SLR-GX-1

Seat No.	

Set P

M.Sc. (Sem-I) (New) (CBCS) Examination: Oct/Nov-2022
(BIOSTATISTICS)
Probability Distributions

Day & Date: Monday, 13-02-2023 Max. Marks: 80
Time: 03:00 PM To 06:00 PM

Instructions: 1) Question no. 1 and 2 are compulsory.
2) Attempt any three questions from Q. No. 3 to Q. No. 7.
3) Figure to right indicate full marks.

Q.1 A) Multiple choice questions. **10**

1) Which of the following distribution can be applied for estimating the number of fishes in a lake?
   a) Geometric b) Binomial
   c) Hypergeometric d) Negative binomial

2) Which of the following distribution have the coinciding mean and variance?
   a) Poisson b) Binomial
   c) Geometric d) Hyper geometric

3) The number of failures before the r^{th} success in a series of independent Bernoulli trials follows _____ distribution.
   a) Binomial b) Negative binomial
   c) Geometric d) Uniform

4) The joint cumulative distribution function is defined as _____.
   a) $P(X = x, Y = y)$ b) $P(X \leq x, Y = y)$
   c) $P(X \geq x, Y \geq y)$ d) $P(X \leq x, y \leq y)$

5) Suppose $(X_1, X_2 \dots \dots X_K)$ is a multinomial random variate then $\text{Cov}(X_i, X_j), i = j = 1,2, \dots \dots, k, i \neq j$ is ______.
   a) np_i b) np_ip_j
   c) $-np_ip_j$ d) $n^2p_ip_j$

6) Which one of the following is not an order statistic?
   a) Maximum b) Minimum
   c) Median d) Mean

7) Let X and **Y** are iid N (0,1) variates. The distribution of Z = Y / X is ____.
   a) Normal b) Cauchy
   c) Chi-square d) F

8) The variance of continuous uniform distribution over (0, b) is _____.
   a) $b^2/2$ b) $b^2/6$
   c) $b^2/12$ d) $b^2/4$

9) If X> 0 then _____.
   a) $E[\sqrt{X}] \leq \sqrt{E(X)}$ b) $E[\sqrt{X}] \geq \sqrt{E(X)}$
   c) $E[\sqrt{X}] = \sqrt{E(X)}$ d) none of these

10) The first four moments about a number '4' are 1, 4, 10, 45 then mean and variance are _____.
   a) (1,4) b) (5,3)
   c) (5,4) d) none of these

B) Fill in the blanks. **06**

1) Negative binomial distribution NB(x: r, p) for r = 1 reduces to ______.
2) If Z is standard normal variate then mean of Z^2 is ______.
3) If X is symmetric about α then $(X - \alpha)$ is symmetric about ______.
4) If a random variable X has mean 3 and standard deviation 5, then the variance of the variable Y = 2 X - 5 is _____.
5) The distribution of sum of n independent exponential random variables is ______.
6) Let X has $B(1, p)$ distribution. The distribution of Y = 1 - X is ______.

Q.2 Answer the following **16**

a) Define, giving suitable examples.
   1) Discrete random variable
   2) Probability mass function of discrete random variable

b) If X is symmetric random variable about α then show that $E(X) = \alpha$.

c) Define negative binomial distribution. State its important properties.

d) Define power series distribution and obtain its MGF.

Q.3 Answer the following. **16**

a) Define hypergeometric distribution. Give any two practical applications of hypergeometric distribution. Obtain its mean and variance.

b) Define location-scale family of distributions. Examine which of the following are in location-scale families.
   1) $N(\mu, \sigma^2)$
   2) $Exp(\mu, \lambda)$

Q.4 Answer the following. **16**

a) Define probability generating function (PGF) of a random variable. Explain how it is used to obtain moments of a distribution.

b) Let X has B(n,p)distribution. Obtain the PGF of X. Hence obtain its mean and variance.

