

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 13535

K

Unique Paper Code : 2374000017

Name of the Paper : Non-Parametric Methods

Name of the Course : **GE**

Semester : VII

Duration : 3 Hours

Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt any **six** questions in all.
3. Question No. **1** is compulsory.
4. Use of a non-programmable calculator is allowed.

1 (a) Multiple Choice

- (i) Which measurement scale has an absolute zero and equal intervals?
A) Nominal
B) Ordinal
C) Interval
D) Ratio
- (ii) Which test is a rank-based paired-sample test that uses signed ranks?
A) Mann-Whitney U test
B) Wilcoxon signed-rank test
C) Kruskal-Wallis test
D) Sign test
- (iii) Mann-Whitney U test is appropriate for:
A) Comparing two independent samples on an ordinal/continuous variable
B) Paired samples
C) >2 independent samples
D) Correlation

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- (iv) Which test is a nonparametric analogue of One-way ANOVA:
A) Sign test
B) Kruskal–Wallis test
C) Mann-Whitney U test
D) Kolmogorov-Smirnov Test
- (v) The quantile function $Q(p)$ gives:
A) The p -th percentile value of a distribution
B) Cumulative frequency at x
C) Variance for probability p
D) PDF at p
- (b) Answer the following questions:
(i) Give any one advantage and disadvantage of nonparametric tests.
(ii) What does a two-sample Kolmogorov–Smirnov test compare?
(iii) What null hypothesis does the Mann–Whitney U test?
(iv) Name a test for association in bivariate ranks.
(v) What is a run (in runs test)? (1×5, 2×5)
- 2 (a) What are non-parametric tests? In what ways non-parametric tests are different from parametric tests? Point out the significance, advantages, and limitations of non-parametric tests.
- (b) Discuss the four types of measurement scales. Identify the measurement scale for the followings:
(i) Military ranks
(ii) Marks obtained by students in an examination (out of 100).
(iii) Postal pin codes of different cities
(iv) IQ scores of students. (7, 8)
- 3 (a) Explain the meaning and importance of testing randomness in a sequence. Write the Null and alternative hypotheses of the runs test. Also state the conditions under which the test is applicable. A sequence of deviations from a fitted trend line is given as: +, +, -, +, +, -, -, +, -, +, +, -.
Test at the 5% level whether the sequence is random. [$R_L = 3$ and $R_U = 10$]
- (b) (i) What is a Quantile? Suppose the monthly income (in ₹) of 10 families is:
[10,000, 12,000, 15,000, 18,000, 20,000, 22,000, 25,000, 30,000, 35,000, 50,000]
Find the 0.25 quantile (Q_1), 0.5 quantile (Median), and 0.9 quantile.

- (ii) Define empirical distribution function.

A teacher has marks of 8 students: {20, 25, 30, 35, 40, 50, 55, 60}. Construct empirical distribution function and use it to find the probability that a randomly chosen student scores ≤ 40 marks. (7, 8)

- 4 (a) Describe Kruskal-Wallis method of analysis for one-way classification of data.
- (b) Write the procedure of median test. In a study, the exam scores of students from two schools were classified as "Above Median" and "Below Median" based on a common median of 50:

	Below Median	Above Median
School A	8	12
School B	14	6

Test whether the exam scores of two schools differ significantly using the Median Test at $\alpha = 0.05$. (where $\chi^2_{1,0.05} = 3.84$, $\chi^2_{4,0.05} = 9.488$). (7, 8)

- 5 (a) Develop Wald Wolfowitz run test for two sample problem.
- (b) Write the procedure of Kolmogorov-Smirnov Test for two samples. When do we use Kolmogorov-Smirnov test for two samples?

The following data gives the life time of bulbs of two different brands:

Brand X: 80, 100, 90, 110, 125, 130, 70

Brand Y: 100, 120, 80, 140, 130, 160, 115, 120

Test whether the brands differ with respect to average life time of the bulb.

(where Critical value of $D_{7,8;0.05} = 0.535$ and $D_{7,8;0.025} = 0.600$)

(6,9)

- 6 (a) Derive the Wilcoxon rank-sum test statistic and explain how it is used to test for equality of two population medians.
- (b) Develop Sign test in detail with assumption for two samples. How do you proceed when the sample size is large?

The diameter of a ball bearing was measured by 12 inspectors, each using two different kinds of callipers, The results were as follows:

Inspector:	1	2	3	4	5	6	7	8	9	10	11	12
Calliper 1:	0.265	0.265	0.266	0.267	0.267	0.265	0.267	0.267	0.265	0.268	0.268	0.265
Calliper 2:	0.264	0.265	0.264	0.266	0.267	0.268	0.264	0.265	0.265	0.267	0.268	0.269

Use paired sample sign test at $\alpha=0.05$ to test if there a significant difference between the median of the population of measurements represented by the two samples?

[Critical value $2 \leq s \leq 10$]

(6, 9)

- 7 (a) Describe the Mann-Whitney-Wilcoxon U-test and obtain the mean and variance of the test statistic T. How is the test carried out for large samples?
- (b) Describe Kendall's Rank Correlation Coefficient (Kendall's Tau), stating what it measures and when it is most appropriately used. Explain how the coefficient is adjusted or calculated in cases of tied ranks. Further, calculate the Kendall's Tau coefficient for the paired ranks of the two ordinal variables — Status Striving *and* Yielding:

Subject:	A,	B,	C,	D,	E,	F,	G,	H,	I,	J,	K,	L
Status striving rank:	3,	4,	2,	1,	8,	11,	10,	6,	7,	12,	5,	9
Yielding rank:	1.5,	1.5,	3.5,	3.5,	5,	6,	7,	8,	9,	10.5,	10.5,	12

(6, 9)