DEPARTMENT OF STATISTICS
B. Sc. (H) Statistics
SEM-II
Category-I

DISCIPLINE SPECIFIC CORE COURSE-4:

THEORY OF PROBABILITY DISTRIBUTIONS

CREDIT DISTRIBUTION, ELIGIBILITY, AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the Course			Eligibility Criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/ Practice		
Theory of probabilit distributions	4	3	0	1	Class XII pass with Mathematics	Descriptive Statistics, Probability Theory, Calculus

Learning Objectives
The learning objectives of this course are as follows:
• Acquaint students with requisite tools for problem-solving available in statistical methodology.
• Prepare students to handle two/three-dimensional data and familiarize them with different measures of association as well as regression.
• Introduction to various discrete and continuous distributions and their properties.

Learning Outcomes
The learning outcomes of this course are as follows:
• Understand the role of expectation and its usefulness. Get familiar with different kind of generating functions and their strength and weaknesses
• Handle problems based on two-dimensional random variables using Jacobians and bivariate transformations.
• Understand and exploit various measures of correlation and regression for problem-solving.
• Familiarize with the concept of partial and multiple correlation coefficients and their properties
• Get acquainted with various discrete and continuous distributions their properties and interrelations and solve problems based on them.

SYLLABUS OF DSC-4

Theory

UNIT I **(09 Hours)**
Expectation
Mathematical Expectation: Conditional expectations and its properties. Bivariate transformations with illustrations. Moments, moment generating function and its properties. Cumulants, cumulant generating function and its properties. Characteristic function and its properties. Inversion theorem for continuous random variables (without proof) along with applications.

UNIT II **(12 Hours)**
Expectation (contd.)
Some inequalities involving expectation - Cauchy Schwartz Inequality, Jenson's inequality.
Two-dimensional random variables: Joint probability mass function/ Joint probability density function, marginal and conditional probability mass function/ probability density function, independence of random variables, examples based on joint/marginal/conditional pmf/pdf.
Conditional expectation and variance, Jacobian of transformation, Bivariate transformation of random variables, and Examples based on bivariate transformation.

UNIT III **(09 Hours)**
Correlation and Regression
Properties of various measures of correlation and regression using expectation, Correlation Ratio, Intra-class correlation, Partial and multiple correlations – definition, Yule's notation, the plane of regression, properties of residuals, multiple and partial correlation coefficients and their properties (derivation based on three variables), the relationship between multiple, partial and total correlations and examples based on them.

UNIT IV **(15 Hours)**

Probability Distributions
Discrete probability distribution – Binomial, Poisson- measures of central tendency, dispersion, skewness and kurtosis, recurrence relations based on moments, moment generating function, cumulant generating function, characteristic function, additive property, fitting of distribution, and examples based on application.
Continuous Probability distribution - Normal - measures of central tendency, dispersion, skewness and kurtosis, recurrence relations based on moments, moment generating function, cumulant generating function, characteristic function, additive property fitting of distribution and examples based on application, Uniform distribution – moments, mgf, mean deviation and examples based on bivariate transformations.

PRACTICAL – 30 Hours

List of Practicals:

1. Practical based on regression lines and properties of regression coefficients.
2. Practical based on Correlation ratio.
3. Practical based on Intra-class correlation.
4. Practical based on multiple correlation coefficient.
5. Practical based on partial correlation coefficient

6. Practical based on planes of regression.
7. Word problems based on application s of Binomial distribution.
8. Practical based on fitting of Binomial distribution (when parameters are given).
9. Practical based on fitting of Binomial distribution (when parameters are not given).
10. Practical based on calculation of area under the normal curve.
11. Practical based on calculation of ordinates given area under the normal curve.
12. Practical based on fitting of the normal curve when parameters are not given.
13. Practical based on use of normal approximation to the binomial distribution.

Practical work to be conducted using electronic spreadsheet / EXCEL/ Statistical Software Package/ SPSS.

ESSENTIAL READINGS

- Goon, A.M., Gupta, M.K. and Dasgupta, B. (2016). *An Outline of Statistical Theory,* Vol. I, The World Press, Kolkata.
- Gupta, S. C. and Kapoor, V. K. (2020). *Fundamentals of Mathematical Statistics*, 12th Edn., S. Chand and Sons. Delhi.
- Hogg, R.V., Tanis, E.A. and Rao, J.M. (2009). *Probability and Statistical Inference*, 7th Ed., Pearson Education, New Delhi.
- Miller, I. and Miller, M. (2006). *John E. Freund's Mathematical Statistics with Applications*, 8th Ed., Pearson Education, Asia.
- Mukhopadhyay, P. (2016). *Mathematical Statistics.* Books And Allied, India.

