Curriculum for Undergraduate Programmes in Statistics (Academic Year 2024-25 onward)

Department of Statistics
Indira Gandhi National Tribal University
Amarkantak, India

Department of Statistics
NEP Course-Structure –3 Year B. Sc. STATISTICS Major
Academic Year 2024-25 Onwards

Semester – I: Course Structure B. Sc. (STATISTICS Major)

Course Type	Course Title	Course Code	Credits	Marks
Major	Descriptive Statistics - I	STAT-M-101	4	100
Minor	*	*	4	100
Multidisciplinary	#	#	3	100
Ability Enhancement Course	*	*	2	50
Skill Enhancement Course	Analytics - I	STAT-SEC-131	3	100
Value Added Courses (2+2)	*	*	4	100
Total			**20**	**550**

* Course offered by departments other than Statistics
# Courses offered at faculty level

Semester – II: Course Structure B. Sc. (STATISTICS Major)

Course Type	Course Title	Course Code	Credits	Marks
Major	Descriptive Statistics - II	STAT-M-102	4	100
Minor	*	*	4	100
Multidisciplinary	#	#	3	100
Ability Enhancement Course	*	*	2	50
Skill Enhancement Course	Analytics – II	STAT-SEC-132	3	100
Value Added Courses (2+2)	*	*	4	100
Total			**20**	**550**

* Course offered by departments other than Statistics
# Courses offered at faculty level

Semester – III: Course Structure B. Sc. (STATISTICS Major)

Course Type	Course Title	Course Code	Credits	Marks
Major - 1	Elements of Probability and Distribution Theory	STAT-M-201	4	100
Major - 2	Statistical Computing and Data Analysis - I	STAT-M-202	4	100
Minor	*	*	4	100
Multidisciplinary	#	#	3	100
Ability Enhancement Course	*	*	2	50
Skill Enhancement Course	Analytics - III	STAT-SEC-232	3	100
Total			**20**	**550**

* Course offered by departments other than Statistics
# Courses offered at faculty level

Semester – IV: Course Structure B. Sc. (STATISTICS Major)

Course Type	Course Title	Course Code	Credits	Marks
Major - 1	Techniques of Statistical Inference	STAT-M-203	4	100
Major - 2	Probability Distributions	STAT-M-204	4	100
Major - 3	Statistical Computing and Data Analysis - II	STAT-M-205	4	100
Major - 4	Sampling Distributions	STAT-M-206	2	50
Minor	*	*	4	100
Ability Enhancement Course	*	*	2	50
Total			**20**	**500**

*Course offered by departments other than Statistics

Semester – V: Course Structure B. Sc. (STATISTICS Major)

Course Type	Course Title	Course Code	Credits	Marks
Major - 1	Design of Experiments	STAT-M-301	4	100
Major - 2	Design of Sample Surveys	STAT-M-302	4	100
Major - 3	Statistical Computing and Data Analysis - III	STAT-M-303	4	100
Major - 4	Non parametric Tests	STAT-M-304	2	50
Minor	*	*	4	100
Internship		STS - I -331	2	50
Total			**20**	**500**

*Course offered by departments other than Statistics

Semester – VI: Course Structure B. Sc. (STATISTICS Major)

Course Type	Course Title	Course Code	Credits	Marks
Major - 1	Linear Models and Regression Analysis	STAT-M-306	4	100
Major - 2	Time Series Modeling	STAT-M-307	4	100
Major - 3	Official Statistics	STAT-M-308	4	100
Major - 4	Statistical Computing and Data Analysis - IV	STAT-M-305	2	50
Major - 5	Project - I	STAT - P - I	2	50
Minor	*	*	4	100
Total			**20**	**500**

*Course offered by departments other than Statistics

Overall Course Structure for B. Sc. (Honors) STATISTICS Major

Course Type	Credits	Marks
Major	60	1500
Minor	24	600
Multidisciplinary	9	300
Ability Enhancement Course	8	200
Skill Enhancement Course	9	300
Value Added Courses (2+2)	8	200
Internship	2	50
Research Project/ Dissertation	0	0
Total	**120**	**3150**

Semester wise List of Minor Courses Offered

Semester	Course Code	Course Title	Credits	Marks
I	STAT-Mi-111	Statistical Methods - I	4	100
II	STAT-Mi-112	Probability and Distributions	4	100
III	STAT-Mi-211	Statistical Inference	4	100
IV	STAT-Mi-212	Survey Sampling	4	100
V	STAT-Mi-311	Design of Experiments	4	100
VI	STAT-Mi-312	Official Statistics and Index Numbers	4	100
Total			**12**	**300**

Department of Statistics
NEP Course-Structure –4 Year B. Sc. (Honors) - STATISTICS Major
Academic Year 2024-25 Onwards

Semester – I: Course Structure B. Sc. (STATISTICS Major)

Course Type	Course Title	Course Code	Credits	Marks
Major	Descriptive Statistics - I	STAT-M-101	4	100
Minor	*	*	4	100
Multidisciplinary	#	#	3	100
Ability Enhancement Course	*	*	2	50
Skill Enhancement Course	Analytics - I	STAT-SEC-131	3	100
Value Added Courses (2+2)	*	*	4	100
Total			**20**	**550**

*Courses offered by departments other than Statistics
Courses offered at faculty level

Semester – II: Course Structure B. Sc. (STATISTICS Major)

Course Type	Course Title	Course Code	Credits	Marks
Major	Descriptive Statistics - II	STAT-M-102	4	100
Minor	*	*	4	100
Multidisciplinary	#	#	3	100
Ability Enhancement Course	*	*	2	50
Skill Enhancement Course	Analytics – II	STAT-SEC-132	3	100
Value Added Courses (2+2)	*	*	4	100
Total			**20**	**550**

*Courses offered by departments other than Statistics
Courses offered at faculty level

Semester – III: Course Structure B. Sc. (STATISTICS Major)

Course Type	Course Title	Course Code	Credits	Marks
Major - 1	Elements of Probability and Distribution Theory	STAT-M-201	4	100
Major - 2	Statistical Computing and Data Analysis - I	STAT-M-202	4	100
Minor	*	*	4	100
Multidisciplinary	#	#	3	100
Ability Enhancement Course	*	*	2	50
Skill Enhancement Course	Analytics - III	STAT-SEC-232	3	100
Total			**20**	**550**

*Courses offered by departments other than Statistics
Courses offered at faculty level

Semester – IV: Course Structure B. Sc. (STATISTICS Major)

Course Type	Course Title	Course Code	Credits	Marks
Major - 1	Techniques of Statistical Inference	STAT-M-203	4	100
Major - 2	Probability Distributions	STAT-M-204	4	100
Major - 3	Statistical Computing and Data Analysis - II	STAT-M-205	4	100
Major - 4	Sampling Distributions	STAT-M-206	2	50
Minor	*	*	4	100
Ability Enhancement Course	*	*	2	50
Total			**20**	**500**

*Course offered by departments other than Statistics

Semester – V: Course Structure B. Sc. (STATISTICS Major)

Course Type	Course Title	Course Code	Credits	Marks
Major - 1	Design of Experiments	STAT-M-301	4	100
Major - 2	Design of Sample Surveys	STAT-M-302	4	100
Major - 3	Statistical Computing and Data Analysis - III	STAT-M-303	4	100
Major - 4	Non parametric Tests	STAT-M-304	2	50
Minor	*	*	4	100
Internship		STS - I -331	2	50
Total			**20**	**500**

*Course offered by departments other than Statistics

Semester – VI: Course Structure B. Sc. (STATISTICS Major)

Course Type	Course Title	Course Code	Credits	Marks
Major - 1	Linear Models and Regression Analysis	STAT-M-306	4	100
Major - 2	Time Series Modeling	STAT-M-307	4	100
Major - 3	Official Statistics	STAT-M-308	4	100
Major - 4	Statistical Computing and Data Analysis - IV	STAT-M-305	2	50
Major - 5	Project	STAT - P	2	50
Minor	*	*	4	100
Total			**20**	**500**

*Course offered by departments other than Statistics

Semester – VII: Course Structure B. Sc. (STATISTICS Major)

Course Type	Course Title	Course Code	Credits	Marks
Major - 1	Advanced Probability Theory	STAT-M-401	4	100
Major - 2	Advanced Distribution Theory	STAT-M-402	4	100
Major - 3	Advanced Design of Experiments	STAT-M-403	4	100
Major - 4	Advanced Sampling Theory	STAT-M-404	4	100
Minor	*	*	4	100
Total			**20**	**500**

*Course offered by departments other than Statistics

Semester – VIII: Course Structure B. Sc. (STATISTICS Major)

Course Type	Course Title	Course Code	Credits	Marks
Major - 1	Estimation	STAT-M-405	4	100
Major - 2	Testing of Hypothesis	STAT-M-406	4	100
Major - 3	Linear Models	STAT-M-407	4	100
Major - 4	Multivariate Analysis	STAT-M-408	4	100
Minor	*	*	4	100
Total			**20**	**500**

