Experiment - 01

Objective :-

Task ① :- (a) Generate sequence of continuous distribution uniform random numbers in the intervals $[X_{min}, X_{max}]$

(b) Plot the c.d.f. of the generated sequence. Use rand( ) function of MATLAB.

Task ② :- (a) Generate sequence of discrete uniform random variable in the range $\left[-\frac{(X_{min}+X_{max})}{2}\ \frac{(X_{min}+X_{max})}{2}\right]$

& plot the sequence.

(b) Plot the pmf of generated sequence.

(c) Plot the C.d.f of generated sequence.

Checked

Accept 24/08/2023

Theory :-

- Random Variable – It is a mapping from the sample space Ω to the set of real numbers.

- Cumulative Distribution Function (cdf) – It gives a complete description of the random variable. It is defined as:

$$F_X(x) = P(\omega \in \Omega : X(\omega) \leq x) = P(X \leq x)$$

→ A random variable can be discrete, continuous or mixed.

- Probability Density function (Pdf) — The Pdf is defined as the derivative of the cdf:

$$\boxed{f_X(x) = \frac{d F_X(x)}{dx}}$$

→ For discrete random variables, it is common to define the probability mass function (Pmf) : $P_i = P(X = x_i)$.

Results :- The sequence of continuous & discrete uniform random numbers were plotted with the help of rand( ) & randi( ) inbuilt function. C.d.f of both random variables & Pmf of discrete uniform r.v. were plotted with the help of MATLAB.

Conclusion :-

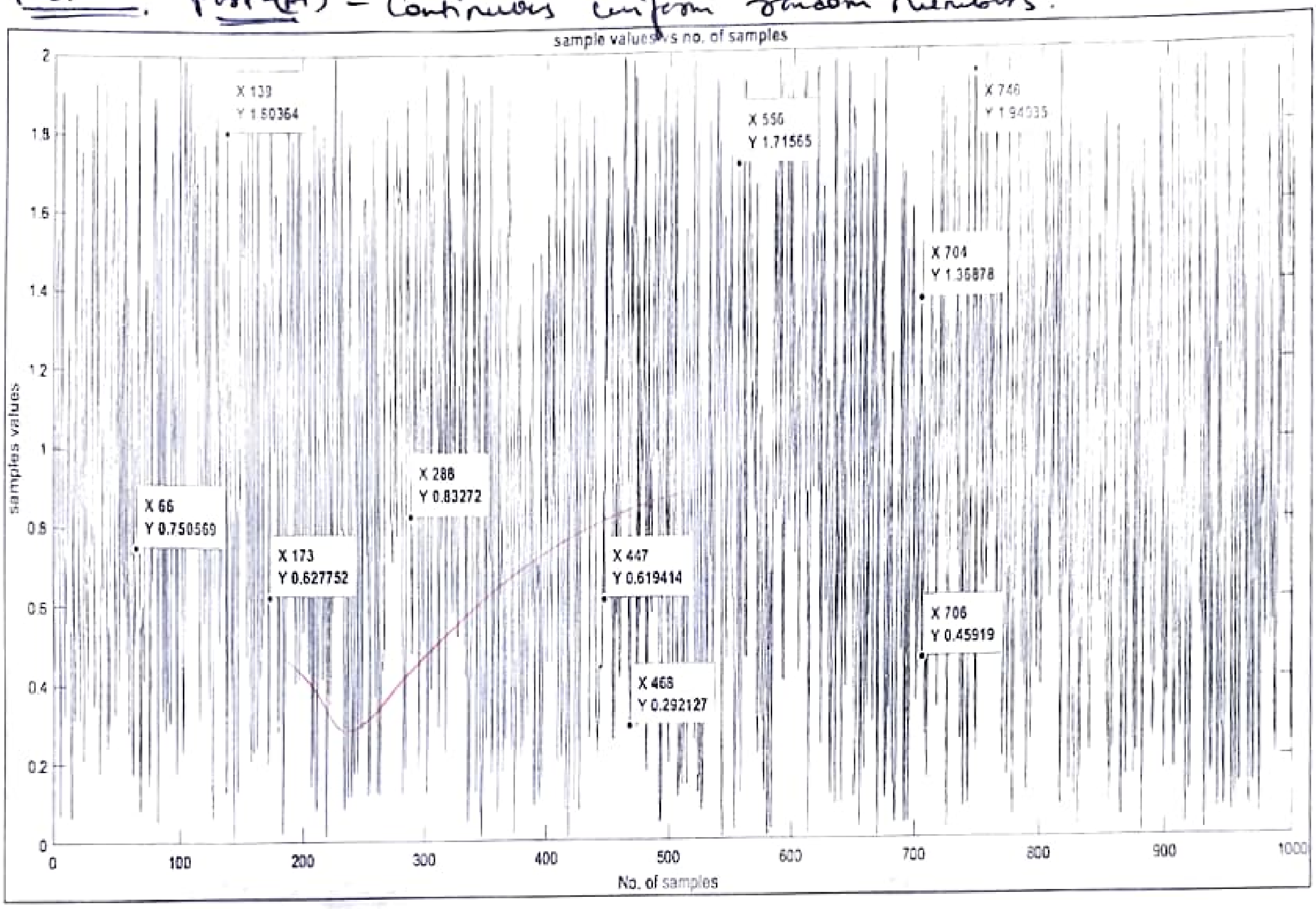
(i) The CDF plot provides a cumulative view of the probabilities of the random variable being less than or equal to a certain value. The slope of the CDF curve reflects the density of probabilities.

(ii) The area under the PDF curve within a certain interval represents the probability of the random variables falling within that interval.

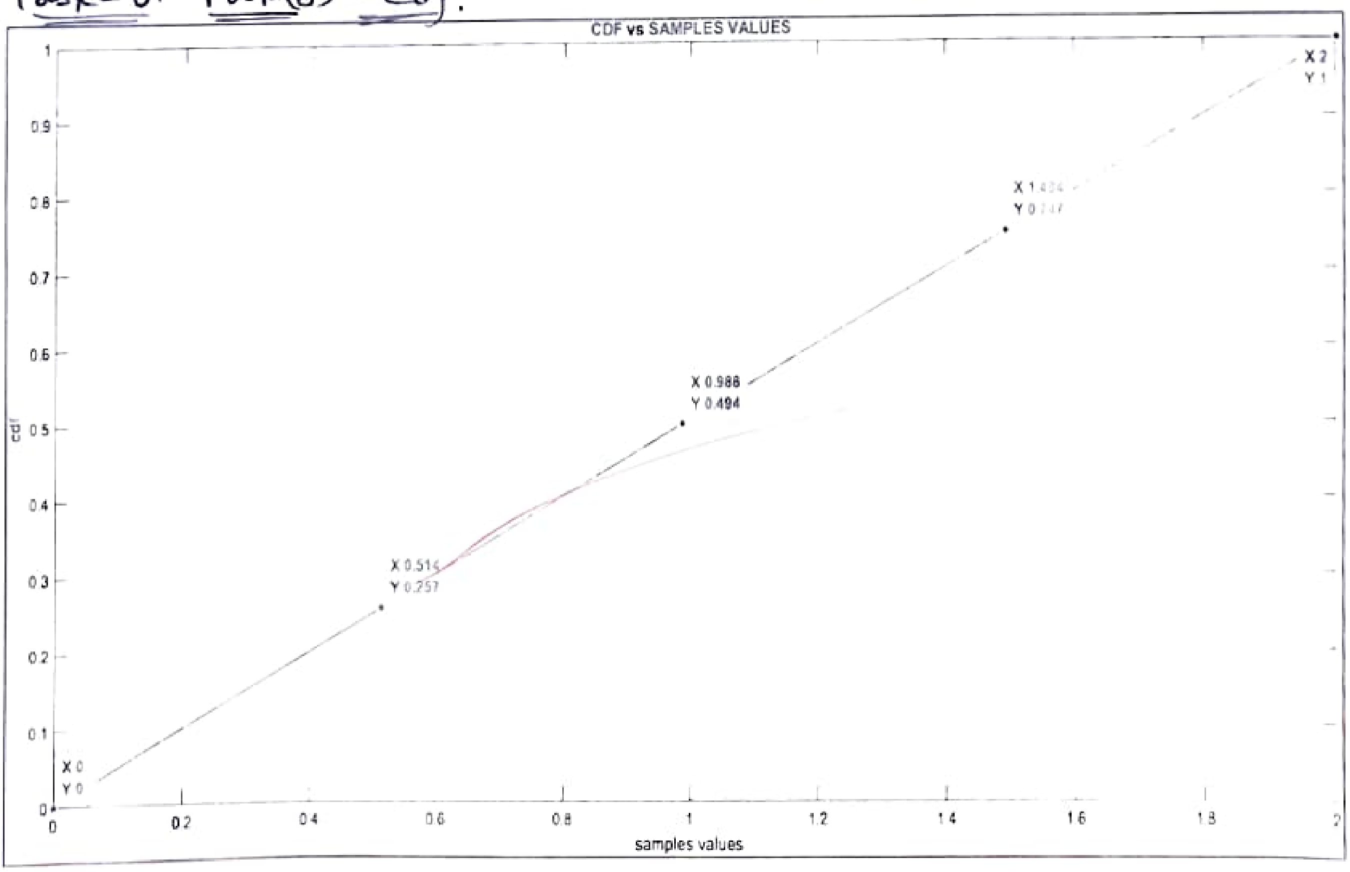
(iii) The PMF plot shows the probabilities associated with each possible value of the random variables.

OBSERVATION:

Task-01 Part-(A) - Continuous uniform random numbers.



Task-01 Part-(B) - Cdf.



