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M.Sc. (Statistics) (Semester - I) (New) (NEP CBCS) Examination: March/April - 2026
Distribution Theory (2329101)

Day & Date: Friday, 17-04-2026 Max. Marks: 60
Time: 03:00 PM To 05:30 PM

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

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

1) A distribution is called symmetric if _____.
   a) Mean = 0
   b) Median = Mode
   c) Mean = Median = Mode
   d) Variance = 1

2) The probability integral transform states that if X has cdf F(x), then F(X) follows _____.
   a) Normal distribution b) Uniform distribution on (0,1)
   c) Exponential distribution d) Poisson distribution

3) A location family is obtained by _____.
   a) Multiplying a parameter b) Adding a parameter
   c) Squaring a parameter d) Taking logarithm

4) Which inequality gives an upper bound for probability using expectation?
   a) Jensen's inequality b) Holder's inequality
   c) Markov inequality d) Minkowski inequality

5) The smallest observation in a sample is called _____.
   a) First order statistic b) Median
   c) Mode d) Range

6) Truncated distribution means _____.
   a) Adding values
   b) Removing part of distribution
   c) Scaling distribution
   d) Mixing distributions

7) A mixture distribution is _____.
   a) Sum of two random variables
   b) Weighted combination of distributions
   c) Product of distributions
   d) Difference of distributions

8) The multinomial distribution is a generalization of _____.
   a) Poisson distribution b) Normal distribution
   c) Binomial distribution d) Exponential distribution

B) State whether following statements are True or False. **04**

a) Poison distribution belongs to location family.
b) Normal distribution has a scale parameter.
c) Order statistic follows the same distribution as that of the original distribution.
d) Jordan theorem is used to decompose the distributions.

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

a) Define expectation.
b) Define moments of a distribution.
c) State Holder inequality.
d) State Jordan Decomposition theorem.
e) Define location family of distribution.
f) State Markov inequality
g) Define Binomial distribution.
h) Define non-central chi square distribution.

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

a) Discuss non central t distribution.
b) Discuss joint and marginal distribution.
c) Discuss non-central F distribution with its properties.
d) Define Distribution function and also state its properties.

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

a) Explain bivariate Poisson distribution.
b) Explain bivariate Exponential distribution.
c) Discuss compounding of distributions.

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

a) Discuss independence of random variables.
b) What is multinomial distribution? Explain in detail.
c) Describe mixture of two distributions.

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M.Sc. (Statistics) (Semester - I) (New) (NEP CBCS) Examination: March/April – 2026
Estimation Theory (2329102)

Day & Date: Monday, 20-04-2026 Max. Marks: 60
Time: 03:00 PM To 05:30 PM

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

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

1) Which of the following distribution does not belong to the exponential family?
   a) Normal b) Poison
   c) Uniform d) All of these

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

3) A statistic which does not contain any information about the parameter is called _____.
   a) Ancillary statistic
   b) Sufficient statistic
   c) Minimal sufficient statistic
   d) Complete statistic

4) An estimator T is said to be _____ of θ if it is biased and the bias tends to zero as the sample size tends to infinity.
   a) Unbiased estimator
   b) Asymptotically unbiased estimator
   c) Good unbiased estimator
   d) Efficient unbiased estimator

5) The correlation coefficient between the UMVUE of $\Psi(\theta)$ and any unbiased of $\Psi(\theta)$ is _____ estimator of $\Psi(\theta)$ is _____.
   a) always zero b) always between -1and 1
   c) always non-negative d) always negative

6) If $T = T(\underline{X})$ is MLE of θ and $\phi(\theta)$ is a function of θ then $\phi(T)$ is MLE of $\phi(\theta)$, if _____.
   a) $\phi(\theta)$ is continuous function of θ
   b) $\phi(\theta)$ is one-to-one function of θ
   c) $\phi(\theta)$ is many to one function of θ
   d) For any $\phi(\theta)$

7) If an estimator T_n of population parameter θ converges in probability to θ as n tends to infinity is said to be _____.
   a) Consistent b) Sufficient
   c) Efficient d) Unbiased

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

B) State whether following statements are True or False. **04**

1) Consistent estimator is always unbiased.
2) An estimator may have variance less than CRLB.
3) In Bayesian estimation, parameter is assumed to be a constant.
4) Information function is always non-negative.

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

a) Define unbiased estimator.
b) Define asymptotically unbiased estimator.
c) Define completeness of a statistic.
d) Define power series family of distributions.
e) Define absolute error loss function.
f) State Neyman-Fisher factorization theorem.
g) State two distributions which do not belong to the exponential family.
h) Show that if two consistent estimators exist, there can be infinitely many such estimators.

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

a) Discuss method of scoring for estimation of parameters.
b) Show that family of normal pdf s with μ unknown and σ^2 known is a one parameter exponential family.
c) Prove or disprove: An unbiased estimator belongs to the parameter space.
d) Le X_1, X_2 be random sample from Poisson (λ) distribution. Show that $X_1 + X_2$ is sufficient for λ.