*Course offered by departments other than Statistics

Overall Course Structure for B. Sc. (Honors) STATISTICS Major

Course Type	Credits	Marks
Major	92	2300
Minor – I	32	800
Multidisciplinary	9	300
Ability Enhancement Course	8	200
Skill Enhancement Course	9	300
Value Added Courses (2+2)	8	200
Internship	2	50
Research Project/ Dissertation	0	0
Total	**160**	**4150**

Semester wise List of Minor Courses Offered

Semester	Course Code	Course Title	Credits	Marks
I	STAT-Mi-111	Statistical Methods - I	4	100
II	STAT-Mi-112	Probability and Distributions	4	100
III	STAT-Mi-211	Statistical Inference	4	100
IV	STAT-Mi-212	Survey Sampling	4	100
V	STAT-Mi-311	Design of Experiments	4	100
VI	STAT-Mi-312	Official Statistics and Index Numbers	4	100
VII	STAT-Mi-411	Statistical Methods - II	4	100
VIII	STAT-Mi-412	Time Series Analysis and Statistical Quality Control	4	100
Total			**16**	**400**

Department of Statistics
NEP Course-Structure –B. Sc. (Honors with Research) -STATISTICS Major
Academic Year 2024-25 Onwards

Semester – I: Course Structure B. Sc. (STATISTICS Major)

Course Type	Course Title	Course Code	Credits	Marks
Major	Descriptive Statistics - I	STAT-M-101	4	100
Minor	*	*	4	100
Multidisciplinary	#	#	3	100
Ability Enhancement Course	*	*	2	50
Skill Enhancement Course	Analytics - I	STAT-SEC-131	3	100
Value Added Courses (2+2)	*	*	4	100
Total			**20**	**550**

* Course offered by departments other than Statistics
# Courses offered at faculty level

Semester – II: Course Structure B. Sc. (STATISTICS Major)

Course Type	Course Title	Course Code	Credits	Marks
Major	Descriptive Statistics - II	STAT-M-102	4	100
Minor	*	*	4	100
Multidisciplinary	#	#	3	100
Ability Enhancement Course	*	*	2	50
Skill Enhancement Course	Analytics – II	STAT-SEC-132	3	100
Value Added Courses (2+2)	*	*	4	100
Total			**20**	**550**

* Course offered by departments other than Statistics
# Courses offered at faculty level

Semester – III: Course Structure B. Sc. (STATISTICS Major)

Course Type	Course Title	Course Code	Credits	Marks
Major - 1	Elements of Probability and Distribution Theory	STAT-M-201	4	100
Major - 2	Statistical Computing and Data Analysis - I	STAT-M-202	4	100
Minor	*	*	4	100
Multidisciplinary	#	#	3	100
Ability Enhancement Course	*	*	2	50
Skill Enhancement Course	Analytics - III	STAT-SEC-232	3	100
Total			**20**	**550**

* Course offered by departments other than Statistics
# Courses offered at faculty level

Semester – IV: Course Structure B. Sc. (STATISTICS Major)

Course Type	Course Title	Course Code	Credits	Marks
Major - 1	Techniques of Statistical Inference	STAT-M-203	4	100
Major - 2	Probability Distributions	STAT-M-204	4	100
Major - 3	Statistical Computing and Data Analysis - II	STAT-M-205	4	100
Major - 4	Sampling Distributions	STAT-M-206	2	50
Minor	*	*	4	100
Ability Enhancement Course	*	*	2	50
Total			**20**	**500**

*Course offered by departments other than Statistics

Semester – V: Course Structure B. Sc. (STATISTICS Major)

Course Type	Course Title	Course Code	Credits	Marks
Major - 1	Design of Experiments	STAT-M-301	4	100
Major - 2	Design of Sample Surveys	STAT-M-302	4	100
Major - 3	Statistical Computing and Data Analysis - III	STAT-M-303	4	100
Major - 4	Non parametric Tests	STAT-M-304	2	50
Minor	*	*	4	100
Internship		STS - I -331	2	50
Total			**20**	**500**

*Course offered by departments other than Statistics

Semester – VI: Course Structure B. Sc. (STATISTICS Major)

Course Type	Course Title	Course Code	Credits	Marks
Major - 1	Linear Models and Regression Analysis	STAT-M-306	3	100
Major - 2	Time Series Modeling	STAT-M-307	3	100
Major - 3	Official Statistics	STAT-M-308	3	100
Major - 4	Statistical Computing and Data Analysis - IV	STAT-M-305	3	100
Major - 5	Project - I	STAT - P - I	4	100
Minor	*	*	4	100
Total			**20**	**600**

*Course offered by departments other than Statistics

Semester – VII: Course Structure B. Sc. (STATISTICS Major)

Course Type	Course Title	Course Code	Credits	Marks
Major - 1	Advanced Probability Theory	STAT-M-401	4	100
Major - 2	Advanced Distribution Theory	STAT-M-402	4	100
Major - 3	Advanced Design of Experiments	STAT-M-403	4	100
Major - 4	Advanced Sampling Theory	STAT-M-404	4	100
Minor	*	*	4	100
Total			**20**	**500**

*Course offered by departments other than Statistics

Semester – VIII: Course Structure B. Sc. (STATISTICS Major)

Course Type	Course Title	Course Code	Credits	Marks
Major - 1	Estimation	STAT-M-405	2	50
Major - 2	Testing of Hypothesis	STAT-M-406	2	50
Minor	*	*	4	100
Research Project/ Dissertation		STAT-M-409	12	300

Overall Course Structure for B. Sc. (Honors) STATISTICS Major

Course Type	Credits	Marks
Major	80	2000
Minor	32	800
Multidisciplinary	9	300
Ability Enhancement Course	8	200
Skill Enhancement Course	9	300
Value Added Courses (2+2)	8	200
Internship	2	50
Research Project/ Dissertation	12	300
Total	**160**	**4150**

Semester wise List of Minor Courses Offered

Semester	Course Code	Course Title	Credits	Marks
I	STAT-Mi-111	Statistical Methods - I	4	100
II	STAT-Mi-112	Probability and Distributions	4	100
III	STAT-Mi-211	Statistical Inference	4	100
IV	STAT-Mi-212	Survey Sampling	4	100
V	STAT-Mi-311	Design of Experiments	4	100
VI	STAT-Mi-312	Official Statistics and Index Numbers	4	100
VII	STAT-Mi-411	Statistical Methods - II	4	100
VIII	STAT-Mi-412	Time Series Analysis and Statistical Quality Control	4	100
Total			**16**	**400**

MAJOR Courses

STAT-M-101: Descriptive Statistics - I

Statistical Data and Frequency distributions: Collecting statistical data, method of collection; methods of presentation; graphic presentation; rates, ratios and percentages; frequency distributions, frequency curves, types of frequency distributions, generalized system of frequency curves; cumulative frequency distributions and ogive; Describing frequency distribution by a fitted curve.

Liner data: moments, Sheppard's correction for moments; measures of central tendency, dispersion, skewness and kurtosis based on moments; median, mode, weighted and unweighted geometric mean and harmonic mean; range, mean deviation, Gini's mean difference, quartile deviation, coefficient of variation, curve of concentration.

Circular data: Diagrammatical representation, ungrouped data and grouped data – circular histograms, linear histograms, rose diagrams; representation of axial data; Frequency distributions: unimodal and multimodal; summary statistics: mean direction, median direction, circular variance, decomposition of dispersion, circular standard deviation, circular mean difference, circular range; Trigonometric moments; measures of skewness and kurtosis.

Time series data: Components of a time series; measurement of circular trend: free hand curve fitting, method of moving averages, method of mathematical curves, group average method, semi-average method; measurement of seasonal fluctuations: methods of seasonal averages, ratio-to-moving average method, ratio-to-trend method, method of link relatives, changing seasonal patterns.

References

1. Croxton, F. E. and Cowdon, D. J. (1964). Applied General Statistics, Prentice – Hall of India LTD, New Delhi.
2. Gun A.M., Gupta M.K. and Dasgupta B. (2002). Fundamentals of Statistics, Vol. I, 8th Edn. The World Press, Kolkata.
3. Gun A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. II, 8th Edn. The World Press, Kolkata.
4. Mardia, K. V. and Jupp, P. E. (2000). Directional Data, Johan Wiley and Sons, LTD.
5. Snedecor, George W. and Cochran, William G. (1989). Statistical Methods, Affifliated East West Press and Iowa State University Presss.
6. Weatherburn, C. E. (1990). A First Course in Mathematical Statistics, S. Chand and Company LTD, New Delhi.
7. Yule, G. Udny. (1922). An Introduction to the Theory of Statistics, Charles Griffins and Company Limited, London.

STAT-M-102: Descriptive Statistics - II

Two ratio / interval variables: Bivariate data, scatter diagram, correlation, correlation coefficient: properties, simple linear regression; polynomials and transformations; correlation index, correlation ratio. Curve fitting and orthogonal polynomials. Polynomial regression.

Three ratio / interval variables: Multivariate data, multiple regression, multiple correlation, partial correlation, relation between partial regression and partial correlation coefficients, relation between multiple correlation coefficient and partial correlation coefficients, expression of higher / lower - order coefficients in terms of lower / higher - order coefficients.