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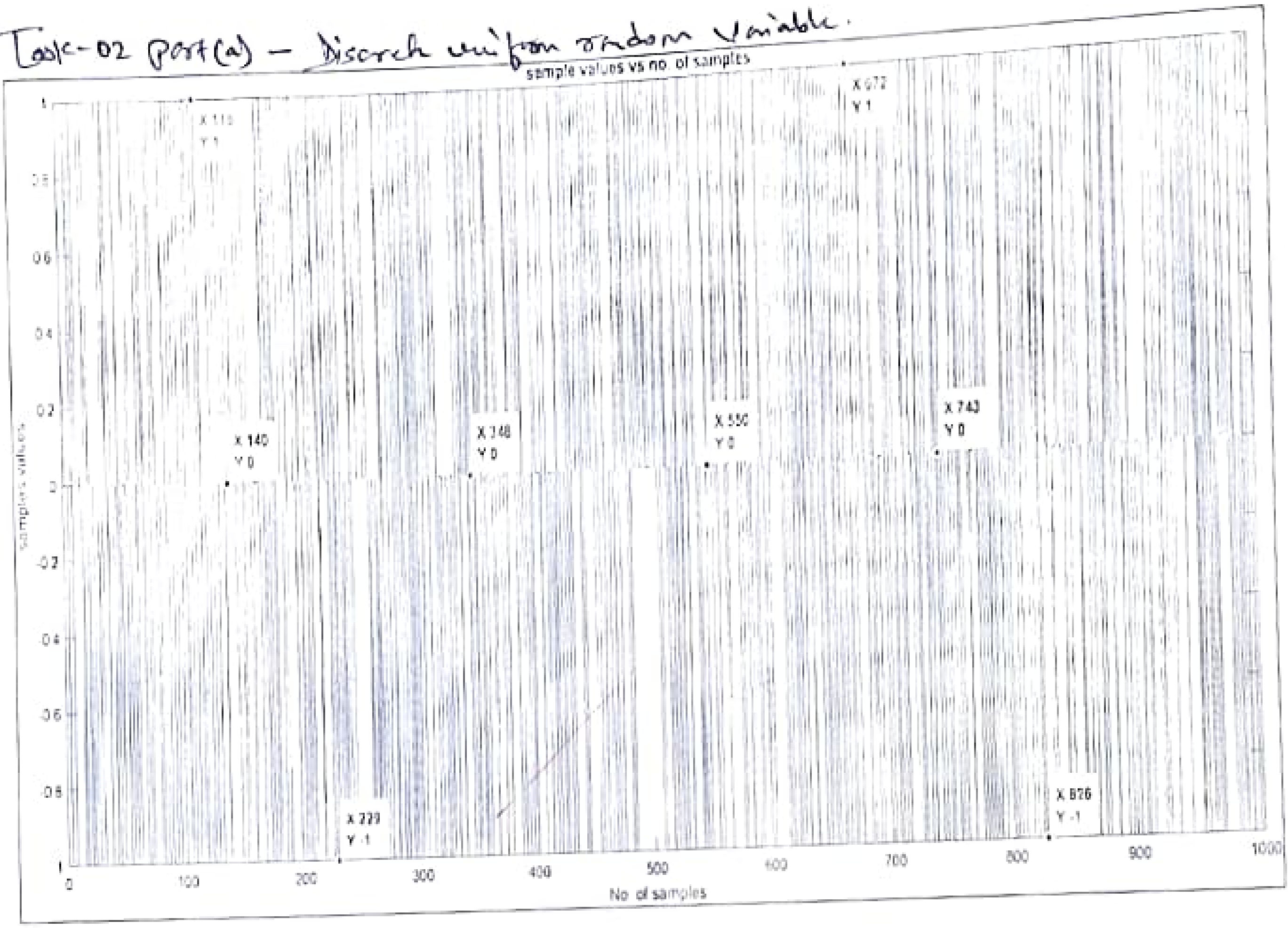
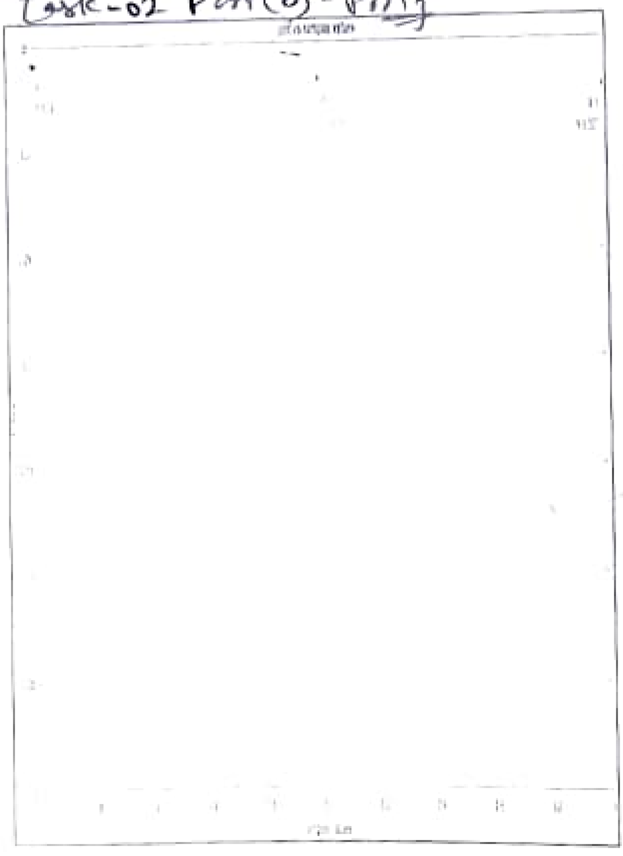
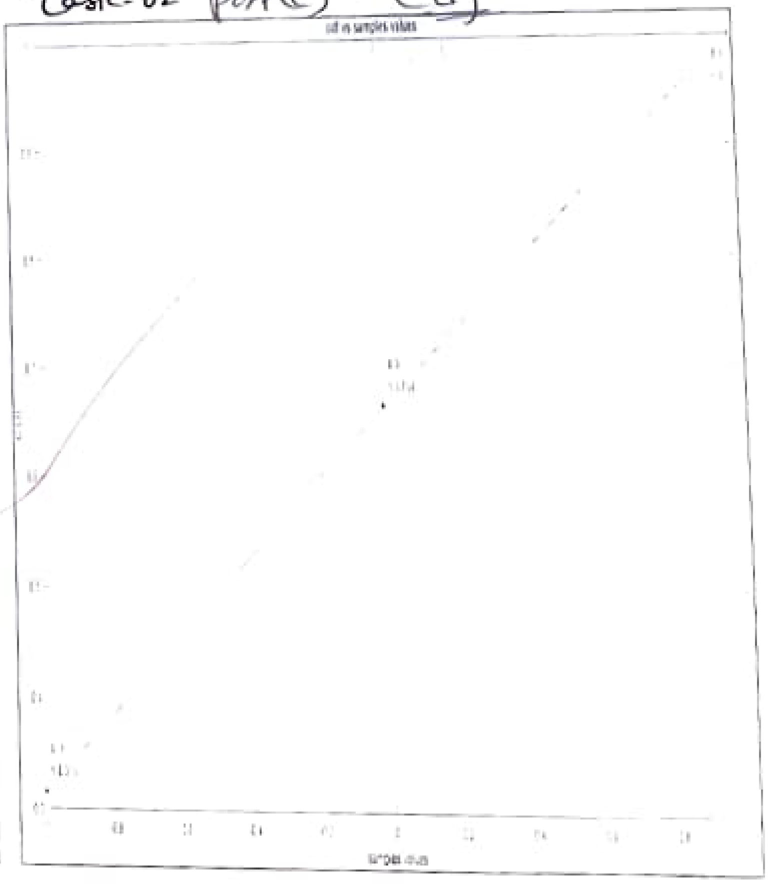
Task-02 part(a) - Discrete uniform random variable.



Task-02 Part(b) - Pmf



Task-02 part(c) - Cdf



Name - Sourabh Kumar Singh
Role No - 2101202

Experiment - 02

Objective :-

Task 1 :- Generate Single Tone Signal.

(i) → Generate a Sinosoid of frequency equal to last digit of ~~your~~ my roll no. for
(a) under Sample (b) Oversample (c) Sample at Nyquist rate.

(ii) Plot the Signal of all three Cases.

Task 2 :- Generate multitone Signal Such that Nyquist theorem hold and plot it.

f_1 = Last digit of roll no.
f_2 = Ten's place of roll no.

Good

Task 3 :- Add noise to single tone signal and plot it.

Theory :-

(i) Single Tone Signal :- If the message Signal Contains a ~~signal~~ Single frequency component, it's a single tone Signal and modulating ~~it~~ via a Suitable Carrier leads to what is popularly called Single tone modulation. A Simplest example of Such a signal is a Sinusoidal Signal.

- Under Sample - Sampling a Signal at a sample rate below its Nyquist rate.

- Nyquist rate = $\boxed{\Delta T \leq \frac{1}{2f_m}}$ $\boxed{f_s \geq 2f_m}$

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• Oversample :- Sampling a signal at a sample r. above its Nyquist rate.

(ii) Multi Tone Signal :- The multi-tone signal is Composed of multiple sinusoidal waves. Multi tone signal has two or more frequency.

(iii) Noise :- It is an unwanted signal which interferes with the original message signal and corrupts the parameters of the message signal. This alteration in the communication process, leads to the message getting altered. It is most likely to be entered at the channel or the receiver.

