TIME:3 Hrs   **MARKS:75**
N.B:-Scientific calculator is allowed.

Q.No   **Choose the appropriate option**   **20 Marks**

1   Which of the following comes under inferential statistics?
        a) ANOVA
        b) Median
        c) Frequency distribution
        d) Standard deviation

2.   Which of the following plots is three dimensional?
        a) Histogram
        b) Contour plot
        c) Pie chart
        d) Surface response plot

3.   In data set 21, 3, 49, 8, 12, 19, 23, 34, 11 the median is
        a) 19
        b) 21
        c) 12
        d) 20

4.   Correlation co-efficient denoted as $R_{a.bc}$ indicates that
        a) a is the dependent variable and b, c are the independent variables
        b) a is the independent variable and b, c are the dependent variables
        c) a, b are the dependent variables and c is the independent variable
        d) a, b are the independent variables and c is the dependent variable

5.   Which of the following values of r indicate a moderate correlation
        a) 0.95
        b) 0.1
        c) 0.56
        d) – 0.88

6.   In a linear regression analysis, the regression co-efficient and intercept were found to be 15.1
        and 2.2 respectively. For an independent variable value of 0.8, what would be the value of the
        dependent variable?
        a) 16.86
        b) 34.24
        c) 14.28
        d) 2.44

7.   In a certain population, 20% of individuals have a specific genetic trait. If a random sample of
        100 individuals is selected from this population, what are the mean and variance of the number
        of individuals in the sample who have the genetic trait?
        a) Mean = 20, Variance = 16
        b) Mean = 20, Variance = 4
        c) Mean = 5, Variance = 4
        d) Mean = 5, Variance = 16

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8. In a hospital, it is observed that the number of patients arriving at the emergency room follows a Poisson distribution with a mean of 5 patients per hour. What is the variance of the number of patients arriving in an hour?
    a) 5
    b) 10
    c) 25
    d) 30

9. Suppose Z is a standard normal random variable. What is the probability that Z takes on a value between -1 and 1?
    a) 0.1587
    b) 0.3413
    c) 0.6826
    d) 0.9544

10. While referring to a t distribution table, if the α is changed from 0.05 to 0.01for the same degrees of freedom, the critical t value would
    a) Increase
    b) Decrease
    c) Remain same
    d) Become ∞

11. In Mann-Whitney U test, if the two sample sizes are 10 and 11, then the sum of the two U values would be _____
    a) 21
    b) 1.1
    c) 110
    d) 100

12. Which of the following tests can be used for comparison of medians
    a) Paired t test
    b) One-way ANOVA
    c) Correlation analysis
    d) Mann Whitney U test

13. Type II error in hypothesis testing is the probability of
    a) Rejecting the null hypothesis when it should have been accepted
    b) Accepting the null hypothesis when it should have been rejected
    c) Incorrectly stating the null hypothesis
    d) Incorrectly stating the alternate hypothesis

14. If a sample of size 8 is drawn for performing a single sample t test, the degrees of freedom would be

    a) 8
    b) 9
    c) 7
    d) 6

15   A sample of 9 tablets have mean tablet weight of 102 mg with a standard deviation of 6 mg. What is the standard error of the mean?

   a) 17 mg
   b) 2 mg
   c) 0.66 mg
   d) 1.5 mg

16   An orally disintegrating formulation of a drug was prepared with and without taste masking. The taste masked formulation was given to 7 volunteers and asked to rank the bitterness in a scale of 1 to 10. The formulation without taste masking was then given to 9 volunteers who were also asked to rank the bitterness in a scale of 1 to 10 i.e. the data is in ordinal scale. Which of the following tests can be used to compare whether the level of bitterness is same in the two types of formulation?

   a) Two independent samples t test
   b) Mann Whitney U test
   c) Kruskall Wallis test
   d) ANOVA

17.   Which of the following non-parametric tests uses a χ^2 table
   a) Mann Whitney U test
   b) Spearman's rank correlation analysis
   c) Kruskall Wallis test
   d) Wilcoxon Sign Rank test

18   What is R?
   a) A database management system
   b) A statistical programming language
   c) A web browser
   d) An operating system

19.   In a factorial design, if the effect of five factors is to be investigated with each factor being taken at two levels, the minimum number of experiments to be performed would be
   a) 25
   b) 10
   c) 32
   d) 7