Two categorical variables Data: on two or more attributes; joint, conditional and marginal frequency distributions; measures of association; manifold two-way classifications; Karl Pearsons coefficient of contingency; Table structure for two dimensions: contingency tables and independence; Odds, odds ratio and relative risk; Odds ratios for I × Jcontingency tables. Summary measures of association: Gamma, Goodmanand Kruskal's tau, and uncertainty coefficient.

Other correlations: Spearmans rank correlation coefficient, Kendal's rank correlation coefficient, grade correlation, intra-class correlation, tetrachoric correlation, biserial correlation, point biserial correlation, point tetrachoric correlation. Time series data: serial correlation and correlogram, correlation between two time series, lag correlation.

References

1. Croxton, F. E. and Cowdon, D. J. (1964). Applied General Statistics, Prentice – Hall of India LTD, New Delhi.
2. Gun A.M., Gupta M.K. and Dasgupta B. (2002). Fundamentals of Statistics, Vol. I, 8th Edn. The World Press, Kolkata.
3. Gun A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. II, 8th Edn. The World Press, Kolkata.
4. Mardia, K. V. and Jupp, P. E. (2000). Directional Data, Johan Wiley and Sons, LTD.
5. Snedecor, George W. and Cochran, William G. (1989). Statistical Methods, Affifliated East West Press and Iowa State University Presss.
6. Weatherburn, C. E. (1990). A First Course in Mathematical Statistics, S. Chand and Company LTD, New Delhi.
7. Yule, G. Udny. (1922). An Introduction to the Theory of Statistics, Charles Griffins and Company Limited, London.

STAT-M-201: Elements of Probability and Distribution Theory

Random experiments and probability, Trial, sample point, sample space, definitions of equally likely, mutually exclusive and exhaustive events, definition of probability, classical and relative frequency approach to probability, axiomatic approach to probability and its properties, merits and demerits of these approaches.

Total and compound probability theorems, conditional probability, independence of events, Bayes theorem and its applications in real life problems.

Random variables: Discrete and Continuous - Probability mass function / probability density functions with distribution function, Expectation and conditional expectations, Variance, Moments in terms of expectation: Raw and central moments and their relations, Moments Generating Functions and Cumulative Generating Functions and their properties Simple problems.

Convergence and Limit Theorems: Chebychev's inequality, Cauchy Schwartz inequality, Definition of convergence in probability and distribution, Weak law of large numbers, strong law of large numbers and Central Limit theorem for i.i.d case (statement only).

Texts

1. Mood, Alexander M., Graybill, Franklin A., and Boes, Duane C. (2001). Introduction to the theory of Statistics, Third Edition, McGraw Hill Education (India) Private Limited, New Delhi.
2. Rohatgi, Vijay K., and Saleh, A. K. md.Ehsanes. (2000). An Introduction to Probability and Statistics, Second Edition, Johan Wiley and Sons, INC.
3. Hogg, R.V. ,Mc Kean J W and Craig, A.T.(2005). Introduction to Mathematical Statistics, 6/e Pearson Edition.

References

1. Rao, C.R. (2009). Linear Statistical Inference and its Applications, 2nd Edition, Wiley Eastern.
2. Pitman, J. (1993). Probability. Narosa Publishing House.
3. Lipschutz, S., Lipson, M.L. and Jain, K. (2010). Schaums Outline of Probability. 2nd Edition. McGraw Hill Education Pvt. Ltd, New Delhi.
4. Johnson, S. and Kotz, S. (1972). Distribution in Statistics Vol. I-II & III, Houghton and Mifflin.
5. Hanagal, D.D. (2009). Introduction to Applied Statistics: A Non Calculus Based Approach. Narosa Publishing Comp. New Delhi.
6. Dudewicz, E.J. and Mishra, S.N. (2008). Modern Mathematics Statistics, Wiley.

STAT-M-202: Statistical Computing and Data Analysis - I

R

Setting up R: installing R, starting R, working directory, writing scripts, help and supporting material. R as a calculating environment: arithmetic, variables, functions, vectors, missing data: NA, expressions and assignments, logical expressions, matrices, workspace.

Statistical Computing and data analysis

Generating a random sample: Probability integral transform, Box – Muller algorithm, Accept – Reject algorithm, Metropolis algorithm; Empirical cumulative distribution function and survival function, quantile – quantile plots, histograms, density curves and stem-and-leaf plots, measures of location, estimating variability of location estimates by the bootstrap, measures of dispersion, boxplots, exploring relationships with scatter plots.

Texts

1. Peter Dalgaard. (2008). Introductory Statistics with R, 2nd edition, Springer.
2. Jared P Lander (2014). R for Everyone: Advanced Analytics and Graphics, Pearson Education Inc.
3. Jones, O., Maillardet, R and Robinson, A. (2014). Introduction to Scientific Programming and Simulation Using R, Second Edition, CRC Press.
4. Rice, John. A. (2014). Mathematical Statistics and Data Analysis, CENGAGE Learning.

STAT-M-203: Techniques of Statistical Inference

Methods of Finding Estimators: Method of moments, method of minimum chi square, maximum likelihood estimation, Properties of maximum likelihood estimators (without proof), method of least squares, method of minimum chi-square, Bayes estimators.

Methods of Evaluating Estimators: Mean squared error, best unbiased estimator, minimum variance bound estimators, Cramer-Rao inequality (statement and applications), sufficiency and Rao- Blackwell theorem (statement and applications). Bhattacharya bounds, Sufficient estimator, factorization theorem. complete statistics, Rao-Blackwell theorem**.**

Methods of Finding Tests: Likelihood ratio tests, Bayesian tests, union – intersection and intersection – union tests. Methods of Evaluating Tests: Error probabilities and power function, most powerful tests, Neyman – Pearson lemma (statement and applications), unbiased tests, p-value. Randomized test. Likelihood ratio test. Wald's SPRT, OC and ASN functions. Elements of decision theory

Methods of Finding Confidence intervals: Inverting a test statistic, pivotal quantiles, pivoting a CDF and Bayesian intervals. Confidence interval estimation, optimum confidence bounds. resampling, bootstrap and Jacknife.

Texts

1. Casella, George and Berger, Roger L. (2016). Statistical Inference, Second Edition, CENGAGE Learning.
2. Mood, A.M., Graybill, A.M. and Boes, D.C. (2011). Introduction to theory of Statistics, McGraw Hill.

References

1. Lehmann, E.L. and Casella, G. (1998).Theory of Point Estimation, Springer International.
2. Rajagopalan, M. and Dhanavanthan, P. (2012). Statistical Inference, PHI Learning Pvt. Ltd.
3. Rao, C.R. (2009). Linear Statistical Inference and its Applications, 2nd Edition, Wiley Eastern.
4. Rohatgi, V.K. and Saleh, A.K.(2002). An Introduction to Probability and Statistics , 2/e, John Wiley.

STAT-M-204: Probability Distributions

Discrete Distributions Discrete uniform, Bernoulli, binomial, Poisson, geometric, negative binomial, hypergeometric, negative hypergeometric, beta-binomial, logarithmic.

Continuous Distributions Uniform, normal, bivariate normal, exponential, gamma distributions, Weibull, beta, Cauchy, lognormal, double exponential / Laplace, logistic, Pareto,Gumbel, exponential families, location families and scale families of distributions.

Texts

1. Mood, Alexander M., Graybill, Franklin A., and Boes, Duane C. (2001). Introduction to the theory of Statistics, Third Edition, McGraw Hill Education (India) Private Limited, New Delhi.
2. Rohatgi, Vijay K., and Saleh, A. K. md.Ehsanes. (2000). An Introduction to Probability and Statistics, Second Edition, Johan Wiley and Sons, INC.

References

1. Johnson, N.L, Kotz, S. and Balakrishnan, N. (1994): Continuous Univariate Distributions, Vol. 1 & 2, Wiley Series in Probability and Statistics.
2. Johnson, N.L , Kemp A.W. &Kotz, S. (1994): Univariate Discrete Distributions, Wiley Series in Probability and Statistics.

STAT-M-205: Statistical Computing and Data Analysis - II

R

Basic programming: Branching with if, looping with for, looping with while, vector-based programming, program flow, basic debugging, good programming habits. Input and output: text, input from a file, input from the keyboard, output to a file, plotting.

Statistical computing and data analysis

1. Estimation: Method of moments, maximum likelihood estimation, confidence intervals, Bayesian approach to parameter estimation. EM algorithm.
2. Testing of Hypothesis: Likelihood ratio tests, tests for normality, Fitting of probability distributions and assessing the goodness of fit.
3. Analysis of categorical data: Fisher's exact test, chi-square test for homogeneity, chi-square test for independence, matched pairs design, odds ratio.

Texts

1. Peter Dalgaard (2008). Introductory Statistics with R, 2nd edition, Springer.
2. Jared P Lander (2014). R for Everyone: Advanced Analytics and Graphics, Pearson Education Inc.
3. Jones, O., Maillardet, R and Robinson, A. (2014). Introduction to Scientific Programming and Simulation Using R, Second Edition, CRC Press.
4. Rice, John. A. (2014). Mathematical Statistics and Data Analysis, CENGAGE Learning.

