=k/n is called the code rate for a convolution code where k is the number of parallel input bits and n is the number of parallel decoded Output bits, m is the symbolized number of shift registers. Shift register is used to store the state information of convolution Encoder and constraint length (K) relates the number of bits upon which the output depends.

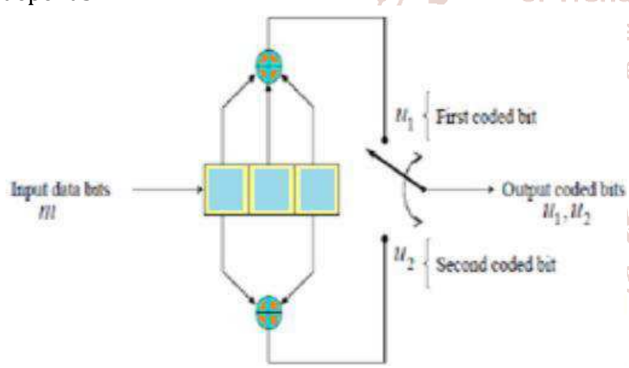


Fig.1: Convolution encoder with rate ½, k=1, n=2, m=3, k=4

IV. SYSTEM PERFOMANCE MEASURES

A. Bit Error Rate (BER):

In Digital communication system, the number of bit errors is the number of received bits of a stream of da ta over a communication channel that may be altered due to noise, distortion, interfe rence, or bit synchro nization error s. The bit error rate (BER) is the ratio between the numbers of bits in error to the total number of transferred bits d uring a studied time interval. BER is a unit less performance It is measured and expressed as a percentage. The bit error probability Pb is expressed by the following manner-

BER (Pb) = Number of bits in error / Total number of bits transferred.

B. signal-to-noise density ratio (Eb/No), (Eb is the energy per bit and No is the noise density):

Signal to noise ratio (SNR) is a measurement of the amount of Signal divided by the receipt of noise. In general a high SNR is good because it means we are getting more signal and less noise.

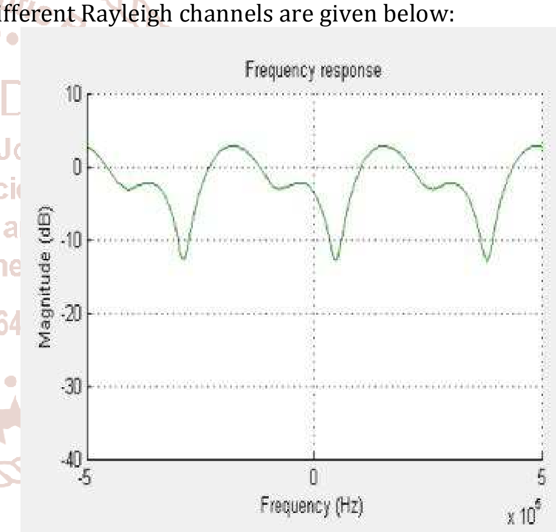
Usually SNR is measured using a logarithmic scale, which mea ns that the SNR value is the actual ratio logarithm. Generally, low SNR can lead to high BER. The BER is too small to good. It is important to note that POE is proportional to Eb/No and is a form of signal to noise ratio [14].

SNR = 10log10 ( ) dB ……………………….. (1)

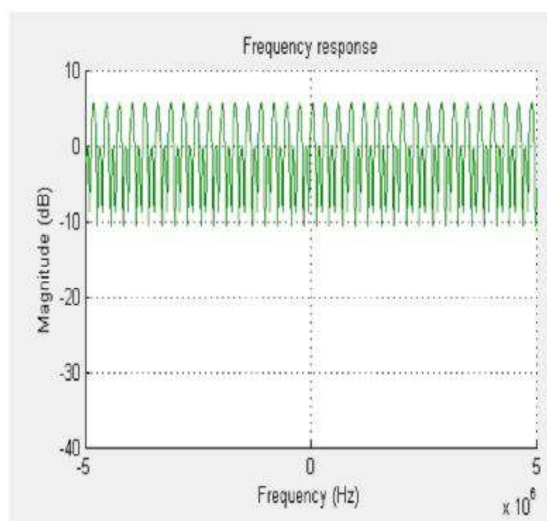
The Probability of bit error is directly proportional to the distance between the closest points in the constellation diagram, which implies that a modulation technique with a constellation that is densely packed is less energy efficient than a modulation scheme that has sparse constellation [5][12] [14].