SUGGESTED READINGS

- Mood, A.M. Graybill, F.A. and Boes, D.C. (2007). *Introduction to the Theory of Statistics*, 3rd Ed., (Reprint), Tata McGraw-Hill Pub. Co. Ltd.
- Rohatgi, V. K and Saleh M. E. (2015). *An Introduction to Probability and Statistics,* 3rd Edn. John Wiley & Sons, Inc., New Jersey.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch University of Delhi, from time to time

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DISCIPLINE SPECIFIC CORE COURSE-5:
APPLIED STATISTICS I

CREDIT DISTRIBUTION, ELIGIBILITY, AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the Course			Eligibility Criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/ Practice		
Applied Statistics I	4	3	0	1	Class XII pass with Mathematics	Descriptive Statistics

Learning Objectives

The learning objectives of this course are as follows:

● This course will help students to know the applications of Statistics and learn and apply these concepts in real life situations.
● This course will give exposure to two applied fields of statistics viz. Vital Statistics and Index Numbers.
● They will be having hands on practice of working on the data related to above mentioned fields.
● This course will help them understand about the working of the Indian Official Statistical System.

Learning Outcomes:

The learning outcomes of this course are as follows:

•   Understanding of the distinction between Vital Statistics and Demography.
•   Knowledge of basic measures of Mortality, Fertility, and Population Growth.
•   Ability to construct of Life Tables.
•   Understanding of fundamental concepts of Index Numbers.
•   Ability to construct Price and Quantity Index numbers, Consumer and Wholesale Price Index Numbers.
•   Knowledge of Official Statistical System in India, Statistical offices at the Centre and States along with their functions.

SYLLABUS OF DSC-5

Theory

UNIT I   **(18 Hours)**
Vital Statistics
Introduction, Sources of collecting vital statistics, Errors in census and registration data, Uses of Vital Statistics. Measurements of mortality: Crude death rate (CDR), Age specific death rate (ASDR), Standardized death rates and Infant mortality rate. Life table: Assumptions, description and construction of Complete life table. Definition of Abridged life table.
Measurements of fertility: Crude birth rate (CBR), General fertility rate (GFR), Age specific fertility rate (ASFR), Total fertility rate (TFR).
Measurements of population growth: Crude rate of natural increase, Pearle's vital index, Gross reproduction rate (GRR) and Net reproduction rate (NRR).

UNIT 2   **(12 Hours)**
Index numbers
Introduction, Problems involved in the construction of index numbers, Constructions of index numbers of Prices and Quantities. Index numbers based on Average of Price Relatives, Criteria for a good Index numbers. Errors in the measurement of Price and Quantity Index Numbers, Consumer price index number, Concept of Wholesale price index number with interpretation. Uses and Limitation of Index numbers.

UNIT 3   **(15 Hours)**
Indian Official Statistics

Introduction, Present official statistical system in India, Statistical offices at the Centre, Statistical offices in the States, Methods of collection of official statistics on population, price (retail as well wholesale).

PRACTICAL -30 Hours

List of Practicals:

1. To calculate CDR and ASDR for a given set of data
2. To find Standardized death rate by Direct and Indirect method
3. To construct a complete life table
4. To fill in the missing entries in a life table
5. To calculate CBR and GFR for a given set of data
6. To calculate ASFR for a given set of data
7. To calculate TFR for a given set of data
8. To calculate Crude rate of Natural Increase and Pearle's Vital Index
9. To calculate GRR and NRR for a given set of data and compare them
10. To Construct price and quantity index numbers by Laspeyre's, Paasche's, Marshall- Edgeworth, Drobish -Bowley, Walsch and Fisher's Formula.
11. To test the goodness of an Index number using Time Reversible Test and Factor Reversible Test
12. To Construct price index numbers based on Average of Price Relatives
13. To Construct Chain base index numbers
14. Base shifting, Splicing and Deflating of Index Numbers
15. To construct Consumer price index number using Aggregate Expenditure method and Family Budget method and compare

Practical work to be conducted using electronic spreadsheet / EXCEL/ Statistical Software Package/ SPSS.

ESSENTIAL READINGS:
- Croxton, Fredrick E, Cowden, Dudley J. and Klein, S. (1973): Applied General Statistics, 3rd edition, Prentice Hall of India Pvt. Ltd.
- Gun, A.M., Gupta, M.K. and Dasgupta, B. (2008): Fundamentals of Statistics, Vol. II, 9th edition, World Press Pvt. Ltd.
- Gupta, S.C., and Kapoor, V.K. (2008): Fundamentals of Applied Statistics, 4th edition (reprint 2010), Sultan Chand and Sons.
- Mukhopadhyay P. (2011): Applied Statistics, 2nd edition (revised reprint), Books and Allied Pvt. Ltd.

SUGGESTED READINGS
- Benjamin, B. (1968): Health and Vital Statistics. G. Allen and Unwin.
- Mudgett B.D. (1951): Index Numbers, John Wiley.
- Allen R.G.D. (1975): Index Numbers in Theory and Practice, Macmillan.
- Nagar A.L. & Das R. K. (1976): Basic Statistics.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch University of Delhi, from time to time.