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

a) Discuss Fisher information function in detail.
b) Prove the necessary and sufficient condition for existence of UMVUE.
c) Prove: If T is complete sufficient statistic, and there exists an unbiased estimator T_1 of $\Psi(\theta)$ then there exists unique UMVUE of $\Psi(\theta)$ which is given by $\phi(T) = E[T_1/T]$

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

a) Obtain Chapman-Robin-Kiefer Lower Bound (CRKLB).
b) Define MLE of a parameter. Let $X_1, X_2, \ldots, X_n$ be iid random variables with pdf $f(x, \theta) = (\theta\ a)x^{a-1}e^{-\theta x^a}, x > 0$, a is known. Find MLE of θ.
c) Let $X \sim B(n, \theta), n$ is known and prior distribution of θ is $B_1(a, b)$. Obtain posterior distribution of θ given $X = x$

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M.Sc. (Statistics) (Semester - I) (New) (NEP CBCS) Examination: March/April – 2026
Statistical Mathematics (2329107)

Day & Date: Wednesday, 22-04-2026 Max. Marks: 60
Time: 03:00 PM To 05:30 PM

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

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

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

2) 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

3) Greatest lower bound is also called as _____.
   a) Infimum b) Supremum
   c) Limit point d) Interior point

4) If A is subset of B and B is a countable set, then A is _____.
   a) Countable
   b) Uncountable
   c) May or may not be countable
   d) None of the above

5) If A is a 4×4 matrix with rank 3, then determinant of A is _____.
   a) 0 b) 1
   c) 4 d) 6

6) Which of the following property does not hold for matrix multiplication?
   a) Commutative b) Associative
   c) Distributive d) All of these

7) Let B be any real matrix and A be its inverse then _____.
   a) BA = I b) AB = I
   c) both (a) and (b) d) None of these

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

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

1) For skew-symmetric matrix, diagonal elements are ____.
2) The determinant of identity matrix is _____.
3) If transpose of the given matrix is equal to the identity matrix, then given matrix must be _____.
4) In the system of linear equations AX=b with unique solution, the matrix A is _____.

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

a) Define convergence limit of a sequence of real numbers.
b) Prove or disprove: A superset of countable set is always countable.
c) Define countable set.
d) Define bounded sequence.
e) Define trace of a matrix.
f) Define G-inverse of a matrix.
g) Define idempotent matrix
h) Define identity matrix.

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

a) State mean value theorem. Also state its applications.
b) Discuss any two tests for convergence of a series.
c) Discuss Taylor's theorem in detail.
d) Write a note on basis of a vector space.

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

a) Discuss limit superior and limit inferior of a sequence of real numbers.
b) Define additive inverse of a vector. Show that additive inverse of any vector in a vector space is unique.
c) Prove: If G is g-inverse of A, then G_1=GAG is also a g-inverse of A.

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

a) Discuss Riemann integration in details.
b) Show that the rank of a product of two matrices cannot exceed the rank of either matrix.
c) Find G-inverse of the below matrix:

$$\begin{bmatrix} 1 & 2 & 4 \\ 2 & 9 & 6 \end{bmatrix}$$

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M.Sc. (Statistics) (Semester - I) (New) (NEP CBCS) Examination: March/April – 2026
Research Methodology in Statistics (2329103)

Day & Date: Monday, 27-04-2026 Max. Marks: 60
Time: 03:00 PM To 05:30 PM

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

Q.1 A) Choose the most correct alternative. (MCQ) 08

1) What is the main difference between a population and a sample?
   a) A population is a subset of the sample
   b) A population includes all the members of a group, while a sample is a subset of that population
   c) A population and a sample refer to the same thing
   d) A population refers to data, while a sample refers to theory

2) Which of the following is NOT a feature of Stratified Sampling?
   a) The population is divided into homogeneous groups
   b) Random samples are taken from each group
   c) Each element of the population has an equal chance of selection
   d) The groups are based on some characteristic relevant to the study

3) Which of the following is a non-probability sampling method?
   a) Simple Random Sampling with Replacement (SRSWR)
   b) Stratified Sampling
   c) Quota Sampling
   d) Systematic Sampling

4) Which method is used in PPSWR (Probability Proportional to Size with Replacement) sampling?
   a) Units with a larger size have a lower probability of being selected
   b) Units with a larger size have a higher probability of being selected
   c) All units have the same probability of being selected
   d) Units are selected with replacement, and there is no connection to size

5) _____ basic principles of experimental design?
   a) Randomization, replication, and control
   b) Objectivity, accuracy, and analysis
   c) Flexibility, simplicity, and precision
   d) Sampling, data collection, and interpretation

6) In Lahiri's method, if a unit is selected with probability proportional to size (PPS), the size measure is used to _____.
   a) Assign equal probabilities to all units
   b) Calculate cumulative probabilities for selection
   c) Select one unit randomly and another based on the size measure
   d) Generate a random number to select the unit

7) Action research is most commonly used in which field?
   a) Medicine b) Agriculture
   c) Technology d) Education

8) A literature review is used to _____.
   a) Propose a hypothesis
   b) Collect data for analysis
   c) Understand existing research on the topic and identify research gaps
   d) Present new experimental data

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

1) The primary objective of research is to _____ problems and contribute to knowledge.
2) The _____ estimator is used to estimate a population mean for PPSWOR sampling when sample size is general.
3) The primary advantage of stratified sampling is that it ensures _____ representation of all subgroups.
4) _____ sampling involves selecting units at regular intervals from a sampling frame, ensuring every k^{th} element is chosen.

