Seat No.	

Set P

M.Sc. (Semester - I) (New) (NEP CBCS) Examination: Oct/Nov-2023
STATISTICS
Distribution Theory (2329101)

Day & Date: Friday, 05-01-2024 Max. Marks: 60
Time: 03:00 PM To 05:30 PM

Instructions: 1) All questions are compulsory.
2) Figure to right indicate full marks.

Q.1 A) Fill in the blanks by choosing correct alternatives given below. **08**

1) Let X be distributed as $B\ (n, p)$. The distribution of $Y = n - X$ is _____.
   a) not Binomial b) $B(n-1, p)$
   c) $B(n-1, n-p)$ d) $B(n, 1-p)$

2) Let X be distributed as $Exp\ (Mean\ \theta)$ .Then distribution of $Y = X/\theta$ is ____.
   a) $Exp\ (Mean\ \theta)$ b) $Exp\ (Mean\ 1)$
   c) $U\ (0, 1)$ d) $U\ (0, \theta)$

3) A random variable X is said to be symmetric about point α if _____.
   a) $P(X \geq \alpha + x) = P(X \geq \alpha - x)$
   b) $P(X \geq \alpha + x) = P(X \leq \alpha - x)$
   c) $P(X \leq \alpha + x) = P(X \leq \alpha - x)$
   d) $P(X \leq \alpha + x) = P(X \geq \alpha - x)$

4) 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

5) Which of the following is not a scale family?
   a) $U(0, \theta)$ b) $U(0,1)$
   c) $N(0, \sigma^2)$ d) $Exp(\theta)$

6) Let X and Y be independent random variables each having the $U(0,1)$ distribution. Then Var$(X + Y)$ is equal to ______.
   a) $1/6$ b) $5/2$
   c) 4 d) 6

7) Let X and Y be two iid random variables with $pdf\ f(x) = 2_e{}^{-2x}, x \geq 0$. The distribution of $Z = X - Y$ is _____.
   a) exponential b) beta
   c) Laplace d) Cauchy

8) Suppose $X_{1,}X_2, \dots, X_k$ is a multinomial random variate then $Cov(X_i, X_j), i = j = 1,2, \dots, k, i \neq j$ is ______.
   a) $n\, p_i$ b) $-n\, p_i\, p_j$
   c) $n\, p_i\, p_j$ d) $n^2\, p_i\, p_j$

B) Fill in the blanks. **04**

1) If Z is standard normal variate then mean of Z^2 is _____.
2) The pdf of random variable X is $f(x) = 2x, 0 \leq x \leq 1$ then $P(X = 0.5)$ is _____.
3) Let X and Y be two independent Poisson random variates with means 1 and 2 respectively then variance of $(2X + 3Y)$ is _____.
4) The PGF of Poisson distribution with mean λ is given by _____.

Q.2 Answer the following (Any Six) **12**

a) Define cumulative distribution function (c.d.f.) of a random variable X.
b) Define a symmetric random variable.
c) Define location family.
d) State Holder's inequality.
e) Define moment generating function (MGF) of random variable X.
f) State the relation between distribution function of a continuous random variable and uniform random variable.
g) Define Marshall-Olkin bivariate exponential distribution.
h) Define multinomial distribution.

Q.3 Answer the following. (Any Three) **12**

a) Let X follows $N(0,1)$ distribution. Find the distribution of $Y = X^2$.
b) Define scale family of distributions. Examine which of the following are in scale family.
   i) $X \sim N(0, \sigma^2)$
   ii) $X \sim U(0, \theta)$
c) Let F be a distribution function of a random variable X. Examine whether $[F(x)]^2$ and $1 - F(x)$ are distribution functions.
d) Derive the pdf of smallest order statistic based on a random sample of size n from a continuous distribution with pdf $f(x)$ and cdf $F(x)$.

Q.4 Answer the following. (Any Two) **12**

a) State and prove Markov's inequality.
b) Let X is a non-negative random variable with pmf $P(X = x) = P_x$, $x = 1,2,...$ then show that

$$E(X) = \sum_{x=1}^{\infty} P[X \geq x]$$

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

Q.5 Answer the following. (Any Two) **12**

a) Define multinomial distribution. Obtain its MGF. Hence or otherwise obtain its variance-covariance matrix.
b) Let X and Y are jointly distributed with pdf

$$f(x,y) = \begin{cases} k\ (x + 2y), 0 < x < 2, 0 < y < 1 \\ 0, \ otherwise \end{cases}$$

Find marginal distributions of X and Y.
c) Let (X, Y) has $BVN(\mu_1, \mu_2, \sigma_1^2, \sigma_2^2, \rho)$. Obtain the marginal distributions of X.

SLR-ER-2

Seat No.	

Set P

M.Sc. (Semester - I) (New) (NEP CBCS) Examination: Oct/Nov-2023
STATISTICS
Estimation Theory (2329102)

Day & Date: Sunday, 07-01-2024 Max. Marks: 60
Time: 03:00 PM To 05:30 PM

Instructions: 1) All questions are compulsory.
2) Figure to right indicate full marks.

Q.1 A) Choose the correct alternative. **08**

1) A sufficient statistic contains all the information which is contained in_____.
   a) population b) sample
   c) parameter d) none of the above

2) Suppose$T$ sufficient for θ.Then $g(T)$ is sufficient for $g(\theta)$ if _____.
   a) g is a real valued function b) g is a continuous function
   c) g is one-to-one function d) g is a bounded function.

3) $U(0, \theta)$ is a member of_____.
   a) one parameter exponential family.
   b) Pitman family.
   c) power series family.
   d) none of the above

4) Cramer-Rao inequality with regards to the variance of an unbiased estimator provides _____.
   a) lower bound b) upper bound
   c) asymptotic variance d) Fisher information

5) If an estimator T_n of population parameter θ converges in probability to θ as n tends to infinity is said to be_____.
   a) sufficient b) efficient
   c) consistent d) unbiased

6) 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

7) Let T_n be an unbiased estimator of θ.Then_____.
   a) T_n^2 is unbiased estimator of θ^2.
   b) $\sqrt{T_n}$ is unbiased estimator of $\sqrt{\theta}$.
   c) e^{T_n} is unbiased estimator of e^{θ}
   d) $3T_n + 4$ is unbiased estimator of $3\theta + 4$

8) Prior distribution is the_____.
   a) distribution of parameter θ.
   b) distribution of sample X.
   c) conditional distribution of X given θ.
   d) conditional distribution of θ given X

B) Fill in the blanks. **04**

1) If the distribution of $T(X)$ is independent of θ then statistic $T(X)$ is said to be _____ statistic
2) Let $X_1, X_2, \dots, X_n$ is a random sample of size n from $U(0,\theta)$distribution then MLE of θ is _____.
3) Bayes estimator of a parameter under absolute error loss function is_____.
4) Bhattacharya bound is the generalization of _____ inequality.

Q.2 Answer the following. (Any Six) **12**

a) Define one parameter exponential family of distributions.
b) Define sufficient statistic.
c) Define maximum likelihood estimator (MLE).
d) State Lehmann-Schffe theorem.
e) Define Fisher information in a single observation and in n iid observations.
f) State Neyman-Fisher factorization theorem.
g) Define consistent estimator.
h) Define Pitman family of distributions.

Q.3 Answer the following. (Any Three) **12**

a) Let random variable X has $U(0,\theta), \theta > 0$ distribution. Show that distribution of X is complete.
b) Let X_1 and X_2 are iid Poisson (λ). Using the definition of sufficient statistic, examine whether $X_1 + X_2$ to be sufficient statistics for λ .
c) Show that Poisson distribution belong to power series family.
d) Find Cramer-Rao lower bound (CRLB) for the variance of unbiased estimator of θ based on random sample of size n from $f(x,\theta) = \theta e^{-\theta x}, x \geq 0, \theta > 0$.

Q.4 Answer the following. (Any Two) **12**

a) Describe the method of maximum likelihood estimation for estimating an unknown parameter.
b) Let $X_1, X_2, \dots, X_n$ is a random sample of size n from exponential distribution with mean $\theta.$ Obtain MLE of $\theta.$ Show that it is unbiased estimator of θ.
c) Let $X_1, X_2, \dots, X_n$ be a random sample from $U(0,\theta), \theta > 0$. Obtain two consistent estimators for θ.

Q.5 Answer the following. (Any Two) **12**

a) State and prove Rao-Blackwell theorem.
b) Let $X_1, X_2, \dots, X_n$ be a random sample of size n from $U(0,\theta), \theta > 0$. Find UMVUE of (i) θ and (ii) θ^2.
c) Let $\{T_n\}$ be a sequence of estimators such that $E(T_n) = \theta$ and $Var(T_n) \to 0$ as $n \to \infty$ then show that T_n is consistent for θ.

Seat No.	

Set P

M.Sc. (Semester - I) (New) (NEP CBCS) Examination: Oct/Nov-2023
STATISTICS
Statistical Mathematics (2329107)

Day & Date: Tuesday, 09-01-2024 — Max. Marks: 60
Time: 03:00 PM To 05:30 PM

Instructions: 1) All Questions are compulsory.
2) Figure to right indicate full marks.

Q.1 A) Choose the correct alternative. **08**

1) If there exists one to one correspondence between given set and set of natural numbers, then the given set is _____.
   a) Perfect set b) Good set
   c) Countable set d) Uncountable set

2) Which of the following sequences of real numbers do always converge?
   a) Sequence of constant term
   b) Monotonic increasing sequence
   c) Monotonic decreasing sequence
   d) Oscillatory sequence

3) If $\sum_{n=1}^{\infty} a_n$ converges, then $\lim_{n\to\infty} a_n =$ _____.
   a) -1 b) 1
   c) Infinity d) Zero

4) A convergent sequence Have _____.
   a) Only one limit b) Atmost two limits
   c) Atmost n limits d) Infinite limits

5) A Cauchy sequence of real numbers is always _____.
   a) Convergent b) Divergent
   c) Oscillatory d) None of these

6) The smallest sub-space containing finite set of vectors (S) is _____.
   a) Superclass of S b) Span of S
   c) Subset of S d) Basis of S

7) A set of vectors containing a null vector is _____.
   a) Not necessarily dependent b) Necessarily dependent
   c) Necessarily independent d) A vector space

8) If number of columns is less than number of rows, then the matrix is called as _____.
   a) Horizontal matrix b) Vertical matrix
   c) Row matrix d) Column matrix

B) Fill in the blanks. **04**

1) If all the elements below the diagonal are zero, then such matrix is called as _____.
2) If AB is invertible then $(AB)^{-1} =$ _____.
3) If determinant of a square matrix is zero, then such matrix is called as _____.
4) The inverse of identity matrix is _____.

Q.2 Answer the following. (Any Six) **12**

a) Define orthogonal matrix.
b) Define a square matrix.
c) Define a skew-symmetric matrix.
d) Define convergence limit of a sequence.
e) Define bounded sequence.
f) Define geometric series.
g) Define infimum of a set.
h) Define ratio test of convergence.

Q.3 Answer the following. (Any Three) **12**

a) Show that every monotonic bounded above sequence of real numbers converges.
b) Define and illustrate limit superior of a sequence of real numbers.
c) Reduce the following matrix to a row-reduced form and hence determine its rank.

$$A = \begin{bmatrix} 1 & 3 & 8 \\ 5 & 2 & 1 \\ 7 & 6 & 1 \end{bmatrix}$$

d) Define and illustrate rank of a matrix.

Q.4 Answer the following. (Any Two) **12**

a) Define limit superior and limit inferior of a sequence. Find the same for the following sequence, hence verify its convergence.

$$S_n = 2 + \frac{(-1)^n}{n}, n \in N$$

b) Obtain the Riemann integration of $f(x) = 3x, x \in (0,2)$.
c) Examine the convergence of p-series for various values of p.

