# JEPPIAAR ENGINEERING COLLEGE 

Jeppiaar Nagar, Rajiv Gandhi Salai - 600119

## DEPARTMENT OF S \& H

## QUESTION BANK



## II SEMESTER

MA 3251 - Statistics and Numerical Methods
Regulation - 2021

|  |  | LESSON PLAN |  |  | Semester : II |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Sub Code \& Name: MA 3251 <br> STATISTICS AND NUMERICAL METHODS <br> Unit: I <br> Branch: |  | Sem |  |
| UNIT I TESTING OF HYPOTHESIS |  |  |  |  |  |
| Large sample test based on Normal distribution for single mean and difference of means - Tests based on t, Chi ${ }^{2}$ and F distributions for testing means and variances - Contingency table (Test for Independency) - Goodness of fit. <br> Reference: Grewal. B.S., and Grewal. J.S., "Numerical Methods in Engineering and Science", 9th Edition, Khanna Publishers, New Delhi, 2007. |  |  |  |  |  |
| PART - A |  |  |  |  |  |
| Q.No. |  |  | BT Level | Competence | PO |
| 1. | What is st | tical hypothesis?(Nov/Dec-2017) | BTL-1 | Remembering | PO1 |
| 2. | Define chi-s | uare. ?(Nov/Dec-2017) | BTL-1 | Remembering | PO1 |
| 3. | Write typ ov/Dec-20 | and type II errors .(Apr/May-May/Jun-2016) | BTL-1 | Remembering | PO1 |
| 4. | What are 2016)(Apr | assumptions in ' $t$ ' distribution?(Nov/Dec- ay-2015) | BTL -1 | Remembering | PO1 |
| 5. | State the <br> ( Apr/May | ortant properties of the $t$-distribution. 15) | BTL -1 | Remembering | PO1 |
| 6. | Write any distributio | ree applications of Chi-Square May/Jun-2014) | BTL -1 | Remembering | PO1 |
| 7. | Define nu | d alternative hypothesis. | BTL-2 | Understanding | PO2 |
| 8. | When do | use the t-distribution? (Nov/Dec-2016) | BTL-2 | Understanding | PO2 |
| 9. | What is m | t by level of significance? (Apr/May-2016) | BTL -2 | Understanding | PO2 |
| 10. | $\begin{array}{\|l\|} \hline \text { Define Sta } \\ \text { 2016) } \\ \hline \end{array}$ | ard error and Critical region. (Nov/Dec- | BTL -2 | Understanding | PO2 |
| 11. | Write any | applications of ' t '-distribution. (Nov/Dec- | BTL -3 | Applying | PO3 |
| 12. | Write the | dition for the application of $\chi^{2}$ test. | BTL -3 | Applying | PO3 |
| 13. | Write an (Nov/Dec- | ee applications of ' $F$ ' distribution. <br> 5) | BTL -6 | Creating | $\begin{gathered} \hline \text { PO1,PO2, } \\ \text { PO5 } \end{gathered}$ |
| 14. | State (Nov/Dec | important properties of F-distribution. <br> 1) | BTL -4 | Analyzing | $\begin{gathered} \text { PO1,PO2, } \\ \text { PO5 } \end{gathered}$ |
| 15. | Define sam | ng distribution. (Apr/May-2013) | BTL -4 | Analyzing | $\begin{gathered} \hline \text { PO1,PO2, } \\ \text { PO5 } \end{gathered}$ |
| 16. | Define Ch | uare test of goodness of fit. (Apr/May-2014) | BTL -3 | Applying | PO5 |





| 7. (b) | Samples of two types of electric bulbs were tested for length of life and following data were obtained. |  |  |  |  | BTL -3 | Applying | PO12 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | Type - 1 | Type - II |  |  |  |
|  |  | Sample size |  | 8 | 7 |  |  |  |
|  |  | Sample mean |  | 1234 hrs | 1036 hrs |  |  |  |
|  | Analyze that, is the difference in the means sufficient to warrant that type I is superior to type II regarding the length of life? (Nov/Dec-2015) |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| 8. (a) | A survey of 320 families with 5 children each revealed the following distribution |  |  |  |  | BTL -6 | Creating | $\begin{aligned} & \text { PO1,PO2, } \\ & \text { PO12 } \end{aligned}$ |
|  | Boys | 5 | 4 | 2 | 0 |  |  |  |
|  | Girls | 0 | 1 | 3 4 | 5 |  |  |  |
|  | Is this result consistent with the hypothesis that male and female births are equally probable? |  |  |  |  |  |  |  |
| 8.(b) | The mean produce of wheat from a sample of 100 fields comes to 200 kg 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? (Apr/May-2015) |  |  |  |  | BTL -2 | Understanding | PO2 |
| 9. (a) | Two independent samples of sizes 9 and 7 from a normal population had the following values of the variables Sample 1 $\begin{array}{lllllllll}18 & 13 & 12 & 15 & 12 & 14 & 16 & 14 & 15\end{array}$ <br> $\begin{array}{llllllll}\text { Sample } 2 & 16 & 19 & 13 & 16 & 18 & 13 & 15\end{array}$ Justify whether the difference between the means of samples of samples significant? (Nov/Dec-2016) |  |  |  |  | BTL -1 | Remembering | PO1 |
| 9.(b) | A simple sample of heights of 6400 Englishmen has a mean of 170 cms and a standard deviation of 6.4 cms , while a simple sample of heights of 1600 Americans has a mean of 172 cms and a standard deviation of 6.3 cms . Do the data indicate that Americans are, on the average, taller than Englishmen?(BTL4) (Apr/May-2016) |  |  |  |  | BTL -1 | Remembering | PO1 |
| 10.(a) | Two random samples gave the following results: |  |  |  |  | BTL -1 | Remembering | PO1 |
|  | Sampl e | Size | $\begin{gathered} \hline \text { Sampl } \\ \text { e } \\ \text { Mean } \end{gathered}$ | Sum of squares of deviation from the mean |  |  |  |  |
|  | 1 | 10 | 15 |  |  |  |  |  |
|  | 2 | 12 | 14 |  | 8 |  |  |  |
|  | Analyze whether the samples have come from the same normal population. (Nov/Dec-2013) |  |  |  |  |  |  |  |
| 10.(b) | 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 concluded that the medicine was responsible for the increase in B.P. 5\% l.o.s (Apr/May- 2012) |  |  |  |  | BTL -1 | Remembering | PO1 |



|  | (Nov/Dec-2012) |  |  |  |
| :---: | :--- | :--- | :--- | :--- |
| 14.(b) | In a year there are 956 births in a town A of which 52.5\% were <br> male while in towns A and B combined, this proportion in a <br> total of 1406 births was 0.496.Is there any significant <br> difference in the proportion of male births in the two towns ? <br> (Apr/May-2011) | BTL -2 | Understanding | PO2 |


| UNIT - II DESIGN OF EXPERIMENTS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| 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 | PO |
| 1. | Write the advantages of Latin Square (Nov/Dec-2017) | BTL -1 | Remembering | PO1 |
| 2. | What are the conditions to be followed in one way classification?(Nov/Dec-2017) | BTL -1 | Remembering | PO1 |
| 3. | What is meant by analysis of variance?(May/Jun-2016) | BTL -1 | Remembering | PO1 |
| 4. | Why a $2 \times 2$ Latin square is not possible?Explain.(May/Jun-2016)(May/Jun-2014). | BTL -1 | Remembering | PO1 |
| 5. | Define Replication and Randomization.(Nov/Dec- | BTL -1 | Remembering | PO1 |
| 6. | What is the advantage of factorial experiment? (Nov/Dec-2016) | BTL -1 | Remembering | PO1 |
| 7. | What is the aim of design of experiment?(Apr/May2015) | BTL -2 | Understanding | PO2 |
| 8. | What are the basic principles of experimental design? (Apr/May-2015) | BTL -2 | Understanding | PO2 |
| 9. | Write the advantages and disadvantages of RBD?(Apr/May-2015) | BTL -2 | Understanding | PO2 |
| 10. | What is Latin Square design ? | BTL -2 | Understanding | PO2 |
| 11. | Define Raw Sum of Squares and Correction factor | BTL -3 | Applying | P01,PO2,PO12 |
| 12. | Write any 3 applications of LSD. (Nov/Dec-2014) | BTL -3 | Applying | P01,PO2,PO12 |
| 13. | How do you calculate the Correction factor in LSD? (Nov/Dec-2012) | BTL -3 | Applying | P01,PO2,PO12 |
| 14. | What do you mean by design of nts?(Nov/Dec-2014) | BTL -4 | Analyzing | PO5 |


| 15. | What are the subject matters included in the design of experiment? | BTL -4 | Analyzing | PO5 |
| :---: | :---: | :---: | :---: | :---: |
| 16. | What are the assumptions in ANOVA? ?(Apr/May- | BTL -4 | Analyzing | PO5 |
| 17. | are the three essential steps to plan an experiment? | BTL -5 | Evaluating | PO1,PO2,PO5 |
| 18. | What are the basic steps in ANOVA? ?(Apr/May-2014) | BTL -5 | Evaluating | PO1,PO2,PO5 |
| 19. | Write the steps to find F-ratio. (Nov/Dec-2016) | BTL -6 | Creating | PO1,PO2,PO5 |
| 20. | Discuss the advantages of Completely Randomized block design. | BTL -6 | Creating | PO1,PO2,PO5 |
| 21 | State the uses of ANOVA. ? (Apr/May-2015) | BTL -4 | Analyzing | PO12 |
| 22 | Explain the word treatment in ANOVA. ?(Apr/May2015) | BTL -4 | Analyzing | PO12 |
| 23 | What do you mean by 2-way classification? | BTL -4 | Analyzing | PO12 |
| 24 | Indicate the characteristics of a good experimental Design (Nov/Dec-2011) | BTL -5 | Evaluating | PO1,PO2,PO5 |
| 25 | What are the important designs of experiments? | BTL -5 | Evaluating | PO1,PO2,PO5 |
| 26 | What is an experimental error ? (Nov/Dec-2011) | BTL -6 | Creating | PO1,PO2,PO5 |
| 27 | What is meant by CRD? ?(Apr/May-2012) | BTL -6 | Creating | PO1,PO2,PO5 |
| 28 | Compare RBD and LSD. | BTL -3 | Applying | PO1,PO2,PO5 |
| 29 | Compare LSD and RBD. ?(Apr/May-2015) | BTL -3 | Applying | PO1,PO2,PO5 |
| 30 | What are the uses of Chi-Square test? | BTL -4 | Analyzing | PO5 |
| 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. Analyse the classification. | BTL -1 | Remembering | PO1 |
| 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: | BTL -2 | Understanding | PO2 |




