

DEPARTMENT OF STATISTICS

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B. Sc. (H) Statistics

Category-I

DISCIPLINE SPECIFIC CORE COURSE-7: SAMPLE SURVEYS

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		
Sample Surveys	4	3	0	1	Passed Class XII with Mathematics	Descriptive Statistics and probability theory

Learning Objectives:

The learning objectives of this course are to introduce:

- Tools and techniques for selecting a representative sample from a target population keeping in mind the objectives to be fulfilled.
- Obtain an estimator of the population parameter on the basis of the selected sample and study its properties.

Learning Outcomes:

After successful completion of this course, students should be able to:

- Understand the fundamental concepts of population and sample and the principles of sample survey
- Describe the value and methodologies for sample surveys versus other approaches to collecting information from populations.
- Determine the appropriate sample size and its allocation for nationwide sample surveys or for surveys to be conducted in a program area.
- Identify a proper sampling frame and select primary sample points.
- Apply steps involved in selecting a sample using Simple Random Sampling with or without replacement, Stratified Sampling, Systematic Sampling and Ratio and Regression Methods of Estimation

SYLLABUS OF DSC-7

Theory

UNIT I

(10 Hours)

Basics of Survey Sampling

Concept of population and sample, complete enumeration versus sampling, sampling and non-sampling errors. Types of sampling: non-probability and probability sampling, basic principles of sample survey, Steps involved in survey sampling.

UNIT II

(8 Hours)

Simple Random Sampling

Simple random sampling (SRS) with and without replacement, their properties, procedures of selecting a simple random sample, estimation of population mean and total, sampling for proportions, determination of sample size, bivariate population.

UNIT III

(10 Hours)

Stratified Random Sampling

Stratified Random Sampling: Estimation of population mean and total, Allocation of sample in different strata using equal, proportional, optimum and Neyman allocations, comparison with SRS, practical difficulties in adopting Neyman allocation, estimation of gain in precision due to stratification.

UNIT IV

(7 Hours)

Systematic Random Sampling

Systematic Random Sampling: Estimation of population mean and total, comparison with SRS and stratified sampling in the presence of linear trend, Yates' correction, definition of circular systematic sampling.

UNIT V

(10 Hours)

Ratio and Regression Method of Estimation

Ratio method of estimation, first approximation to ratio estimator and its bias, first approximation to variance of ratio estimator, estimator of variance of ratio estimator, comparison of ratio with SRS.

Regression method of estimation, first approximation to linear regression estimator and its bias, first approximation to variance of the linear regression estimator, estimator of variance of the linear regression estimator, comparison with SRS and ratio estimator.

Practical -30 Hours

List of Practicals :

1. To select SRS with and without replacement.
2. For a population of size 5, estimate population mean, population mean square and population variance. Enumerate all possible samples of size 2 by WR and establish all properties relative to SRS.
3. For a population of size 5, estimate population mean, population mean square and population variance. Enumerate all possible samples of size 2 by WOR and establish all properties relative to SRS.
4. Estimate mean, standard error and the sample size for SRSWOR.
5. Stratified Sampling: allocation of sample to strata by proportional. Compare the efficiencies of above method relative to SRS.
6. Stratified Sampling: allocation of sample to strata by Neyman's methods. Compare the efficiencies of above method relative to SRS.
7. Estimation of gain in precision in stratified sampling.
8. Comparison of systematic sampling with stratified sampling and SRS in the presence of a linear trend and using end's correction.
9. Ratio estimation: Calculate the population mean or total of the population. Calculate mean squares. Compare the efficiency of ratio estimator relative to SRS.
10. Regression estimation: Calculate the population mean or total of the population.
11. Calculate mean squares. Compare the efficiency of regression estimator relative to SRS.

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

ESSENTIAL READINGS

- Goon A M, Gupta M K and Dasgupta B (2018): Fundamentals of Statistics, Volume II, 9th Edition and 4th reprint.
- Cochran, W.G. (2011): Sampling Techniques (3rd Ed.), Wiley Eastern John Wiley and Sons.
- Sukhatme, P. V., Sukhatme, B. V., Sukhatme, S., Asok, C.(1984). Sampling Theories of Survey with Application, IOWA State University Press and Indian Society of Agricultural Statistics.

SUGGESTIVE READINGS:

- Gupta, S.C. and Kapoor, V.K. (2007): Fundamentals of Applied Statistics, Sultan Chand and Sons.
- Singh, D. and Chaudhary, F. S. (2015): Theory and Analysis of Sample Survey Designs.
- Murthy M.N. (1977): Sampling Theory & Statistical Methods, Statistical Pub. Society, Calcutta.
- Des Raj and Chandhok P. (1998): Sample Survey Theory, Narosa Publishing House.

