



**Dr. Shakuntala Misra National Rehabilitation University,
Lucknow, Uttar Pradesh, 226017**

DEPARTMENT OF MATHEMATICS AND STATISTICS

Syllabus for B.Sc. (Statistics)

As per NEP 2020

(Academic Year 2024-25 and onwards)

BoS Meeting held on 05/06/2024

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COURSE STRUCTURE

B.Sc. (STATISTICS)

Year	Sem.	Course Code	Paper Title	Theory/Practical	Credits
I	I	STAT101	Descriptive Statistics (Univariate) and Theory of Probability	Theory	04
		STAT102	Descriptive Data Analysis Lab (Univariate)	Practical	02
		STAT103 (Open Elective)	Statistical Techniques for Data Analysis Using MS Excel	Theory	02
	II	STAT104	Descriptive Statistics (Bivariate) and Probability Distributions	Theory	04
		STAT105	Descriptive Data Analysis Lab	Practical	02
	II	III	STAT201	Inferential Statistics	Theory
STAT202			Inferential Statistics Lab	Practical	02
IV		STAT203	Sampling Techniques	Theory	04
		STAT204	Sampling Techniques Lab	Practical	02
III	V	STAT301	Multivariate Analysis	Theory	04
		STAT302	Analysis of Variance and Design of Experiment	Theory	04
		STAT303	Multivariate Analysis and DOE Lab	Practical	02
	VI	STAT304	Applied Statistics	Theory	04
		STAT305	Operations Research	Theory	04
		STAT306	Applied Statistics Lab	Practical	02
VII		STAT401	Mathematical Analysis		04
		STAT402	Advance Statistical Methods for Data Analysis	Theory	04
		STAT403	Sampling Techniques	Theory	04
		STAT404	Advance Probability	Theory	04

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IV		STAT405	Lab based on theory papers and M.S. Excel	Practical	04	
		STAT406	Research Project** (will be evaluated in semester VIII)	Theory	04	
		STAT407(Open Elective)	Quantitative Techniques for Data Analysis	Theory	04	
	VIII		STAT408	Advanced Statistical	Theory	04
			STAT409	Advanced Multivariate Analysis	Theory	04
			STAT410	Statistical Quality Control and Reliability	Theory	04
			STAT411	Regression Analysis and Econometrics or Health Statistics	Theory	04
			STAT412	Lab based on theory papers and SPSS	Practical	04
			STAT413	Research Project**	Theory	04

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SUBJECT PREREQUISITES

To study this subject a student must have the subject Mathematics in class 12 equivalent.

PROGRAMME OUTCOMES (POs)

Students with Degree in B.Sc. (with Statistics) should have knowledge of different concepts and fundamentals of Statistics and the ability to apply this knowledge in various fields of industry/Organization. They may pursue their future career in the field of Statistics and Research.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

On completing B.Sc. (with Statistics) the student should have:

- Knowledge of different concepts, principles, methodologies and tools (skills) of Statistics.
- Ability to collect, tabulate, represent graphically, analyze and interpret data/information by using appropriate statistical tools.
- Ability to identify and solve a wide range of problems in real life/industry related to Statistics.
- Familiarity with computational techniques and statistical software including programming Language (e.g. R) for mathematical and statistical computation.
- Capability to use appropriate statistical skills in interdisciplinary areas such as finance, health, agriculture, government, business, industry, telecommunication and bio-statistics.
- Ability to compete with industrial/private sector demand in the field of data analysis, marketing survey, etc. professionally and pursue their future career in the field of Statistics.
- Ability to develop original thinking for formulating new problems and providing their solutions.

As a result, they will be able to pursue higher studies or research in the field of Statistics.



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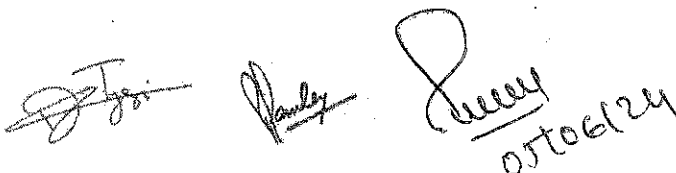
SEMESTER I

STAT101: DESCRIPTIVE STATISTICS (UNIVARIATE) AND THEORY OF PROBABILITY 4 CREDITS

Course Objectives: The objective of this course is to provide a comprehensive understanding of various statistical methodologies. The course covers foundational statistical concepts including measures of central tendency and dispersion, correlation and regression analysis, as well as parametric and non-parametric testing. These methodologies are crucial for analyzing, interpreting, and making informed decisions based on data.

Course Specific Outcomes: On completing this course a student will have:

- Knowledge of Statistics, its scope and importance in various fields.
- Ability to understand concepts of sample vs. population and the difference between different types of data.
- Knowledge of methods for summarizing data sets, including common graphical tools (such as boxplots, histograms and stem plots). Interpret histograms and boxplots.
- Ability to describe data with measures of central tendency and measures of dispersion.
- Ability to understand measures of skewness and kurtosis and their utility and significance.
- Ability to understand the concept of probability along with basic laws and axioms of probability.
- Ability to understand the terms mutually exclusive and independence and their relevance.
- Ability to identify the appropriate method (i.e. union, intersection, conditional, etc.) for solving a problem.
- Ability to apply basic probability principles to solve real life problems.
- Ability to understand the concept of random variable (discrete and continuous), concept of probability distribution.

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UNIT I: Introduction to Statistics, Meaning of Statistics, Importance of Statistics, Scope of Statistics in Industry, Introduction and contribution of Indian Scholars in Statistics. Statistical population, Attributes and Variables (Discrete and Continuous), Different types of scales – Nominal, Ordinal, Ratio and Interval, Primary data – designing a questionnaire and schedule, collection of primary data, checking their consistency, Secondary data.

Presentation of data: Classification, Tabulation, Diagrammatic & Graphical Representation of Grouped data, Frequency distributions, Cumulative frequency distributions and their graphical representations, Histogram, Frequency polygon and Ogives. Stem and Leaf plot, Box Plot.

UNIT II: Measures of Central tendency and Dispersion and their properties, Merits and Demerits of these Measures. Moments and Factorial moments, Shephard's correction for moments, Measures of Skewness and Kurtosis and their significance, Measures based on quartiles.

UNIT III: Random experiment, Trial, Sample point and Sample space, Events, Operations of events, Equally likely, Mutually exclusive and Exhaustive events. Definition of Probability: Classical, Relative frequency and Axiomatic approaches. Discrete Probability Space, Properties of Probability under Set Theory Approach, Independence of Events, Conditional Probability, Total and Compound Probability theorems, Bayes theorem and its Applications.

UNIT IV: Random Variables – Discrete and Continuous, Probability Mass Function (pmf) and Probability density function (pdf), Cumulative distribution function (cdf). Joint distribution of two random variables, Marginal and Conditional distributions, Independence of random variables. Expectation of a random variable and its properties, Expectation of the sum of random variables and product of independent random variables, Conditional expectation and related problems. Moments, Moment generating function (m.g.f.) & their properties, Continuity theorem for m.g.f. (without proof). Chebyshev's inequality, Weak law of large numbers for a sequence of independently and identically distributed random variables and their applications. (Statement Only)

References:

David, S. (1994): Elementary Probability, Cambridge University Press.

Dudewicz, E.J. and Mishra, S.N. (2008): Modern Mathematics Statistics, Wiley.



