Department of Statistics

University of Allahabad

M.A./M.Sc. Statistics

To be effective from 2016

Course Outline

1st Semester July to December

Paper	Duration L-T-P-C	Maximum Marks
STA501: Matrix Algebra, Linear Estimation & Regression Analysis	4-1-0-5	100
STA502: Multivariate Analysis	4-1-0-5	100
STA503: Survey Sampling	4-1-0-5	100
Elective 1	4-1-0-5	100
STA531: Lab	0-1-5-3	100

2nd Semester January to May

Paper	Duration L-T-P-C	Maximum Marks
STA504: Measure and Probability Theory	4-1-0-5	100
STA505: Estimation Theory	4-1-0-5	100
STA506: Time Series Analysis	4-1-0-5	100
Elective 2	4-1-0-5	100
STA532: Lab	0-1-5-3	100

3rd Semester July to December

Paper	Duration L-T-P-C	Maximum Marks
STA601: Testing of hypothesis, Sequential Analysis & Nonparametric Inference	4-1-0-5	100
Elective 3	4-1-0-5	100
Elective 4	4-1-0-5	100
STA631: Lab	0-1-5-3	100
STA632: Minor Project	5 credit	100

4th Semester January to May

Paper	Duration L-T-P-C	Maximum Marks
STA602: Analysis of Variance and Design of Experiments	4-1-0-5	100
Elective 5	4-1-0-5	100
Elective 6	4-1-0-5	100
STA633: Lab	0-1-5-3	100
STA634: Major project	5 credit	100

List of Core Courses: (4-1-0-5)

1. STA501: Matrix Algebra, Linear Estimation & Regression Analysis
2. STA502: Multivariate Analysis
3. STA503: Survey Sampling
4. STA504: Measure and Probability Theory
5. STA505: Estimation Theory
6. STA506: Time Series Analysis
7. STA601: Testing of hypothesis, Sequential Analysis & Nonparametric Inference
8. STA602: Analysis of Variance and Design of Experiments

List of Elective Courses: (4-1-0-5)

1. STA551: R Programming and Statistical Computing
2. STA552: Knowledge Discovery and Data Mining
3. STA651: Survival Analysis
4. STA652: Statistical Decision Theory and Bayesian Theory
5. STA653: Official and National Development Statistics
6. STA654: Advanced Multivariate Analysis
7. STA655: Econometrics
8. STA656: Stochastic Process

L: Lectures per week, T: Tutorials per week, P: Practical per week, C: Credits

Marks distribution:

15 (Best of two tests) + 25 (mid semester examination) + 10 (assignment/ seminar/GD) + 50 (End semester examination)

List of Compulsory Papers

STA501: Matrix Algebra, Linear Estimation & Regression Analysis

UNIT I

Inverse of partitioned matrices, g-inverse, orthogonal matrices, properties of idempotent matrices, characteristic roots and vectors, Cayley-Hamilton theorem, quadratic forms, definite, semi-definite and indefinite forms, simultaneous reduction of two quadratic forms, properties of similar matrices.

UNIT II

Multiple linear regression model and assumptions, estimation of parameters, estimable functions, error and estimation space, Gauss-Markov theorem, use of g-inverse, model in deviation form, ANOVA for linear model, R^2, adjusted R^2 and other model selection criterion, tests of linear hypothesis, forecasting.

UNIT III

Model Adequacy Checking: checking of linear relationship, residual analysis and scaling of residuals, regression variable hull, PRESS residuals, R-student residuals, residual plots, partial residual plots, detection and treatment of outliers, Diagnostics for leverage and influence, measures of influence.

UNIT IV

Model specification tests, tests for parameter constancy and structural change, use of dummy variables. Estimation of parameters by generalized least squares (GLS) in linear models with non-spherical disturbances, Gauss Markov theorem for GLS estimator, heteroscedasticity of disturbances, estimation under heteroscedasticity and tests of heteroscedasticity, tests for autocorrelation, estimation and forecasting under autocorrelated disturbances.

UNIT-V

Estimation of regression coefficients under exact and stochastic restrictions, restricted regression and mixed regression estimators and their properties. Model with stochastic regressors and errors in variable model, instrumental variable estimator.