Q.5 Answer the following. (Any Two) **12**

a) Define vector space and subspace. State the conditions needed to verify whether a subset of a vector space is a subspace.
b) Prove: For any vector in $\underline{u}$ vector space $V, 0.\underline{u} = \underline{0}$
c) How the independence of vectors is examined? Also verify whether following set is a set of independent vectors.

$$S = \left\{\begin{pmatrix} 1 \\ 2 \end{pmatrix}, \begin{pmatrix} 5 \\ 4 \end{pmatrix}\right\}$$

SLR-ER-6

Seat No.	

Set P

M.Sc. (Semester - I) (New) (NEP CBCS) Examination: Oct/Nov-2023
STATISTICS
Research Methodology in Statistics (2329103)

Day & Date: Thursday, 11-01-2024 Max. Marks: 60
Time: 03:00 PM To 05:30 PM

Instructions: 1) All Questions are compulsory.
2) Figure to right indicate full marks.

Q.1 A) Choose the correct alternative. **08**

1) Research can be defined as _____.
   a) scientific and systematic search for pertinent information on a specific topic
   b) a search for knowledge
   c) systematized effort to gain new knowledge
   d) All the above

2) A research study undertaken to gain familiarity with a phenomenon or to achieve new insights into it is termed as _____.
   a) exploratory research study b) descriptive research studies
   c) diagnostic research studies d) All of the above

3) The _____ is that which utilizes historical sources like documents, remains, etc. to study events or ideas of the past.
   a) Historical research b) Diagnostic research
   c) Longitudinal research d) One point research

4) Decisions regarding what, where, when, how much, by what means concerning an inquiry or a research study constitute a _____.
   a) Research design b) Sampling design
   c) Report writing d) Descriptive research

5) _____ concerns with the question of how many items are to be observed and how the information and data gathered are to be analyzed.
   a) observational design b) the sampling design
   c) the statistical design d) the operational design

6) The regression estimator is appropriate in a situation where _____.
   a) Regression of Y on X is linear and line passes through origin
   b) Regression of Y on X is linear and line does not pass through origin
   c) Regression of Y on X is non-linear and passes through origin
   d) Regression of Y on X in non-linear and does not passes through origin

7) In sampling with probability proportional to size, the units are selected with probability proportion to _____.
   a) Size of the unit b) Size of the population
   c) Size of the sample d) None of these

8) Which of the following estimators is generally biased?
   a) Horvitz - Thompson b) Des Raj
   c) Heartly - Ross d) Ratio

B) Fill in the blanks. **04**

1) The process of examining the truth of a statistical hypothesis, relating to some research problem, is known as _____.
2) Under _____ scheme, ratio estimator exactly becomes unbiased.
3) A random start automatically fixes the subsequent selection of sample units in _____ sampling method.
4) In SRSWR, _____ is unbiased estimator of population variance.

Q.2 Answer the following. (Any Six) **12**

a) Define descriptive research.
b) Define quantitative research.
c) Define applied research.
d) Define extraneous variable.
e) What is meant by sampling error?
f) Define cluster sampling.
g) Define judgement sampling.
h) Differentiate between SRSWR and SRSWOR.

Q.3 Answer the following. (Any Three) **12**

a) Discuss response and non-response errors.
b) Describe stratified sampling.
c) Describe criteria of a good research.
d) Discuss experimental and control group.

Q.4 Answer the following. (Any Two) **12**

a) With usual notations, prove that in simple random sampling, the bias of $\overline{y}_l$ is $Bias(\overline{y}_l) = -cov(\overline{x}, b)$.
b) Obtain Horvitz - Thompson estimator for population mean for PPSWOR method.
c) Discuss research methods and research methodology.

Q.5 Answer the following. (Any Two) **12**

a) Discuss the need of research design.
b) Explain the significance of report writing.
c) Explain Lahiri’s method in detail.

SLR-ER-7

Seat No.	

Set P

M.Sc. (Semester - I) (Old) (CBCS) Examination: Oct/Nov-2023
STATISTICS
Real Analysis (MSC16101)

Day & Date: Friday, 05-01-2024 Max. Marks: 80
Time: 03:00 PM To 06:00 PM

Instructions: 1) Q. No. 1 and Q. No 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) The set of limit points of the set (0,2] is: _____.
   a) (0,2) b) (0,2]
   c) [0,2) d) [0,2]

2) Set of all rationals is _____.
   a) Countable b) Uncountable
   c) Finite d) None of the above

3) A set is compact if and only if it is bounded and _____.
   a) Semi open b) Open
   c) Closed d) Semi closed

4) Least upper bound is also called as _____.
   a) Infimum b) Supremum
   c) Limit point d) Interior point

5) The set $\left\{\left(8+\frac{(-1)^n}{n}\right), n \in N\right\}$has _____ limit point.
   a) One b) Two
   c) Zero d) Four

6) A sequence $S_n = (-1)^n, n \in N$ is _____ sequence.
   a) Divergent b) Convergent
   c) Oscillatory d) none of these

7) A superset of uncountable set is always _____.
   a) Countable b) Uncountable
   c) May or may not be countable d) None of these

8) A function f(x)=|x-3| on (-1,1) is _____.
   a) Continuous as well as differentiable
   b) Continuous, but not differentiable
   c) Differentiable but not continuous
   d) Neither continuous nor differentiable

9) Riemann integral is a particular case of _____.
   a) Riemann- John integral
   b) Riemann-Lebesgue integral
   c) Riemann-Stieltje's integral
   d) None of the above

10) The limit of sequence $S_n = \frac{1}{n^2}, n \in N$ is _____.
   a) 0 b) 1
   c) 100 d) 2

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

1) Every subset of countable set is _____.
2) A finite set with n elements has _____ number of limit points.
3) If for a geometric series, common ratio r > 1, then series _____.
4) Greatest lower bound of a set is also called as _____.
5) The function $f(x) = -x^2 + 2x + 3$ has maximum at point x= _____.
6) The union of two closed sets is _____.

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

a) Construct a bounded set of real numbers with exactly three limit points.

b) Prove or disprove:
   i) A subset of open set is always open.
   ii) A subset of closed set is always closed.

c) Define and illustrate:
   i) Limit point of a set
   ii) Interior point of a set.

d) What is meant by absolute convergence of a series? Does it imply regular convergence?

Q.3 Answer the following.

a) Prove or disprove: Countable union of countable sets is always Countable **08**

b) Let A be an open subset of R. Then show that every point of A is also its limit point. **08**

Q.4 Answer the following.

a) When do you say a set is countable? Show that set of real numbers IR is uncountable. **08**

b) When a series of real numbers is said to be convergent? Discuss ratio test and comparison test of convergence. **08**

Q.5 Answer the following.

a) Define Cauchy sequence. Show that a sequence is convergent if and only if it is a Cauchy sequence. **08**

b) Discuss the convergence of the series $\Sigma \frac{1}{n^p}$. **08**

Q.6 Answer the following.

a) Define continuous function. Show that every continuous function is Riemann integrable. **08**

b) Define limit superior and limit inferior of a sequence. Find the same for the following sequences, hence verify their convergence. **08**

i) $$S_n = 2 + \frac{(-1)^n}{n}, n \in N$$

ii) $$S_n = sin\frac{n\pi}{2}, n \in N$$

Q.7 Answer the following.

a) Show that the set of all rationals is countable. **08**

b) Discuss the convergence of a geometric series with common ratio r. **08**

Seat No.	

Set P

M.Sc. (Semester - I) (Old) (CBCS) Examination: Oct/Nov-2023
STATISTICS
Linear Algebra & Liner Models (MSC16102)

Day & Date: Sunday, 07-01-2024 Max. Marks: 80
Time: 3:00 PM To 6:00 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) Choose the correct alternative: **10**

1) If v_1, v_2, v_3 are three vectors such that $4v_1 + 2v_2 + v_3 = 0$,then
   a) v_1, v_2, v_3 are linearly dependent vectors
   b) v_1, v_2, v_3 are linearly independent vectors
   c) Need to verify other linear combinations to check independence
   d) None of these

2) What is the dimension of the vector space R^2 over the field R?
   a) 1 b) Infinite
   c) 2 d) 4

3) If A is an non-empty subset of B and B is set of independent vectors, then the vectors in A are ______.
   a) Independent vectors
   b) May or may not be independent vectors
   c) Dependent vectors
   d) None of these

4) If determinant of a square matrix is zero, then such matrix is called as
   a) Zero matrix b) Insignificant matrix
   c) Non-singular matrix d) None of these

5) If for a 3×3 matrix A, the determinant ($|A|$) is zero, then ___.
   a) Rank $(A) = 1$ b) Rank $(A) < 3$
   c) Rank $(A) = 3$ d) None of these

6) Le B any real matrix and A be its inverse then
   a) $BA = I$ b) $AB = I$
   c) Both (a) and (b) d) None of these

7) If A and B are two matrices of order $n \times n$ with ranks r_1 and r_2, then___
   a) Rank $(AB) = r_1 + r_2$
   b) Rank $(AB) > r_1 + r_2$
   c) Rank$(AB) \geq r_1 + r_2 - n$
   d) Rank $(AB) \leq r_1 + r_2$

8) If transpose of the given matrix is equal to the matrix itself, then it is called____.
   a) Orthogonal matrix b) Symmetric matrix
   c) Scalar matrix d) Identity matrix

9) Vectors whose direction remains unchanged even after applying liner transformation with the matrix are called?
   a) Minor of a matrix b) Eigen values
   c) Cofactor matrix d) Eigen vectors

10) Which of the following is true for Gauss-Markov model
   a) $Y = X\beta + \varepsilon$ b) $E(\varepsilon) = 0$
   c) $cov(\varepsilon) = \sigma^2 I$ d) All of these

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

1) The set of all linear combinations of a finite set of vectors (S) is called as _____.

2) If transpose of the given matrix is equal to the identity matrix, then given matrix must be _____

3) Linear combinations of estimable functions are _____.

4) The matrix with only one column is called as ______.

5) In the system of linear equations $AX = b$ with unique solution, the matrix A is ______.

6) The eigen values of a 2×2 matrix A are 3 and x. If $|A| = 12$,the value of x must be _____.

Q.2 Answer the following **16**

a) Write a note of vector space.

b) Define and illustrate:
   i) Symmetric matrix
   ii) Skew-symmetric matrix

c) Define inverse and g-inverse of a matrix.

d) Write a note on minor and cofactor of an element of a matrix.

Q.3 Answer the following.

a) How Gram-Schmidt orthogonalisation is performed to obtain orthogonal vectors? **08**

b) Let V be a vector space and $S \subset V$, then show that he span of vectors in S is a subspace of V. **08**

Q.4 Answer the following.

a) When a set of vectors is said to be linearly independent vectors? Check whether following set is a set of linearly independent vectors- **08**

$$A = \left\{ \begin{pmatrix} 1 \\ 0 \\ 2 \end{pmatrix}, \begin{pmatrix} 2 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 3 \\ 0 \\ 5 \end{pmatrix} \right\}$$

b) Show that every matrix can be written a sum of symmetric and skew-symmetric matrices. **08**

Q.5 Answer the following.

a) Show that the rank of a matrix is unaltered by multiplication with a non-singular matrix. **08**

b) State and prove necessary and sufficient condition for estimability of linear parametric functions. **08**

Q.6 Answer the following.

a) Find inverse and g-inverse for the below matrix: **08**

$$\begin{bmatrix} 1 & 2 & 3 \\ 3 & 4 & 7 \\ 7 & 1 & 3 \end{bmatrix}$$

b) Show that the below equations are consistent. Also solve them. **08**

$x + \mathrm{y} + \mathrm{z} = 6$

$x + 2y + 3z = 14$

$x + 4y + 7z = 30$

Q.7 Answer the following.

a) Describe echelon form of a matrix. Show that rank of an echelon matrix is equal to the number of non-zero rows in the matrix. **08**

b) Define- **08**

i) Non-singular matrix

ii) Rank of a matrix

Show that all non- singular matrices of order n have same rank.

