

**BACHELORS WITH STATISTICS AS MAJOR
5th SEMESTER**

STS522J1: STATISTICS: SAMPLING THEORY

Credits: 3 Theory +1 Practical

THEORY: 45 HOURS & PRACTICAL: 30 HOURS

Course Objectives:

To understand the concept of sampling technique and their applications in statistical inference.

Course Learning Outcomes:

After completing this course, students must be able:

- To understand the concept of census and sampling process, reasons for opting the sampling methods, sampling and non-sampling errors.
- To understand the concept of probability sampling with their applications in various fields.

THEORY: 03 CREDITS

UNIT I

Sampling Theory: Concept of population and sample, Need for sampling, Census and sample survey, basic concept in sampling, Principles of sample survey, Principle Steps of Sample Survey, advantages of sample survey over census. Sampling and non-Sampling errors, Types of sampling: non-probability (definition only) and probability sampling, sample size determination.

UNIT II

Simple random sampling (SRS) with and without replacement. Merits and demerits of Simple random sampling (SRS). Methods of selecting SRS. Estimation of mean and variance.

UNIT III

Stratified random sampling: Need for stratification. Principles of stratification. Advantages of stratified sampling over simple random sampling. Estimation of mean and variance. Proportion and equal allocation: Allocation of sample size under proportional and equal allocation and variance under these allocation.

PRACTICAL: 01 CREDIT

Using Statistical / Computational Software's

Problems based on:

- I. Selection of sample and determination of sample size.
- II. Estimation of mean and variance under SRSWR
- III. Estimation of mean and variance under SRSWOR
- IV. Estimation of mean and variance under Stratified sampling
- V. Allocation of sample size in stratified sampling

BOOKS RECOMMENDED:

1. Murthy M.N: Sampling theory and Methods, Statistical Publisher Society, Calcutta,(1967).
2. Des Raj: sample Survey Theory, Narosa publishing house,India(2000).
3. Sampath S.: Sampling theory and Methods. Narosa Publishing House,India (2000).
4. Sukhatme B.V.: Sample Survey methods and its Applications, Indian Society of Agricultural Statistics(1984).
5. S.C Gupta and V.K Kapoor: Fundamentals of Applied Statistics.10th Edition; Sultan Chand & Sons,(2002).
6. William G Cochran: Sampling Techniques: 3rd Edition; John Wiley and Sons,(1977).

**BACHELORS WITH STATISTICS AS MAJOR
5th SEMESTER**

STS522J2: STATISTICS: OPERATIONS RESEARCH-I

Credits: 4 Theory +2 Practical

THEORY: 60 HOURS & PRACTICAL: 60 HOURS

Course Objectives:

- To have a clear understanding of when to apply various optimization techniques like Simplex Methods, Transportation and Assignment Problems.

Course Learning Outcomes:

- After completing this course, students must be able:
- To understand the concept of linear programming its formulation and applications.
- To understand the concept of Graphical method, Simplex method and Transportation problems.

THEORY: 04 CREDITS

UNIT I

Operations Research (OR): Introduction to Operations Research its Development, characteristics and scope. Importance of Operations Research in industry. Limitations of OR. Linear programming: Introduction to linear programming (LPP), basic solution, basic feasible solution, non-feasible solution and optimum solution. Slack & surplus variables in LPP's.

UNIT II

Mathematical formulation of LPP, Concept of Convex set, graphical method of solving LPP, Standard form of LPP. Simplex Method: Iterative nature of simplex method, basic computational details of simplex algorithm and summary. Concept of duality with simple examples.

UNIT III

Artificial variable techniques (Two-phase and Big-M techniques) for solving a general LPP. Transportation Problem (TP): Balanced and unbalanced Transportation Problem, Mathematical formulation and tabular representation. Concept of feasible, Basic feasible and optimal solutions with reference to T.P.

UNIT IV

Methods for finding initial basic feasible solution: North West Corner Rule, Lowest Cost Entry, Vogel's Approximation method. Modified Distribution method to find the optimal solution. Assignment problem: Balanced and unbalanced Assignment Problem, Hungarian method to find optimal assignment.

PRACTICAL: 02 CREDITS

Using Statistical / Computational Software's

Problems based on:

- I. Formulation of LPPs.
- II. Solving LPPs by graphical and simplex methods.
- III. Solving LPPs by artificial technique.
- IV. Problems based on transportation problems.
- V. Problems based on Assignment problems.

