# VALLIAMMAI ENGINEERING COLLEGE

**S.R.M. Nagar, Kattankulathur - 603203**

## DEPARTMENT OF MATHEMATICS

## QUESTION BANK

## II YEAR / IV SEMESTER

**B.TECH-IT – 1, 2 & 3**

## MA8391- PROBABILITY AND STATISTICS

**Regulation – 2017**

**Academic Year – 2018 - 19**

***Prepared by***

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# VALLIAMMAI ENGNIEERING COLLEGE

**SRM Nagar, Kattankulathur – 603203.**

## DEPARTMENT OF MATHEMATICS

## UNIT I PROBABILITY AND RANDOM VARIABLES

Probability – Axioms of probability – Conditional probability – Baye's theorem – Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions.

| S.No | QUESTIONS | BTLevel | Competence |
|---|---|---|---|
| | **PART - A** | | |
| 1. | If the probability density function of a random variable X is f(x) = ¼ in – 2 < x < 2 find P($\|x\| > 1$) | BTL1 | Remembering |
| 2. | If X is a geometric variate, taking values 1,2,3…..∞, $find\ P(X\ is\ odd)$ | BTL1 | Remembering |
| 3. | State the memory less property of the exponential distribution. | BTL1 | Remembering |
| 4. | The mean and variance of binomial distribution are 5 and 4 Find the distribution of *X*. | BTL1 | Remembering |
| 5. | The mean of Binomial distribution is 20 and standard deviation is 4. Find the parameters of the distribution. | BTL1 | Remembering |
| 6. | If the events $A$ and $B$ are independent then show that $\bar{A}$ and $\bar{B}$ are independent. | BTL1 | Remembering |
| 7. | If a random variable X takes values 1,2,3, 4 such that $2P(X=1)=3P(X=2)=P(X=3)=5P(X=4)$. Find the probability distribution of X. | BTL2 | Understanding |
| 8. | Find the Moment generating function of a continuous random variable X whose pdf is $f(x)=\begin{cases} xe^{x/2}, & x>0 \\ 0, & x\le 0 \end{cases}$ | BTL2 | Understanding |
| 9. | 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. | BTL2 | Understanding |
| 10. | If a random variable X has the MGF $M_X$(t) =$\frac{2}{2-t}$ . Find the standard deviation of X. | BTL2 | Understanding |
| 11. | Show that the function $f(x) = \begin{cases} e^{-x}, & x \ge 0 \\ 0, & x < 0 \end{cases}$ is a probability density function of a continuous random variable X. | BTL3 | Applying |
| 12. | Show that the moment generating function of the uniform distribution $f(x) = \frac{1}{2a}, -a < x < a,$ about origin is $\frac{sinh(at)}{at}$. | BTL3 | Applying |
| 13. | If the MGF of a uniform distribution for a RV X is $\frac{1}{t}(e^{5t} - e^{4t})$. Find E(X). | BTL3 | Applying |
| 14. | $A$ is known to hit the target in 2 out of 5 shots whereas $B$ is known to hit the target in 3 of 4 shots. Find the probability of the target being hit when they both try? | BTL4 | Analyzing |
| 15. | If the probability that a communication system has high selectivity is 0.54 and the probability that it will have fidelity is 0.81 and the probability that it will have both is 0.18. Find the probability that a system with high fidelity will have high selectivity. | BTL4 | Analyzing |
| 16. | If A dn B are events in S such that $P(A) = 1/3$ , $P(B) = 1/4$ and $P(A \cup A) = 1/2$ . Find $P(A \cap \bar{B})$ and $P(A\|\bar{B})$. | BTL4 | Analyzing |
| 17. | The number of hardware failures of a computer system in a week of | BTL5 | Evaluating |

<table>
<tr><td></td><td>operations has the following p.d.f. Find the mean of the number of failures in a week.<br><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></td><td></td></tr>
<tr><td>18.</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.<br><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>BTL5</td><td>Evaluating</td></tr>
<tr><td>19.</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>BTL6</td><td>Creating</td></tr>
<tr><td>20.</td><td>The probability that a candidate can pass in an examination is 0.6. What is the probability that he will pass in third trial?</td><td>BTL6</td><td>Creating</td></tr>
<tr><td colspan="4"><b>PART – B</b></td></tr>
<tr><td>1. (a)</td><td>A random variable X has the following probability distribution:<br><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 $k$<br>(ii) $P(1.5 < X < 4.5 / X > 2)$</td><td>BTL1</td><td>Remembering</td></tr>
<tr><td>1. (b)</td><td>Find the MGF of Binomial distribution and hence find its mean and variance</td><td>BTL2</td><td>Understanding</td></tr>
<tr><td>2. (a)</td><td>A bolt is manufactured by 3 machines <i>A</i>, <i>B</i>, and <i>C</i>. <i>A</i> turns out twice as many items as <i>B</i> and machines <i>B</i> and <i>C</i> produce equal number of items. 2% of bolts produced by <i>A</i> and <i>B</i> are defective and 4% of bolts produced by <i>C</i> are defective. All bolts are put into 1 stock pile and 1 is chosen from this pile. What is the probability that it is defective?</td><td>BTL2</td><td>Understanding</td></tr>
<tr><td>2. (b)</td><td>Find the moment generating function of a geometric random variable. Also find its mean.</td><td>BTL1</td><td>Remembering</td></tr>
<tr><td>3. (a)</td><td>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)</td><td>BTL1</td><td>Remembering</td></tr>
<tr><td>3. (b)</td><td>Find the MGF of Poisson distribution and hence find its mean and variance.</td><td>BTL3</td><td>Applying</td></tr>
<tr><td>4. (a)</td><td>An urn contains 10 white and 3 black balls. Another urn contains 3 white and 5 black balls. Two balls are drawn at random from the first urn and placed in the second urn and then 1 ball is taken at random from the latter. What is the probability that it is a white ball?</td><td>BTL2</td><td>Understanding</td></tr>
<tr><td>4. (b)</td><td>Find the MGF of Uniform distribution and hence find its mean and variance.</td><td>BTL4</td><td>Analyzing</td></tr>
<tr><td>5. (a)</td><td>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 pdf 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?</td><td>BTL3</td><td>Understanding</td></tr>
<tr><td>5. (b)</td><td>The probability of a man hitting a target is 1.4. If he fires 7 times, what is the probability of his hitting the target at least twice? And how many times must he fire so that the probability of his hitting the target at least once is greater than 2/3?</td><td>BTL5</td><td>Evaluating</td></tr>
</table>

