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

Department of Statistics
Indira Gandhi National Tribal University
Amarkantak, India

Department of Statistics
NEP Course-Structure –2 Year PG Program in STATISTICS with Coursework Only
Academic Year 2024-25 Onwards

Semester – I

Course Type	Course Title	Course Code	Credits	Marks
Theory	Advanced Probability Theory	STAT-M-401	4	100
Theory	Advanced Distribution Theory	STAT-M-402	4	100
Theory	Advanced Design of Experiments	STAT-M-403	4	100
Theory	Advanced Sampling Theory	STAT-M-404	4	100
Practical	Statistical Computing and Analytics – I	STAT-M-409	4	100
Total			**20**	**500**

Semester – II

Course Type	Course Title	Course Code	Credits	Marks
Theory	Estimation	STAT-M-405	4	100
Theory	Testing of Hypothesis	STAT-M-406	4	100
Theory	Linear Models	STAT-M-407	4	100
Theory	Multivariate Analysis	STAT-M-408	4	100
Practical	Statistical Computing and Analytics – II	STAT-M-410	4	100
Total			**20**	**500**

Semester – III

Course Type	Course Title	Course Code	Credits	Marks
Theory	Survival Analysis	STAT-M-501	4	100
Theory	Real Analysis	STAT-M-502	4	100
Theory	Elective - I	*	4	100
Theory	Elective - II	*	4	100
Practical	Statistical Computing and Analytics – III	STAT-M-503	4	100
Total			**20**	**500**

Semester – IV

Course Type	Course Title	Course Code	Credits	Marks
Theory	Matrix Algebra and Multi – variable Calculus	STAT-M-504	4	100
Theory	Elective - III	*	4	100
Theory	Elective - IV	*	4	100
Practical	Statistical Computing and Analytics – IV	STAT-M-505	4	100
Project	Project	STAT -P -506	4	100
Total			**20**	**500**

List of Electives:

S. No.	Course Title	Course Code
1	Bioassay and Clinical Trials	STAT-E-601
~~2~~	Econometrics	STAT-E-602
3	Stochastic Processes	STAT-E-603
4	Generalized Linear Models	STAT-E-604
5	Statistical Quality Assurance	STAT-E-605
6	Demography and Vital Statistics	STAT-E-606

Overall Course Structure for 2 Year PG Program in STATISTICS with Coursework Only

Course Type	Credits	Marks
Theory	64	1600
Practical	16	400
Total	**80**	**2000**

Department of Statistics
NEP Course-Structure –2 Year PG Program in STATISTICS (Coursework with Research)
Academic Year 2024-25 Onwards

Semester – I

Course Type	Course Title	Course Code	Credits	Marks
Theory	Advanced Probability Theory	STAT-M-401	4	100
Theory	Advanced Distribution Theory	STAT-M-402	4	100
Theory	Advanced Design of Experiments	STAT-M-403	4	100
Theory	Advanced Sampling Theory	STAT-M-404	4	100
Practical	Statistical Computing and Analytics – I	STAT-M-409	4	100
Total			**20**	**500**

Semester – II

Course Type	Course Title	Course Code	Credits	Marks
Theory	Estimation	STAT-M-405	4	100
Theory	Testing of Hypothesis	STAT-M-406	4	100
Theory	Linear Models	STAT-M-407	4	100
Theory	Multivariate Analysis	STAT-M-408	4	100
Practical	Statistical Computing and Analytics – II	STAT-M-410	4	100
Total			**20**	**500**

Semester – III

Course Type	Course Title	Course Code	Credits	Marks
Theory	Survival Analysis	STAT-M-501	4	100
Theory	Real Analysis	STAT-M-502	4	100
Theory	Elective - I	*	4	100
Theory	Elective - II	*	4	100
Practical	Statistical Computing and Analytics – III	STAT-M-503	4	100
Total			**20**	**500**

Semester – IV

Course Type	Course Title	Course Code	Credits	Marks
Research	Research	STAT-M-601	20	500

List of Electives:

S. No.	Course Title	Course Code
1	Bioassay and Clinical Trials	STAT-E-601
~~2~~	Econometrics	STAT-E-602
3	Stochastic Processes	STAT-E-603
4	Generalized Linear Models	STAT-E-604
5	Statistical Quality Assurance	STAT-E-605
6	Demography and Vital Statistics	STAT-E-606

Overall Course Structure for 2 Year PG Program in STATISTICS (Coursework with Research)

