Roll No. .....

Question Booklet Number

O. M. R. Serial No.

M. Sc. (Second Semester)
(NEP) EXAMINATION, 2025-26
STATISTICS
(Multivariate Analysis)

Paper Code							
B	0	6	0	8	0	1	T

Questions Booklet Series
D

Time : 1:30 Hours] [*Maximum Marks : 75*

Instructions to the Examinee :

1. Do not open the booklet unless you are asked to do so.

2. The booklet contains 100 questions. Examinee is required to answer 75 questions in the OMR Answer-Sheet provided and not in the question booklet. All questions carry equal marks.

3. Examine the Booklet and the OMR Answer-Sheet very carefully before you proceed. Faulty question booklet due to missing or duplicate pages/questions or having any other discrepancy should be got immediately replaced.

परीक्षार्थियों के लिए निर्देश :

1. प्रश्न-पुस्तिका को तब तक न खोलें जब तक आपसे कहा न जाए।

2. प्रश्न-पुस्तिका में 100 प्रश्न हैं। परीक्षार्थी को 75 प्रश्नों को केवल दी गई OMR आन्सर-शीट पर ही हल करना है, प्रश्न-पुस्तिका पर नहीं। सभी प्रश्नों के अंक समान हैं।

3. प्रश्नों के उत्तर अंकित करने से पूर्व प्रश्न-पुस्तिका तथा OMR आन्सर-शीट को सावधानीपूर्वक देख लें। दोषपूर्ण प्रश्न-पुस्तिका जिसमें कुछ भाग छपने से छूट गए हों या प्रश्न एक से अधिक बार छप गए हों या उसमें किसी अन्य प्रकार की कमी हो, तो उसे तुरन्त बदल लें।

(Remaining instructions on the last page) **(शेष निर्देश अन्तिम पृष्ठ पर)**

(Only for Rough Work)

1. If $p = 1$, Hotelling's T^2 reduces to :

(A) Chi-square test
(B) Student's t-test
(C) Z-test
(D) Sign test

2. The degrees of freedom for T^2 transformation depend on :

(A) n and p
(B) Only p
(C) Only n
(D) None of the above

3. Mahalanobis distance is invariant under :

(A) Linear transformations
(B) Nonlinear transformations
(C) Squaring transformations
(D) Log transformations

4. In testing linear hypotheses, the statistic used is :

(A) Modified Hotelling's T^2
(B) Z-statistic
(C) Chi-square statistic
(D) t-statistic

5. The matrix used to test linear hypotheses on mean vectors is :

(A) Contrast matrix
(B) Identity matrix
(C) Diagonal matrix
(D) Covariance matrix

6. The hypothesis $H_0 : \mu_1 = \mu_2 = ... = \mu_p$ implies :

(A) Equal means across variables
(B) Equal variances
(C) Equal correlations
(D) Equal sample sizes

7. Testing equality of components of a mean vector involves :

(A) Testing $\mu_1 = \mu_2 = ... = \mu_p$
(B) Testing variance equality
(C) Testing independence
(D) Testing regression

8. If D^2 is large, it indicates :

(A) Means are similar
(B) Means differ significantly
(C) No correlation
(D) Perfect correlation

9. The squared Mahalanobis distance between two mean vectors is used in :

(A) Cluster analysis
(B) Discriminant analysis
(C) Multivariate testing
(D) All of the above