Books recommended:

1. Draper, N.R. and Smith H. (1998), Applied Regression Analysis, 3rd Ed. Wiley.
2. Johnston, J. (1984). Econometric methods, Third edition, McGraw Hill.
3. Montgomery, D.C. Elizabeth A. P., Vining G.G. (2006), Introduction to Linear Regression Analysis, Wiley.

4. Rao, C. R., Toutenburg, H., Shalabh, Heumann, C (2008). Linear Models and Generalizations-Least squares and alternatives, Springer.
5. Monahan J.F. (2008). A Primer on Linear Models, CRC Press.
6. Khuri Andre I. (2010). Linear Model Methodology, CRC Press.
7. Seber, George A. F. and Lee Alan J. (2003), Linear Regression Analysis, Wiley.

STA502: Multivariate Analysis

UNIT I

Multivariate normal distribution, moment generating function and Characteristic function, marginal and conditional distributions, multiple and partial correlation coefficients.

UNIT II

Maximum likelihood estimators of the mean vector and covariance matrix, Distribution of sample mean vector. Wishart distribution and its properties.

UNIT III

Null distribution of sample correlation coefficient, sample multiple and partial correlation coefficients and their null sampling distributions, distribution of sample regression coefficient.

UNIT IV

Null distribution and non-null distribution of Hotelling's T^2 statistic, Applications in tests forthe mean vector of one and more multivariate normal populations, equality of the components of a mean vector in a multivariate normal population and their applications, Mahalanobis' D^2,

UNIT V

Classification and discrimination procedures for discrimination between two multivariate normal populations, sample discriminant function, tests associated with discriminant functions, probabilities of misclassification and their estimation, classification into more than two multivariate normal populations, Fisher-Behren Problem, Principal component analysis, Canonical correlations and variables.

Books recommended:

1. Anderson, T.W. (2003). An Introduction to Multivariate Statistical Analysis, 3rd edn., Wiley.

2. Johnson, R.A. and Wichern, D.W. (2002). Applied Multivariate Analysis, 3rd edn. Wiley.
3. Srivastava, M.S. and Khatri C.G. (1979). Introduction to multivariate statistics, North-Holland.

STA503: Survey Sampling

UNIT I

Varying probability sampling with and without replacement, cumulative total and Lahiri's methods of selection, Estimation of population mean, Desraj ordered estimates, unordered estimators.

UNIT II

Horvitz-Thompson estimator, its variance and unbiased estimator of variance and Yates- Grundy modification, schemes of sampling due to Midzuno-Sen, Narain.

UNIT III

Deep stratification, Post Stratification, Double sampling in ratio estimation.

UNIT IV

Double sampling in regression estimation, sub sampling.

UNIT - V

Non-sampling errors, Randomized Response techniques (Warner's model: related and unrelated questionnaire methods), Ranked set sampling.

Books recommended:

1. Chaudhuri, A. (2010). Essentials of Survey Sampling, Prentice Hall of India.
2. Chaudhuri, A. and Vos, J.W.E. (1988). Unified Theory of Strategies of Survey Sampling, North Holland, Amsterdam.
3. Hedayat, A. S. and Sinha, B.K. (1991). Design and Inference in Finite Sampling, Wiley.
4. Murthy, M.N. (1967). Sampling Theory and Methods. Statistical Publishing Society, Kolkata.
5. Mukhopadhyay, P. (1996). Inferential Problems in Survey Sampling, .New Age International.
6. Sukhatme, P.V., Sukhatme, B.V., Sukhatme, S. and Asok, C. (1984). Sampling Theory of Surveys with Applications, Iowa State University Press and Indian Society of Agricultural Statistics.
7. Cochran, W.G. (1977). Sampling Techniques, Third Edition, Wiley.

8. Sarndal, C.E., Swensson and Wretman (1977). Model Assisted Survey Sampling. Springer.
9. Singh, D. and Chuddar, F. S. (1986). Theory and Analysis of Sample Survey Designs. New Age International.
10. Sarjinder Singh (2003). Advanced Sampling Theory with Application. Kluwer Academic Publishers

STA504: Measure and Probability Theory

UNIT I

Basics of ring, field and set function, Monotone collection of sets.

