	LESSON PLAN	
	Sub Code & Name: MA 3251 **STATISTICS AND NUMERICAL METHODS** **Unit: I Branch:**	**Semester : II**

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.

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 statistical hypothesis?(Nov/Dec-2017)	BTL -1	Remembering	PO1
2.	Define chi-square. ?(Nov/Dec-2017)	BTL -1	Remembering	PO1
3.	Write type I and type II errors .(Apr/May-ov/Dec-2013)(May/Jun-2016)	BTL -1	Remembering	PO1
4.	What are the assumptions in 't' distribution?(Nov/Dec-2016)(Apr/May-2015)	BTL -1	Remembering	PO1
5.	State the important properties of the t-distribution. (Apr/May-2015)	BTL -1	Remembering	PO1
6.	Write any three applications of Chi-Square distribution.(May/Jun-2014)	BTL -1	Remembering	PO1
7.	Define null and alternative hypothesis.	BTL -2	Understanding	PO2
8.	When do we use the t-distribution? (Nov/Dec-2016)	BTL -2	Understanding	PO2
9.	What is meant by level of significance? (Apr/May-2016)	BTL -2	Understanding	PO2
10.	Define Standard error and Critical region. (Nov/Dec-2016)	BTL -2	Understanding	PO2
11.	Write any two applications of 't'-distribution. (Nov/Dec-	BTL -3	Applying	PO3
12.	Write the condition for the application of χ^2 test.	BTL -3	Applying	PO3
13.	Write any three applications of 'F' distribution. (Nov/Dec-2015)	BTL -6	Creating	**PO1,PO2, PO5**
14.	State the important properties of F-distribution. (Nov/Dec-2011)	BTL -4	Analyzing	**PO1,PO2, PO5**
15.	Define sampling distribution. (Apr/May-2013)	BTL -4	Analyzing	**PO1,PO2, PO5**
16.	Define Chi-square test of goodness of fit. (Apr/May-2014)	BTL -3	Applying	PO5

17	Write down the form of the 95% confidence interval for the population mean in terms of population S.D.	BTL -5	Evaluating	**PO1,PO2, PO5**
18.	What is the Standard error of the difference between the means of two large samples drawn from different populations with known SD's	BTL -5	Evaluating	**PO1,PO2, PO5**
19.	What is the test statistic used to test the significance of the difference between small sample,mean and population?	BTL -6	Creating	**PO1,PO2, PO5**
20.	What is the test statistic used to test the significance of the ce between the means of two small samples?	BTL -4	Analyzing	**PO1,PO2, PO5**
21	Write down the formula of test stastistic 'Z' to test the significance of difference between the means (large s)	BTL -3	Applying	PO5
22	Write down the formula of test statistic 'Z' to test the significance of difference between the proportions(large samples).	BTL -3	Applying	PO5
23	What is the test statistic used to test the signifiance of the difference between the means of two small samples of same size,when the sample items are correlated?	BTL -6	Creating	**PO1,PO2, PO5**
24	What are the expected frequency of 2x2 contigency table given below. a b C d	BTL -4	Analyzing	**PO1,PO2, PO12**
25	Write down the 1% and 5% critical values for right tailed two tailed Tests.	BTL -4	Analyzing	**PO1,PO2, PO12**
26	What is the difference between confidence limits and tolerance limits?	BTL -3	Applying	PO12
27	What are the assumptions of large sample?	BTL -5	Evaluating	**PO1,PO2, PO12**
28	What is test of goodness of fit?	BTL -3	Applying	PO12
29	Define hypothesis	BTL -6	Creating	**PO1,PO2, PO5**
30	What is meant by population?	BTL -4	Analyzing	**PO1,PO2, PO5**
PART – B				

1.(a)	The mean life time of a sample of 100 light tubes produced by a company is found to be 1580 hours with standard deviation of 90 hours. Examine the hypothesis that the mean life time of the tubes produced by the company is 1600 hours. (Apr/May-2016)	BTL -1	Remembering	PO1
1. (b)	Test of fidelity and selectivity of 190 radio receivers produced the results shown in the following table Use 0.01 level of significance to test whether there is a relationship between fidelity and selectivity. (Nov/Dec- 2017)	BTL -1	Remembering	PO1
2. (a)	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. (Apr/May-2015)	BTL -1	Remembering	PO1
2.(b)	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? (Nov/Dec-2012)	BTL -1	Remembering	PO1
3. (a)	Two independent samples of sizes 8 and 7 contained the following values. (Nov/Dec-2013) (Apr/May-2016)	BTL -2	Understanding	PO2
3.(b)	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.	BTL -2	Understanding	PO2

Fidelity			
Selectivity	Low	Average	High
Low	6	12	32
Average	33	61	18
High	13	15	0

Hair color

Eye color	Fair	Brown	Black	Total
Blue	15	5	20	40
Grey	20	10	20	50
Brown	25	15	20	60
Total	60	30	60	150

