Proposed Syllabus for M. Sc. Statistics under CBCS
Department of Statistics
North-Eastern Hill University

Core courses

1. 1 credit is assigned for each 25 marks and 12 contact hours of teaching for theory or 24 contact hours of teaching for practical.
2. For each course, 25 % marks are to be allotted for internal assessment
3. A minimum of 10 practicals to be done in each practical course of 2 credits.
4. All practicals in core courses except practicals in STA C 106(Prac) (Section C) are to be done using MS-EXCEL.
5. For Open Courses, practical classes/questions are to be included in theory classes/questions.
6. For all theory courses, two questions are to be set from each unit and one question to be attempted.
7. For all practical courses, which are of 50 marks (2 credits) three questions of 15 marks to be set from the list of practicals and two to be attempted. 7.5 marks for the viva voce.
8. For STA C 106(Prac), the course is divided into three sections of 2 credits each. A minimum of 10 practicals to be done in each section. The examination has to be conducted on three different days.

Semester I

STA C 101

Mathematical Analysis

2 Credits

Unit 1 Recap of elements of set theory; Introduction to real numbers. Introduction to n-dimensional Euclidian space; open and closed intervals (rectangles), compact sets, Bolzano – Weirstrass theorem, Heine – Borel theorem.

(9 Lectures)

Unit 2 Sequences and series; their convergence. Real valued function; continuous functions, uniform continuity. Differentiation; maxima – minima of functions, functions of several variables, constrained maxima – minima of functions.

(9 Lectures)

Unit 3 Multiple integrals and their evaluation by repeated integration, change of variables in multiple integration, Improper integrals. Differentiation under the sign of integral – Leibnitz rule.

(6 Lectures)

Text Books

Bartle, R.G. (1976). Elements of Real Analysis, John Wiley & Sons, New York.

Narayan, S. (1993). Mathematical Analysis, S. Chand and Co., New Delhi.

Rudin, W. (1976). Principles of Mathematical Analysis, 3rd edition, McGraw-Hill, New York.

Additional references

Apostol, T.M. (1985). Mathematical Analysis, Narosa Publishing House, New Delhi.

STA C 102

Linear Algebra

2 Credits

Unit 1 Vector spaces over fields of scalars, subspaces, linear independence of vectors, basis and dimension of a vector space, completion theorem, orthogonality of vectors and subspaces, Vector spaces with an inner product, Gram-Schmidt ortghogonalization process, orthonormal basis, linear transformations and projections and their representation by matrices.

(12 Lectures)

Unit 2 Non-singular matrices and their inversion, determinants, ranks, row and column rank of a matrix, Idempotent matrix, its properties, trace, invariance theorems, Sylvestor and Frobenious inequalities, elementary matrices, partitioned matrices, G - inverse, Kronecker product. Systems of homogeneous and non-homogeneous linear equations, their consistency and maximal linearly independent solutions, minimal and characteristic polynomials of a square matrix, Characteristic roots and vectors, Cayley – Hamilton theorem, similarity and diagonalization of square matrices. Real quadratic forms and their value classes, canonical reductions and simultaneous reducibility of quadratic forms.

(12 Lectures)

Text Books

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

Lay, David C. (1997). Linear Algebra and its Applications, Addison-Wesley,

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

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

Additional references

Golub, Gene H and Loan C.F. Van (1996). Matrix Computations (John Hopkins Studies in Mathematical Science) 3rd Edition, John Hopkins University Press, USA.

Gentle, James E. (2005). Matrix Algebra: Theory, Computations and Applications in Statistics, Springer Text in Statistics, Springer-Verlag, New York.

Hoffman, K. and Kunze, R. (1971). Linear Algebra, 2nd edition. Prentice Hall, New Jersey.

Rao, A.R. and Bhimasankaram, P. (1992). Linear Algebra, Tata McGraw-Hill, New Delhi

Rao, C.R. (1995). Linear Statistical Inference and its Applications, Wiley Eastern, New Delhi.