STAT-M-206: Sampling Distributions

Random Samples: Population, random sample, statistic, sample mean, sample variance and sample standard deviation; Sample covariance and sample correlation coefficient; Sample moments.Ideas about various convergence concepts and their application in statistical inference.

Sampling Distributions: Sampling from normal distribution: properties of sample mean and variance; χ^2, $Student's - t$and $Snedecor's - F$distributions.. Tests of significance based on χ^2, $Student's - t$and $Snedecor's - F$distributions,. Order statistics: minimum, maximum, range and median. Distribution of the correlation coefficient.

Texts

1. Casella, George and Berger, Roger L. (2016). Statistical Inference, Second Edition, CENGAGE Learning.
2. Gun, A.M., Gupta, M.K. and Das Gupta, B. (2016): An Outline of statistical theory, Vol. I, World Press, Calcutta.

3. Mood, Alexander M., Graybill, Franklin A., and Boes, Duane C. (2001). Introduction to the theory of Statistics, Third Edition, McGraw Hill Education (India) Private Limited, New Delhi.

References

1. Lehmann, E.L. and Casella, G. (1998).Theory of Point Estimation, Springer International.
2. Rao, C.R. (2009). Linear Statistical Inference and its Applications, 2nd Edition, Wiley Eastern.
3. Rohatgi, Vijay K., and Saleh, A. K. md.Ehsanes. (2000). An Introduction to Probability and Statistics, Second Edition, Johan Wiley and Sons, INC.

STAT-M-301: Design of Experiments

Design of Experiments Terminology, principles and planning; completely randomized design, randomized block design and latin square design: layout, analysis, advantages and disadvantages; efficiency of randomized block design and latin square design; Greaco - latin square design and cross – over design; missing plot technique.

Factorial Experiments Design of $2^2, 2^3, 3^2$ and 3^3 factorial experiments: defining and testing main effects and interaction effects; confounding: complete and partial; split – plot design and strip –plot design; ANCOVA.

References

1. Cochran .W.G. and Cox .G.M. (1995). Experimental designs, 4/e, Wiley.
2. Das, M. N. and Giri, N. C. (2017). Design and Analysis of Experiments, Third Edition, New Age International Publishers.
3. Gun, A. M., Gupta, M. K. and Dasgupta, B. (2008). Fundamentals of Statistics Volume II, World Press.
4. Gun, A. M., Gupta, M. K. and Dasgupta, B. (2010). An Outline of Statistical Theory, Volume Two, World Press.
5. Joshi, D. D. (1977). Linear Estimation and Design of Experiments.The New Age International Publishers, Delhi.
6. Montgomery, Douglas C.(2013). Design and Analysis of Experiments,Wiley.
7. Rao, C. R. (1973). Linear Statistical Inference and its Applications,Wiley.

STAT-M-302: Design of Sample Surveys

Concepts of sampling Need for sampling, population and sample, sampling unit and sample frame, Basic properties of sample survey and census survey. Principal steps in a Sample survey; Notion of sampling and non-sampling errors.

Simple Random Sampling Simple Random Sampling with and without replacement Estimation of Population mean and Proportion and their variances- Determination of sample size.

Stratified Random Sampling Stratified sampling Principles of stratification Estimation of population mean and its variance Allocation techniques: optimum, proportional and Neyman Estimation of gain due to stratification.

Systematic sampling Linear and Circular systematic sampling Estimation of population mean and variance, Equal Cluster Sampling- Estimation of population mean and variance, Comparison of cluster and random sampling, Comparison of systematic, simple random and stratified.

Texts

1. Cochran, W.G. (1999). Sampling Techniques, Third edition, John Wiley & Sons.
2. Singh D and Choudhary F.S. (1986). Theory and Analysis of Sample Survey and Designs, New Age International.
3. A.K. Swain (2003). Finite Population Sampling, South Asian Publishers.

References

1. Des Raj and Chandhok.(1998). Sampling Theory, Narosa.
2. Mukhopadhay, P. (2009). Theory and Methods of Survey Sampling, Second edition, PHI Learning Pvt Ltd., New Delhi.

STAT-M-303: Statistical Computing and Data Analysis - III

R

Programming with functions: functions, scope and its consequences, arguments, vector-based programming using functions, recursive programming, debugging functions. Graphics with ggplot2.
Statistical computing and data analysis

Comparing two independent samples: parametric and non-parametric methods; Comparing paired samples: parametric and non-parametric methods; ANOVA: parametric and non-parametric methods for one-wayand two-waylayouts; Simple random sampling; Stratified sampling; Systematic sampling

Texts

1. Pierre Andre Cornillon et al. (2012): R for Statistics, CRC Press.

2. Randall E. Schumacker (2014): Learning Statistics using R, SAGE Publications, Inc.
3. Purohit, SudhaG., Gore, Sharad D. and Deshmukh, Shailaja R. (2008): Statistics using R, Alpha Science International Limited.
4. Jones, O., Maillardet, R and Robinson, A. (2014). Introduction to Scientific Programming and Simulation Using R, Second Edition, CRC Press.
5. Rice, John. A. (2014). Mathematical Statistics and Data Analysis, CENGAGE Learning.

References

1. Jared P Lander (2014): R for Everyone: Advanced Analytics and Graphics, Pearson Education Inc.
2. Michael J.Crawley (2007): The R Book, John Wiley and Sons Ltd.
3. Peter Dalgaard (2008): Introductory Statistics with R, 2nd edition, Springer.

STAT-M-304: Non parametric Tests

Single Sample Problems Goodness of fit, Kolmogorov – Smirnov test, sign test, Wilcoxon signed rank test.

Two Sample Problems Wald-Wolfowitz runs test, Mann-Whiteny U-test, Kolmogorov – Smirnov two sample test, chi-square test, median test, Mood test, Freund-Ansari test.

K-Sample Problems The chi-square test for K Bernoulli populations, extended median test, Kruskal – Wallis test, Friedman's test.

Texts

1. Mood, A.M., Graybill, A.M. and Boes, D.C. (2011). Introduction to theory of Statistics, McGraw Hill.
2. Rajagopalan, M. and Dhanavanthan, P. (2012). Statistical Inference, PHI Learning Pvt. Ltd.

References

1. Gibbons, J.D. (2003). Nonparametric Statistical Inference, 4th Edition, Marcel Dekker.
2. Randles, R.H. and Wolfe, D.A. (1979). Introduction to the Theory of Nonparametric Statistics, Wiley.

STAT-M-305: Statistical Computing and Data Analysis - IV

R

Sophisticated data structures: factors, dataframes, lists, the apply family. Pointers to further programming techniques: packages, frames and environments, debugging again, identifying bottlenecks, manipulation of data.

Statistical computing and data analysis

Regression: simple linear regression model, parameter estimation, testing of hypotheses and confidence intervals, prediction and quality of fit. Multiple regression: parameter estimation, interpretations of regression coefficients; regression diagnostics.

Trend fitting: Modified exponential curve, Gompertz curve, logistic curve, moving average method. Measurement of seasonal indices: ratio-to-trend method, ratio-to-moving average method, link relative method. Calculation of variance of random component by variate difference method, forecasting by exponential smoothing, short term forecasting methods.

Texts

1. Peter Dalgaard. (2008). Introductory Statistics with R, 2nd edition, Springer.
2. Jared P Lander. (2014). R for Everyone: Advanced Analytics and Graphics, Pearson Education Inc.
3. Jones, O., Maillardet, R and Robinson, A. (2014). Introduction to Scientific Programming and Simulation Using R, Second Edition, CRC Press.
4. Rice, John. A. (2014). Mathematical Statistics and Data Analysis, CENGAGE Learning.

STAT-M-306: **Linear Models and** Regression Analysis

inear Estimation Gauss – Markov linear models, estimable functions, linear functions belonging to error and BLUEs; estimation space and error space; least square estimators and Gauss – Markov theorem; linear estimation with linear restriction on parameters; linear estimation with correlated variables; independent set, linear set: rank and degrees of freedom; sum of squares due to a linear function and a set of linear functions; partition theorem of sum of squares.

Linear Hypothesis Fixed, random and mixed effects linear models; Canonical form of Gauss – Markov model; testing linear hypothesis; ANOVA for one-way and two-way classified data; estimation of variance components. multiple comparison tests due to Tukey, Scheffe and Student-Newmann-Keul-Duncan

Simple Regression Introduction, steps in regression analysis, covariance and correlation coefficient, the simple linear regression model, parameter estimation, testing of hypotheses and confidence intervals, prediction and quality of fit.
Multiple Regression Parameter estimation, interpretations of regression coefficients, properties of least squares estimators, multiple correlation coefficient, inference pertaining to regression coefficients; Regression diagnostics.

Texts

1. Drapper, Norman R. and Smith H. (). Applied Regression Analysis. Wiley.
2. Chatterjee, Samprit and Hadi, Ali S. (2006). Regression Analysis by Example, Wiley - Interscience.

References

1. Weisberg, S. (1985). Applied Linear Regression, Wiley.
2. Rao, C. R. (2016). Linear Statistical Inference and its Applications, Wiley.
3. Montogomery, D. C., Peck, E. A. and Vining, G. G. Introduction to Linear Regression Analysis.