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

a) Define systematic sampling.
b) Define sample with example.
c) Define applied research.
d) What is quota sampling?
e) What is judgment sampling?
f) Define experiment unit.
g) Define treatments.
h) What is double sampling?

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

a) Discuss various types of probability sampling in brief.
b) Briefly explain the difference between qualitative and quantitative research approaches.
c) Distinguish between research methods and research methodology.
d) Prove: With usual notations, the bias of ratio estimator $\hat{R} = \frac{\bar{y}}{\bar{x}}$ is

$$B(\hat{R}) = -\frac{cov(\hat{R}, \bar{x})}{\bar{X}}$$

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

a) Explain in detail non-probability sampling and their types.

b) Obtain Murthy's unordered estimator corresponding to Des Raj's ordered estimator for the sample size 2.

c) What are the different steps in writing report?

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

a) Prove: In simple random sample an approximate value of bias of $\hat{R} = \frac{\bar{y}}{\bar{x}}$ is given by,

i) $B(\hat{R}) \approx R\ C.V(\bar{x})[C.V(\bar{x}) - \rho\ C.V(\bar{y})]$

ii) $B(\hat{R}) \approx \frac{1-F}{n}(C_{xx} - \rho C_{yx})R$

where $C_{xx} = C_{x^2}, C_{yx} = C_y C_x, C_x = \frac{S_x}{\bar{x}}, C_y = \frac{S_y}{\bar{y}}$

b) Discuss the meaning of the research in detail.

c) Explain in detail the types of research.

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M.Sc. (Statistics) (Semester - II) (New) (NEP CBCS) Examination: March/April – 2026
Stochastic Processes (2329201)

Day & Date: Thursday, 16-04-2026 Max. Marks: 60
Time: 11:00 AM To 01:30 PM

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

Q.1 A) Choose correct alternative. (MCQ) **08**

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

2) The state space and time domain for random walk model are _____ respectively.
   a) discrete and discrete
   b) discrete and continuous
   c) continuous and discrete
   d) continuous and continuous

3) For an irreducible Markov chain with finite state space, all states are _____.
   a) Persistent b) Transient
   c) Periodic d) All of these

4) If states i and j are communicating states, then _____.
   a) state i leads to state j b) state j leads to state i
   c) either (a) or (b) d) both (a) and (b)

5) If $S = \{1,2,3,4\}$ is a state space and state 2 is absorbing state, then transition probability from state 2 to state 3 in 3 steps is _____.
   a) < 0 b) ≥ 0
   c) $= 0$ d) None of these

6) If states i and j are such that $p_{ij}^{(n)} > 0$, for some $n > 0$, then _____.
   a) states i and j are communicating states
   b) states i is accessible from state j
   c) states j is accessible from state i
   d) None of these

7) An ergodic state is always _____.
   a) Recurrent b) Aperiodic
   c) non-null d) All of these

8) State space of stochastic process can be _____.
   a) Discrete b) Continuous
   c) Neither(a) nor (b) d) Both(a) and (b)

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

a) Persistent state is also called as _____.
b) If probability 'p' of positive jump is 0.5 for a random walk, then it is called as _____.
c) If state j is aperiodic persistent non-null then as $n \to \infty, p_{jj}^{(n)} \to$ _____.
d) If $(N(t)\}$ is a Poisson process with parameter λ , then $E\big(N(t)\big) =$ _____.

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

a) Define null recurrent state.
b) Define communicating states.
c) Define persistent state.
d) Define transient state.
e) Define Poisson process.
f) Define stochastic process.
g) Define discrete state space discrete time stochastic process.
h) Define aperiodic state.

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

a) Find the distribution of inter-arrival times for Poisson process.
b) If $\{N(t)\}$ is a Poisson process, then for $s < t$, obtain the distribution of $N(s)$, if it is already known that $N(t) = k$.
c) Describe mean recurrence time of a state.
d) State and prove First Entrance Theorem.

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

a) Prove that persistency is a class property.
b) Define stationary distribution of a Markov chain. Find the same for a Markov chain with state space $\{1,2,3\}$, whose tpm is $\begin{bmatrix} 1/2 & 1/2 & 0 \\ 1/3 & 1/3 & 1/3 \\ 2/5 & 1/5 & 2/5 \end{bmatrix}$
c) Give complete classification of states of random walk model.

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

a) Define pure birth process and obtain its probability distribution.
b) Discuss stationary distribution of a Markov chain in detail. Illustrate with the help of example.
c) Define branching process. Derive expression for the mean of the population size at n^{th} generation.