Course Type	Credits	1200
Theory	48	1600
Practical	12	300
Research	20	500
Total	**80**	**2000**

Department of Statistics
NEP 2024 Batch Course-Structure –2 Year PG Program in STATISTICS(Research)
Academic Year 2024-25 Onwards

Semester – I

Course Type	Course Title	Course Code	Credits	Marks
Theory	Advanced Probability Theory	STAT-M-401	4	100
Theory	Advanced Distribution Theory	STAT-M-402	4	100
Theory	Advanced Design of Experiments	STAT-M-403	4	100
Theory	Advanced Sampling Theory	STAT-M-404	4	100
Practical	Statistical Computing and Analytics – I	STAT-M-409	4	100
Total			**20**	**500**

Semester – II

Course Type	Course Title	Course Code	Credits	Marks
Theory	Estimation	STAT-M-405	4	100
Theory	Testing of Hypothesis	STAT-M-406	4	100
Theory	Linear Models	STAT-M-407	4	100
Theory	Multivariate Analysis	STAT-M-408	4	100
Practical	Statistical Computing and Analytics – II	STAT-M-410	4	100
Total			**20**	**500**

Semester – III

Course Type	Course Title	Course Code	Credits	Marks
Research	Research	STAT-M-602	20	500

Semester – IV

Course Type	Course Title	Course Code	Credits	Marks
Research	Research	STAT-M-603	20	500

Overall Course Structure for 2 Year PG Program in STATISTICS (Research)

Course Type	Credits	Marks
Theory	32	800
Practical	8	200
Research	40	1000
Total	**80**	**2000**

Department of Statistics
NEP Course-Structure –1 Year PG Program in STATISTICS with Coursework Only
Academic Year 2024-25 Onwards

Semester – I

Course Type	Course Title	Course Code	Credits	Marks
Theory	Survival Analysis	STAT-M-501	4	100
Theory	Real Analysis	STAT-M-502	4	100
Theory	Elective - I	*	4	100
Theory	Elective - II	*	4	100
Practical	Statistical Computing and Analytics – III	STAT-M-503	4	100
Total			**20**	**500**

Semester – II

Course Type	Course Title	Course Code	Credits	Marks
Theory	Matrix Algebra and Multi – variable Calculus	STAT-M-504	4	100
Theory	Elective - III	*	4	100
Theory	Elective - IV	*	4	100
Practical	Statistical Computing and Analytics – IV	STAT-M-505	4	100
Project	Project	STAT -P -506	4	100
Total			**20**	**500**

List of Electives:

S. No.	Course Title	Course Code
1	Bioassay and Clinical Trials	STAT-E-601
~~2~~	Econometrics	STAT-E-602
3	Stochastic Processes	STAT-E-603
4	Generalized Linear Models	STAT-E-604
5	Statistical Quality Assurance	STAT-E-605
6	Demography and Vital Statistics	STAT-E-606

Overall Course Structure for 1 Year PG Program in STATISTICS with Coursework Only

Course Type	Credits	Marks
Theory	32	800
Practical	8	200
Total	**40**	**1000**

Department of Statistics
NEP Course-Structure –1 Year PG Program in STATISTICS with Coursework and Research
Academic Year 2024-25 Onwards

Semester – I

Course Type	Course Title	Course Code	Credits	Marks
Theory	Survival Analysis	STAT-M-501	4	100
Theory	Real Analysis	STAT-M-502	4	100
Theory	Elective - I	*	4	100
Theory	Elective - II	*	4	100
Practical	Statistical Computing and Analytics – III	STAT-M-503	4	100
Total			**20**	**500**

Semester – II

Course Type	Course Title	Course Code	Credits	Marks
Research	Research	STAT-M-601	20	500

List of Electives:

S. No.	Course Title	Course Code
1	Bioassay and Clinical Trials	STAT-E-601
~~2~~	Econometrics	STAT-E-602
3	Stochastic Processes	STAT-E-603
4	Generalized Linear Models	STAT-E-604
5	Statistical Quality Assurance	STAT-E-605
6	Demography and Vital Statistics	STAT-E-606

Overall Course Structure for 1 Year PG Program in STATISTICS with Coursework and Research

Course Type	Credits	Marks
Theory	16	400
Practical	4	100
Research	20	500
Total	**40**	**1000**

Department of Statistics
NEP Course-Structure –1 Year PG Program in STATISTICS(Research)
Academic Year 2024-25 Onwards

