# SRM VALLIAMMAI ENGINEERING COLLEGE

**(An Autonomous Institution)**

S.R.M. Nagar, Kattankulathur - 603203

# DEPARTMENT OF MATHEMATICS

**II YEAR / IV SEMESTER**
**B.E Agriculture Engineering**
**&**
**B.TECH-Information Technology**
**1918404 - PROBABILITY AND STATISTICS**
**Regulation – 2019**

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***Prepared by***

**Ms. A. Karpagam, AP(OG)**
**Ms. S. Ramya, AP(OG)**

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<table>
<tr><th>S.No</th><th>QUESTIONS</th><th>BT Level</th><th>Competence</th></tr>
<tr><td colspan="4">UNIT I RANDOM VARIABLES AND PROBABILITY DISTRIBUTIONS<br>Random Variables - Discrete and continuous random variables – Moments – Moment generating functions - Binomial, Poisson, Geometric, Uniform, Exponential and Normal distribution</td></tr>
<tr><td colspan="4">Part - A ( 2 MARK QUESTIONS)</td></tr>
<tr><td>1.</td><td>The number of hardware failures of a computer system in a week of operations has the following p.d.f, Find the mean of the number of failures in a week.
<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>.18</td><td>.28</td><td>.25</td><td>.18</td><td>.06</td><td>.04</td><td>.01</td></tr>
</table></td><td>BTL-2</td><td>Understanding</td></tr>
<tr><td>2.</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-2</td><td>Understanding</td></tr>
<tr><td>3.</td><td>Check whether the function given by $f(x) = \frac{x+2}{25}$ for x=1, 2,3,4,5 can serve as the probability distribution of a discrete random variable.</td><td>BTL-2</td><td>Understanding</td></tr>
<tr><td>4.</td><td>If the random variable X takes the values 1,2,3 and 4 such that $2P(X = 1) = 3P(X = 2) = P(X = 3) = 5P(X = 4)$ , find the probability distribution of X</td><td>BTL-1</td><td>Remembering</td></tr>
<tr><td>5.</td><td>The RV X has the following probability distribution:
<table>
<tr><td>x</td><td>-2</td><td>-1</td><td>0</td><td>1</td></tr>
<tr><td>P(x)</td><td>0.4</td><td>k</td><td>0.2</td><td>0.3</td></tr>
</table>
Find k and the mean value of X</td><td>BTL-2</td><td>Understanding</td></tr>
<tr><td>6.</td><td>If $f(x) = K\,(x + x^2)$ in $1 < x < 5$ is a pdf of a continuous random variables. Find the value of K.</td><td>BTL-1</td><td>Remembering</td></tr>
<tr><td>7.</td><td>The p.d.f of a continuous random variable X is $f(x) = k(1 + x), 2 < x < 5$.Find $k$.</td><td>BTL-1</td><td>Remembering</td></tr>
<tr><td>8.</td><td>For a continuous distribution $f(x) = k(x - x^2), 0 \le x \le 1$, where $k$ is a constant. Find$k$.</td><td>BTL-2</td><td>Understanding</td></tr>
<tr><td>9.</td><td>If $f(x) = kx^2, 0 < x < 3$, is to be a density function, find the value of $k$.</td><td>BTL-2</td><td>Understanding</td></tr>
<tr><td>10.</td><td>A test engineer discovered that the cumulative distribution function of the life time of an equipment ( in years)is given by $F(x) = 1 - e^{-\frac{x}{5}}$, $x \ge 0$. What is the expected lifetime of the equipment?</td><td>BTL-2</td><td>Understanding</td></tr>
<tr><td>11.</td><td>The mean of Binomial distribution is 20 and standard deviation is 4. Find the parameters of the distribution.</td><td>BTL3</td><td>Applying</td></tr>
<tr><td>12.</td><td>In 256 sets of 8 tosses of a coin, in how many sets one may expect heads and tails in equal number?</td><td>BTL4</td><td>Analyzing</td></tr>
<tr><td>13.</td><td>If 3% of the electric bulbs manufactured by a company are defective, Find the probability that in a sample of 100 bulbs exactly 5 bulbs are defective.</td><td>BTL4</td><td>Analyzing</td></tr>
</table>

| | | | |
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| 14. | 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? | BTL3 | Applying |
| 15. | The no. of monthly breakdowns of a computer is a RV having Poisson distribution with mean 1.8. Find the probability that this computer will function for a month with only one breakdown. | BTL4 | Analyzing |
| 16. | If X is a Poisson variate such that $2P(X=0)+P(X=2)=2P(X=1)$, find E(X) | BTL4 | Analyzing |
| 17. | The probability that a candidate can pass in an examination is 0.6. What is the probability that he will pass in third trial? | BTL4 | Analyzing |
| 18. | If X is a geometric variate , taking the values 1,2,3,…, find P(X is odd) | BTL3 | Applying |
| 19. | If the probability that an applicant for a driver's license will pass the road test on any given trial is 0.8, what is the probability that he will finally pass the test on the fourth trial | BTL4 | Analyzing |
| 20. | If X has uniform distribution in (-3,3), find $P(\|x-2\|<2)$ | BTL-2 | Understanding |
| 21. | If the MGF of a continuous RV is $\frac{1}{t}(e^{5t}-e^{4t})$ what is the distribution of X? What are the mean and variance of X? | BTL4 | Analyzing |
| 22. | Suppose that the life of industrial lamp (in thousands of hours) is exponentially distributed with mean life of 3000 hours, Evaluate the probability that the lamp will last between 2000 and 3000 hours. | BTL5 | Evaluating |
| 23. | A continuous RV X has the density function$ce^{-\frac{x}{5}}, x>0$. Find c. Create E(x) and Var(X) | BTL6 | Creating |
| 24. | If X is a normal random variable with mean 3 and variance 9, find the probability that X lies between 2 and 5. | BTL3 | Applying |
| 25. | A normal distribution has mean $\mu$ = 20 and standard deviation $\sigma$ = 10. Evaluate $(15 \le X \le 40)$. | BTL5 | Evaluating |
| | **PART – B (13 MARK QUESTIONS)** | | |
| 1.(a) | A random variable X has the following probability distribution:<br>X: 0 \| 1 \| 2 \| 3 \| 4 \| 5 \| 6 \| 7<br>P(X): 0 \| $k$ \| $2k$ \| $2k$ \| $3k$ \| $k^2$ \| $2k^2$ \| $7k^2$+k<br>Find (i) the value of $k$<br>(ii) $P(1.5 < X < 4.5 / X > 2)$ | BTL-2 | Understanding |
| 1.(b) | Find the MGF of Binomial distribution and hence find its mean and variance | BTL-1 | Remembering |
| 2.(a) | The probability mass function of a discrete R. V X is given in the following table:<br>X: -2 \| -1 \| 0 \| 1 \| 2 \| 3<br>P(X=x): 0.1 \| $K$ \| 0.2 \| $2k$ \| 0.3 \| $k$<br>Find (1) Find the value of *k,* (2) P(X<1),(3) P(-1< X ≤ 2) | BTL-2 | Understanding |
| 2.(b) | Obtain the MGF of Poisson distribution and hence find its mean and variance | BTL-1 | Remembering |
| 3.(a) | The probability mass function of a discrete R. V X is given in the following table<br>X: 0 \| 1 \| 2 \| 3 \| 4 \| 5 \| 6 \| 7 \| 8<br>P(X): a \| 3a \| 5a \| 7a \| 9a \| 11a \| 13a \| 15a \| 17a<br>Find (i) the value of a , (ii) $P(X<3)$, (iii) Mean of X, (iv) Variance of X. | BTL-2 | Understanding |