STA C 103

Probability Theory

4 Credits

Unit 1 Classes of sets, fields, sigma-fields, minimal sigma-field, Borel sigma-field in R^k, sequence of sets, limsup and liminf of a sequence of sets. Measure, Probability measure, properties of a measure, Caratheodory extension theorem (statement only)

(16 Lectures)

Unit 2 Measurable functions as limit of simple functions, Random variables, sequence of random variables, almost sure convergence, convergence in probability (and in measure). Integration of a measurable function with respect to a measure. Expectation and moments. (statements of) Monotone convergence theorem, Fatou's lemma, and Dominated convergence theorem (and discussion).

(12 Lectures)

Unit 3 Probability inequalities (Tchebyshef, Markov, Jensen). Independence Borel- Cantelli Lemma, Kolmogorov zero-one law and Borel zero-one law. Kolmogorov's Strong Law of Large numbers for iid sequences.

(8 Lectures)

Unit 4 Convergence in distribution, characteristic functions and their elementary properties, Inversion and Uniqueness theorem (statement and discussion), Polya's theorem and Levy's continuity theorem (statement only), de Moivre-Laplace Central Limit Theorem (CLT), Lindeberg-Levy's CLT, statement and discussion of Lindeberg-Feller's CLT.

(12 Lectures)

Text Books

Parthasarthy, K. R. (1980). Introduction to Probability Theory and Measure. McMillan, India.

Ross, S.M. (2005). A First Course in Probability, 7th Edition, Prentice Hall, New Jersy.

Ross, S. M. and Erol, A. Prekoz (2007): A Second Course in Probability, www. Probability Book Store. Com, Boston, USA.

Singh, B. M. (2002). Measure, Probability and Stochastic Processes, South Asian Publishers, New Delhi.

Additional References

Billingsley, P. (1986). Probability and Measure. John Wiley & Sons, New York.

Feller, W. (1985). Introduction to Probability theory and its Applications.(Vol. 1&2). Wiley Eastern, New Delhi.

Kingman, J F C and Taylor, S. J. (1966). Introduction to Measure and Probability. Cambridge University Press.

Natarajan, A. M. and Tamilarasi. A. (2003). Probability, Random Process and Queuing Theory, New Age International Publishers, New Delhi.

Rao, C. R. (1995). Linear Statistical Inference and its Applications. Wiley Eastern, New Delhi.

STA C 104

Distribution Theory I

2 Credits

Unit 1 Joint, marginal and conditional pmfs and pdfs. Computations of probability, expectations and variances by conditioning, Generating functions (m.g.f and p.g.f) of random variables, their properties and applications.

(6 Lectures)

Unit 2 Some continuous distributions(Cauchy, pareto, Weibull, lognormal), Bivariate normal and bivariate exponential distributions and their properties, multinomial distribution.

(6 Lectures)

Unit 3 Functions of random variables and their distributions using Jacobian and other tools, convolution and compound distributions, truncated and mixture distributions,

(6 Lectures)

Unit 4 Sampling distributions from normal population central and non - central Chi-square, t and F distributions.

(6 Lectures)

Text Books

Hogg, R.V. and Craig, A.L. (1978). Introduction to Mathematical Statistics, McMillan, New York.

Mood, A.M., Grabyl, F.A. and Boes, D.C. (2001). Introduction to Theory of Statistics, Tata McGraw Hill, New Delhi.

Ross, Sheldon M (2004) Introduction to Probability and Statistics for Engineers and Scientist, Third Edition, Elsevier Academic Press, USA.

Rohatgi V.K. and Saleh, A.K.Md. E. (2001). An Introduction to Probability and Statistics (Second Edition), John Wiley and Sons(Asia), Singapore.

Additional Reference

Dudewicz, E.J. and Mishra, S.N. (1988). Modern Mathematical Statistics, John Wiley, New York.

Johnson, S and Kotz, S. (1970). Continuous univariate Distributions I and II John Wiley, New York..

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

STA C 105

Distribution Theory II

2 credits

Unit 1 Order statistics and their distributions and properties. Joint and marginal distributions of order statistics. Extreme values and their asymptotic distribution (statement only) with applications, Asymptotic distribution of median, distribution of quantiles.

(9 Lectures)

Unit 2 Multivariate normal distribution, p.d.f and c.d.f moments, marginal and conditional distributions.