Measure, Properties of measure, Random variable as a measurable function. Almost everywhere convergence, Convergence in Probability and in measure, Mean convergence, Almost sure convergence, σ -field induced by sequence of random variables.

Lebesgue Dominated Convergence Theorem, Monotone Convergence Theorem, Fatou Lemma, Fubini Theorem (Without Proof).

UNIT II

Decomposition of distribution functions in purely discrete, absolutely continuous and singular components. Holder's inequality, Minkowski inequality, Lyapunov inequality, Kolmogorov's inequality.

UNIT III

Weak (WLLN) and Strong (SLLN) Law of Large Numbers, Khintchin's Theorem and Kolmogorov Strong Law of Large Numbers, Borel zero- one Law, Borel – Cantelli lemma.

UNIT IV

Weak and complete convergence of sequence of distribution functions, Weak compactness Theorem, Helly Bray Lemma & Theorem, Characteristic function, Inversion Theorem, Continuity Theorem.

UNIT V

One dimensional Central Limit Theorems: Lindeberg- Levy for i.i.d. random variables, Lyapunov (without proof), Lindeberg & Feller Theorem (without proof) for independent random variables.

Books recommended:

Books recommended:

1. Bhat, B.R. (1999). Modern Probability Theory, 3rd edn. New Age International.
2. Chow Y.S. and Teicher, H.(2008) Probability theory, 3rd edn. Springer.
3. Chung, K.L. (2001). A course in probability theory, Academic Press.
4. Eisen, M. M. (1969) Introduction to mathematical probability theory Prentice-Hall.
5. Feller, W. (1968 and 1971) . An introduction to probability theory and its applications, vol I and II, Wiley.
6. Gnedenko, B.V. (1978). The theory of probability MIR Publishers.
7. Loève, M. (1977 & 1978) Probability theory, vol I & II Springer.
8. Rohatgi, V.K. and Saleh, A.K. Md. E. (2001). An Introduction to Probability and Statistics. Wiley.
9. Tucker, H.G. (1967) A graduate course in probability theory Academic Press Inc.
10. Ash, Robert. (1972). Real Analysis and Probability. Academic Press.
11. Bhat, B.R. (1999). Modern Probability Theory, 3rdedn. New Age International.
12. Bauer, H. (1991): Probability theory and elements of measure theory, Academic Press.
13. Burrill C. W. (1972).Measure, Integration, and Probability,McGraw-Hill
14. Basu, A.K. (2004). Measure Theory and Probability, Prentice Hall of India.
15. Halmos, P.R. (1974). Measure Theory, Springer.

STA505: Estimation Theory

UNIT I

Sufficiency, Fisher-Neyman-Halmos-Savage factorization criterion, minimal sufficiency, Sufficiency and completeness of n-tuple of order statistic.

UNIT II

Completeness, Bounded completeness, Ancillary statistics, Basu's theorem on independence of Statistics, Exponential family.

UNIT III

Bhattacharyya bound, Chapman Robbins and Kiefer (CRK) bound, Generalized RaoCramér bound for the multiparameter case.

UNIT IV

Maximum likelihood estimation, Zehna theorem for invariance, Cramér theorem for weak consistency,.

UNIT V

Asymptotic normality, BAN and CAN estimators, asymptotic efficiency, equivariant estimation.

Books Recommended:

1. Casella, G and Berger, R. L. (2002). Statistical Inference, 2nd edition, Duxbury Press.
2. Lehmann, E.L. and Casella, G. (1998). Theory of Point Estimation, Springer.
3. Rohatgi, V. K. and Saleh, A. K. Md E. (2001). An Introduction to Probability and Statistics, Wiley.
4. Zacks, S. (1971). The theory of statistical inference, John Wiley.

STA506: Time Series Analysis

UNIT I

Time series as a stationary or nonstationary stochastic process, sample autocovariance function (acvf) and autocorrelation function (acf) at lag k, partial autocorrelation function (pacf), correlogram, lag operators and linear filters, Ergodocity and Stationarity.

UNIT II

Wold decomposition, general linear process and its acvf, acf. Autoregressive (AR) process, moving average (MA) process, acf and pacf for AR and MA processes, Yule-Walker equations for AR processes, mixed ARMA process.