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M.Sc. (Statistics) (Semester - II) (New) (NEP CBCS) Examination: March/April – 2026
Theory of Testing of Hypotheses (2329202)

Day & Date: Saturday, 18-04-2026 Max. Marks: 60
Time: 11:00 AM To 01:30 PM

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

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

1) Probability of rejecting the false hypothesis is _____.
a) power of the test b) level of significance
c) size of type-II error d) confidence coefficient

2) Let X has a $N(\mu, \sigma^2)$ distribution where both μ and σ^2 are unknown. Then the simple hypothesis is _____.
a) $H_0: \sigma = 5$ b) $H_0: \mu = 10$
c) $H_0: \mu = 5, \sigma = 1$ d) $H_0: \mu \neq 5, \sigma = 4$

3) Family of Cauchy $(1, \theta)$ distribution _____.
a) has MLR property
b) belong to one parameter exponential family
c) has mean θ
d) does not have MLR property

4) In testing $H_0: \sigma = \sigma_0$ in $N(0, \sigma^2)$ the critical region based on n observations is $\sum_{i=1}^{n} X_i^2 < k$. For which alternative hypothesis does this provide UMP test?
a) $\sigma \neq \sigma_0$ b) $\sigma < \sigma_0$
c) $\sigma > \sigma_0$ d) $\sigma = \sigma_0$

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

6) A size α test is said to be unbiased if _____.
a) It has maximum power in the class of all size α tests.
b) size and power are equal
c) power is smaller than size
d) size of the test does not exceed its power.

7) A good confidence set should have _____.
- a) minimum coverage and maximum length
- b) maximum coverage and minimum length
- c) maximum coverage and maximum length
- d) minimum coverage and minimum length

8) A UMP test _____.
- a) is an unbiased test
- b) is biased test
- c) always exist
- d) none of these

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

1) Level of significance is the probability of _____ error.
2) A test function which takes either value 0 or 1 is called _____ test function.
3) Acceptance region of _____ test leads to an UMAU confidence set.
4) In Kruskal-Wallis test of k samples, the appropriate degrees of freedom are ____.

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

a) Define simple hypothesis and composite hypothesis. Give on example for each.

b) Explain the terms:
1) Randomized test
2) Nonrandomized test.

Give one example for each.

c) Define monotone likelihood ratio (MLR) property.

d) Define uniformly most accurate unbiased family of confidence sets.

e) Define pivotal quantity. Give an example.

f) Define:
1) similar test and,
2) test having Neyman structure.

g) Define confidence set and UMA confidence set of level $(1-\alpha)$.

h) Define shortest length confidence interval.

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

a) Define unbiased test. Show that MP level α test is always an unbiased test.

b) Let X be exponential with mean θ and $H_0: \theta = 1$ against $H_1: \theta = 2$ is to be tested. Suppose the test ϕ rejects H_0 for $x > 2$. Obtain size and power of test ϕ.

c) Describe a goodness of fit test based on chi-square distribution.

d) Prove or disprove: A UMP test is unbiased.

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

a) Define most powerful (MP) test. Prove that the power of MP test for testing simple hypothesis against simple alternative is greater than its size.

b) Obtain MP test to test $H_0: \mu = 0$ against $H_1: \mu = 1$ on the basis of a random sample $X_1, X_2, \ldots X_n$ of size n from $N(\mu, 1)$ distribution.

c) 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.

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

a) Describe likelihood ratio test (LRT). Show that LRT for testing simple hypothesis against simple alternative is equivalent to Neyman-Pearson test.

b) Let $X_1, X_2, \ldots X_n$ be a random sample from $N(\theta, \sigma^2)$ distribution where both θ and σ^2 are unknown. Find the likelihood ratio test of $H_0: \sigma = \sigma_0$ against $H_1: \sigma \neq \sigma_0$

c) Describe Bartlett's test for homogeneity of variances.

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M.Sc. (Statistics) (Semester - II) (New) (NEP CBCS) Examination: March/April – 2026
Probability Theory (2329207)

Day & Date: Tuesday, 21-04-2026 Max. Marks: 60
Time: 11:00 AM To 01:30 PM

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

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

1) Monotonic sequence of sets _____.
   a) Always converges
   b) Converges, only if it is bounded above
   c) Converges, only if it is bounded below
   d) Converges, only if it is bounded

2) Which of the following is the weakest mode of convergence?
   a) convergence in r^{th} mean
   b) convergence in probability
   c) convergence in distribution
   d) convergence in almost sure

3) If F_1 and F_2 are two fields, then _____ is always a field.
   a) $F_1 \cap F_2$ b) $F_1 \cup F_2$
   c) Both (a) and (b) d) Neither a) nor (b)

4) 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

5) If for events A and $B, A \cup B = \Omega$ then these events are called as _____.
   a) exhaustive b) exclusive
   c) both (a) and (b) d) complementary

6) Probability measure is continuous from _____.
   a) Above b) Below
   c) Both (a) and (b) d) Either above or below