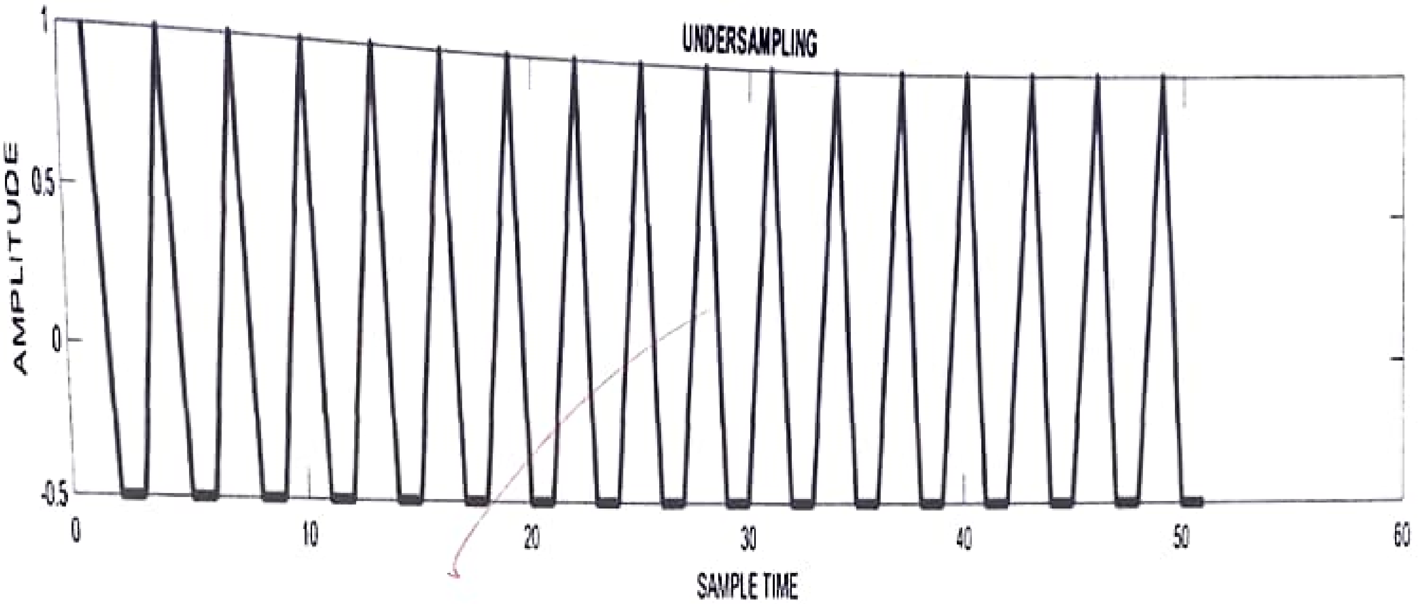
Result :- The first plot show a - single tone signal with f=2KHz & S. frequency of 2Hz, 4Hz, 8Hz respectively. The second plot show a - multi tone signal composed of two frequency : 1KHz, 2KHz. The third plot show a received signal ~~at~~ which is a mixer of single tone and noise signal.

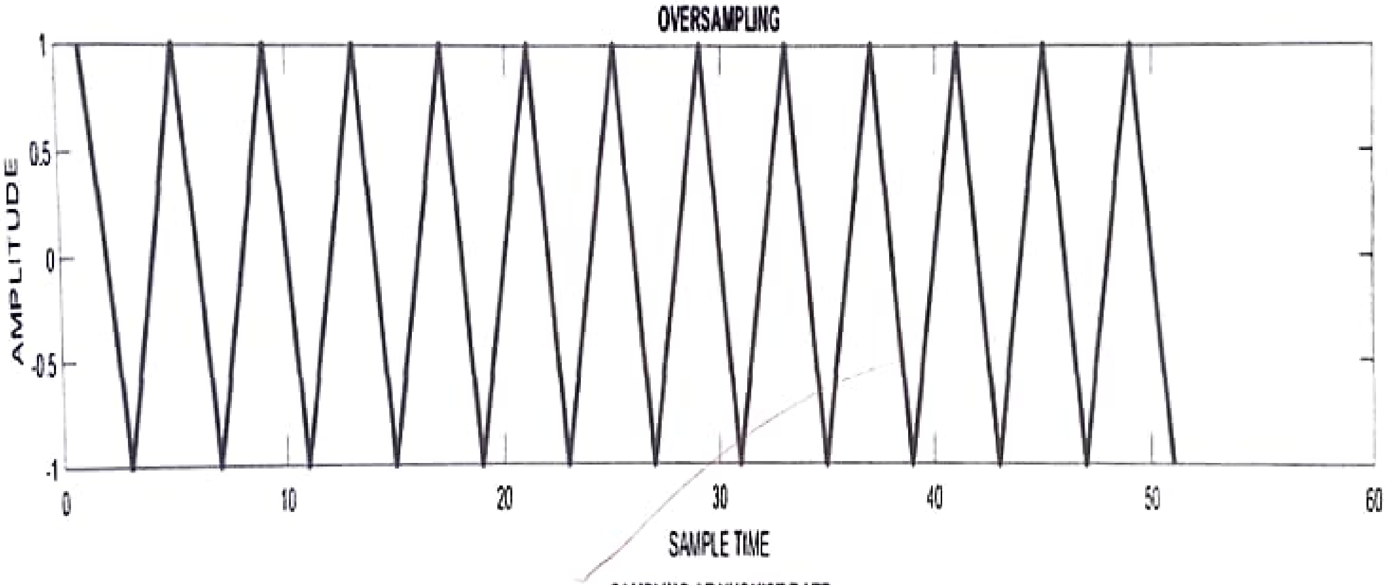
Conclusion :- Q. Why noise is modeled as gaussian r.v.!

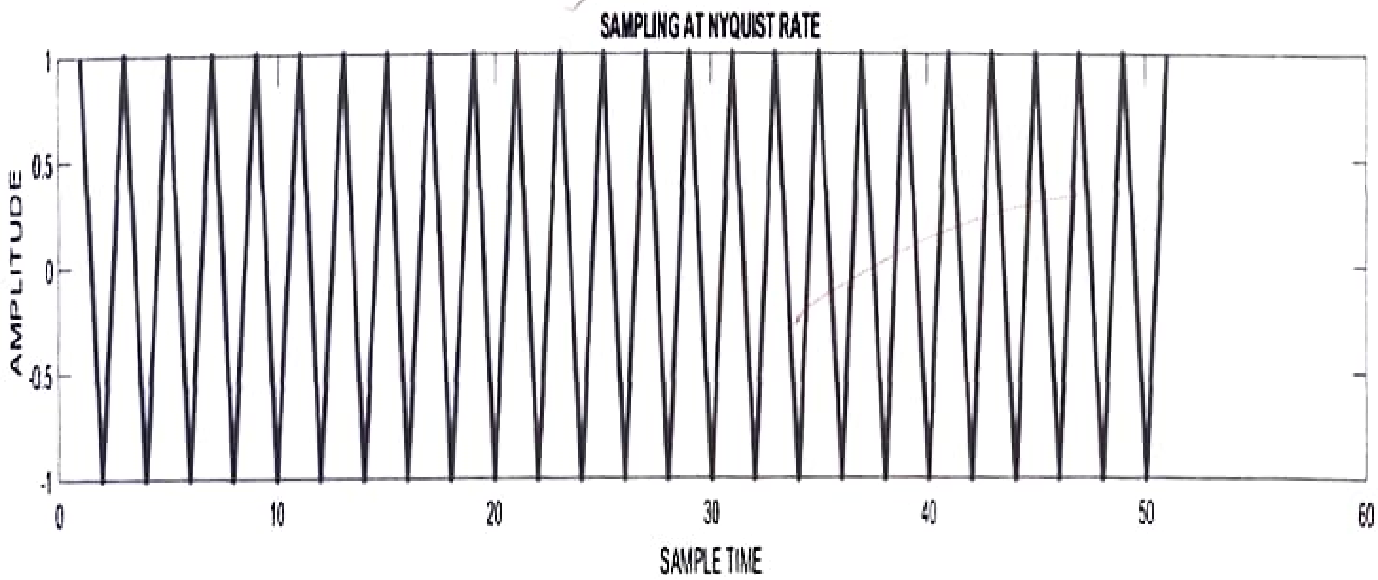
→ Noise are independent and identically distributed means that each noise value is not correlated with the values of other noise instances and all are drawn from the same probability distribution. When a large no. of IID r.v are added together, their sum tends to approach a Gaussian distribution. So noise is modeled as gaussian r.v.

OBSERVATION :

