



INDEX

DEPARTMENT OF STATISTICS SEMESTER – II

<u>Sl. No.</u>	<u>Content</u>	<u>Page No.</u>
1	B.SC. (Hons.) Statistics DISCIPLINE SPECIFIC CORE (DSC) (1) Theory of Probability and distribution (2) Applied Statistics-I (3) Algebra of Statistics	02-09
2	B.A/B.Sc.(Program) with Statistics as Major DISCIPLINE SPECIFIC CORE (DSC) (1) Probability Theory and Discrete Probability Distributions (2) Random Variables and Continuous Probability Distributions	10-15
3	Bachelor in Multidisciplinary with Statistics as Non-Major DISCIPLINE SPECIFIC CORE (DSC) (1) Statistical Methods	16-18
4	POOL OF GENERIC ELECTIVES (1) Introductory Probability (2) Applications in Statistics-II	19-23

DEPARTMENT OF STATISTICS

B. Sc. (H) Statistics

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 probability distributions	4	3	0	1	B.Sc.(H) Statistics, Semester I	DSC-1,2,3 (STAT-DSC_101, 102, 103)

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

Hours:09

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

Hours:12

Expectation (contd.)

Some inequalities involving expectation - Cauchy Schwartz Inequality, Jensen'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

Hours:09

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

Hours:12

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

Hours:30

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 applications 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.

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	B.Sc.(H) Statistics, Semester	DSC-1,2,3 (STAT-DSC_101,

					I	102, 103)
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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

Hours:18

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

Hours:12

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

Hours:12

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

Hours:30

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.

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		
Algebra of Statistics	4	3	0	1	B.Sc.(H) Statistics, Semester I	DSC-1,2,3 (STAT-DSC_101, 102, 103)

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

Hours:09

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

Hours:12

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

Hours:09

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

Hours:12

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

Hours:30

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 XX' for any matrix X of order $n \times k$; $k < n$, where G is generalized inverse of 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.

Semester II

B.A./B.SC. (Program) with Statistics as Major

Category II

Discipline Specific Core Course-3: Probability Theory and Discrete 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		
Probability Theory and Discrete Probability Distributions	4	3	0	1	Class XII pass with mathematics	Knowledge of Basic Statistics

Course Objectives:

The Learning Objectives of this course are as follows:

- Understanding the concept of Probability
- 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.

Course Learning Outcomes:

After completing this course, there should be a clear understanding of:

- Understand the meaning of probability and probabilistic experiments.
- Familiarize with the four approaches to probability theory and particularly, the axiomatic approach, and use and manipulate the four axioms of probability comfortably to derive the results of other set operations
- Understand and exploit Addition and Multiplicative laws of probability
- Understand the meaning of conditional probability, Bayes' rule, and applications.

- The fundamental concept of discrete distributions and their properties.
- Moment-generating function, and recurrence relations for the said distributions

Syllabus of DSC- 3

Theory

Unit I: (15 hours)

Basics of Probability

Random experiment, sample point, sample space, event, algebra of events, Definition of Probability, classical, relative frequency, and axiomatic approaches to probability, merits, and demerits of these approaches (only general ideas to be given). Theorems on probability, conditional probability, and independent events. Bayes' theorem and its applications.

Unit II (10 hours)

Discrete probability distributions-I

Bernoulli distribution, Binomial distribution: Moments, moment generating function (m.g.f.), recurrence relation for probabilities, additive property for the binomial distribution, numerical problems based on binomial distributions, fitting of the binomial distribution.

Unit III (8 hours)

Discrete probability distributions-II

Poisson Distribution: Moments, moment generating function (m.g.f.), recurrence relation for probabilities, additive property of independent Poisson variates, numerical problems based on Poisson distributions, fitting of Poisson distribution.

Unit IV (12 hours)

Discrete probability distributions-III

Discrete uniform distribution, Negative Binominal distribution: Moments, moment generating function (m.g.f.). Geometric distribution: moments and m.g.f., Lack of memory property of Geometric distribution. Hypergeometric distribution: Mean and Variance.

Practical: (30 Hours)

List of Practicals:

1. Problems based on probabilities using the empirical definition of probability.
2. Problems based on Bayes theorem.
3. Problems based on conditional probability, and joint probabilities.
4. Fitting of binomial distributions for n and $p = q = \frac{1}{2}$ given.
5. Fitting of binomial distributions for n and p given.
6. Fitting of binomial distributions computing mean and variance.
7. Fitting of Poisson distributions for given value of λ .
8. Fitting of Poisson distributions after computing mean.
9. Application problems based on binomial distribution.
10. Application problems based on Poisson distribution.