SLR-ER-9

Seat No.	

Set **P**

M.Sc. (Semester - I) (Old) (CBCS) Examination: Oct/Nov-2023
STATISTICS
Distribution Theory (MSC16103)

Day & Date: Tuesday, 09-01-2024 Max. Marks: 80
Time: 03:00 PM To 06:00 PM

Instructions: 1) Question 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) If the distribution function of two dimensional random variates X and Y is denoted by $F(x, y)$, then _____.
   a) $-1 \leq F(x, y) \leq 1$ b) $0 \leq F(x, y) \leq 1$
   c) $-\infty \leq F(x, y) \leq \infty$ d) $0 \leq F(x, y) \leq \infty$

2) Which of the following is a scale family?
   a) $U(0, \theta)$ b) $N(0, \sigma^2)$
   c) $Exp(\theta)$ d) All the above

3) A random variable X is symmetric about point α then _____.
   a) $f(\alpha + x) = f(\alpha - x)$ b) $f(\alpha + x) = f(x - \alpha)$
   c) $f(\alpha + x) = -f(\alpha + x)$ d) none of these

4) Let X be distributed as $U(0, \theta)$ .Then distribution of $Y = X/\theta$ is _____.
   a) $U(0, 1/\theta)$ b) $U(0, \theta)$
   c) $U(0,1)$ d) $Exp\ (Mean\ \theta)$

5) Suppose X is $N(0,1)$ and Y is chi-square with n degrees of freedom. Which of the following is always correct?
   a) $E[X^2 + Y] = 1 + n$ b) $X/\sqrt{\frac{Y}{n}}\ is\ t_n$
   c) $X^2 + Y\ is\ \chi^2_{n+1}$ d) $Var[X + Y] = 1 + 2n$

6) If $\mu_1{}' = 2, \mu_2{}' = 8$ and $\mu_3 = 3$ then value of $\mu_3{}'$ is _____.
   a) 45 b) 35
   c) 25 d) 15

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

8) The probability generating function (PGF) of geometric distribution with parameter p is $P_X(S) =$ _____.
   a) $p/(1 - qS)$ b) $q/(1 - pS)$
   c) $p/(1 - q/S$ d) $q/(1 - p/S$

9) Let (X_1, X_2, X_3) have a trinomial distribution with parameters $(15,0.4,0.4,0.2)$. Then the conditional distribution of X_1 given $X_2 = 5$ is _____.
   a) $B(15,2/3)$ b) $B(10, 2/3)$
   c) $B(15,0.4)$ d) $B(10,0.4)$

10) Let $X_1, X_2, \dots, X_n$ *be* a random sample from $pdf\ f_X(x)$ and $Y_1 \le Y_2 \le \cdots \le Y_n$ be its order statistics.
If pdf of Z is $n[1 - F_X(z)]^{n-1} f_X(z)$ then Z is _____.
a) Y_1
b) Y_n
c) $Y_n - Y_1$
d) sample median

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

1) The distribution of the first order statistic in $f(x;\theta) = \theta e^{-\theta x}, x > 0$ is _____.
2) Let X and Y be independent random variables each having the $U(0,1)$ distribution. Then $Var(X + Y)$ is equal to _____.
3) If X is symmetric about α then $(X - \alpha)$ is symmetric about _____.
4) Let X and y be two independent Poisson random variates with means 1 and 2 respectively then variance of $(2X + 3Y)$ is _____.
5) If Z is standard normal variate then mean of Z^2 is _____.
6) The pdf of random variable X is $f(x) = 2x, 0 \le x \le 1$ then $P(X = 0.5)$ is _____.

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

a) Define location family. Give one example illustrating it.
b) Suppose X has $N(\mu, \sigma^2)$ distribution. Find the distribution of $Y = e^x$.
c) Define a symmetric random variable. State any two properties of the same.
d) If F_1 and F_2 are distribution functions and $0 < \alpha < 1$, show that $F = \alpha F_1 + (1 - \alpha) F_2$ is a distribution function.

Q.3 Answer the following.

a) Define distribution function of bivariate random variate (X, Y). State and prove its important properties. **08**
b) Define convolution of two random variables. Let X and Y are independent standard exponential random variables. Find the p.d.f of $X + Y$ using convolution. **08**

Q.4 Answer the following.

a) State and prove Holder's inequality. **08**
b) Let X is a non-negative random variable with $pmf\ P(X = x) = P_x, x = 1,2, \dots$ then show that $E(X) = \sum_{x=1}^{\infty} P[X \ge x]$. **08**

Q.5 Answer the following.

a) Define probability generating function (PGF) of a random variable. Explain how it is used to obtain moments of a distribution. **08**
b) Let X has $B(n, p)$ distribution. Obtain the PGF of X. Hence obtain its mean and variance. **08**

Q.6 Answer the following.

a) Define multinomial distribution. Obtain its MGF. Hence or otherwise obtain its variance-covariance matrix. **08**
b) Derive the pdf of smallest order statistic based on a random sample of size n from a continuous distribution with $pdf\ f(x)$ and $cdf F(x)$. **08**

Q.7 Answer the following.

a) Let (X, Y) has $BVN\ (\mu_1, \mu_2, \sigma_1^2, \sigma_2^2\ \rho$. Obtain the conditional distribution of Y given $X = x$. **08**

b) Let X and Y are jointly distributed with pdf **08**

$$f(x, y) = \begin{cases} k(x + 2y), 0 < x < 2, 0 < y < 1 \\ 0\ , \ \ otherwise \end{cases}$$

Find marginal distributions of X and Y.

SLR-ER-10

Seat No.	

Set P

M.Sc. (Semester - I) (Old) (CBCS) Examination: Oct/Nov-2023
STATISTICS
Estimation Theory (MSC16104)

Day & Date: Thursday, 11-01-2024 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 the correct alternative. **10**

1) An unbiased estimator of θ based on random sample of size n from a distribution having pdf $f(x,\theta) = 1/\theta, 0 < x < \theta$ is ______.
   a) sample mean b) sample median
   c) largest observation d) double of sample mean

2) Which of the following is not a member of one-parameter exponential family of distributions?
   a) Bernoulli $(1,\theta)$ b) Cauchy $(1,\theta)$
   c) Normal$(\theta, 1)$ d) Poisson(θ)

3) Suppose $f(x,\theta)$is pdf of random variable X for which differentiation under integral sign is permissible. Then $E\left(\frac{\partial \log f(x,\theta)}{\partial\theta}\right)$ is ______.
   a) equal to Fisher information b) less than zero
   c) less than one d) equal to zero

4) The denominator of Cramer-Rao inequality gives ______.
   a) lower bound b) upper bound
   c) amount of information d) none of the above

5) A statistic $T(X)$ for θ is said to be ancillary if ______.
   a) The distribution of $T(X)$ is independent of θ
   b) $T(X)$ is independent of θ
   c) $T(X)$ is dependent of θ
   d) The distribution of $T(X)$ is depends on θ

6) Let $X_1, X_2, \dots, X_n$ are random variables having joint pdf $f_\theta(x_{1,}x_2, \dots, X_n)$, $\theta \in \Theta$, then Fisher information $I(\theta)$ about θ contained in the observations $\underline{x}$ is given by ______.
   a) $E_\theta\left(\frac{\partial^2 \log_e f_\theta(\underline{x})}{\partial\theta^2}\right)$ b) $E_\theta\left(-\frac{\partial^2 \log_e f_\theta(\underline{x})}{\partial\theta^2}\right)^2$
   c) $E_\theta\left(\frac{\partial \log_e f_\theta(\underline{x})}{\partial\theta}\right)^2$ d) None of the above

7) Prior distribution is the ______.
   a) distribution of parameter θ
   b) distribution of sample X
   c) conditional distribution of X given θ
   d) conditional distribution of θ given X

8) Bayes estimator of a parameter under absolute error loss function is ____.
   a) posterior mean b) posterior median
   c) posterior mode d) posterior variance

9) If T_1 is sufficient statistic for θ and T_2 is an unbiased estimator of θ, then an improved estimator of θ in terms of its efficiency is ______.
   a) $E(T_1T_2)$ b) $E(T_1+T_2)$
   c) $E(T_1/T_2)$ d) $E(T_2/T_1)$

10) Regularity conditions of Cramer-Rao inequality are related to ______.
   a) integrability of functions
   b) differentiability of functions
   c) both integrability and differentiability of functions
   d) neither integrability nor differentiability of functions

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

1) Let X_1, X_2 is a random sample from Poisson (λ) distribution. Moment estimator of λ is ______.
2) Let X_1, X_2 be a random sample from $U(0,\theta), \theta > 0$. MLE of θ is _____.
3) Cramer-Rao inequality with regards to the variance of an unbiased estimator provides ______ bound.
4) Suppose T_n sufficient for θ.Then $g(T_n)$ is sufficient for $g(\theta)$ if $g(.)$ is _____ function.
5) The MLE of parameter θ is a statistic that _____ the likelihood function L.
6) Bhattacharya bound is the generalization of the _____.

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

a) Define power series distribution. Give an example of the same.
b) State Basu's theorem. Illustrate the applicability of Basu's theorem with example.
c) Let random variable X has $B(n,\theta)$ distribution. Show that distribution of X is complete.
d) Define MLE. Show that an MLE, if exists, is a function of sufficient statistic.

Q.3 Answer the following.

a) Define one parameter exponential family of distributions. Obtain a minimal sufficient statistic for this family. **08**
b) Using the definition of sufficient statistic, examine whether $X_1 + X_2$ is sufficient for Poisson parameter λ based on random sample X_1, X_2 on Poisson distribution. **08**

Q.4 Answer the following.

a) Describe method of moments and method of minimum chi-square. **08**
b) Let $X_1, X_2, \ldots, X_n$ be iid $U(0,\theta), \theta > 0$. **08**
Find
1) Moment estimator θ
2) MLE of θ.

Q.5 Answer the following.

a) Obtain Bhattacharya bound under regularity conditions to be stated. Obtain C-R lower bound as a special case of Bhattacharya bound. **08**
b) Let $X_1, X_2, \ldots, X_n$ be iid Poisson (λ) random variables. Show that regularity conditions are satisfied. Obtain the C-R lower bound for variance of unbiased estimator of λ. **08**

Q.6 Answer the following.

a) State and prove Rao Blackwell and Lehmann-Scheffe theorems. **08**

b) Use Rao-Blackwell theorem to derive $UMVUE$ of $P(X_1 = 0)$ based on sample $X_1, X_2, \dots, X_n$ from Poisson $(\lambda), \lambda > 0$ distribution. **08**

Q.7 Answer the following.

a) Define prior and posterior distributions. Illustrate with one example for each of them. **08**

b) Let $X_1, X_2, \dots, X_n$ is a random sample from $B(1, \theta)$ distribution and prior density of θ is $B_1(\alpha, \beta)$. Assuming squared error loss function, find the Bayes estimator of θ. **08**

SLR-ER-11

Seat No.	