20.   Which term is used to represent the distance of the axial points from the center in CCD?
   a) Alpha
   b) Beta
   c) Gamma
   d) Delta

Q II   Answer the following (Any 2)

1A   A biologist is studying the distribution of heights (in centimeters) of a   **(5 marks)**
particular species of plant in a field. She measures the heights of 50
randomly selected plants and records the following data:
> 157, 163, 152, 148, 155, 160, 158, 151, 154, 162,
> 150, 159, 156, 161, 153, 157, 162, 150, 155, 158,
> 164, 152, 157, 160, 156, 155, 162, 149, 154, 159,
> 161, 157, 153, 150, 158, 156, 155, 162, 160, 155,
> 153, 161, 159, 164, 158, 151, 152, 157, 155, 163

For the above data
i. Construct a frequency distribution table
ii. Calculate the mean

1B   A researcher is investigating the effect of different irrigation methods on   **(5 marks)**
the yield of a particular crop. She randomly assigns 14 plots of land to four
treatment groups representing different irrigation methods. The yields (in
kg per plot) for each treatment group are as follows:

Treatment 1: 35, 38, 42
Treatment 2: 32, 36, 39, 41
Treatment 3: 30, 33, 36, 38
Treatment 4: 31, 34, 37

Perform an analysis of variance (ANOVA) to determine if there are any
significant differences in the mean yields among the four irrigation
methods. Use a significance level of $\alpha = 0.05$.

2A   Consider a Phase II clinical trial designed to investigate the effectiveness of   **(5 marks)**
a new drug to reduce symptoms of asthma in children. A total of 11
participants are randomized to receive either the new drug or a placebo.
Participants are asked to record the number of episodes of shortness of
breath over a 1 week period following receipt of the assigned treatment. The
data are shown below.

Placebo (x)	7	5	6	4	12	8
New Drug (y)	3	6	4	2	1	

Is there a difference in the number of episodes of shortness of breath over a
1 week period in participants receiving the new drug as compared to those
receiving the placebo? Perform a Mann Whitney U test at 5% significance.
Critical U value is 3.

2B   Write a note on the various phases of clinical trials.   **(5 marks)**
3A   What is an experiential design? Give two examples.   **(2.5 marks)**
3B   The mean weight of a sample of 9 tablets was found to be 502mg with a   **(2.5 marks)**
standard deviation of 3mg. Is this sample taken from a batch whose mean
weight is 500mg? Test at 5% level of significance.

3C The data below are the release rates of drug from tablet obtained as the % **(5 marks)**
polymer coating was increased.

% coating	Release rate mg/hour
5	3.7
10	3
15	2.74
20	2.34
30	1.41
40	0.56

Perform linear regression to calculate the slope and intercept of the least
square line. What would be the release rate for 25% polymer coating?

QIII Answer the following (Any 7)

1A The particle size analysis of powder shows normal distribution. Particle size **(2.5 marks)**
analysis of data of 10,000 particles shows the mean size as 750μm and
standard deviation 50.
Find:
- The proportion of particles with size less than 720 μm.
- The proportion of particles with size between 675 μm and
825 μm.

1B In a clinical trial for a new medication, it is known that 70% of patients with **(2.5 marks)**
a certain medical condition respond positively to the medication. If 10
patients with this medical condition are randomly selected and treated with
the medication, what is the probability that exactly 5 patients will respond
positively? What is the probability that at least 1 patient will respond
positively?

2 Write a note on multiple linear regression and hypothesis testing in multiple **(5 marks)**
linear regression.

3 With the help of illustrations explain central composite design. Give one **(5 marks)**
advantage of this design.

4 A researcher wants to compare the effectiveness of three different **(5 marks)**
treatments (A, B, and C) for pain relief. A sample of patients was
randomly assigned to one of the three treatment groups, and their pain
scores were recorded after treatment. Perform a Kruskal-Wallis test to
determine if there is a significant difference in pain relief among the three
treatment groups.

Treatment A: 5, 7, 8, 9, 10
Treatment B: 6, 7, 7, 8, 9
Treatment C: 4, 5, 6, 6, 8
Critical value of the test statistic is 5.991

5 Write a note on factorial designs to cover the meaning of factorial designs, **(5 marks)**
their advantages, and form of the equation that can be generated from
factorial designs. Also suggest an experimental matrix for factorial design
involving three factors each at two levels.