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| 3.(b) | Deduce the MGF of a geometric distribution and hence find the mean and variance | BTL-1 | Remembering |
| 4.(a) | If the discrete random variable X has the probability function given by the table.<br>$x$ \| 1 \| 2 \| 3 \| 4<br>$P(x)$ \| $k/3$ \| $k/6$ \| $k/3$ \| $k/6$<br>Find the value of k and Cumulative distribution of X. | BTL-2 | Understanding |
| 4.(b) | Derive the MGF of Uniform distribution and hence deduce the mean and variance | BTL-1 | Remembering |
| 5.(a) | 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)$P(\frac{1}{2} < X < \frac{5}{2}/X > 1)$ | BTL3 | Applying |
| 5.(b) | Deduce the MGF of Exponential distribution and hence find its mean and variance | BTL-1 | Remembering |
| 6.(a) | The probability distribution of an infinite discrete distribution is given by P[ X = j ] = $\frac{1}{2^j}$ ( j = 1,2,3…) Find (1)Mean of X, (2)P [X is even], (3) P(X is odd) (4) P(X is divisible by 3) | BTL-2 | Understanding |
| 6.(b) | State and prove the memory less property of exponential distribution | BTL3 | Applying |
| 7.(a) | Find the mean and variance of the following probability distribution<br>$X_i$ \| 1 \| 2 \| 3 \| 4 \| 5 \| 6 \| 7 \| 8<br>$P_i$ \| 0.08 \| 0.12 \| 0.19 \| 0.24 \| 0.16 \| 0.10 \| 0.07 \| 0.04 | BTL-2 | Understanding |
| 7.(b) | Assume that 50% of all engineering students are good in mathematics. Determine the probabilities that among 18 engineering students (i) exactly 10,(ii) at least 15 are good in mathematics. | BTL3 | Applying |
| 8. | Obtain the MGF of a normal distribution and hence find its mean and variance | BTL-1 | Remembering |
| 9.(a) | If a random variable X has p.d.f $f(x) = \begin{cases} \frac{1}{4}, & \lvert X \rvert < 2 \\ 0, & Otherwise \end{cases}$<br>Find (a) $P(X < 1)$ (b) $P(\lvert X \rvert > 1)$ (c) $P(2X + 3 > 5)$. | BTL-2 | Understanding |
| 9.(b) | 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. | BTL3 | Applying |
| 10.(a) | Find the MGF of the random variable X having the probability density function f(x) = $\begin{cases} \frac{x}{4}e^{-\frac{x}{2}}, & x > 0 \\ 0, & \text{otherwise} \end{cases}$. Also find the mean and variance | BTL-2 | Understanding |
| 10.(b) | 4 coins were tossed simultaneously. What is the probability of getting (i) 2 heads, (ii) at least 2 heads, (iii) at most 2 heads. | BTL4 | Analyzing |
| 11.(a) | A random variable X has c.d.f$F(x) = \begin{cases} 0, if x < -1 \\ a(1+x), if -1 < x < 1 \\ 1, if x \geq 1 \end{cases}$.<br>Find the value of a. Also P(X>1/4) and$P(-0.5 \leq X \leq 0)$. | BTL-2 | Understanding |
| 11.(b) | The atoms of a radioactive element are randomly disintegrating. If every gram of this element, on average, emits 3.9 alpha particles per second, then what is the probability that during the next second the number of alpha particles emitted from 1 gram is (1) at most 6 (2) at least 2 and (3) at least and at most5 | BTL4 | Analyzing |

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| 12. | If f(x) = $\begin{cases} ax, & 0 \le x \le 1 \\ a, & 1 \le x \le 2 \\ 3a - ax, & 2 \le x \le 3 \\ 0, & elsewhere \end{cases}$ is the p.d.f of X. Calculate<br>(i) The value of a ,<br>(ii) The cumulative distribution function of X<br>(iii) If $X_1, X_2$ and $X_3$ are 3 independent observations of X. Find the probability that exactly one of these 3 is greater than 1.5? | BTL-2 | Understanding |
| 13.(a) | The Probability distribution function of a R.V. X is given by $f(x) = \frac{4x(9-x^2)}{81}$, $0 \le x \le 3$. Find the mean, variance | BTL-2 | Understanding |
| 13.(b) | The number of monthly breakdowns 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. | BTL3 | Applying |
| 14.(a) | 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 | BTL3 | Applying |
| 14.(b) | Suppose that the life of an 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. | BTL3 | Applying |
| 15.(a) | The time (in hours) required to repair a machine is exponentially distributed with parameter $\lambda = 1/2$.<br>(a) What is the probability that the repair time exceeds 2 hours?<br>(b) What is the conditional probability that a repair time exceeds at least 10 hours that its distribution exceeds 9 hours? | BTL4 | Analyzing |
| 15.(b) | Let X be a Uniformly distributed R. V. over [-5, 5]. Evaluate (i) P(X≤ 2) (ii) P(\|X\|>2) (iii) Cumulative distribution function of X (iv) Var(X) | BTL5 | Evaluating |
| 16.(a) | Buses arrive at a specified stop at 15 minutes interval starting at 7am that is, 7,7:15,7:30,7:45, and so on, If a passenger arrives at the stop at a random time that is uniformly distributed between 7 and 77:30 am, evaluate the probability that he waits<br>(a) Less than 5 minutes for a bus and<br>(b) At least 12 minutes for a bus | BTL5 | Evaluating |
| 16.(b) | The marks obtained by a number of students for a certain subject is assumed to be normally distributed with mean 65 and standard deviation 5. If 3 students are taken at random from this set Find the probability that exactly 2 of them will have marks over 70? | BTL4 | Analyzing |
| 17. | In a test on 2000 electric bulbs, it was found that the life of a particular make, was normally distributed with an average life of 2040 hours and Standard Deviation of 60 hours. Find the number of bulbs likely to burn for (i) more than 2150 hours (ii) less than 1950 hours and (iii) more than 1920 hours burs less than 2160 hours. | BTL3 | Applying |
| 18.(a) | The mileage which car owners get with a certain kind of radial tire is a RV having an exponential distribution with mean 40,000 km. Find the | BTL-2 | Understanding |

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| | probabilities that one of these will last (a) at least 20,000 kn, and (b) at most 30,000km. | | |
| 18.(b) | The annual rainfall in inches in a certain region has a normal distribution with a mean of 40 and variance of 16. What is the probability that the rainfall in a given year is between 30 and 48 inches? | BTL3 | Applying |
| **PART C(15 Mark Questions)** | | | |
| 1. | Out of 2000 families with 4 children each, Create how many family would you expect to have i) at least 1 boy ii) 2 boys and 2 girls iii) at most 2 girls iv) children of both genders | BTL6 | Creating |
| 2. | In a certain factory manufacturing razor blades, there is a small chance of 1/500 for any blade to be defective. The blades are supplied in packets of 10. Use Poisson distribution to calculate the approximate number of packets containing (i) No defective (ii) One defective (iii) Two defective blades Respectively in a consignment of 10,000 packet | BTL4 | Analyzing |
| 3. | Buses arrive at a specified stop at 15 minutes interval starting at 6 AM ie they arrive at 6 AM, 6.15AM, 6.30 AM and so on. If a passenger arrives at the stop at a time that is uniformly distributed between 6 and 6.30 AM. Evaluate the probability that he waits (i) Less than 5 minutes for a bus. (ii) More than 10 minutes for a bus. | BTL5 | Evaluating |
| 4. | The daily consumption of milk in excess of 20,000 liters in a town is approximately exponentially distributed with parameter 1/3000. The town has a daily stock of 35,000L. What is the probability that of 2 days selected at random, the stock is insufficient for both days? | BTL3 | Applying |
| 5. | 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-2 | Understanding |
| **UNIT II TWO – DIMENSIONAL RANDOM VARIABLES**<br>Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables) | | | |
| **PART-A( 2 MARK QUESTIONS)** | | | |
| 1. | 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 | BTL-2 | Understanding |
| 2. | 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. | BTL-2 | Understanding |
| 3. | Find the probability distribution of X + Y from the bivariate distribution of (X,Y) given below:<br>X \ Y: 1 → 0.4, 2 → 0.2; 2 → 0.3, 0.1 | BTL-2 | Understanding |
| 4. | Let X and Y have the joint p.m.f<br>Y \ X: 0, 1, 2 | BTL-2 | Understanding |

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| 0 | 0.1 | 0.4 | 0.1 |
| 1 | 0.2 | 0.2 | 0 |

Find P(X+Y > 1)