| | | | |
|---|---|---|---|
| 6. (a) | A random variable X has cdf $F(x) = \begin{cases} 0, if\ x < -1 \\ a(1+x), if\ -1 < x < 1 \\ 1, if\ x \geq 1 \end{cases}$.<br>Find the value of a. also P(X>1/4 ) and $P(-0.5 \leq X \leq 0)$. | BTL2 | Understanding |
| 6. (b) | State and Prove forget fullness property of exponential distribution . Using this property solve the following problem:<br>The length of the shower on a tropical island during the rainy season has on exponential distribution with parameter 2, time being measured in minutes. What is the probability that a shower will last more than 3 minutes. | BTL3 | Applying |
| 7. (a) | In a normal population with mean 15 and standard deviation 3.5, it is found that 647 observations exceed 16.25. What is the total number of observations in the population. | BTL5 | Evaluating |
| 7. (b) | If the probability mass function of a RV X is given by<br>$P(X = x) = k\,x^3$, $x = 1,2,3,4$, Find the value of k,<br>$P\left[\left(\frac{1}{2} < X < \frac{3}{2}\right) / X > 1\right]$, mean and variance of X. | BTL2 | Understanding |
| 8. (a) | 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? | BTL1 | Remembering |
| 8. (b) | A bag contains 5 balls and it is not known how many of them are white. Two balls are drawn at random from the bag and they are noted to be white. What is the change that all balls in the bag are white? | BTL6 | Evaluating |
| 9. (a) | 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 | BTL1 | Remembering |
| 9. (b) | 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. | BTL6 | Creating |
| 10. (a) | In a certain city , the daily consumption of electric power in millions of kilowatt hours can be treated as a RV having Gamma distribution with parameters λ = ½ and k =3.If the power plant of this city has a daily capacity of 12 million kilowatt – hours, Find the probability that this power supply will be inadequate on any given day? | BTL1 | Remembering |
| 10. (b) | 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. | BTL4 | Analyzing |
| 11. (a) | 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 10 are good in mathematics. | BTL1 | Remembering |
| 11. (b) | The life (in years) of a certain electrical switch has an exponential distribution with an average life of $\frac{1}{\lambda} = 2$. If 100 of these switches are installed in different systems; find the probability that atmost 30 fail during the first year. | BTL2 | Understanding |
| 12. (a) | The probability mass function of a discrete R. V X is given in the following table: | BTL2 | Understanding |

<table>
<tr><td></td><td><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) the value of $k$, (2) P(X<1), (3) $P(-1< X \le 2)$, (4) E(X)</td><td></td><td></td></tr>
<tr><td>12. (b)</td><td>Let X be a continuous R.V with probability density function<br>$f(x)=\begin{cases} xe^{-x}, & x>0 \\ 0 \;, & otherwise \end{cases},$<br>Find (1) The cumulative distribution of X,<br>(2)Moment Generating Function $M_x(t)$ of X,<br>(3) P(X<2),<br>(4) E(X)</td><td>BTL1</td><td>Remembering</td></tr>
<tr><td>13. (a)</td><td>Find the MGF of the random variable X having the probability density function f(x) = $\begin{cases} \frac{x}{4}e^{-x/2} & x>0 \\ 0 & \text{otherwise.} \end{cases}$ Also find the first four moments about the origin.</td><td>BTL1</td><td>Remembering</td></tr>
<tr><td>13. (b)</td><td>Let X be a Uniformly distributed R. V. over [-5, 5]. Determine<br>(i) $P(X\le 2)$ (ii) P(|X|>2) (iii) Cumulative distribution function of X (iv) Var(X).</td><td>BTL3</td><td>Applying</td></tr>
<tr><td>14. (a)</td><td>The Probability distribution function of a R.V. X is given by<br>$f(x)=\frac{4x(9-x^2)}{81}, \; 0\le x\le 3$. Find the mean, variance and 3rd moment about origin.</td><td>BTL2</td><td>Understanding</td></tr>
<tr><td>14. (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>BTL1</td><td>Remembering</td></tr>
</table>

## UNIT II - TWO - DIMENSIONAL RANDOM VARIABLES

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).

| Q.No. | Question | BT Level | Competence |
|---|---|---|---|
| | | | |
| 1. | Define the distribution function of two dimensional random variables (X,Y) . State any two properties. | BTL -1 | Remembering |
| 2. | 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 $P(X+Y\le 1)$. | BTL -1 | Remembering |
| 3. | 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) | BTL -1 | Remembering |
| 4. | The joint probability density function of the random variable (X,Y) is given by f(x, y) = $Kxye^{-(x^2+y^2)}$ , $x>0, \; y>0$ Calculate the value of K. | BTL -3 | Applying |
| 5. | If X has mean 4 and variance 9 while Y has mean -2 and variance 5, they two are independent, Identify Var (2X + Y-5 ). | BTL -1 | Remembering |
| 6. | Assume that the random variable X and Y have the probability density function f(x,y). What is E(E(X/Y)) ?. | BTL -1 | Remembering |