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- Goon, A.M., Gupta, M.K. and Dasgupta, B. (2013): Fundamental of Statistics, Vol I, World Press, Kolkata.
- Goon, A.M., Gupta, M.K. and Dasgupta, B. (2011): Fundamental of Statistics, Vol II, World Press, Kolkata.
- Gupta, S.C. and Kapoor, V.K. (2000): Fundamentals of Mathematical Statistics (10th ed.), Sultan Chand and Sons.
- Johnson, S. and Kotz, S. (1972): Distribution in Statistics Vol. I-II & III, Houghton and Mifflin.
- Lipschutz, S., Lipson, M. L. and Jain, K. (2010): Schaum's Outline of Probability. McGraw Hill.
- Miller, I. and Miller, M. (2006): John E. Freund's Mathematical Statistics with Applications, Pearson.
- Meyer, P. (2017): Introductory Probability and Statistical Applications, Oxford & IBH Publishing.
- Mood A.M., Graybill F.A. and Boes D.C. (2007): Introduction to the Theory of Statistics, Tata McGraw Hill.
- Mukhopadhyay, P. (1996): Mathematical Statistics, New Delhi, New Central Book Agency Pvt. Ltd.
- Parzen, E.S. (1992): Modern Probability Theory and its Applications. Wiley.
- Pitman, J. (1993): Probability, Narosa Publishing House.
- Rohatgi, V.K. and Saleh, A.E. (2008): An Introduction to Probability Theory and Mathematical Statistics, Wiley.
- Weatherburn, C.E. (1961). A First Course in Mathematical Statistics, The English Lang Book Society and Cambridge Univ. Press.



05/06/24

STAT102: PRACTICAL - DESCRIPTIVE DATA ANALYSIS LAB (UNIVARIATE)

2 CREDITS

Course Objectives: The objective of this course is to provide a practical understanding of statistical concepts including Bayes theorem of probability, conditional probability, measures of central tendency and dispersion, and correlation and regression analysis which are crucial for analysing, interpreting, and making informed decisions based on data.

Course Specific Outcomes: On completing this course a student will have:

- Ability to represent/summarize the data/information using appropriate Graphical methods including common graphical tools (such as boxplots, histograms and stem and leaf plots) and also to draw inferences from these graphs
- Acquire the knowledge to identify the situation to apply appropriate measure of central tendency as per the nature and need of the data and draw meaningful conclusions regarding behaviour of the data.
- Acquire the knowledge to identify the situation to apply appropriate measure of dispersion as per the nature and need of the data and draw meaningful conclusions regarding the heterogeneity of the data.
- Ability to measure skewness and kurtosis of data and define their significance.
- Acquire the knowledge to compute conditional probabilities based on Bayes Theorem.

List of Practical

1. Problems based on graphical representation of data by Histogram, Frequency polygons, frequency curves and Ogives, Stem and Leaf Plot, Box Plot.
2. Problems based on calculation of Measures of Central Tendency.
3. Problems based on calculation of Measures of Dispersion.
4. Problems based on calculation of Moments, Measures of Skewness and Kurtosis.



5. Computation of conditional probabilities based on Bayes theorem.
6. Some more Practicals based on theory.

References:

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(OPEN ELECTIVE FOR OTHER DEPARTMENTS)

STAT103: STATISTICAL TECHNIQUES FOR DATA ANALYSIS USING MS EXCEL

2 CREDITS

Course Objectives: The objective of this course is to make students software-friendly which will help them to go in corporate field as well as in govt. sector. Students will gain foundational as well as advanced knowledge of MS Excel including detailed understanding of statistical measures and interpretation in this course, would be beneficial in future aspects.

Course Specific Outcomes: On completing this course a student will have:

- Knowledge of Statistics, its scope and importance in various fields.
- Ability to understand concepts of sample vs. population and difference between different types of data.
- Knowledge of methods for summarizing data sets, including common graphical tools
- Ability to analyze measures of central tendency and measures of dispersion using Excel.
- Ability to understand and measures of skewness and kurtosis and their utility and significance using Excel.
- Ability to understand the concept of random variables (discrete and continuous

UNIT I: Introduction to Statistics, Importance of Statistics, Scope of Statistics in Industry, Statistical population, Attributes and Variables (Discrete and Continuous), Different types of scales – Nominal, Ordinal, Ratio and Interval, Primary data – designing a questionnaire and schedule, collection of primary data, checking their consistency, Secondary data. Presentation of data through Excel: Classification, Tabulation, Diagrammatic & Graphical Representation of Grouped data, Frequency distributions, Cumulative frequency distributions and their graphical representations, Histogram, Frequency polygon and Ogives. Stem and Leaf plot, Box Plot.

UNIT II: Measures of Central Tendency and Dispersion through Excel and their properties, Merits and Demerits of these Measures. Measures of Skewness and Kurtosis and their significance,

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Measures based on quartiles. Bivariate data: Definition, scatter diagram, Karl Pearson's coefficient of Correlation, Spearman's Rank Correlation. Simple linear regression, principle of least squares and Properties of Regression coefficients using Excel.

References:

David, S. (1994): Elementary Probability, Cambridge University Press.


Goon, A.M., Gupta, M.K. and Dasgupta, B. (2013): Fundamental of Statistics, Vol I, World Press.

Freund R.J. and Wilson W.J. (2003): Statistical Methods, Academic Press.

Narosa. Lipschutz, S., Lipson, M. L. and Jain, K. (2010): Schaum's Outline of Probability. McGraw Hill Education Pvt. Ltd.

Meyer, P. (2017): Introductory Probability and Statistical Applications, Oxford & IBH Publishing Co. Pvt. Ltd.

Verma, J.P. (2019): Statistics and Research Methods in Psychology using Excel, Springer.



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SEMESTER II (CERTIFICATE)

STAT104: DESCRIPTIVE STATISTICS (BIVARIATE) AND PROBABILITY DISTRIBUTIONS 4 CREDITS

Course Objectives: The objective of this course is to develop skills on bivariate data analysis and detailed understanding of probability distributions. Knowledge of the method of least squares for curve fitting, correlation and simple linear regression and performance of correlation and regression analysis would help them to resolve and analyse real-life problems.

Course Specific Outcomes: On completing this course a student will have:

- Knowledge of the method of least squares for curve fitting to theoretically describe experimental data with a function or equation and to find the parameters associated with the model.
- Knowledge of the concepts of correlation and simple linear regression and Perform correlation and regression analysis.
- Ability to interpret results from correlation and regression.
- Ability to compute and interpret rank correlation. .
- Ability to understand concept of qualitative data and its analysis.
- Knowledge of discrete distributions. Discuss appropriate distribution negative binomial, Poisson, etc. with their properties and application of discrete distribution models to solve problems.
- Knowledge of continuous distributions. Discuss the appropriate distribution (i.e. uniform, exponential, normal, etc.) with their properties and application of continuous distribution models to solve problems.
- Knowledge of the formal definition of order statistics, derive the distribution function and probability density function of the r th order statistic and joint distribution of r th and s th order statistics.
- Ability to identify the application of theory of order statistics in real life problems.



UNIT I: Bivariate data, Principles of least squares, Most plausible values, Meaning of curve fitting, Fitting of straight line, parabola, logarithmic, power curves and other simple forms by method of least squares, Bi-variate frequency table, Correlation, Types of relationships, Scatter diagram, Karl-Pearson's, Correlation Coefficient and its properties.

