

# SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

S.R.M. Nagar, Kattankulathur - 603203

## DEPARTMENT OF MATHEMATICS

### QUESTION BANK



IV SEMESTER

B.Tech- ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

MA3428–Applied Mathematics for Data Science

Regulation – 2023

Academic Year – 2025 - 2026

*Prepared by*

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(An Autonomous Institution)

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DEPARTMENT OF MATHEMATICS



S.No	QUESTIONS	BT Level	Competence	COs																
<b>UNIT I-RANDOM VARIABLES AND PROBABILITY DISTRIBUTIONS</b>																				
Discrete and continuous random variables- Binomial, Poisson and Normal distributions																				
<b>Part - A ( 2 MARK QUESTIONS)</b>																				
1.	State the addition theorem on probability.	BTL -1	Remembering	CO1																
2.	Define independent events.	BTL -1	Remembering	CO1																
3.	Define Probability of an event.	BTL -2	Understanding	CO1																
4.	State the Axioms of Probability.	BTL -2	Understanding	CO1																
5.	Define mutually exclusive events.	BTL -2	Understanding	CO1																
6.	Define Conditional Probability.	BTL -2	Understanding	CO1																
7.	State the theorem of total probability.	BTL -1	Remembering	CO1																
8.	State Baye's theorem.	BTL -2	Understanding	CO1																
9.	A ball is drawn at random from a box containing 5 red balls, 3 white balls and 4 blue balls. Find the probability that the ball drawn is not red.	BTL -1	Remembering	CO1																
10.	What is the Probability that a leap year selected at random will have 53 Sundays?	BTL -1	Remembering	CO1																
11.	If a box contains 75 good items and 25 defective items , and 12 items are selected at random, find the probability that at least one item is defective	BTL -2	Understanding	CO1																
12.	A and B are events with $P(A) = \frac{5}{8}$ , $P(B) = \frac{1}{2}$ and $P(A \cap B) = \frac{1}{4}$ . Find $P(\bar{A} \cap \bar{B})$	BTL -2	Understanding	CO1																
13.	The number of hardware failures of a computer system in a week of operations has the following p.d.f, Calculate the value of k. <table border="1" style="margin-left: auto; margin-right: auto; border-collapse: collapse;"> <tr> <td>No.of failures</td> <td>0</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> <td>6</td> </tr> <tr> <td>Probability</td> <td>k</td> <td>2 k</td> <td>2 k</td> <td>k</td> <td>3 k</td> <td>k</td> <td>4 k</td> </tr> </table>	No.of failures	0	1	2	3	4	5	6	Probability	k	2 k	2 k	k	3 k	k	4 k	BTL -1	Remembering	CO1
No.of failures	0	1	2	3	4	5	6													
Probability	k	2 k	2 k	k	3 k	k	4 k													
14.	If $p(x) = kx^2, x = 0,1,2,3$ , is to be a density function, find the value of k.	BTL -1	Remembering	CO1																
15.	Write the probability function of Binomial Distribution.	BTL -2	Understanding	CO1																
16.	The mean of Binomial distribution is 36 and standard deviation is 6. Find the parameters of the distribution.	BTL -1	Remembering	CO1																
17.	For a Binomial distribution the mean is 6 and standard deviation is $\sqrt{2}$ . Find parameters of the distribution	BTL -1	Remembering	CO1																
18.	If 20% of the bolts produced by a machine are defective, Determine the probability that out of 4 bolts chosen at random exactly one defective.	BTL -2	Understanding	CO1																
19.	If the mean and variance of a binomial distribution are respectively 6 and 2.4, find $P(x=2)$ .	BTL -2	Understanding	CO1																
20.	Write the probability function of Poisson Distribution.	BTL -2	Understanding	CO1																
21.	Suppose that, on an average , in every three pages of a book there is one typographical error. If the number of typographical errors on a single page of the book is a Poisson random variable. What is the probability if at least one error on a specific page of the book?	BTL -2	Understanding	CO1																

22.	Define Normal distribution.	BTL -1	Remembering	CO1
23.	Suppose that X has a Poisson distribution with parameter $\lambda = 2$ . Compute $P[X \geq 1]$ .	BTL -1	Remembering	CO1
24.	If X is a Poisson distribution such that $P(x = 1) = 4 P(x = 2)$ . Find its mean and variance.	BTL -2	Understanding	CO1
25.	State any two properties of normal distribution.	BTL -2	Understanding	CO1

**PART – B (16 MARK QUESTIONS)**

1.	$f(x) = \begin{cases} ax, & 0 \leq x \leq 1 \\ a, & 1 \leq x \leq 2 \\ 3a - ax, & 2 \leq x \leq 3 \\ 0, & \text{elsewhere} \end{cases}$ is the pdf of X. Calculate (i) the value of a ,(ii) the cumulative distribution function of X and (iii) If $X_1, X_2$ and $X_3$ are 3 independent	BTL -4	Analyzing	CO1																				
2.	The probability mass function of a RV X is given by $P(X = r) = kr^3, r = 1,2,3,4$ . Find (1) the value of k, (2) $P(\frac{1}{2} < X < \frac{5}{2} / X > 1)$ , (3) Mean and (4) Variance	BTL -4	Analyzing	CO1																				
3.	Out of 2000 families with 4 children each, Find how many family would you expect to have i) at least 1 boy ii) 2 boys iii) 1 or 2 girls iv) no girls	BTL -3	Applying	CO1																				
4.(a)	If the discrete random variable X has the probability function given by the table. <table border="1" style="margin: 10px auto;"> <tr> <td>x</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> </tr> <tr> <td>P(x)</td> <td>k/3</td> <td>k/6</td> <td>k/3</td> <td>k/6</td> </tr> </table> Find the value of k and Cumulative distribution of X.	x	1	2	3	4	P(x)	k/3	k/6	k/3	k/6	BTL -3	Applying	CO1										
x	1	2	3	4																				
P(x)	k/3	k/6	k/3	k/6																				
4.(b)	Find the MGF of Binomial distribution and hence find its mean and variance	BTL -3	Applying	CO1																				
5.	The probability mass function of a discrete R. V X is given in the following table <table border="1" style="margin: 10px auto;"> <tr> <td>X</td> <td>0</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> <td>6</td> <td>7</td> <td>8</td> </tr> <tr> <td>P(X)</td> <td>a</td> <td>3a</td> <td>5a</td> <td>7a</td> <td>9a</td> <td>11a</td> <td>13a</td> <td>15a</td> <td>17a</td> </tr> </table> Find(i) the value of a , (ii) $P(X < 3)$ , (iii) Mean of X, (iv) Variance of X and (v) CDF	X	0	1	2	3	4	5	6	7	8	P(X)	a	3a	5a	7a	9a	11a	13a	15a	17a	BTL -3	Applying	CO1
X	0	1	2	3	4	5	6	7	8															
P(X)	a	3a	5a	7a	9a	11a	13a	15a	17a															
6.(a)	A random variable X has the following probability distribution: <table border="1" style="margin: 10px auto;"> <tr> <td>X</td> <td>0</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> <td>6</td> <td>7</td> </tr> <tr> <td>P(X)</td> <td>0</td> <td>k</td> <td>2k</td> <td>2k</td> <td>3k</td> <td><math>k^2</math></td> <td><math>2k^2</math></td> <td><math>7k^2+k</math></td> </tr> </table> Find (i) the value of k (ii) $P(1.5 < X < 4.5 / X > 2)$	X	0	1	2	3	4	5	6	7	P(X)	0	k	2k	2k	3k	$k^2$	$2k^2$	$7k^2+k$	BTL -3	Applying	CO1		
X	0	1	2	3	4	5	6	7																
P(X)	0	k	2k	2k	3k	$k^2$	$2k^2$	$7k^2+k$																
6.(b)	Derive the MGF of Poisson distribution and hence find its mean and variance	BTL -3	Applying	CO1																				
7.	In an Engineering examination, a student is considered to have failed, secured second class, first class and distinction, according as he scores less than 45%,between 45% and 60% between 60% and 75% and above 75%respectively. In a particular year 10% of the students failed in the examination and 5% of the students get distinction. Find the percentage of students who have got first class and second class. Assume normal distribution of marks.	BTL -4	Analyzing	CO1																				