ESSENTIAL READINGS:

1. Gupta, S.C and Kapoor, V. K (2021): Fundamental of mathematical statistics. S. Chand and sons.
2. Ross, S.M. (2002): A first course in Probability, 6th edition. Pearsons.
3. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2002). Fundamentals of Statistics, Vol. I, 8th Ed., The World Press, Kolkata.

SUGGESTED READINGS:

1. Miller, I. and Miller, M. (2006). John E. Freund's Mathematical Statistics with Applications, 7th Ed., Pearson Education, Asia.
2. 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.

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

Discipline Specific Core Course-4: Random Variables and Continuous 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		
Random Variables and Continuous Probability Distribution	4	3	0	1	Class XII pass with mathematics	Knowledge of Basic Statistics

Course Objectives:

- To know the difference between discrete and continuous random variables.
- Understanding of different probabilities distributions (Discrete and Continuous).
- To develop the thinking of students so that they can use the concepts of statistical probability distribution in real life.

Course Learning Outcomes:

After completing this course, there should be a clear understanding of:

- Understand the concept of a random variable, differentiate between independent and uncorrelated random variables,
- Distinguish between discrete, continuous, random variables and be able to represent them using probability mass, probability density, and cumulative distribution functions.
- Understand expectation and its properties, Compute variance and covariance in terms of expectation.
- Moment generating function, cumulant generating function and characteristic function.
- Marginal and conditional distribution
- The fundamental concept of continuous distributions and their properties.
- Moment generating function, and recurrence relations for the said distributions

Syllabus of DSC- 4

Theory

Unit –I

(15 hours)

Random Variables and Distribution Functions

Random variables: Discrete and continuous random variables, pmf, pdf, and cdf, illustrations of random variables and their properties, Bivariate probability distributions, marginal and conditional distributions; independence of variates (only general idea to be given). Transformation in univariate and bivariate distributions.

Unit II

(6 hours)

Mathematical Expectation and generating functions

Expectation of a random variable and its properties, Moments and cumulants, moment generating function, cumulant generating function, and characteristic function.

Unit III

(12 hours)

Continuous Distribution-I

Uniform distribution: moments, moment generating function (m.g.f.). Normal distribution as a limiting form of binominal distribution, characteristics of Normal distribution; mode, median, moments, and moment generating function (m.g.f.) of Normal Distribution, a linear combination of independent normal variates, area property of Normal distribution and related numerical problems, importance, and fitting of normal distribution.

Unit IV

(12 hours)

Continuous Distribution-II

Gamma distribution: Moments, moment generating function (m.g.f.). Beta distribution (first and second kind): Mean and variance. Exponential distribution: moments and m.g.f., memoryless property of Exponential distribution.

Practical: (30 Hours)

List of Practical:

1. Problems based on properties of pmf and pdf.
2. Problems based on Raw moments.
3. Problems based on Moments about any arbitrary point.
4. Problems based on Central Moments.
5. Problems based on the relation between Raw moments, Moments about any arbitrary point, and Central Moments.

6. Problems based on moments involving correct/incorrect values.
7. Problems based on marginal distributions.
8. Problems based on area property of normal distribution.
9. To find the ordinate for a given area for normal distribution.
10. Application based problems using normal distribution.
11. Fitting of normal distribution when parameters are given.
12. Fitting of normal distribution when parameters are not given.

ESSENTIAL READINGS:

4. Miller, I. and Miller, M. (2006). John E. Freund's Mathematical Statistics with Applications, 7th Ed., Pearson Education, Asia.
5. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2002). Fundamentals of Statistics, Vol. I, 8th Ed., The World Press, Kolkata.
6. Gupta, S.C and Kapoor, V. K (2021): Fundamental of mathematical statistics. S. Chand and sons

SUGGESTED READINGS:

1. 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.
2. Gupta, S. P. (2022). Statistical Methods 46th Edition, S. Chand and sons.

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

Bachelor in Multidisciplinary with Statistics as Minor

Category-III

DISCIPLINE SPECIFIC CORE COURSE – 2: 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	Knowledge of Basic 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.
- Discrete probability distributions with their properties.
- Continuous probability distributions with their properties.

SYLLABUS OF DSC

Theory

Unit – 1 (15 hours)

Random Variables

Random variables: Discrete and continuous random variables, pmf, pdf and cdf, illustrations of random variables and its properties, expectation of random variable and its properties. Variance, covariance and their properties with illustrations. Moments and cumulants, moment generating function with properties, cumulant generating function and characteristic function.

Unit – 2 (8 hours)

Bivariate Probability Distribution

Bivariate probability distributions, marginal and conditional distributions, independence of variates (only general idea to be given). Transformation in univariate and bivariate distributions.