C. Transfer functions of designed four Rayleigh channels:

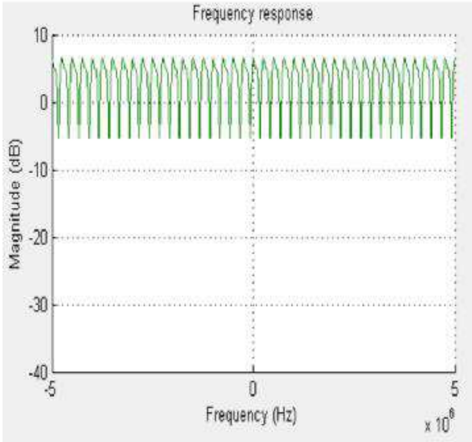
Rayleigh channels are useful tools of real-world phenomena in wireless communications. This phenomenon includes Fig 2: For channel 1 multipath scattering effects, time dispersion effect and Doppler shifts that arise from relative motion between the transmitter and receiver. Here we design four types Rayleigh channels. The Transfer functions of designed different Rayleigh channels are given below:



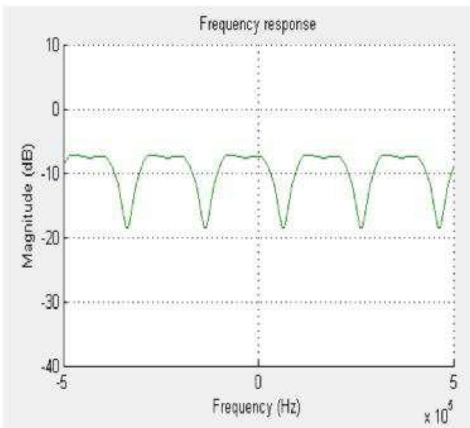
Transfer function for channel 1



Transfer function for channel 2



Transfer function for channel 3



Transfer function for channel 4

V. PERFORMANCE ANALYSIS OF M-Ary PSK, M-Ary QAM USING MATLAB CODING

For designing different Rayleigh channels we use MATLAB programming. We change the bit rate, Doppler frequency, path delay and path gain to design the various Rayleigh channels. Their transfer functions are shown in the above four figures IV. C section. The Doppler frequency range is 170 Hz to 400 Hz. In V.A section we discuss the simulation result without convolution encoder for various channels. In V .B section we discuss the simulation result with convolution encoder for various code rates and for various channels.

A. Simulation Result without Convolution Encoder over channel 1, channel 2, channel 3, channel 4 for different digital modulation techniques

