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 – 2024 - 2025

Prepared by

Dr. G.SASIKALA, Assistant Professor / Mathematics

<table>
<tr><th>S.No</th><th>QUESTIONS</th><th>BT Level</th><th>Competence</th><th>COs</th></tr>
<tr><td colspan="5">UNIT I-RANDOM VARIABLES AND PROBABILITY DISTRIBUTIONS
Discrete and continuous random variables- Binomial, Poisson and Normal distributions</td></tr>
<tr><td colspan="4">Part - A (2 MARK QUESTIONS)</td><td></td></tr>
<tr><td>1.</td><td>Define Probability of an event.</td><td>BTL -1</td><td>Remembering</td><td>CO1</td></tr>
<tr><td>2.</td><td>State the Axioms of Probability.</td><td>BTL -1</td><td>Remembering</td><td>CO1</td></tr>
<tr><td>3.</td><td>State the addition theorem on probability.</td><td>BTL -2</td><td>Understanding</td><td>CO1</td></tr>
<tr><td>4.</td><td>Define independent events.</td><td>BTL -2</td><td>Understanding</td><td>CO1</td></tr>
<tr><td>5.</td><td>Define mutually exclusive events.</td><td>BTL -2</td><td>Understanding</td><td>CO1</td></tr>
<tr><td>6.</td><td>Define Conditional Probability.</td><td>BTL -2</td><td>Understanding</td><td>CO1</td></tr>
<tr><td>7.</td><td>State the theorem of total probability.</td><td>BTL -1</td><td>Remembering</td><td>CO1</td></tr>
<tr><td>8.</td><td>State Baye’s theorem.</td><td>BTL -2</td><td>Understanding</td><td>CO1</td></tr>
<tr><td>9.</td><td>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.</td><td>BTL -1</td><td>Remembering</td><td>CO1</td></tr>
<tr><td>10.</td><td>What is the Probability that a leap year selected at random will have 53 Sundays?</td><td>BTL -1</td><td>Remembering</td><td>CO1</td></tr>
<tr><td>11.</td><td>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</td><td>BTL -2</td><td>Understanding</td><td>CO1</td></tr>
<tr><td>12.</td><td>A and B are events with$\mathrm{P(A)} = \frac{5}{8}, \mathrm{P}(B) = \frac{1}{2}$ and $P(A \cap B) = \frac{1}{4}$. Find $P(\bar{A} \cap \bar{B})$</td><td>BTL -2</td><td>Understanding</td><td>CO1</td></tr>
<tr><td>13.</td><td>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>
<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></td><td>BTL -1</td><td>Remembering</td><td>CO1</td></tr>
<tr><td>14.</td><td>If $p(x) = kx^2, x = 0,1,2,3$, is to be a density function, find the value of k.</td><td>BTL -1</td><td>Remembering</td><td>CO1</td></tr>
<tr><td>15.</td><td>Write the probability function of Binomial Distribution.</td><td>BTL -2</td><td>Understanding</td><td>CO1</td></tr>
<tr><td>16.</td><td>The mean of Binomial distribution is 36 and standard deviation is 6. Find the parameters of the distribution.</td><td>BTL -1</td><td>Remembering</td><td>CO1</td></tr>
<tr><td>17.</td><td>For a Binomial distribution the mean is 6 and standard deviation is $\sqrt{2}$. Find parameters of the distribution</td><td>BTL -1</td><td>Remembering</td><td>CO1</td></tr>
<tr><td>18.</td><td>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.</td><td>BTL -2</td><td>Understanding</td><td>CO1</td></tr>
<tr><td>19.</td><td>If the mean and variance of a binomial distribution are respectively 6 and 2.4, find P(x=2).</td><td>BTL -2</td><td>Understanding</td><td>CO1</td></tr>
<tr><td>20.</td><td>Write the probability function of Poisson Distribution.</td><td>BTL -2</td><td>Understanding</td><td>CO1</td></tr>
<tr><td>21.</td><td>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?</td><td>BTL -2</td><td>Understanding</td><td>CO1</td></tr>
<tr><td>22.</td><td>If X is a Poisson distribution such that P(x = 1) = 4 P(x = 2).</td><td>BTL -1</td><td>Remembering</td><td>CO1</td></tr>
</table>