Unit – 3 (10 hours)

Discrete Probability Distributions

Discrete probability distributions – 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.

Unit – 4 (12 hours)

Continuous Probability Distributions

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 and examples. Exponential distribution – moment generating function and lack of memory. Gamma distribution – moment generating function, cumulant generating function and additive property.

Practicals

List of Practicals: (30 hours)

(Practical to be performed on computer using Microsoft Excel/Electronic Spreadsheet/SPSS/Any Statistical Package)

1. Problems based on expectations, variance and co-variances.
2. Fitting of binomial distributions for n and $p = q = \frac{1}{2}$ and for n and p given.
3. Fitting of binomial distributions computing mean and variance.

4. Fitting of Poisson distributions for given λ and after estimating mean.
5. Fitting of suitable distribution.
6. Application problems based on Binomial distribution.
7. Application problems based on Poisson distribution.
8. Problems based on the Area property of Normal distribution.
9. Application problems based on Normal distribution.
10. Problems based on bivariate probability distributions.

Essential Readings

1. Goon, M., Gupta, M. K. and Dasgupta, B. (2003). *An outline of Statistical Theory*, Vol. I, 4th Ed., World Press, Kolkata.
2. Gupta, S. C. and Kapoor, V. K. (2020). *Fundamentals of Mathematical Statistics*, 12th Ed., Sul tan Chand and Sons.
3. Hogg, R. V., McKean, J., and Craig, A. T. (2005). *Introduction to mathematical statistics*. Pearson Education.
4. Rohtagi, V. K. and Saleh, A. K. Md. E. (2009). *An Introduction to Probability and Statistics*, 2nd Ed., John Wiley and Sons.

Suggestive Readings

1. Ross, S. A. (2007). *Introduction to Probability Models*, 9th Ed., Academic Press
2. Mood, A. M., Graybill, F. A. and Boss, D. C. (2007). *Introduction to the Theory of Statistics*, 3rd Ed., Tata McGraw Hill Publication.

DEPARTMENT OF STATISTICS

B. Sc. (H) Statistics

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES OFFERED BY DEPARTMENT OF STATISTICS CATEGORY-IV

GENERIC ELECTIVES : INTRODUCTORY PROBABILITY

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)	Department offering the Course
		Lecture	Tutorial	Practical/ Practice			
Introductory Probability	4	3	0	Nil	Class XII pass with Mathematics	Nil	Statistics

Learning Objectives :

- Acquaint students with the mathematical foundation of probability.
- familiarize students with important tools for statistical analyses at introductory level.
- Introduction to some common discrete and continuous distributions and their properties.

Learning Outcomes:

After taking this paper, the student should be able to:

- Understand the meaning of probability and probabilistic experiment. Various approaches to probability theory and in particular the axiomatic approach. Laws of probability, conditional probability, conditioning, and reduced sample space, compute joint and conditional probabilities. Bayes' rule and applications.
- Understand the concept of a random variable, expectation and its properties, Compute variance and covariance in terms of expectation. Moment generating function and its properties.
- Get familiar with some standard discrete and continuous distribution and the usefulness of Central limit Theorem in daily life.

SYLLABUS OF GE

Theory

UNIT-I**Hours:12****Probability**

Probability: Introduction, random experiments, sample space, events and algebra of events. Definitions of Probability – classical, statistical, and axiomatic. Conditional Probability, laws of addition and multiplication, independent events, theorem of total probability, Bayes' theorem and its applications.

UNIT II**Hours:16****Random Variables**

Random Variables: Discrete and continuous random variables, pmf, pdf, cdf. Illustrations of random variables and its properties. Expectation, variance, moments and moment generating function.

UNIT III**Hours:14****Probability Distributions**

Standard probability distributions: Binomial, Poisson, Geometric, Negative Binomial, Hypergeometric, Uniform, Normal, Exponential, Beta, Gamma. De-Moivre Laplace and Lindeberg-Levy Central Limit Theorem (C.L.T.) (Only Statements)

PRACTICAL**Hours:30****List of Practical:**

1. Application problems based on addition law of probability.
2. Application problems based on conditional probability.
3. Application problems based on Bayes law.
4. Application problems based on Expectation of random variable.
5. Computing MGF and how it helps in finding moments.
6. Computing cdf for discrete and continuous random variables drawing its graph.
7. Fitting of binomial distributions for n and $p = q = \frac{1}{2}$
8. Fitting of binomial distributions for n and p given.
9. Fitting of binomial distributions computing mean and variance.
10. Fitting of Poisson distributions for given value of λ .
11. Fitting of Poisson distributions after computing mean.
12. Application problems based on binomial distribution.
13. Application problems based on Poisson distribution.
14. Problems based on area property of normal distribution.
15. To find the ordinate for a given area for normal distribution.
16. Application based problems using normal distribution.
17. Fitting of normal distribution when parameters are given.
18. Fitting of normal distribution when parameters are not given.
19. Computing probabilities using Microsoft Excel functions `binomdist()`, `poisson()`, `normsdist()`, `normsinv()`, `normdist()`, and `norminv()`.
20. Computing Binomial probabilities for large n and small p using Microsoft Excel functions `binomdist()` and `poisson()`.
21. Computing Binomial probabilities for large n and $p \in (0.4, 0.6)$ using Microsoft Excel functions `binomdist()` and `normdist()`.