14. $\quad$ 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.
Analyze the data and give your conclusion (with $\alpha=$

1\%)

BTL -3
Applying

| BLOCKS | Yields (Per Plot) |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| I | $(1)$ | a | b | ab |
|  | 23 | 25 | 22 | 38 |
| II | P | $(1)$ | K | KP |
|  | 40 | 26 | 36 | 38 |
| III | $(1)$ | K | KP | P |
|  | 29 | 20 | 30 | 20 |
|  | KP | K | P | $(1)$ |
|  | 34 | 31 | 24 | 28 |



## UNIT III SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS

Newton Raphson method - Gauss elimination method - pivoting - Gauss Jordan methods - Iterative methods of Gauss Jacobi and Gauss Seidel - Matrix inversion by Gauss Jordan method - Eigen values of a matrix by power method.
Textbook : Grewal. B.S., and Grewal. J.S., "Numerical Methods in Engineering and Science", 9th Edition,Khanna Publishers, New Delhi, 2007.

| PART - A |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Q.No | Questions | $\begin{gathered} \text { BT } \\ \text { Level } \end{gathered}$ | Competence | PO |
| 1 | State the order (rate) of convergence and convergence condition for Newton Raphson method. (A.U.N/D 2017, N/D 2011,2012, M/J 2013) | BTL-4 | Analyzing | PO1 |
| 2 | Give Newton Raphson iterative formula. (A.U N/D 2009,M/J 2012,2014) | BTL-2 | Understanding | $\begin{aligned} & \text { PO1,PO2 } \\ & \text {,PO3 } \\ & \hline \end{aligned}$ |
| 3 | Establish an iteration formula to find the reciprocal of a positive number $N$ by Newton Raphson method. (A.U.N/D 2010, M/J 2012) | BTL-1 | Remembering | P01,PO2 |
| 4 | State the principle used in Gauss-Jordan method. (A.U M/J 2011) | BTL-1 | Remembering | PO1 |
| 5 | Give the sufficient condition of convergence of Gauss Seidel method. . (A.U M/J 2011) | BTL-1 | Remembering | PO1 |
| 6 | Write the conditions for convergence in Gauss Seidel iterative technique. (or) When the method of iteration will be useful ? ( A.U M/J 2009) | BTL-3 | Applying | PO1 |
| 7 | State Gauss Seidel method. (A.U M/J 2011,N/D 2012) | BTL-1 | Remembering | P01,PO2 |
| 8 | Gauss Seidel method always converges - True or False. . (A.U | BTL-1 | Remembering | P01,PO2 |


|  | M/J 2016) |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| 9 | Write the first iteration values of $x, y, z$ when the equations $27 x+6 y-$ $z=85,6 x+15 y+2 z=72, x+y+5 z=110$ are solved by Gauss Seidel method. (A.U N/D 2009,M/J 2012,2016) | BTL-3 | Applying | PO1 |
| 10 | Compare Gauss Elimination and Gauss Jordan methods for solving linear systems of the form $A X=B$. (A.U M/J 2016) | BTL-1 | Remembering | PO1 |
| 11 | What type of Eigen value can be obtained using power method? (A.U.N/D 2017, N/D 2011,2012, M/J 2014) | BTL-1 | Remembering | PO1 |
| 12 | $\begin{aligned} & \text { Find the dominant eigen value of } A=\begin{array}{lll} 11 & 2 \mid \\ \text { method. (A.U M/J 2012) } \end{array} \\ & \left.\begin{array}{ll} 3 & 4 \end{array}\right] \text { by power } \end{aligned}$ | BTL-1 | Remembering | PO1 |
| 13 | On what type of equations Newton's method can be applicable ? (A.U A/M 2016) | BTL-1 | Remembering | $\begin{aligned} & \hline \text { PO1,PO2 } \\ & \text {,PO5 } \end{aligned}$ |
| 14 | By Gauss elimination method solve $x+y=2$ and $2 x+3 y=5$. (A.U M/J 2014) | BTL-1 | Remembering | PO1 |
| 15 | Why Gauss Seidel iteration is a method of successive corrections? <br> (A.U M/J 2016) | BTL-4 | Analyzing | PO1 |
| 16 | What are the merits of Newton's method of iteration? | BTL-1 | Remembering | PO1 |
| 17 | Give two direct methods to solve a system of linear equations. . (A.U A/M 2013) | BTL-2 | Understanding | PO2 |
| 18 | Compare Gauss Elimination with Gauss Seidel method.( A.U M/J 2017) | BTL-1 | Remembering | PO1 |
| 19 | Find inverse of $A=\left[\begin{array}{ll}11 & 2 \\ 3 & 4\end{array}\right]$ by Gauss Jordan method. <br> (A.U M/J 2013) | BTL-1 | Remembering | PO1,PO2 |
| PART-B |  |  |  |  |
| 1 | Solve $x \log _{10} x=12.34$ with $\mathrm{x}_{0}=10$ using Newton's method. <br> (A.U.N/D 2017, N/D 2011,2012, M/J 2013) | BTL-4 | Analyzing | $\begin{gathered} \text { PO1,PO2 } \\ \text {,PO5 } \end{gathered}$ |
| 2 | Find the negative root of the equation $\sin x=1+x^{3}$ by using Newton Raphson method. (A.U M/J 2015) | BTL-4 | Analyzing | $\begin{gathered} \text { PO1,PO2 } \\ \text {,PO5 } \end{gathered}$ |
| 3 | Solve the following equation by Gauss Elimination method $\begin{aligned} & 10 x-2 y+3 z=23 \\ & 2 x+10 y-5 z=-33 \text { (A.U.N/D 2017, N/D } \\ & 3 x-4 y+10 z=41 \\ & \text { 2011,2012, M/J 2014) } \end{aligned}$ | BTL-5 | Evaluating | $\begin{gathered} \text { PO1,PO2 } \\ \text {,PO5 } \end{gathered}$ |
| 4 | Solve the equation by Gauss Jordan method : $\begin{aligned} & 2 x_{1}+x_{2}+4 x_{3}=4 \\ & x_{1}-3 x_{2}-x_{3}=-5 \\ & 3 x_{1}-2 x_{2}+2 x_{3}=-1 \end{aligned}$ | BTL-5 | Evaluating | $\begin{gathered} \text { PO1,PO2 } \\ \text {,PO5 } \end{gathered}$ |


| 5 | Find the inverse of $\left.\left\lvert\, \begin{array}{lll}{\left[\left.\begin{array}{lll}2 & 2 & 3 \\ 2 & 1 & 1 \\ \lfloor 1 & 3 & 5\end{array} \right\rvert\,\right.}\end{array}\right.\right]$ using Gauss Jordan method. | BTL-2 | Understanding | PO1,PO2 |
| :---: | :---: | :---: | :---: | :---: |
| 6 | Solve by Gauss Siedel method $\begin{aligned} & x+y+54 z=110 \\ & 27 x+6 y-z=85 \\ & 6 x+15 y+2 z=72 \end{aligned}$ <br> (A.U.N/D 2017, N/D 2011,2013, M/J 2014) | BTL-2 | Understanding | PO1,PO2 |
| 7 | Find the dominant (largest) eigen value and the corresponding eigen vector of $A={ }^{2}\left\|\begin{array}{ccc}{[1} & -3 & 2 \\ \left\|\begin{array}{ccc}6 & 4 & -1\end{array}\right\| \\ 6 & 5\end{array}\right\|$ by power method. <br> (A.U M/J 2015) | BTL-5 | Evaluating | $\begin{gathered} \text { PO1,PO2 } \\ \text {,PO5 } \end{gathered}$ |
| 8 | Find the numerically largest eigen value of $\mathrm{A}=$ $\left[\left.\begin{array}{ccc}25 & 1 & 2 \\ 1 & 3 & 0 \\ \mid 2 & 0 & -4\end{array} \right\rvert\,\right\rfloor$ by power method and the corresponding eigen vector. <br> (A.U M/J 2011,N/D 2012) | BTL-5 | Evaluating | $\begin{gathered} \text { PO1,PO2 } \\ \text {,PO5 } \end{gathered}$ |
| 9 | Find the numerically largest eigen value of $A=$ $\left\|\begin{array}{ccc}5 & 4 & 3 \\ 10 & 8 & 6 \\ \mid\lfloor 20 & -4 & 22\end{array}\right\|$ <br> by power method with the initial eigen <br> (A.U M/J 2016) | BTL-5 | Evaluating | $\begin{gathered} \text { PO1,PO2 } \\ \text {,PO5 } \end{gathered}$ |