Q.5 Answer the following. **16**

a) State and prove Holder's inequality. Deduce Cauchy-Schwartz inequality from it.

b) Let X follows N(0,1) distribution. Find the distribution of
   1) $Y = X^2$
   2) $Y = |X|$

Q.6 Answer the following. **16**

a) Let (X, Y) is a bivariate discrete random variable.
Define
1) Joint probability mass function.
2) Marginal probability mass functions of X and Y.
3) Conditional probability mass functions of X given Y = y and Y given X = x
4) Independence of X and Y.

b) The joint probability distribution of (X, Y) is given by.

$$P(x, y) = \begin{cases} k(2x + 3y), x = 0,1,2, y = 1,2,3 \\ 0, \text{othrwise} \end{cases}$$

Find
1) k
2) Marginal probability mass functions of X and Y.
3) Conditional distribution of X given Y = y

Q.7 Answer the following. **16**

a) Define order statistics. Based on a random sample from continuous distribution with pdf f (x) and cdf F(x), derive the pdf of k^{th} order statistic.

b) Let (X,Y) has $\mathrm{BVN}(\mu_1, \mu_2, \sigma_1^2, \sigma_2^2, \rho)$. Obtain the conditional distribution of Y given $\mathrm{X} = x$.

SLR-GX-7

Seat No.	

Set P

M.Sc. (Semester - II) (New) (CBCS) Examination: Oct/Nov - 2022
(BIOSTATISTICS)
Statistical Inference - I

Day & Date: Tuesday, 21-02-2023 Max. Marks: 80
Time: 11:00 AM To 02:00 PM

Instructions: 1) Q. Nos. 1 and. 2 are compulsory.
2) Attempt any three questions from Q. No. 3 to Q. No. 7
3) Figure to right indicate full marks.

Q.1 A) Fill in the blanks by choosing correct alternatives given below. **10**

1) Let $X_1, X_2, \dots \dots, X_n$ be iid from $B(1, \theta)$. The $\bar{X}$ is ______.
   a) sufficient statistic b) unbiased estimator
   c) complete sufficient statistic d) all the above

2) A statistic which does not contain any information about the parameter is called ______.
   a) sufficient statistic b) minimal sufficient statistic
   c) ancillary statistic d) complete statistic

3) Cramer-Rao inequality gives ______.
   a) upper bound to the variance of unbiased estimator of $\psi(\theta)$
   b) lower bound to the variance of unbiased estimator of $\psi(\theta)$
   c) lower bound to the mean of unbiased estimator of $\psi(\theta)$
   d) None of these

4) Let $T(X)$ is a complete sufficient statistic and $A(X)$ is ancillary statistic, then which one of the following statements is correct?
   a) $T(X)$ and $A(X)$ are distributionally dependent
   b) $T(X)$ and $A(X)$ are functionally dependent
   c) $T(X)$ and $A(X)$ are statistically independent
   d) none of the above

5) The MLE of parameter θ is a statistic which _______.
   a) is sufficient for parameter for θ
   b) maximizes the likelihood function L
   c) is a solution of $\frac{\partial \log L}{\partial \theta} = 0$
   d) is always unbiased

6) If T is an unbiased estimator of θ then T^2 is ______.
   a) biased estimator for θ^2
   b) unbiased estimator for θ^2
   c) unbiased estimator for $(\theta^2 + 1)$
   d) biased estimator for $(\theta^2 + 1)$

7) Let $X_1, X_2, \dots \dots, X_n$ is a random sample of size n from $U(0, \theta)$ distribution then what is unbiased estimator of θ ?
   a) $\bar{X}$ b) $\bar{X}/2$
   c) $2\bar{X}$ d) $\sqrt{\bar{X}}$

8) If a statistic T_n is such that $E(T_n) \to \theta$ and $Var(T_n) \to 0$ as $n \to \infty$, then for θ T_n will be ______.
   a) consistent b) efficient
   c) sufficient d) none of these