7) A class $\mathcal{F}$ is said to be closed under finite intersection, if $A, B \in \mathcal{F}$ implies.
   a) $A \cap B \in \mathcal{F}$, for all $A, B \in \mathcal{F}$
   b) $A^C \in \mathcal{F}, B^C \in \mathcal{F}$
   c) both (a) and (b)
   d) None of these

8) Expectation of a simple non-negative random variable satisfies _____.
   a) Linearity property b) Scale preserving property
   c) Non-negativity property d) All of these

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

1) If $\{A_n\}$ is a sequence of independent events, such that $\sum_{n=1}^{\infty} P(A_n) < \infty$, then $P(\underline{lim} A_n) =$ _____.
2) The sequence of sets $\{A_n\}$, where $A_n = \left(0,2 + \frac{1}{n}\right)$ converges to _____.
3) If for two independent events A and $B, P(A) = 0.2, P(B) = 0.4$, then $P(A \cup B) =$ _____.
4) The collection of all subsets of Ω is called as _____.

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

a) Define σ-field.
b) Define probability measure.
c) Define Lebesgue-Stieltjes measure.
d) State Liapouniv's CLT.
e) Prove or disprove: Union of two fields is again a field.
f) Define almost sure convergence.
g) Define simple function.
h) Define elementary random variable.

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

a) Prove that if P and Q are probability measures then, $P^*(A) = \alpha P(A) + (1 - \alpha)Q(A), 0 \leq \alpha \leq 1$ is a probability measure.
b) Prove that inverse mapping preserves all set relations.
c) Examine for the class of finite or co-finite sets to be a field.
d) Write a note on Lebesgue measure.

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

a) State and prove Borel-Cantelli lemma.
b) Prove that probability measure is a continuous measure.
c) Prove that expectation of a random variable X exists, if and only if $E|X|$ exists.

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

a) Prove that collection of sets whose inverse images belong to σ-field, is a also a σ-field.

b) Prove that inverse image of σ-field, is also a σ-field

c) Prove or disprove:

i) Convergence in distribution implies convergence in probability

ii) Convergence in probability implies convergence in distribution

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M.Sc. (Statistics) (Semester - III) (New) (NEP CBCS)
Examination: March/April – 2026
Multivariate Analysis (2329301)

Day & Date: Friday, 17-04-2026 Max. Marks: 60
Time: 11:00 AM To 01:30 PM

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

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

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

2) Let A has $W_p(n, \sum)$ distribution and B is $a\ (q \times p)$ matrix then distribution of BAB' is _____.
   a) $W_p(n, \sum)$ b) $W_q(n, \sum)$
   c) $W_p(n, B\sum B')$ d) $W_q(n, B\sum B')$

3) 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

4) For a multivariate normal random vector, the variance-covariance matrix is always _____.
   a) square matrix b) symmetric
   c) non-negative definite d) All of these

5) Marginal distribution of any single variable from multivariate normal vector follows _____.
   a) Univariate normal b) Beta
   c) Gamma d) None of these

6) Principal Component Analysis is a multivariate method that _____.
   a) reduces skewness of data
   b) reduces heterogeneity of data
   c) reduces dimension of data
   d) reduces multicollinearity of data

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

8) For calculating canonical correlation between two random vectors $\underline{X}$ and $\underline{Y}$ with dimensions $px1$ and $qx1$ respectively, we must have _____.
   a) $p > q$
   b) $p < q$
   c) $p = q$
   d) p and q may have any relation

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

1) _____ is a clustering procedure where all objects start out as individual cluster.
2) Let A has $W_p(n, \Sigma)$ distribution then $E(A) =$ _____
3) A _____ is a graphical device for displaying clustering results.
4) The number of principal components explaining more information than PC_3 is _____.

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

a) State the density of Wishart distribution.
b) Define sample variance-covariance matrix.
c) State the density of multivariate normal random vector.
d) Define complete linkage.
e) Define average linkage.
f) State Fisher's discriminant function.
g) Write down the MLEs of mean vector as well as variance-covariance matrix of a multivariate normal density.
h) State MGF of multivariate normal distribution.

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

a) Obtain moment generating function of multivariate normal distribution.
b) Write a note on Wishart distribution.
c) Write a note on generalized variance of a random vector.
d) Describe discrimination problem with two populations. Also describe the errors associated with classification.

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

a) Explain principal components analysis in detail.
b) Obtain Fisher's best discriminant function for discriminating between two populations.
c) Explain the concept of canonical correlation between two random vectors.

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

a) Obtain the MLE of variance-covariance matrix of a multivariate normal density.

b) Illustrate agglomerative clustering with the help of example considering any distance matrix for 4 observations.

c) Prove the additive property of the multivariate normal distribution.

Seat No.	