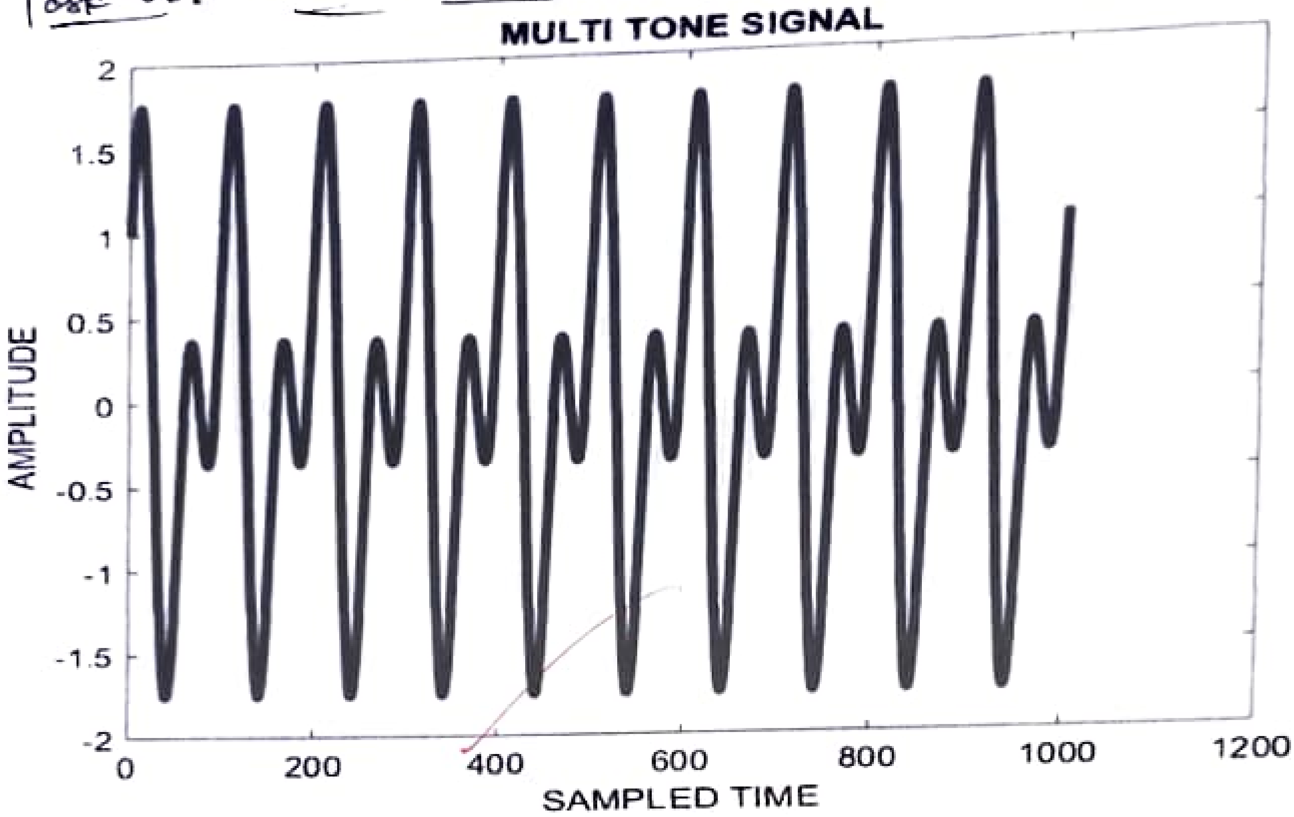
Task-01: Single tone Signal



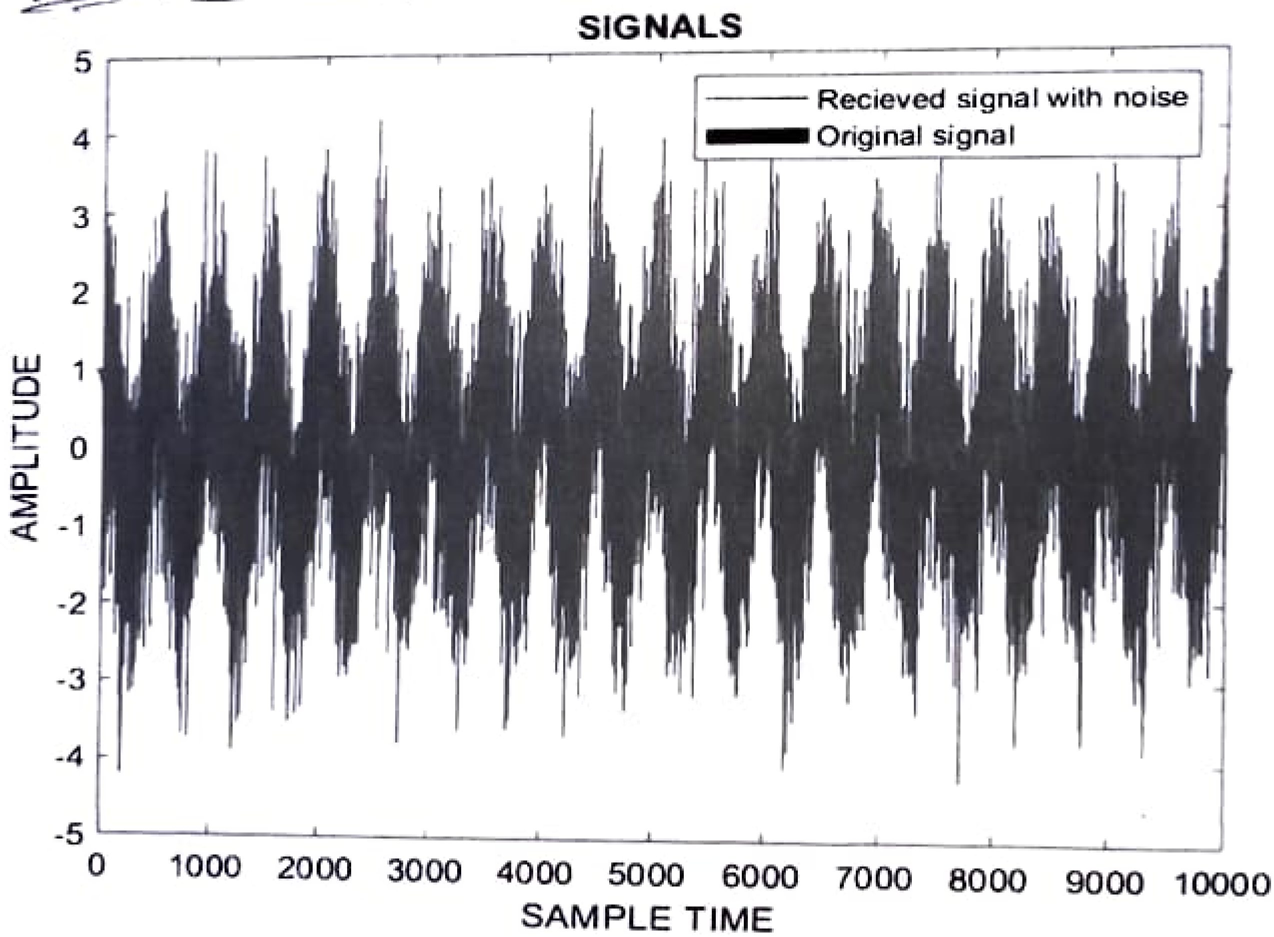




Task-02 :- Multi Tone Signal.



Task-03: Received signal with noise.



Name - Sourabh Kumar Singh

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Experiment - 03

Objective :-

Task-01 :- Generate a random digital sequence of 15 bits.

0 ⟶ with Probability (0.4)

1 ⟶ with Probability (0.6)

Task-02 :- Plot a BPSK signal for this bit sequence. Each bit duration is 0.01s.

Task-03 :- Plot Scatter for this bit sequence.

Theory :-

Binary Phase Shift Keying (BPSK) is a digital modulation scheme where the phase of the carrier signal is shifted to represent binary data. For instance, one bit value (e.g. 1) might be represented by a phase shift of 180 degrees, while the other bit value (e.g., 0) is represented by no phase shift.

The carrier signal is a high-frequency sinusoidal waveform. Mathematically, the carrier signal can be represented as:

$$x(t) = A^* \cos(2\pi f_c t + \phi)$$

A → Amplitude of the carrier signal.

f_c → Carrier frequency.

t → time

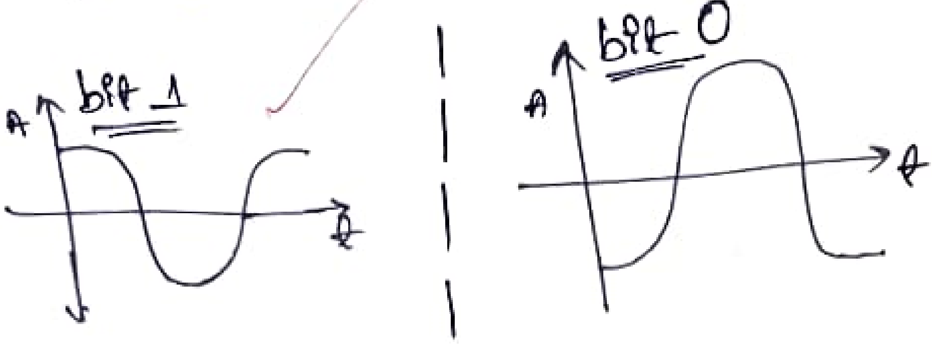
ϕ → Phase of the carrier signal.

The modulation process involves mapping each binary bit a phase shift and then applying that phase shift to the carrier signal. This can be represented as -