Sample I	19	17	15	21	16	18	16	14
Sample II	15	14	15	19	15	18	16	

Days	Sun	Mon	Tues	Wed	Thu	Fri	Sat
No. of accidents	14	16	8	12	11	9	14

4. (a)	Two independent samples of 8 and 7 items respectively had the following Values of the variable(weight in kgs) Use 0.05 LOS to test Sample I: 9 11 13 11 15 9 12 14 Sample II: 10 12 10 14 9 8 10 whether the variances of the two population's sample are equal. (Apr/May-2014)	BTL -2	Understanding	PO2
5. (a)	A group of 10 rats fed on diet A and another group of 8 rats fed on diet B. Recorded the following increase the following increase in weight.(gm) Diet A: 5 6 8 1 12 4 3 9 6 10 Diet B: 2 3 6 8 10 1 2 8 - - Find the variances are significantly different. (Use F–test) (Nov/Dec-2014)	BTL -2	Understanding	PO2
5 (b)	The marks obtained by a group of 9 regular course students and another group of 11 part time course students in a test are given below: Sample I: 56 62 63 54 60 51 67 69 58 Sample II: 62 70 71 62 60 56 75 64 72 68 66 Examine whether the marks obtained by regular students and part – time students differ significantly at 5% and 1% levels of significance. (Apr/May-2012)	BTL -4	Applying	PO12
6. (a)	Two independent samples of sizes 8 and 7 contained the following values. Sample I: 19 17 15 21 16 18 16 14 Sample II: 15 14 15 19 15 18 16 Test if the two populations have the same variance.	BTL -2	Understanding	PO2
6.(b)	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? (Nov/Dec-2014)	BTL -4	Applying	PO12
7. (a)	Records taken of the number of male and female births in 800 families having four Children are as follows : Number of male births : 0 1 2 3 4 Number of female births :4 3 2 1 0 Number of Families :32 178 290 236 64 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. (Apr/May-2014)	BTL -4	Analyzing	**PO1,PO2, PO5**

<table>
<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>1234 hrs</td><td>1036 hrs</td></tr><tr><td>Sample S.D</td><td>36 hrs</td><td>40 hrs</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? (Nov/Dec-2015)</td><td>BTL -3</td><td>Applying</td><td>PO12</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><td>PO1,PO2, PO12</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? (Apr/May-2015)</td><td>BTL -2</td><td>Understanding</td><td>PO2</td></tr>
<tr><td>9. (a)</td><td>Two independent samples of sizes 9 and 7 from a normal population had the following values of the variables Sample 1 18 13 12 15 12 14 16 14 15
Sample 2 16 19 13 16 18 13 15
Justify whether the difference between the means of samples of samples significant? (Nov/Dec-2016)</td><td>BTL -1</td><td>Remembering</td><td>PO1</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 cms and a standard deviation of 6.3cms. Do the data indicate that Americans are, on the average, taller than Englishmen?(BTL4) (Apr/May-2016)</td><td>BTL -1</td><td>Remembering</td><td>PO1</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. (Nov/Dec-2013)</td><td>BTL -1</td><td>Remembering</td><td>PO1</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 concluded that the medicine was responsible for the increase in B.P. 5% l.o.s (Apr/May- 2012)</td><td>BTL -1</td><td>Remembering</td><td>PO1</td></tr>
</table>

<table>
<tr><td>11.(a)</td><td>200 digits were chosen at random from a set of tables. The frequencies of the digits were given below:
Use χ^2 test to access the correctness of hypothesis that the digits were distributed in equal nos. in the table, given that the values of χ^2 are16.9, 18.3, 19.7 for 9, 10, 11 degrees of freedom at 5% level of significance.</td><td>BTL -3</td><td>Applying</td><td>PO12</td></tr>
<tr><td>11.(b)</td><td>4 coins were tossed 160 times and the following results were obtained
No. of heads : 0 1 2 3 4
Observed frequencies: 17 52 54 31 6
Under the assumption that the coins are balanced, find the expected frequencies of getting 0, 1, 2, 3, 4 heads and test the goodness of fit. (Nov/Dec-2014)</td><td>BTL -5</td><td>Evaluating</td><td>PO1,PO2, PO5</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>Drugs</td><td>No Drugs</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? (Apr/May- 2015)</td><td>BTL -1</td><td>Remembering</td><td>PO1</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 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><td>PO1,PO2, PO12</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?
(Nov/Dec-2014)</td><td>BTL -1</td><td>Remembering</td><td>PO1</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</td><td>8</td><td>7</td></tr><tr><td>S.D</td><td>1234 hrs</td><td>1036 hrs</td></tr><tr><td>No. of sample</td><td>36 hrs</td><td>40 hrs</td></tr></table>Test at 5 % level, that the mean height is the same for adults in the two places. (Apr/May-2012)</td><td>BTL -2</td><td>Understanding</td><td>PO2</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><td>PO1,PO2, PO5</td></tr>
</table>