9) Let T_n be an unbiased and consistent estimator of θ. Then T_n^2 as an estimator of θ^2 is
   a) unbiased and consistent b) unbiased and inconsistent
   c) biased and consistent d) biased and inconsistent

10) Mean squared error of an estimator $T_n$of θ is expressed as ______.
   a) $Var_\theta(T_n) + Bias$ b) $Var_\theta(T_n) + [Bias]^2$
   c) $[Var_\theta(T_n)]^2 + [Bias]^2$ d) $[Var_\theta(T_n) + Bias]^2$

B) Answer the following **06**

1) If $E_\theta(T) \neq \theta$ then T is ______ estimator of θ.
2) MLE of parameter θ of the distribution $f(x, \theta) = \frac{1}{2} e^{-|x-\theta|}$ is ______
3) Let X has U (0, θ) distribution then the MLE of θ is ______.
4) If T_n is consistent estimator of θ then a consistent estimator for $(a\theta^2 + b)$ is ______.
5) An estimator T_n of θ is said to be more efficient than any other estimator T_n^* of θ if and only if ______.
6) ______ statistic is independent of every complete sufficient statistic.

Q.2 Answer the following **16**

a) Explain the following:
   1) Weak consistency
   2) Strong consistency

b) Let random variable X has $N(\theta, 1)$ distribution. Show that family of X is complete.

c) Define Fisher information in a single observation. Find the same for $B(n, \theta)$ distribution, when n is known.

d) Let $X_1, X_2, \dots\dots, X_n$ be iid from $N(\theta, 1)$, computing the actual probability show that $\overline{X_n}$ is consistent estimator of θ.

Q.3 Answer the following **16**

a) Define sufficient statistic. State Neyman-Fisher factorization theorem. Examine whether one-to-one function of a sufficient statistic is also sufficient.

b) Let X_1, X_2 are iid Poisson random variables with parameter λ.
Let $T_1 = X_1 + X_2$ and $T_2 = X_1 + 2X_2$. Show that T_1 is sufficient statistic but T_2 is not sufficient.

Q.4 Answer the following **16**

a) Define joint and marginal consistency for a vector parameter θ . Show that joint consistency is equivalent to marginal consistency.

b) Let $X_1, X_2, \dots\dots, X_n$ be a random sample from $U(0, \theta)$. Find two consistent estimators of θ.

Q.5 Answer the following **16**

a) State and prove Lehmann-Scheffe theorem.

b) Derive UMVUE of $(1/\theta)$ based on a random sample from $U(0, \theta)$ distribution.

Q.6 Answer the following **16**

a) State and prove Cramer-Rao inequality with necessary regularity conditions.

b) Let $X_1, X_2, \dots \dots ., X_n$ be iid Poisson (λ) random variables. Obtain Cramer-Rao lower bound for unbiased estimator of λ.

Q.7 Answer the following **16**

a) Define maximum likelihood estimator (MLE). Describe the method of maximum likelihood estimation for estimating an unknown parameter.

b) Let $X_1, X_2, \dots \dots ., X_n$ be a random sample of size n from $N(\mu, \sigma^2)$ distribution. Find MLE of μ and σ^2

Seat No.	

Set P

M.Sc. (Sem-III) (New) (CBCS) Examination: Oct/Nov-2022
(BIOSTATISTICS)
STATISTICAL INFERENCE - II

Day & Date: Monday, 13-02-2023 Max. Marks: 80
Time: 11:00 AM To 02:00 PM

Instructions: 1) Question no. 1 and 2 are compulsory.
2) Attempt any three questions from Q. No. 3 to Q. No. 7.
3) Figure to right indicate full marks.