UNIT II: Rank correlation and its coefficient (Spearman and Kendall Measures), Regression analysis through both types of regression equations for X and Y variables. Attributes: Notion and Terminology, Contingency table, Class frequencies and Ultimate class frequencies, Consistency, Association of Attributes, Independence, Measures of association for 2X2 table, Chi-square, Karl Pearson's and Tschuprow's Coefficient of Association.

UNIT III: Discrete Probability Distributions: Binomial distribution, Poisson distribution (as limiting case of Binomial distribution), Hyper geometric, Geometric and Negative Binomial, Uniform and Multinomial distributions, fitting of Binomial, Poisson and Uniform distributions. Continuous Probability Distributions: Exponential, Gamma, Beta distributions and Cauchy distributions.

UNIT IV: Normal distribution and its properties, Standard Normal variate, Normal distribution as limiting case of Binomial distribution, fitting of Normal distribution. Order Statistics, Distributions of minimum, r th and maximum order statistic, Joint distribution of r th and s th order statistics (in continuous case), Distribution of sample range & sample median for uniform and exponential distributions.

References:

Agarwal, B. L. (2010): Programmed Statistics (2nd ed.), New age international Pvt Ltd publishers


David, S. (1994) : Elementary Probability, Cambridge University Press.

David, H.A. (1981). Order Statistics (2nd ed.), New York, John Wiley.

Dudewicz, E.J. and Mishra, S.N. (2008). Modern Mathematics Statistics, Wiley.

Goon, A.M., Gupta, M.K. and Dasgupta, B. (2013). Fundamental of Statistics, Vol I, World Press, Kolkata.

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Gupta, S.C. and Kapoor, V.K. (2000). Fundamentals of Mathematical Statistics (10th ed.), Sultan Chand and Sons.

Johnson, S. and Kotz, S. (1972). Distribution in Statistics Vol. I-II & III, Houghton and Mifflin.

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

Meyer, P. (2017). Introductory Probability and Statistical Applications (2nd ed.), New Delhi, Oxford & IBH Publishing Co. Pvt. Ltd.

Mood A.M., Graybill F.A. and Boes D.C. (2007). Introduction to the Theory of Statistics (3rd ed.), New Delhi, Tata McGraw Hill Publishing Co. Ltd.

Mukhopadhyay, P. (1996). Mathematical Statistics, New Delhi, New Central Book Agency Pvt. Ltd.

Lipschutz, S., Lipson, M. L. and Jain, K. (2010). Schaum's Outline of Probability. McGraw Hill Education Pvt. Ltd, New Delhi.

Parzen, E.S. (1992). Modern Probability Theory and its Applications. Wiley Interscience.

Pitman, J. (1993). Probability. Narosa Publishing House.

Rohatgi, V.K. and Saleh, A.E. (2008). An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.

Weatherburn, C.E. (1961). A First Course in Mathematical Statistics, The English Lang. Book Society and Cambridge Univ. Press.

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STAT105: PRACTICAL - DESCRIPTIVE DATA ANALYSIS LAB (BIVARIATE)

2 CREDITS

Course Objectives: The objective of this course is to provide practical knowledge of bivariate data analysis, fitting of curves, regression analysis etc. in this course, would be beneficial in future aspects.

Course Specific Outcomes: On completing this course a student will have:


- Ability to deal with problems based on the fitting of curves by Method of least squares, fitting of straight line, second degree polynomial, power curve, exponential curve etc.
- Ability to deal with problems based on determination of Regression lines and calculation of Correlation coefficient – grouped and ungrouped data.
- Ability to deal with problems based on determination of Rank correlation.
- Ability to fit binomial and Poisson distribution for given data.

List of Practical

1. Problems based on fitting of curves by Method of least squares e.g. fitting of straight line, second degree polynomial, power curve, exponential curve etc.
2. Problems based on determination of Regression lines and calculation of Correlation coefficient – grouped and ungrouped data.
3. Problems based on determination of Rank correlation.
4. Fitting of binomial, Poisson and Normal distribution.
5. Some more Practicals based on theory.

References:

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SEMESTER III

STAT201: INFERENCE STATISTICS

4 CREDITS


Course Objectives: This course will enable student to gain knowledge of inferential statistics. Knowledge of point estimation, interval estimation, testing of hypothesis etc. will provide basic knowledge of this paper which would be very helpful in field of research as well as competitive exams and the corporate sector.

Course Specific Outcomes: On completing this course a student will have:

- Ability to understand the difference between parameter & statistic and standard error & standard deviation.
- Knowledge of the concept of Point and Interval Estimation and discuss characteristics of a good estimator.
- Ability to understand and practice various methods of estimations of parameters.
- Knowledge of terms like null and alternative hypotheses, two-tailed and one-tailed alternative hypotheses, significant and insignificant, level of significance and confidence, p-value etc.
- Ability to understand the concept of MP, UMP and UMPU tests
- Ability to understand under what situations one would conduct the small sample and large sample tests (in case of one sample and two sample tests).

UNIT I: Sampling distribution, Parameter, Statistic and Standard error, Point estimation: Characteristics of a good estimator: Unbiasedness, consistency, sufficiency and efficiency. Problems and examples, Interval estimation. Method of Maximum Likelihood and properties of maximum likelihood estimators (without proof), Method of minimum Chi-square. Method of least squares and methods of moments for estimation of parameters.

UNIT II: Cramer-Rao inequality and its use in finding Minimum Variance Unbiased estimators (MVUE), Interval estimation, Pivotal quantity and its use in finding confidence intervals and best confidence intervals.



05/08/24

UNIT III: Testing of hypotheses: Statistical hypotheses and their classifications, Type I and Type II errors, significance level, p-value, power of a test, Most Powerful (MP), Uniformly Most Powerful (UMP) and Uniformly Most Powerful Unbiased (UMPU) tests, Neyman-Pearson's lemma and its applications (simple vs. simple).

UNIT IV: Test of significance: Large sample tests for (Attributes and Variables) proportions and means (i) for one sample (ii) for two samples, Small samples tests based on t, F and Chi-square distributions. Test of Correlation coefficient.

References:

Ferund J.E (2001) : Mathematical Statistics, Prentice Hall of India.

Freedman, D., Pisani, R. and Purves, R. (2014). Statistics. 4th Edition. Norton & Comp.

Goon, A.M., Gupta, M.K. & Dasgupta, B. (2002). Fundamentals of Statistics, Vol. I , Kolkata, The World Press.

Gupta, S.C. and Kapoor, V.K. (2000). Fundamentals of Mathematical Statistics, Sultan Chand and Sons.

Hogg, R.V., McKean, J.W. & Craig, A.T. (2009). Introduction to Mathematical Statistics (6th ed.), Pearson.

Kenney, J.F. and Keeping, E.S. (1947). Mathematics of Statistics. Part I. Chapman & Hall.

Mood A.M., Graybill F.A. and Boes D.C. (2007). Introduction to the Theory of Statistics, Tata McGraw Hill Publishing Co. Ltd.

Tanner, M. (1990). An Investigation for a Course in Statistics. McMillan, New York.

Tanur, J.M. (1989) Statistics. A Guide to the Unknown, Duxbury Press.

Yule, G.U. and Kendall, M.G. (1973). An Introduction to the Theory of Statistics, Charles Griffin & Comp.

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Course Objectives: The objective of the course is to impart necessary knowledge about practical aspects of various statistical tools and techniques of Inferential statistics to the students. Formulation of hypothesis to application of suitable tests and their results' interpretation will help them to enhance technical aspects of mind.