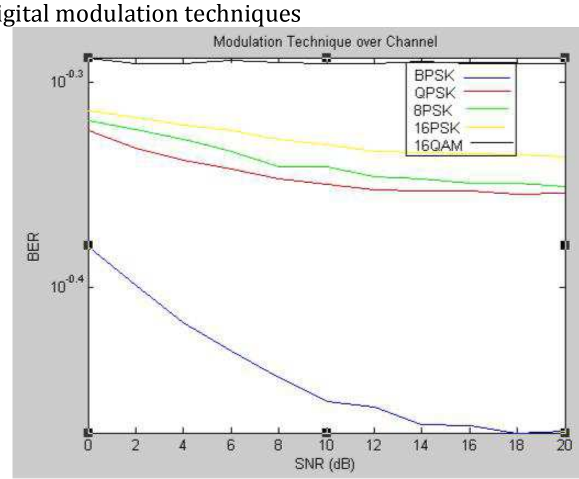


Fig 2: For channel 1

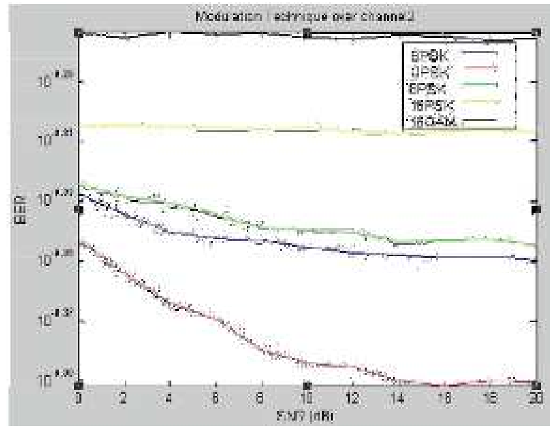


Fig 3: For channel 2

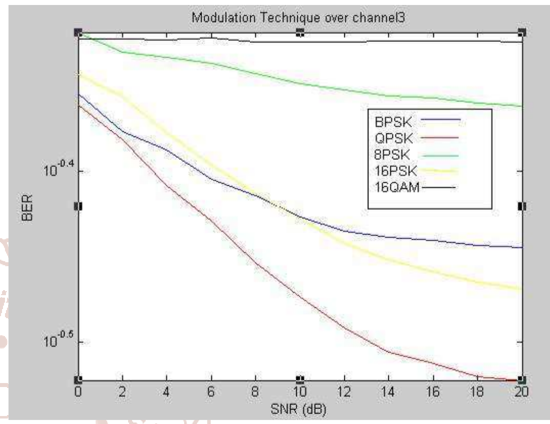


Fig4: For channel 3

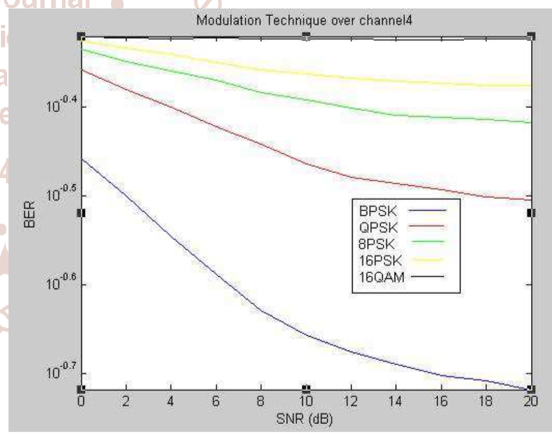


Fig 5: For channel 4

B. Simulation Result with Convolution Encoder for different code rates over channel 1, channel 2, channel 3, channel 4 for different digital modulation techniques

