[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 12423 **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. Answer the following questions:

(i) Discuss at least two situations where non-parametric methods are preferred over parametric ones.

(ii) Differentiate between nominal and ordinal scales of measurement along with suitable examples.

(iii) Explain the two advantages of non-parametric over parametric method.

(iv) Write first two moments of the null distribution of the number of runs r, for two independent samples of sizes m and n.

(v) In case of signed rank test what do we do with the pairs with same magnitude?

b. Fill in the blanks:

(i) A parametric test assumes that the underlying population distribution is _____.

(ii) The most common measure of central tendency used in non-parametric tests is the _____.

(iii) Non-parametric tests are also called _____ tests because they do not assume a specific population distribution.

(iv) Relation between two values of U statistic is _____.

(v) The measurement scale used in case of Automobile License Plates is ____.

(2×5, 1×5)

2 (a) Define empirical distribution function. Let data set {1, 2, 5, 7, 8} and then

(i) find the empirical distribution $F_n(0)$, $F_n(2)$, $F_n(2.5)$, $F_n(5)$, $F_n(7.2)$ and $F_n(9)$.

(ii) define quantiles and find the quantile distribution $Q_{0.25}$,$Q_{0.50}$, and $Q_{0.75}$ for the above data set.

(b) Explain steps involved in Wald-Wolfowitz run test for two samples. The weights (in grams) of seeds from two batches are given below:

Batch 1: 12, 14, 15, 16, 17, 18, 13, 19, 12, 16, 15, 18, 17, 20, 21, 22, 19, 18, 17, 13, 14

Batch 2: 11, 13, 14, 16, 19, 20, 21, 18, 17, 15, 14, 13, 12, 15, 16, 17, 19, 20, 22, 21, 23, 24, 25, 18

Test at α=0.05 whether the two samples come from the same population. [$Z_{0.05}$ = 1.96 and $Z_{0.025}$ = 1.645] **(7, 8)**

3 (a) Distinguish between parametric and non-parametric tests.

(b) Describe the sign test for testing that the population median is M_0 against the alternative that the median is M_1 (> M_0).

The breaking strength (in pounds) of a random sample of 10 ropes made by a manufacturer is given by 163, 165, 165, 160, 171, 158, 151, 162, 169, 172. Use sign test to test the manufacturer's claim that the average breaking strength of a rope is greater than 160 pounds at 5% level of significance.[$N_{10,\,0.05}$ = 8, $N_{9,\,0.05}$ = 8] **(7, 8)**

4 (a) Describe Wilcoxon Signed-Rank Test for a two-sample problem.

The following data represent the differences in blood pressure (before and after treatment) for 8 patients:−2, 3, 4, −1, 5, −3, 6, 2; Using the Wilcoxon Signed-Rank Test, test whether the treatment has a significant effect on blood pressure at α = 0.05. [$T_{8,\,0.05}$ = 3, $T_{8,\,0.025}$ = 2]

(b) Describe the Mann-Whitney-Wilcoxon U-test and obtain the mean and variance of the test statistic U. How is the test carried out for large samples? The following data represents lifetime (in hours) of batteries for 2 different brands A and B

Brand A: 40, 30, 55, 40, 35, 35, 30, 40, 55, 45, 40, 30

Brand B: 45, 60, 50, 60, 35, 50, 55, 60, 50, 50, 40, 55

Examine the average life of 2 brands is same at 5% level of significance.

[$U_{0.05} = 37$, $U_{0.01} = 27$] **(7, 8)**

5 (a) Explain the meaning and importance of testing randomness in a sequence. Also state the conditions under which the test is applicable.

(b) Discuss a non-parametric test analogous to one-way analysis of variance for testing that k-independent sample are drawn from different populations.

Given the following data for four independent groups:

Group1:	8,	5,	7,	11,	9,	6
Group2:	10,	12,	11,	9,	13,	12
Group3:	11,	14,	10,	16,	17,	12
Group4:	18,	20,	16,	15,	14,	22

State null and alternative hypotheses. Calculate appropriate test statistic, test the hypothesis at the 5% significance level and interpret the results. [$\chi^2_{3,0.05}$=7.815; $\chi^2_{4,0.05}$=9.488; $\chi^2_{3,0.025}$=9.348; $\chi^2_{4,0.025}$=11.143] **(7, 8)**

6 (a) Develop median test for testing the hypothesis that two or more independent groups differ in central tendencies

(b) Write the procedure of Kolmogorov–Smirnov Test for single sample. When do we use Kolmogrov-Smirnov test for single sample?

A coin is tossed 400 times in sets of four. The frequencies of getting 0 to 4 tails are:

Number of Tails	0	1	2	3	4	Total
Frequency	23	95	164	92	26	400

Examine the fairness of coin using Kolmogrov-Smirnov test at 5% level of significance.

[$D_{400, 0.05} = 0.068$, $D_{400, 0.025} = 0.074$] **(6, 9)**

P.T.O.

7 (a) Define measure of association in a bivariate population. Compare Spearman's rank correlation and Kendall's Tau.

(b) Describe Kendall's rank correlation coefficient (Kendall's tau). In what type of data and situations it is most appropriately used? Calculate Kendall's tau coefficient for the following paired ranks of two ordinal variables Status Striving and Authoritarianism.

(X, Y): (3, 2), (4, 6), (2,5), (1, 1), (6, 3), (7,4), (5,7), (8,10), (11,9), (10,8), (9,11), (12, 12)

(6, 9)