(6 Lectures)

Unit 3 Distribution of linear and quadratic forms in normal variables, expectations, variances and covariances, characteristic functions, independence of quadratic forms, conditions for a quadratic form to be distributed as chi-square and non-central chi-square, decomposition of quadratic forms, Cochran's theorem and James' theorem.

(9 Lectures)

Text Books

Hogg, R.V. and Craig, A.L. (1978). Introduction to Mathematical Statistics, McMillan, New York.

Rohatgi V.K. and Saleh, A.K.Md. E. (2001). An Introduction to Probability and Statistics (Second Edition), John Wiley and Sons(Asia), Singapore.

Singh, B.M.(2002). Multivariate Statistical Analysis. South Asian Publishers Pvt. Ltd., New Delhi.

Additional references

David, W.S.(2003). Order Statistics. (Second Edition). John Wiley and Sons, New York.

Dudewicz, E.J. and Mishra, S.N. (1988). Modern Mathematical Statistics. John Wiley and Sons, New York.

Ferguson, T.S. (1996). A Course on Large Sample Theory. Chapman and Hall, London.

Johnson, N.L. and Kotz, S.(1970). Continuous Univariate Distributions – 2, John Wiley and Sons, New York.

STA C 106 (Prac)

Distribution, Computing & Programming

6 Credits

Section A: Probability Distribution

2 Credits

List of Practicals:

1. Stem and Leaf, Box and Whisker's plots
2. Empirical Distribution plots
3. Fitting of some standard distributions using chi square – p-p and q-q plots
4. Plotting of density and distribution functions for exponential family with varying location, scale, and shape parameters
5. Model sampling from standard distributions
6. Generating samples using probability integral transform/ Box-Muller transformation
7. Sample generation from chi-square, t, F and lognormal distributions using standard normal variates; comparison of histogram of the generated data and the corresponding density plot
8. Sampling from mixture distributions (normal and exponential) and drawing histograms
9. Fitting of Pareto distribution
10. Fitting of Weibull distribution
11. Fitting of lognormal distribution

Text Books

Dudewicz, E.J. and Mishra, S.N. (1988). Modern Mathematical Statistics, John Wiley, New York.

Goon, A.M., Gupta, M.K. and Disrupt, B. (2000). Fundamentals of Statistics, Vol. I, World Press, Collate.

Hogg, R.V. and Tanis, E.A. (2003). Probability and Statistical Inference, Pearson Education, Delhi.

Rohatgi V.K. and Saleh, A.K.Md. E. (2001). An Introduction to Probability and Statistics (Second Edition), John Wiley and Sons(Asia, Singapore.

Wasserman, L.(2004). All of Statistics: A Concise Course in Statistical Inference, Springer Science+Buisness Media, Inc., New York.

Section B: Computing Techniques

2 Credits

List of Practicals:

1. Determinant: pivotal consideration method
2. Solutions of a system of linear equations: Gauss elimination method
3. Matrix inversion – Gauss Jordon elimination method
4. Computation of G – inverse
5. Charasteristic roots and vectors by power method/singular value decomposition
6. Triangular reduction of a positive definite matrix
7. QR decomposition of a non-singular matrix
8. Spectral decomposition of a real symmetric matrix
9. Canonical reduction of quadratic forms
10. Numerical integration : Trapezoidal rule/ Simpson $\frac{1}{3}$ or $\frac{3}{8}$ rule
11. Solution to non-linear equation : Bisection method/Newton-Raplson/Steepest descent
12. Numerical differentiation using Newton's/Lagrange's formulae
13. Univariate optimization using Fisher's scoring/iteratively reweighted least squares

Text Books

Gentle, James E (2005). Matrix Algebra: Theory, Computations and Applications in Statistics, Springer, New York.

Givens, G. H. and Hoefting, J. A. (2005). Computational Statistics, John Wiley & Sons, New York.

Golub Gene H. and Loan C.F. Van (1996). Matrix Computations (John Hopkins Studies in Mathematical Science) 3rd Edition; John Hopkins University Press, USA.

Rao, A. R. and Bhimasankaran, P. (1992), Linear Algebra, Tata Mc Graw Hill, New Delhi.