$\Rightarrow$ $1 \rightarrow A\cos(2\pi f_c t)$

$0 \rightarrow A\cos(2\pi f_c t + \pi)$

$\Rightarrow$ $0 \rightarrow -A\cos(2\pi f_c t)$

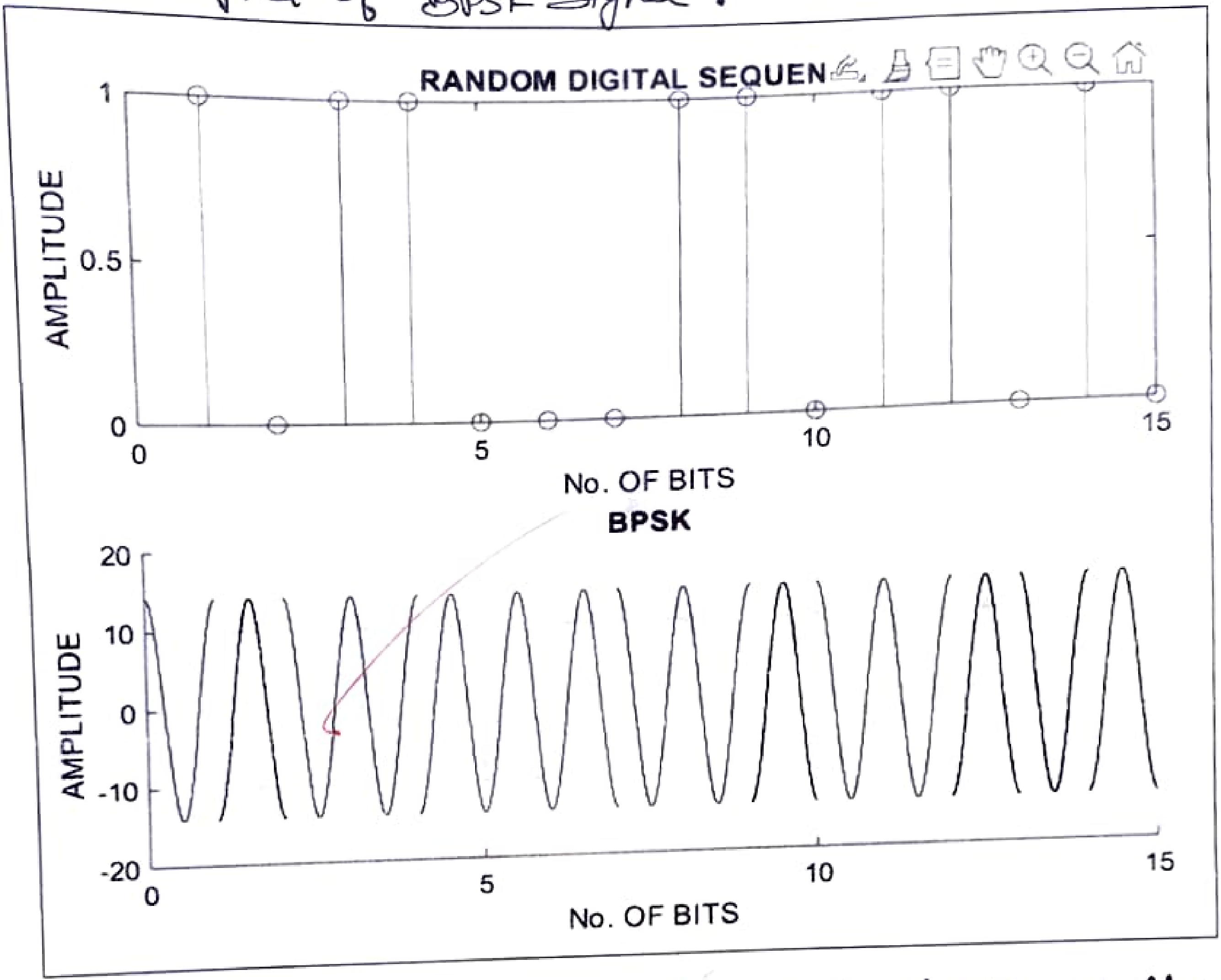


Result:- The 15 bits sequence of random digital sequence ploted with the help of 'rand() function' and successfully generate a BPSK signal. Also ploted the scatter plot of this 15 bits sequence named as Constellation diagram.

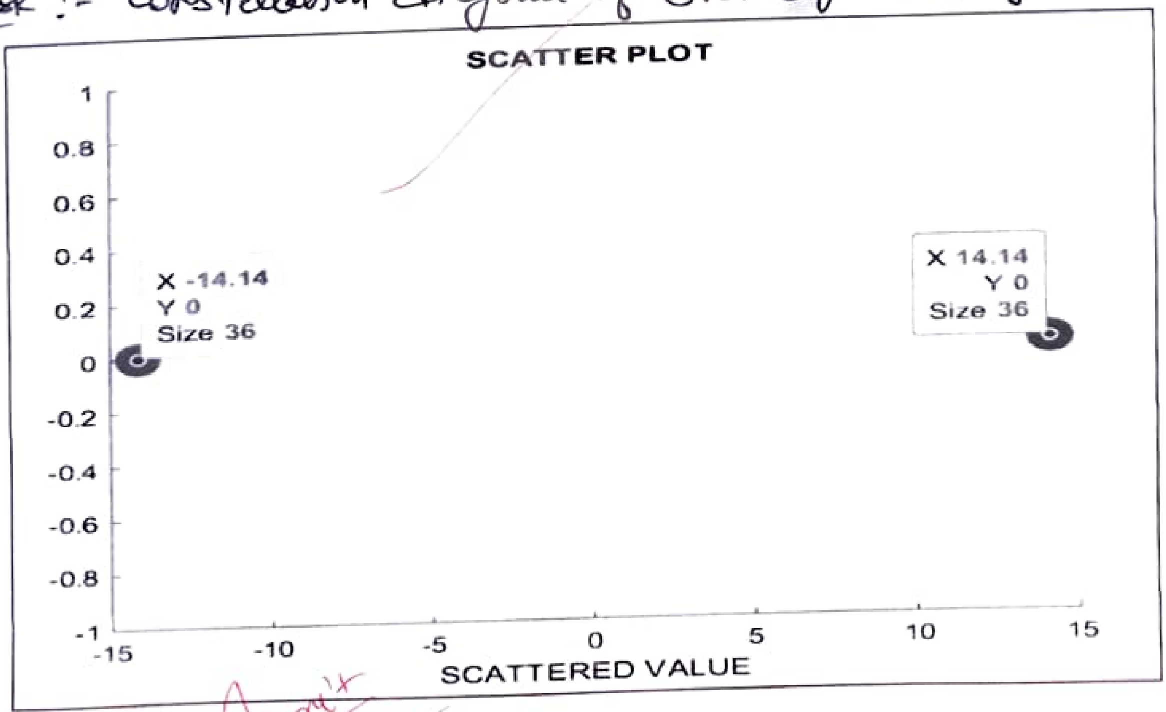
Conclusion:- BPSK modulation is a fundamental concept in digital communication systems. This experiment helps to understand the basics of how binary data can be transmitted using phase shift of a carrier signal. ~~and how~~ It also demonstrates the how BPSK is dealing with noise and phase changes in the communicated signal.

OBSERVATION:

Task 01 :- 15 bits sequence of random digital sequence.
And plot of BPSK signal.



Task :- Constellation diagram of BPSK signal using scatter fn.



Sourabh Kr Singh

Experiment - 04

Roll no - 2101202

Objective :- To generate random binary sequence, modulates them using QPSK and visualize the modulated signal and constellation diagram.

Theory :- Quadrature phase shift keying (QPSK) is a digital modulation scheme where four different phases of a carrier signal are used to represent digital data. Each phase represent a specific combination of two bits (00, 01, 10, 11).

00 is mapped to $A\cos(2\pi ft + \pi/4)$
01 $\longrightarrow$ $A\cos(2\pi ft + 3\pi/4)$
10 $\longrightarrow$ $A\cos(2\pi ft + 5\pi/4)$
11 $\longrightarrow$ $A\cos(2\pi ft + 7\pi/4)$

$$\boxed{S_{in}(t) = \sqrt{\frac{2E}{T_s}}\cos\left[2\pi f_c t + (2i-1)\frac{\pi}{4}\right]}$$

Result :- The QPSK modulation scheme efficiently transmitted ~~Signal~~ digital data at a rate of 2 bits per symbol, effectively utilizing the available bandwidth. The constellation scatter plot effectively illustrates the constellation points used in QPSK modulation.

Good ✓

Conclusion :- The results indicate that QPSK is robust in presence of noise and interference, making suitable for various communication application. The scatter plot provides a visual representation of the QPSK modulation scheme.

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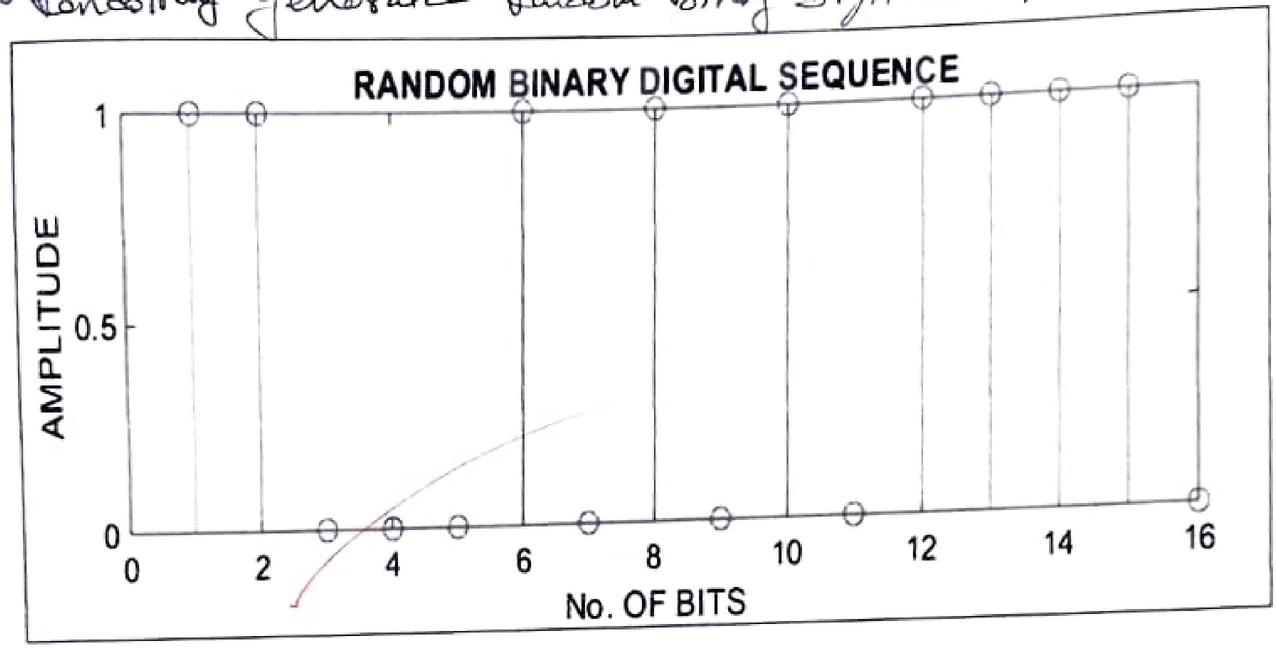
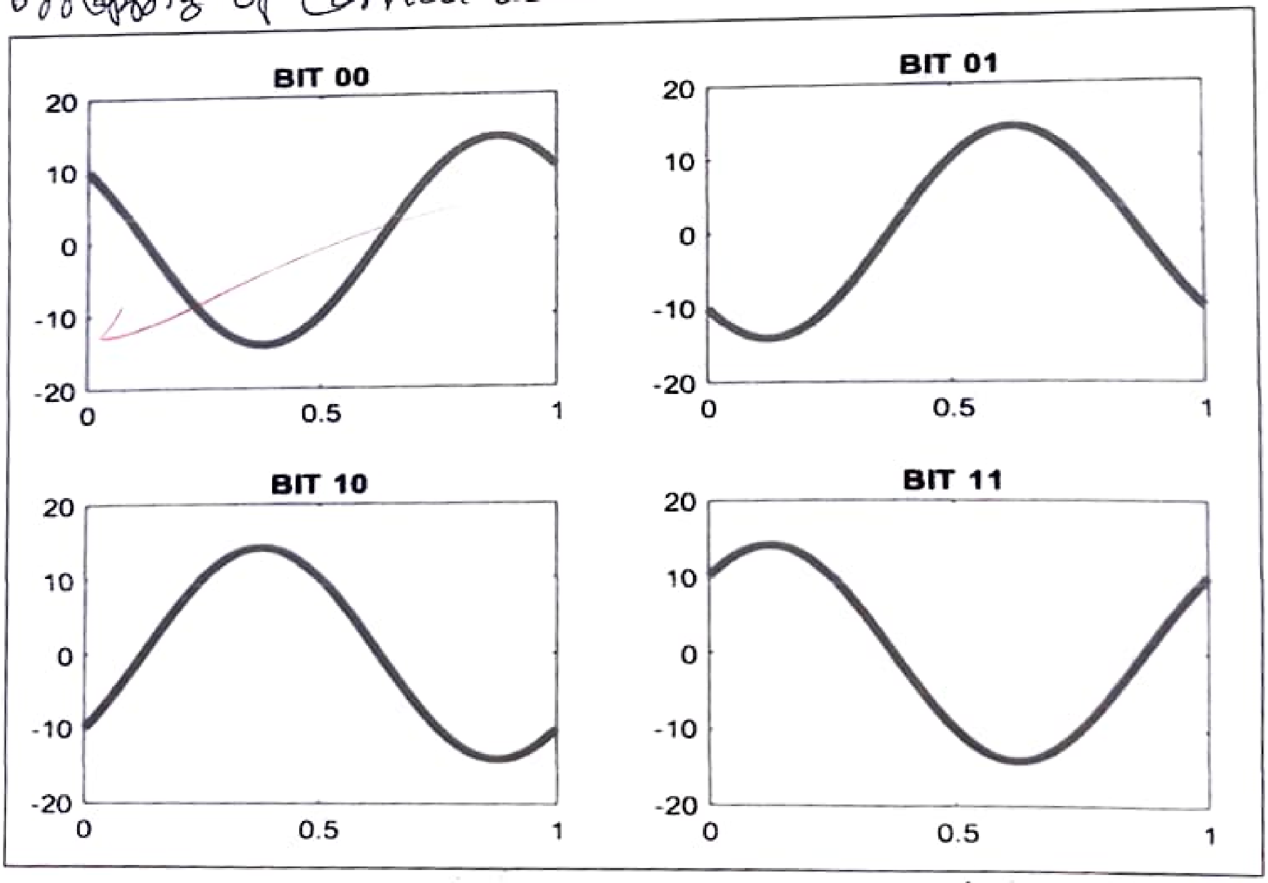
OBSERVATION:-