Course Specific Outcomes: On completing this course a student will have:

- Ability to specify Null and Alternate Hypothesis.
- Ability to conduct test of significance.
- Knowledge about Fisher's Z-transformation and its use in testing
- Ability to deal with problems based on large sample tests.
- Ability to deal with problems based on exact sampling distribution.

List of Practical:

1. Problems based on t – test.
2. Problems based on F-test.
3. Problems based on Chi-square test.
4. Problems based on Fisher's Z-transformation and its use in testing
5. Problems based on calculation of power curve.
6. Problems based on large sample tests.
7. Some more Practicals based on theory.

References:

As suggested for paper code STAT201.



18/08/24

SEMESTER IV (DIPLOMA)

STAT203: SAMPLING TECHNIQUES

4 CREDITS

Course Objectives: The important concepts of sample, population and sampling techniques etc. in this paper will introduce the students with detailed concepts of sampling survey, which would be helpful in drawing gainful insights about the population.

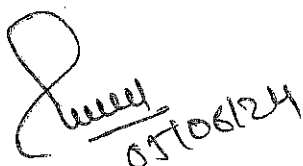
Course Specific Outcomes: On completing this course a student will have:

- Ability to understand the concept of sampling and how it is different from complete enumeration.
- Knowledge of various probability and non-probability sampling methods along with estimates of population parameters
- Ability to identify the situations where the various sampling techniques shall be used.
- Knowledge of sampling and non-sampling errors.
- Knowledge of regression and ratio methods of estimation in simple random sampling (SRS).

UNIT I: Universe, population and sample, sampling vs. complete enumeration, sampling units and frame, precision and efficiency of estimators, Simple Random sampling with and without replacement, use of random number tables in selection of simple random sample, Estimation of population mean and proportion, derivation of expression for variance of these estimators, estimation of variances, sample size determination.

UNIT II: Stratified random sampling, Problem of allocation: equal, proportional and optimum (Neyman), Derivation of the expressions for the standard errors of the usual estimators when these allocations are used, Gain in precision due to stratification, Role of sampling cost in the sample allocation, Minimization of variance for fixed cost, Systematic sampling: estimation of population mean and population total, standard errors of these estimators.

UNIT-III: Regression method of estimation, Ratio methods of estimation in simple random sampling, Cluster sampling with equal clusters, estimation of population mean and their mean square error.



05/06/24

UNIT IV: Double sampling, Two-stage sampling with equal first stage units: estimation of population mean and its variance, Multi-stage sampling with examples (definition only). Non-sampling errors.

References:

Ardilly, P. and Yves T. (2006). Sampling Methods: Exercise and Solutions. Springer.

Cochran, W.G. (2008). Sampling Techniques, Wiley India.

Des Raj. (1976). Sampling Theory. Tata McGraw Hill, New York.

DesRaj and Chandhok, P. (1998). Sample Survey Theory, Narosa Publishing House.

Mukhopadyay, P. (2007). Survey Sampling. Narosa Publisher, New Delhi.

Murthy, M. N. (1977). Sampling Theory and Statistical Methods. Statistical Pub. Society, Kolkata.

Singh, D. and Choudhary, F.S. (1977). Theory and Analysis of Sample Survey Designs. New Age

Sukhatme, P.V. and Sukhatme, B.V. (1970). Sampling Theory Surveys with Applications, Iowa State University Press.

Sukhatme, P.V., Sukhatme, B.V., Sukhatme, S. & Asok, C. (1984): Sampling Theories of Survey with Applications, IOWA State University Press and ISAS.

Thompson, S.K. (2012). Sampling. John Wiley & Sons.






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STAT204: PRACTICAL- SAMPLING TECHNIQUE LAB**2 CREDITS**

Course Objectives: This paper will provide the practical application of above theoretical paper. The practical application of determination of sample size, sample selection, application of various sampling techniques like SRS, Stratified sampling, two-stage sampling, two phase sampling etc., student will study in this paper.

Course Specific Outcomes: On completing this course a student will have:

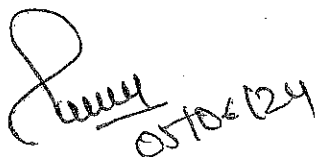
- Ability to draw a simple random sample with the help of table of random numbers.
- Ability to estimate population means and variance in simple random sampling.
- Ability to deal with problems based on Stratified random sampling for population means.
- Ability to deal with problems based on Systematic random sampling.
- Ability to deal with problems based on Ratio and regression estimation of population mean.

List of Practical:

1. Problems based on drawing a simple random sample with the help of table of random numbers.
2. Problems based on estimation of population means and variance in simple random sampling.
3. Problems based on Stratified random sampling for population means (proportional and optimum allocation).
4. Problems based on Systematic random sampling
5. Problems based on two stage sampling
6. Problems based on Ratio method of estimation and Regression method of estimation of population mean and total.
7. Some more Practicals based on theory.

References:

As suggested for paper code STAT203.



SEMESTER V

STAT301: MULTIVARIATE ANALYSIS AND NON-PARAMETRIC METHODS

4 CREDITS

Course Objectives: The objective of the course is to impart necessary knowledge about theoretical aspects of multivariate distribution theory giving special emphasis to the inferential procedures related to random sampling from multivariate populations.

Course Specific Outcomes: On completing this course a student will have:

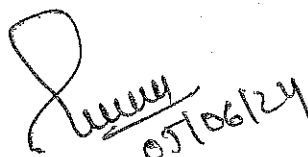
- Ability to understand the basic concepts of vector space and matrices in order to study multivariate distribution.
- Knowledge of the applications of multivariate normal distribution and Maximum Likelihood estimates of mean vector and dispersion matrix.
- Knowledge of Principal Component Analysis and Factor Analysis.
- Ability to apply distribution free tests (Non-parametric methods) for one and two sample cases.

UNIT I: Vector Space, Subspace, Linear Combination, Span, Linear Independence, Inner Product, Norm, Orthogonality, Dimension of Vector Space. Row and Column Rank, Rank of Matrix, Elementary operations on Matrices, Inverse of a matrix.

UNIT II: Multivariate Normal Distribution, Marginal and Conditional Distributions, Moment Generating and Characteristics functions. Maximum Likelihood Estimation of Mean vector and Dispersion matrix, Independence and point sufficiency of these estimates.

UNIT III: Applications of Multivariate Analysis: Principal Components Analysis and Factor Analysis (Application Oriented discussion, derivations not required), Multiple and Partial correlations and Multiple Regressions.

UNIT IV: Non-parametric tests, Tests for randomness and test for goodness of fit. One sample tests: Sign test, Wilcoxon Signed rank tests. Two sample tests: Run test, Kolmogorov – Smirnov's test, Median test and Mann-Whitney U test.



05/06/24

References:

Anderson, T.W. (2003): An Introduction to Multivariate Statistical Analysis, John Wiley

Gibbons, J. D. and Chakraborty, S (2003): Nonparametric Statistical Inference, Marcel Dekker, CRC.

Goon, A.M., Gupta, M.K. and Dasgupta, B. (2002): Fundamentals of Statistics, Vol. I, The World Press, Kolkata.

Johnson, R.A. And Wichern, D.W. (2007): Applied Multivariate Analysis, Pearson & Prentice Hall.

Muirhead, R.J. (1982): Aspects of Multivariate Statistical Theory, John Wiley.

Rohatgi, V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics. John Wiley and Sons.

Siegel, S. & Castellan, N. J. (1988). Nonparametric Statistics for the Behavioral Sciences, 2nd ed. New York: McGraw-Hill.