10. The pooled covariance matrix is a :

(A) Weighted average of sample covariance matrices

(B) Simple average

(C) Difference of matrices

(D) Product of matrices

11. In the two-sample test, the pooled covariance matrix is used when :

(A) Means differ

(B) Covariance matrices are equal

(C) Sample size is small

(D) Variance is zero

12. The two-sample Hotelling's T^2 test assumes :

(A) Unequal covariance matrices

(B) Equal covariance matrices

(C) Independent means only

(D) Equal sample sizes only

13. When comparing two multivariate means, the statistic used is :

(A) Student's *t*-test

(B) Hotelling's T^2 two-sample test

(C) Chi-square test

(D) Sign test

14. For large sample size, T^2 approximately follows :

(A) Chi-square distribution with *p* degrees of freedom

(B) Normal distribution

(C) *t*-distribution

(D) F-distribution

15. The Hotelling's T^2 statistic is mainly used to test :

(A) Regression coefficients

(B) Mean vector

(C) Variance only

(D) Correlation only

16. The covariance matrix used in T^2 statistic is :

(A) Population covariance matrix

(B) Sample covariance matrix

(C) Diagonal matrix

(D) Identity matrix

17. Here *p* represents :

(A) Sample size

(B) Number of variables

(C) Number of groups

(D) Degrees of freedom

18. Under H_0, the statistic $\frac{(n-p)}{p(n-1)}\ T^2$ follows :

(A) $F_{p,n-p}$ distribution

(B) t_n distribution

(C) χ^2_p distribution

(D) Normal distribution

19. If the population is multivariate normal, the statistic T^2 follows :

(A) Chi-square distribution directly

(B) *t*-distribution

(C) F-distribution after transformation

(D) Normal distribution

20. For testing $H_0 : \mu = \mu_0$, the Hotelling's T^2 statistic is :

(A) $n(\bar{x}-\mu_0)' S^{-1}(\bar{x}-\mu_0)$

(B) $(\bar{x}-\mu_0)' S(\bar{x}-\mu_0)$

(C) $n(\bar{x}-\mu_0)^2$

(D) $(\bar{x}-\mu_0)'(\bar{x}-\mu_0)$

21. Hotelling's T^2 statistic is the multivariate generalization of :

(A) Chi-square test

(B) Student's t-test

(C) F-test

(D) Z-test

22. If variables are uncorrelated with equal variances, Mahalanobis distance reduces to :

(A) Manhattan distance

(B) Euclidean distance

(C) Zero distance

(D) Infinite distance

23. Mahalanobis D^2 is particularly useful in :

(A) Time series analysis

(B) Multivariate classification

(C) Sampling theory

(D) Regression

24. The formula for Mahalanobis distance is :

(A) $(x-\mu)'(x-\mu)$

(B) $(x-\mu)' S^{-1}(x-\mu)$

(C) $(x-\mu)\, S(x-\mu)'$

(D) $(x-\mu)^2$

25. Mahalanobis D^2 statistic measures :

(A) Euclidean distance

(B) Distance accounting for covariance structure

(C) Correlation only

(D) Mean difference

26. PCA is based on decomposition of :

(A) Covariance or correlation matrix

(B) Regression matrix

(C) Residual matrix

(D) Mean matrix

27. Kaiser criterion suggests retaining components with eigenvalues :

(A) Greater than 1

(B) Less than 1

(C) Equal to 0

(D) Greater than sample size

28. In canonical correlation analysis, the maximum number of canonical correlations equals :

(A) Larger number of variables in the two sets

(B) Smaller number of variables in the two sets

(C) Number of observations

(D) Number of factors

29. Discriminant analysis is mainly applied when the dependent variable is :

(A) Continuous

(B) Categorical

(C) Time dependent

(D) Random

30. Eigenvalues in PCA represent :

(A) Means of variables

(B) Variance explained by components

(C) Correlations

(D) Regression slopes

31. The number of principal components equals :

(A) Number of observations

(B) Number of variables

(C) Number of groups

(D) One only

32. Factor analysis differs from PCA because it :

(A) Focuses on explaining covariance structure