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| 5. | Find the marginal distributions of X and Y from the bivariate distribution of (X,Y) given below:<br><br>X \ Y: 1: 0.1, 0.3; 2: 0.2, 0.4 | BTL-2 | Understanding |
| 6. | The joint probability distribution function of the random variable (X,Y) is given by $f(x,y) = k(x^3y - xy^3), 0 \le x \le 2, 0 \le y \le 2$. Derive the value of k | BTL3 | Applying |
| 7. | If the joint probability density function of a random variable X and Y is given by $f(x,y) = \begin{cases} \frac{x^3y^3}{16}, 0 < x < 2, 0 < y < 2 \\ 0, \quad otherwise \end{cases}$.<br>Obtain the marginal density function of X. | BTL3 | Applying |
| 8. | 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 $k$. | BTL5 | Evaluating |
| 9. | The joint probability density function of a random variable $(X,Y)$ is $f(x,y) = k\,e^{-(2x+3y)}, x \ge 0,\ y \ge 0$. Point out the value of $k$. | BTL4 | Analyzing |
| 10. | If the joint pdf of (X, Y) is $f(x,y) = \begin{cases} \frac{1}{4}, 0 < x, y < 2 \\ 0, \quad otherwise \end{cases}$.<br>Find $P(X + Y \le 1)$ | BTL4 | Analyzing |
| 11. | Let X and Y be random variables with joint density function<br>$f(x,y) = \begin{cases} 4xy, & 0 < x < 1, 0 < y < 1 \\ 0, & otherwise \end{cases}$ formulate the value of E(XY) | BTL4 | Analyzing |
| 12. | Let the joint density function of a random variable X and Y be given by $f(x,y) = 8xy, 0 < y \le x \le 1$.Calculate the marginal probability function of X | BTL3 | Applying |
| 13. | What is the condition for two random variables are independent? | BTL-1 | Remembering |
| 14. | If the joint probability density function of X and Y is $f(x,y) = e^{-(x+y)}, x, y \ge 0$.Are X and Y independent | BTL4 | Analyzing |
| 15. | State any tow properties of correlation coefficient | BTL-1 | Remembering |
| 16. | Write the angle between the regression lines | BTL-1 | Remembering |
| 17. | The regression equations are x + 6y = 14 and 2x + 3y = 1. Evaluate the correlation coefficient between X & Y **.** | BTL5 | Evaluating |
| 18. | If $\bar{X} = 970, \bar{Y} = 18, \sigma_x = 38, \sigma_y = 2$ and r = 0.6 , Devise the line of regression of X on Y. | BTL4 | Analyzing |
| 19. | 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? | BTL3 | Applying |
| 20. | The regression equations are 3x + 2y = 26 and 6x + y = 31. Find the correlation coefficient**.** | BTL3 | Applying |
| 21. | State central limit theorem | BTL-1 | Remembering |
| 22. | Prove that $-1 \le r_{xy} \le 1$ | BTL-2 | Understanding |

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| 23. | The equations of two regression lines are 3x+2y=19 and 3y+9x=46. Obtain the mean of X and Y. | BTL3 | Applying |
| 24. | The equations of two regression lines are 3x+2y=19 and 3y+9x=46. Derive the correlation coefficient between X and Y. | BTL3 | Applying |
| 25. | If $X = R\cos\varphi$ and $Y = R\sin\varphi$, how are the joint probability density function (X,Y) and $(R, \varphi)$ are related? | BTL3 | Applying |
| | **PART B (13 Mark Questions)** | | |
| 1. | From the following table for bivariate distribution of (X, Y). Find<br>(i) $P(X \leq 1)$ (ii)$P(Y \leq 3)$ (iii) $P(X \leq 1, Y \leq 3)$<br>(iv)$P(X \leq 1/\ Y \leq 3)$ (v) $P(Y \leq 3/\ X \leq 1)$ (vi)$P(X + Y \leq 4)$<br>Y / X: 1 \| 2 \| 3 \| 4 \| 5 \| 6<br>0 \| 0 \| 0 \| $\frac{1}{32}$ \| $\frac{2}{32}$ \| $\frac{2}{32}$ \| $\frac{3}{32}$<br>1 \| $\frac{1}{16}$ \| $\frac{1}{16}$ \| $\frac{1}{8}$ \| $\frac{1}{8}$ \| $\frac{1}{8}$ \| $\frac{1}{8}$<br>2 \| $\frac{1}{32}$ \| $\frac{1}{32}$ \| $\frac{1}{64}$ \| $\frac{1}{64}$ \| 0 \| $\frac{2}{64}$ | BTL-2 | Understanding |
| 2.(a) | 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 marginal distributions of X and Y. Also find the conditional distribution of Y given X = 1 also find the conditional distribution of X given Y = 1. | BTL3 | Applying |
| 2.(b) | The joint pdf a bivariate R.V(X, Y) is given by<br>$f(x,y) = \begin{cases} Kxy & , \ 0 < x < 1, 0 < y < 1 \\ 0 & , \quad otherwise \end{cases}$<br>Find K. (2) Find P(X+Y<1). (3)Are X and Y independent R.V's. | BTL3 | Applying |
| 3.(a) | If the joint pdf of (X, Y) is given by $P(x, y) = K(2x+3y)$, x=0, 1, 2, 3, y = 1, 2, 3 Find all the marginal probability distribution. Also find the probability distribution of X+Y. | BTL3 | Applying |
| 3.(b) | The joint pdf of the RV (X,Y) is given by $f(x,y) = kxye^{-(x^2+y^2)}$, $x > 0, y > 0$. Find the value of k. Also prove that X and Y are independent | BTL4 | Analyzing |
| 4. | The following table represents the joint probability distribution of the discrete RV (X,Y). Find all the marginal and conditional distributions.<br>Y / X: 1 \| 2 \| 3<br>1 \| 1/2 \| 1/6 \| 0<br>2 \| 0 \| 1/9 \| 1/5<br>3 \| 1/18 \| 1/4 \| 2/15 | BTL-2 | Understanding |
| 5. | Find the marginal distribution of X and Y and also P($P(X \leq 1, Y \leq 1)$, $P(X \leq 1), P(Y \leq 1)$. Check whether X and Y are independent. The joint probability mass function of X and Y is<br>Y / X: 0 \| 1 \| 2<br>0 \| 0.10 \| 0.04 \| 0.02<br>1 \| 0.08 \| 0.20 \| 0.06 | BTL-2 | Understanding |

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| | 2 \| 0.06 \| 0.14 \| .030 | | | |
| 6. | A machine is used for a particular job in the forenoon and for a different job in the afternoon. The joint probability distribution of (X, Y), where X and Y represent the number of times the machine breakdown in the forenoon and in the afternoon respectively, is given in the following table. Examine if X and Y are independent RV's | BTL4 | Analyzing |
| 7. | If the joint pdf of a two-dimensional RV(X,Y) is given by $f(x,y)=\begin{cases}x^2+\frac{xy}{3}; 0<x<1, 0<y<2\\ 0, \ elsewhere\end{cases}$. Find (i) $P\left(X>\frac{1}{2}\right)$ (ii) $P(Y<\frac{1}{2}, X<\frac{1}{2})$ (iii)$P\left(Y<\frac{1}{2}/X<\frac{1}{2}\right)$ | BTL3 | Applying |
| 8. | 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) $P(X+Y)\le 1$. | BTL3 | Applying |
| 9. | (b)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 $f_y(y)$ | BTL3 | Applying |
| 10. | Find the Coefficient of Correlation between industrial production and export using the following table<br>Production (X): 14, 17, 23, 21, 25<br>Export (Y): 10, 12, 15, 20, 23 | BTL-2 | Understanding |
| 11. | 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<br>X: 65, 66, 67, 67, 68, 69, 70, 72<br>Y: 67, 68, 65, 68, 72, 72, 69, 71 | BTL-2 | Understanding |
| 12. | Obtain the lines of regression<br>X: 50, 55, 50, 60, 65, 65, 65, 60, 60<br>Y: 11, 14, 13, 16, 16, 15, 15, 14, 13 | BTL-2 | Understanding |
| 13. | 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), Evaluate the correlation coefficient $\rho$. | BTL5 | Evaluating |
| 14. | Two random variables X and Y have the joint density function $f(x,y)=x+y, 0\le x\le 1, 0\le y\le 1$. Evaluate the Correlation coefficient between X and Y. | BTL5 | Evaluating |
| 15.(a) | 20 dice are thrown. Find the approximate probability that the sum obtained is between 65 and 75 using central limit theorem | BTL3 | Applying |
| 15.(b) | The two regression lines are 4x-5y+33=0 and 20x-9y=107. Find the mean of X and Y. Also find the correlation coefficient between them | BTL3 | Applying |
| 16.(a) | If $X_1, X_2, X_3, \cdots X_n$ are Poisson variates with mean 2, use central limit theorem to estimate $P(120<S_n<160)$ where $S_n=X_1+X_2+X_3+\cdots+X_n$ and n=75. | BTL4 | Analyzing |
| 16.(b) | If X and Y each follow an exponential distribution with parameter 1 and are independent, find the pdf of U = X-Y. | BTL4 | Analyzing |
| 17.(a) | If X and Y independent Random Variables with pdf $e^{-x}, x\ge 0$ and | BTL4 | Analyzing |