Semester – I

Course Type	Course Title	Course Code	Credits	Marks
Research	Research	STAT-M-602	20	500

Semester – II

Course Type	Course Title	Course Code	Credits	Marks
Research	Research	STAT-M-603	20	500

Overall Course Structure for 1 Year PG Program in STATISTICS (Research)

Course Type	Credits	Marks
Research	40	1000
Total	**40**	**1000**

Core Courses

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-409 (LAB) Statistical Computing and Analytics – I

Broad Topics

1. Introduction to statistical software (R, Python, or SAS)
2. Data types, data import/export, and data cleaning
3. Descriptive statistics and data visualization
4. Basic probability distributions and simulations
5. Simple hypothesis testing (t-tests, chi-square tests)
6. Lab assignments: Data cleaning, summary statistics, basic plots

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.

STAT-M-410 Statistical Computing and Analytics (LAB) – II

Broad Topics

1. Regression analysis (linear and logistic)
2. Analysis of variance (ANOVA)
3. Non-parametric tests
4. Introduction to multivariate statistics (PCA, clustering)
5. Statistical report writing
6. Lab assignments: Regression modeling, ANOVA, cluster analysis

STAT-M-501: Survival Analysis

Basic concepts Concepts of time, order and random censoring and likelihood in these cases - Life distributions – Exponential, Gamma, Weibull, Lognormal, Pareto, Linear Failure rate Parametric inference (Point estimation, Scores, MLE).

Life tables failure rate, mean residual life and their elementary properties - Ageing classes and their properties - Bathtub Failure rate.

Estimation Estimation of survival function – Actuarial Estimator – Kaplan Meier estimator - Estimation under the assumption of IFR / DFR – Tests of exponentiality against non-parametric classes – Total time on test, Deshpande test.

Two Sample Problems Two sample problem: Gehan test, Log rank test. Mantel – Haenszel test, Tarone – Ware tests. Semi- parametric regression for failure rate – Cox's proportional hazards model with one and several convariates - Rank test for the regression coefficients.

Texts

1. Miller, R.G. (1981) : Survival analysis, John Wiley
2. Cox, D.R. and Oakes, D. (1984): Analysis of Survival Data, Chapman and Hall, New York.
3. Elisa T.Lee, John Wenyu Wang and Timothy Wenyu Patt (2003): Statistical Methods for Survival Data Analysis, 3/e, Wiley Inter Science.
4. Klein P. John and Moeschberger(2003): Survival Analysis: Techniques for Censored and Truncated Data, 2/e, Springer.

References

1. Gross, A.J. and Clark, V.A. (1975): Survival distribution : Reliability applications in the Biomedical Sciences, John Wiley and Sons.
2. Elandt –Johnson, R.E. Johnson N.L.(1999): Survival Models and Data Analysis, John Wiley and sons.
3. Kalbfleisch J.D. and Prentice R.L.(2003), The Statistical Analysis of Failure Time Data, John Wiley.
4. Lawless J.F. (2002): Statistical Models and Methods for Life Time Data, 2/e, John Wiley & Sons.
5. Xian Liu(2012): Survival Analysis Models and Applications- John Wiley & Sons.

STAT-M-502: Real Analysis

R^n , open sets and closed sets; The Bolzano Weierstrass theorem, Cantor intersection theorem, Lindelof covering theorem and Heine – Borel theorem; Metric spaces, compact subsets of a metric space.

Convergent sequences in a metric space, Cauchy sequence, complete metric space; limit of a function, continuous functions, uniform continuity, derivatives, Rolle's theorem, the mean value theorem for derivatives, intermediate value theorem for derivatives, Taylor's formula with remainder.

Infinite series, tests for convergence of a series with positive terms; sequence of functions, point wise and uniform convergence, uniform convergence and continuity, uniform convergence and Reimann - Stieltjes integral, uniform convergence and differentiation.

The Reimann - Stieltjes integral, the Lebesgue integral, multiple Riemann in integrals, multiple Lebesgue integrals, Generalised Riemann integrals.

Text

1. Apostol, T. M. (1985). Mathematical Analysis, Second Edition, Narosa Publishing House,New Delhi.
2. Rudin, Walter. (1976). Principles of Mathematical Analysis, McGraw Hill.