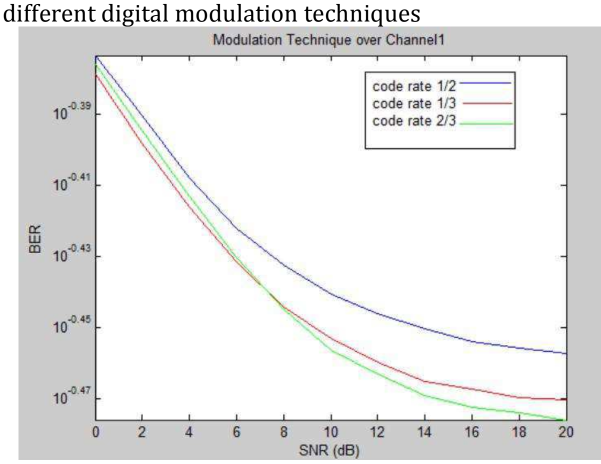


Fig 6: BPSK over channel 1

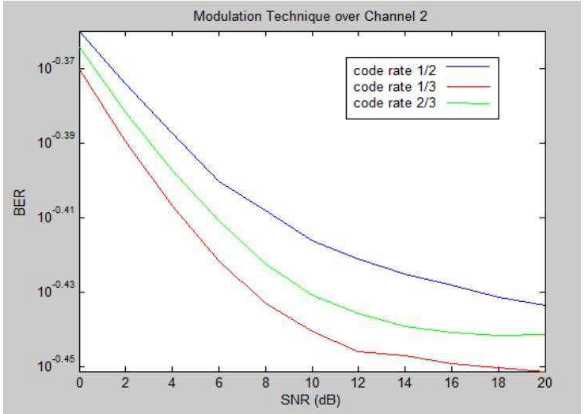


Fig7: BPSK over c hannel 2

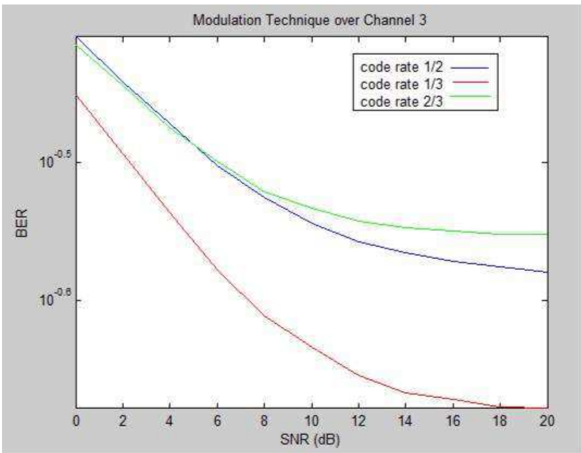


Fig 8: BPSK over ch annel 3

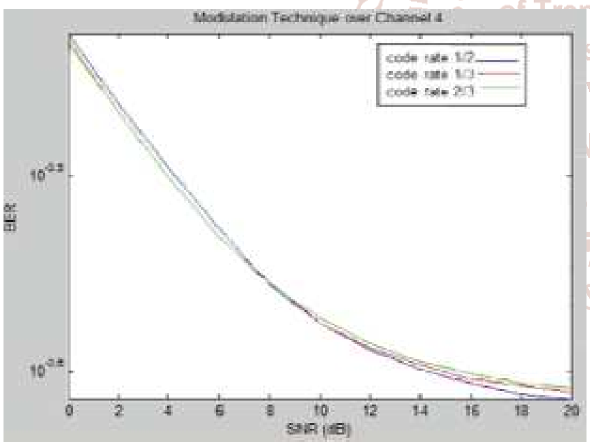


Fig 9: BPSK over channel 4

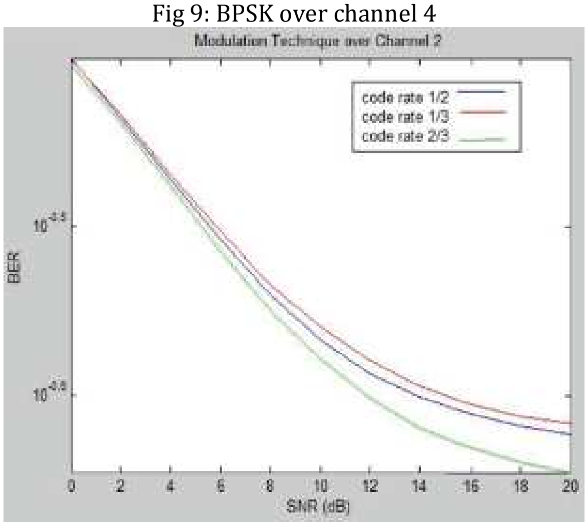


Fig 10: QPSK over channel 1

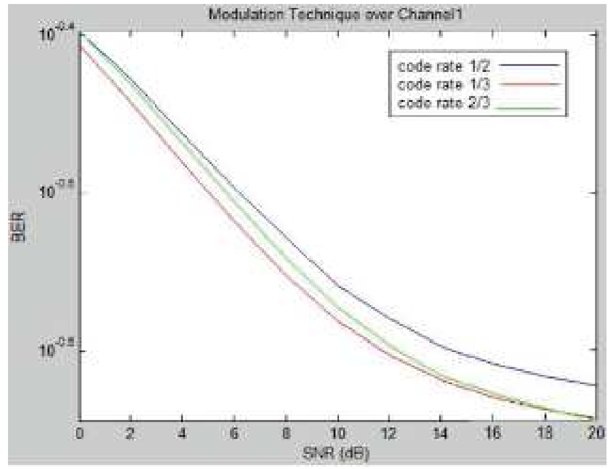


Fig 11: QPSK over channel 2

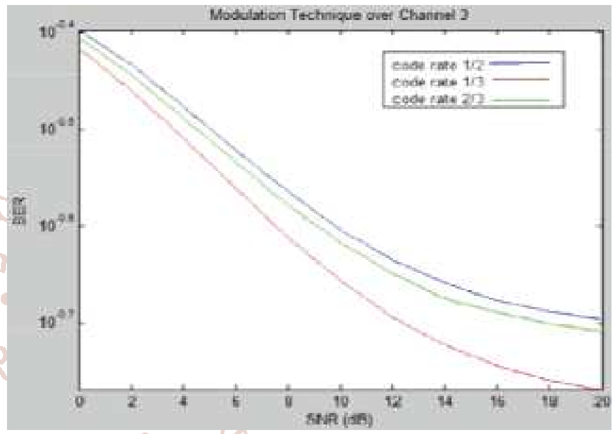


Fig 12: QPSK over ch annel 3

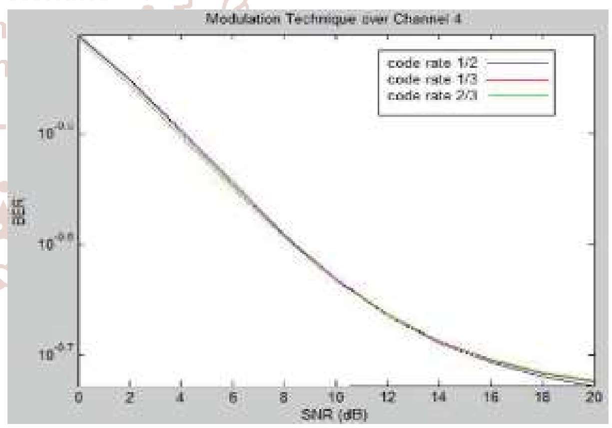


Fig 13: QPSK over channe l 4

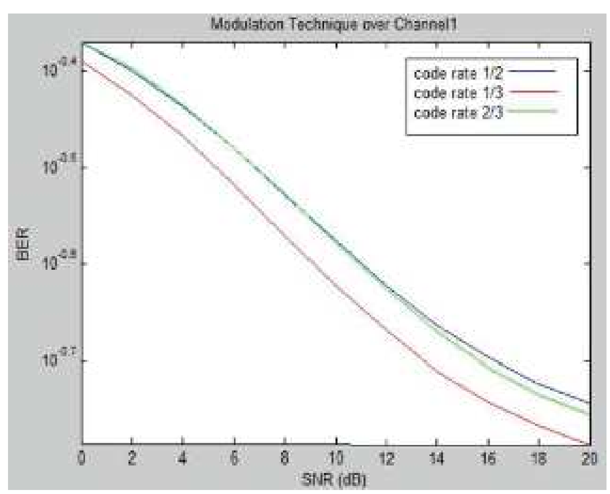


Fig 14: 8-PSK over chan nel 1