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STAT302: ANALYSIS OF VARIANCE AND DESIGN OF EXPERIMENT 4 CREDITS

Course Objectives: To provide the background of fundamental theories and practices of statistical design of experiments used in various disciplines, especially in agriculture, biological, manufacturing and medical industry etc. To give the idea in which situation which design should be used.

Course Specific Outcomes: On completing this course a student will have:

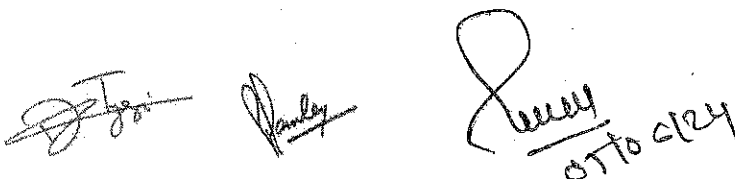
- Knowledge of the concept of Analysis of Variance (ANOVA).
- Ability to carry out the ANOVA for One way and Two way Classification.
- Ability to carry out the post-hoc analysis.
- Knowledge of the concept of Design of experiment and its basic principles.
- Ability to perform the basic symmetric designs CRD, RBD and LSD with and without missing observations.
- Knowledge of the concept of factorial experiments and their practical applications.

UNIT I: Definition of Analysis of Variance, Assumptions and Limitations of ANOVA, One way classification. Two way classification with equal number of observations per cell. Duncan's multiple comparison tests.

UNIT II: Principles of Design of Experiment: Randomization, Replication and Local Control, Choice of size and type of a plot using uniformity trials. Completely Randomized Design (CRD) Randomized Block Design (RBD), Concept and definition of efficiency of design, Comparison of efficiency between CRD and RBD.

UNIT III: Latin Square Design (LSD), Lay-out, ANOVA table, Comparison of efficiencies between LSD and RBD; LSD and CRD. Missing plot technique: Estimation of missing plots by minimizing error sum of squares in RBD and LSD with one or two missing observations.

UNIT IV: Factorial Experiments: General description of factorial experiments, 2^2 and 2^3 factorial experiments arranged in RBD, Definition of Main effects and Interactions in 2^2 and 2^3 factorial



experiments, Preparation of ANOVA by Yates procedure, Estimates and tests for main and interaction effects (Analysis without confounding).

References:

Cochran, W. G. and Cox, G. M. (1957). Experimental Design. John Wiley & Sons, New York.

Das, M. N. and Giri, N. S. (1986). Design and Analysis of Experiments. Wiley.


Dean, A. and Voss, D. (1999). Design and Analysis of Experiments. Springer-Verlag, New York.

Federer, W.T. (1955). Experimental Design: Theory and Applications. Oxford & IBH Publishing Company, Calcutta, Bombay and New Delhi.

Joshi, D.D. (1987). Linear Estimation and Design of Experiments. New Age International (P) Ltd. New Delhi.

Kempthorne, O. (1965). The Design and Analysis of Experiments, John Wiley

Montgomery, D.C. (2017). Design and analysis of Experiments, John Wiley & Sons.

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STAT303: PRACTICAL - NON-PARAMETRIC METHODS AND DESIGN OF EXPERIMENT LAB **2 CREDITS**

Course Objectives: This paper will impart students to develop their practical knowledge of application of various designs for e.g. CRD, RBD, LSD etc. and appropriate application of Non-parametric tests.

Course Specific Outcomes: On completing this course a student will have:

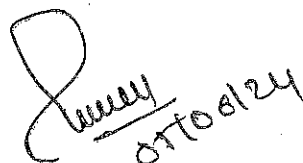
- Ability to conduct test of significance based non-parametric tests.
- Ability to deal with multivariate data.
- Knowledge of Principal Component Analysis and Factor Analysis. Ability to perform ANOVA for one way and two classification.
- Ability to conduct analysis of CRD, RBD and LSD with and without missing observations.
- Ability to conduct analysis for Factorial experiments (without confounding).

List of Practical:

1. Problems based on Non-parametric tests for one sample.
2. Problems based on Non-parametric tests for two samples.
3. Problems based on Rank and Inverse of a matrix.
4. Problems based on Mean vector and Dispersion matrix of a multivariate normal distribution.
5. Problems based on Analysis of variance in one-way and two-way classification (with and without interaction terms).
6. Problems based on Analysis of a Latin square design.
7. Problems based on Analysis of variance in RBD and LSD with one or two missing observations.
8. Some more Practicals based on theory.

References:

As suggested for paper code STAT301 and STAT302



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SEMESTER VI (DEGREE)

STAT304: APPLIED STATISTICS

4 CREDITS

Course Objectives: This paper will inculcate various concepts of applied statistics like Time series and its applications, Index no. and its applications, vital statistics, factors of population change, life table and its components including their applications, statistical quality control etc. which would be helpful in future perspectives.

Course Specific outcomes: On completing this course a student will have:

- Familiarity with different aspects of Applied Statistics and their use in real-life situations.
- Ability to understand the concept of Time series along with its different components.
- Knowledge of Index numbers and their applications along with different types of Index numbers.
- Familiarity with various demographic methods and different measures of mortality and fertility.
- Ability to understand the concept of life table and its construction.
- Knowledge to understand the concept of statistical quality control and different control charts for variables and attributes.

UNIT I: Introduction & Definition of Time Series, its different components, illustrations, additive and multiplicative models. Determination of trend by free hand curve, semi average method, moving average method, method of least squares, Analysis of Seasonal Component by Simple average method, Ratio to moving Average Ratio to Trend, Link relative method.

UNIT II: Index number – its definition, application of index number, price relative and quantity or volume relatives, link and chain relative, problem involved in computation of index number, use of averages, simple aggregative and weighted average method. Laspeyre's, Paasche's and Fisher's index number, time and factor reversal tests of index numbers, consumer price index.

UNIT III: Vital Statistics: Measurement of Fertility– Crude birth rate, general fertility rate, age-specific birth rate, total fertility rate, gross reproduction rate, net reproduction rate, standardized death rates Complete life table, its main features and construction.



UNIT IV: Introduction to Statistical Quality Control, Process control, tools of statistical quality control, 3σ control limits, Principle underlying the construction of control charts. Control charts for variables, 'X' and 'R' charts, construction and interpretation, Control charts for attributes 'p' and 'c' charts, construction and interpretation.

References:

Hangal, D. D. (2009). Introduction to Applied Statistics: A Non-Calculus Based Approach. Narosa Publishing Comp. New Delhi.

Tanner, M. (1990). An Investigation for a Course in Statistics. McMillan, New York.

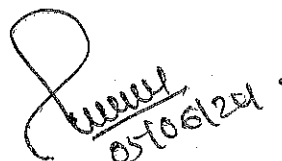
Tanur, J.M. (1989) Statistics. A Guide to the Unknown, Duxbury Press.

Croxtan F.E., Cowden D.J. and Klein, S. (1973). Applied General Statistics, Prentice Hall of India Pvt. Ltd.

Gupta, S.C. and Kapoor, V.K. (2008). Fundamentals of Applied Statistics, Sultan Chand and Sons.

Montgomery D.C. (2009): Introduction to Statistical Quality Control, Wiley India Pvt. Ltd.

Mukhopadhyay, P (2011): Applied Statistics, Books and Allied (P) Ltd.