UNIT III

Stationarity and invertibility conditions, ARIMA(p,d,q) model, estimation of parameters for AR, MA, ARMA and ARIMA processes, identification of processes with ACF PACF, Model order estimation techniques-AIC, AICC, BIC, EDC, FPE and forecasting.

UNIT IV

Forms of nonstationarity in time series, random walk model, Dickey-Fuller, augmented Dickey-Fuller and Phillips-Perron tests for unit root.
ARCH and GARCH processes.

UNIT V

Frequency domain analysis- spectral density and its properties, spectral density function of stationary linear processes, cross-spectrum for multivariate processes, Spectral distribution function, estimation of spectral density function, Periodogram analysis.

Books recommended:

1. Box, George E. P., Gwilym M. Jenkins, Gregory C. Reinsel, Greta M. Ljung. (2015) Time Series Analysis, Forecasting and Control, Wiley.

2. Brockwell, P.J. and Davis, (2009) R.A.. Time Series: Theory and Methods (Second Edition), Springer-Verlag.
3. Chatfield, C. (1975) The Analysis of Time Series: Theory and Practice Springer-Verlag.
4. Granger, C.W.J. and Hatanka, M. (1964): Spectral Analysis of Economic Time Series, Princeton Univ. Press, N.J.
5. Granger, C.W.J. and Newbold (1984): Forecasting Econometric Time Series, Third Edition, Academic Press.
6. Kirchgassner, G. and Wolters, J. (2007). Introduction to Modern Time Series Analysis, Springer.
7. Montgomery, D.C. and Johnson, L.A. (1977): Forecasting and Time Series Analysis, McGraw Hill.
8. Priestley, M.B. (1981). Spectral Analysis & Time Series, Griffin, London

STA601: Testing of Hypothesis, Sequential Analysis & Nonparametric Inference

UNIT I

Relationship between interval estimation and hypothesis testing, Generalized Neyman Pearson lemma, UMP tests for distributions with MLR tests. UMPU tests, similar regions, Neyman structure, Invariant tests, Properties of LR tests (only statement).

UNIT II

SPRT, Fundamental identity, OC and ASN functions, Wald’s equation. Wolfowitz generalization of FRC bound, Stein’s two stage procedure, asymptotic theory of sequential estimation, sequential estimation of normal mean.

UNIT III

Moments of Order Statistics, Asymptotic distribution of an order statistic, nonparametric estimation of distribution function and Glivenko-Cantelli fundamental theorem of statistics.

UNIT IV

The Mann-Whitney U test, Application of U-statistic to rank tests, One sample and two sample Kolmogorov-Smirnov tests.

UNIT V

The Kruskal-Wallis One-Way ANOVA Test, Friedman's Two-Way Analysis of Variance by ranks.

Efficiency criteria, Theoretical basis for Calculating the ARE, Pitman ARE.

Books recommended:

1. David, H.A. and Nagaraja, H.N.. (1981), Order Statistics Wiley.
2. Gibbons, J.D. and Chakraborti,S. (2003). Nonparametric Statistical Inference, 4-th Edition, Marcel Dekker, Inc., New York.
3. Hájek, J. (1969) A course in Nonparametric statistics. Holden-Day, San Francisco
4. Lehmann, E.L. (2006), Nonparametrics. Statistical methods based on ranks Springer.
5. Randles, R.H. and Wolfe, D.A. (1979). Introduction to the Theory of Nonparametric Statistics, Wiley.
6. Ghosh, B.K.. (1970). Sequential tests of statistical hypothesis, Addison Wesley.
7. Ghosh, M., N. Mukhopadhyay, and P.K. Sen. (2011), Sequential Estimation John Wiley.
8. Lehmann, E L (1986). Testing Statistical Hypotheses, Springer.
9. Rohatgi, V. K. and Saleh, A. K. Md E. (2001). An Introduction to Probability and Statistics, Wiley.
10. Srivastava, M. and Srivastava, N. (2009). Statistical Inference -Testing of Hypotheses, Prentice Hall.

STA602: Analysis of Variance and Design of Experiments

UNIT I

Linear regression model, Random and mixed effect models, estimation of variance component in one way and two-way random effects model.General two- way classification.