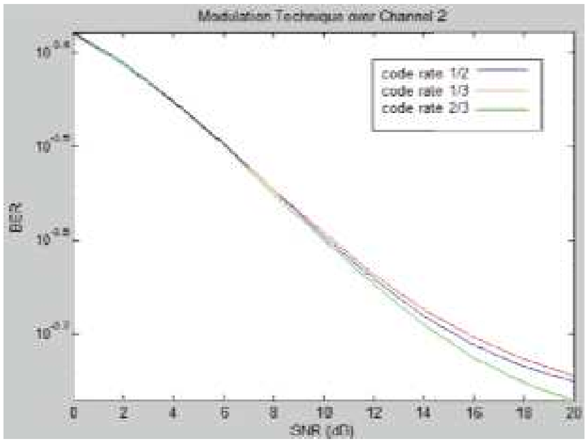


Fig 15: 8-PSK over channel 2

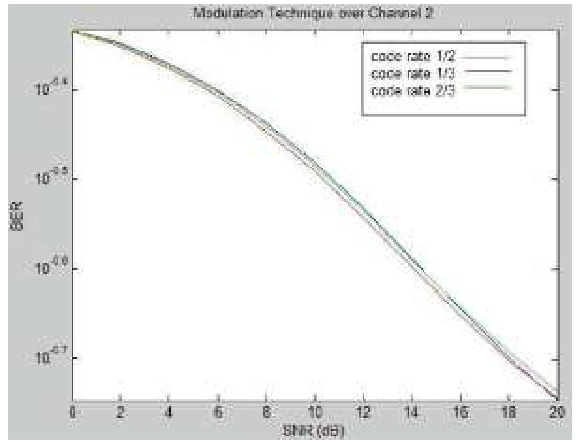


Fig19:16-PSK over cha nnel2

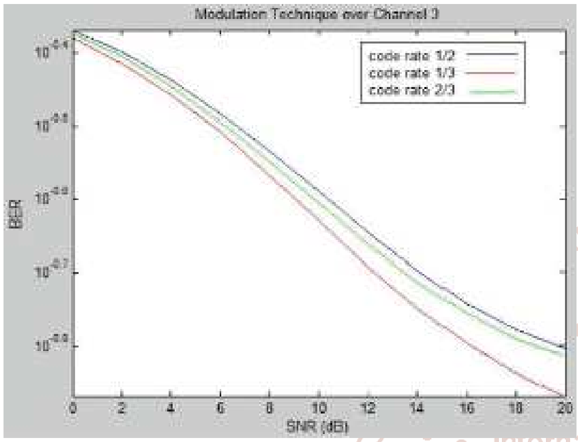


Fig 16: 8-PSK over channel 3

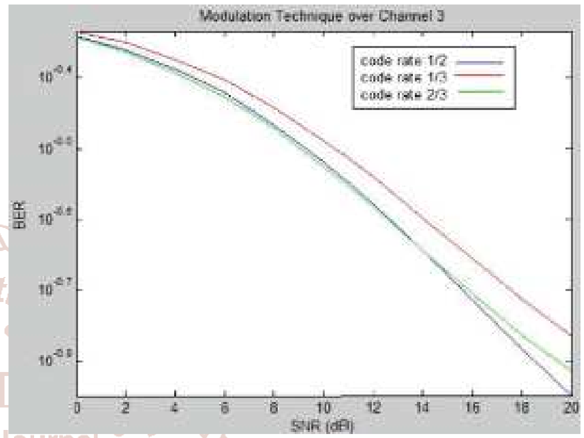


Fig 20: 16-PSK over cha nnel 3

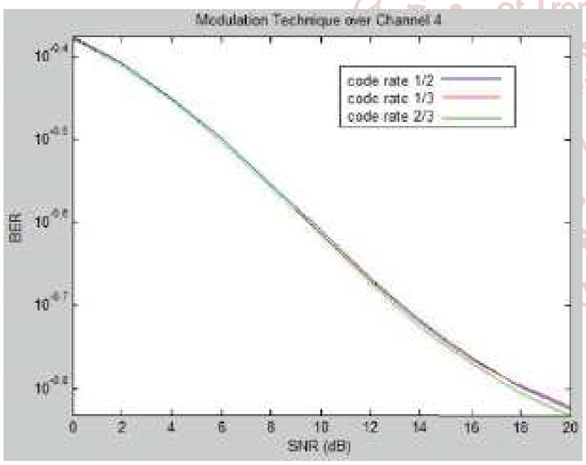


Fig 17: 8-PSK over channel 4

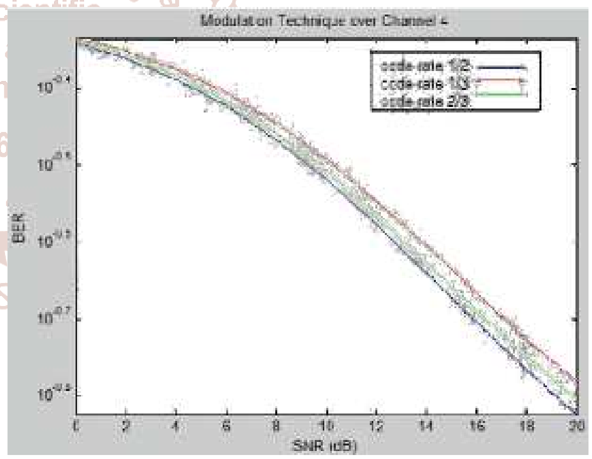


Fig 21: 16-PSK over channel 4

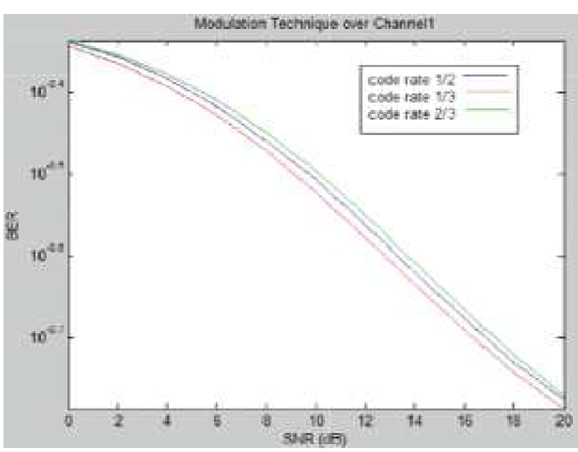


Fig18:16-PSK over channel 1

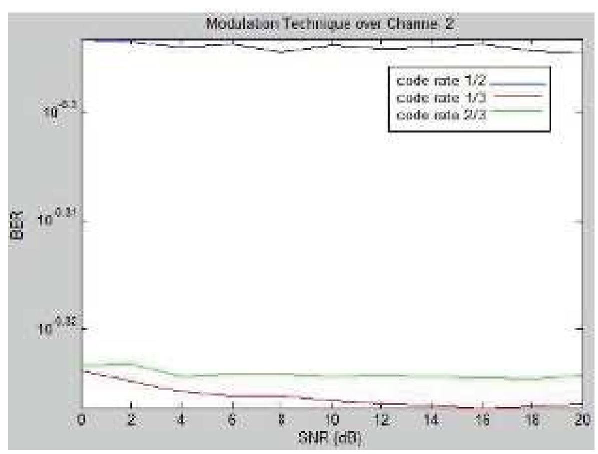


Fig 22: 16-QAM over channel1

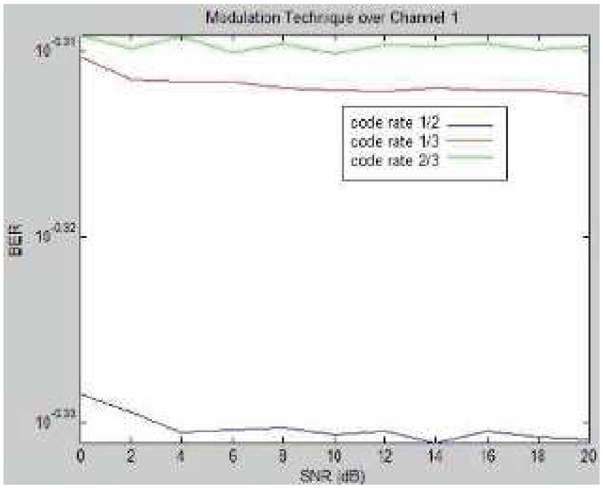