	(Nov/Dec-2012)			
14.(b)	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 births was 0.496.Is there any significant difference in the proportion of male births in the two towns ? (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 2x2 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/May-2015)	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	**PO1,PO2,PO12**
12.	Write any 3 applications of LSD. (Nov/Dec-2014)	BTL -3	Applying	**PO1,PO2,PO12**
13.	How do you calculate the Correction factor in LSD? (Nov/Dec-2012)	BTL -3	Applying	**PO1,PO2,PO12**
14. n	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/May-2015)	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. Mixture 1 : 0.56 1.12 0.90 1.07 0.94 Mixture 2 : 0.72 0.69 0.87 0.78 0.91 Mixture 3 : 0.62 1.08 1.07 0.99 0.93 (Apr/May-2017)	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: A 55 49 42 21 52 B 61 112 30 89 63 C 42 97 81 95 92 D 169 137 169 85 154 (Apr/May-2016)	BTL -2	Understanding	PO2

<table>
<tr><td>2. (a)</td><td>The following table shows the lives in hours of four brands of electric lamps brand
A:1610, 1610, 1650, 1680, 1700, 1720, 1800
B: 1580, 1640, 1640, 1700, 1750
C:1460, 1550, 1600, 1620, 1640, 1660, 1740, 1820
D:1510, 1520, 1530, 1570, 1600, 1680
Identify an analysis of variance and test the homogeneity of the mean lives of the four brands of lamps. (Apr/May-2014)</td><td>BTL -1</td><td>Remembering</td><td>PO1</td></tr>
<tr><td>2.(b)
3.</td><td>A company appoints 4 salesmen A, B, C and D and observes their sales in 3 seasons, summer winter and monsoon. The figures are given in the following table:
<table>
<tr><td></td><td colspan="4">SALESMEN</td></tr>
<tr><td>SEASON</td><td>1</td><td>2</td><td>3</td><td>4</td></tr>
<tr><td>SUMMER</td><td>45</td><td>40</td><td>28</td><td>37</td></tr>
<tr><td>WINTER</td><td>43</td><td>41</td><td>45</td><td>38</td></tr>
<tr><td>MONSOON</td><td>39</td><td>39</td><td>43</td><td>41</td></tr>
</table>
Carry out an Analysis of variances. (Apr/May-2013) In order to determine whether there is significant difference in the durability of 3 makes of computers, samples of size</td><td>BTL -2</td><td>Understanding</td><td>PO2</td></tr>
<tr><td>4.</td><td>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?
<table>
<tr><td colspan="3">MAKES</td></tr>
<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>
(Apr/May-2012)</td><td>BTL -1</td><td>Remembering</td><td>PO1</td></tr>
<tr><td>5.</td><td>Five doctors each test five treatments for a certain disease and observe the number of days each patient take store cover. The results are as follows (recovery time in days)
<table>
<tr><td></td><td colspan="5">TREATMENT</td></tr>
<tr><td>DOCTOR</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</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. (Nov/Dec-2017)
Perform a 2-way ANOVA on the data given below:
Treatment 1
1 2 3
tm en t 2 1 30 26 38</td><td>BTL -2
BTL -3</td><td>Understanding
Applying</td><td>PO2
PO1,PO2,PO5</td></tr>
</table>

	2 24 29 28 3 33 24 35 4 36 31 30 5 27 35 33 Use the coding method subtracting 30 from the given no. (Nov/Dec-2016)			
6.	The following data represent a certain person to work from Monday to Friday by 4 different routes. DAYS: MON TUE WED THU FRI ROUTES 1: 22 26 25 25 31 2: 25 27 28 26 29 3: 26 29 33 30 33 4: 26 28 27 30 30 Test at 5% level of significance whether the differences among the means obtained for the different routes are significant and also whether the differences among the means obtained for the different days of the week are significant. (Nov/Dec-2015)	BTL -2	Understanding	PO2
7.	Analyze the variance in the following Latin square of yields of paddy where A, B, C, D denote the different methods of cultivation.. D122 A121 C123 B122 B124 C123 A122 D125 A120 B119 D120 C121 C122 D123 B121 A122 Examine whether the different methods of cultivation have given significantly different yields. (Nov/Dec- 2014)	BTL -4	Analyzing	PO5
8. (a)	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. A16 B17 C20 B16 C21 A15 C15 A12 B13 (Nov/Dec-2013)	BTL -1	Remembering	PO1
8.(b)	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. C25 B23 A20 D20 A19 D19 C21 B18 B19 A14 D17 C20 D17 C20 B21 A15 (Nov/Dec-2012)	BTL -5	Evaluating	PO5