<table>
<tr><td></td><td>Find its mean and variance.</td><td></td><td></td><td></td></tr>
<tr><td>23.</td><td>Suppose that X has a Poisson distribution with parameter $\lambda = 2$. Compute $P[X \geq 1]$.</td><td>BTL -1</td><td>Remembering</td><td>CO1</td></tr>
<tr><td>24.</td><td>Define Normal distribution.</td><td>BTL -2</td><td>Understanding</td><td>CO1</td></tr>
<tr><td>25.</td><td>State any two properties of normal distribution.</td><td>BTL -2</td><td>Understanding</td><td>CO1</td></tr>
<tr><td colspan="4">PART – B (16 MARK QUESTIONS)</td><td></td></tr>
<tr><td>1.</td><td>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</td><td>BTL -2</td><td>Understanding</td><td>CO1</td></tr>
<tr><td>2.</td><td>The probability mass function of a discrete R. V X is given in the following table
<table>
<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</td><td>BTL -2</td><td>Understanding</td><td>CO1</td></tr>
<tr><td>3.</td><td>f(x) = $\begin{cases} ax, & 0 \leq x \leq 1 \\ a, & 1 \leq x \leq 2 \\ 3a - ax, & 2 \leq x \leq 3 \\ 0, & elsewhere \end{cases}$ 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</td><td>BTL -3</td><td>Applying</td><td>CO1</td></tr>
<tr><td>4.(a)</td><td>If the discrete random variable X has the probability function given by the table.
<table>
<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.</td><td>BTL -3</td><td>Applying</td><td>CO1</td></tr>
<tr><td>4.(b)</td><td>Find the MGF of Binomial distribution and hence find its mean and variance</td><td>BTL -3</td><td>Applying</td><td>CO1</td></tr>
<tr><td>5.</td><td>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</td><td>BTL -3</td><td>Applying</td><td>CO1</td></tr>
<tr><td>6.(a)</td><td>A random variable X has the following probability distribution:
<table>
<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>2 k</td><td>2 k</td><td>3 k</td><td>k^2</td><td>$2k^2$</td><td>$7k^2$+k</td></tr>
</table>
Find (i) the value of k
(ii) $P(1.5 < X < 4.5 / X > 2)$</td><td>BTL -3</td><td>Applying</td><td>CO1</td></tr>
<tr><td>6.(b)</td><td>Derive the MGF of Poisson distribution and hence find its mean and variance</td><td>BTL -3</td><td>Applying</td><td>CO1</td></tr>
<tr><td>7.</td><td>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.</td><td>BTL -4</td><td>Analyzing</td><td>CO1</td></tr>
<tr><td>8.(a)</td><td>The probability mass function of a discrete R. V X is given in the</td><td>BTL -4</td><td>Analyzing</td><td>CO1</td></tr>
</table>

<table>
<tr><td></td><td>following table:
<table><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>Find (1) Find the value of k, (2) P(X<1),
(3) $P(-1< X \le 2)$, (4) E(X)</td><td></td><td></td><td></td></tr>
<tr><td>8.(b)</td><td>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.</td><td>BTL -4</td><td>Analyzing</td><td>CO1</td></tr>
<tr><td>9.</td><td>A random variable X has cdf $F(x) = \begin{cases} 0, \text{if } x < -1 \\ a(1+x), \text{if } -1 < x < 1 \\ 1, \text{if } x \ge 1 \end{cases}$.
(1) Find the value of a (2) $P(X > 1/4)$ and $P(-0.5 \le X \le 0)$.</td><td>BTL -4</td><td>Analyzing</td><td>CO1</td></tr>
<tr><td>10(a)</td><td>Let X be a continuous R.V with probability density function
$f(x) = \begin{cases} xe^{-x}, & x > 0 \\ 0, & otherwise \end{cases}$,
Find (1) The cumulative distribution of X, (2)Moment Generating Function $M_x(t)$ of X, (3) P(X<2) and (4) E(X)</td><td>BTL -3</td><td>Applying</td><td>CO1</td></tr>
<tr><td>10(b)</td><td>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.</td><td>BTL -3</td><td>Applying</td><td>CO1</td></tr>
<tr><td>11.</td><td>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.</td><td>BTL -4</td><td>Analyzing</td><td>CO1</td></tr>
<tr><td>12(a)</td><td>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.</td><td>BTL -3</td><td>Applying</td><td>CO1</td></tr>
<tr><td>12(b)</td><td>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.</td><td>BTL -3</td><td>Applying</td><td>CO1</td></tr>
<tr><td>13.</td><td>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.</td><td>BTL -4</td><td>Analyzing</td><td>CO1</td></tr>
<tr><td>14</td><td>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
(i) For less than 6 minutes
(ii) For more than 3.5 minutes and
(iii) Between 3.4 and 6.2 minutes.</td><td>BTL -3</td><td>Applying</td><td>CO1</td></tr>
<tr><td>15.</td><td>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</td><td>BTL -4</td><td>Analyzing</td><td>CO1</td></tr>
</table>