BOOKS RECOMMENDED:

1. Gass S.I: Linear Programming Methods and Applications, McGraw Hill,(1975).
2. S.D. Sharma: Operations Research, Kedar Nath Ram Nath & Co, Meerut,(1994).
3. P. K. Gupta and D.S. Hira: Operations Research, S. Chand New Delhi,(2009).
4. H.A. Taha: Operations Research: An introduction Person Prentice Hall,(2009).
5. KantiSwarup, Gupta, P.K. and Manmohan: Operations Research, 13th Edition, Sultan Chand and Sons,(2007).

**BACHELORS WITH STATISTICS AS MAJOR
5th SEMESTER**

STS522J3: STATISTICS: NON-PARAMETRIC TESTS

Credits: 4 Theory +2 Practical

THEORY: 60 HOURS & PRACTICAL: 60 HOURS

Course Objectives:

To have a clear understanding of the concepts and applications of non-parametric tests and measures of association with multiple classifications.

Course Outcomes:

After completing this course, students shall be able:

- To Understand the concept of sign tests, median tests, and Wilcoxon-Signed Rank tests with their applications.
- To test the equality of k independent samples using the Kruskal-Wallis test.
- To test the Kendall's Tau and Spearman's coefficient for measuring association in bivariate samples.
- To test the Friedman's two-way ANOVA by ranks with multiple classifications.

THEORY: 04 CREDITS

UNIT I

Non- Parametric Inference: Introduction, Advantages and disadvantages of non- parametric tests. Sign Test-one sample and two samples: assumptions, applications and importance. Median test assumptions: applications and importance.

UNIT II

Wilcoxon-Signed rank test- one sample and two samples, assumptions, applications and importance, Wilcoxon –Mann Whitney test :assumptions, applications and importance. Test of randomness based on total number of runs:assumptions, applications and importance.

UNIT-III

Wald –Wilfritz run test, Kolmogorov-Smirnov- one sample and two samples test (for samples of equal size)::assumptions, applications and importance. Tests for equality of k independent samples: Kruskal-Wallis one way ANOVA test.

UNIT-IV

Measures of Association for bivariate samples: Kendall's Tau coefficient, Spearman's coefficient of Rank correlation, Measures of association in multiple classifications: Friedman's two-way ANOVA by ranks in a k x n table.

Problems based on:

- I. Conduct a Median Test using two samples.
- II. Apply the Wilcoxon-Signed Rank Test on a one-sample dataset.
- III. Conduct a Wilcoxon–Mann–Whitney test on two independent samples.
- IV. Perform a Wald–Wolfowitz Run Test for randomness based on a given dataset.
- V. Apply the Kolmogorov-Smirnov Test for two independent samples of equal size.
- VI. Conduct a Kruskal-Wallis One-Way ANOVA Test on a dataset with more than two independent samples.
- VII. Calculate Kendall's Tau coefficient for a bivariate dataset.
- VIII. Perform a Friedman's Two-Way ANOVA by ranks.

BOOKSRECOMMENDED:

1. Johnston, J.. Econometric Methods, Mc Graw Hill Kogakusha Ltd,(1984).
2. Judge, G.C., Hill, R.C. Griffiths, W.E., Lutkepohl, H. and Lee, T-C. Introduction to the Theory and Practice of Econometrics, Second Edition, John Wiley & Sons(1988).
3. Kendall, M.G. and Stuart, A.. The Advanced Theory of Statistics (Vol. III), Second Edition, Charles Griffin(1968).
4. Kmenta, J.. Elements of Econometrics, Second Edition, Mac millan,(1986).
5. Medhi, J.. Stochastic Processes, Second Edition, Wiley Eastern, New Delhi,(1994)
6. Montgomery, D.C. and Johnson, L.A.. Forecasting and Time Series Analysis, Mc Graw Hill, New York,(1976).
7. Peter J. Brockwell and Richard A. Daris. Introduction to time Series and Forecasting, Second Edition. Springer-Verlag, New York, Inc.(2002) (Springer Texts in Statistics)

**BACHELORS WITH STATISTICS AS MAJOR
5th SEMESTER**

STS522N: STATISTICS: SAMPLING THEORY

Credits: 3 Theory +1 Practical

THEORY: 45 HOURS & PRACTICAL: 30 HOURS

Course Objectives:

To understand the concept of sampling technique and their applications in statistical inference.