Searle, S. R.(1982). Matrix Algebra useful for Statistics, John Wiley & Sons, Inc., New York.
Thisted, R. A. (1988). Elements of Statistical Computing. Chapman and Hall.

Section C: Computer Programming

2 Credits

Features of C language, data type, variables, operators. Expressions and statements input/output, Control constructs, Loops, Pointers and arrays, and linking to data bases.

Computer Programmes for the following will be written ,

1. Sorting and finding maximum/minimum
2. Calculation of summary statistics (mean, median, s.d.)
3. Calculation of regression and correlation coefficients
4. ANOVA for CRD
5. Computation of inverse and determinant
6. Solution of a system of linear equation
7. Numerical Integration
8. Root extraction
9. Extraction of characteristic roots and vectors
10. Random Number Generation

Text Books

Balagurusany, E. (2004). Programming in ANSI C. Tata Mc Graw Hill, New Delhi.

Kernighan, B. W. and Ritchie, D. M. (1988). The C Programming Language, Second Edition, Prentice Hall, New Delhi

Press, W. H., Teukolsky, S. A., Vellering, W. T. and Flannery, B. P. (1993). Numerical Recipes in C, Second Edition, Cambridge University Press, New Delhi.

Semester II

STA C 201

Sample Survey

3 Credits

Unit 1 Simple random sampling - estimation based on distinct units in srswor. Systematic sampling (circular, population with trend), domain estimation in srs.

(6 Lectures)

Unit 2 Unequal probability sampling; pps wr and wor methods (including Lahiri's scheme) and related estimators of a finite population mean. Hansen – Hurwitz and Desraj estimators for a general sample size and Murthy's estimator for a sample of size 2. Horvitz – Thompson Estimator (HTE).

(10 Lectures)

Unit 3 Stratified sampling - allocation problem and construction of strata.

(6 Lectures)

Unit 4 Cluster sampling. Two-stage sampling. Ratio and regression estimators based on srswor method of sampling, Double sampling.

(8 Lecture)

Unit 5 Non-sampling errors, modeling observational errors, application to longitudinal studies. Randomized response technique: Warner's related question model, unrelated question model.

(6 Lectures)

Text Books

Cochran, W.G. (1997). Sampling Techniques, Wiley Eastern, New Delhi.

Mukhopadhyay, P.(1998). Theory and Methods of Survey Sampling, Prentice Hall of India, New Delhi.

Sukhatme, P.V., Sukhatme, B.V., Sukhatme, S. and Asok, C. (1984). Sampling Theory of Surveys with Applications, Iowa State University Press and IARS.

Additional References

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Chaudhury, A. and Mukherjee, R. (1988). Randomized Response: Theory and Techniques, Marcel Decker, New York.

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

Raj, D. and Chandhok, P. (1998). Sampling Theory. Narosa Publishing House , New Delhi. .

STA C 202

Statistical Inference - I

3 Credits

Unit 1 Parametric models: Identifiable (indexing) parametric set up, estimation (point and interval) and testing of hypotheses, joint distribution of a sample and induced sampling distribution of a statistic; examples form standard discrete and continuous models. Likelihood function and information in data about the parameter, concept of non - information, sufficiency, Neyman factorizability criterion, likelihood equivalence, minimal sufficient statistic, exponential family, invariance property of sufficiency, Fisher information for one and several parameters model.

(12 Lectures)

Unit 2 Methods of estimation; maximum likelihood method, method of moments method of minimum chi-square, method of scoring. Choice of estimators based on unbiasedness, minimum variance, mean squared error, minimum variance unbiased estimators, Rao-Blackwell theorem, completeness, Lehmann-Scheffe theorem, necessary and sufficient conditions for MVUE, Cramer – Rao Scheffe inequality. Consistency and CAN (statements only)

(12 Lectures)

Unit 3 Tests of Hypotheses: concepts of critical regions, test functions, two kinds of errors, size function, power function, level, MP test, Neyman-Pearson Lemma and likelihood ratio test, asymptolic distribution of L.R. statistic (statement only)

(7 Lectures)

Unit Interval estimation; confidence level, construction of confidence intervals using pivots, shortest expected length confidence interval, construction of confidence interval using tests of hypothesis.