<table>
<tr><td></td><td>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.</td><td></td><td></td><td></td></tr>
<tr><td>16.</td><td>Derive MGF, Mean, Variance of Normal distribution.</td><td>BTL -3</td><td>Applying</td><td>CO1</td></tr>
<tr><td>17.</td><td>If X follows a normal distribution with mean 12 and variance 16 cm, find the probabilities for (i)$P(X \le 20)$(ii) $P(X \ge 20)$, and
(iii) $P(0 \le X \le 12)$</td><td>BTL -4</td><td>Analyzing</td><td>CO1</td></tr>
<tr><td>18.</td><td>X is a normal variable with mean 30 and standard deviation of 5. Find (i) $P[26 \le X \le 40]$ (ii) $P [X \ge 45]$ (iii) $P[X < 30]$</td><td>BTL -3</td><td>Applying</td><td>CO1</td></tr>
<tr><td colspan="5">UNIT II- TWO - DIMENSIONAL RANDOM VARIABLES
Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression</td></tr>
<tr><td colspan="4">PART-A(2 MARK QUESTIONS)</td><td></td></tr>
<tr><td>1.</td><td>Define the conditional distribution function of two dimensional discrete and continuous random variables .</td><td>BTL -1</td><td>Remembering</td><td>CO2</td></tr>
<tr><td>2.</td><td>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 .</td><td>BTL -2</td><td>Understanding</td><td>CO2</td></tr>
<tr><td>3.</td><td>Find the probability distribution of X + Y from the bivariate distribution of (X,Y) given below:
<table>
<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></td><td>BTL -2</td><td>Understanding</td><td>CO2</td></tr>
<tr><td>4.</td><td>The joint probability function (X,Y) is given by
$P(x,y) = k\ (2x + 3y)$,
$x = 0,1,2 \ \ y = 1,2,3$, Find the value of K.</td><td>BTL -2</td><td>Understanding</td><td>CO2</td></tr>
<tr><td>5.</td><td>Let X and Y have the joint p.m.f
<table>
<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)</td><td>BTL -2</td><td>Understanding</td><td>CO2</td></tr>
<tr><td>6</td><td>If the joint pdf of (X, Y) is $f(x,y) = \begin{cases} \frac{1}{4}, 0 < x,y < 2 \\ 0, \ otherwise \end{cases}$. Find $P(X + Y \le 1)$</td><td>BTL -2</td><td>Understanding</td><td>CO2</td></tr>
<tr><td>7.</td><td>Let X and Y be random variables with joint density function
f(x,y) = $\begin{cases} 4xy \ , \ 0 < x < 1 \ , \ 0 < y < 1 \\ 0, \ otherwise \end{cases}$ formulate the value of E(XY)</td><td>BTL -2</td><td>Understanding</td><td>CO2</td></tr>
<tr><td>8</td><td>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.</td><td>BTL -2</td><td>Understanding</td><td>CO2</td></tr>
<tr><td>9.</td><td>If the joint probability density function of a random variable X and Y is given by $f(x,y) = \begin{cases} \frac{x^3y^3}{16}, 0 < x < 2, 0 < y < 2 \\ 0, \quad otherwise \end{cases}$. Find the marginal functions of X and Y.</td><td>BTL -2</td><td>Understanding</td><td>CO2</td></tr>
<tr><td>10</td><td>If X and Y have joint pdf f(x,y) = $\begin{cases} x + y \ , \ 0 < x < 1, \ 0 < y < 1 \\ 0, \ otherwise \end{cases}$
Discuss whether X and Y are independent.</td><td>BTL -2</td><td>Understanding</td><td>CO2</td></tr>
</table>

11.	The joint probability density of a two dimensional random variable (X,Y) is given by $f(x,y) = \begin{cases} kxe^{-y}; 0 \le x < 2, y > 0 \\ 0, \quad otherwise \end{cases}$. Evaluate k.	BTL -2	Understanding	CO2
12.	The joint probability density function of a random varaiable (X,Y) is $f(x,y) = k\,e^{-(2x+3y)}, x \ge 0, y \ge 0$. 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 $\bar{X} = 970$, $\bar{Y} = 18, \sigma_x = 38$, σ_y= 2 and r =0.6 , Find the line of regression and obtain the value of X and Y = 20.	BTL -4	Understanding	CO2
16.	In a partially destroyed laboratory, record of an analysis of correlation data, the following results only are legible; Varaince 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.	If f(x,y)=$\begin{cases} kx^2y, 0 < x < 3, 0 < y < 5 \\ 0 \quad otherwise \end{cases}$ is a pdf of X and Y.Find the value of k.	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)=$\begin{cases} 8xy, 0 < x < y < 1 \\ 0 \quad otherwise \end{cases}$ 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.	Define Conditional probability distribution function of Y given X=x	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.	If the joint pdf of (X, Y) is given by $P(x,y) = K(2x+3y), x = 0,1,2$ & $y = 1,2,3$. Find all the marginal probability distribution. Also find the probability distribution of X+Y.	BTL -2	Understanding	CO2
2.	The joint pdf of X and Y is given by f(x,y)=$\begin{cases} kx(x-y), 0 < x < 2, -x < y < x \\ 0, \quad otherwise \end{cases}$ (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.	The joint pdf of a two dimensional random variable (X, Y) is given by $f(x,y) = xy^2 + \frac{x^2}{8}, 0 \le x \le 2, 0 \le y \le 1.$ Compute (i) $P\left(X > 1 / Y < \frac{1}{2}\right)$ (ii)$P\left(Y < \frac{1}{2} / X > 1\right)$ (iii) $P(X+Y) \le 1.$	BTL -3	Applying	CO2