9.	A farmer wishes to test the effects of four different fertilizers A, B, C, D on the yield of Wheat. In order to eliminate sources of error due to variability in soil fertility, he uses the fertilizers, in a Latin square arrangement as indicated in the following table, where the numbers indicate yields per unit area. A18 C21 D25 B11 D22 B12 A15 C19 B15 A20 C23 D24 C22 D21 B10 A17 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.	BTL -1	Remembering	PO1
10.	Set up the analysis of variance for the following results of a Latin Square Design(use α = 0.01) level of significance A12 C19 B10 D8 C18 B12 D6 A7 B22 D10 A5 C21 D12 A7 C27 B17	BTL -4	Analyzing	PO5
11.	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. A48 E66 D56 C52 B61 D64 B62 A50 E64 C63 B69 A53 C60 D61 E67 C57 D58 E67 B65 A55 E67 C57 B66 A60 D57	BTL -6	Creating	**PO1,PO2,PO5**
12	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. B25 A18 E27 D30 C27 A19 D31 C29 E26 B23 C28 B22 D33 A18 E27 E28 C26 A20 B25 D33 D32 E25 B23 C28 A20	BTL -3	Applying	**PO1,PO2,PO5**
13.	Find out the main effects and interaction effects in the following 2^2 factorial experiment and write down the analysis of variance table BLOCKS 1 0 A 10 B 1 AB 11 I 64 25 30 60 II 75 14 50 33 III 76 12 41 17 IV 75 33 25 10	BTL -3	Applying	**PO1,PO2,PO5**

14.	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 α = 1%)	BTL -3	Applying	**PO1,PO2,PO1 2**

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
IV	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	BT Level	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**	**PO1,PO2 ,PO3**
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**	**PO1,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**	**PO1,PO2**
8	Gauss Seidel method always converges – True or False. . **(A.U**	**BTL-1**	**Remembering**	**PO1,PO2**

	M/J 2016)			
9	Write the first iteration values of x,y,z when the equations 27x+6y-z = 85, 6x+15y+2z = 72, x+y+5z = 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 AX=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	Find the dominant eigen value of A = $\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$ by power method. **(A.U M/J 2012)**	**BTL-1**	**Remembering**	**PO1**
13	On what type of equations Newton's method can be applicable ? **(A.U A/M 2016)**	**BTL-1**	**Remembering**	**PO1,PO2 ,PO5**
14	By Gauss elimination method solve $x+y=2 \ \ and \ \ 2x+3y=5.$ **(A.U M/J 2014)**	**BTL-1**	**Remembering**	**PO1**
15	Why Gauss Seidel iteration is a method of successive corrections? **(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 = $\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$ by Gauss Jordan method. **(A.U M/J 2013)**	**BTL-1**	**Remembering**	**PO1,PO2**
	PART-B			
1	Solve $x\log_{10} x = 12.34$ with x_0 = 10 using Newton's method. **(A.U.N/D 2017, N/D 2011,2012, M/J 2013)**	**BTL-4**	**Analyzing**	**PO1,PO2 ,PO5**
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**	**PO1,PO2 ,PO5**
3	Solve the following equation by Gauss Elimination method $10x - 2y + 3z = 23$ $2x + 10y - 5z = -33$ (**A.U.N/D 2017, N/D 2011,2012, M/J 2014)** $3x - 4y + 10z = 41$	**BTL-5**	**Evaluating**	**PO1,PO2 ,PO5**
4	Solve the equation by Gauss Jordan method : $2x_1 + x_2 + 4x_3 = 4$ $x_1 - 3x_2 - x_3 = -5$ $3x_1 - 2x_2 + 2x_3 = -1$	**BTL-5**	**Evaluating**	**PO1,PO2 ,PO5**

5	Find the inverse of $\begin{bmatrix} 2 & 2 & 3 \\ 2 & 1 & 1 \\ 1 & 3 & 5 \end{bmatrix}$ using Gauss Jordan method.	**BTL-2**	**Understanding**	**PO1,PO2**
6	Solve by Gauss Siedel method $x + y + 54z = 110$ $27x + 6y - z = 85$ $6x + 15y + 2z = 72$ **(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 = $\begin{bmatrix} 1 & -3 & 2 \\ 4 & 4 & -1 \\ 6 & 3 & 5 \end{bmatrix}$ by power method. **(A.U M/J 2015)**	**BTL-5**	**Evaluating**	**PO1,PO2 ,PO5**
8	Find the numerically largest eigen value of A = $\begin{bmatrix} 25 & 1 & 2 \\ 1 & 3 & 0 \\ 2 & 0 & -4 \end{bmatrix}$ by power method and the corresponding eigen vector. **(A.U M/J 2011,N/D 2012)**	**BTL-5**	**Evaluating**	**PO1,PO2 ,PO5**
9	Find the numerically largest eigen value of A = $\begin{bmatrix} 5 & 4 & 3 \\ 10 & 8 & 6 \\ 20 & -4 & 22 \end{bmatrix}$ by power method with the initial eigen vector $X_0 = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}$. **(A.U M/J 2016)**	**BTL-5**	**Evaluating**	**PO1,PO2 ,PO5**

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.