| | | | |
|---|---|---|---|
| | $e^{-y}, y \geq 0$. Devise the density function of $U = \frac{X}{X+Y}$ and $V = X + Y$. Are they independent? | | |
| 17.(b) | Two random variables X and Y have the following joint probability density function $f(x,y) = \begin{cases} x+y; 0 \leq x \leq 1, 0 \leq y \leq 1 \\ 0, \ otherwise \end{cases}$. Find the probability density function of the random variable U = XY. | BTL3 | Applying |
| 18.(a) | A random sample of size 100 is taken from a population whose mean is 60 and variance is 400. Using central limit theorem find what probability that we can assert that the mean of the sample will not differ from μ more than 4? | BTL5 | Evaluating |
| 18.(b) | If X and Y follows an exponential distribution with parameters 2 and 3 respectively and are independent, Create the probability density function of U =X+Y | BTL6 | Creating |
| **PART-C(15 Mark Questions)** | | | |
| 1. | Three balls are drawn at random without replacement from a box containing 2 white, 3 red and 4 blue balls. If X denotes the number of white balls drawn and Y denotes the number of red balls drawn, Find the probability distribution of X and Y. | BTL3 | Applying |
| 2. | Out of the two lines of regression given by $x + 2y - 5 = 0$ and $2x + 3y - 8 = 0$, which one is the regression line of X on Y? Analyze the equations to find the means of X and Y. If the variance of X is 12, find the variance of Y. | BTL4 | Analyzing |
| 3. | 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<br>Marks in Maths : 25 28 35 32 31 36 29 38 34 32<br>Marks in Statistics: 43 46 49 41 36 32 31 30 33 39 | BTL-2 | Understanding |
| 4. | For a particular brand of TV picture tube, it is known that the mean operating life of the tubes is 1000 hours with a standard deviation of 250 hours, Devise the probability that the mean for a random sample of size 25 will be between 950 and 1050 hours? | BTL5 | Evaluating |
| 5. | The lifetime of a certain brand of an electric bulb may be considered a RV with mean 1200h and standard deviation 250h. Find the probability, using central limit theorem, that the average life time of 60 bulbs exceeds 1250 h. | BTL6 | Creating |
| **UNIT III : TESTING OF HYPOTHESIS**<br>Sampling distributions - Estimation of parameters - Statistical hypothesis - Large sample tests based on Normal distribution for single mean and difference of means -Tests based on t, Chi-square and F distributions for mean, variance and proportion - Contingency table (test for independent) - Goodness of fit | | | |
| **PART-A(2 Mark Questions)** | | | |
| 1. | Define Statistics | BTL-1 | Remembering |
| 2. | Define Parameter. | BTL-1 | Remembering |
| 3. | Explain null and alternate hypothesis. | BTL-1 | Remembering |
| 4. | Mention the various steps involved in testing of hypothesis. | BTL-1 | Remembering |

| | | | |
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| 5. | What is the essential difference between confidence limits and tolerance limits? | BTL-1 | Remembering |
| 6. | Define Standard Error. | BTL-1 | Remembering |
| 7. | Define Type I and Type II error. | BTL-1 | Remembering |
| 8. | What are the parameters and statistics in sampling. | BTL-2 | Understanding |
| 9. | Define level of significance. | BTL-2 | Understanding |
| 10. | What is the test statistic for single proportion test? | BTL3 | Applying |
| 11. | A random sample of 25 cups from a certain coffee dispensing machine yields a mean x = 6.9 occurs per cup. Use 0.05 level of significance to test, on the average, the machine dispense $\mu = 7.0$ ounces against the null hypothesis that, on the average, the machine dispenses $\mu < 7.0$ ounces. Assume that the distribution of ounces per cup is normal, and that the variance is the known quantity $\sigma^2$=0.01 ounces | BTL3 | Applying |
| 12. | Twenty people were attacked by a disease and only 18 were survived. The hypothesis is set in such a way that the survival rate is 85% if attacked by this disease. Will you reject the hypothesis that it is more at 5% level.($Z_{0.05} = 1.645$). | BTL-2 | Understanding |
| 13. | In a large city A, 20 percent of a random sample of 900 school boys had a slight physical defect. In another large city B, 18.5 percent of a random sample of 1600 school boys had some defect. Is the difference between the proportions significant? | BTL-2 | Understanding |
| 14. | A standard sample of 200 tins of coconut oil gave an average weight of 4.95 kg with a standard deviation of 0.21 kg. Do we accept that the net weight is 5 kg per tin at 5% level of significance? | BTL-2 | Understanding |
| 15. | Write down the formula of test statistic 't' to test the significance of difference between the population mean and sample mean. | BTL-2 | Understanding |
| 16. | Write down the formula of test statistic 't' to test the significance of difference between two sample means. | BTL-1 | Remembering |
| 17. | What are the applications of t-test? | BTL-1 | Remembering |
| 18. | What is the assumption of t-test? | BTL4 | Analyzing |
| 19. | Write the application of 'F' test. | BTL4 | Analyzing |
| 20. | Define 'F' variate. | BTL-1 | Remembering |

<table>
<tr><td>21.</td><td>What are the properties of “F” test?</td><td>BTL-1</td><td>Remembering</td></tr>
<tr><td>22.</td><td>Write the formula for the chi- square test of goodness of fit of a random sample to a hypothetical distribution.</td><td>BTL4</td><td>Analyzing</td></tr>
<tr><td>23.</td><td>State the main use of $\psi^2$-test</td><td>BTL5</td><td>Evaluating</td></tr>
<tr><td>24.</td><td>What are the expected frequencies of 2x2 contingency table?<br><table><tr><td>a</td><td>b</td></tr><tr><td>c</td><td>d</td></tr></table></td><td>BTL5</td><td>Evaluating</td></tr>
<tr><td>25.</td><td>State any two applications of $\psi^2$-test.</td><td>BTL4</td><td>Analyzing</td></tr>
<tr><td colspan="4">PART-B (13 Marks Questions)</td></tr>
<tr><td>1.(a)</td><td>A sample of 100 students is taken from a large population. The mean height of the students in this sample is 160cms. Can it be reasonably regarded that this sample is from a population of mean 165 cm and standard deviation 10 cm?</td><td>BTL-2</td><td>Understanding</td></tr>
<tr><td>1.(b)</td><td>Test of fidelity and selectivity of 190 radio receivers produced the results shown in the following table<br>Fidelity<br><table><tr><td>Selectivity</td><td>Low</td><td>Average</td><td>High</td></tr><tr><td>Low</td><td>6</td><td>12</td><td>32</td></tr><tr><td>Average</td><td>33</td><td>61</td><td>18</td></tr><tr><td>High</td><td>13</td><td>15</td><td>0</td></tr></table>Use 0.01 level of significance to test whether there is a relationship between fidelity and selectivity.</td><td>BTL-2</td><td>Understanding</td></tr>
<tr><td>2.</td><td>Given the following table for hair color and eye color, identify the value of Chi-square. Is there good association between hair color and eye color?<br><table><tr><td colspan="5">Hair color</td></tr><tr><td rowspan="3">Eye color</td><td></td><td>Fair</td><td>Brown</td><td>Black</td><td>Total</td></tr><tr><td>Blue</td><td>15</td><td>5</td><td>20</td><td>40</td></tr><tr><td>Grey</td><td>20</td><td>10</td><td>20</td><td>50</td></tr></table></td><td>BTL-1</td><td>Remembering</td></tr>
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|---|---|---|---|---|---|---|---|---|
| | | | Brown | 25 | 15 | 20 | 60 | |
| | | | Total | 60 | 30 | 60 | 150 | |

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| 3. | Two independent samples of sizes 8 and 7 contained the following values.<br><br>Sample I: 19, 17, 15, 21, 16, 18, 16, 14<br>Sample II: 15, 14, 15, 19, 15, 18, 16<br><br>Test if the two populations have the same mean. | | | | | | | | | BTL3 | Applying |
| 4. | Two independent samples of 8 and 7 items respectively had the following Values of the variable (weight in kgs.) Use 0.05 LOS to test<br><br>Sample I: 9, 11, 13, 11, 15, 9, 12, 14<br>Sample II: 10, 12, 10, 14, 9, 8, 10<br><br>whether the variances of the two population's sample are equal. | | | | | | | | | BTL-1 | Remembering |
| 5. (a) | A group of 10 rats fed on diet A and another group of 8 rats fed on diet B, Recorded the following increase the following increase in weight.(gm)<br><br>Diet A: 5, 6, 8, 1, 12, 4, 3, 9, 6, 10<br>Diet B: 2, 3, 6, 8, 10, 1, 2, 8, -, -<br><br>Find the variances are significantly different. (Use F-test) | | | | | | | | | BTL3 | Applying |
| 5.(b) | The marks obtained by a group of 9 regular course students and another group of 11 part time course students in a test are given below :<br><br>Sample I: 56, 62, 63, 54, 60, 51, 67, 69, 58, , <br>Sample II: 62, 70, 71, 62, 60, 56, 75, 64, 72, 68, 66<br><br>Examine whether the marks obtained by regular students and part-time students differ significantly at 5% levels of significance. | | | | | | | | | BTL-1 | Remembering |
| 6. | In a certain factory there are two independent processes manufacturing the same item. The average weight in a sample of 250 items produced from one process is found to be 120 Ozs, with a standard deviation of 12 Ozs, while the corresponding figures in a sample of 400 items from the other process are 124 and 14. Is the difference between the two sample means | | | | | | | | | BTL3 | Applying |