STAT-M-307: Time Series Modeling

Time Series as Stochastic Process Time series as a discrete parameter stochastic process, Auto - Covariance, Auto-correlation and their properties. Exploratory time series analysis, Test for trend and seasonality, Exponential and moving average smoothing, Holt Winter smoothing and Forecasting.

Time Series Models Wold representation of linear stationary processes,
Detailed study of the linear time series models: Autoregressive, Moving Average, Autoregressive Moving Average and Autoregressive Integrated Moving Average models; Model identification.

Estimation in Time Series Models Estimation of ARMA models: Yule-Walker estimation for AR Processes, Maximum likelihood and least squarese stimation for ARMA Processes, Discussion (without proof) of estimation of mean, Auto-covariance and auto-correlation function under large samples theory, Residual analysis and diagnostic checking. Forecasting using ARIMA models.

Analysis of Seasonal Models parsimonious models for seasonal time series, General multiplicative seasonal models, forecasting, identification, estimation and diagnosis methods for seasonal time series. Spectral analysis of weakly stationary process. Herglotzic Theorem. Periodogram and correlogram analysis.

Text

1. Brockwell, P.J and Davis R.A. (1987). Time Series: Theory and Methods, Springer-Verlag.
2. Chatfield, C. (2004). The Analysis of Time Series - An Introduction, Sixth edition, Chapman and Hall.
3. Fuller, W. A. Introduction to statistical time series.
4. Montgomery, D.C., C. L. Jennings, Murat, Kulahci. Introduction to Time Series Analysis and Forecasting, Wiley Interscience.

References

1. Box, G.E.P and Jenkins G.M. (1970), Time Series Analysis, Forecastingand Control, Holden-Day.
2. Kendall, M.G. (1978). Time Series, CharlerGraffin.

STAT-M-308: Official Statistics

National and International official statistical systems; Official Statistics: need, uses, users, reliability, relevance, limitations, transparency, its visibility; compilation, collection, processing, analysis and dissemination, agencies involved, methods.

NSSO and CSO: Vision and Mission,; roles and responsibilities; Important activities, Publications. National Statistical Commission: Need, Constitution, its role, functions etc; Legal Acts/ Provisions/ Support for Official Statistics; Important Acts. Population Census: Need, Data Collected, Periodicity, Methods of data collection, dissemination, Agencies involved.

Index Numbers: Different Types, Need, Data Collection Mechanism, Periodicity, Agencies Involved, Uses. Index Numbers: Price relatives and quantity or volume relatives, Link and chain relatives composition of index numbers; Laspeyre's, Paasches', Marshal Edgeworth and Fisher index numbers; chain base index number, tests for index number, Construction of index numbers of wholesale and consumer prices, Income distribution-Pareto and Engel curves, Concentration curve, Methods of estimating national income, Inter-sectoral flows, Interindustry table, Role of CSO.

Sector Wise Statistics: Agriculture, Health, Education, Women and Child etc. Important Surveys & Census, Indicators, Agencies and Usages etc. National Accounts: Definition, Basic Concepts; issues; the Strategy, Collection of Data and Release. Socio Economic Indicators, Gender Awareness/Statistics, Important Surveys and Censuses.

Text:

1. Saluja, M. R. (2017). Measuring India, Oxford University Press.

References:

1. https://mospi.gov.in/
2. https://www.mospi.gov.in/national-statistics-office-nso

STAT-M-401: Advanced Probability Theory

Algebra of sets - fields and sigma-fields, Inverse function Measurable function Probability measure on a sigma field simple properties – Probability space - Random variables and Random vectors Induced Probability space Distribution functions Decomposition of distribution functions.

Expectation and moments definitions and simple properties Moment inequalities Holder, Jenson, Chebyshev, Markov Inequalities Characteristic function definition and properties Inversion formula.

Convergence of a sequence of random variables - convergence in distribution, convergence in probability, almost sure convergence and convergence in quadratic mean - Weak convergence of distribution functions Slustky theorem - Helly-Bray theorem. Definition of product space Fubinis theorem (statement only) - Independence of two events Independence of classes Independence of random variables properties Borel zero one law.

Law of large numbers - Khintchin's weak law of large numbers, Kolmogorov strong law of large numbers, Central Limit Theorem:Lindeberg Levy theorem, Linderberg Feller theorem, Liapounov theorem, Relation between Liapounov and Linderberg Feller forms RadonNikodym theorem and derivative, Conditional expectation definition and simple properties.

Texts

1. Bhat, B. R. (2007). Modern Probability Theory, 3rd edition, New Age International Pvt. Ltd.
2. Ash, R.B. (1972). Real Analysis and Probability, Academic Press.
3. Rohatgi, V.K. and Saleh (2002). An Introduction to Probability Theory and Mathematical Statistics, John Wiley.
4. Athreya K B and Lahiri S N (2005). Measure Theory, Hindustan Book Agency.

References

1. Basu A K. and A Bandopadhyay (2012). Measure Theory and Probability, PHI Learning Pvt. Ltd.
2. Tucker, H.G. (1967). A Graduate course in Probability, Academic Press.
3. Chow, Y.S. and Teicher, H. (1979). Probability Theory, Springer.
4. Billingsley P (1995). Probability and Measure, Wiley.

STAT-M-402: Advanced Distribution Theory

Bivariate / Multivarite Distributions Bivariate binomial , bivariate Poisson, bivariate normal, bivariate exponential of Marshall and Olkin, multinomial distribution, multivariate normal distribution, multivariate hypergeometric distribution, multivariate - negative binomial distribution; Distribution of quadratic forms.

Compound Distributions Compound binomial, compound Poisson and compound negative exponential (Pareto) distributions.

Truncated Distributions Concept of truncation Zero Truncated binomial and Poisson distributions.

Concept of Convolution Mixture of distributions, extreme value distributions.

Texts

1. Mood M., Graybill F.A. and Boes D.C. (2001) : Introduction to the Theory of Statistics, Tata McGraw Hill, New Delhi.
2. Johnson, N.L, Kotz, S. and Balakrishnan, N. (1994): Continuous Univariate Distributions, Vol. 1 & 2, Wiley Series in Probabilty and Statistics.
3. Johnson, N.L, Kemp A.W. &Kotz, S. (1994): Univariate Discrete Distributions, Wiley Series in Probabilty and Statistics.

References

1. Rao C. R., (1973): Linear Statistical Inference and its Applications, Wiley Eastern Ltd, New Delhi.
2. Dudewicz, E.J and Mishra, S.N (1980): Mathematical Statistics, John Wiley, NY.
3. Kocherlakota S and Kocherlakota K (1992): Bivariate Discrete distributions, M. Dekker.
4. Balakrishnan N and Lai C.D. (2009): Continuous Bivariate Distributions, Springer.
5. Rohatgi, V.K. and Saleh (2002): An Introduction to Probability Theory and Mathematical Statistics, John Wiley.
6. ParimalMukhopadhyay(2006): Mathematical Statistics, 3/e, Books and Allied (P) Ltd, Kolkata.
7. Anderson, T.W. (1987). An Introduction to Multivariate Statistical Analysis, 2nd edn., Wiley.

STAT-M-403: Advanced Design of Experiments

Balanced Incomplete Block Designs Varietal trials, incomplete block designs, balanced incomplete block designs (B.I.B. designs), construction and analysis of B.I.B. designs, analysis with recovery of inter-block information.

Partially Balanced Incomplete Block Designs construction and analysis of P.B.I.B. designs, analysis with recovery of inter-block information.

Design for Bio-assays Boi-assays, direct assays, Indirect bio-assays, parallel line assays, incomplete block designs for bio-assays, slope ratio assays.

Response Surface Methodology The method of steepest ascent, analysis of second order response surface, experimental designs for fitting response surfaces, mixture experiments.

Texts

1. Joshi, D. D. Linear Estimation and Design of Experiments.
2. Montgomery, C.D. (1976). Design and Analysis of Experiments, Wiley, New York.
3. Das, M.N. and Giri, N. (1979). Design and Analysis of Experiments, Wiley Eastern.

References

1. Atkinson, A. C. and Donev, A. N. (1992). Optimal Experimental Designs. Oxford University Press.
2. George E. P. Box, Draper N.R. (1987). Empirical Model-Building and Response Surfaces, Wiley.
3. Hicks, C.R., Kenneth V. and Turner, Jr. (1999). Fundamental Concepts in the Design of Experiments, Oxford University Press.
4. John P.W.M. (1971). Linear Models, Wiley.
5. Kshirsagar A.M. (1983). Linear Models, Marcel Dekker.
6. John, P. W. M. (1971). Statistical Design and Analysis of Experiments. MacMillan.
7. Pukelsheim, F. (1993). Optimal Design of Experiments. Wiley.
8. Shah, K. R. and Sinha, B. K. (1989). Theory of Optimal Designs. Springer-Verlag.
9. Dean, A. and Voss, D. (1999). Design and Analysis of Experiments, Springer.
10. Ogawa J. (1974). Statistical Theory of the Analysis of Experimental Design, Marcel Dekker.