Q.1 A) Multiple choice questions. **10**

1) Which one of the following is the probability of rejecting H_0 when H_1 is true?
   a) α b) β
   c) $1-\alpha$ d) $1-\beta$

2) For testing $H_0: \mu = \mu_0$ against $H_1 : \mu > \mu_0$ when population standard deviation is known, the appropriate test is_____.
   a) t - test b) Z - test
   c) $X^2 -$ test d) none of these

3) In SPRT, decision about the hypothesis H_0 is taken _____.
   a) after each successive observation
   b) after fixed number of observations
   c) at least after five observations
   d) when the experiment is over

4) In likelihood ratio test, under some regularity conditions on $f(x, \theta)$, the random variable $-2\log\lambda(x)$ (where $\lambda(x)$ is a likelihood ratio) is asymptotically distributed as ______.
   a) normal b) exponential
   c) chi-square d) F distribution

5) A nonparametric version of the parametric analysis of variance is _____.
   a) Wilcoxon signed-rank test
   b) Kruskal-Wallis test
   c) Mann-Whitney test
   d) sign test

6) If all frequencies of classes are same, the value of Chi-square is _____.
   a) Zero b) One
   c) Infinite d) All of the above

7) The approximate relationship between Kendall's rand Spearman's r_s is _____.
   a) $\tau = r_s$ b) $\tau = (2/5)r_s$
   c) $\tau = (2/3)r_s$ d) $\tau = (1/3)r_s$

8) Wilcoxon's signed-rank test considers the differences $(X_1 - M_0)$ by way of _____.
   a) sign and magnitude both b) signs only
   c) magnitude only d) none of these

9) Based on random sample of size n from $N(\theta, 1)$ distribution, the pivotal quantity for construction of confidence interval for θ is _____.
   a) $(\bar{X} - \theta)/\sqrt{n}$ b) $\sqrt{n}\,(\bar{X} - \theta)$
   c) $(\bar{X} - \theta)/n$ d) $n(\bar{X} - \theta)$

10) Let X has a B(n, p} distribution. Then a simple hypothesis will be _____.
   a) $H_0 : p = 1/2$ b) $H_0 : p \le 1/2$
   c) $H_0 : p \ge 1/2$ d) $H_0 : p \ne 1/2$

B) Fill in the blanks. **06**

1) Level of significance is the probability of _____ error.
2) In testing independence in a 2×3 contingency table, the number of degrees of freedom in χ^2 distribution is _____.
3) The distribution of statistic used in sign test is _____.
4) The degrees of freedom for statistic t for paired t test based on n pairs of observations is _____.
5) In sequential probability ratio test (SPRT), the sample size is ______.
6) If in Wilcoxon's signed-rank test, sample size is large, the statistic T^+ is distributed with mean ______.

Q.2 Answer the following **16**

a) Define simple hypothesis and composite hypothesis. Give on example for each.
b) Discuss 2×2 contingency table analysis.
c) Discuss the merits and demerits of nonparametric tests as compared to parametric tests.
d) Explain in brief the test of significance for testing $H_0 : \sigma^2 = \sigma_0^2$ in case of $N(0, \sigma^2)$ distribution.

Q.3 Answer the following. **16**

a) Describe the test of significance for testing equality of means of two normal population.
   1) for large samples
   2) for small samples
b) A sample of size one from $U(0, \theta)$is drawn to test the hypothesis $H_0 : \theta = 1$ against $H_0 : \theta = 2$. The hypothesis H_0 is accepted if observed value is $x \le 0.5$. Find the probabilities of committing type I and type II errors and also find power of test.

Q.4 Answer the following. **16**

a) State and prove Neyman-Pearson lemma.
b) Use Neyman-Pearson lemma to obtain most powerful test for testing $H_0 : \mu = \mu_0$ against $H_1 : \mu = \mu_1 (< \mu_0)$ based on random sample of size n from $N(\mu, \sigma^2)$, when σ^2 is known.

Q.5 Answer the following. **16**

a) Describe the median test for the two sample location problem. How is the test carried out in case of large samples?
b) Explain Wilcoxon's signed-rank test for paired observations.