(5 Lectures)

Text Books

Casella. G and Berger R.L. (1990) Statistical Inference, Wordsworth and Brooks, California.

Hogg, R.V. and Craig, A.T. (2002). Introduction to Mathematical statistics, Pearson Education, Delhi.

Kale, B.K. (1999). A First Course on Parametric Inferences, Narosa Publishing House, New Delhi.

Rohatgi V. (1998). An Introduction to Probability and Mathematical Statistics. Wiley Eastern.

Additional References

Dudewicz, E.J. and Mishra, S.N. (1988). Modern Mathematical Statistics, John Wiley, New York.

Lehman, E.L. (1986). Testing of Hypothesis, John Wiley, Singapore.

Lehman, E.L. (1996). Theory of Point Estimation, John Wiley, Singapore

Rao, C.R. (1995), Linear Statistical Inference, Wiley Eastern, New Delhi.

Zacks, S. (1971). Theory of Statistical Inference, John Wiley, New York.

STA C 203

Linear Models and Regression Analysis

2 Credits

Unit 1 Gauss-Markov set-up, estimability of parameters, normal equations and least squares estimates, error and estimation spaces, variances and covariance of least squares estimates, estimation of error variance, estimation with correlated observations, least squares estimates with restriction on parameters, simultaneous estimates of linear parametric functions. Tests of hypotheses, linear models with restricted hypothesis, confidence intervals and regions, Analysis of Variance.

(12 Lectures)

Unit 2 Simple linear regression fit of polynomials and use of orthogonal polynomials, multiple regression, logistic regression.

(7 Lectures)

Unit 3 Residual and their plots as tests for departure from assumptions such as fitness of the model, normality, homogeneity of variances, correlated structure and detection of outliers; Remedies; Transformation; Power transformations for dependent and independent variables, problems of multicolinearity.

(5 Lectures)

Text Books

Cook, R. D. and Weisberg, S. (1982). Residual and influence in Regression. Chapman and Hall.

Draper, N. R. and Smith, H. (1998). Applied Regression Analysis, John Wiley, New York.

Montgomery, D. C.; Peck, E. A. and Vining G. G. (2004). Introduction to Linear Regression Analysis . John Wiley, New York.

Searle, S. R. (1971). Linear Models. Wiley, New York.

Seber, G. A. F and Lee Alan J. (2003). Linear Regression Analysis, John Wiley, New York.

Additional References

Chatterjee. S, and Price. B (1991). Regression Analysis by Example, John Wiley. New York.

STA C 204 (Prac)

Sample Survey

2 Credits

List of Practicals:

1. Simple random sampling – all possible samples
2. Estimation using srswr and srswor
3. Estimation using srswr based on distinct units
4. PPS sampling – selection and estimation
5. Stratified Sampling – estimation, sample allocation and construction of strata
6. Estimation in circular systematic sampling
7. Estimation in cluster Sampling - equal and unequal cluster size
8. Estimation in two-stage sampling - equal and unequal size units
9. Estimation in double Sampling – ratio and regression estimator
10. Estimation in double Sampling – for stratification
11. Non sampling errors – call back policies

Text Books

Krishnaiah, P.R. and Rao, C.R. (1988). Hand Book of Statistics, Vol. 6, Elsevier, Netherlands

Singh, D. and Choudhary, F.S. (1986). Theory and Analysis of Sample Survey Designs, New Age International Publishers, New Delhi.

Som, R.K. (1996). Practical Sampling Techniques, Marcel Dekker, New York.

STA C 205 (Prac)

Statistical Inference I & Regression Analysis

2 Credits

List of Practicals:

1. Plotting of likelihood function and finding m.l.e. of parameters – using numerical methods
2. Estimation by the method of scoring for Cauchy and Chi – square distribution.
3. Estimation by the method of minimum Chi – square
4. Estimation by the method of moments
5. Testing of hypotheses, power curves and confidence interval.
6. Fitting of simple regression with one independent variable – inference about parameters
7. Residual Plots; Tests for normality, test for homoscedasticity.
8. Fitting of polynomial regression and orthogonal polynomials
9. Transformation on Y and/or X
10. Fitting of Multiple regression
11. Tests of hypothesis of one or more linear parametric functions, parallelism, intercepts
12. Fitting of logistic regression

Text Books

Bhattacharyya, G.K. and Johnson, R.A. (1977). Statistical Concepts and Methods, John Wiley, New York.