STAT-M-404: Advanced Sampling Theory

Ratio, Product and Regression Estimators Ratio estimators and their properties. Estimation of population mean, evaluation of bias and variance to the first order of approximation, comparison with simple random sampling.

Sampling with probability proportional to size (with and without replacement method), Des Raj and Das estimators for n=2, Horvitz-Thomson's estimator

Double Sampling Double sampling on successive occasions, double sampling for stratification; cost and variance functions. Double sampling in ratio and regression methods of estimation. Concept of Interpenetrating sub-sampling. Two-Stage Sampling Concept of multistage sampling; Two-stage sampling with equal number of second stage units.Two-stage sampling withunequal number of second stage units.

Cluster Sampling Equal cluster sampling - Estimators of mean and variance, optimum cluster size, Unequal cluster sampling - Estimators of meanand variance; Idea of small area estimation.

Texts

1. Cochran, W.G. (1999). Sampling Techniques, Third edition, John Wiley & Sons.
2. Des Raj and Chandhok, P. (1998). Sample Survey Theory, Narosa.
3. Gupta, A. K. and Kabe D.G, (2011). Theory of Sample Surveys, World Scienific Publishing Co. Pte. Ltd., Singapore.
4. Mukhopadhay, P. (2009). Theory and Methods of Survey Sampling, Second edition, PHI Learning Pvt Ltd., New Delhi.
5. Sukhatme, P. V. et al. (1984). Sampling Theory of Surveys with Applications. Iowa State Univ. Press.
6. Mukhopadhyay, P. (1998). Small Area estimation in Survey Sampling, Narosa.

References

1. Chaudhuri, A. and J.W.E. Vos (1988). Unified Theory and Strategies of Survey Sampling, North-Holland, Amsterdam.
2. Chaudhuri, A. and R. Mukerjee (1988). Randomized Response : Theory and Techniques, New York : Marcel Dekker Inc.
3. Hansen, M.H., Hurwitz, W.N. and Madow, W.G. (1953). Sample Survey Methods and Theory, Volume II, John Wiley.
4. Heyday, A. S. and Sinha, B. K. (1991). Design and Inference Sampling in Finite Population. Wiley.
5. Kish, L. (1995). Survey Sampling, John Wiley and Sons.
6. Mukhopadhyay, P. (1996). Inferential Problems in Survey Sampling, New Age International (P).
7. Murthy, M. N. (1977). Sampling Theory & Methods, Statistical Publishing Society, Calcutta.
8. Sarjinder Singh (2004). Advanced Sampling - Theory with Applications, Kluwer Publications.
9. Sampath, S. (2001). Sampling Theory and Methods, Alpha Science International Ltd., India.
10. Wolter, K. M. (1985). Introduction to Variance Estimation, Springer Verlag.

STAT-M-405: Estimation

Point estimation, highest concentration criterion, minimum mean square error criterion, unbiased estimators, Quenoullis method of reducing bias, consistent estimators, sufficient statistics, Fisher's information measure, minimal sufficient statistics, complete statistics,

Minimal variance unbiased estimators, lower bound for variance of unbiased estimators, use of sufficient and complete statistics.Equivariant estimators, minimum risk equivariant estimators (MREE) of location parameters, MREE of scale parameters, MREE of location and scale parameters.

Methods of estimation: method of moments, minimum chi-square and associated methods, method of maximum likelihood, properties of maximum likelihood estimators, method of scoring,

Construction of confidence intervals: shortest average width confidence intervals, construction of confidence intervals for large samples, construction of most accurate confidence intervals.

Texts

1. Rajagopalan, M. and Dhanavanthan, P. (2012). Statistical Inference, PHI Learning Pvt. Ltd.
2. Casella, G. and Berger, R. L. (2002). Statistical Inference, 2nd edition. Duxbury Press

3. Rohatgi, V.K. (1986): Statistical Inference, Wiley Eastern Ltd,.
4. Rao, C. R. (1973). Linear Statistical Inference and its Applications, Wiley.

References

1. Kale, B.K. (1999). A first course in Parametric Inference, Narosa Publishing House.
2. Gun, A. M, Gupta, M. K, and Das Gupta, B.C (1980). An outline of Statistical Theory, Vol. II,The World Press, Calcutta.
3. Lehmann, E .L. and Casella, G. (1998).Theory of Point Estimation, Springer International.
4. Mood, A.M., Graybill, F.A and Boes, D.C. (1974). Introduction to Theory of Statistics, McGraw-Hill Book Company.
5. ParimalMukhopadhyay (2006). Mathematical Statistics, 3/e, Books and Allied (P) Ltd, Kolkata.
6. Zacks, S. (1981). Parametric Statistical Inference, John Wiley, NY.

STAT-M-406: Testing of Hypothesis

Testing statistical hypothesis: Neyman-Pearson theory, test functions or critical functions, most powerful tests, uniformly most powerful tests, monotone likelihood ratio property.

Generalized Neyman-Pearson lemma, tests for one parameter exponential family of distributions, locally most powerful tests, UMPU tests for multiple parameter exponential family of distributions.

Likelihood ratio method for test construction: likelihood ratio tests, asymptotic distribution of LR test criterion, LR test for categorized data, test consistency, LR test when domain of RV depends on parameters. Invariant tests, UMP invariant tests.

Sequential hypothesis testing: sequential probability ratio test, determination of constants B and A for an SPRT, OC and ASN functions of an SPRT, properties of an SPRT, SPRT's when the hypotheses are composite.

Texts

1. Casella, G., and Berger, R. L. (2002). Statistical Inference, 2nd edition. Duxbury Press.
2. Rajagopalan, M. and Dhanavanthan, P. (2012). Statistical Inference, PHI Learning Pvt. Ltd.
3. Rao, C. R. (1973). Linear Statistical Inference and its Applications, Wiley.

References

1. Ghosh, B.K (1970): Sequential Tests of Statistical Hypotheses, Addison Wesley.
2. Kale, B.K. (1999). A first course in Parametric Inference, Narosa Publishing House.
3. Lehmann, E L. (1986). Testing Statistical Hypotheses, Springer.

4. ParimalMukhopadhyay (2006): Mathematical Statistics, 3/e, Books and Allied (P) Ltd, Kolkata.
5. Rohatgi, V.K. and Saleh, A.K. Md. E. (2001). An Introduction to Probability and Statistics. Wiley.
6. Wald, A (1949): Sequential Analysis, John Wiley, NY.

STAT-M-407: Linear Models

Gauss-Markov set-up Theory of linear estimation, Estimability of linear parametric functions, Method of least squares, Gauss-Markov theorem, Estimation of error variance.

Regression analysis Simple regression analysis, Estimation and hypothesis testing in case of simple and multiple regression models, Concept of model matrix and its use in estimation.

Analysis of variance Definitions of fixed, random and mixed effect models, analysis of variance and covariance in one-way classified data for fixed effect models, analysis of variance and covariance in two-way classified data with one observation per cell for fixed effect models

Model checking Prediction from a fitted model, Violation of usual assumptions concerning normality, Homoscedasticity and collinearity, Diagnostics using quantile-quantile plots.

Texts

1. Rao, C.R. (). Linear Statistical Inference and its Applications. Wiley.
2. Gun, A. M., Gupta, M. K. and Dasgupta, B. (2010). An Outline of Statistical Theory, Volume Two, World Press.
3. Joshi, D. D. (1977). Linear Estimation and Design of Experiments. The New Age International Publishers, Delhi.
4. Serele. Linear Models, Wiley

References

1. Weisberg, S. (2005). Applied Linear Regression (Third edition). Wiley.
2. Wu, C. F. J. And Hamada, M. (2009). Experiments, Analysis, and Parameter Design Optimization (Second edition), John Wiley.
3. Renchner, A. C. And Schaalje, G. B. (2008). Linear Models in Statistics (Second edition), John Wiley and Sons.

STAT-M-408: Multivariate Analysis

Multivariate normal distribution Marginal and conditional distributions - characteristic function. Maximum likelihood estimation of the parameters of Multivariate Normal and their sampling distributions - Inference concerning the mean vector when covariance matrix is known.

Total, Partial, Multiple Correlation in the Multivariate Setup MLEs of Total, Partial and Multiple correlation coefficients.Sampling distributions of Total and Multiple Correlation in the null case.Hotelling T2 statistic, derivation and its distribution - Uses of T2 statistic - relation between T2 and D2 - Mahalanobis D2 statistic and its distribution.

Generalized Variance Wishart distribution (statement only) Properties of Wishart distribution - Test for covariance matrix - Test for equality of covariance matrices.

Classification Problems Classification into one of two populations (known and unknown dispersion matrix) - Classification in to one of several populations - Fishers Linear discriminant function.

Principal Components Properties, Extraction of Principal components and their variances Canonical correlation - Estimation of canonical correlation and variates. Factor analysis - Mathematical model- Estimation of Factor Loadings - Concept of factor rotation - Varimax criterion.

Texts

1. Anderson, T.W. (1984) An Introduction to Multivariate Statistical Analysis, John Wiley.
2. Johnson, R. A and. Wichern D.W (2007): Applied Multivariate Statistical Analysis, 6 /e, Prentice-Hall of India Private Ltd., New Delhi.