8.(a)	<p>The probability mass function of a discrete R. V X is given in the following table:</p> <table border="1" data-bbox="145 275 1005 353"> <tr> <td>X</td> <td>-2</td> <td>-1</td> <td>0</td> <td>1</td> <td>2</td> <td>3</td> </tr> <tr> <td>P(X=x)</td> <td>0.1</td> <td>k</td> <td>0.2</td> <td>2k</td> <td>0.3</td> <td>k</td> </tr> </table> <p>Find (1) Find the value of k, (2) P(X&lt;1), (3) P(-1&lt; X ≤ 2), (4) E(X)</p>	X	-2	-1	0	1	2	3	P(X=x)	0.1	k	0.2	2k	0.3	k	BTL -4	Analyzing	CO1
X	-2	-1	0	1	2	3												
P(X=x)	0.1	k	0.2	2k	0.3	k												
8.(b)	<p>Messages arrive at a switch board in a Poisson manner at an average rate of 6 per hour. Find the probability that exactly 2 messages arrive within one hour, no messages arrives within one hour and at least 3 messages arrive within one hour.</p>	BTL -4	Analyzing	CO1														
9.	<p>A random variable X has cdf <math>F(x) = \begin{cases} 0, &amp; \text{if } x &lt; -1 \\ a(1 + x), &amp; \text{if } -1 &lt; x &lt; 1 . \\ 1, &amp; \text{if } x \geq 1 \end{cases}</math></p> <p>(1) Find the value of a (2) P(X &gt; 1/4 ) and P(-0.5 ≤ X ≤ 0).</p>	BTL -4	Analyzing	CO1														
10(a)	<p>Let X be a continuous R.V with probability density function</p> $f(x) = \begin{cases} xe^{-x}, & x > 0 \\ 0, & \text{otherwise} \end{cases}$ <p>Find (1) The cumulative distribution of X, (2)Moment Generating Function M<sub>x</sub>(t) of X, (3) P(X&lt;2) and (4) E(X)</p>	BTL -3	Applying	CO1														
10(b)	<p>Suppose that the life of a industrial lamp in 1,000 of hours is exponentially distributed with mean life of 3,000 hours. Find the probability that (i)The lamp last more than the mean life (ii) The lamp last between 2,000 and 3,000 hours (iii) The lamp last another 1,000 hours given that it has already lasted for 250 hours.</p>	BTL -3	Applying	CO1														
11.	<p>The number of monthly breakdown of a computer is a random variable having a Poisson distribution with mean equal to 1.8. Find the probability that this computer will function for a month (1) without breakdown (2) with only one breakdown and (3) with at least one breakdown.</p>	BTL -4	Analyzing	CO1														
12(a)	<p>The number of monthly breakdown of a computer is a random variable having a Poisson distribution with mean equal to 1.8. Find the probability that this computer will function for a month (1) without breakdown (2) with only one breakdown and (3) with at least one breakdown.</p>	BTL -3	Applying	CO1														
12(b)	<p>Assume that 50% of all engineering students are good in mathematics. Determine the probabilities that among 18 engineering students (i) exactly 10, (ii) atleast 10 are good in mathematics.</p>	BTL -3	Applying	CO1														
13.	<p>A coin is biased so that a head is twice as likely to appear as a tail. If the coin is tossed 6 times, find the probabilities of getting (1) Exactly 2 heads, (2) at least 3 heads, (3) at most 4 heads.</p>	BTL -4	Analyzing	CO1														
14	<p>A bank manager has learnt that the length of time the customers have to wait for being attended by the teller is normally distributed with mean time of 5 minutes and standard deviation of 0.8 minutes. Find the probability that a customer has to wait</p> <p>(i) For less than 6 minutes (ii) For more than 3.5 minutes and (iii) Between 3.4 and 6.2 minutes.</p>	BTL -3	Applying	CO1														
15.	<p>X is a normal variable with mean 30 and standard deviation of 5. Find</p>	BTL -4	Analyzing	CO1														

	(i) $P[26 \leq X \leq 40]$ (ii) $P[X \geq 45]$ (iii) $P[X < 30]$			
16.	Derive MGF, Mean, Variance of Normal distribution.	BTL -3	Applying	CO1
17.	If X follows a normal distribution with mean 12 and variance 16 cm, find the probabilities for (i) $P(X \leq 20)$ (ii) $P(X \geq 20)$ , and (iii) $P(0 \leq X \leq 12)$	BTL -4	Analyzing	CO1
18.	Suppose that the life of a industrial lamp in 1,000 of hours is exponentially distributed with mean life of 3,000 hours. Find the probability that (i)The lamp last more than the mean life (ii) The lamp last between 2,000 and 3,000 hours (iii) The lamp last another 1,000 hours given that it has already lasted for 250 hours.	BTL -3	Applying	CO1

**UNIT II-TWO - DIMENSIONAL RANDOM VARIABLES**

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression

**PART-A( 2 MARK QUESTIONS)**

1.	The joint probability function (X,Y) is given by $P(x, y) = (2x + 3y)$ , $x = 0,1,2$ $y = 1,2,3$ , Find the value of K.	BTL -1	Remembering	CO2												
2.	If the joint pdf of (X, Y) is $f(x, y) = \begin{cases} \frac{1}{4}, & 0 < x, y < 2 \\ 0, & \text{otherwise} \end{cases}$ . Find $P(X + Y \leq 1)$	BTL -2	Understanding	CO2												
3.	Find the probability distribution of X + Y from the bivariate distribution of (X,Y) given below: <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>X \ Y</td> <td>1</td> <td>2</td> </tr> <tr> <td>1</td> <td>0.4</td> <td>0.2</td> </tr> <tr> <td>2</td> <td>0.3</td> <td>0.1</td> </tr> </table>	X \ Y	1	2	1	0.4	0.2	2	0.3	0.1	BTL -2	Understanding	CO2			
X \ Y	1	2														
1	0.4	0.2														
2	0.3	0.1														
4.	Define the conditional distribution function of two dimensional discrete and continuous random variables .	BTL -2	Understanding	CO2												
5.	Let X and Y have the joint p.m.f <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>Y \ X</td> <td>0</td> <td>1</td> <td>2</td> </tr> <tr> <td>0</td> <td>0.1</td> <td>0.4</td> <td>0.1</td> </tr> <tr> <td>1</td> <td>0.2</td> <td>0.2</td> <td>0</td> </tr> </table> Find $P(X+Y > 1)$	Y \ X	0	1	2	0	0.1	0.4	0.1	1	0.2	0.2	0	BTL -2	Understanding	CO2
Y \ X	0	1	2													
0	0.1	0.4	0.1													
1	0.2	0.2	0													
6	The joint probability distribution of X and Y is given by $p(x, y) = \frac{x+y}{21}$ , $x = 1,2,3$ ; $y = 1, 2$ . Find the marginal probability distributions of X and Y .	BTL -2	Understanding	CO2												
7.	Let X and Y be random variables with joint density function $f(x,y) = \begin{cases} 4xy, & 0 < x < 1, 0 < y < 1 \\ 0, & \text{otherwise} \end{cases}$ formulate the value of $E(XY)$	BTL -2	Understanding	CO2												
8	The joint probability density function of the random variable (X,Y) is given by $f(x, y) = Kxye^{-(x^2 + y^2)}$ , $x > 0, y > 0$ Calculate the value of K.	BTL -2	Understanding	CO2												
9.	If the joint probability density function of a random variable X and Y is given by $f(x, y) = \begin{cases} \frac{x^3y^3}{16}, & 0 < x < 2, 0 < y < 2 \\ 0, & \text{otherwise} \end{cases}$ . Find the marginal functions of X and Y.	BTL -2	Understanding	CO2												
10	If X and Y have joint pdf $f(x,y) = \begin{cases} x + y, & 0 < x < 1, 0 < y < 1 \\ 0, & \text{otherwise} \end{cases}$ Discuss whether X and Y are independent.	BTL -2	Understanding	CO2												

11.	The joint probability density of a two dimensional random variable (X,Y) is given by $f(x,y) = \begin{cases} kxe^{-y}; & 0 \leq x < 2, y > 0 \\ 0, & \text{otherwise} \end{cases}$ . Evaluate k.	BTL -2	Understanding	CO2
12.	The joint probability density function of a random variable (X,Y) is $f(x,y) = ke^{-(2x+3y)}, x \geq 0, y \geq 0$ . Find the value of k.	BTL -1	Remembering	CO2
13.	If X,Y denote the deviation of variance from the arithmetic mean and if $\rho = 0.5, \sum XY = 120, \sigma_y = 8, \sum X^2 = 90$ , Find n, the number of times.	BTL -2	Understanding	CO2
14.	The regression equations are $x + 6y = 14$ and $2x + 3y = 1$ . Point out the correlation coefficient between X & Y .	BTL -1	Remembering	CO2
15.	If $\bar{X} = 970, \bar{Y} = 18, \sigma_x = 38, \sigma_y = 2$ and $r = 0.6$ , Find the line of regression and obtain the value of X and Y = 20.	BTL -2	Understanding	CO2
16.	In a partially destroyed laboratory, record of an analysis of correlation data, the following results only are legible; Variance of X = 9; Regression equations are $8X - 10Y + 66 = 0$ and $40X - 18Y = 214$ . Find the mean values of X and Y?	BTL -2	Understanding	CO2
17.	The regression equations are $3x + 2y = 26$ and $6x + y = 31$ . Find the correlation coefficient.	BTL -2	Understanding	CO2
18.	State the correlation coefficient formula.	BTL -1	Remembering	CO2
19.	Give the acute angle between the two lines of regression.	BTL -2	Understanding	CO2
20.	Define Conditional probability distribution function of Y given X=x	BTL -2	Understanding	CO2
21.	Define Marginal probability density function of Y.	BTL -2	Understanding	CO2
22.	Let X be a continuous random variable having the pdf of $f(x) = \begin{cases} 8xy, & 0 < x < y < 1 \\ 0 & \text{otherwise} \end{cases}$ find marginal density function of X	BTL -2	Understanding	CO2
23.	Define Conditional probability distribution function of X given Y=y	BTL -1	Remembering	CO2
24.	If $f(x,y) = \begin{cases} kx^2y, & 0 < x < 3, 0 < y < 5 \\ 0 & \text{otherwise} \end{cases}$ is a pdf of X and Y. Find the value of k.	BTL -2	Understanding	CO2
25.	The joint probability distribution of X and Y is given by $f(x,y) = x+y, x = 0,1,2; y = 1, 2$ . Find the marginal probability distributions of X.	BTL -2	Understanding	CO2