PART – A

CO Mapping : C214.2

Q. No	Questions	BT Level	Competence	PO
1	Define interpolation and extrapolation? **(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. **(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 x : 0 1 3 y : 0 1 0 Then find y(2). **(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 $\int_0^{\pi} \sin x dx$ 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 $\int_0^4 e^x dx$ given $e^0 = 1$, $e^1 = 2.72$, $e^2 = 7.39$, $e^3 = 20.09$, $e^4 = 54.6$	BTL-4	Analyzing	PO1
15	Compare Trapezoidal rule and Simpson's 1/3rd 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. x : 4 6 8 10 y : 1 3 8 16 Use it to find the value of y for x = 5. **(A.U M/J 2011,A/M 2012)**	**BTL-5**	**Evaluating**	**PO1,PO2 , PO3,PO5**
2	The following data are taken from the steam table Temp ^{0} c : 140 150 160 170 180 Pressure kg f/cm^2 : 3.685 4.854 6.302 8.076 10.225 Find the pressure at temperature t = 175^0.	**BTL-4**	**Analyzing**	**PO1,PO2**
3	Using Lagrange's interpolation formula calculate the profit in the year 2000 from the following data Year : 1997 1999 2001 2002 Profit in lakhs of Rs. : 43 65 159 248 **(A.U.N/D 2017, N/D 2011,2012, M/J 2013)**	**BTL-5**	**Evaluating**	**PO1,PO2, PO5,PO12**
4	Find the polynomial f(x) by using Lagrange's formula and hence find f(3) for x : 0 1 2 5 f(x) : 2 3 12 147 **(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**	**PO1,PO2, PO5,PO12**
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. x : 3 4 5 6 7 8 9 y : 4.8 8.4 14.5 23.6 36.2 52.8 73.9 **(A.U M/J 2016)**	**BTL-4**	**Analyzing**	**PO1,PO2, PO5,PO12**
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 time (sec.) : 0 5 10 15 20 velocity (m/sec.) : 0 3 14 69 228 **(A.U N/D 2015)**	**BTL-5**	**Evaluating**	**PO1,PO2, PO5,PO12**
8	Using Trapezoidal rule, evaluate $\int_{-1}^{1} \frac{dx}{1+x^2}$ taking 8 intervals.	**BTL-5**	**Evaluating**	**PO1,PO2, PO5,PO12**

9	Find an approximate value of $\log_e 5$ by calculating to four decimal places by Simpson's rule the integral $\int_0^5 \frac{dx}{4x+5}$ dividing the range into 10 equal parts. **(A.U A/M 2016)**	**BTL-3**	**Applying**	**PO1,PO2, PO5,PO12**
10	Evaluate $\int_0^6 \frac{dx}{1+x^2}$ by dividing the range into 6 equal parts using Simpson's rule.	**BTL-3**	**Applying**	**PO1,PO2, PO5,PO12**
11.	Evaluate $\int_0^1 \frac{dx}{1+x^2}$ take h = 0.125. Hence find π using Simpson's rule. **(A.U.N/D 2017, N/D 2011,2012, M/J 2014)**	**BTL-5**	**Evaluating**	**PO1,PO2, PO5,PO12**
12.	Compute $\int_0^1 \frac{xdx}{x^3+10}$ 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 Level	Competence	PO
1.	State Modified Euler algorithm to solve $y' = f(x,y), y(x_0) = y_0$ at x=x0 +h. **(A.U.N/D 2017, N/D 2011,2012, M/J 2013)**	**BTL -1**	**Remembering**	**PO1**
2.	State the disadvantage of Taylor series method. **(A.U N/D 2009,M/J 2012,2014)**	**BTL -1**	**Understanding**	**PO1**
3.	Write the merits and demerits of the Taylor method of 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**	**PO2,PO 5**
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. **(A.U M/J 2012,N/D 2014)**	**BTL -1**	**Understanding**	**PO1**
9.	Write down Adams-Bashforth Predictor and Adams-Bashforth corrector formula. **(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'(x) and y"(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 x = 0.1 if $f(x,y)= x^2y – 1$,y(0) = 1	**BTL -1**	**Remembering**	**PO1,PO2 ,PO5**
2	Solve: y‟ = x+ y ; y(0) = 1, by Taylor‟s series method. Find the values y at x = 0.1 and x = 0.2	**BTL -3**	**Applying**	**PO1,PO2 ,PO5**
3	Using Taylor‟s series method find y(1.1) given y‟= x + y ,y(1) = 0	**BTL -1**	**Remembering**	**PO1,PO2 ,PO5**

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

ANSWERS FOR TWO MARK QUESTIONS

UNIT –I-TESTING OF HYPOTHESIS

PART-A(2 MARKS)

(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)

$$\chi^2 = \sum_{i=1}^{n}(O_i - E_i)^2 / E_i$$

(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 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 'α'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 χ^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 σ^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.

$$\left(\overline{X} - 1.96\frac{\sigma}{\sqrt{n}}, \overline{X} + 1.96\frac{\sigma}{\sqrt{n}}\right)$$

(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).

$$Z = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

(22) Write down the formula of test statistic 'Z' to test the significance of difference between the proportions(large samples).

$$Z = \frac{p_1 - p_2}{\sqrt{\frac{P_1Q_1}{n_1} + \frac{P_2Q_2}{n_2}}}$$

(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?

$$t = \frac{\bar{d}}{s\sqrt{n-1}}, where\ d_i = x_i - y_i$$

(24) What are the expected frequency of 2x2 contigency table given below.

a	b
C	d

$\frac{(a+b)(a+c)}{N}$	$\frac{(a+b)(b+d)}{N}$
$\frac{(a+c)(d+c)}{N}$	$\frac{(d+b)(d+c)}{N}$

(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	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 2x2 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

$$= (n^2 - 1) - (n-1) - (n-1) - (n-1)$$

$$= (n-1)(n-2)$$

For n=2 ,degrees of freedom of SSE=0 and hence MSE id not defined.Comparision is not possible.Hence 2x2 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

(ii) Randomization and Local control.