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

DISCIPLINE SPECIFIC CORE COURSE-8: ADVANCED 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		
Advanced Probability Distributions	4	3	0	1	Passed Class XII with Mathematics	Theory of probability distributions

Learning Objectives

The learning objectives of this course are as follows:

- The course introduces students to advanced discrete and continuous probability distributions, and their important characteristics.
- It will enable them to understand the applications of these distributions.

Learning Outcomes

After successful completion of this course, students should be able to:

- Understand important advanced discrete probability distributions and their properties.
- Understand and apply important advanced continuous probability distributions and their properties.
- Apply their understanding of these distributions in real-life problems related to different areas of statistics.

SYLLABUS OF DSC-8

Theory

UNIT I

(15 hours)

Discrete Probability Distributions

Negative Binomial Distribution: Probability distribution, particular cases, moment generating function, cumulants, limiting case, derivation of moments from binomial distribution and recurrence relation for probabilities of negative binomial distribution. Examples and applications based on the distribution. Hypergeometric Distribution: Probability distribution, mean, variance, approximation to Binomial Distribution and recurrence relation. Examples and applications based on the distribution. Geometric Distribution: Probability distribution, lack of memory property, moments and moment generating function. Examples and applications based on the distribution. Multinomial Distribution: Probability distribution and practical application.

UNIT II

(15 hours)

Continuous Probability Distributions

Rectangular or Uniform Distribution: Definition, probability distribution and cumulative probability distribution, moments, and moment generating function, characteristic function and mean deviation about mean. Examples and applications based on the distribution. Gamma Distribution: Definition and properties, probability distribution, mean, variance, moment generating function, cumulant generating function, additive property and limiting case. Examples and applications based on the distribution. Beta Distribution: Beta Distribution of the first kind: Definition, probability distribution and cumulative probability distribution, mean, variance and harmonic mean. Beta Distribution of the second kind: Definition, probability distribution, mean, variance and harmonic mean. Examples and applications based on the distributions.

UNIT III

(15 hours)

Continuous Probability Distributions (contd.)

Exponential Distribution: Definition, probability distribution and cumulative probability distribution, moment generating function, mean, variance and lack of memory property. Examples and applications based on the distribution. Standard Laplace (Double Exponential) Distribution: Definition, probability distribution, characteristic function and moments. Two Parameter Laplace Distribution: Definition, probability distribution, characteristic function and moments. Examples and applications based on the distribution. Weibull Distribution: Probability distribution, moments and practical applications. Logistic Distributions: Probability distribution, moments and practical applications. Cauchy Distribution: Definition, probability distribution, characteristics function, additive property and moments. Examples and applications based on the distribution.

PRACTICAL – 30 Hours

List of Practicals:

Practicals based on:

1. Application of Negative Binomial Distribution.

2. Fitting of Negative Binomial Distribution.
3. Application of Hypergeometric Distribution
4. Fitting of Geometric Distribution.
5. Lack of memory property of Geometric Distribution
6. Applications of
 - (a) Geometric Distribution.
 - (b) Multinomial Distribution.
 - (c) Rectangular Distribution
 - (d) Gamma Distribution
 - (e) Beta Distribution.
 - (f) Exponential Distribution.
 - (g) Weibull Distribution.
 - (h) Logistic Distribution.
 - (i) Cauchy Distribution.
7. Lack of memory property of Exponential Distribution.

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

ESSENTIAL READINGS

- Gupta, S. C. and Kapoor, V. K. (2020). Fundamentals of Mathematical Statistics, Twelfth Edition, Sultan Chand and Sons, Delhi.
- Ross, Sheldon M. (2013): A First Course in Probability, Ninth Edition, Pearson.
- Miller, I. and Miller, M. (2006). John E. Freund's Mathematical Statistics with Applications, Eight Edition., Pearson Education, Asia.
- Mood, A.M. Graybill, F.A. and Boes, D.C. (2007). Introduction to the Theory of Statistics, Third Edition, (Reprint), Tata McGraw-Hill Pub. Co. Ltd.

SUGGESTED READINGS

- Rohatgi, V. K and Saleh M. E. (2015). An Introduction to Probability and Statistics, Third Edition, John Wiley and Sons, Inc., New Jersey.
- Hogg, R.V., Tanis, E.A. and Rao, J.M. (2009). Probability and Statistical Inference, 7th Ed., Pearson Education, New Delhi.
- Ross, Sheldon M.(2009). Introduction to Probability and Statistics for Engineers and Scientists, Fourth Edition, Academic Press.