Set P

M.Sc. (Semester - I) (Old) (CBCS) Examination: Oct/Nov-2023
STATISTICS
Statistical Computing (MSC16108)

Day & Date: Friday, 29-12-2023 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 the correct alternative: **10**

1) _____ introduced the Jackknife method.
   a) Newton-Raphson b) Quenouille
   c) Fisher d) Efron

2) In bootstrap resampling _____ method is used.
   a) SRSWR b) SRSWOR
   c) Stratified d) Systematic

3) When applying Simpson's 3/8th rule the number of sub-intervals should be _____.
   a) odd b) even
   c) at least 6 d) multiple of 3

4) Let $X \sim U(0,1)$ then the cumulative distribution function $F_x(X)$ has _____.
   a) Gamma b) $U(2,3)$
   c) $U(3,2)$ d) $U(0,1)$

5) In EM algorithm 'M' stands for _____.
   a) Minimax b) Multivariate
   c) Maximization d) Multinomial

6) The two point Gauss - Legendre quadrature formula is _____.
   a) $$\int_{-1}^{1} f(x)dx \cong f\left(\frac{-1}{\sqrt{3}}\right) + f\left(\frac{1}{\sqrt{3}}\right) + E(I)$$
   b) $$\int_{-1}^{1} f(x)dx \cong f\left(\frac{-1}{\sqrt{3}}\right) - f\left(\frac{1}{\sqrt{3}}\right) + E(I)$$
   c) $$\int_{-1}^{1} f(x)dx \cong f\left(\frac{-1}{\sqrt{3}}\right) + f(0) + f\left(\frac{1}{\sqrt{3}}\right) + E(I)$$
   d) $$\int_{-1}^{1} f(x)dx \cong \frac{\pi}{2} f\left(\frac{-1}{\sqrt{2}}\right) + \frac{\pi}{2} f\left(\frac{1}{\sqrt{2}}\right) + E(I)$$

7) EM is used to obtain _____ estimator.
   a) Maximum Likelihood b) Unbiased
   c) Moment d) None of these

8) The steepest ascent method is used to find _____ of the given function.
   a) minimum b) maximum
   c) nominal level d) mean

9) For $f(x) = -x^2$ with $x_0 = 3$ and $\alpha = 0.5$, the maximum value of the given function using steepest ascent method is _____.
   a) 1 b) 3
   c) 0 d) -3

10) Latent variable is defined as _____.
   a) a variable which is not directly observed
   b) quantitative variable
   c) qualitative variable
   d) None of these

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

1) In Bootstrap resampling technique, from original sample of size n, we get _____ resample.
2) In EM algorithm 'E' stands for _____.
3) If $U_i \sim U(0,1)$ then, $Z = \sum_{i=1}^{12} U_i - 6$ Follows _____ distribution.
4) To generate single random number from bivariate exponential, it requires _____ independent exponential random numbers.
5) Acceptance - Rejection method used to _____.
6) Bootstrap is a _____ technique.

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

a) Describe Monte Carlo integration technique.
b) Describe the Newton - Raphson method of finding the correct root.
c) State advantages and disadvantages of bootstrap technique.
d) What do you mean by gradient search method? Define its types.

Q.3 Answer the following.

a) Explain theory of importance sampling with application to reduce Monte Carlo error. **08**
b) What is acceptance rejection $(A - R)$ method of random number generation? Derive an algorithm for generating random numbers from $N(\mu, \sigma^2)$. **08**

Q.4 Answer the following.

a) Describe linear congruential method of random number generation. Illustrate with example. **08**
b) State and prove the result for generating random numbers from Poisson distribution. **08**

Q.5 Answer the following.

a) Let $X_1, X_2, \dots X_n$ be a random sample of size n from the displaced exponential with pdf $e^{-(x-\theta)} I_{[\theta,\infty]}(x)$ then show that, the jackknife estimator is unbiased estimator of θ. **08**
b) Explain bootstrap technique as bias reduction technique. **08**

Q.6 Answer the following.

a) What is EM algorithm? When we use EM algorithm? Illustrate with example. **08**

b) What is convolution of statistical distribution? State and prove the result of convolution for Poisson distribution. **08**

Q.7 Answer the following.

a) State and prove the result for generating random numbers from discrete uniform distribution. **08**

b) Let $X \sim U(0,1)$ and $Y \sim U(0,1)$. Define $Z = X + Y$, obtain the distribution of Z using convolution theorem. **08**

Seat No.	

Set P

M.Sc. (Semester - II) (New) (CBCS) Examination: Oct/Nov-2023
STATISTICS
Probability Theory (MSC16201)

Day & Date: Monday, 18-12-2023 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) If for a r.v. $X, X(\omega) = c$, a constant for all ω, then r.v. X is called _____.
   a) Good r.v. b) Conjugate r.v.
   c) Degenerate r.v. d) Concave r.v.

2) The largest field of subsets of Ω is called as _____.
   a) power set b) Universal set
   c) sample class d) none of these

3) If P is a probability measure defined on $(\Omega, \mathbb{A})$, then $P(\varphi) =$ _____
   (φ is empty set)
   a) Zero b) One
   c) 0.5 d) 0.3325

4) Lebesgue measure of a singleton set {k} is _____.
   a) 0 b) 1
   c) k d) None of these

5) A class is a collection of _____.
   a) Numbers b) Alphabets
   c) Sets d) none of these

6) The σ- field generated by the intervals of the type $(-\infty, x), x \in R$ is called _____.
   a) Standard σ - field b) Borel σ - field
   c) Closed σ - field d) None of these

7) If a random variable X is integrable, then _____.
   a) X^+ is integrable b) X^- is integrable
   c) $|X|$ is integrable d) all of these

8) If X and Y are independent variables, then $E(X+Y)$ = _____.
   a) $E(X).E(Y)$ b) $E(X)+E(Y)$
   c) $E(X)-E(Y)$ d) $E(X)/E(Y)$

9) The limit of suprema sequence is called as _____.
   a) Limit inferior b) Limit superior
   c) Limit d) None of these

10) If a r.v. X is symmetric about zero, then the characteristic function $\varphi_x(t)$ of X is _____.
   a) Real b) doesn't exist
   c) Complex d) None of these

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

1) A well-defined collection of sets is called as _____.
2) If A is empty set, then $P(A) =$ _____.
3) If Ω contains 3 elements, then the largest field of subsets of Ω contains _____ sets.
4) A non-empty class contains at least _____ sets.
5) If for events A and $B, A \cup B = \Omega$ then these events are called as _____.
6) If P is a probability measure defined on $(\Omega, \mathcal{A})$, then $P(\Omega) =$ _____.

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

a) Prove that inverse mapping preserves all set relations.
b) Define conditional probability measure. Show that it is also a probability measure.
c) Prove or disprove: Arbitrary union of fields is a field.
d) Define mixture of two probability measures. Show that mixture is also a probability measure.

Q.3 Answer the following.

a) Prove that collection of sets whose inverse images belong to a σ - field, is a also a σ - field. **08**
b) Define field and σ - field. Show that there exist classes which are field but not σ - field. **08**

Q.4 Answer the following.

a) Define expectation of simple random variable. If X and Y are simple random variables, prove the following: **08**
- i) $E(X+Y) = E(X) + E(Y)$
- ii) $E(cX) = c\,E(X)$, where c is a real number.
- iii) If $X > 0$ a.s., then $E(X) > 0$.

b) Discuss Borel σ - field. Find the Borel sets. **08**

Q.5 Answer the following.

a) Show that Probability measure is a continuous measure. **08**
b) Define convergence in probability and convergence in distribution. Also prove that convergence in probability implies convergence in distribution. **08**

Q.6 Answer the following.

a) Define the characteristic function of a random variable. Also state its inversion theorem and uniqueness property. **08**
b) Prove that expectation of a random variable X exists, if and only if $E|X|$ exists. **08**

Q.7 Answer the following.

a) Find the characteristic function for binomial distribution. **08**
b) State and prove Yule-Slutsky results. **08**

SLR-ER-14

Seat No.	

Set P

M.Sc. (Semester - II) (New) (CBCS) Examination: Oct/Nov-2023
STATISTICS
Stochastic Processes (MSC16202)

Day & Date: Tuesday, 19-12-2023 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 options. **10**

1) If i and j are communicating states, and state i is persistent, then
   a) State j is also persistent
   b) State j is transient
   c) State j is may or may not be persistent
   d) None of these

2) If period of a state is one, then the state is called as _____.
   a) Uniperiodic b) Aperiodic
   c) Periodic d) None of these

3) If $\{N(t)\}$ is a counting process, then $N(0) =$ _____.
   a) 0 b) 1
   c) 10 d) 2.71

4) If $\{N(t)\}$ is a Poisson process with parameter λ, then $E\big(N(t)\big) =$ _____.
   a) λ b) λt
   c) t d) λ^2

5) The process $\{X(t), t > 0\}$, where $X(t) =$ number of particles in a room at time t, is an example of _____ stochastic process.
   a) discrete time continuous state space
   b) discrete time discrete state space
   c) continuous time continuous state space
   d) continuous time discrete state space

6) For a persistent state 'i' the ultimate first return probability $F_{ii} =$ _____.
   a) 1 b) 0
   c) 0.5 d) 0.33

7) In a Branching process if $E(X_1) = m$, then $E(X_n) =$ _____.
   a) N b) m^n
   c) n^m d) None of these

8) Which of the following are class properties?
   a) Persistency b) Periodicity
   c) Transientness d) all of these

9) The row sum of every row of a transition probability matrix (TPM) is always _____.
   a) Two b) Zero
   c) Non-negative d) One

10) A finite Markov chain which contains only one communication class is called as _____.
    a) irreducible Markov chain b) reducible Markov chain
    c) finite Markov chain d) None of these

B) Fill in the blanks **06**

1) Recurrent state is also called as _____.
2) For non-null recurrent state, the mean recurrent time is _____.
3) For a TPM of a reducible Markov chain, the row sum is _____.
4) If two states are communicating with each other and one of them is transient, then the other one must be _____.
5) For a symmetric random walk, probability ‘p’ of positive jump is _____.
6) The probability of ultimate return for a transient state is _____.

Q.2 Answer the following **16**

a) Define and illustrate Markov chain.
b) Give classification of Stochastic processes according to state space and time domain.
c) Write a short note on Mean recurrent time of a state.
d) Discuss probability of first return for a state.

Q.3 Answer the following

a) Explain Gamblers ruin problem. Obtain the probability that starting with i units the Gamblers fortune will reach N before reaching zero. **08**
b) Verify the states of random walk model for persistency as well as for periodicity **08**

Q.4 Answer the following

a) Prove that, Markov chain is completely specified by one step t.p.m. and initial distribution **08**
b) Describe gambler’s game. If a gambler starts the game with initial amount ‘i’, find his winning probability. **08**

Q.5 Answer the following

a) Define stationary distribution of a Markov chain. Find the same for a Markov chain with state space {1,2,3}, whose tpm is **08**

$$\begin{bmatrix} \frac{1}{2} & \frac{1}{2} & 0 \\ \frac{1}{3} & \frac{1}{3} & \frac{1}{3} \\ \frac{2}{5} & \frac{1}{5} & \frac{2}{5} \end{bmatrix}$$

b) A Markov chain with state space $S = \{1,2,3\}$ has tpm $\begin{bmatrix} 0.2 & 0.4 & 0.4 \\ 0.3 & 0.4 & 0.3 \\ 0.1 & 0.8 & 0.1 \end{bmatrix}$ **08**

It is known that the process has started with the state $X_0 = 2$

i) $P(X_1 = 2)$
ii) $P(X_2 = 3)$
iii) $P(X_0 = 1)$
iv) $P(X_3 = 2/X_1 = 1)$

Q.6 Answer the following

a) State and prove class property of periodicity. **08**

b) If $\{N(t)\}$ is a Poisson process, then for $s < t$, obtain the distribution of $N(s)$, if it is already known that $N(t) = k$. **08**

Q.7 Answer the following

a) Define pure birth process and obtain its probability distribution. **08**

b) Discuss stationary distribution of a Markov chain. Also give illustration. **08**

Seat No.	