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

SUGGESTED READINGS:

1. Hogg, R.V., Tanis, E.A. and Rao, J.M. (2009). Probability and Statistical Inference, 7th Ed, Pearson Education, New Delhi.
2. Miller, I. and Miller, M. John E. Freund (2006). Mathematical Statistics with Applications, 7th Ed., Pearson Education, Asia.
3. Myer, P.L. (1970). Introductory Probability and Statistical Applications, Oxford & IBH Publishing, New Delhi.

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

GENERIC ELECTIVES : APPLICATIONS IN STATISTICS-II

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)	Department offering the Course
		Lecture	Tutorial	Practical/ Practice			
Applications in Statistics-II	4	3	0	Nil	Class XII pass with Mathematics	Nil	Statistics

Learning Objectives:

- Acquaint students with the current official statistical system in India
- Familiarize students with important concepts of Demand Analysis
- Introduction to Utility and Production functions.

Learning Outcomes:

After taking this paper, the student should be able to:

- Understand the current and prevailing official statistical system in India, role of MoSPI, CSO, NSSO, and their important publication
- Understand the laws of demand and supply, Price and Income elasticity of demand.
- Differentiate between Partial and Cross Elasticities of Demand, Engel's law, Pareto's law, and different curves of concentration.
- Understand theory of utility function, Utility Curve, Marginal rate of substitution, Budget line, and Construction of Utility Curve.

SYLLABUS OF GE

Theory

Unit I

Hours:12

Indian Official Statistics

Present official statistical system in India, Methods of collection of official statistics and their reliability and limitations. Role of Ministry of Statistics & Program Implementation (MoSPI), Central Statistical Office (CSO), National Sample Survey Office (NSSO), and National Statistical Commission. Government of India's Principal publications.

Unit II

Hours:10

Demand Analysis

Concept of differentiation and partial differential.

Introduction: Demand and Supply and its laws, Price Elasticity of Demand, Income elasticity of demand, Nature of commodities, Partial and Cross Elasticities of Demand, Types of data required for its estimation, computation of demand function from given price elasticity of demand, Engel's law and Engel Curves, Pareto's law of income distribution, Curves of concentration.

Unit III

Hours:10

Utility Function

Introduction: Theory of Utility, Statistical decision making under Utilities, general definition of utility function, advantages and disadvantage of Utility function, Utility Curve, Basic axioms of Utility, example of utility function, Indifference curves and their properties, Marginal rate of substitution, Budget line, constrained utility maximization, Construction of Utility Curve.

Unit IV

Hours:10

Production Function

Production function, Marginal productivity, Average productivity, Degree of production function, Linear homogeneous production function, Euler's theorem, Returns to scales, Isoquants, Isocost curves, Equilibrium of the firm, Marginal rate of technical substitution, Elasticity of substitution, Constant elasticity of substitution.

PRACTICAL/LAB WORK

Hours:30

List of Practical

1. Fitting of demand curve.
2. Calculate income elasticity of demand from given data.
3. Calculation of price elasticity of demand from the given data.
4. Estimation of constant demand function.
5. To fit Engel's curve and draw them.
6. Comparison of inequality in distribution of expenditure.
7. Fitting of Pareto distribution to given data.
8. Computation and plotting of Lorenz Curve and computation of concentration ratio.

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

ESSENTIAL READINGS:

- Fundamentals of Statistics, Vol.2, Goon, A. M., Gupta, M. K. and Dasgupta, B. (2001). World Press.
- Business Mathematics with Applications, S.R. Arora and Dinesh Khattar, S.Chand & Company Ltd.
- Applied Statistics, Parimal Mukhopadhyay (2011), Books and Allied (P) Ltd.
- Business Mathematics Theory and Applications, V.K. Kapoor (2012), Sultan Chand & Sons.

SUGGESTED READINGS:

- Guide to current Indian Official Statistics, Central Statistical Office, GOI, New Delhi.
- mospi.nic.in/nscr/iss.html.
- Business Mathematics with applications in Business and Economics, R.S. Soni, Pitambar Publishing Company (P) Ltd.

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