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

DISCIPLINE SPECIFIC CORE COURSE – 9: MATHEMATICAL ANALYSIS

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		
Mathematical Analysis- DSC-09	4	3	0	1	Passed Class XII with Mathematics	Nil

Learning Objectives

The learning objectives include:

- To study Real Analysis, which deals with the analytical properties of real functions and sequences.
- To study Numerical Analysis, which is the study of algorithms that use numerical approximation for the problems of mathematical analysis.

Learning Outcomes:

After successful completion of this course, students should be able to:

- Understand the fundamental properties of real numbers and real-valued functions.
- Understand the Analytical properties of sequences.
- Apply Infinite series, their properties and different tests.
- Apply limits, continuity, differentiability, and mean value theorems.
- Use the fundamentals of numerical analysis, interpolation, numerical integration and difference equation.

SYLLABUS OF DSC-9

Theory

UNIT I

(10 hours)

Set Theory and Sequences

Completeness: The Completeness property of \mathbb{R} ; Archimedean property in \mathbb{R} ; Neighbourhood and limit points: Neighbourhood, Open Set, Closed Set, Supremum and Infimum, Limit Point of a Set; Sequences: Definition of a Sequence, Convergent Sequence, Divergent Sequence, Oscillatory Sequence, Cauchy Sequence, Monotone Sequence.

UNIT II

(10 hours)

Series

Infinite series, positive termed series and their convergence, Comparison test, D'Alembert's ratio test, Cauchy's n^{th} root test, Raabe's test. Gauss test, Cauchy's condensation test and integral test (Statements and Examples only). Absolute convergence of series, Conditional convergence.

UNIT III

(10 hours)

Limit and Continuity

Review of limit, continuity and differentiability, uniform Continuity and boundedness of a function. Rolle's and Lagrange's Mean Value theorems. Taylor's theorem with Lagrange's and Cauchy's form of remainder (without proof). Taylor's and Maclaurin's series expansions of $\sin(x)$, $\cos(x)$, $\log(1+x)$.

UNIT IV

(15 hours)

Numerical Methods

Factorial, finite differences and interpolation. Operators, E and divided difference. Newton's forward, backward and divided differences interpolation formulae. Lagrange's interpolation formulae. Gauss and Stirling interpolation formulae. Numerical integration. Trapezoidal rule, Simpson's one-third rule, three-eighths rule, Stirling's approximation to factorial n. Solution of difference equations of first order, Euler Maclaurin's summation formula.

PRACTICAL/LAB WORK – (30 hours)

List of Practical:

Practicals based on:

1. Formation of difference table, fitting of polynomial and missing terms for equal interval of differencing.
2. Newton's Gregory forward difference interpolation formula.
3. Newton's backward difference interpolation formula.
4. Newton's divided difference and Lagrange's interpolation formula.
5. Gauss forward, Gauss backward central difference interpolation formula.
6. Stirling's central difference interpolation formula.
7. Lagrange's Inverse interpolation formula.
8. Method of successive approximation or iteration.
9. Method of reversion of series.
10. Trapezoidal Rule, Simpson's one-third rule, Simpson's three-eighth rule, Weddle's rule.
11. Euler-Maclaurin summation formula

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

ESSENTIAL READINGS

- Appostol, T.M. (1987). Mathematical Analysis, 2nd Ed., Narosa Publishing House, New Delhi
- Ghorpade, S.R. and Limaye, B.V. (2006). A Course in Calculus and Real Analysis, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint.
- Sastry, S.S. (2000). Introductory Methods of Numerical Analysis, 3rd Ed., Prentice Hall of India Pvt. Ltd., New Delhi.

SUGGESTIVE READINGS:

- Bartle, R.G. and Sherbert, D.R. (2002). Introduction to Real Analysis, (3rd Ed.), John Wiley and Sons (Asia) Pte. Ltd., Singapore.
- Jain, M.K., Iyengar, S.R.K. and Jain, R.K. (2003). Numerical methods for scientific and engineering computation, New age International Publisher, India.
- Malik, S.C. and Arora, S. (1994). Mathematical Analysis, Second Edition, Wiley Eastern Limited, New Age International Limited, New Delhi.
- Mukherjee, Kr. Kalyan (1990). Numerical Analysis. New Central Book Agency.
- Narayan, S. (1987). A course of Mathematical Analysis, 12th revised Ed., S. Chand & Co. (Pvt.) Ltd., New Delhi.

- Somasundram, D. and Chaudhary, B. (1987). A First Course in Mathematical Analysis, Narosa Publishing House, New Delhi.

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