STAT305: OPERATIONS RESEARCH AND EDUCATIONAL STATISTICS 4 CREDITS

Course Objectives:

To study the fundamentals of operations research to solve the problems covered in course contents. Students will understand the mathematical formulations of linear programming problems and their applications in real-life problems and role of educational statistics and important terminologies used for the application in this paper.

Course Specific Outcomes: On completing this course a student will have:

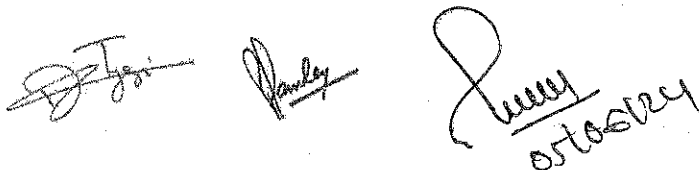
- An idea about the historical background and need of Operations research.
- Ability to identify and develop operational research models from the verbal description of the real life problems.
- Knowledge of the mathematical tools that are needed to solve optimization problems.
- Ability of solving Linear programming problem, Transportation and Assignment problems, Replacement problems, Job sequencing, etc.
- Ability to solve the problems based on Game Theory.

UNIT I: History & background of OR, General linear programming problems and their formulations. Solving LPP by Graphical Method. Solving LPP by, Simplex method, Big-M method, Two phase Method, Degeneracy and Duality in LPP.

UNIT II: Transportation problem: North-west corner rule, Least cost method, Vogel's approximation method. Optimum solution: Stepping stone method. Assignment Problem: Hungarian Method, Travelling Salesman Problem, Replacement problem: Individual and Group replacement. Job sequencing: n jobs – 2 machines, n jobs – k machines, 2 jobs – n machines.

UNIT III: Educational Statistics: Different Scaling procedures: scaling of test items, test scores, rating of qualitative answers and judgements, scaling in terms of normal curve, equivalent scale, percentile scaling, z-scores, t-scores.

UNIT IV: Test theory: linear model of test theory, parallel tests, true score, test reliability, methods for assessing reliability: Parallel test method, test-retest method, split half method, Kuder-



Richardson method, Cronbach's α . Validity of test: conduct validity, construct validity, criterion validity and content validity.

References:

Gupta, S.C. and Kapoor, V.K. (2008). Fundamentals of Applied Statistics, Sultan Chand and Sons.

Hadley, G: (2002): Linear Programming, Narosa Publications

Hillier, F.A and Lieberman, G.J. (2010): Introduction to Operations Research- Concepts and cases, Tata McGraw Hill.

Swarup, K., Gupta P.K. and ManMohan (2007). Operations Research, Sultan Chand & Sons.

Taha, H.A. (2007). Operations Research: An Introduction, Prentice Hall of India.

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Course Objectives: Students will gain practical knowledge of the mathematical formulations of linear programming problems and their applications in real-life problems and application of life table problems, mortality, fertility etc. in this paper.

Course Specific Outcomes: On completing this course a student will have:

- Ability to deal with problems based on time series and calculation of its different components for forecasting.
- Ability to deal with problems based on Index number.
- Acquire knowledge about measurement of mortality and fertility.
- Ability to deal with problems based on life table.
- Ability to work with control charts for variables and attributes and draw inferences.

List of Practical:

1. Problems based on time series and its different
2. Problem based on Index number.
3. Problems based on measurement of mortality and fertility.
4. Problems based on logistic curve fitting.
5. Problems based on life table.
6. Problems based on control charts for variables and attributes.
7. Some more Practicals based on theory.

References:

As suggested for paper code STAT304 & STAT305



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SEMESTER VII

STAT401: MATHEMATICAL ANALYSIS

4 CREDITS

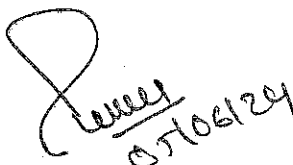
Course Objectives: This course covers the fundamentals of Numerical Analysis, Linear Algebra, Real Analysis and Complex Analysis. It focuses on the utility of abstract concepts and teaches an understanding and construction of proofs.

Course Specific Outcomes:

- Understand the concept of sequence and series of real numbers, and establish their convergence and divergence.
- Determine the limit and continuity of functions defined on subsets of the real line.
- Recognize the difference between point wise and uniform convergence of a sequence of functions
- Use the definitions of vector space and related things and determine the orthogonal basis.
- To understand the linear transformation and its matrix representation.
- To understand the concept of numerical differentiation and numerical integration and to get the solution of ordinary differential equations.
- To understand the concept of analytic function and implication of various theorems.
- To solve complex integrals and calculus problems.

UNIT I: Vector spaces, subspaces, linear dependence, basis, dimension, algebra of linear transformations. Algebra of matrices, rank and determinant of matrices, linear equations. Eigenvalues and eigenvectors, Cayley-Hamilton theorem. Matrix representation of linear transformations. Change of basis, canonical forms, diagonal forms, triangular forms, Jordan forms. Inner product spaces, orthonormal basis.

UNIT II: Numerical solutions of algebraic equations, Method of iteration and Newton-Raphson method, Finite differences, Lagrange, Hermite and spline interpolation, Numerical differentiation and integration, Numerical solutions of ODEs using Picard, Euler, modified Euler and Runge-Kutta methods.



05/06/24

UNIT III: Complex Analysis: Algebra of complex numbers, the complex plane, polynomials, power series, transcendental functions such as exponential, trigonometric and hyperbolic functions. Analytic functions, Cauchy-Riemann equations. Contour integral, Cauchy's theorem, Cauchy's integral formula, Liouville's theorem, Maximum modulus principle, Schwartz lemma.

UNIT IV: Elementary set theory, basic operations, finite, countable and uncountable sets, Real number system as complete ordered field, Archimedean property, Sequences and series, convergence, limit supremum, limit infimum, Taylor series, Laurent series.

UNIT V: Bolzano Weierstrass theorem, Heine Borel theorem. Continuity, uniform continuity, differentiability, mean value theorem. Sequences and series of functions, uniform convergence. Riemann sums and Riemann integral.

References

Apostol, T. M. (1985): Mathematical Analysis. Narosa, Indian Ed.

Bradie, B. (2006): A Friendly Introduction to Numerical Analysis. Pearson Education, India.

Burden, R. L., & Faires, J. D. (2015): Numerical Analysis (10th ed.). Cengage Learning.

Courant, R., & John, F. (1998): Introduction to Calculus and Analysis (Vol. 1, reprint). Wiley.

Gerald, C. F., & Wheatley, P. O. (2007): Applied Numerical Analysis (7th ed.). Pearson Education, India (Archive.org).

Hadley, G. (1987): Linear Algebra. Narosa Publishing House, New Delhi.

Hilderbrand, F. B. (1987): Introduction to Numerical Analysis (2nd ed.). Tata McGraw Hill.

Lay, David C. (2021): Linear Algebra and its Applications (6th ed.). Pearson (Archive.org).

Miller, K. S. (1957): Advanced Real Calculus. Harper, New York

Rao, A. R., & Bhimasankaram, P. (2000): Linear Algebra (2nd ed.). Tata McGraw-Hill, New Delhi.

Sastry, S. S. (2012): Introductory Methods of Numerical Analysis (5th ed.). Prentice Hall of India Pvt. Ltd., New Delhi (Archive.org).

Saxena, H. C. (2005): Finite Differences and Numerical Analysis (15th Rev. ed.). S. Chand and Co., New Delhi.