Set P

M.Sc. (Statistics) (Semester - III) (New) (NEP CBCS) Examination: March/April – 2026
Regression Analysis (2329302)

Day & Date: Monday 20-04-2026 Max. Marks: 60
Time: 11:00 AM To 01:30 PM

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

Q.1 A) Choose correct alternative. (MCQ) 08

1) In the multiple regression model $Y = X\beta + \epsilon$, the variance of $\hat{\beta}$ is _____.
   a) $\sigma^2 (X'X)^{-1}$ b) $(X'X)$
   c) $\sigma^2 X'X$ d) $X^{-1} Y$

2) Which of the following criteria is commonly used for model selection?
   a) Adjusted R^2 b) Mean
   c) Median d) Range

3) Multicollinearity mainly affects _____.
   a) bias of estimators b) variance of estimators
   c) mean of response d) sample size

4) The Cochrane-Orcutt method is used to correct _____.
   a) heteroscedasticity b) autocorrelation
   c) multicollinearity d) Outliers

5) A regression model that is nonlinear in parameters is called _____.
   a) linear regression b) polynomial regression
   c) nonlinear regression d) logistic regression

6) Smoothing splines are mainly used for _____.
   a) classification b) curve fitting
   c) hypothesis testing d) correlation analysis

7) In generalized linear models, the response variable belongs to _____.
   a) normal family only b) exponential family
   c) binomial family only d) geometric family

8) The probit link function is based on_____.
   a) exponential distribution b) normal distribution
   c) Poisson distribution d) uniform distribution

B) State whether the following statements are True or False. **04**

1) Adjusted R^2 always increases when more variables are added to the model.
2) Ridge regression introduces bias in the parameter estimates.
3) Orthogonal polynomials help reduce multicollinearity.
4) Logistic regression is suitable for binary response data.

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

a) What is a prediction interval?
b) Define Mallow's C_p statistic.
c) What is backward elimination method?
d) Define autocorrelation.
e) What is an intrinsically linear model?
f) Define polynomial regression.
g) What is model deviance in GLM?
h) What is the complementary log-log link function?

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

a) Explain hypothesis testing for regression coefficients.
b) Explain adjusted R^2 and its usefulness in model selection.
c) Distinguish between intrinsically linear and intrinsically nonlinear models.
d) Explain cubic splines.

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

a) Explain the forward selection method for variable selection.
b) Discuss consequences and remedies of multicollinearity.
c) Explain polynomial regression in two variables.

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

a) Explain the concept and components of generalized linear models.
b) Explain logistic regression and interpretation of odds ratio.
c) Describe the Cochrane-Orcutt method for handling autocorrelation.

Seat No.	

Set P

M.Sc. (Statistics) (Semester - III) (New) (NEP CBCS) Examination: March/April – 2026
Design and Analysis of Experiments (2329306)

Day & Date: Wednesday, 22-04-2026 Max. Marks: 60
Time: 11:00 AM To 01:30 PM

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

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

1) In a connected block design, rank of estimation space is _____.
   a) $v-1$ b) $b-1$
   c) $v+b-1$ d) $vb-1$

2) In a 2^3 factorial experiment with, the contrast due to main effect AC is _____.
   a) $[(a)+(ab)+(ac)+(abc)-(1)-(b)-(c)-(bc)]$
   b) $[(abc)-(ac)+(bc)-(c)+(ab)-(a)+(b)-(1)]$
   c) $[(abc)+(ac)-(bc)-(c)+(ab)-(a)-(b)+(1)]$
   d) $[(bc)+(ab)-(abc)-(c)+(ac)-(a)-(b)+(1)]$

3) The error degrees of freedom in two-way classification model $Y_{ij}=\mu+\alpha_i+\beta_j++\epsilon_{ij}; 1,2,\dots,I, j=1,2,\dots J$ and assumptions on errors are followed; are _____
   a) $(J-1)$ b) $(I-1)$
   c) $(I-1)(J-1)$ d) $(IJ-1)$

4) Covariance between vector of adjusted treatment totals and vector of block total $\big(Cov(Q,B)\big)$ is _____.
   a) 0 b) 1
   c) 3 d) 2

5) _____is the primary advantage of a factorial design in experiments.
   a) t requires fewer resources than other designs
   b) It allows for the estimation of interactions between factors
   c) It focuses only on main effects
   d) It does not require randomization

6) For Balanced incomplete block design (b,k,v,r,λ)
   a) $bv=kr$ b) $bk=vr$
   c) $r(v-1)=\lambda(k-1)$ d) $v(r-1)=k(\lambda-1)$

7) Which of the following is one-way ANOCOVA model with single covariate?
   a) $Y_{ij} = \mu + \alpha_1 + \beta(X_{ij} - \bar{X}_{...}) + \epsilon_{ij}$; for all $i = 1,2, \dots p, j = 1,2 \dots n_i$
   b) $Y_{ijk} = \mu + \alpha_i + \beta(\bar{X}_{ijk} - \bar{X}_{...}) + \epsilon_{ijk}$; for all $i = 1,2, \dots p, j = 1,2 \dots n_i$
   c) $Y_{ij} = \mu - \alpha_i + \beta(X_{ij} - \bar{X}_{...}) + \epsilon_{ij}$; for all $i = 1,2, \dots p, j = 1,2 \dots n_i$
   d) $Y_{ij} = \mu + \alpha_i - \beta(X_{ij} - \bar{X}_{...}) + \epsilon_{ij}$; for all $i = 1,2, \dots p, j = 1,2 \dots n_i$

8) Smaller the experimental error _____ efficient the design.
   a) less b) more
   c) equally d) None of these

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

1) ANVOCA is a combination of _____ Statistical techniques.
2) In total confounding, every effect is confounded in ____ replicates.
3) BLUE of estimable treatments contrast can be expressed in ____ function of Q.
4) In a 2^6 factorial experiments, there are _____ three factor effects.