References

1. Alvin C. Rencher(2002): Methods of Multivariate Analysis, 2/e, Wiley Interscience.
2. Giri, N. Multivariate Statistical Inference, Academic Publishers.
3. Jolliffe I.T.(2002): Principal Component Analysis, 2/e, Springer.
4. Ksheersagar, A. M. Multivariate Analysis. MarcellDekkar.
5. Morrison, D.F. Multivariate Analysis.
6. Rao, C.R(1998): Linear Statistical Inference and its Applications, Wiley Eastern Ltd.
7. Seber, G.A.F. (1977) Multivariate Observations, Wiley.
8. Srivastava M.S. and Khatri C.G. (1979): Introduction to Multivariate Analysis, Elsevier.

Skill Enhancement Courses

STAT-SEC-131: Analytics - I

R language Essentials Expressions and objects, Assignments, creatingvectors, vectorized arithmetic, creating matrices, operations on matrices,lists, data frames creation, indexing, sorting and conditional selection ;examples.

R Programming conditional statements if and if else; loops for, while,do-while; functions built-in and user defined; Data entry reading from textfile, data editor; examples.

Descriptive Statistics and Graphics Obtaining summary statistics;generating tables; Bar plots, Pie charts, Box plots, Histogram; exercises.

Graphic libraries in R GGally, RGL, ggplot2; curve fitting, performanceanalytics package.

Texts

1. Wickham H and Garrett. R for Data Science
2. Peter Dalgaard (2008). Introductory Statistics with R, 2nd edition, Springer.
3. Jared P Lander (2014). R for Everyone: Advanced Analytics and Graphics, Pearson Education Inc.

STAT-SEC-132: Analytics - II

Data Exploration: R basics, data visualization with ggplot2, workflow: Basics, data transformation with dplyr, workflow: Scripts, exploratory data analysis, workflow: Projects. Communication: R Markdown, graphics for communication with ggplot2, R Markdown format, R Markdown workflow.

Programming: Pipes wthmagritr, functions, vectors, iteration with purrr. Wrangling: Tibbles with tibble, data import with readr, tidy data with tidyr, relational data with dplyr, strings with stringr, factors with forcats, dates and times with lubridate.Productivity Tools: Inroduction to productivity tools, Git and GitHub, reproducible products with R Studio.

Texts

1. Wickham H and Garrett. R for Data Science

STAT-SEC-232: Analytics - III

Modelling: Model basics with modelr, model building, many models with purrr and broom.Machine Learning: Introduction to machine learning, smoothing, cross validation, the caret package, examples of algorithms, machine learning in practice, large data sets, clustering.

Texts

1. Wickham H and Garrett. R for Data Science

MINOR courses offered by the Department of Statistics

STAT-Mi-111: Statistical Methods - I

Scientific studies and variables as means to study a phenomenon, classification of variables based on scale [nominal, ordinal, interval and ratio], based on discreteness and continuity. Linear data and circular data; cross sectional, time series, longitudinal and panel data. Prospective studies and retrospective studies. Primary data and secondary data, cleaning of data.

Central tendency and dispersion; numeric measures and graphical methods to describe and summarize univariate frequency distributions of nominal, ordinal, interval and ratio variables; Utility of third and fourth central moments; coefficient of variation; The concept of change in origin and scale; standardization of a variable. Curve of concentration.

The concept of association in simultaneous study of two variable; Various measures of association depending on the nature of the two variables involved; Intraclass correlation, correlation ratio; Contingency tables and association measures for M × N contingency tables.

Multivariate Data multiple correlation, partial correlation; application to the case of three variables.

References

1. Croxton, F. E. and Cowdon, D. J. (1964). Applied General Statistics, Prentice – Hall of India LTD, New Delhi.
2. Gun A.M., Gupta M.K. and Dasgupta B. (2002). Fundamentals of Statistics, Vol. I, 8th Edn. The World Press, Kolkata.
3. Gun A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. II, 8th Edn. The World Press, Kolkata.
4. Mardia, K. V. and Jupp, P. E. (2000). Directional Data, Johan Wiley and Sons, LTD.
5. Snedecor, George W. and Cochran, William G. (1989). Statistical Methods, Affifliated East West Press and Iowa State University Presss.
6. Weatherburn, C. E. (1990). A First Course in Mathematical Statistics, S. Chand and Company LTD, New Delhi.
7. Yule, G. Udny. (1922). An Introduction to the Theory of Statistics, Charles Griffins and Company Limited, London.

STAT-Mi-112 Probability and Distributions

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

Random Variables: Discrete and continuous random variables, p.m.f., p.d.f. ,c.d.f. Illustrations of random variables and its properties. Expectation, variance, moments and moment generating function.

Convergence in probability, almost sure convergence, Chebyshev's inequality, weak law of large numbers, De-Moivre Laplace and Lindeberg-Levy Central Limit Theorem (C.L.T.).

Standard probability distributions: Binomial, Poisson, geometric, negative binomial, hypergeometric, uniform, normal, exponential, beta, gamma.

Texts

1. Mood, Alexander M., Graybill, Franklin A., and Boes, Duane C. (2001). Introduction to the theory of Statistics, Third Edition, McGraw Hill Education (India) Private Limited, New Delhi.
2. Rohatgi, Vijay K., and Saleh, A. K. md. Ehsanes. (2000). An Introduction to Probability and Statistics, Second Edition, Johan Wiley and Sons, INC.
3. Hogg, R.V. ,Mc Kean J W and Craig, A.T.(2005). Introduction to Mathematical Statistics, 6/e Pearson Edition.

STAT-Mi-211 Statistical Inference

Methods of Finding Estimators: Method of moments, maximum likelihood estimation, Properties of maximum likelihood estimators (without proof), method of least squares.

Methods of Evaluating Estimators: Mean squared error, best unbiased estimator, minimum variance bound estimators, Cramer-Rao inequality (statement and applications), sufficiency, factorization theorem.

Likelihood ratio tests, Bayesian tests, Methods of Evaluating Tests: Error probabilities and power function, most powerful tests, Neyman – Pearson lemma (statement and applications), unbiased tests, p-value.

Methods of Finding Confidence intervals: Inverting a test statistic, pivotal quantiles, pivoting a CDF and Bayesian intervals. Confidence interval estimation, optimum confidence bounds. resampling, bootstrap and Jacknife.

Texts

1. Daniel, Wayne W., Bio-statistics: A Foundation for Analysis in the Health Sciences. John Wiley (2005).
2. Goon, A.M., Gupta M.K. & Das Gupta, Fundamentals of statistics, Vol.-I & II (2005).
3. Dass, M. N. & Giri, N. C.: Design and analysis of experiments. John Wiley.
4. Dunn, O.J Basic Statistics: A primer for the Biomedical Sciences .(1964, 1977) by John Wiley.
5. Bancroft, Holdon Introduction to Bio-Statistics (1962) P.B. Hoebar New York.
6. Goldstein, A Biostatistics-An introductory text (1971). The Macmillion New York.

STAT-Mi-212 Survey Sampling

Concepts of sampling Need for sampling, population and sample, sampling unit and sample frame, Basic properties of sample survey and census survey. Principal steps in a Sample survey; Notion of sampling and non-sampling errors.

Simple Random Sampling Simple Random Sampling with and without replacement Estimation of Population mean and Proportion and their variances- Determination of sample size.

Stratified Random Sampling Stratified sampling Principles of stratification Estimation of population mean and its variance Allocation techniques: optimum, proportional and Neyman Estimation of gain due to stratification.

Systematic sampling Linear and Circular systematic sampling Estimation of population mean and variance, Equal Cluster Sampling- Estimation of population mean and variance, Comparison of cluster and random sampling, Comparison of systematic, simple random and stratified.

Texts

1. Cochran, W.G. (1999). Sampling Techniques, Third edition, John Wiley & Sons.
2. Singh D and Choudhary F.S. (1986). Theory and Analysis of Sample Survey and Designs, New Age International.
3. A.K. Swain (2003). Finite Population Sampling, South Asian Publishers.

References

1. Des Raj and Chandhok.(1998). Sampling Theory, Narosa.
2. Mukhopadhay, P. (2009). Theory and Methods of Survey Sampling, Second edition, PHI Learning Pvt Ltd., New Delhi.

STAT-Mi-311 Design of Experiments

Planning of experments; CRD and RBD: Design, randomisation, normal equations and estimates, analysis of variance for a CRD / RBD, test of hypotheses, efficiency of RBD; Analysis of covariance for a CRD / RBD with one concomitant variable.

Latin Square Design and Graeco-Latin Square Design LSD and Graeco - LSD: Design, randomisation, normal equations and estimates, analysis of variance for LSD and Graeco - LSD, test of hypotheses, efficiency of LSD.

Split Plot and Strip Plot Designs Design, randomisation, normal equations and estimates, analysis of variance and test of hypothesis.