Fig 23: 16-QAM over channel2

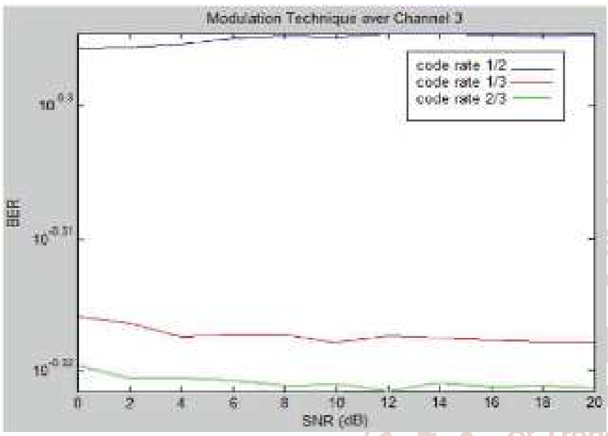


Fig 24: 16-QAM over channel3

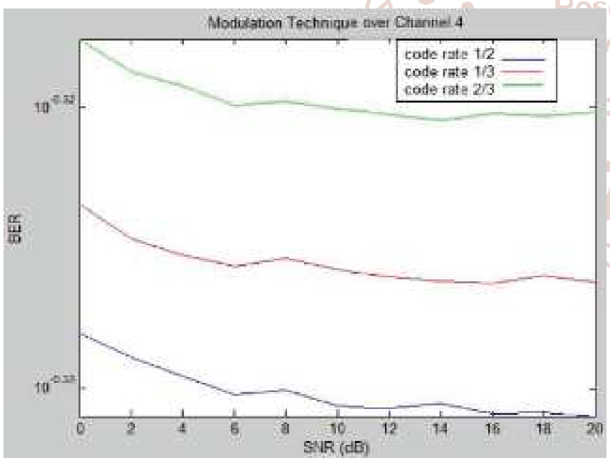


Fig 25: 16-QAM over channel4

Vi. CONCLUSION

Here a comparative study has been do ne of digital modulation techniques used in wireless communi cation system. The quality of service provided by wireless comm unication system may be greatly enhanced with the help of cor rect selection of modulation scheme [16]. From the above figures for without convolution encoder we get the better result in figure 3 and figure 4, i.e. for channel 2 and channe l 3. Here bit error rate is minimized for higher modulation ord er. For channel1 and channel 2 we consider the Doppler fre quency is 170 Hz and 200 Hz. We also consider the bit rate 106 and 107. For higher frequency range i.e. here 400 Hz Code rate ½ always gives the best result except 8-PSK. For 8-PSK 2/3 code rate gives the best result for higher frequency. For lower frequency range code rate ½ and 1/3 gives the best result except 16QAM. From the above graphs we see that among all the modulation techniques and all the channels 16-Q AM for channel 4 and for code rate 1/2 gives the best result. Th e bandwidth is 400 Hz.

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