| | | | |
|---|---|---|---|
| 7. | If random variables X and Y have the joint density function $f(x,y) = \frac{1}{8}(6 - x - y)$ for $0 < x < 2$ and $2 < y < 4$, then find $P[X + Y < 3]$. | BTL -3 | Applying |
| 8. | If the joint probability density function of a random variable X and Y is given by $f(x,y) = \begin{cases} \frac{x^3y^3}{16}, 0 < x < 2, 0 < y < 2 \\ 0, \qquad otherwise \end{cases}$. Find the marginal functions of X and Y. | BTL -3 | Applying |
| 9. | If X and Y have joint pdf f(x,y) = $\begin{cases} x + y\ , 0 < x < 1,\ 0 < y < 1 \\ \qquad 0,\ otherwise \end{cases}$<br>Discuss whether X and Y are independent. | BTL -2 | Understanding |
| 10. | The joint probability mass function of a two dimensional random variable (X,Y) is given by $p(x,y) = k(2x + 3y), x = 0,1,2; y = 1,2,3$. Evaluate $k$. | BTL -5 | Evaluating |
| 11. | If X and Y are RVs such that Y = aX + b where a and b are real constants ,show that the correlation coefficient between them has magnitude 1. | BTL -3 | Applying |
| 12. | What do you mean by correlation between two random variables | BTL -1 | Remembering |
| 13. | Distinguish between correlation and regression. | BTL -2 | Understanding |
| 14. | 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 -4 | Analyzing |
| 15. | The regression equations are x + 6y = 14 and 2x + 3y = 1.Point out the correlation coefficient between X & Y **.** | BTL -4 | Analyzing |
| 16. | If $\bar{X} = 970$ , $\bar{Y} = 18, \sigma_x = 38$ , $\sigma_y$= 2 and r =0.6 , Find the line of regression and obtain the value of X and Y = 20. | BTL -4 | Analyzing |
| 17. | Give the acute angle between the two lines of regression. | BTL -2 | Understanding |
| 18. | The correlation coefficient of two random variables X and Y is - $\frac{1}{4}$ and their variances are 3 and 5. Find the covariance. | BTL -5 | Evaluating |
| 19. | The two regression lines X+6Y=14, 2X+3Y=1. Find the mean values of X and Y. | BTL -6 | Creating |
| 20. | State Central Limit Theorem. | BTL -1 | Remembering |
| | **PART - B** | | |
| 1.(a) | 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, Identify the probability distribution of X and Y. | BTL -1 | Remembering |
| 1. (b) | If X, Y are RV's having the joint density function<br>$f(x,y) = k(6 - x - y), 0 < x < 2, 2 < y < 4$, Point out<br>$(i)\ P\ (x < 1\ , y < 3)\ ii\ )\ P\ (x < 1\ /y < 3)\ iii)P(\ y < 3/x < 1)$<br>$iv)\ P(X + Y\ <\ 3\ )$ | BTL -4 | Analyzing |
| 2.(a) | The joint distribution of X and Y is given by $f(x,y) = \frac{x+y}{21}$,<br>$x = 1,2,3; y = 1,2$. Find the marginal distributions. | BTL-3 | Applying |
| 2.(b) | If the joint probability distribution function of a two dimensional random variable (X,Y) is given by $F(x,y) = \begin{cases} (1 - e^{-x})(1 - e^{-y}); x > 0, y > 0 \\ \qquad 0, \qquad otherwise \end{cases}$.<br>Calculate the marginal densities of X and Y.Are X and Y independent?<br>$Find\ P[1 < X < 3, 1 < Y < 2]$ | BTL -3 | Applying |
| 3. (a) | If the joint pdf of (X, Y) is given by p(x, y)= K(2x+3y), x=0, 1, 2, 3. Find all the marginal probability distribution. Also find the probability distribution of (X+Y). | BTL-3 | Applying |

<table>
<tr><td>3.(b)</td><td>The joint pdf of X and Y is given by<br>f(x,y)=$\begin{cases} kx(x-y), 0<x<2\,, -x<y<x \\ 0, \quad otherwise \end{cases}$<br>(i)Find K (ii) Find $f_x(x)$ and $f_y(y)$ (iii) $f_{\frac{y}{x}}\left(\frac{y}{x}\right)$</td><td>BTL -1</td><td>Remembering</td></tr>
<tr><td>4. (a)</td><td>The joint pdf of (X,Y) is given by<br>$f(x,y)=\begin{cases} 24xy;\ x>0, y>0, x+y\ \le 1 \\ 0, \quad otherwise \end{cases}$<br>Find the conditional mean and variance of Y given X.</td><td>BTL-3</td><td>Applying</td></tr>
<tr><td>4.(b)</td><td>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>(1) Find K.<br>(2) Find P(X+Y<1).<br>(3) Are X and Y independent R.V’s.</td><td>BTL-3</td><td>Applying</td></tr>
<tr><td>5. (a)</td><td>From the following table for bivariate distribution of (X, Y). Find (i) $P(X\le 1)$ (ii) $P(Y\le 3)$ (iii) $P(X\le 1, Y\le 3)$ (iv) $P(X\le 1/\,Y\le 3)$ (v) $P(Y\le 3/\,X\le 1)$ (vi) $P(X+Y\le 4)$
<table>
<tr><td>Y<br>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></tr>
<tr><td>5.(b)</td><td>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) $P(X<Y)$ (iv) $P(X+Y)\le 1$.</td><td>BTL-1</td><td>Remembering</td></tr>
<tr><td>6. (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 for X= $x$. Also find the conditional distribution of Y given X=1.</td><td>BTL-3</td><td>Applying</td></tr>
<tr><td>6.(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></tr>
<tr><td>7. (a)</td><td>The following table represents the joint probability distribution of RV (X, Y). Find the marginal distributions.
<table>
<tr><td>Y</td><td colspan="3">X</td></tr>
<tr><td></td><td>0</td><td>1</td><td>2</td></tr>
<tr><td>0</td><td>$\frac{3}{28}$</td><td>$\frac{9}{28}$</td><td>$\frac{3}{28}$</td></tr>
<tr><td>1</td><td>$\frac{3}{14}$</td><td>$\frac{3}{14}$</td><td>0</td></tr>
<tr><td>2</td><td>$\frac{1}{28}$</td><td>0</td><td>0</td></tr>
</table></td><td>BTL-3</td><td>Applying</td></tr>
<tr><td>7. (b)</td><td>If the joint pdf of a two-dimensional RV(X,Y) is given by<br>. $f(x,y)=\begin{cases} x^2+\frac{xy}{3}; 0<x<1, 0<y<2 \\ 0,\ elsewhere \end{cases}$. Find (i) $P\left(X>\frac{1}{2}\right)$</td><td>BTL-3</td><td>Applying</td></tr>
</table>