Set P

M.Sc. (Semester - II) (New) (CBCS) Examination: Oct/Nov-2023
STATISTICS
Theory of Testing of Hypotheses (MSC16203)

Day & Date: Wednesday, 20-12-2023 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) Which of the following is a simple hypothesis for $N(\mu, \sigma^2)$?
   a) $H_0: \mu = 5, \sigma = 2$ b) $H_0: \mu = 10$
   c) $H_0: \mu = 0, \sigma > 1$ d) $H_0: \mu \neq 3, \sigma = 1$

2) Let $f_\theta, \theta \in \Theta = \{\theta_0, \theta_1\}$. Then MP test is based on _____.
   a) $H_0: \theta \leq \theta_0$ against $H_1: \theta > \theta$
   b) $H_0: \theta_0 < \theta < \theta_1$ against $H_1: \theta \leq \theta_0$ or $\theta > \theta_1$
   c) $H_0: \theta = \theta_0$ against $H_1: \theta = \theta_1$
   d) $H_0: \theta \leq \theta_0$ or $\theta > \theta_1$ against $H_1: \theta_0 < \theta < \theta_1$

3) An UMP test _____.
   a) is biased test b) is an unbiased test
   c) always exist d) none of these

4) Let $X_1, X_2, \ldots, X_n$ are iid with $N(\theta, 1)$. Let $H_0: \theta = \theta_0$ and $H_1: \theta \neq \theta_0$. For any $\alpha, 0 < \alpha < 1$, _____.
   a) there does not exist a UMP level α test.
   b) there exists a UMP level α test.
   c) there exists a test with one sided.
   d) none of these.

5) If λ is the likelihood ratio test statistic, which one of the following has got its asymptotic distribution as χ^2 distribution?
   a) $\log_e(\lambda)$ b) $\log_e(1/\lambda)$
   c) $\log_e(\lambda^2)$ d) $\log_e(1/\lambda^2)$

6) If, for a given $\alpha, 0 \leq \alpha \leq 1$, non-randomized Neyman-Pearson and likelihood ratio test of a simple hypothesis against a simple alternative exists, then which one of the following is correct?
   a) They are one and the same
   b) They are equivalent
   c) They are exactly opposite
   d) One cannot say anything about it.

7) The expected value of the runs in the sequence $XYY\ XY\ X\ X$ is_____.
   a) 3.1 b) 4
   c) 4.4 d) 5.2

8) In Kruskal-Wallis test of k samples, the appropriate degrees of freedom are _____.
   a) k b) $k-1$
   c) $k+1$ d) $n-k$

9) If n_1 and n_1 in Mann-Whitney test are large, the statistic U is distributed with mean_____.
   a) $(n_1 + n_2)/2$ b) $(n_1 - n_2)/2$
   c) $n_1 n_2/2$ d) $n_1 n_2$

10) If $\phi_1(x)$ and $\phi_2(x)$ are two test functions of size α each then size of $\lambda\phi_1(x) + (1-\lambda)\phi_2(x)$ is _____.
   a) α b) $\lambda\alpha$
   c) 1 d) Not defined

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

1) Level of significance is the probability of_____ type of error.
2) The distribution of statistic used in sign test is_____.
3) The non-parametric test for goodness of fit of a distribution is_____.
4) If all frequencies of classes are same, the value of Chi-square is_____.
5) The range of Kendall's rank correlation τ is _____ $(-1$ to $1)$
6) UMAU confidence intervals are obtained from _____ tests.

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

a) Define monotone likelihood ratio (MLR) property.
b) Distinguish between randomized and non-randomized tests.
c) Describe signed-rank test in brief.
d) State two sample U statistic theorem.

Q.3 Answer the following

a) Define most powerful (MP) test. Show that MP test need not be unique using suitable example. **08**
b) Obtain MP test of level α for testing $H_0: \mu = \mu_0$ against $H_1: \mu = \mu_1 (> \mu_0)$ based on a random sample of size n from $N(\mu, \sigma^2)$, where σ^2 is known. **08**

Q.4 Answer the following

a) When a family of densities is said to have monotone likelihood ratio? Show that the one-parameter exponential family of densities belongs to this class of MLR densities. **08**
b) Let $X_1, X_2, \ldots X_n$ be a random sample from $N(\theta, \sigma^2)$,where θ is known. Obtain UMP level α test for testing $H_0: \sigma^2 = \sigma_0^2$ against $H_1: \sigma^2 > \sigma_0^2$ **08**

Q.5 Answer the following

a) Explain the concepts of UMPU tests and show that MP and UMP tests of size α are unbiased. **08**
b) Let $X_1, X_2, \ldots, X_n$ be a random sample of size n from $U(0, \theta)$ distribution. Obtain shortest length confidence interval for θ. **08**

Q.6 Answer the following.

a) Define confidence set and UMA confidence set of level $(1-\alpha)$. Derive the relationship between UMA confidence set and UMP test. **08**
b) Let $X_1, X_2, \ldots, X_n$ be a random sample from exponential distribution with mean θ. Consider the testing of hypothesis problem $H_0: \theta = \theta_0$ against $H_1: \theta < \theta_0$. Find UMA $(1-\alpha)$ level family of confidence sets corresponding to size α UMP test. **08**

Q.7 Answer the following.

a) Slate and prove a necessary and sufficient condition for a similar test to have Neyman structure. **08**

b) Derive LRT for testing $H_0: \mu = \mu_0$ against $H_1: \mu \neq \mu_0$ based on a sample of size n from $N(\mu, 1)$ distribution. **08**

SLR-ER-16

Seat No.	

Set P

M.Sc. (Semester - II) (New) (CBCS) Examination: Oct/Nov-2023
STATISTICS
Sampling Theory (MSC16206)

Day & Date: Thursday, 21-12-2023 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) Selection of Indian cricket team for the world cup is _____ sampling.
   a) random b) systematic
   c) purposive d) cluster

2) In linear systematic sampling of 20 units from a population of 200 units, the probability that units U_{21} and U_{22} are both in a sample is _____.
   a) 0 b) $1/10$
   c) $1/20$ d) $1/400$

3) Systematic sampling means _____.
   a) selecting n continuous units
   b) selecting n units situated at equal intervals
   c) selection of n largest units
   d) selection of any n units

4) In sampling with probability proportional to size, the units are selected with probability proportional to _____.
   a) size of the unit b) size of the sample
   c) size of the population d) None of these

5) In simple random sampling the ratio estimator is _____.
   a) always unbiased
   b) always biased
   c) minimum variance unbiased
   d) None of these

6) A population is divided into clusters and it has been found that all the units within a cluster are same. In this situation, which sampling will be adopted?
   a) SRSWOR
   b) Systematic sampling
   c) Cluster sampling
   d) Stratified random sampling

7) Sampling error can be reduced by _____.
   a) increasing the population
   b) decreasing the sample size
   c) increasing the sample size
   d) None of the above

8) Deming's technique is used to deal with _____.
   a) sampling errors b) non-response errors
   c) non-sampling errors d) None of the above

9) Simple regression estimator of population total is given by ______.
   a) $N[\bar{x} + b(\bar{X} - \bar{y})]$ b) $N[\bar{x} + b(\bar{x} - \bar{y})]$
   c) $N[\bar{y} + b(\bar{X} - \bar{x})]$ d) $N[\bar{y} + b(\bar{x} - \bar{y})J$

10) Non-response in survey means _____.
   a) non availability of respondent
   b) non return of questionnaire by person
   c) refuse to give information by respondent
   d) All the above

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

1) The probability of drawing a unit at each subsequent draw remains same in _____ sampling scheme.
2) In the context of sampling the fraction n/N is called _____.
3) Variance of optimum allocation is always ___ that of proportional allocation.
4) Two stage sampling design is more efficient than single stage sampling if correlation between units in the first stage is _____.
5) Under SRSWOR sampling design, the bias of regression estimator of population mean $\bar{Y}_{Reg}$ is given by _____.
6) If 100 students are selected out of 500, and 25 students are then selected from the selected 100 students. The procedure adopted is _____.

Q.2 Answer the following **16**

a) Give advantages of sampling method over census method.
b) Define ratio estimator of population mean and obtain its expected value.
c) Describe the Lahiri's method of selecting a probability proportional to size sample from a finite population of size N.
d) What is two stage sampling? Give a practical example where two-stage sampling scheme may be adopted.

Q.3 Answer the following.

a) Describe simple random sampling. In SRSWOR, show that the probability of drawing a specified unit at every draw is the same. **08**
b) In SRSWOR, derive an unbiased estimator of a population mean and its sampling variance. **08**

Q.4 Answer the following.

a) What is proportional allocation? Derive the variance of the estimator of the population mean under this allocation. **08**
b) Define linear systematic sampling. Derive the sampling variance of the traditional unbiased estimator of a population mean under this scheme. **08**

Q.5 Answer the following.

a) Define a cluster sampling. Bring out similarities and differences between cluster sampling and stratified sampling. **08**
b) Define PPSWR sampling design. Obtain an unbiased estimator of population total and its variance when PPSWR sample of size n is drawn from a population of size N. **08**

Q.6 Answer the following.

a) Define Horvitz-Thompson estimator of population mean and establish its unbiasedness under an arbitrary sampling design. Also derive its sampling variance. **08**

b) Develop Des Raj's ordered estimator of population mean based sample size 2. Show that it is unbiased. **08**

Q.7 Answer the following.

a) Define linear regression estimator for a population mean. Derive the approximate expression for bias of the estimator. **08**

b) Explain the problem of non-response and any one technique to deal with the non-response. **08**

Seat No.	

Set P

M.Sc. (Semester - III) (New) (CBCS) Examination: Oct/Nov-2023
STATISTICS
Asymptotic Inference (MSC16301)

Day & Date: Friday, 05-01-2024 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) If T_n is consistent of θ then _____
   a) T_n is consistent of θ^2 b) T_n is consistent of $\sqrt{\theta}$
   c) T_n is consistent of e^θ d) None of these

2) Consider the following statements:
   1) Strong consistency implies weak consistency.
   2) Weak consistency implies strong consistency.
   Which of the above statements is / are true?
   a) only 1 b) only 2
   c) both 1 and 2 d) neither 1 nor 2

3) Let T_n be an unbiased and consistent estimator of θ then T_n^2 for θ^2 is _____.
   a) unbiased and consistent both
   b) unbiased only
   c) consistent only
   d) neither unbiased nor consistent

4) Which one of the following is true for estimation of θ for $U(0, \theta)$ distribution by the MLE ______
   a) unbiased but not consistent
   b) consistent but not unbiased
   c) both consistent and unbiased
   d) neither consistent nor unbiased

5) Based on sample of size *n* from $N(\theta, 1)$ an estimator $\bar{X}_n$ for θ is _____.
   a) Unbiased b) Consistent
   c) CAN d) all the above

6) Exponential distribution with location parameter θ is _____.
   a) one parameter exponential family
   b) Cramer family
   c) both (A) and (B)
   d) neither (A) nor (B)

7) For sufficiently large sample size, with probability close to one, the likelihood equation admits _____.
   a) no consistent solution
   b) unique consistent solution
   c) two consistent solutions
   d) more than two consistent solutions

8) Let $X_1, X_2, \dots, X_n$ be iid from Poisson (θ) and $\bar{X}_n$ is CAN for θ. CAN estimator of $P_\theta(X = 1)$ is _____.

a) $\bar{X}_n$ b) $e^{-\bar{X}_n}$
c) $\bar{X}_n e^{-\bar{X}_n}$ d) none of these

9) In LRT, under some regularity conditions on $f\ (x, \theta)$, the random variable $-2 \log \lambda\ (x)$ [where $\lambda(x)$ is likelihood ratio] is asymptotically distributed as _____.

a) chi-square b) exponential
c) Normal d) F-distribution

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) Fill in the blanks. **06**

1) For Cauchy distribution with location parameterθ, consistent estimator of θ is _____.
2) The asymptotic distribution of Wald's statistic is _____.
3) In testing independence in a 2×3 contingency table, the number of degrees of freedom in χ^2 distribution is _____.
4) The variance stabilizing transformation for normal population is _____.
5) Exponential family is _____ than Cramer family.
6) To investigate the significance difference between variances of several normally distributed populations _____ test is used.