UNIT IV INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION

Lagrange's and Newton's divided difference interpolations - Newton's forward and backward difference interpolation - Approximation of derivates using interpolation polynomials - Numerical

| single and double integrations using Trapezoidal and Simpson's $1 / 3$ rules. <br> Textbook : Grewal. B.S., and Grewal. J.S., "Numerical Methods in Engineering and Science", 9th Edition,Khanna Publishers, New Delhi, 2007. |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| PART - A |  |  |  |  |
| CO Mapping: C214.2 |  |  |  |  |
| $\begin{aligned} & \text { Q. } \\ & \text { No } \\ & \hline \end{aligned}$ | Questions | $\begin{gathered} \text { BT } \\ \text { Level } \end{gathered}$ | Competence | PO |
| 1 | Define interpolation and extrapolation? <br> (A.U.N/D 2017, N/D 2011,2012, M/J 2013) | BTL-4 | Analyzing | PO1 |
| 2 | State Newton's formula on interpolation. When it is used? (A.U.N/D 2017, N/D 2011,2012, M/J 2014) | BTL-1 | Remembering | PO1,PO2 |
| 3 | Say True or False. - Newton's divided difference formula is applicable only for equally spaced intervals. <br> (A.U M/J 2011) | BTL-2 | Understanding | PO1,PO2 |
| 4 | State Newton's divided difference formula. | BTL-4 | Analyzing | PO2 |
| 5 | State Lagrange's interpolation formula | BTL-1 | Remembering | PO1 |
| 6 | Use Lagrange's formula to find the quadratic polynomial that takes these values <br> Then find $\mathrm{y}(2)$. <br> (A.U M/J 2011,N/D 2012) | BTL-2 | Understanding | PO1 |
| 7 | By differentiating Newton forward and backward difference formula, find the first derivative of the function $f(x)$. (A.U M/J 2013) | BTL-2 | Understanding | PO1,PO2 |
| 8 | Write down the Newton - cotes quadrature formula. | BTL-1 | Remembering | PO1 |
| 9 | What is the geometrical interpretation of Trapezoidal rule? (A.U M/J 2016,N/D 2012) | BTL-1 | Remembering | PO1 |
| 10 | Using Trapezoidal rule evaluate $\int \sin ^{\pi} x d x$ by dividing the range into 6 equal parts. | BTL-1 | Remembering | PO1 |
| 11 | Why is Trapezoidal rule so called? (A.U N/D 2011,N/D 2014) | BTL-2 | Understanding | PO1,PO2 |
| 12 | What are the truncation errors in Trapezoidal and Simpson's rules of numerical integration? | BTL-4 | Analyzing | PO1 |
| 13 | What is the condition for Simpson's $3 / 8$ rule and state the formula. | BTL-4 | Analyzing | PO1,PO2 |
| 14 | Using Simpson's rule find $\int e^{4} d x$ given $\mathrm{e}=\underset{0}{1, \mathrm{e}=2.72, \mathrm{e} \quad \text {, }}$ $=7.39, \mathrm{e}^{3}=20.09, \mathrm{e}^{4}=54.6$ | BTL-4 | Analyzing | PO1 |
| 15 | Compare Trapezoidal rule and Simpson's $1 / 3^{\text {rd }}$ rule for evaluating numerical integration. (A.U M/J 2015,N/D 2017) | BTL-1 | Remembering | PO1 |
| PART - B |  |  |  |  |


| 1 | Construct Newton's forward interpolation polynomial for the following data. $\begin{array}{lllll} \mathrm{x}: & 4 & 6 & 8 & 10 \\ \mathrm{y}: & 1 & 3 & 8 & 16 \end{array}$ <br> Use it to find the value of $y$ for $x=5$. (A.U M/J 2011,A/M 2012) | BTL-5 | Evaluating | $\begin{aligned} & \text { PO1,PO2 } \\ & \text {, PO3,PO5 } \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: |
| 2 | The following data are taken from the steam table <br> Temp ${ }^{\circ} \mathrm{c}: 140 \quad 150 \quad 160 \quad 170 \quad 180$ Pressure kg f/cm²: $3.685 \quad 4.854 \quad 6.302 \quad 8.076 \quad 10.225$ <br> Find the pressure at temperature $\mathrm{t}=175^{\circ}$. | BTL-4 | Analyzing | PO1,PO2 |
| 3 | Using Lagrange's interpolation formula calculate the profit in the year 2000 from the following data | BTL-5 | Evaluating | $\begin{aligned} & \text { Po1,Po2, } \\ & \text { Pos,Po12 } \end{aligned}$ |
| 4 | Find the polynomial $f(x)$ by using Lagrange's formula and hence find $f(3)$ for $\begin{array}{rlrrr} x: & 0 & 1 & 2 & 5 \\ f(x): & 2 & 3 & 12 & 147 \end{array}$ <br> (A.U.N/D 2017, N/D 2011,2014, M/J 2013) | BTL-4 | Analyzing | PO1,PO2, PO5,PO12 |
| 5 | Using Newton divided difference formula find $u(3)$ given $u(1)=-$ $26, u(2)=12, u(4)=256, u(6)=844$. | BTL-5 | Evaluating | $\begin{aligned} & \text { Po1,PO2, } \\ & \text { Po5,PO12 } \end{aligned}$ |
| 6 | From the given table, the values of y are consecutive terms of a series of which 23.6 is the sixth term. Find the first and tenth terms of the series. $\begin{array}{lllrrrrrrr} x: & 3 & 4 & 5 & 6 & 7 & 8 & 9 & & \\ y: & 4.8 & 8.4 & 14.5 & 23.6 & 36.2 & 52.8 & 73.9 \\ \text { (A.U M/J 2016) } & & & & & \end{array}$ | BTL-4 | Analyzing | $\begin{aligned} & \begin{array}{l} \text { PO1,PO2, } \\ \text { Po5,PO12 } \end{array} \end{aligned}$ |
| 7 | The following data gives the velocity of a particle for 20 seconds at an interval of 5 seconds. Find the initial acceleration using the entire data $\begin{array}{rlllll} \text { time (sec.) } & 0 & 5 & 10 & 15 & 20 \\ \text { velocity (m/sec.) } & 0 & 3 & 14 & 69 & 228 \end{array}$ <br> 2015) $\text { (A.U } \quad \mathrm{N} / \mathrm{D}$ | BTL-5 | Evaluating | $\begin{aligned} & \text { Po1,PO2, } \\ & \text { Po5,Po12 } \end{aligned}$ |
| 8 | Using Trapezoidal rule, evaluate $\quad \int_{-1}^{1} \frac{d x}{1+x^{2}}$ taking 8 intervals. | BTL-5 | Evaluating | $\begin{aligned} & \text { PO1,Po2, } \\ & \text { Pos.Po12 } \end{aligned}$ |


|  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| 9 | Find an approximate value of $\log$ e 5 by calculating to four decimal places by Simpson's rule the integral $\int \frac{5}{4 x+5}$ dividing the range into 10 equal parts. <br> (A.U A/M <br> 2016) | BTL-3 | Applying | PO1,PO2, PO5,PO12 |
| 10 | Evaluate $\int_{0}^{6} \frac{d x}{1+x^{2}}$ by dividing the range into 6 equal parts using Simpson's rule. | BTL-3 | Applying | PO1,PO2, PO5,PO12 |
| 11. | Evaluate $\int_{0}^{1} \frac{d x}{1+x^{2}}$ take $h=0.125$. Hence find $\pi$ using Simpson's rule. <br> (A.U.N/D 2017, N/D 2011,2012, M/J <br> 2014) | BTL-5 | Evaluating | PO1,PO2, PO5,PO12 |
| 12. | Compute $\int_{0}^{1} \frac{x d x}{x^{3}+10}$ using Trapezoidal rule and Simpson's rule with the number of points $3,5,9$. (A.U M/J 2017) | BTL-3 | Applying | PO1,PO2, PO5,PO12 |

## UNIT V NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS

Taylor's series method - Euler's method - Modified Euler's method - Fourth order Runge-Kutta method for solving first and second order equations - Milne's predictor-corrector methods for solving first order equations - Finite difference methods for solving second order equation.