UNIT II

Tukey's test, general two-way classification. Intra and inter block analysis of Incomplete block design.

UNIT III

General block design and its information matrix (C). Criteria for connectedness, balanced and orthogonality: Balanced Incomplete Block Design (BIBD) – Intra and inter block analysis, Simple lattice designs.

UNIT IV

Association schemes and partially balanced incomplete block designs – construction and parameter identification, Analysis of covariance.

UNIT V

General factorial experiments, factorial effects, study of 2^n and 3^n factorial experiments in randomized blocks, complete and partial confounding, construction of confounded factorial experiments, split plot experiment.

Books recommended:

1. Das, M.N. and Giri, N. (1979). Design and Analysis of Experiments, Wiley Eastern.
2. Dean, A. and Voss, D. (1999). Design and Analysis of Experiments, Springer.
3. Dey, A. (1986). Theory of Block Designs, Wiley Eastern.
4. Giri, N. (1986). Analysis of Variance, South Asian Publishers.
5. Joshi, D.D. (1987). Linear Estimation and Design of Experiments, Wiley Eastern.
6. Montgomery, C.D. (1976). Design and Analysis of Experiments, Wiley.
7. Toutenburg, H. and Shalabh (2009). Statistical Analysis of Designed Experiments, Springer.

List of Elective Papers

STA551: R Programming and Statistical Computing

Unit I

Basics of R: Installation of R and packages, R environment, creation of data objects (vector, matrices, arrays, lists and data frames). using scripts and RStudio. Data management through R, Import and export of data.

Unit II

Writing functions, Looping in R, Operations on vectors and matrices, Tabulation and graphs with R, visualization of univariate and multivariate data, panel displays, 2D and 3D and contour plots.

Unit III

Concept of central limit theorem and Markov chains. Random number generation, Requisites of a good random number generator, Generation of random observations using inverse cdf, acceptance rejection and transformation methods.

Unit IV

Simple optimization method: direct search, grid search, interpolatory search, gradient search. Newton-Raphson method, Muller's method, Aitken's extrapolation. Simple problems. EM Algorithm and Applications: EM algorithm for incomplete data, EM algorithm for mixture models, optimization using R.

Unit V

Methods to compute integrals: quadrature formula, double integration, Gaussian integration. Monte Carlo Methods: Monte Carlo integration, Metropolis- Hastings and Gibbs sampler and related methods. Application of Monte Carlo methods to compute expected values of functions of random variables, such as Laplace transform, Fourier transform etc.

Book recommended:

Albert J and Rizzo M (2012): R by Examples. Springer.

Buuren, Stef Van (2012): Flexible Imputation of Missing Data.Chapman and Hall.

Casella, G. and Roberts, C.P. (2004): Monte Carlo Statistical methods, Springer.

Christensen R, Johnson, W., Branscum A. and Fishman, G.S. (1996) Monte Carlo: Concepts, Algorithms, and Applications. Springer.

Gilks, W. R., Richardson, S., and Spiegelhalter, D. (eds.) (1995) Markov Chain Monte Carlo in Practice. Chapman and Hall.

Kennedy W. J. & Gentle J. E. (1980). Statistical Computing (Marcel Dekker)
Law, A.M. and Kelton, W.D. (2000). Simulation, Modeling and Analysis Third Edition. (Tata McGraw Hill)
Mike Allerhand (2011): A Tiny Handbook of R, Springer Briefs in Statistics, Springer-New York.
Rajaraman V. (1993). Computer Oriented Numerical Methods, (Prentice-Hall). Fourth edition
Ripley B. D. (1987) Stochastic Simulation. (John Wiley)
Rizzo M (2008): Statistical Computing with R. Springer.

STA552: Knowledge Discovery and Data Mining

UNIT I

Introduction to databases, tasks in building a data mining database, data warehouses, online analytical data processing, Data mining and machine learning, supervised and unsupervised learning.

Linear dimensionality reduction: principal component analysis for linear feature space, scree plot and its use for determining the number of principal components to retain, basic idea of non parametric kernel density estimation, non linear principal component analysis.

UNIT II

Clustering: Similarity and distance measures, Outliers, Minimum spanning tree, squared error clustering, K-means clustering, Hierarchical clustering, Block clustering and two way clustering: Hartigan's block clustering algorithm, Biclustering, Plaid models for biclustering.

