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
C

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. The multivariate normal distribution is widely used in :

(A) Multivariate statistical inference

(B) Time series only

(C) Nonparametric statistics

(D) Survival analysis

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

(A) Σ_{ij}

(B) μ_i

(C) 0

(D) 1

3. 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) $e^{\mu'\Sigma}$

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

(A) Independent

(B) Dependent

(C) Identical

(D) Random only

5. 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

6. 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) $N_p(0, I)$

7. 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

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

(A) Sample variance

(B) Sample mean vector

(C) Median vector

(D) Mode

9. 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) $N_p(\mu/n, \Sigma)$

10. 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

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

(A) μ

(B) Σ

(C) I

(D) 0

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

(A) Σ

(B) 0

(C) μ

(D) I

13. 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) $e^{it'\Sigma}$

14. 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

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

(A) Exponential

(B) Multivariate normal

(C) Uniform

(D) Gamma

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

(A) Negative definite

(B) Positive definite

(C) Diagonal only

(D) Singular

17. 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

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

(A) Mean vector

(B) Covariance matrix

(C) Correlation matrix

(D) Variance

19. The multivariate normal distribution is completely determined by :

(A) Mean vector and covariance matrix

(B) Mean vector only

(C) Variance only

(D) Correlation only

20. 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

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

(A) 0 and 1

(B) – 1 and + 1

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

(D) 0 and ∞

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

(A) Weak correlation

(B) Strong correlation

(C) No correlation

(D) Random variation

23. 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

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

(A) $1/n$

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

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

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

25. Fisher's transformation is used for :

(A) Hypothesis testing and confidence intervals of correlation

(B) Regression estimation

(C) Variance estimation

(D) Sampling design

26. 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) $Z = \sqrt{r}$

27. 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

28. The sampling distribution of r depends mainly on :

(A) Sample mean

(B) Population correlation coefficient

(C) Sample variance only

(D) Median

29. The population correlation coefficient is denoted by :

(A) r

(B) ρ

(C) μ

(D) σ

30. The sample correlation coefficient is usually denoted by :

(A) ρ

(B) r

(C) σ

(D) β

31. The Wishart matrix is always :

(A) Negative definite

(B) Symmetric positive definite

(C) Skew-symmetric

(D) Diagonal only

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

(A) Likelihood ratio tests

(B) Regression analysis

(C) Sampling distribution of mean

(D) Nonparametric tests

33. The Wishart distribution plays an important role in :

(A) Multivariate statistical inference

(B) Time series analysis

(C) Nonparametric statistics

(D) Survival analysis

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

(A) *t*-distribution

(B) Chi-square distribution

(C) Normal distribution

(D) F-distribution

35. The expectation of a Wishart matrix S is :

(A) $n\sum$

(B) $\sum / n$

(C) I

(D) 0

36. 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

37. 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

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

(A) Sample mean vector

(B) Sample covariance matrix

(C) Regression coefficients

(D) Residuals

39. 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

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

(A) Normal distribution

(B) Chi-square distribution

(C) *t*-distribution

(D) F-distribution

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

(A) Multivariate quality control

(B) Time series analysis

(C) Nonparametric tests

(D) Survival analysis

42. The statistic T^2 depends on :

(A) Sample mean vector

(B) Covariance matrix

(C) Sample size

(D) All of the above

43. 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

44. In discriminant analysis, Mahalanobis distance helps in :

(A) Group classification

(B) Parameter estimation

(C) Hypothesis testing only

(D) Time series analysis

45. 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

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

(A) Multivariate normality

(B) Binomial distribution

(C) Poisson distribution

(D) Uniform distribution

47. The statistic T^2 involves :

(A) Mean vector and covariance matrix

(B) Variance only

(C) Correlation only

(D) Sample size only

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

(A) χ^2_p distribution

(B) Normal distribution

(C) *t*-distribution

(D) F-distribution

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

(A) Mahalanobis D^2

(B) Median

(C) Mode

(D) Range

50. Mahalanobis distance is particularly useful when variables are :

(A) Independent

(B) Correlated

(C) Constant

(D) Binary

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