CREDIT DISTRIBUTION, ELIGIBILITY, AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the Course			Eligibility Criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/ Practice		
Algebra For Statistics	4	3	0	1	Class XII pass with Mathematics	Nil

Learning Objectives
• Algebra serves as a building block that will enable students to learn more advanced techniques that will help them to solve problems more quickly and easily.

Learning Outcomes:
The learning outcomes of this course are as follows:
• Understanding the fundamental concepts of matrices and determinants
• Understanding of partitioning of matrices, Echelon form
• Solving Linear equations
• Knowledge of Vector spaces and Subspaces, Orthonormal Basis
• Identifying rank of a Matrix
• Computing generalized inverse, characteristic roots and vectors, quadratic forms

SYLLABUS OF DSC-6

Theory

UNIT I (09 Hours)

Algebra of matrices
A review related to triangular, symmetric, and skew-symmetric matrices, singular, and non-singular matrices, and their properties.
Idempotent matrices, Hermitian and skew Hermitian matrices, orthogonal matrices, Trace of a matrix, unitary, involutory and nilpotent matrices. Adjoint and inverse of a matrix and related properties. Partitioning of matrices and simple properties.

UNIT II (12 Hours)
Determinants
A review related to properties and applications of determinants for 3rd and higher orders. Alternant determinant, Circulant determinant, Jacobi's Theorem, the product of determinants. Use of determinants in solution to the system of linear equations, row

reduction and echelon forms, the matrix equations AX=B, solution sets of linear equations, Applications of linear equations, inverse of a matrix.

UNIT III   (09 Hours)

Vector spaces
Vector spaces, Subspaces, sum of subspaces, Span of a set, Linear dependence and independence, dimension and basis, Gram Schmidt Orthogonalization Process. Rank of a matrix, row-rank, column-rank, standard theorems on ranks, rank of the sum, and the product of two matrices.

UNIT IV   (15 Hours)
Generalized Inverse
Generalized inverse (concept, properties with illustrations). Characteristic roots and characteristic vector, Properties of characteristic roots and characteristic vector, Cayley Hamilton theorem and application, Spectral Decomposition. Quadratic forms, Derivatives of linear functions, and quadratic forms. Linear orthogonal transformation and their diagonalization.

PRACTICAL – 30 Hours

List of Practicals:

1. Inverse of a matrix by method of partitioning.
2. Every non-singular square matrix can be expressed as product of elementary matrices.
3. Generalised Inverse of a matrix and Symmetric Generalised Inverse of a matrix.
4. Find XGX' for any matrix X of order nxk; k< n, where G is generalized inverse of $X'X$ and study its properties.
5. Construction of Idempotent matrix and study its properties.
6. Construction of Orthogonal matrix and study its properties.
7. Characteristic roots and characteristic vectors and its properties
8. Cayley Hamilton Theorem and application.
9. Quadratic Form:
    (a) Reducing Quadratic Form into canonical form and find rank, index and signature of the form.
    (b) Identify the nature of Quadratic Form.
10. Construction of an orthonormal basis vector using Gram Schmidt Orthogonalization process.

Practical work to be conducted using electronic spreadsheet / EXCEL/ Statistical Software Package/ SPSS.

ESSENTIAL READINGS:
- Searle, S.R.: Matrix Algebra useful for Statistics, John Wiley & Sons, 1982.
- Krishnamurthy, V., Mainra, V.P. and Arora, J.L. (2015). An Introduction to Linear Algebra, East West Press Pvt. Ltd., New Delhi.
- Hadley, G.: Linear Algebra, Narosa Publishing House (Reprint), 2002.
- Gupta, S. C.: An Introduction to Matrices (Reprint), Sultan Chand & Sons, 2008.

SUGGESTED READINGS:

- Biswas, S. (1997). A Textbook of Matrix Algebra, New Age International.
- Singal, M.K. and Singal, Asha Rani: Algebra, R. Chand & Co., 2011.
Note: Examination scheme and mode shall be as prescribed by the Examination Branch University of Delhi, from time to time.

B.Sc.(Prog.)/B.A(Prog.) with Statistics as Major

Category-II

DISCIPLINE SPECIFIC CORE COURSE – 3: Statistical Methods

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Statistical Methods	4	3	0	1	Class XII pass with Mathematics	Descriptive Statistics

Course Objectives:

The learning objectives include:

- To know the difference between discrete and continuous random variables.
- To develop the thinking of students so that they can use the concepts of statistical probability distribution in real life.
- To understand the concept of random variables, probability distributions and expectation

Course Learning Outcomes:

 After completing this course, students should have developed a clear understanding of:

- Concept of random variables.
- Basic concepts of discrete & continuous random variables.
- Distinguish between Moments generating functions & Cumulant generating functions
- Concept of joint, marginal and conditional probability distribution for two dimensional random variables and their independence.