Q.6 Answer the following. **16**

a) Define confidence interval for unknown parameter. Obtain $100(1-\alpha)\%$ confidence intervals for σ^2 in case of $N(\mu, \sigma^2)$ distribution, where μ known.

b) Let $X_1, X_2, \dots\dots, X_N$ be a random sample from $N(\mu, \sigma^2)$ where both μ and σ^2 are unknown. Find likelihood ratio test of $H_0 : \mu = \mu_0$ against $H_1 : \mu \neq \mu_0$

Q.7 Answer the following. **16**

a) Explain Wald's procedure of sequential probability ratio test (SPRT). In what respect SPRT differs from the fixed sample test.

b) Let X be a discrete random variable having probability mass function.

$$f(x, \theta) = \begin{cases} \theta^{*}(1-\theta)^{1-x}, x = 0, 1 \\ \quad 0, \text{otherwise} \end{cases}$$

Where $0 < \theta < 1$. Obtain SPRT for testing $H_0 : \theta = \theta_0$ against $H_1 : \theta = \theta_1$

Set No.	

Set P

M.Sc. (Semester - III) (New) (CBCS) Examination: Oct/Nov-2022
(BIOSTATISTICS)
Micro-array Data Analysis

Day & Date: Tuesday, 14-02-2023 Max. Marks: 80
Time: 11:00 AM To 02:00 PM

Instructions: 1) Q. Nos. 1 and. 2 are compulsory.
2) Attempt any three questions from Q. No. 3 to Q. No. 7
3) Figure to right indicate full marks.

Q.1 A) Choose the correct alternative. **10**

1) Traditional molecular biology research followed a ______ paradigm.
   a) one gene per experiment
   b) Thousands of genes per experiment
   c) Mixture of (a) and (b) strategies
   d) None of these.

2) Consider the steps in the analysis of microarray data ______.
   i) Conducing the microarray experiment
   ii) Converting images into quantitative data
   iii) Applying appropriate data analysis technique
   iv) Getting the scanned image of microarray chips
   v) Preprocessing the data.
   Which of the following is the correct sequence of these tasks?
   a) (i), (ii), (iii), (iv), (v)
   b) (i), (iii), (ii), (v), (iv)
   c) (i), (iv), (ii), (v), (iii)
   d) (hi), (v), (ii), (i), (iv)

3) The complete set of genes in an organism, essentially the master blueprint for that organism, is referred to as its _____.
   a) Genome b) Genocide
   c) Genesis d) Genogram

4) The DNA stands for _____.
   a) Dehydrated nucleic acid
   b) deoxyribonucleic acid
   c) Decentralized nitrogen atoms
   d) None of these

5) A DNA molecule consists of _____ long strand/ strands.
   a) One b) Two
   c) Three d) Four

6) In connection with microarrays, SAM stands for _____.
   a) Similarity adjustment measure
   b) significance analysis of microarrays
   c) Stimulating adherent molecules
   d) None of these

7) A type I error is also called as ______.
   a) False negative error b) True negative
   c) False-positive error d) None of these

8) The protein-coding instructions from a gene are transmitted indirectly Through _____.
   a) mRNA b) tRNA
   c) kRNA d) All of these

9) Genes with p-values falling below a prescribed level (the 'nominal level') may be regarded as _____.
   a) Significant b) Insignificant
   c) Inconclusive d) None of these

10) A type II error is also called as _____.
   a) False negative error b) True negative
   c) False-positive error d) None of these

B) Fill in the blanks. **06**

1) PCR stands for _____.
2) RNA stands for _____.
3) In case of complete linkage, the _____ distance between various units of two clusters is taken to be the distance among these clusters.
4) The significance analysis of microarrays is also called as ______ test.
5) _____ are the fundamental units of all living organisms, both structurally and functionally.
6) FWER stands for _____.