<table>
<tr><td>4.(a)</td><td>The joint distribution of X and Y is given by $f(x,y) = \frac{x+y}{21}$, $x = 1,2,3; y = 1,2$. Find the marginal distributions of X and Y.</td><td>BTL -4</td><td>Analyzing</td><td>CO2</td></tr>
<tr><td>4.(b)</td><td>The joint pdf a bivariate R.V(X, Y) is given by
$f(x,y) = \begin{cases} Kxy \ ; & 0 < x < 1, 0 < y < 1 \\ 0 & , otherwise \end{cases}$
Find (1) K. (2) Find P(X+Y<1). (3)Are X and Y independent R.V's.</td><td>BTL -4</td><td>Analyzing</td><td>CO2</td></tr>
<tr><td>5.(a)</td><td>The two dimensional random variable (X, Y) has the joint probability mass function $f(x,y) = \frac{x+2y}{27}, x = 0,1,2;$ $y = 0,1,2$. Find the conditional distribution of Y given X = 1 also find the conditional distribution of X given Y = 1.</td><td>BTL -3</td><td>Applying</td><td>CO2</td></tr>
<tr><td>5.(b)</td><td>Find $P(X < Y/X < 2Y)$ if the joint pdf of (X,Y) is
$f(x,y) = e^{-(x+y)}, 0 \le x < \infty, \ \ 0 \le y < \infty.$</td><td>BTL -3</td><td>Applying</td><td>CO2</td></tr>
<tr><td>6.</td><td>From the following table for bivariate distribution of (X, Y). Find
(i) $P(X \le 1)$ (ii) $P(Y \le 3)$ (iii) $P(X \le 1, Y \le 3)$
(ii) (iv) $P(X \le 1/ Y \le 3)$ (v) $P(Y \le 3/ X \le 1)$
(iii) (vi) $P(X + Y \le 4)$
<table>
<tr><td>Y / X</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>$\frac{1}{32}$</td><td>$\frac{2}{32}$</td><td>$\frac{2}{32}$</td><td>$\frac{3}{32}$</td></tr>
<tr><td>1</td><td>$\frac{1}{16}$</td><td>$\frac{1}{16}$</td><td>$\frac{1}{8}$</td><td>$\frac{1}{8}$</td><td>$\frac{1}{8}$</td><td>$\frac{1}{8}$</td></tr>
<tr><td>2</td><td>$\frac{1}{32}$</td><td>$\frac{1}{32}$</td><td>$\frac{1}{64}$</td><td>$\frac{1}{64}$</td><td>0</td><td>$\frac{2}{64}$</td></tr>
</table></td><td>BTL -3</td><td>Applying</td><td>CO2</td></tr>
<tr><td>7.</td><td>If the joint pdf of a two-dimensional RV(X,Y) is given by
$f(x,y) = \begin{cases} x^2 + \frac{xy}{3}; 0 < x < 1, 0 < y < 2 \\ \quad 0, \ elsewhere \end{cases}$.
Find (i) $P\left(X > \frac{1}{2}\right)$
(ii) $P(Y < X)$and (iii) $P\left(Y < \frac{1}{2} / X < \frac{1}{2}\right)$</td><td>BTL -3</td><td>Applying</td><td>CO2</td></tr>
<tr><td>8.</td><td>If f(x,y) = $\frac{6-x-y}{8}$, $0 \le x \le 2$, , $2 \le y \le 4$ for a bivariate random variable (X,Y), Find the correlation coefficient ρ.</td><td>BTL -4</td><td>Analyzing</td><td>CO2</td></tr>
<tr><td>9.</td><td>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
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</td><td>BTL -4</td><td>Analyzing</td><td>CO2</td></tr>
<tr><td>10.</td><td>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
<table>
<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></td><td>BTL -3</td><td>Applying</td><td>CO2</td></tr>
<tr><td>11.</td><td>Two random variables X and Y have the following joint probability</td><td>BTL -4</td><td>Analyzing</td><td>CO2</td></tr>
</table>

<table>
<tr><td></td><td>density function $f(x,y) = \begin{cases} x+y; 0 \le x \le 1, 0 \le y \le 1 \\ 0,\ otherwise \end{cases}$. Find the probability density function of the random variable U = XY.</td><td></td><td></td><td></td></tr>
<tr><td>12.</td><td>Two random variables X and Y have the joint density
$f(x,y) = \begin{cases} 2-x-y, 0 < x < 1, 0 < y < 1 \\ 0,\ otherwise \end{cases}$
Show that the Correlation coefficient between X and Y is -1 /11.</td><td>BTL -3</td><td>Applying</td><td>CO2</td></tr>
<tr><td>13.</td><td>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 $(i)\ P\ (x < 1, y < 3)$
$ii)\ P\ (x < 1 / y < 3)$ $iii) P(y < 3/x < 1)$
$iv)\ P(X+Y < 3)$</td><td>BTL -3</td><td>Applying</td><td>CO2</td></tr>
<tr><td>14.</td><td>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.</td><td>BTL -3</td><td>Applying</td><td>CO2</td></tr>
<tr><td>15.</td><td>The joint probability mass function of X and Y is given below
<table><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</td><td>BTL -4</td><td>Analyzing</td><td>CO2</td></tr>
<tr><td>16.</td><td>The joint probability distribution of the random variables X and Y is given below
<table><tr><td>X \ Y</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr><tr><td>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) $P(X \le 1)$(iii)$(X \le 1/Y = 2)$(iv) $P(X < 3/ Y \le 4)$</td><td>BTL -2</td><td>Understanding</td><td>CO2</td></tr>
<tr><td>17.</td><td>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 σ_y if σ_x=2 and σ_x if σ_y=3.</td><td>BTL -4</td><td>Analyzing</td><td>CO2</td></tr>
<tr><td>18.</td><td>Find the correlation coefficient for the following data
<table><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></td><td>BTL -3</td><td>Applying</td><td>CO2</td></tr>
<tr><td colspan="5">UNIT III - ESTIMATION THEORY
Unbiased estimators- Efficiency-Consistency-Sufficiency-Robustness-method of moments-method of maximum likelihood estimator</td></tr>
<tr><td colspan="4">PART-A(2 Mark Questions)</td><td></td></tr>
<tr><td>1.</td><td>Define estimator, estimate and estimation.</td><td>BTL -1</td><td>Remembering</td><td>CO3</td></tr>
<tr><td>2.</td><td>Distinguish between point estimation and interval estimation.</td><td>BTL -1</td><td>Remembering</td><td>CO3</td></tr>
<tr><td>3.</td><td>Mention the properties of a good estimator.</td><td>BTL -1</td><td>Remembering</td><td>CO3</td></tr>
<tr><td>4.</td><td>Define confidence coefficient.</td><td>BTL -2</td><td>Understanding</td><td>CO3</td></tr>
<tr><td>5.</td><td>What is the level of significance in testing of hypothesis?</td><td>BTL -1</td><td>Remembering</td><td>CO3</td></tr>
<tr><td>6</td><td>Define confidence limits for a parameter.</td><td>BTL -2</td><td>Understanding</td><td>CO3</td></tr>
<tr><td>7.</td><td>State the conditions under which a binomial distribution becomes a normal distribution.</td><td>BTL -2</td><td>Understanding</td><td>CO3</td></tr>
</table>