Q.2 Answer the following **16**

a) Define
 i) Weak consistency
 ii) Strong consistency

b) Give an example of consistent estimator which is not CAN.

c) Describe Rao's score test. State its asymptotic distributions

d) Let $X_1, X_2, \dots, X_n$ be *iid* Poisson (λ). Show that sample mean $\bar{X}_n$ is consistent for λ.

Q.3 Answer the following

a) Define consistent estimator. State and prove invariance property of consistent estimator of a real valued parameter θ **08**

b) Let $X_1, X_2, \dots, X_n$ be *iid* from exponential distribution with mean θ. Obtain consistent estimator for first and third quartiles. **08**

Q.4 Answer the following

a) Show that sample distribution function at a given point is CAN for the population distribution function at the same point. **08**

b) Let $X_1, X_2, \dots, X_n$ be *iid* exponential with location θ. Examine whether $X_{(1)}$ is CAN for θ **08**

Q.5 Answer the following

a) Derive asymptotic distribution of Pearson's chi-square statistic. **08**

b) Let $X_1, X_2, \dots, X_n$ be a random sample of size n from $N\ (\mu, \sigma^2)$. Obtain MLE of (μ,σ^2). Show that it is CAN. Obtain its asymptotic variance-covariance matrix. **08**

Q.6 Answer the following

a) Explain variance stabilizing transformations and illustrate their use in large sample estimation and tests. **08**

b) Based on random sample of size n from $N\ (\theta,\ \sigma^2)$, find variance stabilizing transformation for S^2. Using this transformation, obtain $100(1-\alpha)\%$ confidence interval for σ^2. **08**

Q.7 Answer the following

a) Derive Bartlett's test for homogeneity of variances of several normal populations **08**

b) Let $X_1, X_2, \dots, X_n$ be $iid\ B(1,\theta)$. Let $\phi(\theta) = \theta(1-\theta)$. Obtain CAN estimator for $\phi(\theta)$. **08**

Seat No.	

Set P

M.Sc. (Semester - III) (New) (CBCS) Examination: Oct/Nov-2023
STATISTICS
Multivariate Analysis (MSC16302)

Day & Date: Sunday, 07-01-2024 Max. Marks: 80
Time: 11:00 AM To 02:00 PM

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

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

1) A Wishart distribution has _____ parameter/s.
   a) 1 b) 2
   c) 3 d) 4

2) Hotelling's T^2 is multivariate extension of_____.
   a) normal distribution b) chi-square distribution
   c) t-distribution d) F-distribution

3) The first principal component have _____ variance.
   a) Least b) Largest
   c) Average d) none of these

4) A divisive hierarchical clustering method employs a _____ strategy.
   a) Top-down b) Bottom-up
   c) Random d) None of these

5) Let $X_1, X_2, \ldots, X_n$ be a random sample of size n from p-variate normal distribution with mean vector 0 and covariance matrix Σ. The MLE of Σ is _____.
   a) $\frac{1}{n}\sum_{i=1}^{n}(X_i-\bar{X})(X_i-\bar{X})'$ b) $\frac{1}{n-1}\sum_{i=1}^{n}(X_i-\bar{X})(X_i-\bar{X})'$
   c) $\frac{1}{n}\sum_{i=1}^{n}X_iX_i'$ d) $\sum_{i=1}^{n}X_iX_i'$

6) Principal components are _____.
   a) orthogonal
   b) uncorrelated
   c) both (a) and (b)
   d) neither (a) nor (b).

7) Let random vector $X = (X_1, X_2, X_3)'$ follows $N_3(\mu, \Sigma)$, where $\mu' = [1,2,3]$ and $\Sigma = \begin{bmatrix} 1 & 1/2 & 0 \\ 1/2 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ then $X_1 - X_2 + X_3$ follows _____ distribution.
   a) $N(2, 5/2)$ b) $N(0,2)$
   c) $N(2,2)$ d) $N(2,3)$

8) As the distance between two populations increases, misclassification error_____.
   a) Decreases b) Increases
   c) remains constant d) none of these

9) Let X be a random vector with covariance matrix Σ. A decrease in variances of p variables in X will lead to _____.
   a) increase trace(Σ)
   b) decrease trace(Σ)
   c) does not affect trace(Σ)
   d) nothing can be said

10) Total variation explained by all principal components is _____ that by the original variables.
   a) equal to b) greater than
   c) less than d) none of these

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

1) Let $X_1, X_2, \ldots, X_n$ be a random sample of size n from p-variate normal distribution with mean vector μ and covariance matrix Σ. The distribution of mean vector $\bar{X}$ is
2) The mean vector of $(X_1 + X_2, X_1 - X_2)$ is $(10,0)$ then mean vector of $(X_1, 2X_1 - X_2)$ is _____.
3) While applying _____ clustering algorithm, the distance between two clusters is taken to be the smallest distance between observations from two clusters.
4) A _____ is a graphical device for displaying clustering results.
5) If X has $N_p(\mu, \Sigma)$ distribution then moment generating function of vector X is_____.
6) Let vector Y has $N_p(\mu, \Sigma)$ distribution. For a constant matrix $A_{q\times p}$ and vector $b_{q\times 1}$ the distribution of $X = AY + b$ is _____.

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

a) Describe singular and non-singular normal distribution.
b) Find maximum likelihood estimator for $\underline{\mu}$ based on a random sample from multivariate normal distribution $N_P(\underline{\mu}, \Sigma)$.
c) Show that two p-variate normal vectors $\underline{X_1}$ and $\underline{X_2}$ are independent if and only if $cov(\underline{X_1}, \underline{X_2}) = 0$.
d) Define variance-covariance matrix. State its properties.

Q.3 Answer the following.

a) With usual notations, find the mean and variance-covariance matrix of multivariate normal distribution. **08**
b) Obtain the characteristic function of multivariate normal distribution. **08**

Q.4 Answer the following.

a) Discuss the concept of discriminant analysis in detail. **08**
b) Find maximum likelihood estimator of Σ based on a random sample from multivariate normal distribution $N_p(\mu, \Sigma)$. **08**

Q.5 Answer the following.

a) Discuss hierarchical and non-hierarchical clustering. Discuss agglomerative clustering in detail. **08**
b) Explain the concept of clustering in brief. Discuss k-means clustering. **08**

Q.6 Answer the following.

a) Describe- **08**

1) Single linkage
2) Complete linkage

Illustrate with the help of an example.

b) Derive expressions for principle components. Show that total variation explained by principal components is same as total variation in original variables. **08**

Q.7 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 $m \times p$

b) Obtain Fisher's discriminant function for two populations. **08**

SLR-ER-20

Seat No.	

Set P

M.Sc. (Semester - III) (New) (CBCS) Examination: Oct/Nov-2023
STATISTICS
Planning and Analysis of Industrial Experiments (MSC16303)

Day & Date: Tuesday, 09-01-2024 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) Choose the correct alternative. **10**

1) In two replications of 2^4 experiment total number of observations are ____.
   a) 32 b) 16
   c) 64 d) 31

2) In one-fourth fraction of 2^7 experiment with defining relation $I = ABCD = CDEFG$. The aliases of AB are _____.
   a) $CD, ABCDEFG, EFG$ b) $AB, CDEFG, CD$
   c) $CD, ABCDEFG, CDEFG$ d) $ACDEFG, ABEFG, ABCD$

3) A connected block design is _____ orthogonal.
   a) always b) never
   c) may or may not d) none of these

4) When the interaction effect ABC is confounded in 23 factorial design:
   a) the block effect and main effect A are identical
   b) the block effect and interaction AB are identical
   c) the block effect and interaction ABC are identical
   d) the block effect and interaction AC are identical

5) In a BIBD (v, b, r, k, λ), which is not a parametric relationship?
   a) $rv = bk$ b) $N'N = (r - \lambda)I_v + \lambda E_{vv}$
   c) $r(k-1) = \lambda(v-1)$ d) $b \geq v$

6) In principle block of a 2^4 experiment in two blocks with $ABCD$ as generator which of the following treatment is present?
   a) $(1), abcd, abc, abd, bcd, acd, bc, cd$
   b) $(1), ab, ac, ad, bc, bd, cd, abcd$
   c) $a, b, c, d, abc, abd, bcd, acd$
   d) $ab, ac, ad, bc, bd, cd, abc, abd$

7) The two-way ANOVA model without interaction can be written as _____.
   a) $Y_{ij} = \mu + \alpha_i + \beta_j + \epsilon_{ijk}$ $i = 1,2, \dots v; j = 1,2, \dots b$
   b) $Y_{ij} = \alpha_i \times \beta_i + \epsilon_{ijk}$ $i = 1,2, \dots v; j = 1,2, \dots b$
   c) $Y_{ij} = \mu - \alpha_i + \beta_j + \epsilon_{ijk}$ $i = 1,2, \dots v; j = 1,2, \dots b$
   d) $Y_{ij} = \mu + \alpha_i - \beta_j + \epsilon_{ijk}$ $i = 1,2, \dots v; j = 1,2, \dots b$

8) In a BIBD, if number of treatments is equal to the number of plots in a block, then BIBD is _____.
   a) reduces to CRD b) reduces to RBD
   c) reduces to LSD d) none of these

9) In one-way ANOVA model with v treatments, which of the following is not assumption of errors?
   a) errors are uncorrelated
   b) errors have constant variance
   c) errors have mean zero
   d) errors have binomial distribution

10) Smaller the experimental error _____ efficient the design.
   a) Less
   b) more
   c) equally
   d) none of these

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

1) In partial confounding ____ effects are confounded in ____ replications.
2) In a RBD with 5 blocks and 4 treatments, number of plots in each block is _____.
3) ANOVA is statistical method of comparing _____ of several populations.
4) A design in which main effects are confounded with 2-way interactions is Resolution _____ design.
5) The rank of estimation space in one-way ANOVA with v treatment is ____.
6) The degrees of freedom corresponding to error in four replicate of 2^4 design are _____.

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

a) Define one-way classification model. Derive least square estimates of parameters in one-way classification model.
b) Write a short note on effects in factorial experiments.
c) Define Total and Partial confounding. Illustrate any one type of confounding.
d) Write lay out of 3^3 factorial experiment in single replicate.

Q.3 Answer the following.

a) Derive the test for testing treatments in one-way classification. **08**
b) Obtain half-fraction of 2^6 experiments. Write its complete alias structure. **08**

Q.4 Answer the following.

a) Define connected block design. State and prove necessary and sufficient condition for orthogonality of a connected block design. **08**
b) Describe analysis of 2^n factorial experiment. **08**

Q.5 Answer the following.

a) Obtain half fraction of 2^5 experiments. Write its consequences. **08**
b) Define resolution of design and minimum aberration design. Illustrate both. **08**

Q.6 Answer the following.

a) Write 2^5 experiments in four blocks. Explain analysis of confounded experiments. **08**
b) Define one-way ANCOVA model. Derive test for testing hypothesis of treatment in one-way ANCOVA. **08**

Q.7 Answer the following.

a) Define **08**
   1) Orthogonal block design
   2) Balanced block design
   3) BIBD
b) State and prove properties of $Q = T - NK^{-\delta}B$. **08**

SLR-ER-21

Seat No.	