| PART - A |  |  |  |  |  |  |
| ---: | :--- | :---: | :---: | :---: | :---: | :---: |
| CO Mapping : |  |  |  |  |  |  |
| Q.No | Questions | BT <br> Level | Competence | PO |  |  |
| 1. | State Modified Euler algorithm to solve <br> $y^{\prime}=f(x, y), y(x)_{0}=y_{0}$ at $\mathrm{x}=\mathrm{x} 0$ +h. (A.U.N/D 2017, N/D <br> $\mathbf{2 0 1 1 , 2 0 1 2 , ~ M / J ~ 2 0 1 3 ) ~}$ | BTL -1 | Remembering | PO1 |  |  |
| 2. | State the disadvantage of Taylor series method. (A.U N/D <br> 2009,M/J 2012,2014) | BTL -1 | Understanding | PO1 |  |  |
| 3. | Write the merits and demerits of the Taylor method of <br> solution. (A.U.N/D 2010, M/J 2012) | BTL -5 | Understanding | PO1 |  |  |
| 4. | Which is better Taylor"s method or R. K. Method?(or) | BTL -1 | Remembering | PO1 |  |  |


|  | State the special advantage of Runge-Kutta method over taylor series method. (A.U M/J 2011) |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| 5. | Compare Runge-Kutta methods and predictor - corrector methods for solution of initial value problem. (A.U M/J 2011) | BTL -1 | Remembering | PO1 |
| 6. | What is a Predictor-corrector method of solving a differential equation? (A.U M/J 2009) | BTL -1 | Understanding | $\begin{gathered} \mathrm{PO} 2, \mathrm{PO} \\ 5 \end{gathered}$ |
| 7. | State the third order R.K method algorithm to find the numerical solution of the first order differential equation. (A.U M/J 2011,N/D 2012) | BTL -1 | Remembering | PO1 |
| 8. | Write Milne"s predictor formula and Milne"s corrector formula. <br> (A.U M/J 2012,N/D 2014) | BTL -1 | Understanding | PO1 |
| 9. | Write down Adams-Bashforth Predictor and AdamsBashforth corrector formula. <br> (A.U N/D 2011) | BTL -1 | Understanding | PO1 |
| 10. | State Euler formula. (A.U M/J 2013) | BTL -1 | Understanding | PO1 |
| 11. | Write down finite difference formula for $y^{\prime}(x)$ and $y^{\prime \prime}(x)$ (A.U M/J 2012,N/D 2014) | BTL -1 | Understanding | PO1 |
| 12. | Write down the Taylor series formula for solving first order ODE. | BTL -1 | Understanding | PO1 |
| 13. | Using Taylor series method, find the value of $y(0.1)$, from $f(x, y)=x^{2}+y^{2}$ and $y(0)=1$ correct to 4 decimal places | BTL -4 | Analyzing | PO2 |
| 14. | Compare Taylor series method and RungeKutta method. | BTL -2 | Remembering | PO5 |
| 15. | What are the advantages of R-K method over Taylor series method? (A.U N/D 2017) | BTL -2 | Remembering | PO5 |
| 16. | Compare Single-step method Multi-step methods | BTL -1 | Remembering | PO1 |
| 17. | Write down the error in Adam's predictor and corrector formulas | BTL -1 | Understanding | PO1 |
| 18. | Write down the error in Milne's predictor and corrector formulas | BTL -1 | Understanding | PO1 |
| 19. | Compare Adam's Bashforth method with RungeKutta method | BTL -1 | Understanding | PO1 |
| PART-B |  |  |  |  |
| 1. | Using Taylor"s series method find y at $\mathrm{x}=0.1$ if $\mathrm{f}(\mathrm{x}, \mathrm{y})=$ $x^{2} y-1, y(0)=1$ | BTL -1 | Remembering | $\begin{aligned} & \text { PO1,PO2 } \\ & \text {,PO5 } \end{aligned}$ |
| 2 | Solve: $y^{\text {"e }}=\mathrm{x}+\mathrm{y} ; \mathrm{y}(0)=1$, by Taylor"s series method. Find the values y at $\mathrm{x}=0.1$ and $\mathrm{x}=0.2$ | BTL -3 | Applying | $\begin{aligned} & \text { PO1,PO2 } \\ & \text {,PO5 } \end{aligned}$ |
| 3 | Using Taylor"s series method find $y(1.1)$ given $\quad y^{\prime \prime}=x$ $+y, y(1)=0$ | BTL -1 | Remembering | $\begin{aligned} & \text { PO1,PO2 } \\ & \text {,PO5 } \end{aligned}$ |


| 4 | Using Euler"s method find $\mathrm{y}(0.2)$ and $\mathrm{y}(0.4)$ from $\mathrm{y}^{\text {"e }}=\mathrm{x}+\mathrm{y}, \mathrm{y}(0)=1$ with $\quad \mathrm{h}=0.2$ | BTL -1 | Remembering | $\begin{aligned} & \text { PO1,PO2 } \\ & \text {,PO5 } \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: |
| 5 | Consider the initial value problem $y^{\prime \prime}=y-x^{2}+1, y(0)=$ 0.5 using the modified Euler"s method, find $y(0.2)$ | BTL -2 | Understanding | $\begin{aligned} & \text { PO1,PO2 } \\ & \text {,PO5 } \end{aligned}$ |
| 6 | Using R.K method of fourth order, Solve $\frac{u y}{d x}=\frac{y_{2}-x_{2}}{2}+x^{2}$ with $y(0)=1$ at $x=0.2$. | BTL -1 | Remembering | $\begin{aligned} & \text { PO1,PO2 } \\ & \text {,PO5 } \end{aligned}$ |
| 7 | $\begin{aligned} & \text { Using Milne"s method find } y(4.4) \text { givev } 5 x^{\text {e" }}+y^{2}-2 \\ & =0 \text { given } y(4)=1, y(4.1)=1.0049 \text {, } \\ & y(4.2)=1.0097 \text { and } y(4.3)=1.0143 \text {. } \end{aligned}$ | BTL -1 | Remembering | $\begin{aligned} & \text { PO1,PO2 } \\ & \text {,PO5 } \end{aligned}$ |
| 8 | Obtain the approximate value of y at $\mathrm{x}=0.1 \& 0.2$ for the differential equation $\frac{d y}{d x}=2 y+3 e^{x} y(0)=0$ by <br> Taylor's Series method. Compare the numerical solution obtained with the exact solution | BTL -3 | Applying | $\begin{aligned} & \text { PO1,PO2 } \\ & \text {,PO12 } \end{aligned}$ |
| 9 | Solve $\frac{d y}{d x}=\sin x+\cos y, y(2.5)=0$ by Modified Euler's method by choosing $\mathrm{h}=0.5$, find $\mathrm{y}(3.5)$ | BTL -3 | Applying | $\begin{aligned} & \text { PO1,PO2 } \\ & \text {,PO12 } \end{aligned}$ |
| 10 | Solve $(1+x) \frac{d y}{d x}=-y^{2}, \mathrm{y}(0)=1$ by Modified Euler's method by choosing $\mathrm{h}=0.1$, find $\mathrm{y}(0.1)$ and $\mathrm{y}(0.2)$ | BTL -3 | Applying | $\begin{aligned} & \hline \text { PO1,PO2 } \\ & \text {,PO12 } \end{aligned}$ |
| 11 | Apply Runge - Kutta method, to find an approximate value of y when $\mathrm{x}=0.2$ given that $\frac{d y}{d x}=x+y, \mathrm{y}(0)=$ 1. | BTL -5 | Evaluating | $\begin{aligned} & \text { PO1,PO2 } \\ & \text {,PO5 } \end{aligned}$ |
| 12 | Given $\frac{d y}{d x}=x-y^{2} \quad \mathrm{y}(0)=0, \mathrm{y}(0.2)=0.02, \mathrm{y}(0.4)=$ 0.0795 and $y(0.6)=0.1762$. Compute $y(1)$ using Milne's Method. | BTL -3 | Applying | $\begin{aligned} & \text { PO1,PO2 } \\ & \text {,PO12 } \end{aligned}$ |
| 13 | Using Milne's method to find $\mathrm{y}(4.4)$ given that $5 x y^{\prime}+y^{2}-2=0$ given that $\mathrm{y}(4)=1, \mathrm{y}(4.1)=1.0049$, $\mathrm{y}(4.2)=1.0097, \mathrm{y}(4.3)=1.0143$ | BTL -1 | Remembering | $\begin{aligned} & \hline \mathbf{P O 1 , P O 2} \\ & \text {,PO5 } \end{aligned}$ |

## ANSWERS FOR TWO MARK QUESTIONS

## (1).What is statistical hypothesis?(Nov/Dec-2017)

A statistical hypothesis is a hypothesis concerning the parameters or from of the probability distribution for a designated population or populations, or, more generally, of a probabilistic mechanism which is supposed to generate the observations
(2).Define chi-square. ?(Nov/Dec-2017)

$$
\chi^{2}=\sum_{i=1}^{n}\left(O_{i}-E_{i}\right)^{2} / E_{i}
$$

(3)Write type I and type II errors.(Apr/May-2015)(Nov/Dec-2013)(May/Jun-2016)

Type I error: Rejecting $H_{0}$ when is true.
Type II error : Accepting $H_{0}$ when it is false.
(4) What are the assumptions in 't' distribution?(Nov/Dec-2016)(Apr/May-2015)
(i) The parent population from which the sample is drawn is normal.
(ii) The sample is random.
(5) State the important properties of the $t$-distribution.(Apr/May-2015)
(i) For suffiently large value of $n$,the $t$-distribution tends to the standard normal distribution.
(ii) The mean of the $t$-distribution is zero
(iii). The probability curve of the $t$-distribution is similar to the std.normal curve and is symmetric about $\mathrm{t}=0$,bell-shaped.
6). Write any three applications of Chi-Square distribution.(May/Jun-2014)
(i) To test the goodness of fit.
(ii) to test the independence of attributes.
(iii) To test the homogeneity of independent estimates of population.
(7) Define null and alternative hypothesis.