<table>
<tr><td></td><td>significant?</td><td></td><td></td></tr>
<tr><td>7.</td><td>Records taken of the number of male and female births in 800 families having four Children are as follows :<br><br>Number of male births : 0 1 2 3 4<br><br>Number of female births : 4 3 2 1 0<br><br>Number of Families : 32 178 290 236 64<br><br>Infer whether the data are consistent with the hypothesis that the binomial law holds the chance of a male birth is equal to female birth, namely p = ½ = q.</td><td>BTL4</td><td>Analyzing</td></tr>
<tr><td>8.</td><td>A survey of 320 families with 5 children each revealed the following distribution<br><br><table><tr><td>Boys</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr><tr><td>Girls</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>Families</td><td>14</td><td>56</td><td>110</td><td>88</td><td>40</td><td>12</td></tr></table><br>Is this result consistent with the hypothesis that male and female births are equally probable?</td><td>BTL3</td><td>Applying</td></tr>
<tr><td>9.</td><td>The nicotine content in milligram of two samples of toboco where found to be as follows<br><br>Sample 1 24 27 26 21 25<br><br>Sample 2 27 30 28 31 22 36<br><br>Can it be said that this samples where from normal population with the same mean.</td><td>BTL-1</td><td>Remembering</td></tr>
<tr><td>10.</td><td>Two random samples gave the following results:<br><br><table><tr><td>Sample</td><td>Size</td><td>Sample mean</td><td>Sum of squares of deviation from the mean</td></tr><tr><td>1</td><td>10</td><td>15</td><td>90</td></tr><tr><td>2</td><td>12</td><td>14</td><td>108</td></tr></table><br>Analyze whether the samples have come from the same normal population.</td><td>BTL-2</td><td>Understanding</td></tr>
<tr><td>11.</td><td>Mechanical engineers testing a new arc welding technique, classified welds both with respect to appearance and an X-ray inspection</td><td>BTL3</td><td>Applying</td></tr>
</table>

| | | | |
|---|---|---|---|
| | X-ray/Appearance \| Bad \| Normal \| Good<br>Bad \| 20 \| 7 \| 3<br>Normal \| 13 \| 51 \| 16<br>Good \| 7 \| 12 \| 21<br>Test for independence using 0.05 level of significance. | | |
| 12. | A sample of 200 persons with a particular disease was selected. Out of these, 100 were given a drug and the others were not given any drug. The result are as follows:<br>Number of persons \| Drug \| No drug \| Total<br>Cured \| 65 \| 55 \| 120<br>Not cured \| 35 \| 45 \| 80<br>Total \| 100 \| 100 \| 200<br>Test whether the drug is effective or not? | BTL-2 | Understanding |
| 13. | The following data gives the number of aircraft accidents that occurred during the various days of a week. Find whether the accidents are uniformly distributed over the week<br>Days \| Sun \| Mon \| Tues \| Wed \| Thu \| Fri \| Sat<br>No. of accidents \| 14 \| 16 \| 08 \| 12 \| 11 \| 9 \| 14 | BTL3 | Applying |
| 14. | The nicotine content in milligram of two samples of tobacco where found to be as follows, test the significant difference between means of the two samples.<br>Sample I \| 21 \| 24 \| 25 \| 26 \| 27 \| -<br>Sample II \| 22 \| 27 \| 28 \| 30 \| 31 \| 36 | BTL4 | Analyzing |
| 15.(a) | The mean braking strength of the cables supplied by manufacture is 1800 with S.D 100. By a new technique in the manufacturing process it is claimed that the breaking strength of the cable has increased. To test this claim a sample of 50 cables is tested and is found that the mean braking strength is 1850. Can we support the claim at 1% level of significance. | BTL6 | Creating |
| 15.(b) | In a sample of 8 observations, the sum of squares of devaitation of the sample values from the sample mean was 84.4 and in the other sample of 10 observations it was 102.6. Test whether this difference is significant at 5% level, given that the 5% point of F for v1=7 and v2=9 defres of freedom | BTL-2 | Understanding |

<table>
<tr><td></td><td>is 3,27</td><td></td><td></td></tr>
<tr><td>16.(a)</td><td>A simple sample of heights of 6400 Englishmen has a mean of 170cms and a standard deviation of 6.4cms, while a simple sample of heights of 1600 Americans has a mean of 172 cm and a standard deviation of 6.3cms. Do the data indicate that Americans are, on the average, taller than Englishmen?</td><td>BTL4</td><td>Analyzing</td></tr>
<tr><td>16.(b)</td><td>The theory predicts that the population of beans in the four groups A, B, C and D should be 9:3:3:1. In an experiment among 1600 beans, the number in the four groups was 882,313,287 and 118. Do the experimental results support the survey?</td><td>BTL-2</td><td>Understanding</td></tr>
<tr><td>17.(a)</td><td>The mean population of a random sample of 4000 villages in Jaipur district was found to be 400 with a standard deviation of 12. The mean population of a random sample of 400 villages in Meerut district was found to be 395 with standard deviation of 15. Is the difference between the two district's means statistically significant?</td><td>BTL-2</td><td>Understanding</td></tr>
<tr><td>17.(b)</td><td>Discuss the chi square of independence of attributes.</td><td>BTL-2</td><td>Understanding</td></tr>
<tr><td>18.</td><td>The heights of 10 males of a given locality are found to be 70, 67, 62, 68, 61, 68, 70, 64, 64, 66 inches. Is it reasonable to believe that the average height is grater than 64 inches?</td><td>BTL5</td><td>Evaluating</td></tr>
<tr><td colspan="4">Part C: 15 - MARK QUESTIONS</td></tr>
<tr><td>1.</td><td>Twp samples of 6 and 7 items have the following values for a variable.<br><br>Sample 1: 39, 41, 42, 42, 44, 40<br><br>Sample 2 : 40, 42, 39, 45, 38, 39, 40<br><br>Do the sample variances differ significantly?</td><td>BTL-2</td><td>Understanding</td></tr>
<tr><td>2.</td><td>Two random samples gave the following data.<br><br><table><tr><td>Sample</td><td>Size</td><td>Mean</td><td>Variance</td></tr><tr><td>1</td><td>8</td><td>9.6</td><td>1.2</td></tr><tr><td>2</td><td>11</td><td>16.5</td><td>2.5</td></tr></table>Can we conclude that the two samples have drawn from the same normal population?</td><td>BTL3</td><td>Applying</td></tr>
<tr><td>3.</td><td>Random samples drawn from two places gave the following data relating to the heights of male adults:<br><br><table><tr><td></td><td>Place A</td><td>Place B</td></tr><tr><td>Mean height (in inches)</td><td>68.50</td><td>65.50</td></tr></table></td><td>BTL4</td><td>Analyzing</td></tr>
</table>

| | | | |
|---|---|---|---|
| | S.D ( in inches) \| 2.5 \| 3.0<br>No. of adut males in sample \| 1200 \| 1500<br>Test at 5 % level, that the mean height is the same for adults in the two places. | | |
| 4. | Samples of two types of electric bulbs were tested for length of life and following data were obtained.<br>Type I \| Type II<br>Sample Size \| 8 \| 7<br>Sample Mean \| 1234hrs \| 1036hrs<br>Sample S.D \| 36hrs \| 40hrs<br>Analyze that, is the difference in the means sufficient to warrant that type I is superior to type II regarding the length of life? | BTL5 | Evaluating |
| 5. | 5 coins were tossed 320 times. The number of heads observed is given below :<br>No. of heads \| 0 \| 1 \| 2 \| 3 \| 4 \| 5<br>Observed frequencies \| 15 \| 45 \| 85 \| 95 \| 60 \| 20<br>Examine whether the coin is unbiased .Use 5% level of significance. | BTL6 | Creating |
| **UNIT IV : DESIGN OF EXPERIMENTS**<br>One way and two way classifications - Completely randomized design – Randomized block design – Latin square design. | | | |
| 1. | What is the aim of design of experiments? | BTL1 | Remembering |
| 2. | Write the basic assumptions in analysis of variance. | BTL2 | Understanding |
| 3. | When do you apply analysis of variance technique? | BTL1 | Remembering |
| 4. | Define Replication. | BTL3 | Applying |
| 5. | Define Randomization. | | |
| 6. | Define Local control. | BTL2 | Understanding |
| 7. | What is meant by tolerance limits? | | |
| 8. | What is a completely randomized design? | BTL2 | Understanding |
| 9. | Explain the advantages of a Latin square design? | BTL4 | Analyzing |
| 10. | What are the basic elements of a Completely Randomized Experimental Design? | BTL3 | Applying |
| 11. | Demonstrate the purpose of blocking in a randomized block design? | BTL2 | Understanding |
| 12. | Manipulate the Basic principles of the design of experiment? | BTL2 | Understanding |
| 13. | Why a 2x2 Latin square is not possible? Explain. | BTL4 | Analyzing |
| 14. | Demonstrate main advantage of Latin square Design over Randomized Block Design? | BTL2 | Understanding |
| 15. | Analyze the advantages of the Latin square design over the other design. | BTL1 | Remembering |
| 16. | Write any two differences between RBD and LSD. | BTL1 | Remembering |
| 17. | What is ANOVA? | BTL6 | Creating |
| 18. | What are the uses of ANOVA? | BTL4 | Analyzing |
| 19. | Define experimental error. | BTL1 | Remembering |