(B) Uses only regression models

(C) Ignores correlation

(D) Uses time series

33. In PCA, components are :

(A) Correlated

(B) Independent but correlated

(C) Uncorrelated

(D) Identical

34. Canonical variates are :

(A) Linear combinations of variables in each set

(B) Original variables

(C) Random samples

(D) Residuals

35. Mahalanobis distance is used in discriminant analysis to measure :

(A) Distance between observations and group means

(B) Time difference

(C) Euclidean distance only

(D) Sampling error

36. The discriminant score is obtained as :

(A) Weighted sum of predictor variables

(B) Mean of variables

(C) Product of variables

(D) Ratio of variables

37. Varimax method is commonly used for :

(A) Factor extraction

(B) Factor rotation

(C) Hypothesis testing

(D) Classification

38. Orthogonal rotation in factor analysis maintains :

(A) Correlated factors

(B) Uncorrelated factors

(C) Nonlinear factors

(D) Dependent factors

39. Factor loading represents :

(A) Correlation between variable and factor

(B) Mean of variable

(C) Regression coefficient

(D) Error variance

40. In PCA, the total variance of standardized variables equals :

(A) Number of variables

(B) Number of observations

(C) Sum of means

(D) Zero

41. Canonical correlations are obtained from :

(A) Eigenvalues of a matrix derived from covariance matrices

(B) Regression equations

(C) Variance ratios

(D) Residual matrices

42. Canonical correlation analysis studies the relationship between :

(A) Two individual variables

(B) Two sets of variables

(C) One dependent and one independent variable

(D) Three variables

43. Fisher's discriminant function maximizes :

(A) Within-group variance

(B) Between-group variance relative to within-group variance

(C) Total variance

(D) Error variance

44. Linear discriminant analysis assumes that :

(A) Covariance matrices are equal across groups

(B) Means are identical

(C) Sample sizes are equal

(D) Variables are independent

45. The main purpose of discriminant analysis is to :

(A) Estimate regression parameters

(B) Classify observations into groups

(C) Forecast time series

(D) Test independence

46. In factor analysis, communalities represent :

(A) Unique variance of a variable

(B) Variance explained by common factors

(C) Error variance

(D) Total variance

47. Factor analysis attempts to explain correlations among variables in terms of :

(A) Random variables

(B) Regression functions

(C) Latent factors

(D) Independent samples

48. The first principal component explains :

(A) Minimum variance

(B) Average variance

(C) Maximum variance

(D) Zero variance

49. In PCA, the principal components are obtained from :

(A) Eigenvalues of covariance matrix

(B) Eigenvectors of covariance or correlation matrix

(C) Regression coefficients

(D) Residual matrix

50. Principal Component Analysis (PCA) is mainly used for :

(A) Hypothesis testing

(B) Dimension reduction

(C) Time series forecasting

(D) Parameter estimation

51. The multivariate normal distribution is widely used in :

(A) Multivariate statistical inference

(B) Time series only

(C) Nonparametric statistics

(D) Survival analysis

52. The covariance between the components X_i and X_j is given by :

(A) Σ_{ij}

(B) μ_i

(C) 0

(D) 1

53. The moment generating function of $X \sim N_p(\mu, \Sigma)$ is :

(A) $e^{t'\mu + \frac{1}{2}t'\Sigma t}$

(B) $e^{-t'\Sigma t}$

(C) $e^{t'\mu}$

(D) $e^{\mu'\Sigma}$

54. If variables in a multivariate normal vector are uncorrelated, then they are :

(A) Independent

(B) Dependent

(C) Identical

(D) Random only

55. The quadratic form

$$(X-\mu)'\Sigma^{-1}(X-\mu)$$

follows :