UNIT III

Artificial Neural Network: and extensions of regression models, McCullon-Pitts Neuron (Threshold Logic Unit), Rosenblatt's Single layer perceptron, single unit perceptron gradient descent learning algorithm, Multilayer perceptron, feed forward and back propogation learning algorithm, Self organizing maps (SOM) or Kohonen neural network, on-line and batch versions of SOM algorithm, U matrix.

UNIT IV

Classification and Regession Trees (CART): Classification trees, node impurity function and entropy function, choosing the best split pruning algorithm for classification trees. Regression trees, terminal node value and splitting strategy, pruning the tree and best pruned subtree.

Committee Machine: Bagging tree based classifiers and regression tree predictors, Boosting, ADABOOST algorithm for binary classification.

UNIT V

Support vector machine (SVM) with linear class boundaries, multiclass SVM, Latent variable models for blind source separation: Independent component analysis (ICA) and its applications, linear mixing and noiseless ICA, FastICA algorithm for determining single source component, deflation and parallel FastICA algorithm for extracting multiple independent source components.

Books Recommended:

1. Izenman, A.J., (2008), Modern Multivariate Statistical Techniques: Regression, Classification, and Manifold learning, Springer
2. Han, J. and Kamber, M (2006). Data Mining: Concepts and Techniques, 2nd edition, Morgan Kaufmann.
3. Dunham, M. H. (2003). Data Mining: Introductory and Advanced Topics, Pearson Education.
4. Sheskin, D. J. (2004). The Handbook of Parametric and Nonparametric Statistical Procedures, 3rd Edition, Chapman and Hall/CRC.

STA651: Survival Analysis

Unit I

Introduction to Survival Analysis-Introduction, Outlines and objectives, Applications.Basic terms and their inter-relationships.Various properties of hazard function.

Unit II

Types of censoring and truncation, Uses of Life table, Kaplan–Meier Survival Curves and the Log–Rank Test, Log–Rank Statistic for Several Groups.

Unit III

Parametric Survival Models- Exponential, Weibull, Gamma, Normal, Log-normal models.Estimation and testing procedures on these models.

Unit IV

Proportional Hazard Models- Assumption.The Cox Proportional Hazards Model and its Characteristics.The Stratified Cox Procedure.Extension of the Cox Proportional Hazards Model (Time-Dependent).

Unit V

Recurrent Event Survival Analysis- Introduction, Outline and objectives, Competing Risks Survival Analysis-Competing risk events and Frailty models**.**

Books Recommended:

1. Allison , P. D. (2010). Survival Analysis Using SAS: A Practical Guide, SAS Publishing.
2. Kleinbaum, D. G. and Klein, M. (2012). Survival Analysis: A Self-Learning Text, Springer-Verlag New York.
3. Klein , J. P. and Moeschberger, M. L. (2005) Survival Analysis–Techniques for Censored and Truncated Data, Springer.
4. Hosmer, D. W., JR and Lemeshow , S. (2008) Applied survival Analysis: regression modeling of time to event data, Wiley.
5. Cleves , M., Gould, W. and Gutierrez, R. (2010) An introduction to survival analysis using STATA, Stata Press.

STA652: Statistical Decision Theory and Bayesian Analysis

UNIT I

Decision theoretic problem as a game, basic elements, optimal decision rules, Unbiasedness, invariance ordering, Bayes and Minimax principles, generalized Bayes rules, extended Bayes rules, limit of Bayes rules.Admissibility, Completeness, minimal complete class, separating and supporting hyper plane theorems, Complete class Theorem, equalizer rules and examples, minimax theorem.

UNIT II

Multiple decision problems, continuous form of Bayes theorem, its sequential nature, its need in decision making, basic elements of Bayesian decision theory, theorem on optimal Bayes decision function, relationship of Bayes and minimax decision rules, least favorable distributions.

Bayesian sufficiency, improper prior densities, Natural conjugate Bayesian densities (NCBD), posterior odd ratio, HPD regions, Bayesian inference for Normal populations, empirical Bayes procedures.