<table>
<tr><td></td><td>(ii) $P(Y < X)$and (iii) $P\left(Y < \frac{1}{2} / X < \frac{1}{2}\right)$</td><td></td><td></td></tr>
<tr><td>8. (a)</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), Estimate the correlation coefficient $\rho$.</td><td>BTL -2</td><td>Understanding</td></tr>
<tr><td>8.(b)</td><td>Two independent random variables X and Y are defined by<br>$f_X(x) = \left\{\begin{matrix} 4ax: & 0 < x < 1 \\ 0: otherwise & \end{matrix}\right\}$ And $f_Y(y) = \left\{\begin{matrix} 4by: & 0 < y < 1 \\ 0: otherwise & \end{matrix}\right\}$ Show that U=X+Y and V=X-Y are uncorrelated</td><td>BTL -3</td><td>Applying</td></tr>
<tr><td>9. (a)</td><td>From the following data , Give (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</td><td>BTL -2</td><td>Understanding</td></tr>
<tr><td>9.(b)</td><td>Two random variables X and Y have the following joint probability density function $f(x,y) = \begin{cases} x + y; 0 \le x \le 1, 0 \le y \le 1 \\ 0, \ otherwise \end{cases}$. Formulate the probability density function of the random variable U = XY.</td><td>BTL -6</td><td>Creating</td></tr>
<tr><td>10.(a)</td><td>Estimate the correlation coefficient for the following heights of fathers X, their sons Y
<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 -2</td><td>Understanding</td></tr>
<tr><td>10.(b)</td><td>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.</td><td>BTL -4</td><td>Analyzing</td></tr>
<tr><td>11.(a)</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></tr>
<tr><td>11.(b)</td><td>Let (x, y) be a two-dimensional non-negative continuous random variable having the joint density. $f(x,y) = \begin{cases} 4xy\, e^{-(x^2+y^2)}; x \ge 0, y \ge 0 \\ 0, \ otherwise \end{cases}$. Find the density function of U = $\sqrt{x^2 + y^2}$.</td><td>BTL-1</td><td>Remembering</td></tr>
<tr><td>12.(a)</td><td>If X and Y independent Random Variables with pdf $e^{-x}, x \ge 0$ and $e^{-y}, y \ge 0$. Find the density function of $U = \frac{X}{X+Y}$ and $V = X + Y$. Are they independent.</td><td>BTL -1</td><td>Remembering</td></tr>
<tr><td>12.(b)</td><td>A distribution with unknown mean has variance equal to 1.5. Use central limit theorem to find how large a sample should be taken from the distribution in order that the probability will be atleast 0.95 that the sample mean will be within 0.5 of the population mean.</td><td>BTL -4</td><td>Analyzing</td></tr>
<tr><td>13.(a)</td><td>Two random variables X and Y have the joint density<br>f(x,y) = $\begin{cases} 2 - x - y, 0 < x < 1, 0 < y < 1 \\ 0, otherwise \end{cases}$</td><td>BTL -6</td><td>Creating</td></tr>
</table>

<table>
<tr><td></td><td>Calculate the Correlation coefficient between X and Y is -1 /11.</td><td></td><td></td></tr>
<tr><td>.(b)</td><td>The following gives the likely prices X and Y of a commodity at two cities<table><tr><td></td><td>X</td><td>Y</td></tr><tr><td>Mean</td><td>65</td><td>67</td></tr><tr><td>SD</td><td>2.5</td><td>3.5</td></tr></table>The coefficient of correlation between X and Y is 0.8<br>Find (i) The regression line of Y on X<br>(ii) The likely price of Y when X = 70.</td><td>BTL -4</td><td>Analyzing</td></tr>
<tr><td>14.(a)</td><td>If X and Y each follow an exponential distribution with parameter 1and are independent, find the pdf of U = X-Y.</td><td>BTL-2</td><td>Understanding</td></tr>
<tr><td>14.(b)</td><td>Given $f(x,y) = \frac{1}{8}(x+y), 0 \le x \le 2, 0 \le y \le 2$ is the joint pdf of X and Y. Obtain the correlation coefficient between X and Y.</td><td>BTL-4</td><td>Analyzing</td></tr>
</table>

## UNIT III -TESTING OF HYPOTHESIS

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

| Q.No. | Question | BT Level | Competence |
|---|---|---|---|
| 1. | Define the following terms (i)Statistic, (ii)parameter (iii)Standard error (iv)Random sampling | BTL -1 | Remembering |
| 2. | Mention the various steps involved in testing of hypothesis | BTL -1 | Remembering |
| 3. | What are null and alternate hypothesis? | BTL -1 | Remembering |
| 4. | What is the essential difference between confidence limits and tolerance limits? | BTL -1 | Remembering |
| 5. | What are the parameters and statistics in sampling | BTL -1 | Remembering |
| 6. | State level of significance. | BTL -1 | Remembering |
| 7. | 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 |
| 8. | 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 μ = 7.0 ounces against the null hypothesis that, on the average, the machine dispenses<br>μ < 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. | BTL -2 | Understanding |
| 9. | In a large city A, 20 percent of a random sample of 900 school boys had a slight physicaldefect. In another large city B, 18.5 percent of a random sample of 1600 school boys had somedefect. Is the difference between the proportions significant? | BTL -2 | Understanding |
| 10. | 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 | BTL -2 | Understanding |