Course Learning Outcomes:

After completing this course, students must be able:

- To understand the concept of census and sampling process, reasons for opting the sampling methods, sampling and non-sampling errors.
- To understand the concept of probability sampling with their applications in various fields.

THEORY: 03 CREDITS

UNIT I

Sampling Theory: Concept of population and sample, Need for sampling, Census and sample survey, basic concept in sampling, Principles of sample survey, Principle Steps of Sample Survey, advantages of sample survey over census. Sampling and non-Sampling errors, Types of sampling: non-probability (definition only) and probability sampling, sample size determination.

UNIT II

Simple random sampling (SRS) with and without replacement. Merits and demerits of Simple random sampling (SRS). Methods of selecting SRS. Estimation of mean and variance.

UNIT III

Stratified random sampling: Need for stratification. Principles of stratification. Advantages of stratified sampling over simple random sampling. Estimation of mean and variance. Proportion and equal allocation: Allocation of sample size under proportional and equal allocation and variance under these allocation.

Problems based on:

- I. Selection of sample and determination of sample size.
- II. Estimation of mean and variance under SRSWR
- III. Estimation of mean and variance under SRSWOR
- IV. Estimation of mean and variance under Stratified sampling
- V. Allocation of sample size in stratified sampling.

BOOKS RECOMMENDED:

1. Murthy M.N: Sampling theory and Methods, Statistical Publisher Society, Calcutta,(1967).
2. Des Raj: sample Survey Theory, Narosa publishing house,India(2000).
3. Sampath S.: Sampling theory and Methods. Narosa Publishing House,India (2000).
4. Sukhatme B.V.: Sample Survey methods and its Applications, Indian Society of Agricultural Statistics(1984).
5. S.C Gupta and V.K Kapoor: Fundamentals of Applied Statistics.10th Edition; Sultan Chand & Sons,(2002).
6. William G Cochran: Sampling Techniques: 3rd Edition; John Wiley and Sons,(1977).

**BACHELORS WITH STATISTICS AS MAJOR
6th SEMESTER**

STS622J1: STATISTICS: STATISTICAL COMPUTING-I

Credits: 3 Theory +1 Practical

THEORY: 45 HOURS & PRACTICAL: 30 HOURS

Course Objectives:

To express the students to the real-life skill for statistical computing analysis and graphical interpretation using software skill. Hands on training on the real-life problems can be done on any one of the statistical software/excel to enhance data analysis skills.

Course Outcomes:

After completing this course, students must be able:

- To understand the Graphical representation of data sets.
- To understand the descriptive statistics and Correlation analysis.
- To understand the usages of statistical and computational software's.

THEORY: 03 CREDITS

UNIT-I

Introduction to Computers: Historical evolution of Computers. Generations of Computers. Classification of Computers, Applications of Computers, Computer Memory: Primary and Secondary Memory, Hardware: CPU, I/O Devices.

UNIT II

Word Processing: Creating and Saving a Document, Editing the Text: Printing, Saving and Importing Documents. Basics of Excel: Data Entry, Data sorting, Data validation, filtering of data, built in statistical and Mathematical Functions in Excel.

UNIT III

Diagrammatic and Graphical representation of Data in excel: bar diagrams and pie diagrams, Histogram, frequency Polygon, frequency curve, Working with data manipulation, descriptive statistics, simple Correlation.

PRACTICAL: 01 CREDIT

Using Statistical / Computational Software's

- I. Problems based on graphical representation of data by bar diagrams and pie diagrams
- II. Problems based on graphical representation of data by Histogram
- III. Problems based on graphical representation of data by Frequency polygons,
- IV. Problems based on calculation of Measures of Central Tendency.
- V. Problems based on calculation of Measures of Dispersion.
- VI. Problems based on calculation of Correlation.