(9) Write the advantages and disadvantages of RBD?(Apr/May-2015) Advantages :
(i). Accuracy (ii) Flexibility (iii) Easy to analyze Disadvantage : It is not suitable for large number of treatment

(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 $\sum\sum x^2_{ij}$ is known as RSS and the expression $\frac{G^2}{N}$, $where\ G^2 = \sum\sum x^2_{ij}$ 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.

$$F = \frac{S_1^2}{S_2^2} = \frac{Variance\ betweensamples}{Variance\ within\ samples}$$

(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 $|f(x)f''(x) < |[f'(x)]^2$.

2. Give Newton Raphson iterative formula.

Sol. $x_{n+1} = x_n - \frac{f(x_n)}{f'(x)_n}, n = 0,1,2,.....$

3. Establish an iteration formula to find the reciprocal of a positive number N by Newton Raphson method.

Sol. Let x = 1/N

$$\Rightarrow N = \frac{1}{x} \Rightarrow \frac{1}{x} - N = 0$$

$$(i.e.)\quad f(x) = \frac{1}{x} - N \Rightarrow f(x_n) = \frac{1}{x_n} - N,\ f'(x_n) = -\frac{1}{x_n^2}$$

By Newton Raphson method,

$$x_{n+1} = x_n - \frac{f(x_n)}{f'(x)_n} = x_n - \frac{\frac{1}{x_n} - N}{-\frac{1}{x_n^2}} = x_n + x_n^2\left(\frac{1}{x_n} - N\right)$$

$$= x_n(2 - Nx_n).$$

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

Sol. In the equation AX = 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 27x+6y-z = 85, 6x+15y+2z = 72, x+y+5z = 110 are solved by Gauss Seidel method.

Sol. Here the coefficient matrix is diagonally dominant. Then

$$x = \frac{1}{27}(85 - 6y + z) \ldots\ldots (1)$$

$$y = \frac{1}{15}(72 - 6x - 2z) \ldots\ldots (2)$$

$$z = \frac{1}{5}(110 - x - y) \ldots\ldots\ldots (3)$$

First Iteration

Put y = 0, z = 0 in (1), we get x = 3.148

Put x = 3.148, z = 0 in (2), we get y = 3.451

Put x = 3.148, y = 3.451 in (3), we get z = 20.662

10.Compare Gauss Elimination and Gauss Jordan methods for solving linear systems of the form AX=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 $A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$ **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* $2x + 3y = 5.$

Sol. The augmented matrix is

$$[A,B] = \begin{bmatrix} 1 & 1 & 2 \\ 2 & 3 & 5 \end{bmatrix}$$

$$= \begin{bmatrix} 1 & 1 & 2 \\ 0 & 1 & 1 \end{bmatrix} R_2 = R_2 - 2R_1$$

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

$$y = 1$$

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

$$x = 1$$

Hence x = 1, 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*

$$y = y_0 + u\Delta y_0 + \frac{u(u-1)}{2!}\Delta^2 y_0 + \frac{u(u-1)(u-2)}{3!}\Delta^3 y_0 + \ldots\ldots\ldots\ldots$$

where $u = \dfrac{x - x_0}{h}$

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

$$y = y_n + u\nabla y_n + \frac{u(u+1)}{2!}\nabla^2 y_n + \frac{u(u+1)(u+2)}{3!}\nabla^3 y_n + \ldots\ldots\ldots\ldots$$

where $u = \dfrac{x - x_n}{h}$

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. $y = y_0 + (x - x_0)\Delta y_0 + (x - x_0)(x - x_1)\Delta^2 y_0 + (x - x_0)(x - x_1)(x - x_2)\Delta^3 y_0 +$

5. State Lagrange's interpolation formula

Sol.

$$y = f(x) = \frac{(x-x_1)(x-x_2)(x-x_3).....(x-x_n)}{(x_0-x_1)(x_0-x_2)(x_0-x_3).....(x_0-x_n)} y_0$$
$$+ \frac{(x-x_0)(x-x_2)(x-x_3).....(x-x_n)}{(x_1-x_0)(x_1-x_2)(x_1-x_3).....(x_1-x_n)} y_1$$
$$+ \frac{(x-x_0)(x-x_1)(x-x_3).....(x-x_n)}{(x_2-x_0)(x_2-x_1)(x_2-x_3).....(x_2-x_n)} y_2$$
$$+.....+$$
$$+ \frac{(x-x_0)(x-x_1)(x-x_2)(x-x_3).....(x-x_{n-1})}{(x_n-x_0)(x_n-x_1)(x_n-x_2)(x_n-x_3).....(x_n-x_{n-1})} y_n$$

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

x :	**0**	**1**	**3**
y :	**0**	**1**	**0**

Then find y(2).