Set P

M.Sc. (Semester - III) (New) (CBCS) Examination: Oct/Nov-2023
STATISTICS
Regression Analysis (MSC16306)

Day & Date: Thursday, 11-01-2024 Max. Marks: 80
Time: 11:00 AM To 02:00 PM

Instructions: 1) Question 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) Multiple choice questions. **10**

1) The estimate of β in the regression model $Y = \alpha + \beta X + \varepsilon$ by method of least squares is _____.
   a) biased b) unbiased
   c) inconsistent d) none of these

2) In a multiple linear regression model, the hat matrix is _____.
   a) Symmetric but not idempotent
   b) idempotent but not Symmetric
   c) Symmetric and idempotent
   d) Skew-symmetric but not idempotent

3) In a multiple linear regression model with $\varepsilon \sim N(0, \sigma^2 I)$, the distribution of LSE $\hat{\beta}$ is _____.
   a) $N(\beta, H\sigma^2)$ b) $N(\beta, (I - H)\sigma^2)$
   c) $N(\beta, \sigma^2 I)$ d) $N(\beta, (X'X)^{-1}\sigma^2)$

4) The difference between the observed value Y_i and corresponding fitted value $\hat{Y}_i$ is called _____.
   a) intercept b) error
   c) residual d) none of these

5) Normal probability plots show _____.
   a) residuals plotted versus cumulative probability
   b) residuals plotted versus observation numbers
   c) residuals plotted versus predicted values
   d) Y-values plotted versus X-values

6) The coefficient of determination (R^2) is the square of correlation coefficient between (where Y is response) _____.
   a) Y and hat matrix b) Y and its predicted value
   c) regressors d) none of these

7) The multicollinearity problem in regression concerns the ______.
   a) error terms b) regressors
   c) response variable values d) regression coefficients

8) The variance stabilizing transformation $\sqrt{Y}$ is used when distribution of Y is ______.
   a) Poisson b) Binomial
   c) Normal d) none of these

9) Orthogonal polynomials are used to fit a polynomial model of _____.
   a) first order in one variable b) second order in two variables
   c) any order in one variable d) any order in two variables

10) Logistic regression model is an appropriate model when response variable is distributed as _______.
   a) Poisson b) Binomial
   c) Normal d) Gamma

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

1) In a simple linear regression model, the distribution of error term is assumed to be _____.
2) Cochrane-Orkut method of parameter estimation is used in the presence of ______.
3) The model $y = \beta_0\, x^{\beta_1}$ can be linearized by using _____ transformation.
4) The non-linear model transformed to an equivalent linear form is called _____ linear.
5) The joint points of pieces in polynomial fitting are usually called _____.
6) In a multiple linear regression model with $\varepsilon \sim N(0, \sigma^2 I)$, the variance of residual vector e is _____.

Q.2 Answer the following **16**

a) State assumptions of error vector in multiple regression model.
b) In a multiple linear regression model, show that the hat matrix is symmetric and idempotent.
c) Describe eigen value analysis of matrix X'X method for detection of multicollinearity.
d) Describe polynomial models in one variable and two variables.

Q.3 Answer the following.

a) Describe multiple linear regression model. Stating the assumptions, obtain mean and variance of least squares estimators of β. **08**
b) Discuss confidence interval for regression coefficient and prediction interval for future observation in the context of multiple linear regression. **08**

Q.4 Answer the following.

a) Discuss the concept of multicollinearity with suitable example. Discuss the examination of correlation matrix method for detection of multicollinearity. **08**
b) Describe forward selection method for variable selection and state its limitations. **08**

Q.5 Answer the following.

a) State the autocorrelation problem. Explain Durbin-Watson test for detecting autocorrelation. What are its limitations? **08**
b) Explain the residual plots. Outline the procedure of construction of normal probability plot and procedure for checking normality assumption. **08**

Q.6 Answer the following.

a) Define k^{th} order polynomial regression model in one variable. Describe orthogonal polynomial to fit the polynomial model in one variable. **08**
b) Describe the least squares method for parameter estimation in non-linear regression. Discuss the same for $y = \theta_1 e^{\theta_2 x} + \varepsilon$. **08**

Q.7 Answer the following.

a) Define generalized linear model. Derive the maximum likelihood estimates of the parameters in generalized linear model. **08**

b) Define logistic regression model. Derive the maximum likelihood estimates of parameters involved in the single covariate logistic regression model. **08**

Seat No.	

Set P

M.Sc. (Semester - IV) (New) (CBCS) Examination: Oct/Nov-2023
STATISTICS
Data Mining (MSC16401)

Day & Date: Monday, 18-12-2023 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 the correct alternative. **10**

1) The class label of training tuples is not known and the number or set of classes to be learned is also not known in advance. Then it is known as:
a) Self learning b) Unsupervised learning
c) Supervised learning d) None of these

2) _____ maps data into predefined groups.
a) Regression b) Time series analysis
c) Prediction d) Classification

3) An agglomerative hierarchical clustering method uses a _____ strategy.
a) Top-down b) Bottom-up
c) Random d) None of these

4) In k-nearest neighbor algorithm, k stands for _____.
a) Number of neighbors that are investigated
b) Number of Iterations
c) Number of total records
d) Random number

5) In data mining, ANN stands for _____.
a) Artificial Neural Network
b) A-nearest neighbor
c) Adjacent Neural Network
d) None of these

6) Data used to verify performance of the built model is called _____.
a) training data b) trained data
c) testing data d) pre-analysis data

7) k-nearest neighbor method can be used _____.
a) only when class labels are qualitative
b) only when class labels are quantitative
c) Both (a) and (b)
d) None of these

8) Unlike in regression problem, the class label in classification problem is _____.
   a) numeric (ratio scale) b) Categorical
   c) Integer only d) Rational only

9) In a feed- forward network, the connections between layers are _____ from input to output.
   a) Bidirectional b) Unidirectional
   c) Multidirectional d) None of these

10) Data by itself is not useful unless _____.
   a) It is massive
   b) It is properly stated
   c) It is collected from diverse sources
   d) It is processed to obtain information

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

1) Student learns things in the presence of a teacher. This is considered as _____ learning.
2) In _____ machine learning method, patterns are inferred from the unlabeled input data.
3) The part of the entire data, which is used for building the model is called as _____.
4) The problem of finding hidden structure in unlabeled data is called _____.
5) Classification of new species to one of the earlier known families of species is ____.
6) In data mining, SVM stands for _____.

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

a) What are the advantages of unsupervised learning?
b) Discuss, with illustration, the concept of unsupervised learning.
c) Why Bayes' classifier is called Naive classifier?
d) Discuss accuracy and precision of a classifier.

Q.3 Answer the following.

a) Discuss information gain in decision tree. **08**
b) Describe decision tree classifier in detail. **08**

Q.4 Answer the following.

a) Discuss k-nearest neighbor classifier in detail. **08**
b) Write down the algorithm for Bayesian classifier. **08**

Q.5 Answer the following.

a) Discuss the different metrics for Evaluating Classifier Performance. **08**
b) Discuss density based methods for unsupervised learning. **08**

Q.6 Answer the following.

a) Describe unsupervised learning. Also explain in detail, association rules and prediction. **08**

b) Describe - **08**

i) Sensitivity of a model
ii) Specificity of a model

Illustrate with the help of example.

Q.7 Answer the following.

a) Explain in detail, market basket analysis. **08**

b) Discuss characteristics of logistic regression. **08**

SLR-ER-24

Seat No.	

Set P

M.Sc. (Semester - IV) (New) (CBCS) Examination: Oct/Noc-2023
STATISTICS
Industrial Statistics (MSC16402)

Day & Date: Tuesday, 19-12-2023 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) Fill in the blanks by choosing correct alternatives given below. **10**

1) Quality is inversely proportional to _____
   a) cost b) variability
   c) method d) time

2) Which of the following is useful in data collection activity?
   a) check sheet b) control chart
   c) histogram d) Pareto chart

3) The S chart is preferred over R chart for _____ sample sizes.
   a) small b) large
   c) moderate d) moderate to large

4) The use of warning limits used in control charts increases _____.
   a) proportion of defectives b) process capability
   c) risk of false alarms d) process variability

5) The capability index C_p involves _____ parameter(s) to be estimated.
   a) only μ b) only σ
   c) both μ and σ d) none of the above

6) In double sampling plan _____
   a) only two units are checked
   b) only first and last lot is checked
   c) only two samples of respective n_1 and n_2 units are checked necessarily
   d) only two samples of respective n_1 and n_2 units are checked conditionally

7) The curve showing the probability of acceptance of a lot of quality p is known as _____
   a) AOQ curve b) ASN curve
   c) OC curve d) ARL curve

8) In a demerit system, the unit will cause personal injury or property damage is classified as _____ defect.
   a) class A b) class B
   c) class C d) class D

9) If sample size inspected at each stage is one, sequential procedure is called _____
   a) lot-by-lot sequential sampling
   b) item-by-item sequential sampling
   c) group sequential sampling
   d) none of the above

10) An appropriate distribution of run length is _____
   a) normal b) Bernoulli
   c) geometric d) Poisson

B) Fill in the blanks **06**

1) The control limits of the p chart are based on the assumption that the number of nonconforming items follows _____ distribution.
2) Usually 2σ limits are called as _____
3) An out-of-control signal given by a control chart when the process is actually in-control, is called_____
4) V-mask method is used to implement _____ chart.
5) To determine location of a defect _____ SPC tool is used.
6) In 'DMAIC', M stands for _____

Q.2 Answer the following **16**

a) Describe process control and product control.
b) Explain the use of Pareto chart with suitable example.
c) Describe a single sampling plan for attributes.
d) Explain producer's risk and consumer's risk.

Q.3 Answer the following

a) List seven SPC tools and explain in detail any two of them. **08**
b) Outline the steps involved in the construction of $\bar{X}$ and S charts. **08**

Q.4 Answer the following

a) What is an EWMA control chart? Explain the procedure of obtaining the control limits of the same. **08**
b) Explain in detail demerit control chart. **08**

Q.5 Answer the following

a) Define process capability index C_p. Obtain $(1-\alpha)$ level confidence interval for the same. **08**
b) Define process capability index C_{pk} with necessary underlying assumptions if any. State and prove its relationship with probability of nonconformance. **08**

Q.6 Answer the following

a) Explain the assumptions, construction and operation of Hotelling's T^2 control chart. **08**
b) Explain the variable sampling plan when upper specification is given with known standard deviation. **08**

Q.7 Answer the following

a) Describe six-sigma methodology and DMAIC cycle in detail. **08**
b) Discuss nonparametric sign control chart to monitor location of a process. **08**

Seat No.	

Set P

M.Sc. (Semester - IV) (New) (CBCS) Examination: Oct/Nov-2023
STATISTICS
Reliability and Survival Analysis (MSC16403)

Day & Date: Wednesday, 20-12-2023 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) Choose the correct alternative. **10**

1) In a parallel system, the system reliability is _____ than the reliability of single component in the system.
   a) same as b) smaller than
   c) larger than d) none of these

2) The i^{th} component X_i of state vector is _____ random variable.
   a) Geometric b) Bernoulli
   c) Poisson d) Normal

3) A series system is a special case of $k - out - of - n$ system when ____.
   a) $k = 1$ b) $k = 2$
   c) $k = n - 1$ d) $k = n$

4) If a distribution function $F(t)$ is IFRA if and only if its survival function $\bar{F}(t)$ satisfies that _____.
   a) $\bar{F}\ (\alpha t) \geq \alpha\, \bar{F}(t)$ b) $\bar{F}\ (\alpha t) \geq [\ \bar{F}(t)]^{\alpha}$
   c) $\bar{F}\ (\alpha t) \leq \alpha\, \bar{F}(t)$ d) $\bar{F}\ (\alpha t) \leq [\bar{F}(t)^{\alpha}$

5) For which of the following family, each member has non-monotonic failure rate?
   a) Exponential b) Weibull
   c) Lognormal d) Gamma

6) Which of the following rate function corresponds to DFR distribution?
   a) $h(t) = t$ b) $h(t) = e^{t}$
   c) $h(t) = e^{-t}$ d) $h(t) = t\, e^{t}$

7) In survival analysis, the outcome variable is _____.
   a) continuous b) discrete
   c) dichotomous d) none of the above

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 scaled TTT transform for exponential distribution with mean λ is_____.
   a) λt b) λ
   c) $\frac{1}{\lambda}$ d) t

10) Which of the following distribution has no ageing property?
   a) lognormal b) exponential
   c) gamma d) none of these

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

1) Series system of n components has _____ minimal path sets.
2) IFRA property is preserved under _____.
3) The distribution of i^{th} component X_i of state vector is _____.
4) Study period is fixed in _____ censoring.
5) For a distribution with finite mean, the degree of estimability of mean is _____.
6) The survival function ranges between _____ and _____.