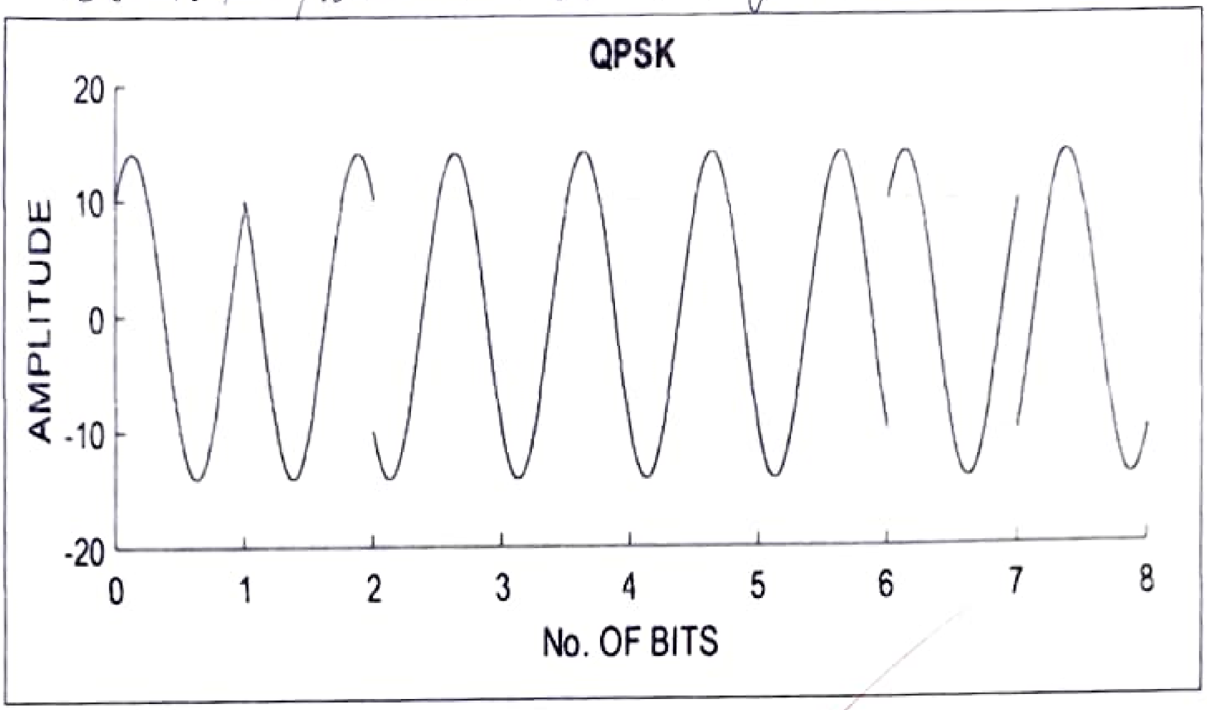
◦ Randomly generated Random Binary Digital Sequence.



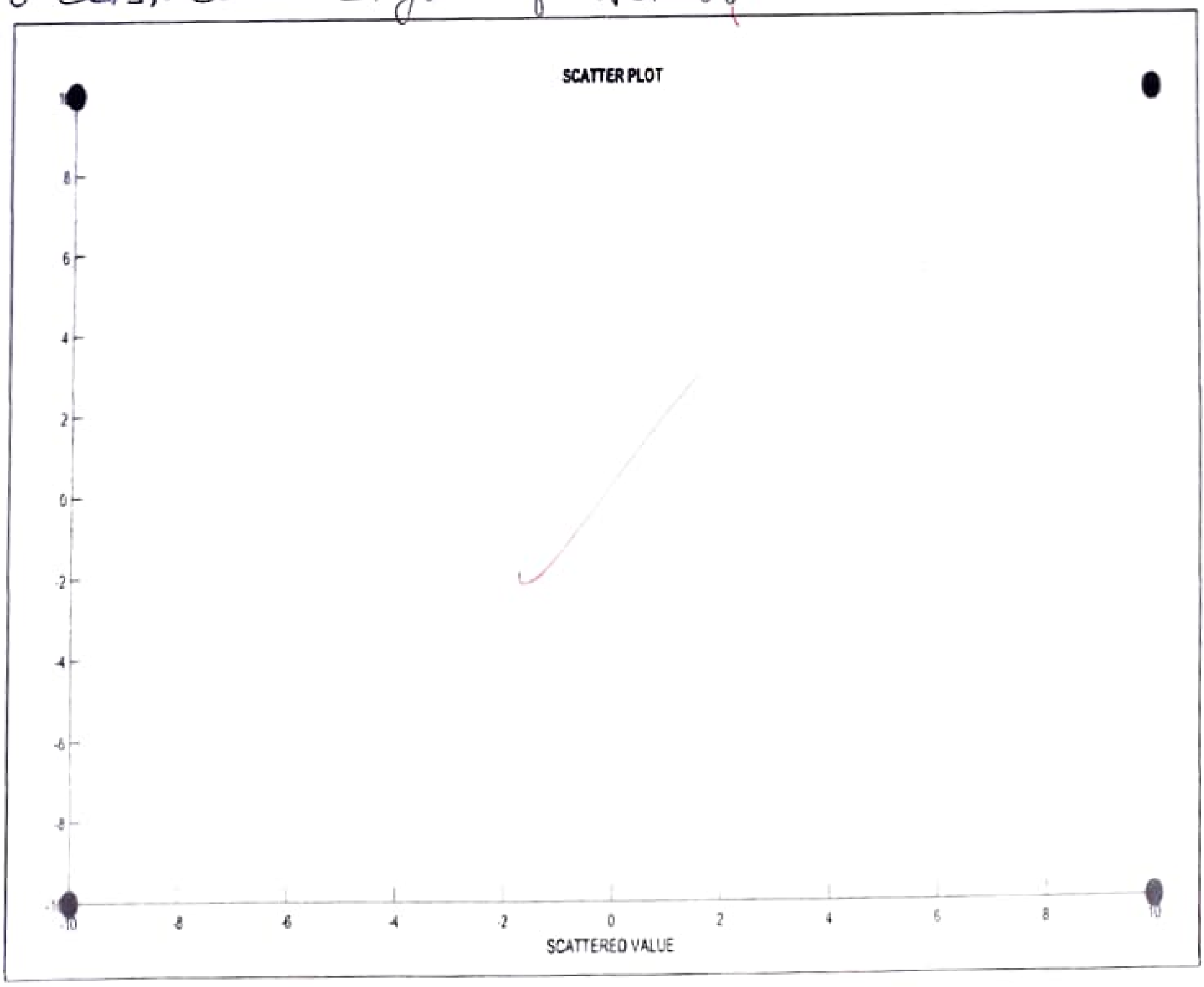
◦ mapping of Carrier wave with each bits.



○ Transmitted / modulated QPSK Signal.



○ Constellation diagram of QPSK modulation.