8	Explain how do you calculate 95% confidence interval for the average of the population?	BTL -1	Remembering	CO3
9.	Write the normal equations for fitting a straight line by the method of least squares.	BTL -1	Remembering	CO3
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 are the merits and demerits of the least square method.	BTL -1	Remembering	CO3
16.	What is a sufficient statistic in estimation theory?	BTL -1	Remembering	CO3
17.	State the Neyman-Fisher Factorization Theorem and its significance in identifying sufficient statistics.	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 – 0.5 y 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 is the definition of an efficient estimator in estimation theory?	BTL -2	Understanding	CO3
24.	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
25.	What is meant by maximum likelihood estimator ?	BTL -2	Understanding	CO3
	PART-B (16 Marks Questions)			
1.	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 -3	Applying	CO3
2.	Obtain the lines of regression X: 50, 55, 50, 60, 65, 65, 65, 60, 60 Y: 11, 14, 13, 16, 16, 15, 15, 14, 13	BTL -3	Applying	CO3
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. x: 1993, 1994, 1995, 1996 y: 100, 107, 128, 140	BTL -3	Applying	CO3
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	BTL -3	Applying	CO3

<table>
<tr><td></td><td>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.</td><td></td><td></td><td></td></tr>
<tr><td>5.</td><td>Find the maximum likelihood estimate for the parameter λ of a poisson distribution on the basis of a sample of size n. Also find its variance. Show that the sample mean x is sufficient for estimating the parameter λ of the poisson distribution.</td><td>BTL -3</td><td>Applying</td><td>CO3</td></tr>
<tr><td>6.</td><td>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</td><td>BTL -2</td><td>Understanding</td><td>CO3</td></tr>
<tr><td>7.(a)</td><td>A random sample (X_1,X_2,X_3,X_4,X_5) of size 5 is drawn from a population with unknown mean μ.
Consider the following estimators to estimate μ.
$t_1 = \frac{(x_1+x_2+x_3+x_4+x_5)}{5}$, $t_2 = \frac{(x_1+x_2)}{2} + X_3$ and $t_3 = \frac{(2x_1+x_2+\lambda x_3)}{3}$ Where λ is such that t_3 is an unbiased estimator of μ. Find λ. Are t_1 and t_2 unbiased ? State giving reason, the estimator which is best among t_1, t_2, and t_3.</td><td>BTL -4</td><td>Analyzing</td><td>CO3</td></tr>
<tr><td>7.(b)</td><td>Let $X_1,X_2,\ldots X_n$ be a random sample of size n from a normal distribution with known variance. Obtain the maximum likelihood estimator of μ.</td><td>BTL -4</td><td>Analyzing</td><td>CO3</td></tr>
<tr><td>8.</td><td>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.</td><td>BTL -4</td><td>Analyzing</td><td>CO3</td></tr>
<tr><td>9.</td><td>Fit an equation of the form $y = ab^x$ to the following data
<table><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></td><td>BTL -4</td><td>Analyzing</td><td>CO3</td></tr>
<tr><td>10.</td><td>Obtain the equation of regression lines y = ax + b from the following data, using the method of least squares.
<table><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></td><td>BTL -4</td><td>Analyzing</td><td>CO3</td></tr>
<tr><td>11.(a)</td><td>Fit a straight line y = ax +c to the following data.
<table><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></td><td>BTL -4</td><td>Analyzing</td><td>CO3</td></tr>
<tr><td>11.(b)</td><td>Find the regression line of Y on X for the data
<table><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></td><td>BTL -4</td><td>Analyzing</td><td>CO3</td></tr>
</table>

<table>
<tr><td>12.</td><td>Prove that the ML estimator of the parameter α of the population having pdf f(x,α) = $2/\alpha^2 (\alpha - x)$. $0 < x < \alpha$ for the sample of unit size is 2x, x being the sample value. Show also that the estimator is not unbiased.</td><td>BTL-4</td><td>Analyzing</td><td>CO3</td></tr>
<tr><td>13.</td><td>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
<table>
<tr><td>X</td><td>71</td><td>68</td><td>73</td><td>69</td><td>67</td><td>65</td><td>66</td><td>67</td></tr>
<tr><td>y</td><td>69</td><td>72</td><td>70</td><td>70</td><td>68</td><td>67</td><td>68</td><td>64</td></tr>
</table></td><td>BTL -3</td><td>Applying</td><td>CO3</td></tr>
<tr><td>14.</td><td>Fit the model $y = ax^b$ to the following data.
<table>
<tr><td>X</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr>
<tr><td>y</td><td>2.98</td><td>4.26</td><td>5.21</td><td>6.10</td><td>6.80</td><td>7.50</td></tr>
</table></td><td>BTL-3</td><td>Applying</td><td>CO3</td></tr>
<tr><td>15.</td><td>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.</td><td>BTL-4</td><td>Analyzing</td><td>CO3</td></tr>
<tr><td>16.</td><td>Fit an equation of the form $y = ab^x$ to the following data
<table>
<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></td><td>BTL -3</td><td>Applying</td><td>CO3</td></tr>
<tr><td>17.</td><td>Obtain the equation of regression lines y = ax + b from the following data, using the method of least squares.
<table>
<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>52
6</td><td>42
1</td><td>58
1</td><td>630</td><td>412</td><td>560</td><td>43
4</td><td>443</td><td>59
0</td><td>57
0</td><td>34
6</td><td>67
2</td></tr>
</table></td><td>BTL-4</td><td>Analyzing</td><td>CO3</td></tr>
<tr><td>18.</td><td>Let $X_1, X_2 \ldots X_n$ be a random sample size n from the Poisson distribution $f(x/\lambda) = \frac{\lambda^x e^{-\lambda}}{x!}$ *where* $0 \le \lambda \le \infty$. Obtain the maximum likelihood estimator of λ</td><td>BTL -3</td><td>Applying</td><td>CO3</td></tr>
</table>