Q.2 Answer the following. **16**

a) Write a note on Fold change method.
b) Write a note on genes.
c) Write a note on gene expression.
d) Write a note on DNA.

Q.3 Answer the following.

a) Explain microarray data analysis with the help of schematic. **08**
b) Explain t test for microarray data analysis. **08**

Q.4 Answer the following.

a) Explain the drawback of applying usual t test in microarray data analysis. Also explain the modified t test. **08**
b) Discuss, in detail, nominal p value. **08**

Q.5 Answer the following.

a) Discuss: **08**
   i) Family wise error rate control
   ii) False discovery rate control
b) Explain Welch test in detail. **08**

Q.6 Answer the following.

a) Explain: **08**
   i) Single linkage
   ii) Complete linkage
   iv) Average linkage
b) Explain hierarchical and non-hierarchical clustering. **08**

Q.7 Answer the following.

a) Discuss, in detail, k-means clustering. **08**
b) Explain Dendrogram with the help of an example. (Use single linkage method). **08**

SLR-GX-12

Seat No.	

Set P

M.Sc. (Semester - III) (New) (CBCS) Examination: Oct/Nov-2022
(BIOSTATISTICS)
Multivariate Statistical Methods

Day & Date: Wednesday, 15-02-2023 Max. Marks: 80
Time: 11:00 AM To 02:00 PM

Instructions: 1) Question 1 and 2 are compulsory.
2) Attempt any Three from Q.3 to Q.7
3) Figures to the right indicate full marks.

Q.1 A) Choose Correct Alternative. **10**

1) Generalised variance is _____ of covariance matrix
a) trace+ determinant b) Trace
c) Determinant d) None of these

2) While applying _____ clustering algorithm, the distance between two clusters is taken to be the smallest distance between observations from two clusters.
a) average linkage b) complete linkage
c) single linkage d) None of these

3) Canonical correlation is _____.
a) Always positive b) Always negative
c) Lies in between (-1,0) d) None of these

4) Let $\underline{\underline{X}_1, \underline{X}_2, \dots, \underline{X}_n}$ be a random sample of size n from p-variate normal distribution with mean vector $\underline{\mu}$ and covariance matrix $\sum$. The unbiased estimator of $\sum$ is _____.
a) $\dfrac{\underline{X}\,\underline{X'} - n\overline{\underline{X}}\,\overline{\underline{X'}}}{n-1}$ b) $\dfrac{\underline{X}\,\underline{X'} - n\overline{\underline{X}}\,\overline{\underline{X'}}}{n}$
c) $\dfrac{\underline{X}\,\underline{X'} - \overline{\underline{X}}\,\overline{\underline{X'}}}{n-1}$ d) $\dfrac{\underline{X}\,\underline{X'} - \overline{\underline{X}}\,\overline{\underline{X'}}}{n}$

5) Let vector $\underline{Y}$ has $N_p(\mu, \sum)$ distribution. For a constant matrix $A_{q\times p}$ and vector $b_{q\times 1}$ the distribution of $\underline{X} = A\underline{Y} + b$ is _____.
a) $N_p(A\mu, A\sum A')$ b) $N_q(A\mu, A\sum A')$
c) $N_p(A\mu + b, A\sum A')$ d) $N_q(A\mu + b, A\sum A')$

6) The mean vector of $(X_1 + X_2, X_1 - X_2)$ is (8,12) then mean vector of $(X_1, 2X_1 - X_2)$ is _____.
a) (8,18) b) (10,18)
c) (10,22) d) (5,5)

7) Let $\underline{X}$ is multivariate normal, then $\underline{a}'\underline{X}$ is univariate normal, only if _____.
a) $\underline{a}$ is zero vector b) $\underline{a}$ is unit vector
c) For all $\underline{a}$ d) None of these

8) If $\underline{X}$ has $N_p(\underline{\mu}, \Sigma)$ distribution then characteristic function of vector $\underline{X}$ is _____.