Goon, A.M., Gupta, M.K. and Disrupt, B. (2000). Fundamentals of Statistics, World Press, Kolkata.

Hogg, R.V. and Tanis, E.A. (2003). Probability and Statistical Inference, Pearson Education, Delhi.

Chatterjee, S. and Price, B. (1991). Regression Analysis by Example, John Wiley, New York.

Draper, N.R. and Smith, H (1998). Applied Regression Analysis, John Wiley, New York.

Montgomery, D. C.; Peck, E. A. and Vining G. G. (2004). Introduction to Linear Regression Analysis . John Wiley, New York.

Seber, G. A. F and Lee Alan J. (2003). Introduction to Linear Regression Analysis, John Wiley, New York.

STA O 206

Introduction to Probability Theory and Distributions

2 Credits

Unit 1 Important Concepts in Probability: Definition of probability - classical relative frequency -subjective and axiomatic approach to probability, merits and demerits of these approaches (only general ideas to be given). Random Experiment: Trial, sample point and sample space, definition of an event, operation of events, mutually exclusive and exhaustive events. Discrete sample space, combinatorics, properties of probability based on axiomatic approach, conditional probability, independence of events, Bayes' theorem and its applications.

(8 Lectures)

Unit 2 Random Variables: Definition of discrete random variables, probability mass function, idea of continuous random variable, probability density function, illustrations of random variables and its properties, expectation of a random variable and its properties -moments, measures of location, dispersion, skewness and kurtosis. Chebyshev's inequality and applications, statements and applications of weak law of large numbers, central limit theorems.

(8 Lectures)

Unit 3 Standard univariate discrete distributions and their properties: Discrete Uniform, Binomial, Poisson, Hypergeometric, and Negative Binomial distributions. Continuous univariate distributions- uniform, normal, exponential, gamma and beta distributions.

(8 Lectures)

Text Books

Bhat B.R, Srivenkatramana T and Rao Madhava K.S. (1997):Statistics: A Beginner' Text, Vol. II, New Age International (P) Ltd.

Edward P.J. and Ford J.S. (1974): Probability for Statistical Decision-Making, Prentice Hall.

Goon A.M., Gupta M.K., Das Gupta. B. (1999): Fundamentals of Statistics, Vol.II, World Press, Calcutta.

Mood A.M, Graybill F.A and Boes D.C. (1974): Introduction to the Theory of Statistics, McGraw Hill.

Ross, S.M. (2005): A First Course in Probability, 7th Edition, Prentice Hall, New Jersy, USA.,

Thomasian, Aj (2000). Structure of Probability Theory with Applications, McGraw Hill, New York, USA.

STA O 207

Introduction to Sample Survey

2 Credits

Unit 1 Sample Surveys, Concepts of population and sample, need for sampling, Census and sample survey, basic concepts in sampling, organizational aspects of survey sampling, sample selection and sample size.

(6 Lectures)

Unit 2 Some basic sampling methods- simple random sampling (SRS) with and without replacement.

(6 Lectures)

Unit 3 Stratified random sampling, systematic sampling (linear only), introduction to ratio and regression methods of estimation under SRS.

(8 Lectures)

Unit 4 Non sampling errors, acquaintance with the working (questionnaires, sampling design, methods followed in field investigation, principal findings etc.) of NSSO and other agencies undertaking sample surveys.

(4 Lectures)

Text Books

Cochran, W.G. (1997). Sampling Techniques, Wiley Eastern, New Delhi.

Mukhopadhyay, P.(1998). Theory and Methods of Survey Sampling, Prentice Hall of India, New Delhi.

Sukhatme, P.V., Sukhatme, B.V., Sukhatme, S. and Asok, C. (1984). Sampling Theory of Surveys with Applications, Iowa State University Press and IARS.

STA O 208

Linear Programming

2 Credits

Unit 1 Introduction to Linear Programming (LP). Mathematical Formulation of Linear Programming Problem (LPP). Graphical solution to LPP.