Name :- Sourabh Kumar Singh

Roll no. :- 2101202

Experiment - 05

Objective :- Generate bit sequence randomly of length 10^5 bits with bit '0' must have probability 0.5 and bit '1' must have Probability 0.5. Generate a BPSK modulated Signal for generated Bits and then Demodulate the Signal at receiver Side. Calculate the theoretical and Practical BER (Bit error rate) for diff. SNR Value and Compare it using Semilogy plot

Theory :- In BPSK Modulation, 0 is mapped to phase of '0' degree and 1 is mapped to a phase of 180 degrees.

→ A Carrier Signal with fixed frequency and amplitude is used in BPSK Passband. The modulated Signal is obtained by multiplying the binary data with the Carrier Signal.

→ At the receiver, the receiver Compares the received Signal Phase with the reference phase for BPSK modulation, which are 0 degrees and 180 degrees.

→ The receiver uses a decision threshold to determine whether the received phase Corresponds to a '0' or '1'.

→ The Output is received based on decision threshold.

Result :- Successfully generated BER Vs SNR plot for different Value of SNR and also plotted both theoretical and practical BER.

Conclusion :- As the SNR Increases (in dB), the BER decreases exponentially. In practical, the BER Performance may deviate from the theoretical Prediction but as we done it for baseband Signal Value of theoretical & practical BER are Seen.

OBSERVATION:-

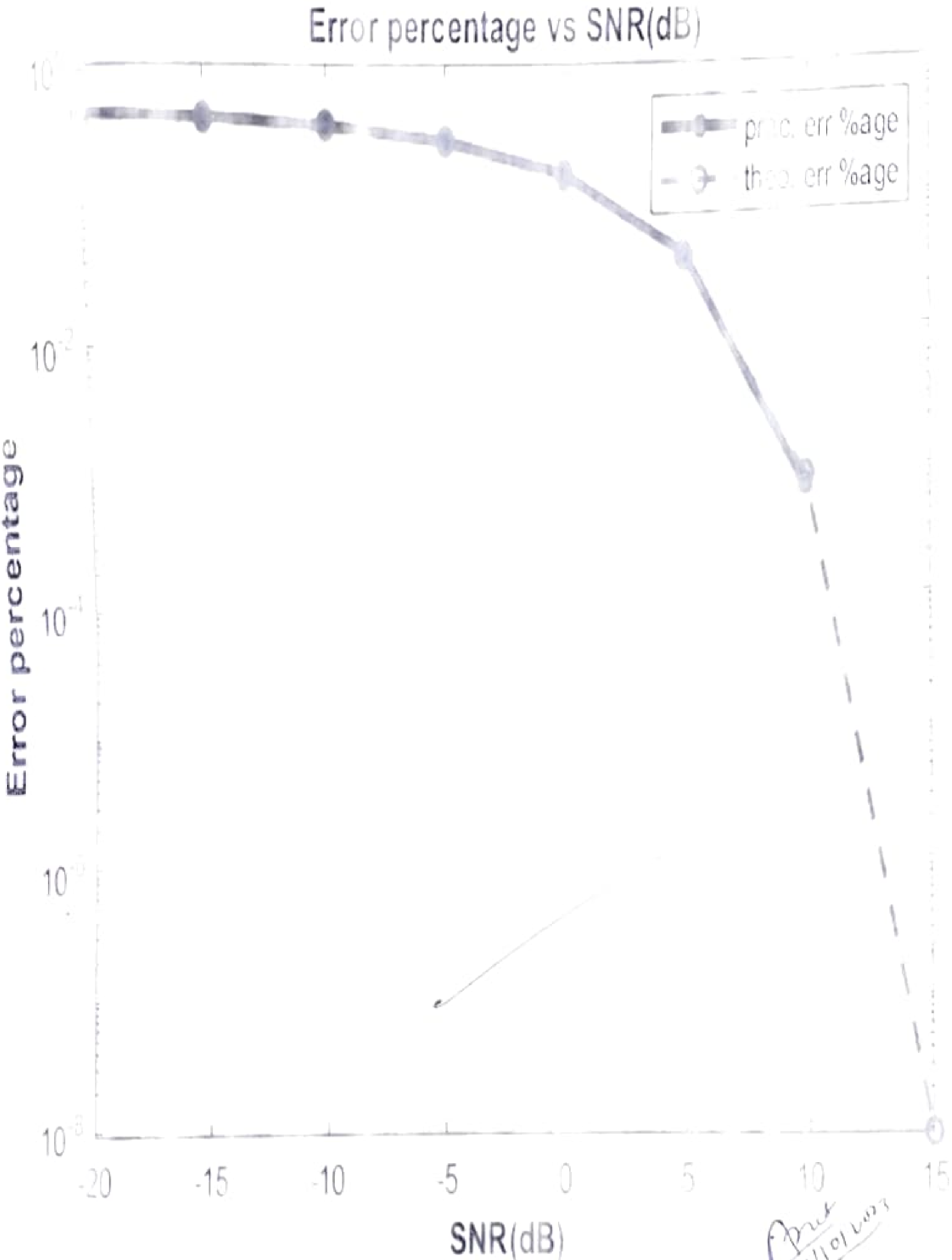


Fig: Theoretical and practical BER of BPSK ~~[illegible]~~ Modulation Scheme

Name - Sourabh Kumar Singh

Roll. No. - 2101202

Experiment - 06

Objective :-

Task 01 :- BASK Modulation

→ Generate a random bit sequence of length 16 bits with bit '0' must be have probability 1/3 & bit '1' must have probability 2/3.

→ Plot the ASK modulated signal for the generated bit sequence. Also general scatter plot.

Task 02 :- BFSK Modulation

→ Generate 16 bit random sequence '0' with probability 1/6.

→ Plot BFSK modulated signal for this bit sequence. Set f_1 as f last digits of your roll no.. Set E = 1 & $T = 1/f_1$.

→ Generate scatter plot.

Theory :-

(a) BASK (Binary Amplitude Shift Keying) is scheme where the lower bit represents 0 and the higher bit represents a positive signal.

$\therefore$ $$0 \rightarrow 0$$
$$1 \rightarrow \sqrt{\frac{2E}{T}} \cos(2\pi f_1 t)$$

Here E = 1.

(b) BFSK (Binary Frequency shift keying) is Binary to analog scheme in which lower bit and higher bit represent two different signal of different frequencies.

$$0 \rightarrow \sqrt{\frac{2E}{T}} \cos(2\pi f_1 t)$$ $f_1, f_2 \rightarrow$ frequen.

$$1 \rightarrow \sqrt{\frac{2E}{T}} \cos(2\pi f_2 t)$$

Result :- The 15 bits Sequence of random digital Sequency plot as successfully generated a BASK & BFSK Signal. Also plotted scatter plot of this 15 Sequence.

Conclusion :- BASK & BFSK modulation is a fundamental Concept in digital Communication System. This experiment helps to understand ~~generates~~ the basics of how binary data can be transmitted using ~~phase~~ ~~Amplitude~~ & frequency shift of a Carrier Signal. It also demonstrate

how BASK & BFSK is dealing with noise and ~~Amplitu~~ ~~Phase~~ & frequency Changes in the Communicated Signal.

14/10/2023

plotted ... the

Observation:-

Task 01 :- BASK (Binary Amplitude Shift Keying) Modulation (Fig. A)

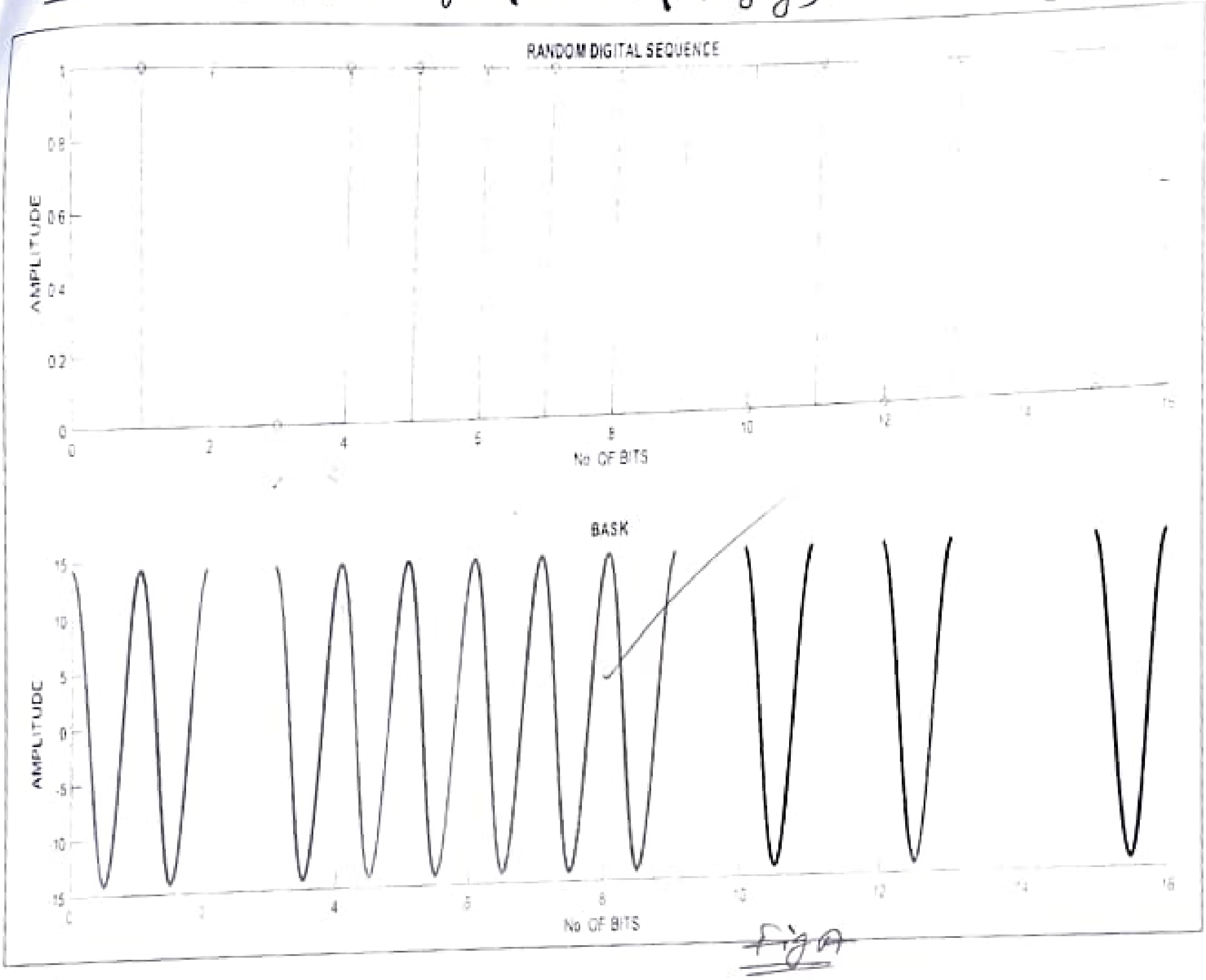


Fig. A

(Fig. B)

Scatter plot for BASK modulation.