<table>
<tr><td>20.</td><td>Write any two advantages of RBD over CRD.</td><td>BTL4</td><td>Analyzing</td></tr>
<tr><td>21.</td><td>Write down the ANOVA table for Latin Square Design.</td><td>BTL5</td><td>Evaluating</td></tr>
<tr><td>22.</td><td>Define one-way classification and two way classifications in ANOVA</td><td>BTL1</td><td>Remembering</td></tr>
<tr><td>23.</td><td>Compare RBD, LSD, CRD</td><td>BTL1</td><td>Remembering</td></tr>
<tr><td>24.</td><td>Write down the ANOVA table for One way classification</td><td>BTL1</td><td>Remembering</td></tr>
<tr><td>25.</td><td>Write down the ANOVA table for Randomized Block Design</td><td>BTL1</td><td>Remembering</td></tr>
<tr><td colspan="4">PART-B (13 Mark Questions)</td></tr>
<tr><td>1.</td><td>The accompanying data resulted from an experiment comparing the degree of soiling for fabric copolymerized with the 3 different mixtures of met acrylic acid. Analyze the classification.<br>Mixture 1 : 0.56 1.12 0.90 1.07 0.94<br>Mixture 2 : 0.72 0.69 0.87 0.78 0.91<br>Mixture 3 : 0.62 1.08 1.07 0.99 0.93</td><td>BTL1</td><td>Remembering</td></tr>
<tr><td>2.</td><td>The following table shows the lives in hours of four brands of electric lamps brand<br>A: 1610, 1610, 1650, 1680, 1700, 1720, 1800<br>B: 1580, 1640, 1640, 1700, 1750<br>C: 1460, 1550, 1600, 1620, 1640, 1660, 1740, 1820<br>D: 1510, 1520, 1530, 1570, 1600, 1680<br>Identify an analysis of variance and test the homogeneity of the mean lives of the four brands of lamps.</td><td>BTL2</td><td>Understanding</td></tr>
<tr><td>3.</td><td>In order to determine whether the significant difference in the durability of 3makes of computers, samples of size 5 are selected from each make and the frequency of repair during the first year of purchase is observed. The results are as follows: In view of the above data, what conclusion can you draw?<br>Makes
<table>
<tr><td>A</td><td>B</td><td>C</td></tr>
<tr><td>5</td><td>8</td><td>7</td></tr>
<tr><td>6</td><td>10</td><td>3</td></tr>
<tr><td>8</td><td>11</td><td>5</td></tr>
<tr><td>9</td><td>12</td><td>4</td></tr>
</table></td><td>BTL2</td><td>Understanding</td></tr>
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<tr><td></td><td><table><tr><td>7</td><td>4</td><td>1</td></tr></table></td><td></td><td></td></tr>
<tr><td>4.</td><td>A random sample is selected from each of 3 makes of ropes and their braking strength are measured with the following results.<br>I : 70 72 75 80 83<br>II : 100 110 108 112 113 120 107<br>III : 60 65 57 84 87 73<br>Test whether the braking strehgth of the ropes differs significantly?</td><td>BTL2</td><td>Understanding</td></tr>
<tr><td>5.</td><td>The following are the number of mistakes made in 5 successive days by four technicians working for a photographic laboratory. Test whether the difference among the four sample means can be attributed to chance. Test at a level of significance $\alpha = 0.01$.<table><tr><td colspan="4">Technician</td></tr><tr><td>I</td><td>II</td><td>III</td><td>IV</td></tr><tr><td>6</td><td>14</td><td>10</td><td>9</td></tr><tr><td>14</td><td>9</td><td>12</td><td>12</td></tr><tr><td>10</td><td>12</td><td>7</td><td>8</td></tr><tr><td>8</td><td>10</td><td>15</td><td>10</td></tr><tr><td>11</td><td>14</td><td>11</td><td>11</td></tr></table></td><td>BTL2</td><td>Understanding</td></tr>
<tr><td>6.</td><td>A random sample is selected from each of three makes of ropes and their breaking strength (in pounds) are measured with the following results<br>Sample I : 70 72 75 80 83<br>Sample II : 100 110 108 112 113 120 107<br>Sample III: 60 65 57 84 87 73<br>Test whether the breaking strength of the ropes differs significantly?</td><td>BTL3</td><td>Applying</td></tr>
<tr><td>7.</td><td>Ten persons were appointed in the officer cadre in an office. Their performance was noted by giving a test and marks were recorded out of 100.<br>Employee : A B C D E F G H I J<br>Before Training : 80 76 92 60 70 56 74 56 70 56<br>After Training : 84 70 96 80 70 52 84 72 72 50<br>By applying t-test can it be concluded that the employees have been</td><td>BTL3</td><td>Applying</td></tr>
</table>

<table>
<tr><td></td><td>benefited by the training?</td><td></td><td></td></tr>
<tr><td>8.</td><td>Five doctors each test five treatments for a certain disease and observe the number of days each patient takes to recover. The results are as follows (recovery time in days)<br><table><tr><td></td><td colspan="5">Treatment</td></tr><tr><td>Doctor</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>A</td><td>10</td><td>14</td><td>23</td><td>18</td><td>20</td></tr><tr><td>B</td><td>11</td><td>15</td><td>24</td><td>17</td><td>21</td></tr><tr><td>C</td><td>9</td><td>12</td><td>20</td><td>16</td><td>19</td></tr><tr><td>D</td><td>8</td><td>13</td><td>17</td><td>17</td><td>20</td></tr><tr><td>E</td><td>12</td><td>15</td><td>19</td><td>15</td><td>22</td></tr></table>Estimate the difference between (a) doctors and (b) treatments for the above data at 5% level.</td><td>BTL4</td><td>Analyzing</td></tr>
<tr><td>9.</td><td>Perform a 2-way ANOVA on the data given below:<br><table><tr><td colspan="2"></td><td colspan="3">Treatment 1</td></tr><tr><td colspan="2"></td><td>1</td><td>2</td><td>3</td></tr><tr><td rowspan="5">Treatment 2</td><td>1</td><td>30</td><td>26</td><td>38</td></tr><tr><td>2</td><td>24</td><td>29</td><td>28</td></tr><tr><td>3</td><td>33</td><td>24</td><td>35</td></tr><tr><td>4</td><td>36</td><td>31</td><td>30</td></tr><tr><td>5</td><td>27</td><td>35</td><td>33</td></tr></table>Use the coding method subtracting 30 from the given no.</td><td>BTL -1</td><td>Remembering</td></tr>
</table>

<table>
<tr>
<td>10.</td>
<td>A chemist wishes to test the effect of four chemical agents on the strength of a particular type of cloth. Because there might be variability from one bolt to another , the chemist decides to use a randomized block design ,with the bolts of cloth consider as blocks ,she selects five bolts and applies all four chemical in random order to each bolt, The resulting tensile strength follows
<table>
<tr><td colspan="2"></td><td colspan="5">BOLT</td></tr>
<tr><td colspan="2"></td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td rowspan="4">CHEMICAL</td><td>1</td><td>73</td><td>68</td><td>74</td><td>71</td><td>67</td></tr>
<tr><td>2</td><td>73</td><td>67</td><td>75</td><td>72</td><td>70</td></tr>
<tr><td>3</td><td>75</td><td>68</td><td>78</td><td>73</td><td>68</td></tr>
<tr><td>4</td><td>73</td><td>71</td><td>75</td><td>75</td><td>69</td></tr>
</table>
Does the tensile strength depend on chemical? Test at 10% level of significance.</td>
<td>BTL -4</td>
<td>Analyzing</td>
</tr>
<tr>
<td>11.</td>
<td>The following data represents the number of units of production per day turned out by different workers using 4 different types of machines
<table>
<tr><td></td><td></td><td colspan="4">Machine Type</td></tr>
<tr><td rowspan="6">Workers</td><td></td><td>A</td><td>B</td><td>C</td><td>D</td></tr>
<tr><td>1</td><td>44</td><td>38</td><td>47</td><td>36</td></tr>
<tr><td>2</td><td>46</td><td>40</td><td>52</td><td>43</td></tr>
<tr><td>3</td><td>34</td><td>36</td><td>44</td><td>32</td></tr>
<tr><td>4</td><td>43</td><td>38</td><td>46</td><td>33</td></tr>
<tr><td>5</td><td>38</td><td>42</td><td>49</td><td>39</td></tr>
</table>
Test whether the mean productivity is the same for the 4 different machines types and 5 different workers?</td>
<td>BTL -6</td>
<td>Creating</td>
</tr>
</table>