<table>
<tr><td></td><td>the net weight is 5 kg per tin at 5% level of significance?</td><td></td><td></td></tr>
<tr><td>11.</td><td>Write down the formula of test statistic‘t’ to test the significance of difference between the means.</td><td>BTL -3</td><td>Applying</td></tr>
<tr><td>12.</td><td>What are the applications of t-test?</td><td>BTL -3</td><td>Applying</td></tr>
<tr><td>13.</td><td>What is the assumption of t-test?</td><td>BTL -6</td><td>Creating</td></tr>
<tr><td>14.</td><td>Write the application of ‘F’ test.</td><td>BTL -4</td><td>Analyzing</td></tr>
<tr><td>15.</td><td>Define ‘F’ variate.</td><td>BTL -4</td><td>Analyzing</td></tr>
<tr><td>16.</td><td>What are the properties of “F” test?</td><td>BTL -3</td><td>Applying</td></tr>
<tr><td>17.</td><td>State any two applications of $\psi^2$-test.</td><td>BTL -5</td><td>Evaluating</td></tr>
<tr><td>18.</td><td>Write the formula for the chi- square test of goodness of fit of a random sample to a hypothetical distribution.</td><td>BTL -5</td><td>Evaluating</td></tr>
<tr><td>19.</td><td>Give the main use of $\psi^2$-test</td><td>BTL -6</td><td>Creating</td></tr>
<tr><td>20.</td><td>What are the expected frequencies of 2x2 contingency table?
<table>
<tr><td>a</td><td>b</td></tr>
<tr><td>c</td><td>d</td></tr>
</table></td><td>BTL -4</td><td>Analyzing</td></tr>
<tr><td colspan="4"><b>PART – B</b></td></tr>
<tr><td>1.(a)</td><td>Given a sample mean of 83, a sample standard deviation of 12.5 and a sample size of 22 ,test the hypothesis that the value of the population mean is 70 against the alternative that it is more than 70. Use the 0.25 significance level .</td><td>BTL -1</td><td>Remembering</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
<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 -1</td><td>Remembering</td></tr>
<tr><td>2. (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? Also estimate the 95% fiducial limits for the mean.</td><td>BTL -1</td><td>Remembering</td></tr>
<tr><td>2.(b)</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?
<table>
<tr><td colspan="6">Hair color</td></tr>
<tr><td rowspan="5">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>
<tr><td>Brown</td><td>25</td><td>15</td><td>20</td><td>60</td></tr>
<tr><td>Total</td><td>60</td><td>30</td><td>60</td><td>150</td></tr>
</table></td><td>BTL -1</td><td>Remembering</td></tr>
</table>

<table>
<tr><td>3. (a)</td><td>Two independent samples of sizes 8 and 7 contained the following values.
<table>
<tr><td>Sample I</td><td>19</td><td>17</td><td>15</td><td>21</td><td>16</td><td>18</td><td>16</td><td>14</td></tr>
<tr><td>Sample II</td><td>15</td><td>14</td><td>15</td><td>19</td><td>15</td><td>18</td><td>16</td><td></td></tr>
</table>
Test if the two populations have the same mean.</td><td>BTL -2</td><td>Understanding</td></tr>
<tr><td>3.(b)</td><td>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.
<table>
<tr><td>Days</td><td>Sun</td><td>Mon</td><td>Tues</td><td>Wed</td><td>Thu</td><td>Fri</td><td>Sat</td></tr>
<tr><td>No. of accidents</td><td>14</td><td>16</td><td>08</td><td>12</td><td>11</td><td>9</td><td>14</td></tr>
</table></td><td>BTL -3</td><td>Applying</td></tr>
<tr><td>4. (a)</td><td>Two independent samples of 8 and 7 items respectively had the
<table>
<tr><td>Sample I</td><td>9</td><td>11</td><td>13</td><td>11</td><td>15</td><td>9</td><td>12</td><td>14</td></tr>
<tr><td>Sample II</td><td>10</td><td>12</td><td>10</td><td>14</td><td>9</td><td>8</td><td>10</td><td></td></tr>
</table>
following Values of the variable (weight in kgs.) Use 0.05 LOS to test whether the variances of the two population's sample are equal.</td><td>BTL -4</td><td>Analyzing</td></tr>
<tr><td>4.(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 -4</td><td>Analyzing</td></tr>
<tr><td>5. (a)</td><td>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)
<table>
<tr><td>Diet A</td><td>5</td><td>6</td><td>8</td><td>1</td><td>12</td><td>4</td><td>3</td><td>9</td><td>6</td><td>10</td></tr>
<tr><td>Diet B</td><td>2</td><td>3</td><td>6</td><td>8</td><td>10</td><td>1</td><td>2</td><td>8</td><td>-</td><td>-</td></tr>
</table>
Find the variances are significantly different. (Use F-test)</td><td>BTL -5</td><td>Evaluating</td></tr>
<tr><td>5.(b)</td><td>The marks obtained by a group of 9 regular course students and another group of 11 part timecourse students in a test are given below :
<table>
<tr><td>Sample I</td><td>56</td><td>62</td><td>63</td><td>54</td><td>60</td><td>51</td><td>67</td><td>69</td><td>58</td><td></td><td></td></tr>
<tr><td>Sample II</td><td>62</td><td>70</td><td>71</td><td>62</td><td>60</td><td>56</td><td>75</td><td>64</td><td>72</td><td>68</td><td>66</td></tr>
</table>
Examine whether the marks obtained by regular students and part-time students differ significantly at 5% and 1% levels of significance.</td><td>BTL -2</td><td>Understanding</td></tr>
<tr><td>6. (a)</td><td><table>
<tr><td>Sample I</td><td>19</td><td>17</td><td>15</td><td>21</td><td>16</td><td>18</td><td>16</td><td>14</td></tr>
<tr><td>Sample II</td><td>15</td><td>14</td><td>15</td><td>19</td><td>15</td><td>18</td><td>16</td><td></td></tr>
</table>
Two independent samples of sizes 8 and 7 contained the following values. Test if the two populations have the same variance.</td><td>BTL -2</td><td>Understanding</td></tr>
<tr><td>6.(b)</td><td>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 significant?</td><td>BTL -3</td><td>Applying</td></tr>
</table>