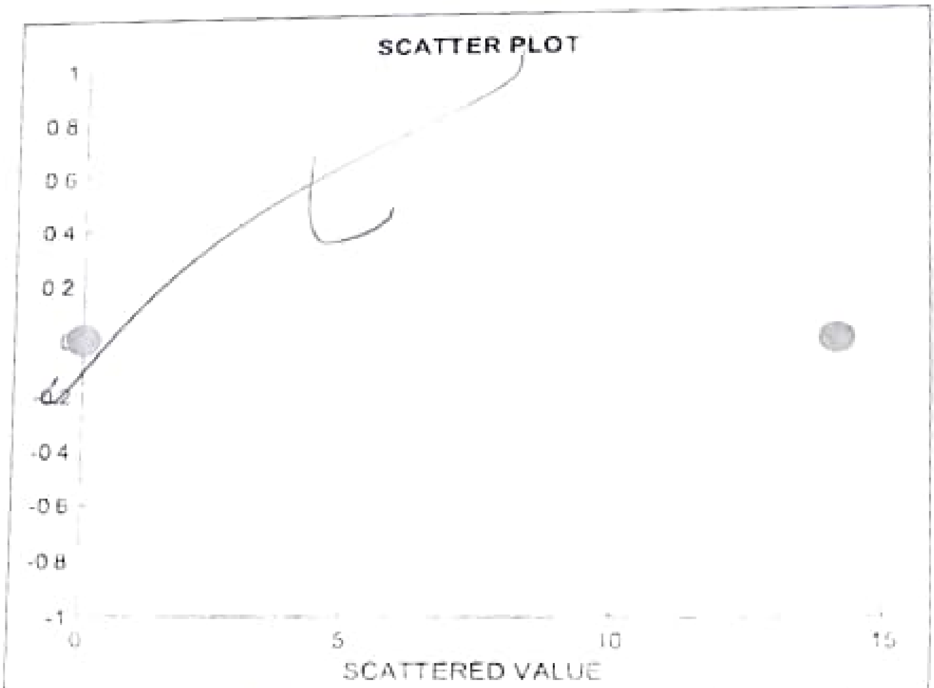


Fig. B

Task-02 :- BFSK (Binary frequency Shifting Keying) modulation (Fig C)

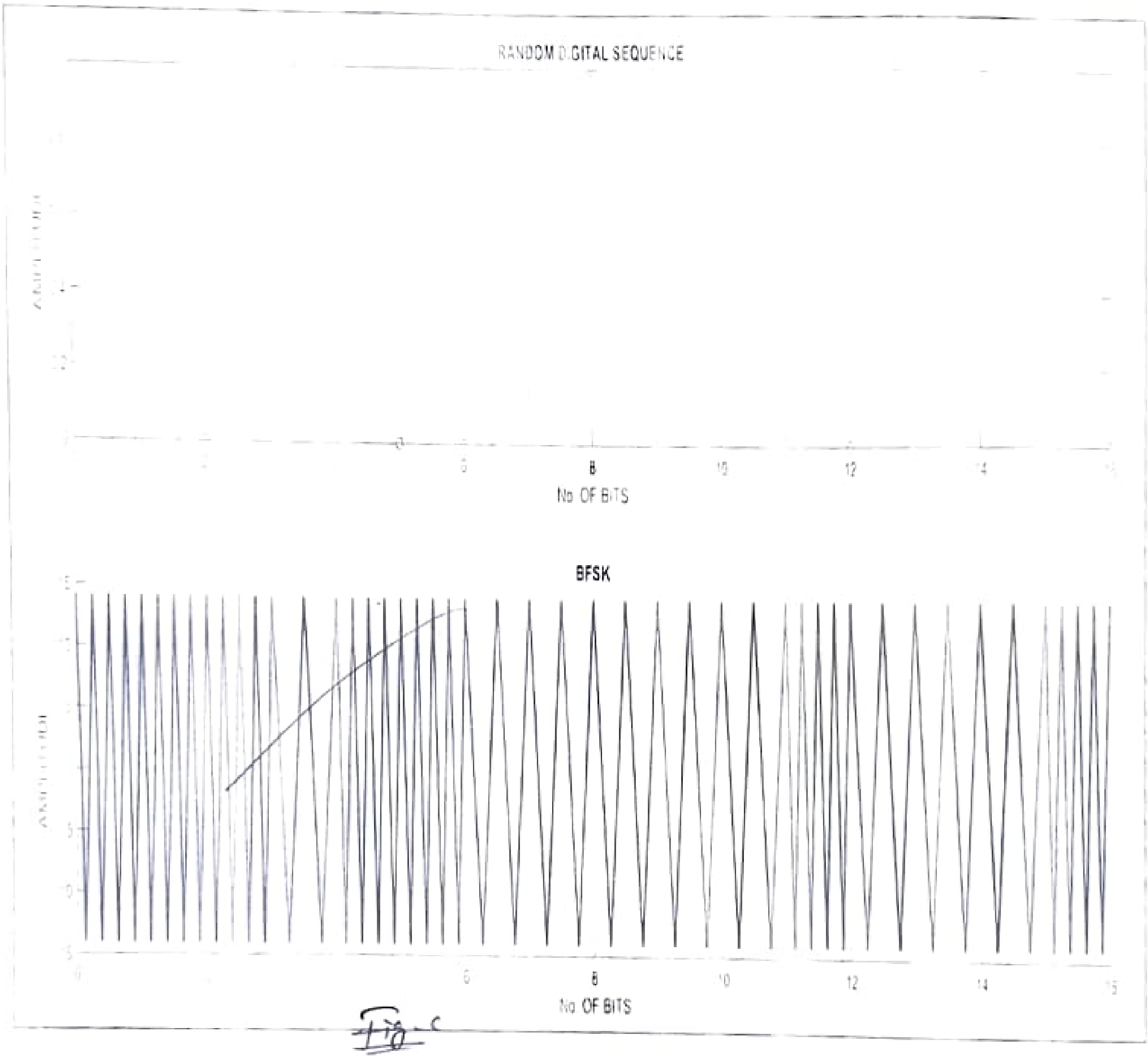


Fig-C

Fig D' Scatter plot for BFSK modulation

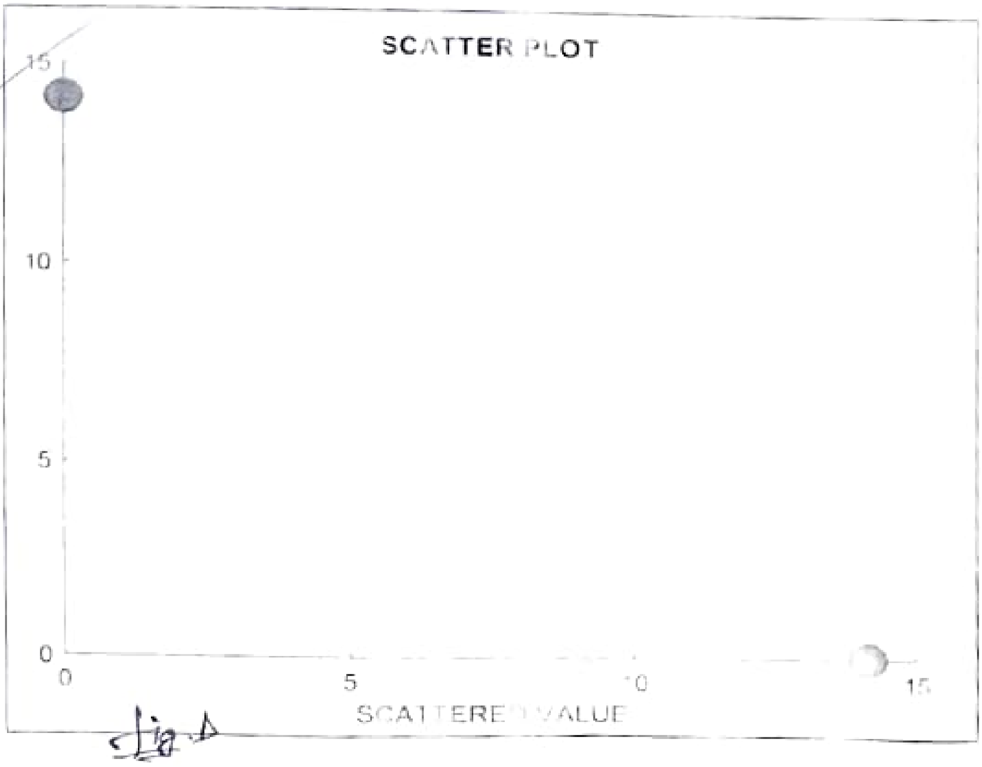


Fig.D