<table>
<tr>
<td>12.</td>
<td>Four different though supposedly equivalent forms of a standardized reading achievement test were given to each of 5 students and the following are the scores, which they obtained
<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="5">Student</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td rowspan="4">Form</td><td>A</td><td>75</td><td>73</td><td>59</td><td>69</td><td>84</td></tr>
<tr><td>B</td><td>83</td><td>72</td><td>56</td><td>70</td><td>92</td></tr>
<tr><td>C</td><td>86</td><td>61</td><td>53</td><td>72</td><td>88</td></tr>
<tr><td>D</td><td>73</td><td>67</td><td>62</td><td>79</td><td>95</td></tr>
</table>
Perform a two way analysis of variance to test at the level of significance 1%.</td>
<td>BTL -3</td>
<td>Applying</td>
</tr>
<tr>
<td>13.</td>
<td>A latin square design was used to compare the bond strength of gold semiconductor lead wires bounded to the lead terminal by five different methods A, B, C, D & E. The bonds were made by five different operators and the device were encapsulated using five different plastics. With the following result ,expressed as pounds of force required to break the bond
<table>
<tr><td>Plastics/ operator</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td>1</td><td>A3</td><td>B2.4</td><td>C1.9</td><td>D2.2</td><td>E1.7</td></tr>
<tr><td>2</td><td>B2.1</td><td>C2.7</td><td>D2.3</td><td>E2.5</td><td>A3.1</td></tr>
<tr><td>3</td><td>C2.1</td><td>D2.6</td><td>E2.5</td><td>A2.9</td><td>B2.1</td></tr>
<tr><td>4</td><td>D2.0</td><td>E2.5</td><td>B3.2</td><td>B2.5</td><td>C2.2</td></tr>
<tr><td>5</td><td>E2.1</td><td>A3.6</td><td>B2.4</td><td>C2.4</td><td>D2.1</td></tr>
</table>
Analyze these results and test with .01 level of significance.</td>
<td>BTL -4</td>
<td>Analyzing</td>
</tr>
</table>

<table>
<tr>
<td>14.</td>
<td>The following data resulted from an experiment to compare three burners A, B, C. A Latin square design was used as the tests were made on 3 engines and were spread over 3 days.
<table>
<tr><td>A 16</td><td>B 17</td><td>C 20</td></tr>
<tr><td>B 16</td><td>C 21</td><td>A 15</td></tr>
<tr><td>C 15</td><td>A 12</td><td>B 13</td></tr>
</table>
Test the hypothesis and infer that there is no difference between the burners.</td>
<td>BTL -4</td>
<td>Analyzing</td>
</tr>
<tr>
<td>15.</td>
<td>A farmer wishes to test the effects of four different fertilizers A,B,C, Don the yield of Wheat. In order to eliminate sources of error due to variability in soil fertility, he uses the fertilizers, in a Latin square arrangement a syndicated in the following table, where the numbers indicate yields per unit area.
<table>
<tr><td>A18</td><td>C21</td><td>D25</td><td>B11</td></tr>
<tr><td>D22</td><td>B12</td><td>A15</td><td>C19</td></tr>
<tr><td>B15</td><td>A20</td><td>C23</td><td>D24</td></tr>
<tr><td>C22</td><td>D21</td><td>B10</td><td>A17</td></tr>
</table>
Design an analysis of variance to determine if there is a significant difference between the fertilizers at $\alpha$=0.05 and $\alpha$=0.01 levels of significance.</td>
<td>BTL -4</td>
<td>Analyzing</td>
</tr>
<tr>
<td>16.</td>
<td>Set up the analysis of variance for the following results of a Latin Square Design(use $\alpha$ = 0.01) level of significance
<table>
<tr><td>A12</td><td>C19</td><td>B10</td><td>D8</td></tr>
<tr><td>C18</td><td>B12</td><td>D6</td><td>A7</td></tr>
<tr><td>B22</td><td>D10</td><td>A5</td><td>C21</td></tr>
<tr><td>D12</td><td>A7</td><td>C27</td><td>B17</td></tr>
</table>
</td>
<td>BTL -3</td>
<td>Applying</td>
</tr>
</table>

| | | | |
|---|---|---|---|
| 17. | In a 5x5 Latin square experiment, the data collected is given in the matrix below Yield per plot is given in quintals for the five different cultivation treatments A, B, C,D and E. Perform the analysis of variance.<br>A48 E66 D56 C52 B61<br>D64 B62 A50 E64 C63<br>B69 A53 C60 D61 E67<br>C57 D58 E67 B65 A55<br>E67 C57 B66 A60 D57 | BTL -4 | Analyzing |
| 18. | In a Latin square experiment given below are the yields in quintals per acre on the paddy crop carried out for testing the effect of five fertilizers A, B, C, D, E. Analyze the data for variations.<br>B25 A18 E27 D30 C27<br>A19 D31 C29 E26 B23<br>C28 B22 D33 A18 E27<br>E28 C26 A20 B25 D33<br>D32 E25 B23 C28 A20 | BTL -3 | Applying |
| **PART –C (15 Marks Questions)** | | | |
| 1. | A set of data involving 4 tropical food stuffs A, B, C, D tried on 20 chicks is given below. All the 20 chicks are treated alike in all respects except the feeding treatments and each feeding treatment is given to 5 chicks. Analyze the data:<br>A 55 49 42 21 52<br>B 61 112 30 89 63<br>C 42 97 81 95 92<br>D 169 137 169 85 154 | BTL -2 | Understanding |

<table>
<tr>
<td>2.</td>
<td>In a test given to two groups of students the marks obtained were as follows,<br><br>First group : 18 20 36 50 49 36 34 49 41<br><br>Second group: 29 28 26 35 30 41 46<br><br>Examine the significance difference between the means of marks secured by students of the above two groups.</td>
<td>BTL -3</td>
<td>Applying</td>
</tr>
<tr>
<td>3.</td>
<td>A company appoints 4 salesmen A, B, C and D and observes their sales in 3 seasons, summer winter and monsoon. The figures are given in the following table:
<table>
<tr><td></td><td colspan="4">Salesmen</td></tr>
<tr><td>Season</td><td>1</td><td>2</td><td>3</td><td>4</td></tr>
<tr><td>Summer</td><td>45</td><td>40</td><td>28</td><td>37</td></tr>
<tr><td>Winter</td><td>43</td><td>41</td><td>45</td><td>38</td></tr>
<tr><td>Monsoon</td><td>39</td><td>39</td><td>43</td><td>41</td></tr>
</table>
Carry out an Analysis of variances.</td>
<td>BTL -2</td>
<td>Understanding</td>
</tr>
<tr>
<td>4.</td>
<td>A variable trial was conducted on wheat with 4 varieties in a Latin square design. The plan of the experiment and the per plot yield are given below.<br><br>C25 B23 A20 D20<br><br>A19 D19 C21 B18<br><br>B19 A14 D17 C20<br><br>D17 C20 B21 A15</td>
<td>BTL -5</td>
<td>Evaluating</td>
</tr>
<tr>
<td>5.</td>
<td>A laboratory technician measures the breaking strength of each of five kinds of linen threads by using four different measuring instruments, and obtain the following results.
<table>
<tr><td rowspan="4">Thread</td><td></td><td colspan="4">Instruments</td></tr>
<tr><td></td><td>I1</td><td>I2</td><td>I3</td><td>I4</td></tr>
<tr><td>1</td><td>20.9</td><td>20.4</td><td>19.9</td><td>21.9</td></tr>
<tr><td>2</td><td>25</td><td>26.2</td><td>27.0</td><td>24.8</td></tr>
<tr><td>3</td><td>25.5</td><td>23.1</td><td>21.5</td><td>24.4</td></tr>
</table>
</td>
<td>BTL-1</td>
<td>Understanding</td>
</tr>
</table>