**PART B (16 Mark Questions)**

1.	<p>From the following table for bivariate distribution of (X, Y). Find</p> <p>(i) <math>P(X \leq 1)</math> (ii) <math>P(Y \leq 3)</math> (iii) <math>P(X \leq 1, Y \leq 3)</math>  (ii) (iv) <math>P(X \leq 1/Y \leq 3)</math> (v) <math>P(Y \leq 3/X \leq 1)</math>  (iii) (vi) <math>P(X + Y \leq 4)</math></p> <table border="1" style="margin-left: 20px;"> <tr> <td style="text-align: center;">Y X</td> <td style="text-align: center;">1</td> <td style="text-align: center;">2</td> <td style="text-align: center;">3</td> <td style="text-align: center;">4</td> <td style="text-align: center;">5</td> <td style="text-align: center;">6</td> </tr> <tr> <td style="text-align: center;">0</td> <td style="text-align: center;">0</td> <td style="text-align: center;">0</td> <td style="text-align: center;"><math>\frac{1}{32}</math></td> <td style="text-align: center;"><math>\frac{2}{32}</math></td> <td style="text-align: center;"><math>\frac{2}{32}</math></td> <td style="text-align: center;"><math>\frac{3}{32}</math></td> </tr> <tr> <td style="text-align: center;">1</td> <td style="text-align: center;"><math>\frac{1}{16}</math></td> <td style="text-align: center;"><math>\frac{1}{16}</math></td> <td style="text-align: center;"><math>\frac{1}{8}</math></td> <td style="text-align: center;"><math>\frac{1}{8}</math></td> <td style="text-align: center;"><math>\frac{1}{8}</math></td> <td style="text-align: center;"><math>\frac{1}{8}</math></td> </tr> <tr> <td style="text-align: center;">2</td> <td style="text-align: center;"><math>\frac{1}{32}</math></td> <td style="text-align: center;"><math>\frac{1}{32}</math></td> <td style="text-align: center;"><math>\frac{1}{64}</math></td> <td style="text-align: center;"><math>\frac{1}{64}</math></td> <td style="text-align: center;">0</td> <td style="text-align: center;"><math>\frac{2}{64}</math></td> </tr> </table>	Y X	1	2	3	4	5	6	0	0	0	$\frac{1}{32}$	$\frac{2}{32}$	$\frac{2}{32}$	$\frac{3}{32}$	1	$\frac{1}{16}$	$\frac{1}{16}$	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{8}$	2	$\frac{1}{32}$	$\frac{1}{32}$	$\frac{1}{64}$	$\frac{1}{64}$	0	$\frac{2}{64}$	BTL -4	Analyzing	CO2
Y X	1	2	3	4	5	6																										
0	0	0	$\frac{1}{32}$	$\frac{2}{32}$	$\frac{2}{32}$	$\frac{3}{32}$																										
1	$\frac{1}{16}$	$\frac{1}{16}$	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{8}$																										
2	$\frac{1}{32}$	$\frac{1}{32}$	$\frac{1}{64}$	$\frac{1}{64}$	0	$\frac{2}{64}$																										
2.	<p>The joint pdf of X and Y is given by</p> $f(x,y) = \begin{cases} kx(x-y), & 0 < x < 2, -x < y < x \\ 0, & \text{otherwise} \end{cases}$ (i) Find K (ii) Find $f_x(x)$ and $f_y(y)$ (iii) $f_{\frac{y}{x}}\left(\frac{y}{x}\right)$	BTL -4	Analyzing	CO2																												

3.	<p>The joint pdf of a two dimensional random variable (X, Y) is given by</p> $f(x, y) = xy^2 + \frac{x^2}{8}, 0 \leq x \leq 2, 0 \leq y \leq 1.$ <p>Compute (i) <math>P\left(X &gt; 1 / Y &lt; \frac{1}{2}\right)</math>  (ii) <math>P\left(Y &lt; \frac{1}{2} / X &gt; 1\right)</math> (iii) <math>P(X + Y) \leq 1.</math></p>	BTL -3	Applying	CO2																		
4.(a)	<p>The joint distribution of X and Y is given by <math>f(x, y) = \frac{x+y}{21}</math>,  <math>x = 1, 2, 3; y = 1, 2.</math> Find the marginal distributions of X and Y.</p>	BTL -4	Analyzing	CO2																		
4.(b)	<p>The joint pdf a bivariate R.V(X, Y) is given by</p> $f(x, y) = \begin{cases} Kxy & ; 0 < x < 1, 0 < y < 1 \\ 0 & , \text{ otherwise} \end{cases}$ <p>Find (1) K. (2) Find <math>P(X+Y &lt; 1).</math> (3) Are X and Y independent R.V's.</p>	BTL -4	Analyzing	CO2																		
5.(a)	<p>The two dimensional random variable (X, Y) has the joint probability mass function <math>f(x, y) = \frac{x+2y}{27}</math>, <math>x = 0, 1, 2;</math>  <math>y = 0, 1, 2.</math> Find the conditional distribution of Y given <math>X = 1</math> also find the conditional distribution of X given <math>Y = 1.</math></p>	BTL -3	Applying	CO2																		
5.(b)	<p>Find <math>P(X &lt; Y / X &lt; 2Y)</math> if the joint pdf of (X, Y) is</p> $f(x, y) = e^{-(x+y)}, 0 \leq x < \infty, 0 \leq y < \infty.$	BTL -3	Applying	CO2																		
6.	<p>If the joint pdf of (X, Y) is given by <math>P(x, y) = K(2x + 3y)</math>, <math>x = 0, 1, 2</math> &amp; <math>y = 1, 2, 3.</math> Find all the marginal probability distribution. Also find the probability distribution of <math>X+Y.</math></p>	BTL -3	Applying	CO2																		
7.	<p>If the joint pdf of a two-dimensional RV(X, Y) is given by</p> $f(x, y) = \begin{cases} x^2 + \frac{xy}{3}; & 0 < x < 1, 0 < y < 2 \\ 0, & \text{ elsewhere} \end{cases}$ <p>Find (i) <math>P\left(X &gt; \frac{1}{2}\right)</math>  (ii) <math>P(Y &lt; X)</math> and (iii) <math>P\left(Y &lt; \frac{1}{2} / X &lt; \frac{1}{2}\right)</math></p>	BTL -4	Analyzing	CO2																		
8.	<p>If <math>f(x, y) = \frac{6-x-y}{8}</math>, <math>0 \leq x \leq 2, 2 \leq y \leq 4</math> for a bivariate random variable (X, Y), Find the correlation coefficient <math>\rho.</math></p>	BTL -4	Analyzing	CO2																		
9.	<p>From the following data , Find (i) The two regression equations (ii) The coefficient of correlation between the marks in Mathematics and Statistics (iii) The most likely marks in Statistics when marks in Mathematics are 30</p> <p>Marks in Maths : 25 28 35 32 31 36 29 38 34 32  Marks in Statistics: 43 46 49 41 36 32 31 30 33 39</p>	BTL -4	Analyzing	CO2																		
10.	<p>Find the correlation coefficient for the following heights of fathers X, their sons Y and also find the equations of regression lines. Hence find the height of son when the height of father is 71</p> <table border="1" data-bbox="145 1883 796 1962"> <tr> <td>X</td> <td>65</td> <td>66</td> <td>67</td> <td>67</td> <td>68</td> <td>69</td> <td>70</td> <td>72</td> </tr> <tr> <td>Y</td> <td>67</td> <td>68</td> <td>65</td> <td>68</td> <td>72</td> <td>72</td> <td>69</td> <td>71</td> </tr> </table>	X	65	66	67	67	68	69	70	72	Y	67	68	65	68	72	72	69	71	BTL -3	Applying	CO2
X	65	66	67	67	68	69	70	72														
Y	67	68	65	68	72	72	69	71														
11.	<p>Two random variables X and Y have the following joint probability density function <math>f(x, y) = \begin{cases} x + y; &amp; 0 \leq x \leq 1, 0 \leq y \leq 1 \\ 0, &amp; \text{ otherwise} \end{cases}</math>. Find the</p>	BTL -4	Analyzing	CO2																		