BOOKS RECOMMENDED:

1. Moore, D.S. and McCabe, G.P. and Craig, B.A.: Introduction to the Practice of Statistics, W.H. Freeman, (2014).
2. Cunningham, B.J.: Using SPSS: An Interactive Hands-on approach, (2012).
3. Cho, M.J., Martinez, W.L.: Statistics in MATLAB: A Primer, Chapman and Hall/CRC, (2014).
4. E.J. Dudewicz and S.N. Mishra. : Modern Mathematical Statistics, Willy, Int'l Students edition, (1988).
5. John Verzani.: Using R for Introductory Statistics. Chapman & Hall/CRC, (2005).

6. S.C. Gupta and V.K. Kapoor: Fundamentals of Mathematical Statistics, Sultan Chand & Sons,(2012).

**BACHELORS WITH STATISTICS AS MAJOR
6thSEMESTER**

STS622J2: STATISTICS:STATISTICAL INFERENCE

Credits: 4 Theory +2 Practical

THEORY: 60 HOURS & PRACTICAL: 60 HOURS

Course Objectives:

To express the students to the concept of good requirements of good estimators and its relations with different theorems and inequalities.

- To express the students to the concept of estimation of Parameters and its practical utility in real life problems.

Course Learning Outcomes:

After completing this course, students must be able:

- To understand the concept of good estimators and their applications in practical world.
- To understand the concept of estimation techniques and their applicability in real data sets.

THEORY: 04 CREDITS

UNIT I

Statistical Inference: Parameter, Parameter space, Statistic and its sampling distribution. Types of Estimation (Point and Interval estimation), Confidence Interval. Estimate and estimator. Requirements of a good estimator with examples. Unbiasedness, consistency, efficiency and sufficiency.

UNIT-II

Methods of Estimation: Maximum likelihood Estimation (MLE), method of moments, method of minimum chi-square, method of minimum variances and method of least square properties and applications. Examples on MLE and method of moments.

UNIT- III

Complete statistic, Minimum variance unbiased estimator (MVUE), Factorization theorem (statement and applications) with examples. Rao-Blackwell statement and applications, Cramer-Rao inequality statement and applications.

UNIT IV

Test of significance: Null and alternative hypotheses (simple and composite), review of Type-I and Type-II errors with examples, critical region, level of significance, size and power, best critical region, most powerful test, uniformly most powerful test, Neyman Pearson Lemma (statement and applications to construct most powerful test).

PRACTICAL: 02 CREDITS**Using Statistical / Computational Software's****Problems based on:**

- I. Unbiased estimators, Consistent estimators, efficient estimators and relative efficiency of estimators.
- II. Sufficient Estimators , Complete Sufficient estimators
- III. Maximum Likelihood Estimation.
- IV. Estimation by the method of moments.

Books Recommended:

1. Goon A.M., Gupta M.K.: Das Gupta. B.: Fundamentals of Statistics, Vol. I, World Press, Calcutta, (2005).
2. Rohatgi V.K. and Saleh, A.K.Md.E.: An Introduction to Probability and Statistics. 2nd Edn. (Reprint) John Wiley and Sons, (2009).
3. Miller, I. and Miller, M.: John E. Freund's Mathematical Statistics (6th addition, low price edition), Prentice Hall of India, (2002).
4. Dudewicz, E.J., and Mishra, S.N.: Modern Mathematical Statistics. John Wiley & Sons, (1988).
5. Bhat B.R, Srivenkatramana T and Rao Madhava K.S.: Statistics: A Beginner's Text, Vol. I, New Age International (P) Ltd, (1997).
6. Snedecor G.W and Cochran W.G: Statistical Methods. Iowa State University Press, (1967).

**BACHELORS WITH STATISTICS AS MAJOR
6th SEMESTER**

STS622J3: STATISTICS:DESIGN OF EXPERIMENTS

Credits: 4 Theory +2 Practical

THEORY: 60 HOURS & PRACTICAL: 60 HOURS

Course Objectives:

- To express the students to the real-life skill for statistical of concept of Completely Randomized Design, Randomized Block Design and Latin Square Design.

Course Learning Outcomes:

After completing this course, students should be able:

- To understand the concept of Analysis of Variance and their applications.
- To understand the concept of Completely Randomized Design, Randomized Block Design and Latin Square Design and its applications.

THEORY: 04 CREDITS

UNIT I

Analysis of Variance (ANOVA): Assumptions and applications, ANOVA for one way and two way classification (using Principle of LSE). ANOVA table its interpretation.