References

1. Bartle, R. G. and Sherbert, D. R. (2000). Introduction to Real Analysis, 3rd edition, John Wiley & Sons, Inc., New York.
2. Tao, T. Analysis, Vol. I, Hindustan Book Agency, Delhi, India.
3. Tao, T. Analysis, Vol. II, Hindustan Book Agency, Delhi, India.

STAT-M-503: Statistical Computing and Analytics (LAB) – III

Broad Topics

1. Machine learning basics (classification, regression, clustering)
2. Time series analysis and forecasting
3. Big data tools (introduction to Hadoop, Spark)
4. Data mining techniques
5. Model evaluation and validation
6. Lab assignments: ML model building, time series forecasting, working with large datasets

STAT-M-504: **Matrix Algebra and Multi – variable Calculus**

Vector spaces: Vector spaces and subspaces, basis of a vector space, linear equations, vector spaces with an inner product. matrix operations, elementary matrices and diagonal reduction of a matrix, determinants, transformations generalized inverse of a matrix, matrix representation of vector spaces, bases, etc., idempotent matrices, special products of matrices

Eigenvalues and reduction of matrices: classification and transformation of quadratic forms, roots of determinantal eqmtions, canonical reduction of matrices, projection operator, results on g-inverse, restricted eigenvalue problem. convex sets in vector spaces: definitions, separation theorems for convex sets.

Inequalities: Cauchy-Schwarz (C-S) inequality, Holder's inequality, Hadamard's inequality, inequalities involving moments, convex functions and Jensen's inequality, inequalities in information theory, Stirling's approximation. Extrema of quadratic forms: general results, minimum trace problems.

Scalar and vector fields; maxima, minima and saddle points, extrema of functions of two variables; extrema with constraints: Lagrange's multipliers; multiple integrals, evaluation of double integrals, integral over general ranges, change of variables in double integrals.

Text

1. Rao, C. R. (1973). Linear Statistical Inference and its Applications, Wiley.
2. Hoffman, K. and Kunze, R. (1971). Linear Algebra, 2nd ed., Prentice Hall, Inc.
3. Graybill, F.A. (1983): Matrices with Applications in Statistics, 2^{nd} \Ed. Wadsworth.
4. Rao, A. R.and Bhimsankaram,P. Linear Algebra, Hindustan Book Agency, Delhi, India.
5. Searle, S.R. (1982): Matrix Algebra for Statistical Applications, John Wiley and Sons inc.

References

1. Bellman, R. (1970). Introduction to Matrix Analysis, 2nd ed. McGraw Hill.
2. Halmos, P.R. (1958): Finite Dimensional Vector Spaces, 2nd ed. van. Nortrand Company Inc.
3. Rao, C. R. and Mitra, S. K. (1971). Generalized Inverse of Matrices and its Applications, John Wiley and Sons, Inc.
4. Shanti Narain: A text book of matrices, S. Chand and Company (Pvt.) Ltd.

STAT-M-505 Statistical Computing and Analytics (LAB) – IV

Broad Topics

1. Advanced topics: Bayesian statistics, deep learning, text analytics
2. Domain-specific analytics (health, finance, social sciences)
3. Capstone project: End-to-end data analysis or analytics project (problem definition, data collection, analysis, interpretation, report, and presentation)
4. Lab assignments: Project milestones, advanced modeling, presentations

Elective Courses

STAT-E-601 Bioassay and Clinical Trials

Bioassay: Direct and indirect assays, quantal and quantitative assays, parallel line and slope ratio assays, design of bioassays, dose allocation schemes. Methods of estimation of parameters: estimation of extreme quantiles; Quantal responses; estimation of points on the quantal response function, sequential procedures, estimation of safe doses, polychotomous quantal response; Bayesian approach to bioassay.

Ratio Estimators: Asymptotic distributions; Fieller's theorem. **Estimating dose-response relationships:** Regression approaches, Logit and probit approaches when dose-response curve for standard preparation is unknown.

Introduction to clinical trials: the need and ethics of clinical trials, bias and random error in clinical studies, conduct of clinical trials, overview of Phase I – IV trials, multicenter trials. Data management: data definitions, case report forms, database design, data collection systems for good clinical practice.

Design of clinical trials: parallel vs. cross-over designs, cross-sectional vs. longitudinal designs, review of factorial designs, objectives and endpoints of clinical trials, design of Phase I trials, design of single-stage and multi-stage Phase II trials, design and monitoring of phase III trials with sequential stopping, Reporting and analysis: analysis of categorical outcomes from Phase I – III trials, analysis of survival data from clinical trials.