	probability density function of the random variable $U = XY$ .																															
12.	Two random variables X and Y have the joint density $f(x,y) = \begin{cases} 2-x-y, & 0 < x < 1, 0 < y < 1 \\ 0, & \text{otherwise} \end{cases}$ Show that the Correlation coefficient between X and Y is $-1/11$ .	BTL -3	Applying	CO2																												
13.	If X, Y are RV's having the joint density function $f(x,y) = k(6-x-y), 0 < x < 2, 2 < y < 4,$ Find (i) $P(x < 1, y < 3)$ ii) $P(x < 1/y < 3)$ iii) $P(y < 3/x < 1)$ iv) $P(X + Y < 3)$	BTL -3	Applying	CO2																												
14.	The equation of two regression lines obtained by in a correlation analysis is as follows: $3x + 12y = 19, 3y + 9x = 46.$ (i) Calculate the correlation coefficient (ii) Mean value of X & Y.	BTL -3	Applying	CO2																												
15.	The joint probability mass function of X and Y is given below <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>Y \ X</td> <td>-1</td> <td>1</td> </tr> <tr> <td>0</td> <td>1/8</td> <td>3/8</td> </tr> <tr> <td>1</td> <td>2/8</td> <td>2/8</td> </tr> </table> Find the correlation coefficient of X and Y	Y \ X	-1	1	0	1/8	3/8	1	2/8	2/8	BTL -4	Analyzing	CO2																			
Y \ X	-1	1																														
0	1/8	3/8																														
1	2/8	2/8																														
16.	The joint probability distribution of the random variables X and Y is given below <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>Y</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> <td>6</td> </tr> <tr> <td>X \ 0</td> <td>0</td> <td>0</td> <td>2K</td> <td>4K</td> <td>4K</td> <td>6K</td> </tr> <tr> <td>1</td> <td>4K</td> <td>4K</td> <td>8K</td> <td>8K</td> <td>8K</td> <td>8K</td> </tr> <tr> <td>2</td> <td>2K</td> <td>2K</td> <td>K</td> <td>K</td> <td>0</td> <td>2K</td> </tr> </table> Find (i) Value of K and marginal probability distribution of X and Y (ii) $P(X \leq 1)$ (iii) $P(X \leq 1/Y = 2)$ (iv) $P(X < 3/Y \leq 4)$	Y	1	2	3	4	5	6	X \ 0	0	0	2K	4K	4K	6K	1	4K	4K	8K	8K	8K	8K	2	2K	2K	K	K	0	2K	BTL -2	Understanding	CO2
Y	1	2	3	4	5	6																										
X \ 0	0	0	2K	4K	4K	6K																										
1	4K	4K	8K	8K	8K	8K																										
2	2K	2K	K	K	0	2K																										
17.	The two lines of regression are $4x-5y+33=0$ and $20x-9y=107$ . Calculate the means of x and y and the coefficient of correlation between x and y. Also find $\sigma_y$ if $\sigma_x=2$ and $\sigma_x$ if $\sigma_y=3$ .	BTL -4	Analyzing	CO2																												
18.	Find the correlation coefficient for the following data <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>X</td> <td>22</td> <td>26</td> <td>29</td> <td>30</td> <td>31</td> <td>31</td> <td>34</td> <td>35</td> </tr> <tr> <td>Y</td> <td>20</td> <td>20</td> <td>21</td> <td>29</td> <td>27</td> <td>24</td> <td>27</td> <td>31</td> </tr> </table>	X	22	26	29	30	31	31	34	35	Y	20	20	21	29	27	24	27	31	BTL -3	Applying	CO2										
X	22	26	29	30	31	31	34	35																								
Y	20	20	21	29	27	24	27	31																								

**UNIT III - ESTIMATION THEORY**

**Unbiased estimators-Efficiency-Consistency-Sufficiency-Robustness-method of moments-method of maximum likelihood estimator**

**PART-A(2 Mark Questions)**

1.	Define confidence limits for a parameter.	BTL -1	Remembering	CO3
2.	State the conditions under which a binomial distribution becomes a normal distribution.	BTL -1	Remembering	CO3
3.	Mention the properties of a good estimator.	BTL -1	Remembering	CO3
4.	Define confidence coefficient.	BTL -2	Understanding	CO3
5.	What is the level of significance in testing of hypothesis?	BTL -1	Remembering	CO3
6.	Define confidence limits for a parameter.	BTL -2	Understanding	CO3
7.	Define estimator, estimate and estimation.	BTL -2	Understanding	CO3
8.	Distinguish between point estimation and interval estimation.	BTL -1	Remembering	CO3
9.	Write the normal equations for fitting a straight line by the method of	BTL -1	Remembering	CO3

	least squares.			
10	An automobile repair shop has taken a random sample of 40 services that the average service time on an automobile is 130 minutes with a standard deviation of 26 minutes. Compute the standard error of the mean.	BTL -2	Understanding	CO3
11.	Two variables X and Y have the regression lines $3X + 2Y - 26 = 0$ , $6X + Y - 31 = 0$ , Find the mean value of X and Y.	BTL -2	Understanding	CO3
12.	State any two properties of regression lines.	BTL -1	Remembering	CO3
13.	Define unbiasedness of a good estimator.	BTL -2	Understanding	CO3
14.	Let the lines of regression concerning two variables x and y be given by $y = 32 - x$ and $x = 13 - 0.25y$ . Obtain the values of the means.	BTL -2	Understanding	CO3
15.	What is the definition of an efficient estimator in estimation theory?	BTL -1	Remembering	CO3
16.	Find the maximum likelihood estimates for the population mean when the population variance is known for random sampling from a normal population.	BTL -1	Remembering	CO3
17.	What is meant by maximum likelihood estimator ?	BTL -2	Understanding	CO3
18.	Give the normal equations to fit the parabola $y = a + bx + cx^2$	BTL -2	Understanding	CO3
19.	Can $Y = 5 + 2.8x$ and $X = 3 - 0.5y$ be the estimated regression equations of y on x and x on y respectively ? Explain.	BTL -1	Remembering	CO3
20.	Obtain the maximum likelihood estimator of $f(x, \theta) = (1 + \theta)x^\theta, 0 < x < 1$ based on a random sample of size x.	BTL -1	Remembering	CO3
21.	What is the sufficiency property of an estimator?	BTL -2	Understanding	CO3
22.	What does it mean for an estimator to be consistent?	BTL -1	Remembering	CO3
23.	What are the merits and demerits of the least square method.	BTL -2	Understanding	CO3
24.	What is a sufficient statistic in estimation theory?	BTL -1	Remembering	CO3
25.	State the Neyman-Fisher Factorization Theorem and its significance in identifying sufficient statistics.	BTL -2	Understanding	CO3

**PART-B (16 Marks Questions)**

1.	Fit a straight line $y = a + bx$ for the following data by the principle of least squares. X : 0    1    2    3    4 Y : 1    1.8    3.3    4.5    6.3 Also find the value of y when $x = 1.5$	BTL -3	Applying	CO3																				
2.	Obtain the lines of regression <table border="1" style="display: inline-table; vertical-align: middle;"> <tr> <td>X</td> <td>50</td> <td>55</td> <td>50</td> <td>60</td> <td>65</td> <td>65</td> <td>65</td> <td>60</td> <td>60</td> </tr> <tr> <td>Y</td> <td>11</td> <td>14</td> <td>13</td> <td>16</td> <td>16</td> <td>15</td> <td>15</td> <td>14</td> <td>13</td> </tr> </table>	X	50	55	50	60	65	65	65	60	60	Y	11	14	13	16	16	15	15	14	13	BTL -3	Applying	CO3
X	50	55	50	60	65	65	65	60	60															
Y	11	14	13	16	16	15	15	14	13															
3.	The price of a commodity during 93-98 are given below. Fit a parabola $y = a + bx + cx^2$ to these data. Calculate the trend values, estimate the period of the commodity for the year 1999. <table border="1" style="display: inline-table; vertical-align: middle;"> <tr> <td>x</td> <td>1993</td> <td>1994</td> <td>1995</td> <td>1996</td> <td>1997</td> <td>1998</td> </tr> <tr> <td>y</td> <td>100</td> <td>107</td> <td>128</td> <td>140</td> <td>181</td> <td>192</td> </tr> </table>	x	1993	1994	1995	1996	1997	1998	y	100	107	128	140	181	192	BTL -3	Applying	CO3						
x	1993	1994	1995	1996	1997	1998																		
y	100	107	128	140	181	192																		
4.	The following data relate to the marks of 10 students in the internal test and the university examination for the maximum of 50 in each. Internal Marks : 25    28    30    32    35    36    38    39    42    45 UniversityMarks:20    26    29    30    25    18    26    35    35    46 a) Obtain the equations of the lines of regression b) The most likely internal mark for the university mark of 25 c) The most likely university mark for the internal mark of 30.	BTL -3	Applying	CO3																				
5.	Find the maximum likelihood estimate for the parameter $\lambda$ of a	BTL -3	Applying																					