UNIT III

Subjective probability, its existence and interpretation.Prior distribution, subjective determination of prior distribution.Improper priors, non-informative (default) priors, invariant priors. Conjugate prior families, construction of conjugate families using sufficient statistics of fixed dimension, mixtures of conjugate priors, hierarchical priors and partial exchangeability.

UNIT IV

Parametric Empirical Bayes, Bayesian inference, summary through posterior, predictive inference.

Bayesian decision theory: Bayes solutions for practical decision problems. Point estimation, credible sets, testing of hypotheses. Comparison with classical procedures.Admissibility and minimaxity of Bayes and generalized Bayes procedures.

UNIT V

Ideas on Bayesian robustness, asymptotic expansion for the posterior density. Bayesian calculation, Monte-Carlo Integration and Markov chain Monte Carlo techniques.

Books Recommended:

1. Berger, J.O. (1993) Statistical Decision Theory and Bayesian Analysis, Springer Verlag.
2. Bernando, J.M. and Smith, A.F.M. (1994). Bayesian Theory, John Wiley and Sons.
3. Box, G.P. and Tiao, G.C. (1992). Bayesian Inference in Statistical Analysis, Addison-Wesley.
4. Gemerman, D and Lopes, H. F. (2006) Markov Chain Monte Carlo: Stochastic Simulation for Bayesian Inference, Chapman Hall.
5. Leonard, T. and Hsu, J.S.J. (1999) Bayesian Methods, Cambridge University Press.
6. Robert, C.P. (1994). The Bayesian Choice: A Decision Theoretic Motivation, Springer.
7. Robert, C.P. and Casella, G. (2004) Monte Carlo Statistical Methods, Springer Verlag.
8. Berger, J.O. (1985). Statistical decision theory-Fundamental concepts and methods, Springer Verlag.
9. Degroot, M. H. (1971). Optimal statistical decisions, McGraw-Hill.
10. Ferguson, T.S. (1967). Mathematical statistics- A decision theoretic approach, Academic press.
11. Lindley, D.V. (1965). Introduction to probability and statistical inference from Bayesian view point, Cambridge university press.

STA653: Official and National Development Statistics

UNIT I

Introduction to Indian and International statistical systems.role, function and activities of central and state statistical organizations, organization of large scale sample surveys, role of national sample survey organization.

UNIT II

General and special data dissemination systems, population growth in developed and developing countries, evaluation and performance of family welfare programmes.

UNIT III

Projections of labour force and manpower, scope and content of population census of India.

UNIT IV

System of collection of agricultural statistics, crop forecasting and estimation, productivity, fragmentation of holdings, support prices, buffer stocks, impact of irrigation projects.

UNIT V

Statistics related to industries, foreign trade, balance of payment, cost of living, inflation, educational and other social statistics.

Books Recommended

1. Basic Statistics Relating to the Indian Economy (CSO), 1990.
2. Guide to Official Statistics (CSO) 1999.
3. Statistical System in India (CSO), 1995.
4. Principles and accommodation of National Population Censuses, UNESCO.
5. Panse, V.G.: Estimation of Crop Yields (FAO).
6. Family Welfare Yearbook, Annual Publication of D/o Family Welfare.
7. Monthly Statistics of Foreign Trade in India, DGCIS, Calcutta and other Govt. Publications.

STA654: Advanced Multivariate Analysis

UNIT I

Inadmissibility of maximum likelihood estimator of mean vector of multivariate normal distribution when dimension is greater than three, James-Stein estimator of the mean vector and improved estimation of dispersion matrix of a multivariate normal distribution.

UNIT II

Wishart distribution, Cochran theorem, the generalized variance and distribution of sample generalized variance, Distribution of characteristic roots and vectors of Wishart matrices.

UNIT III

Principal components, their maximum likelihood estimators and sample variances, Canonical correlations and variables, Inferences on canonical correlations, Factor analysis, Linear factor models, Estimation of factor loadings, Factor rotation, Estimation of factor scores.

UNIT IV

Tests of hypothesis of (i) equality of covariance matrices, (ii) sphericity test for covariance matrix, (iii) mean vector and covariance matrix are equal to given vector and matrix.

UNIT V

Multivariate Analysis of variance (MANOVA) for one way and two way classified data.