(A) Normal distribution

(B) Chi-square distribution with *p* df

(C) *t*-distribution

(D) F-distribution

56. The distribution of $\sqrt{n}(\overline{X}-\mu)$ is :

(A) $N_p(0, \Sigma)$

(B) $N_p(0, n\Sigma)$

(C) $N_p(\mu, \Sigma)$

(D) $N_p(0, I)$

57. The MLE of covariance matrix Σ is :

(A) Sample covariance matrix with denominator *n*

(B) Sample covariance matrix with denominator $n-1$

(C) Identity matrix

(D) Zero matrix

58. The maximum likelihood estimator (MLE) of the mean vector μ is :

(A) Sample variance

(B) Sample mean vector

(C) Median vector

(D) Mode

59. If $X_1, X_2, \ldots, X_n$ are independent Np (μ, Σ), the sample mean vector $\bar{X}$ follows :

(A) $N_p(\mu, \Sigma/n)$

(B) $N_p(\mu, \Sigma)$

(C) $N_p(0, \Sigma)$

(D) $N_p(\mu/n, \Sigma)$

60. If $X \sim N_p(\mu, \Sigma)$, then $AX + b$ follows :

(A) Exponential distribution

(B) Multivariate normal distribution

(C) Poisson distribution

(D) Chi-square distribution

61. The covariance matrix of $X \sim N_p(\mu, \Sigma)$ is :

(A) μ

(B) Σ

(C) I

(D) 0

62. The mean of $X \sim N_p(\mu, \Sigma)$ is :

(A) Σ

(B) 0

(C) μ

(D) I

63. The characteristic function of $X \sim N_p(\mu, \Sigma)$ is :

(A) $e^{it'\mu - \frac{1}{2}t'\Sigma t}$

(B) $e^{t'\mu}$

(C) $e^{-t'\Sigma t}$

(D) $e^{it'\Sigma}$

64. The conditional distribution of a subset of variables given others in a multivariate normal distribution is :

(A) Binomial

(B) Multivariate normal

(C) Chi-square

(D) Poisson

65. The marginal distribution of a subset of variables from a multivariate normal vector is :

(A) Exponential

(B) Multivariate normal

(C) Uniform

(D) Gamma

66. The covariance matrix Σ in a multivariate normal distribution must be :

(A) Negative definite

(B) Positive definite

(C) Diagonal only

(D) Singular

67. In the notation $N_p(\mu, \Sigma)$ p denotes :

(A) Sample size

(B) Number of variables (dimension)

(C) Number of observations

(D) Degrees of freedom

68. If $X \sim N_p(\mu, \Sigma)$ then μ represents :

(A) Mean vector

(B) Covariance matrix

(C) Correlation matrix

(D) Variance

69. The multivariate normal distribution is completely determined by :

(A) Mean vector and covariance matrix

(B) Mean vector only

(C) Variance only

(D) Correlation only

70. A random vector $X = (X_1, X_2, ..., X_p)'$ is said to follow a multivariate normal distribution if :

(A) Each variable is independent

(B) Every linear combination of its components is normally distributed

(C) Variances are equal

(D) Means are zero

71. The value of the simple correlation coefficient lies between :

(A) 0 and 1

(B) – 1 and + 1

(C) $-\infty$ and $+\infty$

(D) 0 and ∞

72. If the absolute value of r is close to 1, it indicates :

(A) Weak correlation

(B) Strong correlation

(C) No correlation

(D) Random variation

73. A confidence interval for population correlation is usually obtained using :

(A) Fisher's Z transformation

(B) Student's t distribution only

(C) Chi-square distribution

(D) Binomial distribution

74. The variance of Fisher's Z statistic approximately equals :

(A) $1/n$

(B) $1/(n-1)$

(C) $1/(n-3)$

(D) $1/(n-2)$

75. Fisher's transformation is used for :

(A) Hypothesis testing and confidence intervals of correlation

(B) Regression estimation

(C) Variance estimation

(D) Sampling design

76. Fisher's Z transformation for correlation coefficient is :

(A) $Z = \ln(1+r)$

(B) $Z = \frac{1}{2}\ln\frac{1+r}{1-r}$

(C) $Z = r^2$

(D) $Z = \sqrt{r}$

77. If $\rho = 0$, the statistic

$$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$$

follows :