	poisson distribution on the basis of a sample of size n. Also find its variance. Show that the sample mean $\bar{x}$ is sufficient for estimating the parameter $\lambda$ of the poisson distribution.			CO3																										
6.	For a random sampling from a normal population find the maximum likelihood estimators for i) The population mean, when the population variance is known. ii) The population variance, when the population mean is known. iii) The simultaneous estimation of both the population mean and variance.	BTL -4	Analyzing	CO3																										
7.(a)	A random sample $(X_1, X_2, X_3, X_4, X_5)$ of size 5 is drawn from a population with unknown mean $\mu$ . Consider the following estimators to estimate $\mu$ . $t_1 = \frac{(x_1 + x_2 + x_3 + x_4 + x_5)}{5}, t_2 = \frac{(x_1 + x_2)}{2} + X_3 \text{ and } t_3 = \frac{(2x_1 + x_2 + \lambda x_3)}{3}$ is such that $t_3$ is an unbiased estimator of $\mu$ . Find $\lambda$ . Are $t_1$ and $t_2$ unbiased? State giving reason, the estimator which is best among $t_1, t_2,$ and $t_3$ .	BTL -4	Analyzing	CO3																										
7.(b)	Let $X_1, X_2, \dots, X_n$ be a random sample of size n from a normal distribution with known variance. Obtain the maximum likelihood estimator of $\mu$ .	BTL -4	Analyzing	CO3																										
8.	The following are the measurements of the air velocity and evaporation coefficient of burning fuel droplets in an impulse engine  Air Velocity (cm/s) : 20    60    100    140    180    220 260    300    340    380  Evaporation Coeff : 0.18    0.37    0.35    0.78    0.56    0.75 1.18    1.36    1.17    1.65 Fit a straight line to these data by the method of least squares, and use it to estimate the evaporation coefficient of a droplet when the air velocity is 190 cm/s.	BTL-5	Evaluating	CO3																										
9.	Fit an equation of the form $y = ab^x$ to the following data <table border="1" style="margin-left: 20px;"> <tr> <td>x</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> <td>6</td> </tr> <tr> <td>y</td> <td>144</td> <td>172.8</td> <td>207.4</td> <td>248.8</td> <td>298.5</td> </tr> </table>	x	2	3	4	5	6	y	144	172.8	207.4	248.8	298.5	BTL -4	Analyzing	CO3														
x	2	3	4	5	6																									
y	144	172.8	207.4	248.8	298.5																									
10.	Obtain the equation of regression lines $y = ax + b$ from the following data, using the method of least squares. <table border="1" style="margin-left: 20px;"> <tr> <td>X</td> <td>6</td> <td>3</td> <td>6</td> <td>9</td> <td>3</td> <td>9</td> <td>6</td> <td>3</td> <td>9</td> <td>6</td> <td>3</td> <td>9</td> </tr> <tr> <td>y</td> <td>526</td> <td>421</td> <td>581</td> <td>630</td> <td>412</td> <td>560</td> <td>434</td> <td>443</td> <td>590</td> <td>570</td> <td>346</td> <td>672</td> </tr> </table>	X	6	3	6	9	3	9	6	3	9	6	3	9	y	526	421	581	630	412	560	434	443	590	570	346	672	BTL -4	Analyzing	CO3
X	6	3	6	9	3	9	6	3	9	6	3	9																		
y	526	421	581	630	412	560	434	443	590	570	346	672																		
11.(a)	Fit a straight line $y = ax + c$ to the following data. <table border="1" style="margin-left: 20px;"> <tr> <td>X</td> <td>1</td> <td>3</td> <td>5</td> <td>7</td> <td>9</td> <td>11</td> <td>13</td> <td>15</td> <td>17</td> </tr> <tr> <td>y</td> <td>10</td> <td>15</td> <td>20</td> <td>27</td> <td>31</td> <td>35</td> <td>30</td> <td>35</td> <td>40</td> </tr> </table>	X	1	3	5	7	9	11	13	15	17	y	10	15	20	27	31	35	30	35	40	BTL -4	Analyzing	CO3						
X	1	3	5	7	9	11	13	15	17																					
y	10	15	20	27	31	35	30	35	40																					
11.(b)	Find the regression line of Y on X for the data <table border="1" style="margin-left: 20px;"> <tr> <td>x</td> <td>1</td> <td>4</td> <td>2</td> <td>3</td> <td>5</td> </tr> <tr> <td>y</td> <td>3</td> <td>1</td> <td>2</td> <td>5</td> <td>4</td> </tr> </table>	x	1	4	2	3	5	y	3	1	2	5	4	BTL -4	Analyzing	CO3														
x	1	4	2	3	5																									
y	3	1	2	5	4																									
12.	Prove that the ML estimator of the parameter $\alpha$ of the population having pdf $f(x, \alpha) = 2/\alpha^2 (\alpha - x)$ . $0 < x < \alpha$ for the sample of unit size is $2\bar{x}$ , $\bar{x}$ being the sample value. Show also that the estimator is not unbiased.	BTL-4	Analyzing	CO3																										

13.	Fit a straight line trend of the form $y = a + bx$ to the data given below by the method of least squares and predict the value of $y$ when $x = 70$								BTL -3	Applying	CO3					
	X	71	68	73	69	67	65	66				67				
	y	69	72	70	70	68	67	68				64				
14.	Fit the model $y = ax^b$ to the following data.								BTL-3	Applying	CO3					
	X	1	2	3	4	5	6									
	y	2.98	4.26	5.21	6.10	6.80	7.50									
15.	If the two variables $x$ and $y$ have the regression lines $3x + 2y = 26$ and $6x + y = 31$ . Find i) Find the mean value of $x$ and $y$ ii) Find the correlation coefficient of $x$ and $y$ .								BTL-4	Analyzing	CO3					
16.	Fit an equation of the form $y = ab^x$ to the following data								BTL -3	Applying	CO3					
	x	2	3	4	5	6										
	y	144	172.8	207.4	248.8	298.5										
17.	Obtain the equation of regression lines $y = ax + b$ from the following data, using the method of least squares.								BTL-4	Analyzing	CO3					
	X	6	3	6	9	3	9	6				3	9	6	3	9
	y	526	42	58	630	412	560	43				443	59	57	34	672
		1	1				4		0	0	6					
18.	Let $X_1, X_2, \dots, X_n$ be a random sample size $n$ from the Poisson distribution $f(x/\lambda) = \frac{\lambda^x e^{-\lambda}}{x!}$ where $0 \leq \lambda < \infty$ . Obtain the maximum likelihood estimator of $\lambda$								BTL -3	Applying	CO3					

**UNIT –IV NON-PARAMETRIC TESTS**

**Introduction- Rank -sum test.-The U test –The H-Test-The Kolmogorov tests**

**PART-A(2 Mark Questions)**

1.	Define H test .	BTL -1	Remembering	CO4
2.	Define Rank-Sum test.	BTL -1	Remembering	CO4
3.	Mention the advantages of Non - parametric Tests.	BTL -1	Remembering	CO4
4.	What is the other name or non-parametric test? Why?	BTL -2	Understanding	CO4
5.	When are non-parametric tests used?	BTL -2	Understanding	CO4
6.	What is the null hypothesis framed in Mann-Whitney test?	BTL -1	Remembering	CO4
7.	Write down the working rule for Mann-Whitney U-test and Kruskal-Wallis test.	BTL -1	Remembering	CO4
8.	Explain sign test.	BTL -2	Understanding	CO4
9.	Define one sample run test?	BTL -1	Remembering	CO4
10.	When is Krushkal-Wallis test used?	BTL -1	Remembering	CO4
11.	Distinguish between Mann-Whitney U-test and Krushkal-Wallis test.	BTL -2	Understanding	CO4
12.	How can you perform sign Test?	BTL -2	Understanding	CO4
13.	Explain Kolmogorov-Smirnov Test for one sample problem.	BTL -2	Understanding	CO4
14.	What are the non-parametric tests available?	BTL -2	Understanding	CO4
15.	Mention the disadvantages of Nonparametric Tests.	BTL -2	Understanding	CO4
16.	State any three Non Parametric test.	BTL -1	Remembering	CO4
17.	How do the non parametric methods differ from parametric methods?	BTL -2	Understanding	CO4
18.	Define Rank sum test.	BTL -2	Understanding	CO4