<table>
<tr><td>7. (a)</td><td>Records taken of the number of male and female births in 800 families having four Children are as follows :<br>Number of male births : 0 1 2 3 4<br>Number of female births : 4 3 2 1 0<br>Number of Families : 32 178 290 236 64<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>BTL -4</td><td>Analyzing</td></tr>
<tr><td>7. (b)</td><td>Samples of two types of electric bulbs were tested for length of life and following data were obtained.
<table>
<tr><td></td><td>Type I</td><td>Type II</td></tr>
<tr><td>Sample Size</td><td>8</td><td>7</td></tr>
<tr><td>Sample Mean</td><td>1234hrs</td><td>1036hrs</td></tr>
<tr><td>Sample S.D</td><td>36hrs</td><td>40hrs</td></tr>
</table>
Analyze that, is the difference in the means sufficient to warrant that type I is superior to type II regarding the length of life?</td><td>BTL -3</td><td>Applying</td></tr>
<tr><td>8. (a)</td><td>A survey of 320 families with 5 children each revealed the following distribution
<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>
Is this result consistent with the hypothesis that male and female births are equally probable?</td><td>BTL -6</td><td>Creating</td></tr>
<tr><td>8.(b)</td><td>The mean produce of wheat from a sample of 100 fields comes to 200kg per acre and another sample of 150 fields gives a mean 220 kg per acre. Assuming the standard deviation of the yield at 11 kg for the universe, test if there is a significant difference between the means of the samples?</td><td>BTL -2</td><td>Understanding</td></tr>
<tr><td>9. (a)</td><td>The nicotine content in milligram of two samples of toboco where found to be as follows<br>Sample 1 24 27 26 21 25<br>Sample 2 27 30 28 31 22 36<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>9.(b)</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>BTL -1</td><td>Remembering</td></tr>
<tr><td>10.(a)</td><td>Two random samples gave the following results:
<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>
Analyze whether the samples have come from the same normal population.</td><td>BTL -1</td><td>Remembering</td></tr>
<tr><td>10.(b)</td><td>A certain medicine administered to each of 10 patients resulted in the following increases in the B.P. 8, 8, 7, 5, 4, 1, 0, 0, -1, -1. Can it be</td><td>BTL -1</td><td>Remembering</td></tr>
</table>

<table>
<tr><td></td><td>concluded that the medicine was responsible for the increase in B.P. 5% l.o.s</td><td></td><td></td></tr>
<tr><td>11.(a)</td><td>Mechanical engineers testing a new arc welding technique, classified welds both with respect to appearance and an X-ray inspection
<table>
<tr><td>X-ray/Appearance</td><td>Bad</td><td>Normal</td><td>Good</td></tr>
<tr><td>Bad</td><td>20</td><td>7</td><td>3</td></tr>
<tr><td>Normal</td><td>13</td><td>51</td><td>16</td></tr>
<tr><td>Good</td><td>7</td><td>12</td><td>21</td></tr>
</table>
Test for independence using 0.05 level of significance .</td><td>BTL -3</td><td>Applying</td></tr>
<tr><td>11.(b)</td><td>5 coins were tossed 320 times. The number of heads observed is given below :
<table>
<tr><td>No. of heads</td><td>:</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td>Observed frequencies</td><td>:</td><td>15</td><td>45</td><td>85</td><td>95</td><td>60</td><td>20</td></tr>
</table>
Examine whether the coin is unbiased .Use 5% level of significance.</td><td>BTL -5</td><td>Evaluating</td></tr>
<tr><td>12.(a)</td><td>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:
<table>
<tr><td>Number of persons</td><td>Drug</td><td>No drug</td><td>Total</td></tr>
<tr><td>Cured</td><td>65</td><td>55</td><td>120</td></tr>
<tr><td>Not cured</td><td>35</td><td>45</td><td>80</td></tr>
<tr><td>Total</td><td>100</td><td>100</td><td>200</td></tr>
</table>
Test whether the drug is effective or not?</td><td>BTL -1</td><td>Remembering</td></tr>
<tr><td>12.(b)</td><td>A certain stimulus administered to each of 12 patients resulted in the following increase of blood pressure<br>5,2,8,-1,3,0,-2,1,5,0, 4 & 6 can it be concluded that the stimulus will, in general, be accompanied by an increase in blood pressure?</td><td>BTL -6</td><td>Creating</td></tr>
<tr><td>13.(a)</td><td>In a referendum submitted by the students to the body at a university, 850menand 560 women voted. 500 men and 320 women voted favorably. Does this indicate a significant difference of opinion between men and women on this matter at 1% level of significance?</td><td>BTL -1</td><td>Remembering</td></tr>
<tr><td>13.(b)</td><td>Random samples drawn from two places gave the following data relating to the heights of male adults:
<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>
<tr><td>S.D ( in inches)</td><td>2.5</td><td>3.0</td></tr>
<tr><td>No. of adult males in sample</td><td>1200</td><td>1500</td></tr>
</table>
Test at 5 % level, that the mean height is the same for adults in the two places.</td><td>BTL -2</td><td>Understanding</td></tr>
<tr><td>14.(a)</td><td>In a random sample of 1000 people from city A, 400 are found to be consumers of rice. In a sample of 800 from city B, 400 are found to be consumers of rice. Does this data give a significant difference between the two cities as far as the proportion of rice consumers is concerned?</td><td>BTL -4</td><td>Analyzing</td></tr>
<tr><td>14.(b)</td><td>In a year there are 956 births in a town A of which 52.5% were male while in towns A and B combined, this proportion in a total of 1406</td><td>BTL -2</td><td>Understanding</td></tr>
</table>