Texts

1. Finney, D. J. (1971). Statistical Method in Bioassay, Griffin.
2. Govindarajulu, Z.(2000). Statistical Techniques in Bioassay, S. Kargar.
3. Fleiss, J. L. (1989). The Design and Analysis of Clinical Experiments. Wiley and Sons.
4. Friedman, L. M., Furburg,C. and Demets, D. L. (1998). Fundamentals of Clinical Trials, Springer Verlag.

References

1. Finney, D. J. (1971). Probit Analysis (3*rd* Ed.), Griffin.
2. Weatherile, G. B.(1966). Sequential Methods in Statistics, Methuen.
3. Jennison, C. and Turnbull, B. W. (1999). Group Sequential Methods with Applications to Clinical Trials, CRC Press.
4. E. Marubeni and M. G. Valsecchi (1994). Analyzing Survival Data from Clinical Trials and Observational Studies, Wiley and Sons.
5. Piantadosi, S. (1997). Clinical Trials: A Methodological Perspective, John Wiley & Sons, New York

STAT-E-602 Econometrics

Multicollinearity Effects of multicollinearity and detection, Remedial methods including the ridge regression. Specification error analysis, inclusion of irrelevant variables and deletion of dominant variables, their effects on the efficiency of optimization procedure.

Hetroscedasticity Consequences and tests for it, estimation procedures under hetroscedastic disturbances. **Auto Correlated Disturbances** Effects on estimation of parameters, Cochran Orcutt and Prais-Winston transformation, Durbin-Watson test. Errorsin-varables model, Inconsistency of least squares procedures, Consistent estimation of Parameters by instrumental variables.

SURE Model Seemingly unrelated regression equation model, estimation of parameters under SURE model and their properties, generalized least squares methods and their asymptotic properties.

Simultaneous Equation Model Problem of indentification, a necessary and sufficient condition for the identifiability of parameters in a structural equation, Ordinary Least squares, indirect least squares, two stage least squares and limited information maximum likelihood method, K-class estimators, Asymptotic properties of estimators.

Suggested Readings

1. Gujarathi, D. (1979): Basic Econometrics, McGraw Hill.
2. Intrulligator, M.D. (1980): Econometric models—Techniques and Applications, Prentice Hall of India.
3. Johnston, J. (1984): Econometric methods. Third edition, McGraw Hill.
4. Koutsoyiannis, A. (1979): Theory of Econometrics, Macmillan Press.

STAT-E-603 Stochastic Processes

Markov Chains Definition, Examples and classification, Discrete renewal equation and basic limit theorem, Absorption probabilities, Criteria for recurrence; Limiting Distribution, Stationary Distribution and Random walk.

Continuous Time Markov Chains Poisson process, General pure birth process, birth and death process, finite state continuous time Markov chains.

Branching Processes Review of discrete time branching process, extinction probabilities and asymptotic behaviour brief excursion to continuous time branching process, two-type branching process, branching process with general lifetime variable (Bellman-Harris process).

Renewal Processes Renewal equation, renewal theorem, applications, generalizations and variations of renewal processes, applications of renewal theory, Brownian motion

Texts

1. Medhi, J. (1994) Stochastic Processes, Second edition, Wiley Eastern.
2. Ross, S. (1996) Stochastic Processes, Second edition, John Wiley.

References

1. Bhat, U. N. (1972). Elements of Applied Stochastic Processes, Wiley.
2. Harris, T. E. The theory of Branching Processes.
3. Hoel, P.G.., Port, S.C. and Stone, C.J. (1972). Introduction to Stochastic Processes, Houghton Miffin & Co.
4. Karlin, S. and Taylor, H.M. (1975). A First Course in Stochastic Processes, second edition, Academic Press.
5. Kulkarni,V.G. (1995). Modeling and Analysis of Stochastic Systems, Chapman and Hall, London

STAT-E-604 Generalized Linear Models

Data and models Components of a generalized linear model, estimation and fit of the model. Model selection, estimation and prediction; the algorithm for fitting generalized linear models.

Models for Binary Responses Link function, parameter interpretation, retrospective sampling. Likelihood functions for binary data: parameter estimation, deviance function, bias and precision of estimates. Over-dispersion.

Models for Polytomous Responses The multinomial distribution, likelihood functions: log-likelihood for multinomial responses, parameter estimation, deviance function. Over-dispersion.

