

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 8136

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Unique Paper Code : 2373010018

Name of the Paper : Non-Parametric Testing

Name of the Course : **DSE (NEP)**

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 6 Questions in all.
3. Question 1 is compulsory.
4. Attempt 5 more questions from the remaining questions.
5. Use of a non-programmable Scientific calculator is permitted.
6. Please write Null and Alternative Hypotheses wherever required.
7. Use 5% level of significance for testing.

Q1. Attempt both parts.

(a) Fill in the blanks:

- (i) The data measured in nominal scale has only.....property.
- (ii) The 3rd quartile is thequantile.
- (iii) If X follows an exponential distribution with mean 4 then the quantile function $Q_X(p)$ is

P.T.O.

- (iv) The sign test statistics under H_0 follow.....distribution with parameters.....
- (v) The r th order statistic from uniform distribution $U_{(r)}$ followsdistribution with.....d.f.

(5)

(b) Solve the following questions:

- (i) Obtain the empirical quantile function $Q_n(u)$ of the sample 26, 17, 15, 29, 35. Hence obtain the 35th and 78th percentile.
- (ii) If $N_A = 20$ and $N_B = 25$ are the number of cases of test A and test B respectively when the significance level is α , obtain the power efficiency of test B. Interpret the result.
- (iii) For the following data:

No. of observations	Sample-1	Sample-2
Above the combined median	7	9
Below the combined median	6	8

Obtain the test statistic for median test.

- (iv) Prove the following:

$$E(X) = \int_0^1 Q_X(p) dp \text{ and } E(X^2) = \int_0^1 Q_X^2(p) dp$$

Where $Q_X(p)$ is the quantile function of the random variable X .

(2.5, 2.5, 2.5, 2.5)

- Q2. (a) Given the ordered statistics $X_{(1)} < X_{(2)} < X_{(3)} < \dots < X_{(n)}$ from any unspecified but continuous distribution $F_X(x)$, we need to test for $H_0: k_p = k_p^0$ where k_p^0 is the p -th quantile of F_X . Obtain the rejection regions for left-tailed, right-tailed and two-tailed alternative hypotheses at α level of significance.

- (b) What are the advantages of the non- parametric tests.

(10, 5)

- Q3. (a) Obtain $100(1 - \alpha)\%$ confidence interval of the unknown population median for the small sample as well as large sample sizes.

- (b) Test the hypothesis that the following observations can be regarded as a sample from an exponential distribution with c.d.f. $F_0(x) = 1 - e^{-x/10}$; $x \geq 0$

10.7, 8.4, 4.9, 7.9, 12.0, 16.2, 6.8

(Note: Use the tabulated value of $D_{7,0.05} = 0.486$)

(9, 6)

- Q4. (a) Discuss the Kolmogorov-Smirnov (K-S) two sample test for both one tailed as well as two tailed alternatives when the samples are small and large.

- (b) A manufacturer of suntan lotion is testing a new formula to see whether it provides more protection from sunburn. He chose 10 persons and applied two types of lotion on their hands, one on each side. The following data was obtained:

Subject	1	2	3	4	5	6	7	8
Old formula	41	42	48	38	38	47	19	28
New formula	37	39	31	39	34	45	20	20

Here, the highest number represents more sunburns. Check whether the new formula appears to be effective using the Wilcoxon signed rank test. Use the Table H which gives $P(T^+ \geq c)$ for one tailed test.

Table H

c	30	31	32	33	34	35
p	0.0547	0.0391	0.0273	0.0195	0.0117	0.0076

(9, 6)

- Q5. (a) Explain the Mann-Whitney U Test for two independent samples for small as well as Large samples. Discuss the case of ties when the sample is large.

- (b) The following data gives the quality scores of boxes produced by two independent production lines A and B:

Production lives	Quality Scores							
A	18	13	20	25	16	14	28	22
B	27	26	17	12	23	26	11	15

Test whether there is significant difference between the two production lines with respect to quality scores using Wald Wolfowitz test.

(The critical value of $r = 4$ when $n_1 = n_2 = 8$, $\alpha = 0.05$)

(9, 6)

- Q6. (a) Calculate the Spearman's rank correlation coefficient and Kendall's rank correlation coefficient between the ranks given by Judge X and Judge Y based on seven essays in order of quality of expository style (rank 1 implies the best essay) as

Essay	a	b	c	d	e	f	g
Rank of Judge X	3	6	2	1	7	4	5
Rank of Judge Y	6	7	5	2	3	1	4

Further test whether there is positive association between the ranks of judge X and Judge Y based on test of significance of Kendall's τ . Refer to the following portion of table Q for the p values of test based on Kendall's rank correlation coefficient:

Table Q

S	1	3	5	7
P	0.5	0.38	0.281	0.191

- (b) Discuss the different methods to deal with ties in the application of rank tests.
(9, 6)

Q7. Write short notes on the following:

- (a) Application of Wald Wolfowitz Run Test when the sample is large.
- (b) Scales of measurement for qualitative data with examples.
- (c) Empirical distribution function and its use.

(5, 5, 5)