UNIT-II

Design of Experiments: Introduction, Terminology in experimental designs. Experiment, Experimental unit, Experimental Error, Treatments, Blocks, Replication, Precision, Contour Map, Yield, Uniformity Trials. Principles of Experimental Design: Randomization, Replication and Local control.

UNIT- III

Completely Randomized Design (CRD): layout, analysis, advantages and disadvantages. Randomized Block Design (RBD): layout, analysis, advantages and disadvantages of RBD over CRD.

UNIT- IV

Latin Square Design (LSD) layout, analysis of $m \times m$ LSD for one observation per experimental unit; advantages and disadvantages. Single missing observation analysis for LSD and RBD. Relative efficiency of LSD over RBD & CRD.

PRACTICAL: 02 CREDITS

Using Statistical / Computational Software's

Problem based on:

- I. Analysis of variance in one-way classification.
- II. Analysis of variance in two-way classification
- III. Analysis of CRD.
- IV. Analysis of RBD.
- V. Analysis of LSD

Books Recommended:

1. Croton F.E and Cowden D.J: Applied General Statistics, Prentice Hall of India,(1969).
2. Goon A.M., Gupta M.K. Das Gupta B.: Fundamentals of Statistics, Vol. II, World Press, and Calcutta,(1986).
3. Croton F.E and Cowden D.J: Applied General Statistics, Prentice Hall of India,(1969).
4. S.C Gupta and V.K Kapoor: Fundamentals of Applied Statistics. S. Chand New Delhi,(2002).
5. Cochran W.G and Cox G.M: Experimental Designs, John Wiley and sons(1957).
6. Das M.N and Giri: Design and Analysis of Experiments, Springer Verlag,(1986).

**BACHELORS WITH STATISTICS AS MAJOR
6th SEMESTER**

STS622N: STATISTICS: STATISTICAL COMPUTING-I

Credits: 3 Theory +1 Practical

THEORY: 45 HOURS & PRACTICAL: 30 HOURS

Course Objectives:

To express the students to the real-life skill for statistical computing analysis and graphical interpretation using software skill. Hands on training on the real-life problems can be done on any one of the statistical software/excel to enhance data analysis skills.

Course Outcomes:

After completing this course, students must be able:

- To understand the Graphical representation of data sets.
- To understand the descriptive statistics and Correlation analysis.
- To understand the usages of statistical and computational software's.

THEORY: 03 CREDITS

UNIT-I

Introduction to Computers: Historical evolution of Computers. Generations of Computers. Classification of Computers, Applications of Computers, Computer Memory: Primary and Secondary Memory, Hardware: CPU, I/O Devices.

UNIT II

Word Processing: Creating and Saving a Document, Editing the Text: Printing, Saving and Importing Documents. Basics of Excel: Data Entry, Data sorting, Data validation, filtering of data, built in statistical and Mathematical Functions in Excel.

UNIT III

Diagrammatic and Graphical representation of Data in excel: bar diagrams and pie diagrams, Histogram, frequency Polygon, frequency curve, Working with data manipulation, descriptive statistics, simple Correlation.

PRACTICAL: 01 CREDIT

Using Statistical / Computational Software's

- I. Problems based on graphical representation of data by bar diagrams and pie diagrams
- II. Problems based on graphical representation of data by Histogram
- III. Problems based on graphical representation of data by Frequency polygons,
- IV. Problems based on calculation of Measures of Central Tendency.
- V. Problems based on calculation of Measures of Dispersion.
- VI. Problems based on calculation of Correlation.

BOOKS RECOMMENDED:

1. Moore, D.S. and McCabe, G.P. and Craig, B.A.: Introduction to the Practice of Statistics, W.H. Freeman, (2014).
2. Cunningham, B.J.: Using SPSS: An Interactive Hands-on approach, (2012).
3. Cho, M.J., Martinez, W.L.: Statistics in MATLAB: A Primer, Chapman and Hall/CRC, (2014).
4. E.J. Dudewicz and S.N. Mishra. : Modern Mathematical Statistics, Willy, Int'l Students edition, (1988).
5. John Verzani.: Using R for Introductory Statistics. Chapman & Hall/CRC, (2005).

7. S.C. Gupta and V.K. Kapoor: Fundamentals of Mathematical Statistics, Sultan Chand & Sons,(2012).