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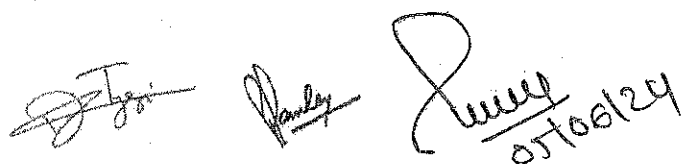
Scarborough, J. B. (1966): Numerical Mathematical Analysis (6th ed.). Oxford and IBH.

Searle, S. R. (1982): Matrix Algebra Useful for Statistics. John Wiley & Sons, New York.

Singh, B. M. (2008): Introductory Linear Algebra. South Asian Publishers Pvt. Ltd., New Delhi.

Sundararajan, D. (2019): Numerical Linear Algebra and Applications. Elsevier.

Trefethen, L. N., & Bau, D. (2022): Numerical Linear Algebra (2nd ed.). SIAM.

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STAT402: ADVANCED STATISTICAL METHODS FOR DATA ANALYSIS 4 CREDITS

Course Objectives: The objective of the course is to impart necessary knowledge about theoretical aspects of various Statistical tools and techniques to the students coming from different undergraduate programme. Starting with the basic techniques of collection, tabulation and graphical representation, the course introduces students to basic methods of data analysis, elementary probability distributions and Testing of Hypothesis.

Course Specific Outcomes: On completing of this course a student shall be:

- Able to analyse, present and interpret the data.
- Able to describe data with the perspective of both univariate and bivariate probability distributions.
- Able to understand concepts like correlation, sampling distribution etc. their utility and significance.
- Able to test the statistical hypothesis using Parametric and non-parametric tests.

UNIT I: Data types, scale of measurement, creating and managing datasets, Summarizing data: Frequency and probability distributions, measures of central tendency, measures of dispersion, skewness and kurtosis. Visualizing data: Histogram, bar chart, pie chart, stem and leaf display, scatter plot, box and whisker plot. Correlation coefficient, Partial and multiple correlation, rank correlation. Bivariate distributions, Marginal and Conditional distributions.

UNIT II: Discrete and continuous random variables. Standard discrete and continuous distributions: Bernoulli, Binomial, Poisson, Geometric, Negative Binomial, Hypergeometric, Multinomial, Uniform, Normal, Exponential, Gamma, Beta, Cauchy Distribution.

UNIT III: Random sample from a distribution, parameter, statistic and standard error. Sampling distributions of sample mean, sample variance, t, chi-square and F (Central and Non-central) (elementary properties only)

UNIT IV: Basics of testing of hypothesis: Null and alternative hypotheses, critical region, type-I error, type-II error, power of the test, level of significance, p-value. Parametric tests: Testing the mean, proportion and variance of a single population, testing the differences of mean and



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proportions of two independent populations. Small sample tests: t, F and chi-square tests for one and two independent/dependent populations.

UNIT V: Non-parametric test: one sample sign test, run test for randomness, Wilcoxon rank sum test (or Mann-Whitney test), Wilcoxon signed-rank test, chi-squared goodness-of-fit test, contingency analysis: chi-square test of independence.

References

Agresti, A., Franklin, C. and Klingenberg, B. (2018): Statistics: The Art and Science of Learning from data, Fourth Edition, Pearson.

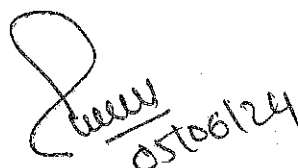
Goon, A.M., Gupta, M.K. and Dasgupta, B. (2013): Fundamental of Statistics, Vol I, World Press, Kolkata

Goon, A.M., Gupta, M.K. and Dasgupta, B. (2011): Fundamental of Statistics, Vol II, World Press, Kolkata

Hogg, R. V. Tanis, E. and Zimmerman, D. (2014): Probability and Statistical Inference, Ninth Edition, Pearson.

Mood, A.M, Graybill, F.A and Boes, D.C. (2017): Introduction to the Theory of Statistics, Third Edition McGraw Hill

Miller, L. and Miller, M. (2013): John E. Freund's Mathematical Statistics with Applications, (8th Edn), Pearson Education, Asia.



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STAT403: SAMPLING TECHNIQUES

4 CREDITS

Course Objectives: The objective of the course is to define the concepts of population under study, the sampling frame. The emphasis of the course is to study various sampling methods, methods for determination of sample size and compilation of information and the applications of sampling techniques in various disciplines.

Course Specific outcomes: On completing this course, the students will

- Be able to know the population, sample and sampling frame.
- Understand the knowledge of adopting a suitable sampling plan in different situations.
- Learn to develop statistical inferences about the population.
- Be capable to determine the appropriate required sample size from the population under study.

UNIT I: Simple Random Sampling (SRSWR/WOR), Stratified Random Sampling, Ratio method of estimation, Combined and Separate ratio estimator, Bias of ratio estimator, comparison with SRS, Regression method of estimation, Cluster sampling, two stage sampling with equal and unequal clusters, Two phase sampling, systematic sampling.

UNIT II: Unequal probability sampling: PPSWR/WOR methods (including Cumulative Total and Lahiri's scheme) and related estimators of a finite population mean. Hansen-Hurwitz and Desraj estimators for general sample size and Murthy's estimator for a sample of size 2.

UNIT III: Horvitz-Thompson estimator, its variance and unbiased estimator of variance, IPPS schemes of sampling due to Midzuno-Sen, Rao-Hartley-Cochran and Sampford, their estimators and variances, comparison with SRS.

UNIT IV: Introduction to the Jackknife and Bootstrap: estimate of bias, estimate of variance. Ratio Estimation in reference to Jackknife and bootstraps, Relationship between the jackknife and the bootstrap estimator.

UNIT V: Interpenetrating sub sampling. Non-sampling errors. Randomized Response techniques (Warner's method: related and unrelated questionnaire methods). Small Area estimation and developing Small domain statistics (basic concepts). Super population modelling (basic concept).



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References

- Chaudhuri, A. and Mukerjee, R. (1988): Randomized Response: Theory and Techniques, New York: Marcel Dekker Inc.
- Cochran, W.G.: Sampling Techniques (3rd Edition, 1977): Wiley (Indian Edition).
- Des Raj and Chandok (1998): Sampling Theory, Narosa.
- Gray, H.L., and Schucany(1972) : The generalized jackknife statistic. New York. Marcel Dekker, Inc.
- Mukhopadhyaya, P. (2009): Theory and methods of survey sampling, PHI Learning, Delhi.
- Murthy, M. N. (1977): Sampling Theory & Methods, Statistical Publishing Society, Calcutta.
- Singh, D. and Chaudhary, F.S. (1986): Theory and Analysis of Sample Survey Designs. New Age International Publishers.
- Sukhatme P.V. and Sukhatme B.V.(1954): Sampling Theory of Surveys with Applications. Piyush Publications, New Delhi.

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STAT404: ADVANCED PROBABILITY THEORY

4 CREDITS

Course Objectives: This course covers the fundamentals of probability theory using measure theoretical approach. It focuses on the utility of abstract concepts such as WLLN, SLLN, CLT, etc. and teaches their applications.

Course Specific Outcomes: After the culmination of this course, a student shall be:

- Able to understand the concepts, laws, axioms and theorems of probability
- Able to understand the measure theoretic approach to probability and its relevance.
- Able to identify the different probability distribution models for problem solving.
- Able to understand the concept of measurable function, random variable and random vector.
- Able to understand the modes of convergence and their interrelationships
- Able to understand the laws of large numbers and the central Limit Theorem.