(A) Chi-square test

(B) Student's t-test

(C) Z-test

(D) Sign test

52. 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

53. Mahalanobis distance is invariant under :

(A) Linear transformations

(B) Nonlinear transformations

(C) Squaring transformations

(D) Log transformations

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

(A) Modified Hotelling's T^2

(B) Z-statistic

(C) Chi-square statistic

(D) t-statistic

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

(A) Contrast matrix

(B) Identity matrix

(C) Diagonal matrix

(D) Covariance matrix

56. 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

57. 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

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

(A) Means are similar

(B) Means differ significantly

(C) No correlation

(D) Perfect correlation

59. 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

60. The pooled covariance matrix is a :

(A) Weighted average of sample covariance matrices

(B) Simple average

(C) Difference of matrices

(D) Product of matrices

61. 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

62. 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

63. 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

64. 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

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

(A) Regression coefficients

(B) Mean vector

(C) Variance only

(D) Correlation only

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

(A) Population covariance matrix

(B) Sample covariance matrix

(C) Diagonal matrix

(D) Identity matrix

67. Here *p* represents :

(A) Sample size

(B) Number of variables

(C) Number of groups

(D) Degrees of freedom

68. 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

69. 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

70. 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) $(\bar{x}-\mu_0)'(\bar{x}-\mu_0)$

71. 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

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

(A) Manhattan distance

(B) Euclidean distance

(C) Zero distance

(D) Infinite distance

73. Mahalanobis D^2 is particularly useful in :

(A) Time series analysis

(B) Multivariate classification

(C) Sampling theory

(D) Regression

74. 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) $(x-\mu)^2$

75. Mahalanobis D^2 statistic measures :

(A) Euclidean distance

(B) Distance accounting for covariance structure

(C) Correlation only

(D) Mean difference

76. PCA is based on decomposition of :

(A) Covariance or correlation matrix

(B) Regression matrix

(C) Residual matrix

(D) Mean matrix

77. Kaiser criterion suggests retaining components with eigenvalues :

(A) Greater than 1

(B) Less than 1

(C) Equal to 0

(D) Greater than sample size

78. 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

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

(A) Continuous

(B) Categorical

(C) Time dependent

(D) Random

80. Eigenvalues in PCA represent :

(A) Means of variables

(B) Variance explained by components

(C) Correlations

(D) Regression slopes

81. The number of principal components equals :

(A) Number of observations

(B) Number of variables

(C) Number of groups

(D) One only

82. 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

83. In PCA, components are :

(A) Correlated

(B) Independent but correlated

(C) Uncorrelated

(D) Identical

84. Canonical variates are :

(A) Linear combinations of variables in each set

(B) Original variables

(C) Random samples

(D) Residuals

85. 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

86. The discriminant score is obtained as :

(A) Weighted sum of predictor variables

(B) Mean of variables

(C) Product of variables

(D) Ratio of variables

87. Varimax method is commonly used for :

(A) Factor extraction

(B) Factor rotation

(C) Hypothesis testing

(D) Classification

88. Orthogonal rotation in factor analysis maintains :

(A) Correlated factors

(B) Uncorrelated factors

(C) Nonlinear factors

(D) Dependent factors

89. Factor loading represents :

(A) Correlation between variable and factor

(B) Mean of variable

(C) Regression coefficient

(D) Error variance

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

(A) Number of variables

(B) Number of observations

(C) Sum of means

(D) Zero

91. Canonical correlations are obtained from :

(A) Eigenvalues of a matrix derived from covariance matrices

(B) Regression equations

(C) Variance ratios

(D) Residual matrices

92. 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

93. Fisher's discriminant function maximizes :

(A) Within-group variance

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

(C) Total variance

(D) Error variance

94. 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

95. The main purpose of discriminant analysis is to :

(A) Estimate regression parameters

(B) Classify observations into groups

(C) Forecast time series

(D) Test independence

96. In factor analysis, communalities represent :

(A) Unique variance of a variable

(B) Variance explained by common factors

(C) Error variance

(D) Total variance

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

(A) Random variables

(B) Regression functions

(C) Latent factors

(D) Independent samples

98. The first principal component explains :

(A) Minimum variance

(B) Average variance

(C) Maximum variance

(D) Zero variance

99. 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

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

(A) Hypothesis testing

(B) Dimension reduction

(C) Time series forecasting

(D) Parameter estimation

(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।