| | | | |
|---|---|---|---|
| | births was 0.496.Is there any significant difference in the proportion of male births in the two Rows ? | | |
| **UNIT IV-DESIGN OF EXPERIMENTS**<br>One way and two way classifications - Completely randomized design – Randomized block design – Latin square design - $2^2$ factorial design | | | |
| **PART – A** | | | |
| Q. No. | Question | BT Level | Competence |
| 1. | What is the aim of design of experiments? | BTL -1 | Remembering |
| 2. | Write the basic assumptions in analysis of variance. | BTL -1 | Remembering |
| 3. | When do you apply analysis of variance technique? | BTL -1 | Remembering |
| 4. | Define Randomization. | BTL -1 | Remembering |
| 5. | Define Replication. | BTL -1 | Remembering |
| 6. | Define Local control. | BTL -1 | Remembering |
| 7. | What is meant by tolerance limits? | BTL -2 | Understanding |
| 8. | What is a completely randomized design. | BTL -2 | Understanding |
| 9. | Explain the advantages of a Latin square design? | BTL -2 | Understanding |
| 10. | What are the basic elements of an Completely Randomized Experimental Design? | BTL -2 | Understanding |
| 11. | Demonstrate the purpose of blocking in a randomized block design? | BTL -3 | Applying |
| 12. | Manipulate the Basic principles of the design of experiment? | BTL -3 | Applying |
| 13. | Why a2x2 Latin square is not possible? Explain. | BTL -3 | Applying |
| 14. | Analyze the advantages of the Latin square design over the other design. | BTL -4 | Analyzing |
| 15. | Demonstrate main advantage of Latin square Design over Randomized Block Design? | BTL -4 | Analyzing |
| 16. | Write any two differences between RBD and LSD. | BTL -4 | Analyzing |
| 17. | What is ANOVA? | BTL -5 | Evaluating |
| 18. | What are the uses of ANOVA? | BTL -5 | Evaluating |
| 19. | Define experimental error. | BTL -6 | Creating |
| 20. | Express $2^2$ factorial designs. | BTL -6 | Creating |
| **PART-B** | | | |
| 1.(a) | 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 | BTL -1 | Remembering |
| 1. (b) | 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. (a)</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>BTL -1</td><td>Remembering</td></tr>
<tr><td>2.(b)</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>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>
<tr><td>7</td><td>4</td><td>1</td></tr>
</table></td><td>BTL -1</td><td>Remembering</td></tr>
<tr><td>4.</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)
<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>BTL -2</td><td>Understanding</td></tr>
<tr><td>5.</td><td>Perform a 2-way ANOVA on the data given below:
<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="2">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>
</table></td><td>BTL -3</td><td>Applying</td></tr>
</table>

<table>
<tr>
<td></td>
<td>
<table>
<tr><td rowspan="3"></td><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></td>
<td></td>
</tr>
<tr>
<td>6.</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" rowspan="2"></td><td colspan="5">BOLT</td></tr>
<tr><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 -2</td>
<td>Understanding</td>
</tr>
<tr>
<td>7.</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>
<tr>
<td>8. (a)</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 -1</td>
<td>Remembering</td>
</tr>
<tr>
<td>8.(b)</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.
<table>
<tr><td>C25</td><td>B23</td><td>A20</td><td>D20</td></tr>
<tr><td>A19</td><td>D19</td><td>C21</td><td>B18</td></tr>
<tr><td>B19</td><td>A14</td><td>D17</td><td>C20</td></tr>
<tr><td>D17</td><td>C20</td><td>B21</td><td>A15</td></tr>
</table>
</td>
<td>BTL -5</td>
<td>Evaluating</td>
</tr>
<tr>
<td>9.</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</td>
<td>BTL -1</td>
<td>Remembering</td>
</tr>
</table>

<table>
<tr><td></td><td>variability in soil fertility, he uses the fertilizers, in a Latin square arrangement a syndicated in the following table, where the numbers indicate yield sperunitarea.
<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 α=0.05 and α=0.01 levels of significance.</td><td></td><td></td></tr>
<tr><td>10.</td><td>Set up the analysis of variance for the following results of a Latin Square Design(use α = 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 -4</td><td>Analyzing</td></tr>
<tr><td>11.</td><td>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.
<table>
<tr><td>A48</td><td>E66</td><td>D56</td><td>C52</td><td>B61</td></tr>
<tr><td>D64</td><td>B62</td><td>A50</td><td>E64</td><td>C63</td></tr>
<tr><td>B69</td><td>A53</td><td>C60</td><td>D61</td><td>E67</td></tr>
<tr><td>C57</td><td>D58</td><td>E67</td><td>B65</td><td>A55</td></tr>
<tr><td>E67</td><td>C57</td><td>B66</td><td>A60</td><td>D57</td></tr>
</table></td><td>BTL -6</td><td>Creating</td></tr>
<tr><td>12.</td><td>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.
<table>
<tr><td>B25</td><td>A18</td><td>E27</td><td>D30</td><td>C27</td></tr>
<tr><td>A19</td><td>D31</td><td>C29</td><td>E26</td><td>B23</td></tr>
<tr><td>C28</td><td>B22</td><td>D33</td><td>A18</td><td>E27</td></tr>
<tr><td>E28</td><td>C26</td><td>A20</td><td>B25</td><td>D33</td></tr>
<tr><td>D32</td><td>E25</td><td>B23</td><td>C28</td><td>A20</td></tr>
</table></td><td>BTL -3</td><td>Applying</td></tr>
<tr><td>13.</td><td>Find out the main effects and interaction effects in the following $2^2$ factorial experiment and write down the analysis of variance table
<table>
<tr><td>BLOCKS</td><td>(1)<br>00</td><td>a<br>10</td><td>b<br>01</td><td>ab<br>11</td></tr>
<tr><td>I</td><td>64</td><td>25</td><td>30</td><td>60</td></tr>
<tr><td>II</td><td>75</td><td>14</td><td>50</td><td>33</td></tr>
<tr><td>III</td><td>76</td><td>12</td><td>41</td><td>17</td></tr>
<tr><td>IV</td><td>75</td><td>33</td><td>25</td><td>10</td></tr>
</table></td><td>BTL -3</td><td>Applying</td></tr>
<tr><td>14.</td><td>An experiment was planned to study the effect of sulphate of potash and super phosphate on the yields of potatoes. All the combinations of 2 levels of super phosphate (p) and two levels of sulphate (k) of potash were studied in a RBD with 4 replication for each. The yields obtained are given in the following table. The yields obtained are given in the following table.</td><td>BTL -3</td><td>Applying</td></tr>
</table>