7.	<p>An experiment designed to compare three preventative methods against corrosion yielded the following maximum depths of pits ( in thousands of an inch) in pieces of wire subjected to the respective treatments:</p> <table border="1" data-bbox="140 309 933 432"> <tbody> <tr> <td>Method A:</td> <td>77</td> <td>54</td> <td>67</td> <td>74</td> <td>71</td> <td>66</td> <td></td> <td></td> </tr> <tr> <td>Method B:</td> <td>60</td> <td>41</td> <td>59</td> <td>65</td> <td>62</td> <td>64</td> <td>52</td> <td></td> </tr> <tr> <td>Method C:</td> <td>49</td> <td>52</td> <td>69</td> <td>47</td> <td>56</td> <td></td> <td></td> <td></td> </tr> </tbody> </table> <p>Use the Kruskal-Wallis test at the 5% level of significance to test the null hypothesis that the three samples come from identical populations.</p>	Method A:	77	54	67	74	71	66			Method B:	60	41	59	65	62	64	52		Method C:	49	52	69	47	56				BTL -3	Applying	CO4			
Method A:	77	54	67	74	71	66																												
Method B:	60	41	59	65	62	64	52																											
Method C:	49	52	69	47	56																													
8.	<p>The following are the measurements of breaking strength of a certain kind of 2 inch cotton ribbon in pounds. Use the sign test to test the hypothesis of 0.05 LOS that the mean breaking strength is 160 pounds.</p> <table border="1" data-bbox="140 616 1050 689"> <tbody> <tr> <td>163</td> <td>165</td> <td>160</td> <td>189</td> <td>161</td> <td>171</td> <td>158</td> <td>151</td> <td>169</td> <td>162</td> </tr> <tr> <td>163</td> <td>139</td> <td>172</td> <td>165</td> <td>148</td> <td>166</td> <td>172</td> <td>163</td> <td>187</td> <td>173</td> </tr> </tbody> </table>	163	165	160	189	161	171	158	151	169	162	163	139	172	165	148	166	172	163	187	173	BTL -3	Applying	CO4										
163	165	160	189	161	171	158	151	169	162																									
163	139	172	165	148	166	172	163	187	173																									
9.	<p>Apply the K-S test to check that the observed frequencies match with the expected frequencies which are obtained from Normal distribution. (Given at <math>n=5</math>, <math>D_n = 0.510</math> at 10% LOS).</p> <table border="1" data-bbox="140 801 981 929"> <tbody> <tr> <td>Test Score</td> <td>51-60</td> <td>61-70</td> <td>71-80</td> <td>81-90</td> <td>91-100</td> </tr> <tr> <td>Observed Frequency</td> <td>30</td> <td>100</td> <td>440</td> <td>500</td> <td>130</td> </tr> <tr> <td>Expected Frequency</td> <td>40</td> <td>170</td> <td>500</td> <td>390</td> <td>100</td> </tr> </tbody> </table>	Test Score	51-60	61-70	71-80	81-90	91-100	Observed Frequency	30	100	440	500	130	Expected Frequency	40	170	500	390	100	BTL -3	Applying	CO4												
Test Score	51-60	61-70	71-80	81-90	91-100																													
Observed Frequency	30	100	440	500	130																													
Expected Frequency	40	170	500	390	100																													
10.	<p>The following data represents the number of hours that a rechargeable hedge trimmer operates before a recharge is required. 1.5,2.2,0.9,1.3,2.0,1.6,1.8,1.5,2.0,1.2 and 1.7. Use the Sign test to test the hypothesis of the 0.05 LOS that this particular trimmer operates with a mean of 1.8 hours before requiring a recharge.</p>	BTL -4	Analyzing	CO4																														
11.	<p>From a Maths class of 12 equally capable students using a programmed material, 5 are selected at random and given additional instructions by the teacher. The results on the final exam is as follows.  Additional Instruction: 87 69 78 91 80  No Additional Instruction: 75 88 64 82 93 79 67  Use the Rank Sum test at 5% LOS to determine if the additional instruction affects the average grade.</p>	BTL -3	Applying	CO4																														
12.	<p>The following are the year of experience (X) and the average customer satisfaction (Y) for 10 service providers. Is there a significant rank correlation between two measures? Use the 0.05 level of significance.  X: 6.3 5.8 6.1 6.9 3.4 1.8 9.4 4.7 7.2 2.4  Y: 5.3 8.6 4.7 4.2 4.9 6.1 5.1 6.3 6.8 5.2</p>	BTL -4	Analyzing	CO4																														
13.	<p>The scores of a written examination of 24 students, who were trained by using three different methods, are given below.</p> <table border="1" data-bbox="140 1630 906 1765"> <tbody> <tr> <td>Video cassetteA</td> <td>74</td> <td>88</td> <td>82</td> <td>93</td> <td>55</td> <td>70</td> <td>65</td> <td></td> <td></td> </tr> <tr> <td>Audio cassetteB</td> <td>78</td> <td>80</td> <td>65</td> <td>57</td> <td>89</td> <td>85</td> <td>78</td> <td>70</td> <td></td> </tr> <tr> <td>Class Room C</td> <td>68</td> <td>83</td> <td>50</td> <td>91</td> <td>84</td> <td>77</td> <td>94</td> <td>81</td> <td>92</td> </tr> </tbody> </table> <p>Use Kruskal-Wallis test at <math>\alpha = 5\%</math> level of significance, whether the three methods of training yield the same results.</p>	Video cassetteA	74	88	82	93	55	70	65			Audio cassetteB	78	80	65	57	89	85	78	70		Class Room C	68	83	50	91	84	77	94	81	92	BTL -4	Analyzing	CO4
Video cassetteA	74	88	82	93	55	70	65																											
Audio cassetteB	78	80	65	57	89	85	78	70																										
Class Room C	68	83	50	91	84	77	94	81	92																									
14.	<p>Apply the K-S test to check that the observed frequencies match with the expected frequencies which are obtained from Normal distribution. (Given at <math>n=7</math>, <math>D_n = 0.486</math> at 5% LOS).</p> <table border="1" data-bbox="140 1951 981 2098"> <tbody> <tr> <td></td> <td>25-30</td> <td>31-36</td> <td>37-42</td> <td>43-48</td> <td>49-54</td> <td>55-60</td> <td>61-66</td> </tr> <tr> <td>Observed Frequency</td> <td>9</td> <td>22</td> <td>25</td> <td>30</td> <td>21</td> <td>12</td> <td>6</td> </tr> <tr> <td>Expected</td> <td>6</td> <td>17</td> <td>32</td> <td>35</td> <td>18</td> <td>13</td> <td>4</td> </tr> </tbody> </table>		25-30	31-36	37-42	43-48	49-54	55-60	61-66	Observed Frequency	9	22	25	30	21	12	6	Expected	6	17	32	35	18	13	4	BTL -3	Applying	CO4						
	25-30	31-36	37-42	43-48	49-54	55-60	61-66																											
Observed Frequency	9	22	25	30	21	12	6																											
Expected	6	17	32	35	18	13	4																											

	Frequency														
15.	The nicotine content of two brands of cigarettes, measured in milligrams was found as follows. Brand A: 2.1 4.0 6.3 5.4 4.8 3.7 6.1 3.3 Brand B: 4.1 0.6 3.1 2.5 4.0 6.2 1.6 2.2 1.9 5.4 Use the Rank Sum test at 5% LOS.											BTL -4	Analyzing	CO4	
16.	The production volume of units assembled by three different operators during 9 shifts is summarized below. Check whether there is significant difference between the production volumes of units assembled by the three operators using Krushkal-Wallis test at a significant level of 0.05.											BTL -3	Applying	CO4	
	Operator I	29	34	34	20	32	45	42	24	35					
	Operator II	30	21	23	25	44	37	34	19	38					
	Operator III	26	36	41	48	27	39	28	46	15					
17.	Melisa's Boutique has three mall locations. Melisa keeps a dairy record for each location of number of customers who actually make a purchase. A sample of those data follows. Using the kruskal-wallis test, can you say at the 0.05 level of significance that her stores have the same number of customers who busy?											BTL -3	Applying	CO4	
	DSF Mall	99	64	101	85	79	88	97	95	90	100				
	Forest Mall	83	102	125	61	91	96	94	89	98	75				
	Big-Ben Mall	89	98	56	105	87	90	87	101	76	89				
18.	Explain the Mann-Whitney test procedure with appropriate examples											BTL -4	Analyzing	CO4	

**UNIT –V: STATISTICAL QUALITY CONTROL**  
**Control charts for measurements (X and R charts) – Control charts for attributes (p,c and np charts) – Tolerance limits – Acceptance sampling**

**PART-A (2 Mark Questions)**

1.	Define product control	BTL1	Remembering	CO5
2.	Define process control	BTL2	Understanding	CO5
3.	What is control Chart?	BTL1	Remembering	CO5
4.	Write down uses of Mean Chart.	BTL2	Understanding	CO5
5.	Write down types of Acceptance sampling plan	BTL1	Remembering	CO5
6.	Define OC Curve	BTL2	Understanding	CO5
7.	What is Statistical quality control?	BTL1	Remembering	CO5
8.	Write down advantage of SQC.	BTL2	Understanding	CO5
9.	What is meant by chance variation?	BTL1	Remembering	CO5
10.	What is meant by Assignable variation?	BTL2	Understanding	CO5
11.	Name the types of Control Chart.	BTL1	Remembering	CO5
12.	Write down types of Causes variation.	BTL2	Understanding	CO5
13.	Write the formula for np chart.	BTL1	Remembering	CO5
14.	What is meant by AQL and LTPD	BTL2	Understanding	CO5
15.	What is the formula for c chart and p chart	BTL1	Remembering	CO5
16.	Define Acceptance Sampling.	BTL2	Understanding	CO5
17.	Explain producers Risk and Consumer Risk.	BTL1	Remembering	CO5
18.	Define Tolerance limits.	BTL2	Understanding	CO5
19.	Define one-sided Tolerance limits.	BTL1	Remembering	CO5
20.	What is an $\bar{X}$ chart used for in Statistical Quality Control?	BTL2	Understanding	CO5
21.	Why are $\bar{X}$ chart and R charts often used together?	BTL1	Remembering	CO5
22.	What are the main differences between an $\bar{X}$ chart and an R chart?	BTL2	Understanding	CO5
23.	Define Two-Sided Tolerance limits.	BTL1	Remembering	CO5