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 Non parametric 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
19.	Write the formula of test statistics for Kolmogorov-Smirnov Test	BTL -2	Understanding	CO4
20.	Define the statistic used in U test and give its mean.	BTL -1	Remembering	CO4
21.	Write a short note of Krushkal Wallis test.	BTL -2	Understanding	CO4
22.	Write a note on non parametric test.	BTL -2	Understanding	CO4
23.	Write the formula of test statistics for Krushkal Wallis test	BTL -1	Remembering	CO4
24.	When is Mann- Whiteney U test used?	BTL -2	Understanding	CO4
25.	Write the formula of test statistics for Mann- Whiteney U test	BTL -2	Understanding	CO4

<table>
<tr><td colspan="5">PART-B (16 Mark Questions)</td></tr>
<tr><td>1.</td><td>
<table>
<tr><td>Sand I</td><td>63</td><td>17</td><td>35</td><td>49</td><td>18</td><td>43</td><td>12</td><td>20</td><td>47</td></tr>
<tr><td>“</td><td>136</td><td>51</td><td>45</td><td>84</td><td>32</td><td>40</td><td>44</td><td>25</td><td></td></tr>
<tr><td>Sand II</td><td>113</td><td>54</td><td>96</td><td>26</td><td>39</td><td>88</td><td>92</td><td>53</td><td>101</td></tr>
<tr><td>“</td><td>48</td><td>89</td><td>107</td><td>111</td><td>58</td><td>62</td><td></td><td></td><td></td></tr>
</table>
In a study of sedimentary rocks, the following data were obtained from samples of 32 grains from two kinds of sand. Apply Mann-Whitney U test with suitable null and alternative hypotheses.</td><td>BTL -3</td><td>Applying</td><td>CO4</td></tr>
<tr><td>2.</td><td>In 30 tosses of a coin, the following sequence of head and tails is obtained HTTHTHHHTHHTTHTHTHHTHTTHTHHTHT
(i) Determine the number of runs
(ii) Test at 0.10 level of significance, whether the sequence is random</td><td>BTL -4</td><td>Analyzing</td><td>CO4</td></tr>
<tr><td>3.</td><td>On tossing a coin 15 times the following sequence of heads H and tails T was obtained TTHHHTHTHHHTTHH. Test whether the coin is unbiased by the run test.</td><td>BTL -3</td><td>Applying</td><td>CO4</td></tr>
<tr><td>4.</td><td>25 individual were sample as two whether they liked or did not like a product . The resulting sample is obtained below LLNNNNLLLNLNNLNNNNNNLLLLNN. (i) Determine the number of runs (ii) Test at the 0.05 level of significance, whether the responses are random.</td><td>BTL -3</td><td>Applying</td><td>CO4</td></tr>
<tr><td>5.</td><td>The following is an arrangement of 25 mena dn 15 women lined up up to purchase tickets for a premier picture show. Test the randomness of the arrangement for the following data.
MWWMMMWMMWMWMWWWMMMWMMWWWMMMMMM WWWMMMMMM.</td><td>BTL -3</td><td>Applying</td><td>CO4</td></tr>
<tr><td>6.</td><td>The following are the prices in Rs. per kg of a commodity from 2 random samples of shops from 2 cities A&B.
<table>
<tr><td>City A</td><td>2.7</td><td>3.8</td><td>4.3</td><td>3.2</td><td>4.7</td><td>3.6</td><td>3.8</td><td>4.1</td><td></td></tr>
<tr><td></td><td>2.7</td><td>2.8</td><td>3.2</td><td>3.4</td><td>3.8</td><td>4.4</td><td>4.9</td><td>3.9</td><td>4.7</td></tr>
<tr><td>City B</td><td>3.7</td><td>5.3</td><td>4.7</td><td>3.6</td><td>4.7</td><td>4.8</td><td>6.0</td><td>4.8</td><td>4.9</td></tr>
<tr><td></td><td>3.8</td><td>3.9</td><td>4.8</td><td>5.2</td><td>6.1</td><td>3.6</td><td>3.8</td><td></td><td></td></tr>
</table></td><td>BTL -3</td><td>Applying</td><td>CO4</td></tr>
</table>