Analyze the data and give your conclusion (with α = 1%)

| Block | Yields ( per plot) | | | |
|---|---|---|---|---|
| I | (1)<br>23 | K<br>25 | P<br>22 | KP<br>38 |
| II | P<br>40 | (1)<br>26 | K<br>36 | KP<br>38 |
| III | (1)<br>29 | K<br>20 | KP<br>30 | P<br>20 |
| IV | KP<br>34 | K<br>31 | P<br>24 | (1)<br>28 |

## 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

| | | | |
|---|---|---|---|
| 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 process control | BTL2 | Understanding |
| 7. | Define product 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. | Define OC Curve | BTL3 | Applying |
| 12. | Write down types of Causes variation. | BTL4 | Analyzing |
| 13. | Write the formula for np chart. | BTL4 | Analyzing |
| 14. | What is meant by AQL and LTPD | BTL4 | Analyzing |
| 15. | What is the formula for 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 |

### PART-B

| | | | |
|---|---|---|---|
| 1.(a) | What do you understand by SQC. Discuss its utility and limitations? | BTL1 | Remembering |
| 1.(b) | 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. | BTL6 | Creating |

| Sample | Weight of the parts in ounces | | | |
|---|---|---|---|---|
| 1 | 10 | 12 | 10 | 12 |
| 2 | 10 | 12 | 13 | 13 |
| 3 | 10 | 10 | 9 | 11 |
| 4 | 11 | 10 | 9 | 14 |
| 5 | 12 | 12 | 12 | 12 |

<table>
<tr><td>2.(a)</td><td>Write the role and advantages of SQC.</td><td>BTL1</td><td>Remembering</td></tr>
<tr><td>2.(b)</td><td>You are given the value of sample means ( $\bar{X}$ ) 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>( $\bar{X}$ )</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>BTL2</td><td>Understanding</td></tr>
<tr><td>3.(a)</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 $\bar{X}$ and R comment.
<table>
<tr><td>Sample No.</td><td colspan="6">Life time ( in hours)</td></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>BTL3</td><td>Applying</td></tr>
<tr><td>3.(b)</td><td>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.</td><td>BTL2</td><td>Understanding</td></tr>
<tr><td>4.</td><td>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</td><td>BTL1</td><td>Remembering</td></tr>
<tr><td>5.(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>( $\bar{X}$ )</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.<br>(Conversion factors for $n = 5$ are $A_2 = 0.58$ $D_3 = 0, D_4 = 2.115$)</td><td>BTL3</td><td>Applying</td></tr>
<tr><td>5.(b)</td><td>Explain in detail the R-Chart clearly?</td><td>BTL1</td><td>Remembering</td></tr>
</table>

<table>
<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>BTL3</td><td>Applying</td></tr>
<tr><td>6.(b)</td><td>Explain in detail the $\overline{X}$ Chart clearly?</td><td>BTL1</td><td>Remembering</td></tr>
<tr><td>7.(a)</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>BTL2</td><td>Understanding</td></tr>
<tr><td>7.(b)</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>8.(a)</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>8.(b)</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>
<tr><td>9.(a)</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>9.(b)</td><td>Write the Procedure for acceptance sampling.</td><td>BTL2</td><td>Understanding</td></tr>
</table>

<table>
<tr><td>10.(a)</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>10.(b)</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>11. (a)</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>11.(b)</td><td>Write the Procedure to draw the $\bar{X}$-chart and R-chart.</td><td>BTL2</td><td>Understanding</td></tr>
<tr><td>12.</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>13.</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>
<tr><td rowspan="4">Weight of Boxes (X)</td><td>10</td><td>10.3</td><td>11.5</td><td>11</td><td>11.3</td><td>10.7</td><td>11.3</td><td>12.3</td><td>11</td><td>11.3</td><td>12.5</td><td>11.9</td><td>12.1</td><td>11.9</td><td>10.6</td></tr>
<tr><td>10.2</td><td>10.9</td><td>10.7</td><td>11.1</td><td>11.6</td><td>11.4</td><td>11.4</td><td>12.1</td><td>13.1</td><td>12.1</td><td>11.9</td><td>12.1</td><td>11.1</td><td>12.1</td><td>11.9</td></tr>
<tr><td>11.3</td><td>10.7</td><td>11.4</td><td>10.7</td><td>11.9</td><td>10.7</td><td>11.1</td><td>12.7</td><td>13.1</td><td>10.7</td><td>11.8</td><td>11.6</td><td>12.1</td><td>13.1</td><td>11.7</td></tr>
<tr><td>12.4</td><td>11.7</td><td>12.4</td><td>11.4</td><td>12.1</td><td>11</td><td>10.3</td><td>10.7</td><td>12.4</td><td>11.5</td><td>11.3</td><td>11.4</td><td>11.7</td><td>12</td><td>12.1</td></tr>
</table></td><td>BTL6</td><td>Creating</td></tr>
<tr><td>14.</td><td>The following are the $\bar{X}$ and R values for 20 samples of readings. Draw $\bar{X}$ 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>$\bar{X}$</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>$\bar{X}$</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>BTL2</td><td>Understanding</td></tr>
</table>