a) $Exp\left(i\underline{t}'\,\underline{\mu} - \frac{1}{2}\,\underline{t}'\,\Sigma\,\underline{t}\right)$ b) $Exp\left(i\underline{t}\,\underline{\mu} + \frac{1}{2}\,\underline{t}'\,\Sigma\,\underline{t}\right)$

c) $Exp\left(i\underline{t}'\,\underline{\mu} - \frac{1}{2}\,\underline{t}'\,\Sigma^{-1}\,\underline{t}\right)$ d) $Exp\left(i\underline{t}'\,\underline{\mu} + \frac{1}{2}\,\underline{t}'\,\Sigma^{-1}\,\underline{t}\right)$

9) Principal Component Analysis is a multivariate method that _____.

a) reduces skewness of data b) reduces heterogeneity of data

c) reduces dimension of data d) reduces multicollinearity of data

10) Cluster is

a) Group of similar objects that differ significantly from other objects
b) Operations on a database to transform or simplify data in order to prepare it for a machine-learning algorithm
c) Symbolic representation of facts or ideas from which information can potentially be extracted
d) None of these

B) Fill in the blanks **06**

1) The diagonal elements of variance-covariance matrix represent _____.
2) If there are p variables in the random vector $\underline{X}$, then ____ number of principal components are obtained from it.
3) In case of complete linkage, the _____ distance between various units of two clusters is taken to be the distance among these clusters.
4) The eigen values of the matrix $\begin{bmatrix} 3 & 1.5 \\ 0 & 7 \end{bmatrix}$ are _____.
5) The range for canonical correlation is _____.
6) If $\underline{X} \sim N_p(\underline{\mu}, \Sigma)$, then the distribution of components of $\underline{X}$ follows _____ distribution.

Q.2 Answer the following. **16**

1) Obtain moment generating function of multivariate normal distribution.
2) Write a note on multivariate normal distribution.
3) Write a note on sample dispersion matrix.
4) Write a note on Wishart distribution

Q.3 Answer the following.

a) Explain complete linkage method in detail with the help of illustration. **08**
b) Explain canonical correlation in detail. **08**

Q.4 Answer the following.

a) What do you mean by principal components analysis? Explain in detail. **08**
b) With usual notations, derive the density of multivariate normal distribution. **08**

Q.5 Answer the following.

a) For p-variate normal distribution obtain the MLE for variance covariance matrix. **08**
b) How clustering is done with k-means clustering method? Discuss in detail. **08**

Q.6 Answer the following.

a) If $\underline{X} \sim N_p(\underline{\mu}, \Sigma)$, them find the distribution of the following: **08**

1) $\underline{a}'\,\underline{X}$, where $\underline{a}$ is a p-dimensional vector of constants.
2) $A\underline{X}$, where A is matrix of order $m + p$

b) Describe Wishart distribution State and prove additive property of Wishart distribution. **08**

Q.7 Answer the following.

a) Find the mean vector and variance covariance matrix of multivariate normal density. **08**

b) What is meant by discriminant analysis? Obtain the classification rule for the case of two populations with densities $N_p(\underline{\mu_1}, \Sigma)$ and $N_p(\underline{\mu_2}, \Sigma)$. **08**

SLR-GX-16

Seat No.	

Set P

M.Sc. (Semester - IV) (New) (CBCS) Examination: Oct/Nov-2022
(BIOSTATISTICS)
Survival Analysis

Day & Date: Wednesday, 22-02-2023 Max. Marks: 80
Time: 03:00 PM To 06:00 PM

Instructions: 1) Q. Nos. 1 and 2 are compulsory.
2) Attempt any three questions from Q. No. 3 to Q. No. 7
3) Figure to right indicate full marks.