<table>
<tr><td></td><td>Apply the run test to examine whether the distribution of prices of commodity in the two cities is the same.</td><td></td><td></td><td></td></tr>
<tr><td>7.</td><td>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:
<table>
<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></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></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></tr>
</table>
Use the Kruskal-Wallis test at the 5% level of significance to test the null hypothesis that the three samples come from identical populations.</td><td>BTL -3</td><td>Applying</td><td>CO4</td></tr>
<tr><td>8.</td><td>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.
<table>
<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>
</table></td><td>BTL -3</td><td>Applying</td><td>CO4</td></tr>
<tr><td>9.</td><td>Apply the K-S test to check that the observed frequencies match with the expected frequencies which are obtained from Normal distribution. (Given at n=5, $D_n = 0.510$ at 10% LOS).
<table>
<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>
</table></td><td>BTL -3</td><td>Applying</td><td>CO4</td></tr>
<tr><td>10.</td><td>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.</td><td>BTL -4</td><td>Analyzing</td><td>CO4</td></tr>
<tr><td>11.</td><td>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.</td><td>BTL -3</td><td>Applying</td><td>CO4</td></tr>
<tr><td>12.</td><td>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</td><td>BTL -4</td><td>Analyzing</td><td>CO4</td></tr>
<tr><td>13.</td><td>The scores of a written examination of 24 students, who were trained by using three different methods, are given below.
<table>
<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>
</table>
Use Krushkal-Wallis test at α = 5% level of significance, whether the three methods of training yield the same results.</td><td>BTL -4</td><td>Analyzing</td><td>CO4</td></tr>
<tr><td>14.</td><td>Apply the K-S test to check that the observed frequencies match with the expected frequencieswhich are obtained from Normal distribution. (Given at n=7, $D_n = 0.486$ at 5% LOS).
<table>
<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</td><td>9</td><td>22</td><td>25</td><td>30</td><td>21</td><td>12</td><td>6</td></tr>
</table></td><td>BTL -3</td><td>Applying</td><td>CO4</td></tr>
</table>

	<table><tr><td>Frequency</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Expected Frequency</td><td>6</td><td>17</td><td>32</td><td>35</td><td>18</td><td>13</td><td>4</td></tr></table>			
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. <table><tr><td>Operator I</td><td>29</td><td>34</td><td>34</td><td>20</td><td>32</td><td>45</td><td>42</td><td>24</td><td>35</td></tr><tr><td>Operator II</td><td>30</td><td>21</td><td>23</td><td>25</td><td>44</td><td>37</td><td>34</td><td>19</td><td>38</td></tr><tr><td>Operator III</td><td>26</td><td>36</td><td>41</td><td>48</td><td>27</td><td>39</td><td>28</td><td>46</td><td>15</td></tr></table>	BTL -3	Applying	CO4
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? <table><tr><td>DSF Mall</td><td>99</td><td>64</td><td>101</td><td>85</td><td>79</td><td>88</td><td>97</td><td>95</td><td>90</td><td>100</td></tr><tr><td>Forest Mall</td><td>83</td><td>102</td><td>125</td><td>61</td><td>91</td><td>96</td><td>94</td><td>89</td><td>98</td><td>75</td></tr><tr><td>Big-Ben Mall</td><td>89</td><td>98</td><td>56</td><td>105</td><td>87</td><td>90</td><td>87</td><td>101</td><td>76</td><td>89</td></tr></table>	BTL -3	Applying	CO4
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.	What is Statistical quality control?	BTL-2	Understanding	CO5
2.	Write down advantage of SQC.	BTL-1	Remembering	CO5
3.	What is meant by chance variation?	BTL-2	Understanding	CO5
4.	What is meant by Assignable variation?	BTL-2	Understanding	CO5
5.	Name the types of Control Chart.	BTL-2	Remembering	CO5
6	Define product control	BTL-1	Remembering	CO5
7.	Define process control	BTL-2	Remembering	CO5
8	What is control Chart?	BTL-2	Remembering	CO5
9.	Write down uses of Mean Chart.	BTL-2	Understanding	CO5
10	Write down types of Acceptance sampling plan	BTL-1	Understanding	CO5
11.	Define OC Curve	BTL-2	Applying	CO5
12.	Write down types of Causes variation.	BTL-2	Understanding	CO5
13.	Write the formula for np chart.	BTL-2	Understanding	CO5
14.	What is meant by AQL and LTPD	BTL-1	Understanding	CO5
15.	What is the formula for c chart and p chart	BTL-2	Remembering	CO5
16.	Define Acceptance Sampling.	BTL-2	Evaluating	CO5
17.	Explain producers Risk and Consumer Risk.	BTL-2	Applying	CO5
18.	Define Tolerance limits.	BTL-1	Creating	CO5
19.	Define one-sided Tolerance limits.	BTL-2	Remembering	CO5
20.	Define Two-Sided Tolerance limits.	BTL-2	Understanding	CO5
21.	What is the purpose of an R chart in Statistical Quality Control?	BTL-2	Understanding	CO5

<table>
<tr><td>22.</td><td>How are control limits for an R chart determined?</td><td>BTL-2</td><td>Understanding</td><td>CO5</td></tr>
<tr><td>23.</td><td>What is an $\overline{X}$ chart used for in Statistical Quality Control?</td><td>BTL-1</td><td>Understanding</td><td>CO5</td></tr>
<tr><td>24.</td><td>Why are $\overline{X}$ chart and R charts often used together?</td><td>BTL-2</td><td>Understanding</td><td>CO5</td></tr>
<tr><td>25.</td><td>What are the main differences between an $\overline{X}$ chart and an R chart?</td><td>BTL-2</td><td>Understanding</td><td>CO5</td></tr>
<tr><td colspan="4">PART-B (16 Mark Questions)</td><td></td></tr>
<tr><td>1.</td><td>What do you understand by SQC. Discuss its utility
and limitations?</td><td>BTL -3</td><td>Applying</td><td>CO5</td></tr>
<tr><td>2.</td><td>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.
<table>
<tr><td>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></td><td>BTL -4</td><td>Analyzing</td><td>CO5</td></tr>
<tr><td>3.</td><td>You are given the value of sample means ($\overline{X}$) and Range for 10 samples of size 5 each. Draw mean chart and comment on the state of control of the process.
<table>
<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>($\overline{X}$)</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></td><td>BTL -3</td><td>Applying</td><td>CO5</td></tr>
<tr><td>4.(a)</td><td>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:
<table>
<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>($\overline{X}$)</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>
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 $n = 5$ are $A_2 = 0.58$ $D_3 = 0, D_4 = 2.115$)</td><td>BTL -3</td><td>Applying</td><td>CO5</td></tr>
<tr><td>4.(b)</td><td>Explain in detail the R-Chart clearly?</td><td>BTL -3</td><td>Applying</td><td>CO5</td></tr>
<tr><td>5.</td><td>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.</td><td>BTL -4</td><td>Analyzing</td><td>CO5</td></tr>
<tr><td>6.(a)</td><td>The following data show the values of sample mean $\overline{X}$ 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.
<table>
<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>($\overline{X}$)</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>
(Conversion factors for $n = 5$ are $A_2 = 0.577$ $D_3 = 0, D_4 = 2.115$)</td><td>BTL -3</td><td>Applying</td><td>CO5</td></tr>
</table>