Sol. By Lagrange's formula

$$y = f(x) = \frac{(x-x_1)(x-x_2)}{(x_0-x_1)(x_0-x_2)} y_0 + \frac{(x-x_0)(x-x_2)}{(x_1-x_0)(x_1-x_2)} y_1$$
$$+ \frac{(x-x_0)(x-x_1)}{(x_2-x_0)(x_2-x_1)} y_2$$
$$y = f(x) = \frac{(x-1)(x-3)}{(0-1)(0-3)}.0 + \frac{(x-0)(x-3)}{(1-0)(1-3)}.1 + \frac{(x-0)(x-1)}{(3-0)(3-1)}.0$$
$$y(x) = \frac{x^2-3x}{-2}$$

Hence y(2) = 1.

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

Sol. Newton forward interpolation formula is

$$y = y_0 + u\Delta y_0 + \frac{u(u-1)}{2!}\Delta^2 y_0 + \frac{u(u-1)(u-2)}{3!}\Delta^3 y_0 + ...$$

where $u = \frac{x-x_0}{h}$

$$\frac{dy}{dx} = \frac{dy}{du}.\frac{du}{dx}$$
$$= \frac{1}{h}\left[\Delta y_0 + \frac{2u-1}{2}\Delta^2 y_0 + \frac{3u_2-6u+2}{6}\Delta_3 y_0\right.$$

$$+\frac{2u_3-9u_2+11u-3}{12}\Delta_4 y_0+\ldots\ldots\Big]$$

Newton backward interpolation formula is

$$y=y_n+u\nabla y_n+\frac{u(u+1)}{2!}\nabla^2 y_n+\frac{u(u+1)(u+2)}{3!}\nabla^3 y_n+\ldots\ldots\ldots\ldots$$

where $u=\frac{x-x_n}{h}$

$$\frac{dy}{dx}=\frac{dy}{du}\cdot\frac{du}{dx}$$

$$=\frac{1}{h}\left[\nabla y_n+\frac{2u+1}{2}\nabla^2 y_n+\frac{3u_2+6u+2}{6}\nabla^3 y_n+\frac{2u_3+9u_2+11u+3}{12}\nabla^4 y_n+\ldots\ldots\right]$$

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

Sol.

$$\int_{x_0}^{x_n} f(x)dx=h\left\{ny_0+\frac{n^2}{2}\Delta y_0+\frac{1}{2}\left(\frac{n^3}{3}-\frac{n^2}{2}\right)\Delta^2 y_0+\frac{1}{6}\left(\frac{n^4}{4}-n^3+n^2\right)\Delta^3 y_o+\ldots\ldots\right\}$$

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 $\int_0^{\pi}\sin x dx$ by dividing the range into 6 equal parts.

Sol. $h=\frac{\pi-0}{6}=\frac{\pi}{6}$

When h = $\frac{\pi}{6}$, the values of y = sinx are

x :	0	$\frac{\pi}{6}$	$\frac{2\pi}{6}$	$\frac{3\pi}{6}$	$\frac{4\pi}{6}$	$\frac{5\pi}{6}$	π
y=sinx:	0	0.5	.8660	1	.8660	0.5	0

Trapezoidal rule is

$$\int_0^{\pi}\sin x dx=\frac{h}{2}\left[(y_0+y_n)+2(y_1+y_2+y_3+\ldots\ldots\ldots y_{n-1}\right]$$

$$=\frac{\pi}{6(2)}\left[(0+0)+2(0.5+0.8660+1+0.8660+0.5)\right]$$

$$=0.9770$$

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 $-\frac{h^3}{12} f'(\theta)$. Error in the Trapezoidal rule is of the order h^2.

Error in the Simpson's one-third rule is $-\frac{h^5}{90} f^{IV}(\theta)$. Error in Simpson's one-third rule is of the order h^4.

Error in the Simpson's three eighth rule is $-\frac{3h^5}{80} f^{IV}(\theta)$. Error in the Simpson's three eighth rule is of the order 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

$$\int_{x_0}^{x_n} f(x)dx = \frac{3h}{8}\left[(y_0 + y_n) + 3(y_1 + y_2 + y_4 + y_5 + y_7 + \ldots\ldots\ldots) + 2(y_3 + y_6 + y_9 + \ldots\ldots\ldots\ldots\ldots)\right]$$