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

a) Define resolution V design.

b) What is complete block design?

c) In a 2^3 factorial experiment, the eight treatment combinations are grouped into two blocks of size 4 as follows:

Block 1	(c), (bc), (ac), (abc)
Block 2	(1), (b), (a), (ab)

Determine the confounded factorial effect.

d) Explain in brief orthogonal block design.

e) What is interblock analysis?

f) Check whether the given design is connected or not.

Block	Treatments
I	1,2
II	2,3
III	8,9

g) Explain in brief analysis of variance.

h) Define resolution IV design.

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

a) Define two-way ANOVA model with interaction. Obtain the least square estimates of parameters of the same model.

b) Define BIBD. Show that in a BIBD (b, k, v, r, λ) $\lambda(v-1) = r(k-1)$

c) Explain partial confounding with example.

d) Show that $c = (R^{\delta} - Nk^{-\delta}\acute{N})^{\mathsf{T}}$

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

a) Derive the test for testing treatment in one-way ANCOVA models.

b) Describe the analysis of 2^4 factorial experiments.

c) Derive the necessary and sufficient condition for orthogonality of a connected block design and hence show that RBD is connected as well as orthogonal.

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

a) Derive the test for testing hypothesis of equality of all treatment effects in two-way classification model without interaction.

b) Describe the analysis of 3^2 factorial experiments.

c) Explain the structure of half fraction in fraction factorial experiment.

Seat No.	

Set P

M.Sc. (Statistics) (Semester - IV) (New) (NEP CBCS) Examination: March/April – 2026
Reliability and Survival Analysis (2329402)

Day & Date: Thursday, 16-04-2026 Max. Marks: 60
Time: 03:00 PM To 05:30 PM

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

Q.1 A) Choose correct alternative. (MCQ) **08**

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

2) For any distribution, hazard rate $(h(t))$ is _____.
   a) $0 \leq h(t) \leq 1$ b) Always < 1
   c) Always ≤ 1 d) None of these

3) Censoring technique is used for reducing _____.
   a) time of experiment b) cost of experiment
   c) number of failures d) none of the above

4) Which of the following is an example of right censored observation?
   a) patient decided to move elsewhere
   b) patient become non-cooperative
   c) person may not experience the event before the study ends
   d) all the above

5) Nonparametric estimator of survival function under complete data is _____.
   a) unbiased estimator
   b) biased estimator
   c) unbiased and consistent estimator
   d) biased and consistent estimator

6) The censoring time is not identical for every censored observations in _____.
   a) right random censoring
   b) type I censoring
   c) type II censoring
   d) both type I and type II censoring

7) Greenwood's formula is used for estimating approximate value of _____ of Kaplan-Meier estimator.
   a) Mean b) Variance
   c) confidence interval d) Bias

8) Which of the following distribution has no ageing property?
   a) Lognormal b) Gamma
   c) Exponential d) None of these

B) State whether following statements are True or False. **04**

a) Exponential distribution has strictly decreasing failure rate.
b) MRL stands for Maximum Residual Life.
c) In time censoring, experimental time is fixed.
d) In series system with n-components, there are n cut sets.

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

a) Define IFRA class of distributions.
b) Define cumulative hazard function
c) Define $k-out-of-n$ system of components.
d) Define survival function of a random variable. Also obtain it for exponential random variable.
e) What is meant by a parallel system?
f) Obtain structure function for series system.
g) What do you mean by Decreasing Failure Rate distribution?
h) When is a vector said to be a path vector?

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

a) Discuss minimal path vector and minimal path set in detail.
b) Discuss reliability of a coherent system. Obtain the reliability of parallel system of n independent components.
c) For structure function, show that dual of a dual is primal.
d) Discuss relevant and irrelevant components.

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

a) Define type-I censoring and obtain the likelihood corresponding to a parametric model for lifetime distribution.
b) Describe NBU and NWU class of distributions. Also illustrate with the help of example.
c) How structure function is obtained using Minimal Path Sets? Discuss in detail, also illustrate with the help of an example.

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

a) Describe actuarial method of estimation of survival function.
b) Obtain maximum likelihood estimate of mean of the exponential distribution under type II censoring.
c) Define IFR and IFRA classes of distributions. Prove that $IFR \subset IFRA$.

Seat No.	