For applying the tests of significance, we first set up a hypothesis which is a definite statement about the population parameter called Null hypothesis.Any hypothesis which is complementary to null hypothesis is called an alternative hypothesis.
(8) When do we use the t-distribution?

When the sample size is 30 or less and the population standard deviation is unknown, we use the $t$-distribution.
(9) What is meant by level of significance?

The probability ' $\alpha$ 'that a random value of the statistic ' $t$ ' belongs to the critical region is known as level of significance.
(10) Define Standard error and Critical region.

The standard deviation of the sampling distribution of a statistic is known as the standard error. A region corresponding to a statistic ' t ' in the sample S amounts to rejection of the null hypothesis is called critical region.
(11) Write any two applications of ' $t$ '-distribution.

The t -distribution is used to test the significance of the difference between
(i) the mean of the small sample and mean of the population.
(ii) The coefficient of correlation in the small sample and that in the population
assumed zero.
(12) Write the condition for the application of $\chi^{2}$ test.
(i) The sample observations should be independent.
(ii) N , the total frequency should be at least 50 .
(iii) Theoritical cell frequency should be less 5.
(13) Write any three applications of ' $F$ ' distribution. F-test is used to test whether
(i) Two independent samples have been drawn from the normal populations with the same variance $\sigma^{2}$.
(ii) Two independent estimate of the population variance are homogeneous are not.
(14) State the important properties of F-distribution.
(i) The square of the t -variate with n degrees of freedom follows a F-distribution with 1 and n of freedom.
15) Define sampling distribution.

Different samples from the same population will result in general in distinct estimates, will form a statistical distribution called sampling distribution.
(16) Define Chi-square test of goodness of fit.

Chi-square test of goodness of fit is a test to find if the deviation of the experiment from theory is just by chance or it is due to the inadequacy of the theory to fit the observed data.
(17) Write down the form of the $95 \%$ confidence interval for the population mean in terms of population S.D.
$\left(\bar{X}-1.96 \frac{\sigma}{\sqrt{n}}, \bar{X}+1.96 \frac{\sigma}{\sqrt{n}}\right)$
(18) What is the Standard error of the difference between the means of two large samples drawn from different populations with known SD's.

$$
\sqrt{\frac{\sigma_{1}^{2}}{n_{1}}+\frac{\sigma_{2}^{2}}{n_{2}}}
$$

(19) What is the test statistic used to test the significance of the difference between small sample,mean and population?

$$
t=\frac{\bar{x}-\mu}{\frac{\sigma}{\sqrt{n}}}
$$

(20) What is the test statistic used to test the significance of the difference between the means of two small samples?

$$
t=\frac{\overline{x_{1}}-\overline{x_{2}}}{\sigma \sqrt{\frac{1}{n_{1}}+\frac{1}{n_{2}}}}
$$

(21) Write down the formula of test stastistic ' $Z$ ' to test the significance of difference between the means (large samples).
$Z=\frac{\overline{x_{1}}-\overline{x_{2}}}{\sqrt{\frac{s_{1}^{2}}{n_{1}}+\frac{s_{2}^{2}}{n_{2}}}}$
(22) Write down the formula of test statistic ' $Z$ ' to test the significance of difference between the proportions(large samples).

$$
Z=\frac{p_{1}-p_{2}}{\sqrt{\frac{P_{1} Q_{1}}{n_{1}}+\frac{P_{2} Q_{2}}{n_{2}}}}
$$

(23) What is the test statistic used to test the signifiance of the difference between the means of two small samples of the same size,when the sample items are correlated?

$$
t=\frac{d}{s \sqrt{n-1}} \text {, where } d_{i}=x_{i}-y_{i}
$$

(24) What are the expected frequency of $2 \times 2$ contigency table given below.


$$
\begin{array}{|c|c|}
\hline \frac{(a+b)(a+c)}{N} & \frac{(a+b)(b+d)}{N} \\
\hline \frac{(a+c)(d+c)}{N} & \frac{(d+b)(d+c)}{N} \\
\hline
\end{array}
$$

(25) Write down the $1 \%$ and $5 \%$ critical values for right tailed and teo tailed Tests.

|  | 1\% | 5\% |
| :---: | :---: | :---: |
| Two tailed test | 2.58 | 1.96 |

Right tailed test : $2.33 \quad 1.645$
(26) What is the difference between confidence limits and tolerance limits

Confidence limits: To estimate a parameter of a population
Tolerance limits: To indicate between what limits one can find a certain proportion of a population.
(27) What are the assumptions of large sample?
(i) it should be normal
(ii) values given by the samples are suffienctly close to the populatio parameters.
(28) What is test of goodness of fit?

To determine whether the actual sample distribution matches a known theoretical distribution.

## (29) Define hypothesis

Hypothesis is a statement about the population parameter.it is tested on the basis of the outcome of the random sample.
There are 2 types (i) null hypothesis and (ii) alternate hypothesis
(30) What is meant by population?

A population in statistics means a set of objects which are measurement or observations pertaining to the objects.

## UNIT -II-DESIGN OF EXPERIMENTS

PART-A(2 MARKS)
1).Write the advantages of Latin Square design.(Nov/Dec-2017)

Advantages of latin square designs. Controls more variation than CR or RCB designs because of 2- way stratification.
(2).What are the conditions to be followed in one way classification?(Nov/Dec-2017)

In statistics, one-way analysis of variance (abbreviated one-way ANOVA) is a technique that can be used to compare means of two or more samples (using the F distribution). This technique can be used only for numerical response data, the " $Y$ ", usually one variable, and numerical or (usually) categorical input data, the "X", always one variable, hence "one-way"
(3).What is meant by analysis of variance?(May/Jun-2016)

Analysis of Variance is a technique that will enable us to test for the significance of the difference among more than two sample means.
4).Why a $2 \times 2$ Latin square is not possible?Explain.(May/Jun-2016)(May/Jun-2014).

Consider a nxn latin Square design ,then the degrees of freedom for SSE

$$
\begin{aligned}
& =\left(n^{2}-1\right)-(n-1)-(n-1)-(n-1) \\
& =(n-1)(n-2)
\end{aligned}
$$

For $\mathrm{n}=2$, degrees of freedom of SSE=0 and hence MSE id not defined.Comparision is not possible. Hence $2 \times 2$ Latin Square is not possible.
(5)Define Replication and Randomization.(Nov/Dec-2016)

Replication is the repetition of an experimental condition so that the variability associated with the phenomenon can be estimated. In other words replication as "the repetition of the set of all the treatment combinations to be compared in an experiment. Each of the repetitions is called a replicate."

A method based on chance alone by which study participants are assigned to a treatment group. Randomization minimizes the differences among groups by equally distributing people with particular characteristics among all the trial arms.
(6) What is the advantage of factorial experiment?(Nov/Dec-2016)
(i) Factorial designs allow additional factors to be examined at no additional cost
(ii) Factorial designs allow the effects of a factor to be estimated at several levels of the other factors, yielding conclusions that are valid over a range of experimental conditions.
(7)What is the aim of design of experiment?(Apr/May-2015)(May/Jun-2014)

The design of experiments (DOE, DOX, or experimental design) is the design of any task that aims to describe or explain the variation of information under conditions that are hypothesized to reflect the variation.
(8) What are the basic principles of experimental design?(Apr/May-2015)
(i) Replication

$$
\begin{aligned}
& \text { (ii) Randomization and Local control. } \\
& \text { (9) Write the advantages and disadvantages of RBD?(Apr/May-2015) Advantages : } \\
& \text { (i). Accuracy (ii) Flexibility (iii) Easy to analyze Disadvantage : It is not suitable for } \\
& \text { large number of treatment }
\end{aligned}
$$

(10) What is Latin Square design ?

A useful method of eliminating fertility variations consist in an experimental layout which will control in 2 perpendicular directions such a layout is a LSD.
(11)Define Raw Sum of Squares and Correction factor.

The expression $\sum \sum x^{2}{ }_{i j}$ is known as RSS and the expression $\quad \frac{G^{2}}{N}$, where $G^{2}=\sum \sum x_{i j}^{2}$ is called the correction factor.
(12) Write any 3 applications of LSD.
(i) The statistical analysis is simple.
(ii) Even with the missing data analysis remains relatively simple.
(iii) More than one factor can be investigated simultaneously.
(13) How do you calculate the Correction factor in LSD?

By squaring the grand total and dividing it by the number of observations ,we calculate the correction factor.
(14) What do you mean by design of experiments?(Nov/Dec-2014)

It is defined as the logical construction of the experiment in which the degree of uncertainty with which the inference is drawn , may be well defined.
(15) What are the subject matters included in the design of experiment?
(i) Planning of the experiment.
(ii) Obtaining relevant information from it regarding the statiscal hypothesis under study.
(16) What are the assumptions in ANOVA?