14. Using Simpson's rule find $\int_0^4 e^x dx$ given $e^0 = 1$, $e^1 = 2.72$, $e^2 = 7.39$, $e^3 = 20.09$, $e^4 = 54.6$

Soln The following data is

x :	0	1	2	3	4
y :	1	2.72	7.39	20.09	54.6

Simpson's 1/3rd rule is

$$\int_{x_0}^{x_n} f(x)dx = \frac{h}{3}\left[(y_0 + y_n) + 4(y_1 + y_3 + y_5 + \ldots\ldots\ldots) + 2(y_2 + y_4 + y_6 + \ldots\ldots\ldots\ldots\ldots)\right]$$

$$\int_0^4 e^x dx = \frac{1}{3}\left[(1 + 54.6) + 4(2.72 + 20.09) + 2(7.39)\right]$$

$$= 53.8733$$

15. Compare Trapezoidal rule and Simpson's 1/3rd rule for evaluating numerical integration.

Sol. i) In Newton Cotes Quadrature formula, if we put n = 1 we get Trapezoidal rule whereas if we put n = 2, we get Simpson's 1/3rd rule.

ii) In Trapezoidal rule, the interpolating polynomial is linear whereas in Simpson's 1/3rd 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 1/3rd 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 $y' = f(x, y), y(x_0) = y_0$ at x=x0 +h. **(A.U.N/D 2017, N/D 2011,2012, M/J 2013)**

$$y_{n+1} = y_n + hf\left[x_n + \frac{h}{2}y_n + \frac{h}{2}f(x_n, y_n)\right]$$

$$y_1 = y_0 + hf\left[x_0 + \frac{h}{2}y_0 + \frac{h}{2}f(x_0, y_0)\right]$$

2. State the disadvantage of Taylor series method.

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

Solution:

In the differential equation $f(x, y), \frac{dy}{dx} = f(x, y)$ the function f (x, 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 f (x, 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 $x_n, x_{n-1}, x_{n-2}, \ldots$ for computing the value of y at . x_{n+1}
- We first use a formula to find the value of y at x_{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 $y' = f(x, y)$ by the third order R.K method, we use the following algorithm.

$$k_1 = hf(x, y)$$
$$k_2 = hf\left(x + \frac{h}{2}, y + \frac{k_1}{2}\right)$$
$$k_3 = hf(x + h, y + 2k_2 - k_1)$$
$$\text{and } \Delta y = \frac{1}{6}(k_1 + 4k_2 + k_3)$$

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

$$y_{4,p} = y_0 + \frac{4h}{3}[2y_1' - y_2' + 2y_3']$$

- Milne‟s corrector formula is

$$y_{4,c} = y_2 + \frac{h}{3}[y_2' + 4y_3' + y_4']$$

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

Solution

Adams-Bashforthpredictor formula is

$$y_{4,p} = y_3 + \frac{h}{24}[55y_3' - 59y_2' + 37y_1' - 9y_0']$$

Adams-Bashforthcorrector formula is

$$y_{4,c} = y_3 + \frac{h}{24}[9y_4' + 19y_3' - 5y_2' + y_1']$$

10.State Euler formula **(A.U M/J 2013)**

Solution:

$y_{n+1} = y_n + hf[x_n, y_n]$ when n = 0,1,2.....

11.Write down finite difference formula for y'(x) and y''(x) **(A.U M/J 2012,N/D 2014)**

Solution:

$y'(x) = \frac{y_{i+1} - y_i}{h}$, $y''(x) = \frac{y_{i-1} - 2y_i + y_{i+1}}{h^2}$

12. Write down the Taylor series formula for solving first order ODE.

$$y_{n+1} = y_n + \frac{h}{1!}y_n' + \frac{h^2}{2!}y_n'' + \frac{h^3}{3!}y_n''' + \cdots.$$

13.Using Taylor series method, find the value of y (0.1), from $\frac{dy}{dx} = x^2 + y^2$ and y(0) = 1 correct to 4decimal places

Solution:

$y' = x^2 + y^2$ x =0

$y_0' = 2x + 2yy'$ y=1

$y' = 2 + 2yy' + 2(y')^2$ $y' = 1$

$y^{iv} = 2yy'' + 6y'y''$ $y' = 2; y'' = 8; y^{iv} = 28$

By using Taylor series formula, $y_1 = 1.11145$

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	Single-step method	Multi-step method

1	It requires only the numerical valuey$_i$in order to compute the next value y$_{i+1}$	It requires not only the numerical valuey$_i$but also atleast four of the past valuesy$_{i-1}$,y$_{i-2}$,…,
2	Taylor series, Euler's and R-K methodsare single step methods	Milne's, Adam's methods are multi stepmethods

.

17. Write down the error in Adam's predictor and corrector formulas.

Solution:

Order of error is h^5

Error in predictor $h^5 \frac{251}{720} y^v$

Error in corrector $h^5 \frac{19}{120} y^v \xi$

18. Write down the error in Milne's predictor and corrector formulas.

Solution:

Order of error is h^5

Error in predictor $h^5 \frac{14}{45} y^v \xi$

Error in corrector $h^5 \frac{1}{90} y^v \xi$

19.Compare Adam's Bashforth method with RungeKutta method

Solution:

S. No	Adam's Bashforth Method	Runge-Kutta Method
1	Multi step method	Single step method
2	Need four prior values of y$_i$'s	Need only the last prior value
3	Does not permits changes in the step size	Permits changes in the step size