Factorial Experiments 2^n and 3^n factorial experiments: Notation, main effects, interactions and confounding, general method for construction of confounded factorials; Analysis of variance and test of hypothesis

References

1. Cochran .W.G. and Cox .G.M. (1995). Experimental designs, 4/e, Wiley.
2. Das, M. N. and Giri, N. C. (2017). Design and Analysis of Experiments, Third Edition, New Age International Publishers.
3. Gun, A. M., Gupta, M. K. and Dasgupta, B. (2008). Fundamentals of Statistics Volume II, World Press.
4. Gun, A. M., Gupta, M. K. and Dasgupta, B. (2010). An Outline of Statistical Theory, Volume Two, World Press.
5. Joshi, D. D. (1977). Linear Estimation and Design of Experiments.The New Age International Publishers, Delhi.
6. Montgomery, Douglas C.(2013). Design and Analysis of Experiments,Wiley.
7. Rao, C. R. (1973). Linear Statistical Inference and its Applications,Wiley.

STAT-Mi-312 Official Statistics and Index Numbers

Present official statistical system in India Methods of collection of official statistics, their reliability and limitations. Role of Ministry of Statistics & Program Implementation (MoSPI), Central Statistical Office (CSO), National Sample Survey Office (NSSO), and National Statistical Commission. Government of Indias Principal publications containing data on the topics such as population, industry and finance.

National and International official statistical systems; Official Statistics: need, uses, users, reliability, relevance, limitations, transparency, its visibility; compilation, collection, processing, analysis and dissemination, agencies involved, methods. NSSO and CSO: Vision and Mission,; roles and responsibilities; Important activities, Publications. National Statistical Commission: Need, Constitution, its role, functions etc; Legal Acts/ Provisions/ Support for Official Statistics; Important Acts. Population Census: Need, Data Collected, Periodicity, Methods of data collection, dissemination, Agencies involved.

Index Numbers: Different Types, Need, Data Collection Mechanism, Periodicity, Agencies Involved, Uses. Index Numbers: Price relatives and quantity or volume relatives, Link and chain relatives composition of index numbers; Laspeyre's, Paasches', Marshal Edgeworth and Fisher index numbers; chain base index number, tests for index number.

Construction of index numbers of wholesale and consumer prices, Income distribution-Pareto and Engel curves, Concentration curve, Methods of estimating national income, Inter-sectoral flows, Interindustry table, Role of CSO.

Texts

1. Kapoor.V.K. and Gupta.S. (2014). Fundamentals of Applied Statistics, Sultan Chand and Sons.
2. Parimal Mukhopadhyay (2022). Applied Statistics, Books and Allied (P) Ltd, Kolkata.
3. B L Agarwal (2013). Basic Statistics, New Age International Publishers.

References

1. Goon.A.M., Gupta.M.K. and Das Gupta .B (2016). Fundamental of Statistics , Vol. II, World Press , Calcutta.
2. Bogue.D.J. (1969). Principles of Demography , John Wiley.
3. Misra.B.D. (1982). An Introduction to the Study of Population, South Asian Publishing.

STAT-Mi-411 Statistical Methods – II

Estimation of population mean, confidence intervals for the parameters of a normal distribution (one sample and two sample problems). Tests of hypotheses for the parameters of a normal distribution (one sample and two sample problems). Analysis of variance, one-way and two-way classification. Analysis of covariance. Confidence interval for: population mean / proportion, the difference between two population means / proportions, variance of a normally distributed population.

Categorical data: Tests of proportions, tests of association and goodness-of-fit using Chisquare test, Yates' correction. Tests for the significance of correlation coefficient. Sign test for median, Sign test for symmetry, Wilcoxon two-sample test.

Regression Models; Distinction between independent (explanatory) and dependent variables; the linear regression model, parameters of the model, their estimates, interpretation of the estimated parameters, testing the significance of the parameters and fit of the model itself.

Tests of: goodness of fit, independence and homogenity; Relative risk, odds ratios and Mantel - Haenszel statistics. Non-parametric and Distribution Free Statistics Sign test, Wilcoxon signed - rank test for location, median test, Mann - Whitney test.

References

1. Croxton, F. E. and Cowdon, D. J. (1964). Applied General Statistics, Prentice – Hall of India LTD, New Delhi.
2. Gun A.M., Gupta M.K. and Dasgupta B. (2002). Fundamentals of Statistics, Vol. I, 8th Edn. The World Press, Kolkata.
3. Gun A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. II, 8th Edn. The World Press, Kolkata.
4. Mardia, K. V. and Jupp, P. E. (2000). Directional Data, Johan Wiley and Sons, LTD.
5. Snedecor, George W. and Cochran, William G. (1989). Statistical Methods, Affifliated East West Press and Iowa State University Presss.

6. Weatherburn, C. E. (1990). A First Course in Mathematical Statistics, S. Chand and Company LTD, New Delhi.
7. Yule, G. Udny. (1922). An Introduction to the Theory of Statistics, Charles Griffins and Company Limited, London.

STAT-Mi-412 Time Series Analysis and Statistical Quality Control

Components of time series, Decomposition of time series- Additive and multiplicative model with their merits and demerits, Illustrations of time series. Measurement of trend by method of free-hand curve, method of semi-averages and method of least squares (linear, quadratic and modified exponential).Measurement of seasonal variations by method of ratio to trend.

Autoregressive, Moving Average, Autoregressive Moving Average and Autoregressive Integrated Moving Average models; Model identification.

Statistical Quality Control: Importance of statistical methods in industrial research and practice. Determination of tolerance limits. Causes of variations in quality: chance and assignable. General theory of control charts, process & product control, Control charts for variables: X- bar and R-charts. Control charts for attributes: p and c-charts

Acceptance Sampling by Variables Sampling plans for a single specification limit with known and unknown variance, Sampling plans with double specification limits, Comparison of sampling plans by variable and attributes, Continuous sampling plans I, II and III.

Texts

4. Kapoor.V.K. and Gupta.S. (2014). Fundamentals of Applied Statistics, Sultan Chand and Sons.
5. Parimal Mukhopadhyay (2022). Applied Statistics, Books and Allied (P) Ltd, Kolkata.
6. B L Agarwal (2013). Basic Statistics, New Age International Publishers.

References

4. Goon.A.M., Gupta.M.K. and Das Gupta .B (2016). Fundamental of Statistics , Vol. II, World Press , Calcutta.
5. Bogue.D.J. (1969). Principles of Demography , John Wiley.
6. Misra.B.D. (1982). An Introduction to the Study of Population, South Asian Publishing.

Multidisciplinary courses offered by the Department of Statistics

STAT-MD-131 Foundations of Data Analysis and SPSS

Introduction to Data Analysis and SPSS: Overview of data analysis in research, Introduction to SPSS environment and interface, Data types, variables, and scales of measurement

Data Entry and Management: Data input, coding, and cleaning, Importing/exporting data, Handling missing data

Descriptive Statistics: Measures of central tendency and variability, Frequency distributions, Data visualization (charts, histograms, boxplots)

Introduction to Computational Thinking: Problem decomposition, Pattern recognition in datasets, Introduction to algorithmic thinking in data analysis.

References

1. *Handbook of Univariate and Multivariate Data Analysis and Interpretation with SPSS* (covers introductory SPSS, descriptive statistics, and data management).

2. Exploration on Teaching Reform of SPSS Data Analysis and Application Course Using Project-based Learning (emphasizes the importance of integrating theory and practice in SPSS teaching).

STAT-MD-132 Inferential Statistics and Intermediate SPSS Skills

Hypothesis Testing: Concepts of population, sample, and hypothesis, t-tests (one-sample, independent, paired), Confidence intervals.

Analysis of Variance (ANOVA): One-way and two-way ANOVA, Post-hoc tests.

Correlation and Regression: Pearson and Spearman correlation, Simple linear regression.

Data Transformation and Advanced Data Management: Recoding variables, Computing new variables, Merging and splitting datasets.

Application of Computational Thinking: Applying computational strategies to solve statistical problems, Developing SPSS syntax for automation.

References

1. Handbook of Univariate and Multivariate Data Analysis and Interpretation with SPSS (sections on inferential statistics, ANOVA, correlation, regression, and SPSS syntax).
2. Exploration on Teaching Reform of SPSS Data Analysis and Application Course Using Project-based Learning (project-based approach to reinforce statistical concepts).

STAT-MD-231Advanced Analysis, Research Application, and Reporting

Multivariate Analysis: Multiple regression, Factor analysis (exploratory), Cluster analysis.

Non-parametric Tests: Chi-square test, Mann-Whitney U, Wilcoxon, Kruskal-Wallis tests.

Reliability and Validity Testing: Cronbach's alpha, Exploratory reliability analysis.

Research Project Design: Designing research with appropriate statistical methods, Data collection and ethical considerations.

Reporting and Interpretation: Interpreting SPSS output, Writing research reports and presenting findings, Visualizing complex results

Comprehensive Application: Capstone project: End-to-end data analysis using SPSS on real-world or simulated data, Application of computational thinking to solve complex data analysis problems

References

1. Handbook of Univariate and Multivariate Data Analysis and Interpretation with SPSS (multivariate analysis, reliability, nonparametric tests, and reporting).
2. Exploration on Teaching Reform of SPSS Data Analysis and Application Course Using Project-based Learning (project-based learning and comprehensive application).
3. Application of SPSS Data Analysis in Base Station Construction (example of real-world application and modeling with SPSS).