Books Recommended:

1. Anderson T.W. (1984) An introduction to multivariate statistical analysis, 2nd Ed., J.Wiley.
2. Giri N.C. (1977) Multivariate statistical inference, Academic Press.
3. Kshirsagar A.M. (1972) Multivariate analysis, Marcel Dekker.
4. Muirhead, R. J. (1982) Aspects of multivariate statistical theory, J. Wiley.
5. Rencher, A.C. (1998) Multivariate Statistical Inference and its Applications, Wiley and Sons.
6. Srivastava M.S. and Khatri C.G. (1979) An introduction to multivariate statistics, North Holland.

STA655: Econometrics

UNIT I

Models with discrete and limited dependent variable, LOGIT, PROBIT, TOBIT and multinomial choice models, Poisson regression models.

Problem of multicollinearity, consequences and solutions, ridge regression and LASSO estimators.

UNIT II

Seemingly unrelated regression equation (SURE) model and its estimation, Panel data models: estimation in random effect and fixed effect models.

UNIT III

Simultaneous equations model, examples, concept of structural and reduced forms, problem of identification, rank and order conditions of identifiability.

UNIT IV

Methods of estimation in simultaneous equations model, indirect least squares, two stage least squares and limited information maximum likelihood estimation, k class

estimator, idea of three stage least squares and full information maximum likelihood estimation, prediction and simultaneous confidence intervals.

UNIT V

Multivariate time series processes and their properties, Vector autoregressive (VAR), vector moving average (VMA) and vector autoregressive moving average (VARMA) processes.

Granger causality, instantaneous Granger causality and feedback, characterization of causal relations in bivariate models, Granger causality tests, Haugh-Pierce test, Hsiao test.

Cointegration, Granger representation theorem (without proof), Bivariatecointegration and cointegration test in static model.

Books Recommended:

1. Apte, P.G. (1990): Text books of Econometrics, Tata McGraw Hill.
2. Gujarathi, D. (1979): Basic Econometrics, McGraw Hill.
3. Johnston, J. (1984): Econometric methods. Third edition, McGraw Hill.
4. Judge, G.G., W.E. Griffiths, R.C. Hill Lütkepohl and T. C. Lee (1985). The theory and practice of econometrics, Wiley.
5. Koutsoyiannis, A. (1979): Theory of Econometrics, Macmillan Press.
6. Srivastava, V.K. and Giles D.A.E. (1987): Seemingly unrelated regression equations models, Marcel Dekker.
7. Ullah, A. and Vinod, H.D. (1981). Recent advances in Regression Methods,Marcel Dekker

STA656: Stochastic Processes

UNIT I

Two state Markov sequences, Markov chains, determination of n-step transition probabilities, Chapman-Kolmogorov equations, first return and first passage probabilities, classification of states, communicating states, periodicity, stationary probability distributions and limit theorems for ergodic chains.

UNIT II

Continuous time Markov processes, Poisson (point) process, Inter arrival time distribution, Random walk and Brownian motion as a random walk, gambler’s ruin problem.

UNIT III

Branching processes of discrete type, average size and variance of the population in the n-th generation, fundamental theorem of extinction.

UNIT IV

Birth and death processes, renewal processes, Queueing Theory: M/M/1, M/M/k and M/G/1 queueing processes.

UNIT V

Wiener process, Arc-sine law, Martingales, stopping times, optional sampling theorem.

Books recommended:

1. Adke, S. R. and Manjunath, S. M. (1984). An Introduction to Finite Markov Processes, Wiley Eastern.
2. Cinlar, E. (1975). Introduction to Stochastic Processes, Prentice Hall.
3. Feller, W. (1968). Introduction to Probability and Applications, New Age India International.
4. Harris, T. E. (1963). The Theory of Branching Processes, Springer Verlag.
5. Hoel, P. G., Port, S. C. and Stone, C. J. (1991). Introduction to Stochastic Processes, University Book Stall.
6. Karlin, S. and Taylor, H. M. (1995). A First Course in Stochastic Processes, Academic Press.
7. Medhi, J. (2012). Stochastic Processes, 3rd edition, New Age India International.
8. Ross, S. M. (1996). Stochastic Processes, Wiley.