24.	What is the purpose of an R chart in Statistical Quality Control?	BTL2	Understanding	CO5																																	
25.	How are control limits for an R chart determined?	BTL2	Understanding	CO5																																	
PART-B (16 Mark Questions)																																					
1.	<p>You are given the value of sample means (<math>\bar{X}</math>) and Range for 10 samples of size 5 each. Draw mean chart and comment on the state of control of the process.</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 10%;">Sample No</td> <td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td> </tr> <tr> <td>(<math>\bar{X}</math>)</td> <td>43</td><td>49</td><td>37</td><td>44</td><td>45</td><td>37</td><td>51</td><td>46</td><td>43</td><td>47</td> </tr> <tr> <td>R</td> <td>5</td><td>6</td><td>5</td><td>7</td><td>7</td><td>4</td><td>8</td><td>6</td><td>4</td><td>6</td> </tr> </table>	Sample No	1	2	3	4	5	6	7	8	9	10	( $\bar{X}$ )	43	49	37	44	45	37	51	46	43	47	R	5	6	5	7	7	4	8	6	4	6	BTL -3	Applying	CO5
Sample No	1	2	3	4	5	6	7	8	9	10																											
( $\bar{X}$ )	43	49	37	44	45	37	51	46	43	47																											
R	5	6	5	7	7	4	8	6	4	6																											
2.	<p>The following data give the weight of an automobile part. Five samples of four items each were taken on a random sample basis (at an interval of 1 hour each). Draw the mean Control Chart and find out if the production process is in control.</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 10%;">Sample</td> <td colspan="4">Weight of the parts in ounces</td> </tr> <tr> <td>1</td> <td>10</td><td>12</td><td>10</td><td>12</td> </tr> <tr> <td>2</td> <td>10</td><td>12</td><td>13</td><td>13</td> </tr> <tr> <td>3</td> <td>10</td><td>10</td><td>9</td><td>11</td> </tr> <tr> <td>4</td> <td>11</td><td>10</td><td>9</td><td>14</td> </tr> <tr> <td>5</td> <td>12</td><td>12</td><td>12</td><td>12</td> </tr> </table>	Sample	Weight of the parts in ounces				1	10	12	10	12	2	10	12	13	13	3	10	10	9	11	4	11	10	9	14	5	12	12	12	12	BTL -4	Analyzing	CO5			
Sample	Weight of the parts in ounces																																				
1	10	12	10	12																																	
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3	10	10	9	11																																	
4	11	10	9	14																																	
5	12	12	12	12																																	
3.	What do you understand by SQC. Discuss its utility and limitations?	BTL -3	Applying	CO5																																	
4.(a)	<p>A machine is set to deliver packets of a given weight, 10 samples of size 5 each were recorded. Below are given the relevant data:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 10%;">Sample No</td> <td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td> </tr> <tr> <td>(<math>\bar{X}</math>)</td> <td>15</td><td>17</td><td>15</td><td>18</td><td>17</td><td>14</td><td>18</td><td>15</td><td>17</td><td>16</td> </tr> <tr> <td>R</td> <td>7</td><td>7</td><td>4</td><td>9</td><td>8</td><td>7</td><td>12</td><td>4</td><td>11</td><td>5</td> </tr> </table> <p>Calculate the values of the Central Line and the control limits for the mean chart and the range chart and then comment on the state of control. (Conversion factors for <math>n = 5</math> are <math>A_2 = 0.58</math> <math>D_3 = 0</math>, <math>D_4 = 2.115</math>)</p>	Sample No	1	2	3	4	5	6	7	8	9	10	( $\bar{X}$ )	15	17	15	18	17	14	18	15	17	16	R	7	7	4	9	8	7	12	4	11	5	BTL -3	Applying	CO5
Sample No	1	2	3	4	5	6	7	8	9	10																											
( $\bar{X}$ )	15	17	15	18	17	14	18	15	17	16																											
R	7	7	4	9	8	7	12	4	11	5																											
4.(b)	Explain in detail the R-Chart clearly?	BTL -3	Applying	CO5																																	
5.	<p>15 tape-recorders were examined for quality control test. The number of defects in each tape-recorder is recorded below. Draw the appropriate control chart and comment on the state of control.</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 10%;">Unit No (i)</td> <td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td> </tr> <tr> <td>No of defects (c)</td> <td>2</td><td>4</td><td>3</td><td>1</td><td>1</td><td>2</td><td>5</td><td>3</td><td>6</td><td>7</td><td>3</td><td>1</td><td>4</td><td>2</td><td>1</td> </tr> </table>	Unit No (i)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	No of defects (c)	2	4	3	1	1	2	5	3	6	7	3	1	4	2	1	BTL -4	Analyzing	CO5	
Unit No (i)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15																						
No of defects (c)	2	4	3	1	1	2	5	3	6	7	3	1	4	2	1																						
6.(a)	<p>The following data show the values of sample mean <math>\bar{X}</math> and the range R for the samples of size 5 each. Calculate the values for central line and control limits for mean-chart and range chart and determine whether the process is in control.</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 10%;">Sample No</td> <td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td> </tr> <tr> <td>(<math>\bar{X}</math>)</td> <td>11.2</td><td>11.8</td><td>10.8</td><td>11.6</td><td>11</td><td>9.6</td><td>10.4</td><td>9.6</td><td>10.6</td><td>10</td> </tr> <tr> <td>R</td> <td>7</td><td>4</td><td>8</td><td>5</td><td>7</td><td>4</td><td>8</td><td>4</td><td>7</td><td>9</td> </tr> </table> <p>(Conversion factors for <math>n = 5</math> are <math>A_2 = 0.577</math> <math>D_3 = 0</math>, <math>D_4 = 2.115</math>)</p>	Sample No	1	2	3	4	5	6	7	8	9	10	( $\bar{X}$ )	11.2	11.8	10.8	11.6	11	9.6	10.4	9.6	10.6	10	R	7	4	8	5	7	4	8	4	7	9	BTL -3	Applying	CO5
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R	7	4	8	5	7	4	8	4	7	9																											
6.(b)	Explain in detail the $\bar{X}$ Chart clearly?	BTL -3	Applying	CO5																																	