(A) Normal distribution

(B) t-distribution with $n-2 df$

(C) Chi-square distribution

(D) F-distribution

78. The sampling distribution of r depends mainly on :

(A) Sample mean

(B) Population correlation coefficient

(C) Sample variance only

(D) Median

79. The population correlation coefficient is denoted by :

(A) r

(B) ρ

(C) μ

(D) σ

80. The sample correlation coefficient is usually denoted by :

(A) ρ

(B) r

(C) σ

(D) β

81. The Wishart matrix is always :

(A) Negative definite

(B) Symmetric positive definite

(C) Skew-symmetric

(D) Diagonal only

82. The determinant of a Wishart matrix is used in :

(A) Likelihood ratio tests

(B) Regression analysis

(C) Sampling distribution of mean

(D) Nonparametric tests

83. The Wishart distribution plays an important role in :

(A) Multivariate statistical inference

(B) Time series analysis

(C) Nonparametric statistics

(D) Survival analysis

84. If $p = 1$, the Wishart distribution reduces to :

(A) *t*-distribution

(B) Chi-square distribution

(C) Normal distribution

(D) F-distribution

85. The expectation of a Wishart matrix S is :

(A) $n\sum$

(B) $\sum / n$

(C) I

(D) 0

86. In the Wishart distribution $W_p(n, \sum)$, *n* denotes :

(A) Dimension of matrix

(B) Number of observations (degrees of freedom)

(C) Number of parameters

(D) Number of correlations

87. If $S \sim W_p(n, \sum)$, then *p* represents :

(A) Sample size

(B) Number of variables

(C) Degrees of freedom

(D) Number of groups

88. The Wishart distribution is associated with the distribution of :

(A) Sample mean vector

(B) Sample covariance matrix

(C) Regression coefficients

(D) Residuals

89. If $X_1, X_2, ..., X_n$ are independent multivariate normal vectors, the matrix $S = \sum X_i X_i'$ follows :

(A) Normal distribution

(B) Wishart distribution

(C) *t*-distribution

(D) Gamma distribution

90. The Wishart distribution is a multivariate generalization of the :

(A) Normal distribution

(B) Chi-square distribution

(C) *t*-distribution

(D) F-distribution

91. Hotelling's T^2 is widely used in :

(A) Multivariate quality control

(B) Time series analysis

(C) Nonparametric tests

(D) Survival analysis

92. The statistic T^2 depends on :

(A) Sample mean vector

(B) Covariance matrix

(C) Sample size

(D) All of the above

93. A large value of T^2 statistic leads to :

(A) Acceptance of H_0

(B) Rejection of H_0

(C) No decision

(D) Increase in variance

94. In discriminant analysis, Mahalanobis distance helps in :

(A) Group classification

(B) Parameter estimation

(C) Hypothesis testing only

(D) Time series analysis

95. If the covariance matrix is singular, then :

(A) T^2 cannot be computed

(B) T^2 becomes zero

(C) T^2 becomes infinite

(D) No problem occurs

96. The main assumption of Hotelling's T^2 test is :

(A) Multivariate normality

(B) Binomial distribution

(C) Poisson distribution

(D) Uniform distribution

97. The statistic T^2 involves :

(A) Mean vector and covariance matrix

(B) Variance only

(C) Correlation only

(D) Sample size only

98. For multivariate normal data, D^2 approximately follows :

(A) χ^2_p distribution

(B) Normal distribution

(C) *t*-distribution

(D) F-distribution

99. In multivariate outlier detection, the statistic used is :

(A) Mahalanobis D^2

(B) Median

(C) Mode

(D) Range

100. Mahalanobis distance is particularly useful when variables are :

(A) Independent

(B) Correlated

(C) Constant

(D) Binary

(Only for Rough Work)

4. Four alternative answers are mentioned for each question as—A, B, C & D in the booklet. The candidate has to choose the correct answer and mark the same in the OMR Answer-Sheet as per the direction :

Example :

Question :

Q. 1 (A) ● (C) (D)
Q. 2 (A) (B) ● (D)
Q. 3 (A) ● (C) (D)

Illegible answers with cutting and over-writing or half filled circle will be cancelled.

