[This question paper contains 2 printed pages.]

Your Roll No................

Sr. No. of Question Paper : 7462 **L**

Unique Paper Code : 2373570008 (NEP-UGCF)

Name of the Paper : Introduction to Non-Parametric Methods (DSE)

Name of the Course : **B.A. (P) / B.Sc. (P)**

Semester : VIII

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 out of **EIGHT**.
3. Each question carries **15** marks.
4. Use of nonprogrammable scientific calculator is allowed.
5. All necessary critical values are provided at the end of each numerical part.

1.(a) Define the Chi-Square Goodness of Fit test. State its null and alternative hypotheses. Write the test statistic formula and explain each component. What are the assumptions and conditions required for the valid application of this test?

(b) A die is rolled 60 times and the following results are obtained:

Face	1	2	3	4	5	6
Observed Frequency	14	10	8	12	9	7

Test at the 5% level of significance whether the die is fair. *[Critical Value: $\chi^2(0.05, 5) = 11.070$]*

2.(a) Explain the Kolmogorov–Smirnov one-sample test for goodness of fit. State its hypotheses, define the test statistic D, and describe the step-by-step procedure. What are the advantages of this test over the Chi-Square Goodness of Fit test? State the level of measurement required for this test.

(b) The following 8 observations are drawn from a population claimed to follow a Uniform distribution on [0, 1]: 0.12, 0.34, 0.41, 0.55, 0.63, 0.72, 0.85, 0.97

Using the Kolmogorov–Smirnov one-sample test, test at the 5% level of significance whether the data follows a Uniform (0, 1) distribution. *[Critical Value: $D(0.05, n=8) = 0.454$]*

3.(a) Define a 'run'. Describe the One-Sample Runs Test for randomness. State the null and alternative hypotheses. Write the formulae for the expected number of runs and the standard error. Explain when and why this test is used.

(b) A quality inspector records whether each item on a production line is Defective (D) or Non-defective (N) in the order of production. The sequence of 16 items is:

N N D D D N N N D D N N D N N D

Test at the 5% level of significance whether the sequence is random.

[Critical Value: For a two-tailed test at $\alpha = 0.05$, use $Z(0.025) = \pm 1.96$]

4.(a) Explain the Sign Test for testing the median of a population. State the null and alternative hypotheses. Describe the procedure of the test including how ties are handled. What are the assumptions of this test?

(b) The following data represents the daily output (in units) of 10 workers: 15, 18, 22, 12, 25, 20, 17, 28, 14, 23.

Use the Sign Test to test at the 5% level of significance whether the median daily output is 19 units.

[Critical Value: For $n = 10$ (two-tailed), critical value of S at $\alpha = 0.05$ is 1 (i.e., reject H_0 if $\min(S^+, S^-) \leq 1$)]

5. (a) Describe nominal, ordinal, interval, and ratio scales of measurement with appropriate examples.

(b) Discuss the advantages and disadvantages of parametric and non-parametric tests.

6. (a) Explain the Wald–Wolfowitz Runs Test for two independent samples. State the null and alternative hypotheses. Describe the procedure for combining the samples, counting runs, and determining the decision rule.

(b) Two teaching methods are used and the scores of students are recorded:

Method A: 45, 52, 61, 38, 55

Method B: 40, 58, 47, 63, 50

Using the Wald–Wolfowitz Runs Test, test at the 5% level of significance whether the two samples come from the same continuous distribution.

[Critical Value: For $n_1 = 5$, $n_2 = 5$ at $\alpha = 0.05$ (two-tailed), reject H_0 if $R \leq 2$ or $R \geq 10$]

7.(a) Describe the Mann–Whitney U Test. State its null and alternative hypotheses. Write the formula for the U statistic and explain the complete testing procedure. What are the assumptions of this test?

(b) The marks obtained by students in two sections are:

Section A: 65, 72, 58, 80, 69, 75

Section B: 60, 55, 78, 63, 70

Using the Mann–Whitney U Test, test at the 5% level of significance whether the two sections have the same median marks.

[Critical Value: $U(0.05, n_1=6, n_2=5$, two-tailed$) = 5$]

8.(a) Define the Spearman Rank-Order Correlation Coefficient. Write its formula and explain each term. Describe the procedure to compute it. How does it differ from the Pearson correlation coefficient? State the null and alternative hypotheses for testing its significance.

(b) Two judges rank 8 contestants in a talent show as follows:

Contestant	A	B	C	D	E	F	G	H
Judge 1 Rank	1	3	5	2	7	4	8	6
Judge 2 Rank	2	4	6	1	8	3	7	5

Compute the Spearman Rank Correlation Coefficient and test its significance at the 5% level.

[Critical Value: $r_s(0.05, n=8$, two-tailed$) = 0.738$]