Set **P**

M.Sc. (Statistics) (Semester - IV) (New) (NEP CBCS)
Examination: March/April – 2026
Industrial Statistics (2329401)

Day & Date: Saturday, 18-04-2026 Max. Marks: 60
Time: 03:00 PM To 05:30 PM

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

Q.1 A) Choose correct alternative. (MCQ) **08**

1) The control limits of the p and np charts are based on the assumption that the number of nonconforming items follows _____ distribution.
   a) normal b) binomial
   c) poisson d) geometric

2) Which of the following is useful in searching the root cause of a problem?
   a) Ishekawa diagram b) Control chart
   c) Pareto chart d) defect concentration diagram

3) Which of the following is not a part of magnificent seven of SPC?
   a) Pareto chart b) Check sheet
   c) Scatter diagram d) single sampling plan

4) The capacity 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

5) When acceptance quality levels are very small, the sample size required by attribute sampling plan is _____.
   a) very large b) very small
   c) moderate to large d) none of the above

6) In demerit system, the unit will possibly fail in service and has a major defect in finish or appearance is classified as _____ defects.
   a) class A b) class B
   c) class C d) class D

7) Producer's risk is the probability of ____.
   a) accepting a good lot b) accepting a bad lot
   c) rejecting a good lot d) rejecting a bad lot

8) Normality assumption of population data values is made for _____ index.
   a) C_p b) C_{pk}
   c) c_{pm} d) all the above

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

1) The variation due to _____ causes cannot be identified and removed from the process.
2) The concept of Six-Sigma was developed by the _____ company.
3) For Shewhart control chart, appropriate distribution of run length is _____.
4) An out-of-control signal given by a control chart when the process is actually in-control is called _____.

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

a) Distinguish between defect and defective.
b) State the control limits of $\overline{X}$ and R charts when standards are known.
c) Discuss relation between testing of hypothesis and control chart.
d) What is CUSUM chart?
e) Define Consumer's risk and Producer's risk.
f) Write advantages of process control over product control.
g) What is DMAIC?
h) Define index C_{PK} and state relation between C_P and C_{PK}.

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

a) Define single sampling plan for attributes. Obtain OC function of the same.
b) What is CUSUM chart? Explain tabular CUSUM procedure for monitoring process mean.
c) Discuss various steps involved in the construction of p chart with fixed sample size.
d) Discuss various definitions of quality and various dimensions of quality.

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

a) List seven quality control tools and explain in detail any two of them.
b) Stating the assumptions, explain the construction and operations of the Hotelling T^2 chart to monitor process mean vector.
c) Describe construction, operation and underlying statistical principle of c chart.

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

a) Outline the steps involved in the construction of $\overline{X}$ and S charts.
b) Define process capability index C_P. Obtain $(1-\alpha)$ level confidence interval for C_P.
c) Explain variable sampling plan when upper specification is given and σ is known.

Seat No.	

Set P

M.Sc. (Statistics) (Semester - IV) (New) (NEP CBCS) Examination: March/April – 2026
Data Mining (2329405)

Day & Date: Tuesday, 21-04-2026 Max. Marks: 60
Time: 03:00 PM To 05:30 PM

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

Q.1 A) Choose correct alternative. (MCQ) **08**

1) Outlier detection is mainly performed in _____.
   a) Data cleaning b) Data discretization
   c) Data transformation d) Data validation

2) Which of the following algorithms is a lazy learner?
   a) Naive Bayes b) Decision Tree
   c) KNN d) Logistic Regression

3) Logistic regression outputs values between ____.
   a) $-\infty$ to $+\infty$ b) 0 to 1
   c) -1 to $+1$ d) Only integers

4) In SVM, data points that lie closest to the hyperplane are called _____.
   a) Support vectors b) Outliers
   c) Centroids d) Kernels

5) Support and Confidence are measures used in _____.
   a) Regression
   b) Classification
   c) Association rule mining
   d) Clustering

6) Decision trees may suffer from _____.
   a) Underfitting only
   b) Overfitting only
   c) Both overfitting and underfitting
   d) None of these

7) Which of the following is a non-linear activation function?
   a) Identity b) Sigmoid
   c) Linear d) Step function

8) In kNN, the value of “k” represents _____.
   a) Number of attributes
   b) Number of nearest neighbours to consider
   c) Number of classes
   d) Depth of the tree

B) State whether following statements are True or False. **04**

1) In decision trees, Information Gain is one of the criteria used for attribute selection.
2) Market Basket Analysis is mainly used for identifying classification rules.
3) Artificial Neural Networks always use linear activation functions.
4) Imbalanced data means that the number of instances in each class is approximately equal.

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

a) Define Supervised Learning.
b) What is Market Basket Analysis?
c) Explain the need of data cleaning.
d) Explain Tanh activation function.
e) Define sensitivity of the classifier.
f) Write the advantages of neural networks.
g) Explain Data transformation.
h) Write note on need for data Visualization.

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

a) Write the difference between Supervised Learning and Unsupervised Learning.
b) What is a confusion matrix? Also explain how evaluation measures are calculated using it.
c) Define the concept of an optimal hyperplane in SVM.
d) Explain the problem of imbalanced data. How can it affect model performance?

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

a) Discuss the types of activation functions.
b) Describe the steps involved in the data mining process from data collection to model validation.
c) Explain in detail, decision tree.

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

a) Explain artificial neural network in detail.
b) Explain the concept of entropy and how it is related to Information Gain.
c) Describe the CRISP-DM process model for data mining.