7.	<p>The following data relate to the number of defects in each of 15 units drawn randomly from a production process. Draw the control chart or the number of defects and comment on the state of control. The Units are 6, 4, 9, 10, 11, 12, 20, 10, 9, 10, 15, 10, 20, 15, 10.</p>	BTL -4	Analyzing	CO5																																																																													
8.	<p>The following data relate to the life (in hours) of 10 samples of 6 electric bulbs each drawn at an interval of one hour from a production process. Draw the control chart for <math>\bar{X}</math> and R comment.</p> <table border="1" data-bbox="209 501 1070 949"> <thead> <tr> <th>Sample No.</th> <th colspan="6">Life time ( in hours)</th> </tr> </thead> <tbody> <tr><td>1</td><td>620</td><td>687</td><td>666</td><td>689</td><td>738</td><td>686</td></tr> <tr><td>2</td><td>501</td><td>585</td><td>524</td><td>585</td><td>653</td><td>668</td></tr> <tr><td>3</td><td>673</td><td>701</td><td>686</td><td>567</td><td>619</td><td>660</td></tr> <tr><td>4</td><td>646</td><td>626</td><td>572</td><td>628</td><td>631</td><td>743</td></tr> <tr><td>5</td><td>494</td><td>984</td><td>659</td><td>643</td><td>660</td><td>640</td></tr> <tr><td>6</td><td>634</td><td>755</td><td>625</td><td>582</td><td>683</td><td>555</td></tr> <tr><td>7</td><td>619</td><td>710</td><td>664</td><td>693</td><td>770</td><td>534</td></tr> <tr><td>8</td><td>630</td><td>723</td><td>614</td><td>535</td><td>550</td><td>570</td></tr> <tr><td>9</td><td>482</td><td>791</td><td>533</td><td>612</td><td>497</td><td>499</td></tr> <tr><td>10</td><td>706</td><td>524</td><td>626</td><td>503</td><td>661</td><td>754</td></tr> </tbody> </table> <p>(Given for <math>n = 6, A_2 = 0.483, D_3 = 0, D_4 = 2.004</math>)</p>	Sample No.	Life time ( in hours)						1	620	687	666	689	738	686	2	501	585	524	585	653	668	3	673	701	686	567	619	660	4	646	626	572	628	631	743	5	494	984	659	643	660	640	6	634	755	625	582	683	555	7	619	710	664	693	770	534	8	630	723	614	535	550	570	9	482	791	533	612	497	499	10	706	524	626	503	661	754	BTL -3	Applying	CO5
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9.	<p>From the information given below construct an appropriate control chart</p> <table border="1" data-bbox="140 1128 1043 1227"> <thead> <tr> <th>Sample No.(each of 100)</th> <th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th> </tr> </thead> <tbody> <tr> <td>No. of defectives</td> <td>12</td><td>7</td><td>9</td><td>8</td><td>10</td><td>6</td><td>7</td><td>11</td><td>8</td> </tr> </tbody> </table> <p>State your conclusions. Write all the steps in the construction of the above chart including formula for UCL and LCL.</p>	Sample No.(each of 100)	1	2	3	4	5	6	7	8	9	No. of defectives	12	7	9	8	10	6	7	11	8	BTL -4	Analyzing	CO5																																																									
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No. of defectives	12	7	9	8	10	6	7	11	8																																																																								
10.	<p>The following table gives the inspection data relating to 10 samples of 100 items each, concerning the production of bottle corks.</p> <table border="1" data-bbox="150 1375 1043 1832"> <thead> <tr> <th>Sample Number</th> <th>Size of Sample</th> <th>Number of Defectives</th> <th>Fraction Defective</th> </tr> </thead> <tbody> <tr><td>1</td><td>100</td><td>5</td><td>.05</td></tr> <tr><td>2</td><td>100</td><td>3</td><td>.03</td></tr> <tr><td>3</td><td>100</td><td>3</td><td>.03</td></tr> <tr><td>4</td><td>100</td><td>6</td><td>.06</td></tr> <tr><td>5</td><td>100</td><td>5</td><td>.05</td></tr> <tr><td>6</td><td>100</td><td>6</td><td>.06</td></tr> <tr><td>7</td><td>100</td><td>8</td><td>.08</td></tr> <tr><td>8</td><td>100</td><td>10</td><td>.10</td></tr> <tr><td>9</td><td>100</td><td>10</td><td>.10</td></tr> <tr><td>10</td><td>100</td><td>4</td><td>.04</td></tr> </tbody> </table> <p>Construct a p- chart.</p>	Sample Number	Size of Sample	Number of Defectives	Fraction Defective	1	100	5	.05	2	100	3	.03	3	100	3	.03	4	100	6	.06	5	100	5	.05	6	100	6	.06	7	100	8	.08	8	100	10	.10	9	100	10	.10	10	100	4	.04	BTL -4	Analyzing	CO5																																	
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11.	<p>Construct <math>\bar{X}</math> chart for following data</p> <table border="1" data-bbox="140 1906 1043 2063"> <thead> <tr> <th>Sample No</th> <th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th> </tr> </thead> <tbody> <tr> <td rowspan="3">Observation</td> <td>32</td><td>28</td><td>39</td><td>50</td><td>42</td><td>50</td><td>44</td><td>22</td> </tr> <tr> <td>36</td><td>32</td><td>52</td><td>42</td><td>45</td><td>29</td><td>52</td><td>35</td> </tr> <tr> <td>42</td><td>40</td><td>28</td><td>31</td><td>34</td><td>21</td><td>35</td><td>44</td> </tr> </tbody> </table> <p>Also determine whether the process is in control.</p>	Sample No	1	2	3	4	5	6	7	8	Observation	32	28	39	50	42	50	44	22	36	32	52	42	45	29	52	35	42	40	28	31	34	21	35	44	BTL -4	Analyzing	CO5																																											
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	36	32	52	42	45	29	52	35																																																																									
	42	40	28	31	34	21	35	44																																																																									

12.	<p>The following are the <math>\bar{X}</math> and R values for 20 samples of readings. Draw <math>\bar{X}</math> chart and R chart and write your conclusion.</p> <table border="1" data-bbox="140 277 1056 584"> <tr> <td>Samples</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td></tr> <tr> <td><math>\bar{X}</math></td><td>34</td><td>31.6</td><td>30.8</td><td>33</td><td>35</td><td>33.2</td><td>33</td><td>32.6</td><td>33.8</td><td>37.8</td></tr> <tr> <td>R</td><td>4</td><td>4</td><td>2</td><td>3</td><td>5</td><td>2</td><td>5</td><td>13</td><td>19</td><td>6</td></tr> <tr> <td>Samples</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td><td>16</td><td>17</td><td>18</td><td>19</td><td>20</td></tr> <tr> <td><math>\bar{X}</math></td><td>35.8</td><td>38.4</td><td>34</td><td>35</td><td>38.8</td><td>31.6</td><td>33</td><td>28.2</td><td>31.8</td><td>35.6</td></tr> <tr> <td>R</td><td>4</td><td>4</td><td>14</td><td>4</td><td>7</td><td>5</td><td>5</td><td>3</td><td>9</td><td>6</td></tr> </table> <p>(Given for n = 5 are <math>A_2 = 0.58</math> <math>D_3 = 0</math>, <math>D_4 = 2.12</math>)</p>	Samples	1	2	3	4	5	6	7	8	9	10	$\bar{X}$	34	31.6	30.8	33	35	33.2	33	32.6	33.8	37.8	R	4	4	2	3	5	2	5	13	19	6	Samples	11	12	13	14	15	16	17	18	19	20	$\bar{X}$	35.8	38.4	34	35	38.8	31.6	33	28.2	31.8	35.6	R	4	4	14	4	7	5	5	3	9	6	BTL -3	Applying	CO5
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13.	An inspection of 10 samples of size 400 each from 10 lots revealed the following number of defective units 17,15,14,26,9,4,19,12,9,6	BTL -4	Analyzing	CO5																																																																		
14.	Explain Control Limits for the sample mean $\bar{X}$ and sample range R.	BTL -3	Applying	CO5																																																																		
15.	<p>Construct R chart for following data</p> <table border="1" data-bbox="140 846 986 1227"> <thead> <tr> <th>Sample No.</th><th colspan="4">Observation</th></tr> </thead> <tbody> <tr><td>1</td><td>1.7</td><td>2.2</td><td>1.9</td><td>1.2</td></tr> <tr><td>2</td><td>0.8</td><td>1.5</td><td>2.1</td><td>0.9</td></tr> <tr><td>3</td><td>1</td><td>1.4</td><td>1</td><td>1.3</td></tr> <tr><td>4</td><td>0.4</td><td>0.6</td><td>0.7</td><td>0.2</td></tr> <tr><td>5</td><td>1.4</td><td>2.3</td><td>2.8</td><td>2.7</td></tr> <tr><td>6</td><td>1.8</td><td>2</td><td>1.1</td><td>0.1</td></tr> <tr><td>7</td><td>1.6</td><td>1.</td><td>1.5</td><td>2</td></tr> <tr><td>8</td><td>2.5</td><td>1.6</td><td>1.8</td><td>1.2</td></tr> <tr><td>9</td><td>2.9</td><td>2</td><td>0.5</td><td>2.2</td></tr> </tbody> </table> <p>Comment on State of Control.</p>	Sample No.	Observation				1	1.7	2.2	1.9	1.2	2	0.8	1.5	2.1	0.9	3	1	1.4	1	1.3	4	0.4	0.6	0.7	0.2	5	1.4	2.3	2.8	2.7	6	1.8	2	1.1	0.1	7	1.6	1.	1.5	2	8	2.5	1.6	1.8	1.2	9	2.9	2	0.5	2.2	BTL -4	Analyzing	CO5																
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16.	<p>Construct a Control Chart for fraction defectives ( p-Chart) for following data.</p> <table border="1" data-bbox="140 1339 1018 1460"> <tr> <td>Sample No.</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td></tr> <tr> <td>Sample Size</td><td>90</td><td>65</td><td>85</td><td>70</td><td>80</td><td>80</td><td>70</td><td>95</td><td>90</td><td>75</td></tr> <tr> <td>No of defectives</td><td>9</td><td>7</td><td>3</td><td>2</td><td>9</td><td>5</td><td>3</td><td>9</td><td>6</td><td>7</td></tr> </table>	Sample No.	1	2	3	4	5	6	7	8	9	10	Sample Size	90	65	85	70	80	80	70	95	90	75	No of defectives	9	7	3	2	9	5	3	9	6	7	BTL -4	Analyzing	CO5																																	
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17.	<p>The following data gives the number of defectives in 10 samples each of size 100. Construct a np chart for these data and also determine whether the process is in control</p> <table border="1" data-bbox="140 1576 1056 1751"> <tr> <td>Sample No.</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td></tr> <tr> <td>No. of defectives</td><td>24</td><td>38</td><td>62</td><td>34</td><td>26</td><td>36</td><td>38</td><td>52</td><td>33</td><td>44</td></tr> </table>	Sample No.	1	2	3	4	5	6	7	8	9	10	No. of defectives	24	38	62	34	26	36	38	52	33	44	BTL -4	Analyzing	CO5																																												
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Comment on State of Control.									

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