UNIT I: Classes of sets, fields, sigma-field, minimal sigma-field, Borel sigma-field in \mathbb{R}^k , sequence of sets, limsup and liminf of a sequence of sets. Measure, Probability measure, properties of a measure, Bayes' Theorem and its application.

UNIT II: Measurable functions, Random variables, sequence of random variables, Caratheodory extension theorem (statement only), Lebesgue and Lebesgue-Steljes measures on \mathbb{R}^k , Almost sure convergence, Convergence in probability, Convergence in distribution, Convergence in r^{th} mean and their properties

UNIT III: Integration of a measurable function with respect to a measure, Monotone convergence theorem, Fatou's lemma and its different lemma, Dominated convergence theorem and its different lemma,

UNIT IV: Borel- Cantelli Lemma, Independence, Weak law and strong law of large numbers for iid sequences, Characteristic function, inversion theorem, uniqueness theorem, Levy's continuity theorem (statement only), Central Limit Theorem for a sequence of independent random variables under Lindeberg's condition, CLT for iid random variables.



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UNIT V: Exponential family of distributions, Geometric Power Series Distribution, Compound, truncated and mixture distributions. Markov, Holder, Jensen, Kolmogorov and Liapunov inequalities.

References

Ash, Robert. (1972): Real Analysis and Probability. Academic Press.

Bhat, B.R. (2015): Probability Theory. New Age International (P) Ltd., New Delhi.

Billingsley, P. (1986): Probability and Measure. Wiley.

Dudewicz, E.J. and Mishra, S.N. (1988): Modern Mathematical Statistics. Wiley, Int'l Students' Edition.

Rohatgi, V.K. and Saleh, A.K.M.E. (2006): An Introduction to Probability Theory and Mathematical Statistics. Wiley (Indian Edition).

Rao, C.R. (1973): Linear Statistical Inference and Its Applications, 2/e. Wiley Eastern.

STAT405: Lab based on theory papers and M.S. Excel

4 CREDITS

STAT406: Research Project**

4 CREDITS

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OPEN ELECTIVE FOR OTHER FACULTY

STAT407: Statistical Quantitative techniques for Data Analysis

4 CREDITS

Course Objectives: The objective of this course is to provide a comprehensive understanding of various statistical methodologies. The course covers foundational statistical concepts including measures of central tendency and dispersion, random variables, some basic distributions, correlation and regression analysis, as well as parametric and non-parametric testing. These methodologies are crucial for analyzing, interpreting, and making informed decisions based on data.

Course Specific Outcomes: On completing this course, students will be:

- Able to accurately analyze, present, and interpret data.
- Proficient in describing data using measures of central tendency and dispersion.
- Skilled in understanding and applying correlation and regression techniques.
- Knowledgeable in conducting and interpreting parametric and non-parametric tests.

UNIT I:

Data Types and Scales of Measurement: Different data types and scales of measurement.

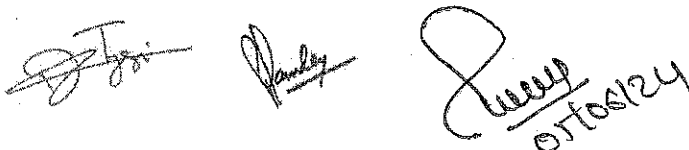
Summarizing Data: Frequency distributions, Probability distributions, Measures of Central Tendency: Mean, Median, Mode. Measures of Dispersion: Range, Variance, Standard Deviation, Interquartile Range, Skewness and Kurtosis

Visualizing Data: Histogram, Bar Chart, Pie Chart, Stem and Leaf Display, Scatter Plot, Box and Whisker Plot

UNIT II: Correlation and Regression:

Correlation Coefficient, Partial and Multiple Correlation, Rank Correlation. Regression Analysis: Simple Linear Regression, Multiple Regression, Assumptions of Regression Models, Interpretation of Regression Coefficients.

UNIT III: Theory of probability, types of events, sample space, Definition of Probability: Classical Definition of probability, empirical definition of probability, Random variables. mathematical expectations, some basic probability distributions and their properties: Bernoulli, binomial, poisson, geometric distribution, uniform distribution, normal distribution.

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UNIT IV: Parametric Tests:

Basics of Hypothesis Testing: Null and Alternative Hypotheses, Critical Region, type I and type II Errors, power of the Test, level of Significance, p-value, Parametric Tests: Testing the Mean, Proportion, and Variance of a Single Population, Testing the Differences of Means and Proportions of Two Independent Populations Small Sample Tests: t, F, and Chi-square Tests for One and Two Independent/Dependent Populations

UNIT V: Non-Parametric Tests: Introduction to Non-Parametric Tests: One Sample Sign Test, Run Test for Randomness, Wilcoxon Rank Sum Test (Mann-Whitney Test), Wilcoxon Signed-Rank Test, Chi-squared Goodness-of-Fit Test, Contingency Analysis: Chi-square Test of Independence

References:

Agresti, A., Franklin, C., & Klingenberg, B. (2018): Statistics: The Art and Science of Learning from Data, Fourth Edition, Pearson.

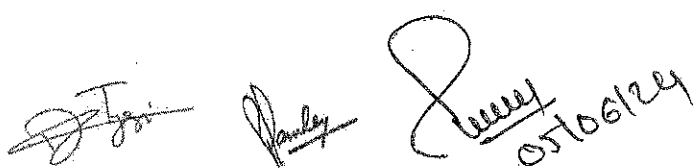
Goon, A. M., Gupta, M. K., & Dasgupta, B. (2013): Fundamentals of Statistics, Vol I, World Press, Kolkata.

Goon, A. M., Gupta, M. K., & Dasgupta, B. (2011): Fundamentals of Statistics, Vol II, World Press, Kolkata.

Hogg, R. V., Tanis, E., & Zimmerman, D. (2014): Probability and Statistical Inference, Ninth Edition, Pearson.

Mood, A. M., Graybill, F. A., & Boes, D. C. (2017): Introduction to the Theory of Statistics, Third Edition, McGraw Hill.

Miller, L., & Miller, M. (2013): John E. Freund's Mathematical Statistics with Applications; (8th Edn), Pearson Education, Asia.

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SEMESTER OUTCOME

- **MATHEMATICAL ANALYSIS** paper will cover important topics of ISS exam, CSIR NET, state public service exams and assistant statistical officer exams conducted by different states along with some topics in field of research.
- **ADVANCED STATISTICAL METHODS FOR DATA ANALYSIS** paper will help you to strengthen basic statistical methods topics including important topics of statistical inference. It covers the syllabus of state public services exams, assistant statistical officer exams conducted by different states, ISS exam, UGC NET etc.
- **SAMPLING TECHNIQUES** paper will improve basic concepts of sampling as well as detailed knowledge of unequal probability sampling. It will cover the syllabus of state public services exams, assistant statistical officer exams conducted by different states, ISS exam etc.
- **ADVANCED PROBABILITY THEORY** paper will provide detailed study of probability theory which will help to learn important results and lemma that will be helpful in ISS exam, CSIR NET, state public service exams and assistant statistical officer exams conducted by different states along with some topics in field of research.
- **STATISTICAL QUANTITATIVE TECHNIQUES FOR DATA ANALYSIS** covers various statistical methodologies concepts including measures of central tendency and dispersion, random variables, some basic distributions, correlation and regression analysis, as well as parametric and non-parametric testing. These methodologies are crucial for analyzing, interpreting, and making informed decisions based on data.

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