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 4 | 24.8 | 21.2 | 23.5 | 25.7 | |
| | | | 5 | 19.6 | 21.2 | 22.1 | 22.1 | |
| | Perform a 2-way ANOVA using the 0.05 level of significance. | | | | | | | |

**UNIT 5- 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 Marks)**

| Q. No. | Question | BT Level | Competence |
|---|---|---|---|
| 1. | What is Statistical quality control? | BTL2 | Understanding |
| 2. | Write down advantage of SQC. | BTL1 | Remembering |
| 3. | What is meant by chance variation? | BTL2 | Understanding |
| 4. | What is meant by Assignable variation? | BTL1 | Remembering |
| 5. | Name the types of Control Chart. | BTL1 | Remembering |
| 6. | Define product control | BTL2 | Understanding |
| 7. | Define process control | BTL2 | Understanding |
| 8. | What is control Chart? | BTL1 | Remembering |
| 9. | Write down uses of Mean Chart. | BTL3 | Applying |
| 10. | Write down types of Acceptance sampling plan | BTL1 | Remembering |
| 11. | What are the uses of Quality control chart | BTL3 | Applying |
| 12. | Write down types of Causes variation. | BTL4 | Analyzing |
| 13. | Write the formula for np chart. | BTL4 | Analyzing |
| 14. | The total number of defects in 20 pieces is 220 .what is the UCL and LCL? | BTL4 | Analyzing |
| 15. | Define c chart and p chart | BTL1 | Remembering |
| 16. | Define Acceptance Sampling. | BTL5 | Evaluating |
| 17. | Explain producers Risk and Consumer Risk. | BTL3 | Applying |
| 18. | Define Tolerance limits. | BTL6 | Creating |
| 19. | Define one-sided Tolerance limits. | BTL1 | Remembering |
| 20. | Define Two-Sided Tolerance limits. | BTL2 | Understanding |
| 21. | Write down the objectives of statistical quality control | BTL5 | Evaluating |
| 22. | A garment was sampled on 10 consecutive hours of production. The number of defects found per garment is given below: Defects: 5,1,7,0,2,3,4,0,3,2 Compute upper and lower control limits for monitoring number of defects. | BTL3 | Applying |
| 23. | Write down the control limits for mean chart. | BTL6 | Creating |

| | | | |
|---|---|---|---|
| 24. | Write down the control limits for range chart | BTL1 | Remembering |
| 25. | Write down the control limits for c-chart. | BTL2 | Understanding |

## PART-B(13 Marks)

| | | | |
|---|---|---|---|
| 1. | What do you understand by SQC. Discuss its utility and limitations? | BTL1 | Remembering |
| 2. | 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.<br>Sample \| Weight of the parts in ounces<br>1 \| 10 \| 12 \| 10 \| 12<br>2 \| 10 \| 12 \| 13 \| 13<br>3 \| 10 \| 10 \| 9 \| 11<br>4 \| 11 \| 10 \| 9 \| 14<br>5 \| 12 \| 12 \| 12 \| 12 | BTL6 | Creating |
| 3. | 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.<br>Sample No \| 1 \| 2 \| 3 \| 4 \| 5 \| 6 \| 7 \| 8 \| 9 \| 10<br>( $\overline{X}$ ) \| 43 \| 49 \| 37 \| 44 \| 45 \| 37 \| 51 \| 46 \| 43 \| 47<br>R \| 5 \| 6 \| 5 \| 7 \| 7 \| 4 \| 8 \| 6 \| 4 \| 6 | BTL2 | Understanding |
| 4. | For a sampling plan N = 1,200, n = 64 and c = 1, determine the probability of acceptance of the following lots; (i) 0.5%defective, (ii) 0.8%defective, (iii) 1%defective, (iv) 2%defective, (v) 4% defective, (vi) 10%defective. Also draw and OC curve. | BTL2 | Understanding |
| 5. | 10 samples each of size 50 were inspected and the number of defectives in the inspection were: 2,1,1,2,3,5,5,1,2,3.Draw the appropriate control chart for defectives. | BTL1 | Remembering |
| 6. | 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:<br>Sample No \| 1 \| 2 \| 3 \| 4 \| 5 \| 6 \| 7 \| 8 \| 9 \| 10<br>( $\overline{X}$ ) \| 15 \| 17 \| 15 \| 18 \| 17 \| 14 \| 18 \| 15 \| 17 \| 16<br>R \| 7 \| 7 \| 4 \| 9 \| 8 \| 7 \| 12 \| 4 \| 11 \| 5<br>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.<br>(Conversion factors for $n = 5$ are $A_2 = 0.58$ $D_3 = 0, D_4 = 2.115$) | BTL3 | Applying |
| 7. | Explain in detail the R-Chart clearly | BTL1 | Remembering |
| 8. | 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.<br>Sample No \| 1 \| 2 \| 3 \| 4 \| 5 \| 6 \| 7 \| 8 \| 9 \| 10<br>( $\overline{X}$ ) \| 11.2 \| 11.8 \| 10.8 \| 11.6 \| 11 \| 9.6 \| 10.4 \| 9.6 \| 10.6 \| 10<br>R \| 7 \| 4 \| 8 \| 5 \| 7 \| 4 \| 8 \| 4 \| 7 \| 9<br>(Conversion factors for $n = 5$ are $A_2 = 0.577$ $D_3 = 0, D_4 = 2.115$) | BTL3 | Applying |

<table>
<tr><td>9.</td><td>Explain in detail the $\overline{X}$ Chart clearly?</td><td>BTL1</td><td>Remembering</td></tr>
<tr><td>10.</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>BTL4</td><td>Analyzing</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>
Also determine whether the process is in control.</td><td>BTL5</td><td>Evaluating</td></tr>
<tr><td>12.</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>BTL5</td><td>Evaluating</td></tr>
<tr><td>13.</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>BTL6</td><td>Creating</td></tr>
<tr><td>14(a).</td><td>Explain Control Limits for the sample mean $\bar{X}$ and sample range R.</td><td>BTL1</td><td>Remembering</td></tr>
<tr><td>14(b).</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>BTL6</td><td>Creating</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>BTL4</td><td>Analyzing</td></tr>
<tr><td>16.</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>BTL4</td><td>Analyzing</td></tr>
</table>

| | | | |
|---|---|---|---|
| 17. | 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 | BTL2 | Understanding |
| 18. | The following data gives the average life in hours and range in hours of 12 samples each of 5 lamps. Construct X - chart and R- chart, comment on state of control. | BTL4 | Analyzing |

| Sample no | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean X | 120 | 127 | 152 | 157 | 160 | 134 | 137 | 123 | 140 | 144 | 120 | 127 |
| Range R | 30 | 44 | 60 | 34 | 38 | 35 | 45 | 62 | 39 | 50 | 35 | 41 |

**PART-C(15 Marks)**

| | | | |
|---|---|---|---|
| 1. | 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. | BTL6 | Creating |

| Sample No. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 |

| | | | |
|---|---|---|---|
| 2. | 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. | BTL2 | Understanding |

| Samples | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| $\overline{X}$ | 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 |
| $\overline{X}$ | 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 |

(Given for $n = 5$ are $A_2 = 0.58$ $D_3 = 0, D_4 = 2.12$)

| | | | |
|---|---|---|---|
| 3. | The following table gives the inspection data relating to 10 samples of 100 items each, concerning the production of bottle corks. | BTL2 | Understanding |

| 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 | | |
| | Construct a p- chart. | | | | | | |
| 4. | 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. | | | | | | BTL3 | Applying |
| | 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 | |
| | (Given for n = 6,$A_2 = 0.483$ $D_3 = 0, D_4 = 2.004$) | | | | | | | |
| 5. | The following data give the measurements of 10 samples each of size 5 in the production process taken in an interval of 2 hours. Calculate the sample means and ranges and draws the control charts for mean and range. | | | | | | | | | | | BTL3 | Applying |
| | | Sample Number | | | | | | | | | | | |
| | Observed Measurements X | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
| | | 49 | 50 | 50 | 48 | 47 | 52 | 49 | 55 | 53 | 54 | | |
| | | 55 | 51 | 53 | 53 | 49 | 55 | 49 | 55 | 50 | 54 | | |
| | | 54 | 53 | 48 | 51 | 50 | 47 | 49 | 50 | 54 | 52 | | |
| | | 49 | 46 | 52 | 50 | 44 | 56 | 53 | 53 | 47 | 54 | | |
| | | 53 | 50 | 47 | 53 | 45 | 50 | 45 | 57 | 51 | 56 | | |