5. Each question carries equal marks. Marks will be awarded according to the number of correct answers you have.
6. All answers are to be given on OMR Answer Sheet only. Answers given anywhere other than the place specified in the answer sheet will not be considered valid.
7. Before writing anything on the OMR Answer Sheet, all the instructions given in it should be read carefully.
8. After the completion of the examination candidates should leave the examination hall only after providing their OMR Answer Sheet to the invigilator. Candidate can carry their Question Booklet.
9. There will be no negative marking.
10. Rough work, if any, should be done on the blank pages provided for the purpose in the booklet.
11. To bring and use of log-book, calculator, pager and cellular phone in examination hall is prohibited.
12. In case of any difference found in English and Hindi version of the question, the English version of the question will be held authentic.

Impt. : On opening the question booklet, first check that all the pages of the question booklet are printed properly. If there is any discrepancy in the question Booklet, then after showing it to the invigilator, get another question Booklet of the same series.

4. प्रश्न-पुस्तिका में प्रत्येक प्रश्न के चार सम्भावित उत्तर—A, B, C एवं D हैं। परीक्षार्थी को उन चारों विकल्पों में से सही उत्तर छाँटना है। उत्तर को OMR आन्सर-शीट में सम्बन्धित प्रश्न संख्या में निम्न प्रकार भरना है :

उदाहरण :

प्रश्न :

प्रश्न 1 (A) ● (C) (D)
प्रश्न 2 (A) (B) ● (D)
प्रश्न 3 (A) ● (C) (D)

अपठनीय उत्तर या ऐसे उत्तर जिन्हें काटा या बदला गया है, या गोले में आधा भरकर दिया गया, उन्हें निरस्त कर दिया जाएगा।

5. प्रत्येक प्रश्न के अंक समान हैं। आपके जितने उत्तर सही होंगे, उन्हीं के अनुसार अंक प्रदान किये जायेंगे।
6. सभी उत्तर केवल ओ. एम. आर. उत्तर-पत्रक (OMR Answer Sheet) पर ही दिये जाने हैं। उत्तर-पत्रक में निर्धारित स्थान के अलावा अन्यत्र कहीं पर दिया गया उत्तर मान्य नहीं होगा।
7. ओ. एम. आर. उत्तर-पत्रक (OMR Answer Sheet) पर कुछ भी लिखने से पूर्व उसमें दिये गये सभी अनुदेशों को सावधानीपूर्वक पढ़ लिया जाये।
8. परीक्षा समाप्ति के उपरान्त परीक्षार्थी कक्ष निरीक्षक को अपनी OMR Answer Sheet उपलब्ध कराने के बाद ही परीक्षा कक्ष से प्रस्थान करें। परीक्षार्थी अपने साथ प्रश्न-पुस्तिका ले जा सकते हैं।
9. निगेटिव मार्किंग नहीं है।
10. कोई भी रफ कार्य, प्रश्न-पुस्तिका के अन्त में, रफ-कार्य के लिए दिए खाली पेज पर ही किया जाना चाहिए।
11. परीक्षा-कक्ष में लॉग-बुक, कैलकुलेटर, पेजर तथा सेल्युलर फोन ले जाना तथा उसका उपयोग करना वर्जित है।
12. प्रश्न के हिन्दी एवं अंग्रेजी रूपान्तरण में भिन्नता होने की दशा में प्रश्न का अंग्रेजी रूपान्तरण ही मान्य होगा।

महत्वपूर्ण : प्रश्नपुस्तिका खोलने पर प्रथमतः जाँच कर देख लें कि प्रश्न-पुस्तिका के सभी पृष्ठ भलीभाँति छपे हुए हैं। यदि प्रश्नपुस्तिका में कोई कमी हो, तो कक्षनिरीक्षक को दिखाकर उसी सिरीज की दूसरी प्रश्न-पुस्तिका प्राप्त कर लें।