Log-linear models The Poisson log-likelihood function, over dispersion, asymptotic theory, multiple responses: canonical correlation models, multivariate regression models, log-linear regression models, Likelihood equations.

Model Diagnostics for Generalised Linear Models Score tests for extra parameters, checks for systematic departure from the model: residuals, variance function, link function, scale of covariates, checks for compound discrepancies. Checks for isolated departure from the model: measure of leverage, consistency.

Texts

1. McCullagh, P and Nelder, J. A. Generalized Linear Models. Chapman and Hall.

References

1. Agresti, A. Introduction to Categorical Data Analysis. Wiley.

STAT-E-605 Statistical Quality Assurance

Quality and Quality Assurance Methods of quality assurance, Introduction to TQM and ISO 9000 standards, statistical quality control: Acceptance sampling for attributes, Single sampling, Double sampling, Multiple and sequential sampling plans, Measuring the performance of these plans.

Control charts Basic ideas, designing of control charts for the number of non-conformities and fraction non-conformities mean charts, Median charts, Extreme value charts, R-charts, and S-charts, ARL, Economic design of Shewarts control 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.

Process Capability Studies Statistical aspect of six sigma philosophy, Control charts with memory - CUSUM charts, EWMA-mean charts, OC and ARL for control charts, The Taguchi Method: The Taguchi philosophy of Quality, Loss functions, SN ratios, Performance measures, Experimental design in Taguchi Methods: Orthogonal arrays and linear graph, Estimation of effects, Parameter Design.

Texts

1. Montgomery, R.C. (1985). Introduction to Statistical Quality Control, Fourth edition, Wiley.
2. The ISO 9000 book, Second Edition, Rabbit, J T and Bergle, PA Quality resources, Chapter-I.

References

1. Schilling, E.G. (1982) Acceptance Sampling in Quality Control, MarcelDekker.
2. Mitra, A.(2000) Fundamentals of Quality Control and ImprovementPearson Education Asia.

STAT-E-606 Demography and Vital Statistics

Sources of demographic data, census, registration, ad-hoc surveys, Hospital records, Demographic profiles of the Indian Census; Basic demographic measures: Ratios, Proportions and percentages, Population Pyramids, Sex ratio Crude rates, Specific rates, Labor force participationrates, Density of population, Probability of dying.

Construction of a life table, Graphs of l_x, q_x, d_x, Functions L_x, T_x and E_x. Abridged life tables Mortality: Rates and Ratios, Infant mortality,Maternal mortality, Expected number of deaths, Direct and Indirect Standardization, Compound analysis, Morbidity.

Measures of Fertility, Reproductivity formulae, Rates of natural increase, Fertility Schedules, Differential fertility, Stable populations, Calculation of the age distribution of a stable population, Model Stable Populations. Measurement of Mortality: Crude death rate, Standardized death rates, Age-specific death rates, Infant Mortality rate, Death rate by cause. Internal migration and its measurement, migration models, concept of international migration. Net migration. International and postcensal estimates.

Population Projections Component method, Mortality basis for projections, Fertility basis for projections, Migration basis for projections, Ageing of the population, Estimation of demographic measures from incomplete data. Projection method including logistic curve fitting. Decennial population census in India

Texts

1. Ram, F. and Pathak, K. B. (1998): Techniques of Demographic Analysis, 2nd Ed, Himalaya Publishing House, Bombay.
2. Alho, J., and Spencer, B. (2005). Statistical Demography and Forecasting. Springer-Verlag, New York.

References

1. Bhende, A. A. and Kanitkar,T. (2003). Principles of Population Studies, Sixteenth Revised Edition, Himalaya Publishing House, Mumbai.
2. Keyfilz, N. and Caswell, H. (2005) Applied Mathematical Demography, Third edition, Springer.
3. Pollard, A.H. Yusuf, F. and Pollard, G.N. (1990). Demographic Techniques, Pergamon Press.
4. Retherford, R. D. and Choe, M. K. (1993). Statistical Models for Causal Analysis, John Wiley & Sons, Inc.
5. Siegel, J. S. and Swanson, D. A. (2004). The Methods and Materials of Demography, Second Edition, Elsevier Science, USA.
6. United Nations Manuals on Demography.
7. Weeks, J. R. (2005). Population: An Introduction to Concepts and Issues, Nineth Edition, Wadsworth Publishing Company, Belmont, California.