6 The following are the ages of 10 patients admitted in a hospital **(5 marks)**
35, 82, 21, 43, 39, 62, 36, 12, 74, 45, 87, 53
Calculate the standard deviation and standard error of the mean

7 Weights of 6 patients before and after treatment with Fenfluramine were as **(5 marks)** follows:

Before	92	106	107	130	99	127
After	91.5	105	110	120	102	120

Apply a suitable test and state if there is change in the weight of patients due to treatment with Fenfluramine.

8 Write a note on blocking and confounding in two level factorial designs. **(5 marks)**
9 What are contour plots and surface response plots? Write a note on any one **(5 marks)** open source free statistical software/ programming language.

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t Distribution: Critical Values of *t*

Degrees of freedom	Two-tailed test: One-tailed test:	10% 5%	5% 2.5%	2% 1%	1% 0.5%	0.2% 0.1%	0.1% 0.05%
1		6.314	12.706	31.821	63.657	318.309	636.619
2		2.920	4.303	6.965	9.925	22.327	31.599
3		2.353	3.182	4.541	5.841	10.215	12.924
4		2.132	2.776	3.747	4.604	7.173	8.610
5		2.015	2.571	3.365	4.032	5.893	6.869
6		1.943	2.447	3.143	3.707	5.208	5.959
7		1.894	2.365	2.998	3.499	4.785	5.408
8		1.860	2.306	2.896	3.355	4.501	5.041
9		1.833	2.262	2.821	3.250	4.297	4.781
10		1.812	2.228	2.764	3.169	4.144	4.587
11		1.796	2.201	2.718	3.106	4.025	4.437
12		1.782	2.179	2.681	3.055	3.930	4.318
13		1.771	2.160	2.650	3.012	3.852	4.221
14		1.761	2.145	2.624	2.977	3.787	4.140
15		1.753	2.131	2.602	2.947	3.733	4.073
16		1.746	2.120	2.583	2.921	3.686	4.015
17		1.740	2.110	2.567	2.898	3.646	3.965
18		1.734	2.101	2.552	2.878	3.610	3.922
19		1.729	2.093	2.539	2.861	3.579	3.883
20		1.725	2.086	2.528	2.845	3.552	3.850
21		1.721	2.080	2.518	2.831	3.527	3.819
22		1.717	2.074	2.508	2.819	3.505	3.792

Significance level

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F Distribution: Critical Values of F (5% significance level)

v_2 \ v_1	1	2	3	4	5	6	7	8	9	10	12	14	16
1	161.45	199.50	215.71	224.58	230.16	233.99	236.77	238.88	240.54	241.88	243.91	245.36	246.46
2	18.51	19.00	19.16	19.25	19.30	19.33	19.35	19.37	19.38	19.40	19.41	19.42	19.43
3	10.13	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81	8.79	8.74	8.71	8.69
4	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00	5.96	5.91	5.87	5.84
5	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77	4.74	4.68	4.64	4.60
6	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10	4.06	4.00	3.96	3.92
7	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68	3.64	3.57	3.53	3.49
8	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39	3.35	3.28	3.24	3.20
9	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18	3.14	3.07	3.03	2.99
10	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02	2.98	2.91	2.86	2.83
11	4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90	2.85	2.79	2.74	2.70
12	4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80	2.75	2.69	2.64	2.60
13	4.67	3.81	3.41	3.18	3.03	2.92	2.83	2.77	2.71	2.67	2.60	2.55	2.51
14	4.60	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65	2.60	2.53	2.48	2.44
15	4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59	2.54	2.48	2.42	2.38
16	4.49	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54	2.49	2.42	2.37	2.33
17	4.45	3.59	3.20	2.96	2.81	2.70	2.61	2.55	2.49	2.45	2.38	2.33	2.29
18	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46	2.41	2.34	2.29	2.25
19	4.38	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.42	2.38	2.31	2.26	2.21
20	4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39	2.35	2.28	2.22	2.18

Table of Standard Normal Probabilities for Positive Z-scores
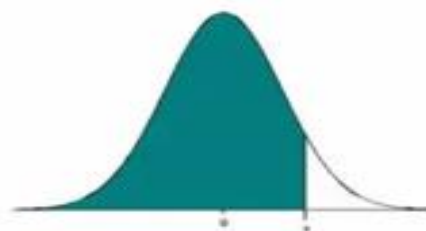
z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990