Q.1 A) Choose correct alternative. **10**

1) A parallel system is a special case of k-out-of-n system when ______.
   a) $\mathrm{k} = 1$ b) $\mathrm{k} = 2$
   c) $\mathrm{k} = \mathrm{n} - 1$ d) $\mathrm{k} = \mathrm{n}$

2) Which of the following rate function corresponds to IFR distribution?
   a) $\mathrm{h(t) = t}$ b) $\mathrm{h(t) = e^t}$
   c) $\mathrm{h(t) = t\,e^t}$ d) All the above

3) Let p_i is the reliability of i^{th}component then reliability of series system of n independent components is ______.
   a) $\coprod_{i=1}^{n} p_i$ b) $\prod_{i=1}^{n} p_i$
   c) $\sum_{i=1}^{n} p_i$ d) $\prod_{i=1}^{n} (1 - p_i)$

4) A life time distribution *F* having finite mean is said to be NBUE for $t \geq 0$, if ______.
   a) $\mu_t \leq \mu_0$ b) $\mu_t \geq \mu_0$
   c) $\mu_t = \mu_0$ d) None of these

5) A function $P(x) \geq 0 \text{ for all } x$ is a Polya function of order 2 if ______.
   a) $\log P(x)$ is convex
   b) $\log P(x)$ is concave
   c) for fixed Δ, $\frac{P(x+\Delta)}{P(x)}$ is increasing function
   d) None of these

6) In random censoring ______ is random.
   a) number of uncensored observations
   b) time for which study lasts
   c) both (A) and (B)
   d) neither (A) nor (B)

7) Log-rank test for equality of two distributions is based on ______ data.
   a) left censored b) right censored
   c) type I censoring d) type II censoring

8) Actuarial method of estimation of survival function is used when data consists of ______.
   a) only censored observations
   b) only uncensored observations
   c) complete data
   d) All the above

9) The censoring time for every censored observation is identical in ______ censoring.
   a) type I b) type II
   c) random d) both in (A) and (B)

10) In type I censoring, the number of uncensored observations has ______ distribution.
   a) Geometric b) Binomial
   c) Normal d) Exponential

B) Fill in the blanks: **06**

1) The number of minimal paths in 2-out-of-3 system are ______.
2) IFRA property is preserved under ______.
3) Reliability of a system always lies between ______ and ______.
4) The scaled TTT transform for standard exponential distribution is ___.
5) In failure censoring experiments with $n = 10, m = 2$ and failure epochs are 15 and 20. Then total time on test statistic is ______.
6) Censoring technique is used for reducing ______.

Q.2 Answer the following. **16**

a) Define reliability of a system. Obtain the reliability of parallel system of n independent components.
b) Define minimal path sets and minimal cut sets. Illustrate the same by example.
c) Give two real life examples where both left and right censoring occurs.
d) Show that for exponential distribution normalized spacings are independently distributed.

Q.3 Answer the following.

a) Define coherent system. Show that k-out-of-n system is coherent system. Obtain structure function of a coherent system using minimal cut sets. **08**
b) Illustrate the same by an example. **08**

Q.4 Answer the following.

a) Define type-I censoring. Derive the likelihood function of observed data under type I censoring hence obtain MLE of mean of exponential distribution. **10**
b) Discuss maximum likelihood estimation of parameters of a gamma distribution under complete data. **06**

Q.5 Answer the following.

a) Define mean time to failure (MTTF) and mean residual life (MRL) function. Obtain the same for exponential distribution. **08**
b) Define Poly function of order 2 (PF_2). Prove that if $f \in PF_2$ then $F \in$ IFR. **08**

Q.6 Answer the following.

a) Obtain the actuarial estimator of the survival function. Clearly state the assumption that you need to make. Greenwood's formula for the variance of the estimator. **08**

b) Describe two sample problem under randomly censored set up and develop Gehan's test for the same. **08**

Q.7 Answer the following.

a) Define IFR and IFRA class of distributions. If $F \in IFR$ then show that $F \in IFRA$. **08**

b) Define TTT transform. Obtain relation between TTT transform and failure rate function of a survival distribution. **08**