Each of samples is drawn from a normal population and the variances for the population from which samples have been drawn are equal.
(17) What are the three essential steps to plan an experiment?
(i) A statement of the objective.
(ii) Statement should clearly mention the hypothesis to be tested.
(iii) Description should include the type of experimental material,size of the experiment and the number of replications.
(18) What are the basic steps in ANOVA?
(i) Estimate the population variance among the sample means.
(ii) Estimate the population variance from the variance within the sample means.
(19) Write the steps to find F-ratio.

$$
F=\frac{S^{2}}{S_{2}^{2}}=\frac{\text { Variance betweensamples }}{\text { Variance within samples }}
$$

(20) Discuss the advantages of Completely Randomized block design.
(i) easy to lay out
(ii) allows flexibility (iii)simple
statiscal information
(iv). The lot of information due to missing data is smaller than with any other design
(21) State the uses of ANOVA.
(i) The effects of some fertilizer on the yields are significantly different.
(ii) The mean qualities of outputs of various machines differ significantly.
(22) Explain the word treatment in ANOVA.

The word treatment in ANOVA is used to refer to any factor in experiment is controlled at different levels or values.
(23) What do you mean by 2-way classification?

In two way classification ,the datas are classified according to different criteria or factors.
(24) Indicate the characteristics of a good experimental design.
(i) Absolute (ii) Comparative.
(25) What are the important designs of experiments?
(i) Completely Randomized design(or) One-Way classification
(ii) Randomized Block Design (or) Two-Way classification
(iii) Latin Square Design (or) Threee-Way classification.
(26) What is an experimental error?

The variation from plot to plot caused by uncontrolled factors is known as experimental error.
(27) What is meant by CRD?

It is defined as a type of experimental design where the experimental units are allocated to the treatments in a completely random fashion. This is used to study the effects of one primary factor without the need to take other nuisance variables into account.
(28)Compare RBD and LSD.

RBD is more efficient than CRD for most types of experiment work.
In CRD, grouping of the experiments sixe so as to allocate the treatments at random to the experimental units is not done.But in RBD , treatments are allocated at random within the units of each stratum.

RBD is more flexible than CRD,since no restrictions are placed on the number or treatments or the number if replicatins.
(29) Compare LSD and RBD.

In LSD, the number of treatments is equal to the number of replications, whereas there are no such restrictions on treatments and replications in RBD.
(30) What are the uses of Chi-Square test?
(i) To test significance difference between experimental values and theoretical values.
(ii) To find whether two or more attributes are associated or not.

UNIT III SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS

Newton Raphson method - Gauss elimination method - pivoting - Gauss Jordan methods - Iterative
methods of Gauss Jacobi and Gauss Seidel - Matrix inversion by Gauss Jordan method - Eigen values of a matrix by power method.
Textbook : Grewal. B.S., and Grewal. J.S., "Numerical Methods in Engineering and Science", 9th Edition,Khanna Publishers, New Delhi, 2007.
1.State the order (rate) of convergence and convergence condition for Newton Raphson method.

Sol. The order of convergence of Newton Raphson method is 2
(quadratic) and convergence condition is $\mid f(x) f^{\prime \prime}(x)<\left[f^{\prime}(x)\right]^{2}$.

## 2. Give Newton Raphson iterative formula.

Sol. $\quad x_{n+1}=x_{n}-\frac{f\left(x_{n}\right)}{f^{\prime}(x)_{n}}, n=0,1,2, \ldots \ldots$.
3. Establish an iteration formula to find the reciprocal of a positive number $\mathbf{N}$ by Newton Raphson method.
Sol. $\quad$ Let $x=1 / N$

$$
\begin{aligned}
& \Rightarrow N=\frac{1}{x} \Rightarrow \frac{1}{x}-N=0 \\
& \text { (i.e.) } f(x)=\frac{1}{x}-N \Rightarrow f\left(x{\underset{n}{n}}^{x}=\frac{1}{x_{n}}-N, f^{\prime}(x)_{n}=-\frac{1}{x_{n}^{2}}\right.
\end{aligned}
$$

By Newton Raphson method,

$$
\begin{aligned}
x_{n+1}=x_{n}-\frac{f\left(x_{n}\right)}{f^{\prime}(x)_{n}}=x-\frac{x_{n}-N}{-\frac{1}{x_{n}^{2}}} & =x_{n}+x^{2}{ }^{2}(1-N) \\
& =x_{n}\left(2-N x_{n}\right) .
\end{aligned}
$$

4. State the principle used in Gauss-Jordan method.

Sol. In the equation $\mathrm{AX}=\mathrm{B}$, the matrix A is transformed into an identity matrix.

## 5. Give the sufficient condition of convergence of Gauss Seidel method.

Sol. The absolute value of the leading diagonal element is greater than the sum of the absolute values of the other elements in that row, which is called diagonally dominant.
6. Write the conditions for convergence in Gauss Seidel iterative technique. (or) When the method of iteration will be useful?
Sol. The coefficient matrix should be diagonally dominant.

## 7. State Gauss Seidel method.

Sol. As soon as a new value for a variable is found by iteration it is used immediately in the following equations. This method is called Gauss Seidel method.
8. Gauss Seidel method always converges - True or False.

Sol. False.
9. Write the first iteration values of $x, y, z$ when the equations $27 x+6 y-z=85,6 x+15 y+2 z=72$, $x+y+5 z=110$ are solved by Gauss Seidel method.

Sol. Here the coefficient matrix is diagonally dominant. Then

$$
\begin{align*}
& \mathrm{x}=\frac{1}{27}(85-6 y+z) \ldots \ldots  \tag{1}\\
& \mathrm{y}=\frac{1}{15}(72-6 x-2 z) \ldots \ldots  \tag{2}\\
& \mathrm{z}=\frac{1}{5}(110-x-y) \ldots \ldots \tag{3}
\end{align*}
$$

First Iteration

$$
\begin{aligned}
& \text { Put } y=0, z=0 \text { in (1), we get } x=3.148 \\
& \text { Put } x=3.148, z=0 \text { in (2), we get } y=3.451 \\
& \text { Put } x=3.148, y=3.451 \text { in (3), we get } z=20.662
\end{aligned}
$$

10.Compare Gauss Elimination and Gauss Jordan methods for solving linear systems of the form $A X=B$.
Sol. In Gauss Elimination method, the coefficient matrix reduced to upper triangular matrix and we get the solution by back substitution whereas in Gauss Jordan method, the coefficient matrix reduces to an unit or identity matrix and we get the solution without using back substitution.
11.What type of Eigen value can be obtained using power method?

Sol. Dominant eigen value.
12.Find the dominant eigen value of $\mathbf{A}=\left[\begin{array}{ll}1 & 2 \\ 3 & 4\end{array}\right]$ by power method.

Sol. Dominant eigen value $=5.3722$

## 13. On what type of equations Newton's method can be applicable?

Sol. Newton's method can be applicable to the solution of both algebraic and transcendental equation and can be also used when the roots are complex.
14. By Gauss elimination method solve $x+y=2$ and $2 x+3 y=5$.

Sol. The augmented matrix is

$$
\begin{aligned}
{[\mathrm{A}, \mathrm{~B}] } & =\left[\begin{array}{lll}
1 & 1 & 2 \\
2 & 3 & 5 \\
\hline 1 & 1 & 2 \\
\hline
\end{array}\right] \\
& =\left[\begin{array}{lll}
0 & 1 & 1
\end{array}\right] R_{2}=R_{2}-2 R_{1}
\end{aligned}
$$

By back substitution, $\quad x+y=2---(1)$

$$
y=1
$$

(1) becomes, $x+1=2$

$$
x=1
$$

Hence $\mathrm{x}=1, \mathrm{y}=1$.

## 15. Why Gauss Seidel iteration is a method of successive corrections?

Sol. Because we replace approximations by corresponding new ones as soon the latter have been computed.

## 16. What are the merits of Newton's method of iteration?

Sol. Newton's method is successfully used to improve the result obtained by other methods. It is applicable to the solution of equations involving algebraical functions as well as transcendental functions.
17. Give two direct methods to solve a system of linear equations.

| Sol. Gauss Elimination method and Gauss Jordan method. |  |  |
| :---: | :---: | :---: |
| 18. Compare Gauss Elimination with Gauss Seidel method. |  |  |
| Sol. | Gauss Elimination | Gauss Seidel |
|  | i.Direct method | i. Indirect method |
|  | ii. Used to find inverse of the matrix also. | ii. Used to solve system of equations only |
|  | iii. Diagonally dominant condition is not insisted. | iii. Diagonally dominant condition is insisted. |

## UNIT IV INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION

Lagrange's and Newton's divided difference interpolations - Newton's forward and backward difference interpolation - Approximation of derivates using interpolation polynomials - Numerical single and double integrations using Trapezoidal and Simpson's $1 / 3$ rules.
Textbook : Grewal. B.S., and Grewal. J.S., "Numerical Methods in Engineering and Science", 9th Edition,Khanna Publishers, New Delhi, 2007.

## 1. Define interpolation and extrapolation?

Sol. The process of computing the value of a function inside the given range is called interpolation. The process of computing the value of a function outside the given range is called extrapolation.
2. State Newton's formula on interpolation. When it is used?