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

a) Define reliability of component. Obtain the reliability of series system of n independent components.
b) Define dual of a structure function. Show that dual of dual is primal.
c) Describe Type-I censoring with one illustration.
d) Define:
   i) survival function
   ii) cumulative hazard function

Q.3 Answer the following.

a) Define coherent system. Show that k-out-of-n system is coherent system. **08**
b) For a coherent system with n components prove that: **08**
   i) $\phi(0) = 0$ and $\phi(1) = 1$
   ii) $\prod_{i=1}^{n} X_i \leq \phi(X) \leq \coprod_{i=1}^{n} X_i$

Q.4 Answer the following.

a) Define IFR and IFRA class of distributions. If $F \in$ IFR then show that $F \in$ IFRA. **08**
b) If failure time of item has Weibull distribution with distribution function **08**
$F(t) = \begin{cases} 1 - e^{-(\lambda t)^{\alpha}}, & t > 0 \\ 0, otherwise \end{cases}$.
Examine whether it belongs to IFR or DFR.

Q.5 Answer the following.

a) Define Poly function of order 2 (PF_2). Prove that if $\mathrm{f} \in \mathrm{PF}_2$ then $F \in$ IFR. **08**
b) Discuss maximum likelihood estimation of parameters of a gamma distribution under complete data. **08**

Q.6 Answer the following.

a) Describe type II censoring. Obtain maximum likelihood estimate of mean of the exponential distribution under type II censoring. **08**
b) Describe Kaplan-Meier estimator and derive an expression for the same. **08**

Q.7 Answer the following.

a) Describe Gehan's test for two sample testing problem in presence of censoring. **08**

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

SLR-ER-26

Seat No.	

Set P

M.Sc. (Semester - IV) (New) (CBCS) Examination: Oct/Nov-2023
STATISTICS
Optimization Techniques (MSC16404)

Day & Date: Thursday, 21-12-2023 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) Figures to the right indicate full marks.

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

1) For a given LPP, if Z is objective function, then ______.
   a) $Max\ Z = -Min\ Z$ b) $Max\ Z = Min\ (-Z)$
   c) $Max\ Z = -Max\ Z$ d) $None\ of\ these$

2) An optimal solution to an LPP ______.
   a) Always corresponds to an extreme point of feasible region
   b) Always lies on the boundary of feasible region
   c) Always exists
   d) None of these

3) The dual has an infeasible solution, primal has ______.
   a) an unbounded solution b) an infeasible solution
   c) a feasible d) None of these

4) The size of the payoff matrix of a game can be reduced by using the principle of ________.
   a) game inversion b) dominance
   c) game transpose d) rotation

5) Dual simplex method is applicable to those LPPs that starts with _____.
   a) an infeasible solution b) a feasible solution
   c) an infeasible but optimum d) a feasible but optimum

6) In an integer linear programming problem _______.
   a) all decision variables are integers
   b) all decision variables are real numbers
   c) all decision variables are complex numbers
   d) all decision variables are non-negative

7) Which of the following is not associated with LPP?
   a) Proportionality b) Uncertainty
   c) Additivity d) Divisibility

8) The right-hand side of a constraint in a primal problem appears in the corresponding dual as _____.
   a) a coefficient in the objective function
   b) a right-hand side of a constraint
   c) an input-output coefficient
   d) None of these

9) In quadratic programming problem constraints are _______.
   a) non-linear equation form
   b) non-linear inequality form
   c) linear inequality form
   d) none of these

10) If two constraints do not intersect in the positive quadrant of the graph, then ______.
   a) a solution is infeasible   b) a solution is unbounded
   c) a solution is feasible   d) a solution is degenerate

Q.1 B) Write true or false. **06**

1) Feasible region may or may not be bounded.
2) In two phase simplex method the value of the objective function of phase-I cannot exceed zero.
3) For an LPP having n decision variables, there must be equal number of constraints.
4) Two phase simplex method is an alternative method to Big M method.
5) If only proper subset of the decision variables in a LPP are restricted to integer values the problem is known as mixed integer programming.
6) In a two-person zero sum game the optimal gain of two players is zero.

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

a) Write a note on Dominance property.
b) Write a note on Sensitivity analysis.
c) Show that dual of dual is primal.
d) Write a short note on Big-M method.

Q.3 Answer the following.

a) Write down simplex algorithm to solve linear programming problem. **08**
b) Develop necessary Kuhn Tucker conditions for an optimal solution to a quadratic programming problem. **08**

Q.4 Answer the following.

a) Show that: i^{th} constraint in the primal is an equality if i^{th} dual variable is unrestricted sign. **08**

b) Describe effect of change in coefficients of objective function $c_j's$ in sensitivity analysis. **08**

Q.5 Answer the following.

a) Write down dual simplex algorithm. **08**

b) Solve following game **08**

$$\begin{array}{cc} & Player\ B \\ Player\ A & \begin{pmatrix} 10 & 5 & -2 \\ 13 & 12 & 15 \\ 16 & 14 & 10 \end{pmatrix} \end{array}$$

Q.6 Answer the following.

a) Solve the following LPP **08**

$Maximize\ Z = -x_1 + 2x_2 - x_3$

sub to

$3x_1 + x_2 - x_3 \leq 10$

$-x_1 + 4x_2 + x_3 \leq 6$

$x_2 + x_3 \leq 4$

$x_1, x_2, x_3 \geq 0$

b) Explain Gomory's cutting plane method to solve integer programming problem. **08**

Q.7 Answer the following.

a) Use Branch and Bound method to solve following integer programming problem **08**

$Maximize\ Z = 7x_1 + 9x_2,$ subject to constraints

$-x_1 + 3x_2 < 6,\ \ 7x_1 + x_2 \leq 35,\ \ x_2 \leq 7,\ \ x_1, x_2 \geq 0\ and\ integers$

b) i) State and prove weak duality theorem. **08**

ii) State and prove strong duality theorem.

Seat No.	

Set P

M.Sc. (Semester - IV) (New) (CBCS) Examination: Oct/Nov-2023
STATISTICS
Time Series Analysis (MSC16407)

Day & Date: Friday, 22-12-2023 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) Choose the correct alternative. **10**

1) The time series $X_t - 0.5X_{t-1} = Z_{t-1}$, where $\{Z_t\} \sim WN(0, \sigma^2)$ is _____.
   a) causal only
   b) invertible only
   c) both causal and invertible both
   d) none of these

2) The mean of a stationary process $X_t = \mu + \phi_1 X_{t-1} + Z_t$ where $\{Z_t\} \sim WN(0, \sigma^2)$ is _____.
   a) 0 b) $\mu + \phi$
   c) μ d) $\mu^2 + \phi$

3) The variance of the process $X_t - 0.5X_{t-1} = Z_{t-1}$ where $\{Z_t\} \sim WN(0,1)$ is ______.
   a) $4/3$ b) $3/4$
   c) $1/4$ d) $1/2$

4) Autoregressive process of order two can be represented as ____.
   a) $X_t = \mu + \phi_1 X_{t-1} + \phi_2 X_{t-2} {}^* Z_t$
   b) $X_t = \mu + \phi_1 X_{t-1} + \phi_2 X_{t-2} + Z_t$
   c) $X_t = \mu \times \phi_1 X_{t-1} + \phi_1 X_{t-1} \times Z_t$
   d) $X_t = \mu + \phi_1 X_{t-1} + Z_t$

5) The two-sided moving average method is defined as _____.
   a) $X_t = \frac{1}{2q}\sum_{j=0}^{q} X_{t-j}$ b) $X_t = \frac{1}{2q}\sum_{j=-q}^{q} X_{t-j}$
   c) $X_t = \frac{1}{(2q+1)}\sum_{j=-q}^{q} X_{t-j}$ d) $X_t = \frac{1}{(2q+1)}\sum_{j=0}^{q} X_{t-j}$

6) The singe exponential smoothing equation is _____.
   a) $S_{t=}\alpha Y_{t-1} + (1-\alpha)S_{t-1} \quad t \geq 2$
   b) $S_t = \alpha^2 Y_{t-1} + (1-\alpha)S_{t-1} \quad t \geq 2$
   c) $S_t = \alpha Y_{t-1} + (1-\alpha)^2 S_{t-1} \quad t \geq 2$
   d) $S_t = \alpha^2 Y_{t-1} + 2(1-\alpha)S_{t-1} \quad t \geq 2$

7) If there is trend and seasonal component present in the given series, then _____ method can be used.
   a) Single exponential smoothing
   b) Double exponential smoothing
   c) Triple exponential smoothing
   d) Quadratic smoothing

8) The parameters of $AR\ (p)$ model can be estimated using _____ equations.
   a) Lease square b) Yule walker
   c) Likelihood d) Geometric

9) The sample autocorrelation follows _____ distribution.
   a) Student's t b) Asymptotic Normal
   c) Chi-square d) F distribution

10) The process $X_t = \phi_1 X_{t-1} + Z_t$ where $\{Z_t\} \sim WN(0, \sigma^2)$ is causal process if _____.
   a) $|\phi_1| < 1$ b) $|\phi_1| > 1$
   c) $|\phi_1| = 1$ d) $|\phi_1| < 1.5$

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

1) The additive model of time series is given by _____.
2) The ACF of $AR\ (p)$ process is _____.
3) The smoothing parameter in single exponential method is selected such that, _____ is minimum.
4) _____ method can be used to eliminate both trend and seasonality.
5) Causality is the property of ______ in the process $\phi(B)X_t = \theta(B)Z_t$.
6) The causal representation of $ARMA(p, q)$ process $\{X_t\}$ is _____.

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

a) Define weak stationary process and strong stationary process. Give one example each.
b) Explain moving average as a method of elimination of trend only.
c) Write a short note on single exponential smoothing.
d) Write a short note on conditional heteroscedastic models.

Q.3 Answer the following.

a) Define $AR\ (1)$ process and hence obtain its partial autocorrelation function. **08**
b) Define ARMA $(1,1)$ process. Obtain causal representation of the same process. **08**

Q.4 Answer the following.

a) Describe the diagnostic checking methods in time series analysis. **08**
b) Verify whether the process $X_t + 0.6X_{t-1} = Z_t + 0.04Z_{t-1}$, is causal or not. Hence derive its autocovariance function. **08**

Q.5 Answer the following.

a) Derive the expression for autocorrelation function $ARMA\ (1,1)$ process. **08**
b) Derive the Yule - Walker equations for parameter estimation in $AR(p)$ process. **08**

Q.6 Answer the following.

a) Explain Turning point test and Difference sign - test for testing trend. **08**
b) Describe analysis of $ARIMA\ (p, d, q)$ process. **08**

Q.7 Answer the following.

a) Explain moving average as a method of estimation and elimination of trend. **08**
b) Discuss in detail residual analysis in time series analysis. **08**