<table>
<tr><td>6.(b)</td><td>Explain in detail the $\overline{X}$ Chart clearly?</td><td>BTL -3</td><td>Applying</td><td>CO5</td></tr>
<tr><td>7.</td><td>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.
<table>
<tr><td>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></td><td>BTL -4</td><td>Analyzing</td><td>CO5</td></tr>
<tr><td>8.</td><td>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 $\overline{X}$ and R comment.
<table>
<tr><th>Sample No.</th><th colspan="6">Life time (in hours)</th></tr>
<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>
</table>
(Given for n = 6, $A_2 = 0.483$ $D_3 = 0, D_4 = 2.004$)</td><td>BTL -3</td><td>Applying</td><td>CO5</td></tr>
<tr><td>9.</td><td>From the information given below construct an appropriate control chart
<table>
<tr><td>Sample No.(each of 100)</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></tr>
<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>
</table>
State your conclusions. Write all the steps in the construction of the above chart including formula for UCL and LCL.</td><td>BTL -4</td><td>Analyzing</td><td>CO5</td></tr>
<tr><td>10.</td><td>The following table gives the inspection data relating to 10 samples of 100 items each, concerning the production of bottle corks.
<table>
<tr><th>Sample Number</th><th>Size of Sample</th><th>Number of Defectives</th><th>Fraction Defective</th></tr>
<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>
</table>
Construct a p- chart.</td><td>BTL -4</td><td>Analyzing</td><td>CO5</td></tr>
<tr><td>11.</td><td>Construct $\overline{X}$ chart for following data
<table>
<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></tr>
<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>
</table></td><td>BTL -4</td><td>Analyzing</td><td>CO5</td></tr>
</table>

<table>
<tr><td></td><td>Also determine whether the process is in control.</td><td></td><td></td><td></td></tr>
<tr><td>12.</td><td>The following are the $\overline{X}$ and R values for 20 samples of readings. Draw $\overline{X}$ chart and R chart and write your conclusion.
<table>
<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>$\overline{X}$</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>$\overline{X}$</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>
(Given for $n = 5$ are $A_2 = 0.58$ $D_3 = 0, D_4 = 2.12$)</td><td>BTL -3</td><td>Applying</td><td>CO5</td></tr>
<tr><td>13.</td><td>An inspection of 10 samples of size 400 each from 10 lots reveled the following number of defective units17,15,14,26,9,4,19,12,9,6</td><td>BTL -4</td><td>Analyzing</td><td>CO5</td></tr>
<tr><td>14.</td><td>Explain Control Limits for the sample mean $\overline{X}$ and sample range R.</td><td>BTL -3</td><td>Applying</td><td>CO5</td></tr>
<tr><td>15.</td><td>Construct R chart for following data
<table>
<tr><td>Sample No.</td><td colspan="4">Observation</td></tr>
<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>
</table>
Comment on State of Control.</td><td>BTL -4</td><td>Analyzing</td><td>CO5</td></tr>
<tr><td>16.</td><td>Construct a Control Chart for fraction defectives (p-Chart) for following data.
<table>
<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></td><td>BTL -4</td><td>Analyzing</td><td>CO5</td></tr>
<tr><td>17.</td><td>The following data gives the number of defectives in 10 samples each of size 100.Constuct a np chart for these data and also determine whether the process is in control
<table>
<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></td><td>BTL -4</td><td>Analyzing</td><td>CO5</td></tr>
<tr><td>18.</td><td>A machine fills boxes with dry cereal. 15 samples of 4 boxes are drawn randomly. The weights of the sampled boxes are shown as follows. Draw the control charts for the sample mean and sample range and determine whether the process is in a state of control.
<table>
<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><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td></tr>
</table></td><td>BTL -3</td><td>Applying</td><td>CO5</td></tr>
</table>

		Weight of Boxes (X)	10	10.3	11.5	11	11.3	10.7	11.3	12.3	11	11.3	12.5	11.9	12.1	11.9	10.6			
			10.2	10.9	10.7	11.1	11.6	11.4	11.4	12.1	13.1	12.1	11.9	12.1	11.1	12.1	11.9			
			11.3	10.7	11.4	10.7	11.9	10.7	11.1	12.7	13.1	10.7	11.8	11.6	12.1	13.1	11.7			
			12.4	11.7	12.4	11.4	12.1	11	10.3	10.7	12.4	11.5	11.3	11.4	11.7	12	12.1			

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