Sol. Newton's forward interpolation formula is

$$
\begin{gathered}
y=y_{0}+u \Delta y_{0}+\frac{u(u-1)}{2!} \Delta^{2} y_{0}+\frac{u(u-1)(u-2)}{3!} \Delta^{3} y_{0}+\ldots \ldots \ldots \ldots \ldots \ldots \\
\text { where } u=\frac{x-x_{0}}{h}
\end{gathered}
$$

This formula is used mainly for interpolating the values of $y$ near the beginning of a set of tabular values.
Newton's backward interpolation formula is

$$
\begin{gathered}
y=y_{n}+u \nabla y_{n}+\frac{u(u+1)}{2!} \nabla^{2} y_{n}+\frac{u(u+1)(u+2)}{3!} \nabla^{3} y_{n}+\ldots \ldots \ldots \ldots \ldots . . \\
\text { where } u=\frac{x-x_{n}}{h}
\end{gathered}
$$

This formula is used mainly for interpolating the values of $y$ near the end of a set of tabular values.
3. Say True or False. - Newton's divided difference formula is applicable only for equally spaced intervals.
Sol. False.
4. State Newton's divided difference formula.

Sol. $y=y_{0}+\left(x-x_{0}\right) \Delta y_{0}+(x-x)_{0}(x-x) \Delta^{2} y_{0}+(x-x)_{0}(x-x)_{1}(x-x)_{2} \Delta^{3} y_{0}+$
5. State Lagrange's interpolation formula

Sol.

$$
\begin{aligned}
y=f(x) & =\frac{\left(x-x_{1}\right)\left(x-x_{2}\right)\left(x-x_{3}\right) \ldots \ldots .\left(x-x_{n}\right)}{\left(x_{0}-x_{1}\right)\left(x_{0}-x_{2}\right)\left(x_{0}-x_{3}\right) \ldots \ldots .\left(x_{0}-x_{n}\right)} y_{0} \\
& +\frac{\left(x-x_{0}\right)\left(x-x_{2}\right)\left(x-x_{3}\right) \ldots \ldots .\left(x-x_{n}\right)}{\left(x_{1}-x_{0}\right)\left(x_{1}-x_{2}\right)\left(x_{1}-x_{3}\right) \ldots \ldots .\left(x_{1}-x_{n}\right)} y_{1} \\
& +\frac{\left(x-x_{0}\right)\left(x-x_{1}\right)\left(x-x_{3}\right) \ldots \ldots .\left(x-x_{n}\right)}{\left(x_{2}-x_{0}\right)\left(x_{2}-x_{1}\right)\left(x_{2}-x_{3}\right) \ldots \ldots .\left(x_{2}-x_{n}\right)} y_{2} \\
& +\ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots . \ldots_{n} \\
& +\frac{\left(x-x_{0}\right)\left(x-x_{1}\right)\left(x-x_{2}\right)\left(x-x_{3}\right) \ldots \ldots . .\left(x-x_{n-1}\right)}{\left(x_{n}-x_{0}\right)\left(x_{n}-x_{1}\right)\left(x_{n}-x_{2}\right)\left(x_{n}-x_{3}\right) \ldots \ldots .\left(x_{n}-x_{n-1}\right)} y_{n}
\end{aligned}
$$

6. Use Lagrange's formula to find the quadratic polynomial that takes these values

$$
\begin{array}{l:lll}
\mathrm{x}: & \mathbf{0} & 1 & 3 \\
\mathrm{y}: & \mathbf{0} & 1 & 0
\end{array}
$$

## Then find $\mathbf{y}(2)$.

Sol. By Lagrange's formula

$$
\begin{aligned}
& \begin{aligned}
& y=f(x)= \frac{\left(x-x_{1}\right)\left(x-x_{2}\right)}{\left(x_{0}-x_{1}\right)\left(x_{0}-x_{2}\right)} y_{0}+\frac{\left(x-x_{0}\right)\left(x-x_{2}\right)}{\left(x_{1}-x_{0}\right)\left(x_{1}-x_{2}\right)} y_{1} \\
& \quad+\frac{\left(x-x_{0}\right)\left(x-x_{1}\right)}{\left(x_{2}-x_{0}\right)\left(x_{2}-x_{1}\right)} y_{2} \\
& y=f(x)= \frac{(x-1)(x-3)}{(0-1)(0-3)} .0+\frac{(x-0)(x-3)}{(1-0)(1-3)} \cdot 1+\frac{(x-0)(x-1)}{(3-0)(3-1)} .0 \\
& \\
& \quad y(x)= \frac{x^{2}-3 x}{-2} \\
& \text { Hence } y(2)=1 .
\end{aligned}
\end{aligned}
$$

7. By differentiating Newton forward and backward difference formula, find the first derivative of the function $f(x)$.
Sol. Newton forward interpolation formula is

$$
\begin{aligned}
& y=y_{0}+u \Delta y_{0}+\frac{u(u-1)}{2!} \Delta^{2} y_{0}+\frac{u(u-1)(u-2)}{3!} \Delta^{3} y_{0}+ \\
& \quad \text { where } u=\frac{x-x_{0}}{h} \\
& \frac{d y}{d x}=\frac{d y}{d u} \cdot \frac{d u}{d x} \\
& =\frac{1}{d} \Gamma+\frac{2 u-1}{} \Delta^{2}+\frac{3 u_{2}-6 u+2}{} \Delta_{3} \\
& \\
& h\left[\begin{array}{lll}
y_{0} & 2 & y_{0}
\end{array}\right.
\end{aligned}
$$

$$
\left.+\frac{2 u_{3}-9 u_{2}+11 u-5}{12} \Delta_{4} y_{0}+\ldots . .\right]
$$

Newton backward interpolation formula is

$$
y=y_{n}+u \nabla y_{n}+\frac{u(u+1)}{2!} \nabla^{2} y_{n}+\frac{u(u+1)(u+2)}{3!} \nabla^{3} y_{n}+.
$$

where $u=\frac{x-x_{n}}{h}$
$\frac{d y}{d x}=\frac{d y}{\int d u} \cdot \frac{d u}{d x}$


## 12

8. Write down the Newton - cotes quadrature formula..

Sol.
$\int_{x_{0}}^{\substack{x_{n}}} f(x) d x=h\left\{n y_{0}+\frac{n^{2}}{2} \Delta y_{0}+\frac{1}{2}\left(\frac{n^{3}}{3}-\frac{n^{2}}{2}\right) \Delta^{2} y_{0}+\frac{1}{6}\left(\frac{n^{4}}{4}-n^{3}+n^{2}\right) \Delta^{3} y_{o}+\ldots \ldots \ldots\right\}$
9. What is the geometrical interpretation of Trapezoidal rule?

Sol. We are finding the area of the curve enclosed by $y=f(x)$, the $X$-axis, the ordinates $x=a$ and $x=$ b by using the area of trapezium.
10. Using Trapezoidal rule evaluate $\int_{0}^{\pi} \sin x d x$ by dividing the range into 6 equal parts.

Sol. $\quad h=\frac{\pi-0}{6}=\frac{\pi}{6}$
When $\mathrm{h}=\frac{\pi}{6}$, the values of $\mathrm{y}=\sin \mathrm{x}$ are
$\begin{array}{rcccccccc}\mathrm{x}: & 0 & \frac{\pi}{6} & \frac{2 \pi}{6} & \frac{3 \pi}{6} & \frac{4 \pi}{6} & \frac{5 \pi}{6} & \pi \\ \mathrm{y}=\sin \mathrm{x}: & 0 & 0.5 & .8660 & 1 & .8660 & 0.5 & 0\end{array}$
Trapezoidal rule is

$$
\begin{aligned}
\int_{0}^{\pi} \sin x d x & =\frac{h}{2}\left[\left(y_{0}+y_{n}\right)+2\left(y_{1}+y_{2}+y_{3}+\ldots \ldots \ldots y_{n-1}\right]\right. \\
& =\frac{\pi}{6(2)}[(0+0)+2(0.5+0.8660+1+0.8660+0.5)] \\
& =0.9770
\end{aligned}
$$

## 11. Why is Trapezoidal rule so called?

Sol. The Trapezoidal rule is so called, because it approximates the integral by the sum of $n$

## trapezoids.

12. What are the truncation errors in Trapezoidal and Simpson's rules of numerical integration? Sol. Error in the Trapezoidal rule is $\frac{-}{12} f^{\prime} \theta$. Error in the Trapezoidal rule is of the order $\mathrm{h}^{2}$. 12 Error in the Simpson's one-third rule is $-\frac{h^{5}}{90} f^{I V}(\theta)$. Error in Simpson's one-third rule is of the order $\mathrm{h}^{4}$.
$-\underline{3 h^{5}} f^{I V}(\theta)$

80
. Error in the Simpson's three eighth rule Error in the Simpson's three eighth rule is is of the order $\mathrm{h}^{4}$.
13. What is the condition for Simpson's $3 / 8$ rule and state the formula.

Sol. The condition for Simpson's $3 / 8$ rule is the number of sub-intervals should be a multiple of 3 . Simpson's $3 / 8$ rule is

$$
\begin{array}{r}
\int_{x_{0}}^{x_{n}} f(x) d x=\frac{3 h}{8}\left[\left(y_{0}+y_{n}\right)+3\left(y_{1}+y_{2}+y_{4}+y_{5}+y_{7}+\ldots \ldots \ldots\right)\right. \\
\left.+2\left(y_{3}+y_{6}+y_{9}+\ldots \ldots \ldots \ldots \ldots .\right)\right]
\end{array}
$$

14. Using Simpson's rule find $\int^{f} e_{x} d x$ given $\mathbf{e}^{\mathbf{0}}=1, \mathbf{e}^{\mathbf{1}}=2.72, \mathrm{e}^{\mathbf{2}}=7.39, \mathbf{e}^{\mathbf{3}}=20.09, \mathrm{e}^{4}=54.6$ 0
Soln The following data is

| $\mathrm{x}:$ | 0 | 1 | 2 | 3 | 4 |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{y}:$ | 1 | 2.72 | 7.39 | 20.09 | 54.6 |

Simpson's $1 / 3^{\text {rd }}$ rule is

$$
\begin{aligned}
& \int_{x_{0}}^{x_{n}} f(x) d x=\frac{h}{3}\left[\left(y_{0}+y_{n}\right)+4\left(y_{1}+y_{3}+y_{5}+\ldots \ldots \ldots\right)\right. \\
&\left.+2\left(y_{2}+y_{4}+y_{6}+\ldots \ldots \ldots \ldots \ldots .\right)\right]
\end{aligned}
$$

$$
\int_{0}^{4} e^{x} d x=\frac{1}{3}[(1+54.6)+4(2.72+20.09)+2(7.39)]
$$

$$
=53.8733
$$

15. Compare Trapezoidal rule and Simpson's $1 / \mathbf{3}^{\text {rd }}$ rule for evaluating numerical integration.

Sol. i) In Newton Cotes Quadrature formula, if we put $\mathrm{n}=1$ we get
Trapezoidal rule whereas if we put $\mathrm{n}=2$, we get Simpson's $1 / 3^{\text {rd }}$ rule.
ii) In Trapezoidal rule, the interpolating polynomial is linear whereas in

Simpson's $1 / 3^{\text {rd }}$ rule, the interpolating polynomial is of degree 2 .
iii) In Trapezoidal rule, there is no restriction on the number of intervals whereas in Simpson's $1 / 3^{\text {rd }}$ rule, the number of intervals should be even.

## UNIT V NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS

Taylor's series method - Euler's method - Modified Euler's method - Fourth order Runge-Kutta method for solving first and second order equations - Milne's predictor-corrector methods for solving first order equations - Finite difference methods for solving second order equation.
1.State Modified Euler algorithm to solve $y^{\prime}=f(x, y), y(x)_{0}=y \underset{0}{\text { at } x=x 0+h . ~(A . U . N / D ~ 2017, ~ N / D ~}$ 2011,2012, M/J 2013)

$$
\begin{aligned}
y_{n+1} & =y_{n}+h f\left[x_{n}+\frac{h}{2} y_{n}+\frac{h}{2} f\left(x_{n}, y_{n}\right)\right] \\
y_{1} & =y_{0}+h f\left[x_{0}+\frac{h}{2} y_{0}+\frac{h}{2} f\left(x_{0}, y_{0}\right)\right]
\end{aligned}
$$

2. State the disadvantage of Taylor series method.

## (A.U N/D 2009,M/J 2012,2014)

## Solution:

In the differential equation $f(x, y), \frac{\mathrm{dy}}{\mathrm{dx}}=f(x, y)$ the function $\mathrm{f}(\mathrm{x}, \mathrm{y})$, may have a complicated algebraical structure. Then the evaluation of higher order derivatives may become tedious. This is the demerit of this method.
3. Write the merits and demerits of the Taylor method of solution. (A.U.N/D 2010, M/J 2012) Solution:
The method gives a straight forward adaptation of classic to develop the solution as an infinite series. It is a powerful single step method if we are able to find the successive derivatives easily.
If $f(x . y)$ involves some complicated algebraic structures then the calculation of higher derivatives becomes tedious and the method fails.This isthe major drawback of this method.
However the method will be very useful for finding the starting values for powerful methods like Runge - Kutta method, Milne"s method etc.,
4. Which is better Taylor"s method or R. K. Method?(or) State the special advantage of Runge-Kutta method over taylor series method (A.U M/J 2011)
Solution:
$>$ R.K Methods do not require prior calculation of higher derivatives of $y(x)$, as the Taylor method does. Since the differential equations using in applications are often complicated, the calculation of derivatives may be difficult.
$>$ Also the R.K formulas involve the computation of $\mathrm{f}(\mathrm{x}, \mathrm{y})$ at various positions, instead of derivatives and this function occurs in the given equation.
5. Compare Runge-Kutta methods and predictor - corrector methods for solution of initial value problem. (A.U M/J 2011)

## Solution:

## Runge-Kutta methods

$>$ Runge-methods are self starting,since they do not use information from previously calculated points.
$>$ As mesne are self starting, an easy change in the step size can be made at any stage. 3.Since these methods require several evaluations of the function $f(x, y)$, they are time consuming.
$>$ In these methods,it is not possible to get any information about truncation error.

## Predictor Corrector methods

$>$ These methods require information about prior points and so they are not self starting.
$>$ In these methods it is not possible to get easily a good estimate of the truncation error.
6. What is a Predictor-corrector method of solving a differential equation? (A.U M/J 2009) Solution:
$>$ Predictor-corrector methods are methods which require the values of y at $\mathrm{x}_{\mathrm{n}}, \mathrm{x}_{\mathrm{n}-1}, \mathrm{x}_{\mathrm{n}-2}, \ldots$ for computing the value of y at . $\mathrm{x}_{\mathrm{n}+1}$
$>$ We first use a formula to find the value of y at $\mathrm{x}_{\mathrm{n}+1}$ and this is known as a predictor formula.
The value of y so got is improved or corrected by another formula known as corrector formula
7. State the third order R.K method algorithm to find the numerical solution of thefirst order differential equation. (A.U M/J 2011,N/D 2012)
Solution: To solve the differential equation $y^{\prime}=f(x, y)$ by the third order R.K method, we use the following algorithm.

$$
\begin{aligned}
k_{1} & =h f(x, y) \\
k_{2} & =h f\left(x+\frac{h}{2}, y+\frac{k_{1}}{2}\right) \\
k_{3} & =h f\left(x+h, y+2 k_{2}-k_{1}\right) \\
\text { and } \Delta y & =\frac{1}{6}\left(k_{1}+4 k_{2}+k_{3}\right)
\end{aligned}
$$

8. Write Milne"s predictor formula and Milne"s corrector formula.

## (A.U M/J 2012,N/D 2014)

## Solution:

> Milne"s predictor formula is

$$
y_{4, p}=y_{0}+\frac{4 h}{3}\left[2 y_{1}^{\prime}-y_{2}^{\prime}+2 y_{3}^{\prime}\right]
$$

> Milne" S corrector formula is

$$
y_{4, c}=y_{2}+\frac{h}{3}\left[y_{2}^{\prime}+4 y_{3}^{\prime}+y_{4}^{\prime}\right]
$$

9. Write down Adams-Bashforth Predictor and Adams-Bashforth corrector formula.
(A.U N/D 2011)

## Solution

Adams-Bashforthpredictor formula is

$$
y_{4, p}=y_{3}+\frac{h}{24}\left[55 y_{3}^{\prime}-59 y_{2}^{\prime}+37 y_{1}^{\prime}-9 y_{0}^{\prime}\right]
$$

Adams-Bashforthcorrector formula is

$$
y_{4, c}=y_{3}+\frac{h}{24}\left[9 y_{4}^{\prime}+19 y_{3}^{\prime}-5 y_{2}^{\prime}+y_{1}^{\prime}\right]
$$

## 10.State Euler formula

(A.U M/J 2013)

## Solution:

$y_{n+1}=y_{n}+h f\left[x_{n}, y_{n}\right]$ when $\mathrm{n}=0,1,2 \ldots \ldots \ldots$.
11.Write down finite difference formula for $y^{\prime}(x)$ and $y "(x)$ (A.U M/J 2012,N/D 2014) Solution:

$$
\mathrm{y}^{\prime}(\mathrm{x})=\frac{y_{i+1}-y_{i}}{h}, \quad \mathrm{y}^{\prime}(\mathrm{x})=\frac{y_{i-1}-2 y_{i}+y_{i+1}}{h^{2}}
$$

 ${ }_{n+1} \quad y_{n} \quad \overline{1!} y_{n} \quad \overline{2!} y_{n} \quad \overline{3!} y_{n} \quad \cdots$.
13.Using Taylor series method, find the value of $y(0.1)$, from dy $=x^{2}+y^{2}$ and $y(0)=1$ correct to 4decimal places
Solution:

$$
\begin{array}{ll} 
& \begin{array}{l}
y^{\prime}=x^{2}+y^{2} \\
y^{\prime}=2 x+2 y y^{\prime} \\
{ }_{0}
\end{array} \\
y^{\prime}=2+2 y y^{\prime}+2\left(y^{\prime}\right)^{2} \\
y^{\text {iv }}=2 y^{\prime}+6 y^{\prime} y^{\prime}
\end{array} \quad \begin{aligned}
& y^{\prime}=1
\end{aligned}
$$

By using Taylor series formula, $\mathrm{y}_{1}=1.11145$
14. Compare Taylor series method and Runge Kutta method.

## Solution:

$>$ The use of R-K method gives quick convergence to the solutions of the differential equations than Taylor's series method.
> The labour involved in R-K method is comparatively lesser.
> In R-K method, the derivatives of higher order are not required for calculation as in Taylor series method.

## 15. What are the advantages of R-K method over Taylor series method?

Solution:
The Rungekutta methods are designed to give greater accuracy and they possess the advantage of requiring only the function values at some selected points on the sub interval.

## 16. Compare Single-step method Multi-step methods. (A.U N/D 2017)

Solution:
S.No $\quad$ Single-step method $\quad$ Multi-step method