(4 Lectures)

Unit 2 General LPP, Canonical and Standard forms of General LPP, Duality in LPP , Simplex Method. Big-M method and Two-phase method.

(14 Lectures)

Unit 3 Transportation and Assignment problems. (Including Traveling Salesman's Problem).

(6 Lectures)

Text Book

Gass, S. I. (1975) Linear Programming: Method and Application, Mc Graw – Hill, New York.

Shevoy, G. V. (1992), Linear Programming: Methods and Applications, Wiley Eastern, New Delhi.

Semester III

STA C 301

Design of Experiments

3 Credits

Unit 1 Block Design, multiple comparison, Von Ferroni, Tukey and Scheffe, simultaneous confidence interval. Incomplete Block Design, Balance Incomplete Block Design (BIBD), introduction to Partially Balanced Incomplete Block Design (PBIBD), Analysis of covariance in a general Gauss-Markov model,

(15 Lectures)

Unit 2 General factorial experiments, factorial effects, best estimates and testing the significance of factorial effects, study of 2 and 3 factorial experiments in randomized blocks, complete and partial confounding. Fractional replication for symmetric factorials.

(15 Lectures)

Unit 3 Application areas, response surface experiments, clinical trials, longitudinal data.

(6 Lectures.)

Text Books

Cochran, W.G. and Cox, G.M. (1959). Experimental Designs, Asia Publishing House, Singapore.

Das, M.N. and Giri, N. (1979). Design and Analysis of Experiments, Wiley Eastern, New Delhi.

Giri, N. (1986). Analysis of Variance, South Asian Publishers.

Joshi, D.D. (1987). Linear Estimation and Design of Experiments, Wiley Eastern, New Delhi.

Montgomery, C.D. (2001). Design and Analysis of Experiments, John Wiley, New York.

Additional References

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

Dey , Aloke (1986). Theory of Block Designs, Wiley Eastern, New Delhi.

Pearce, S.C. (1984). Design of Experiments, John Wiley, New York.
Searle, S.R. Casella, G. and McGulloch, C.E. (1992). Variance Components, John Wiley, New York.

STA C 302

Statistical Inference II

3 Credits

Unit 1 Unbiased test, UMP and UMPU tests, Wald's SPRT with prespecified errors of two kinds

(8 Lectures)

Unit 2 One sample location problem, sign test and signed rank test, one and two sample Kolmogorov Smirnov tests. Two sample location problems. Wilcoxon-Mann-Whitney test, normal score test, ARE of various tests based on linear rank statistics. Kruskal-Wallis K sample test, one and two sample U statistics, asymptolic distribution of U statistics.

(10 Lectures)

Unit 3 Basic concepts of decision theory; inference problems viewed as decision problem. Problem of classification, minimax approach and Baye's approach, structure of Baye's rule, complete class of rules, construction of minimax rule.

(8 Lectures)

Unit 4 Concepts and evaluation of subjective probability of an event; subjective prior distribution of a parameter. Baye's theorem and computation of posterior distribution. Natural conjugate family of prior for a model. Loss function, Baye's risk. Bayesian estimation of parameters of binomial, poisson, normal and exponential distributions.

(10 Lectures)

Text Books

Bansal, A. K. (2007): Bayesian Parametric Inference, Narosa Publishing House, New Delhi.

Casella. G and Berger, R.L. (1990) Statistical Inference, Wordsworth and Brooks, California.

Ferguson, T.S. (1996). Mathematical Statistics- A Decision theory approach, Academic press, London.

Gibbons, J.D. (1985). Non-parametric Statistical Inference, Marcel Dekker, New York.

Kale, B.K. (1999). A first Course on Parametric Inference, Narosa Publishing House, New Delhi.

Rohatgi V. (1988). An Introduction to Probability and Mathematical Statistics, Wiley Eastern, New Delhi

Additional References

Dudewicz, E.J. and Mishra, S.N. (1988). Modern Mathematical Statistics. John Wiley and Sons, New York.

Mukhopadhyay, N. (2000). Probability and Statistical Inference, CRC, London

Mukhopadhyay, N. (2006). Introductory Statistical Inference, CRC, London

STA C 303

Statistics for National Development & Environmental Statistics

2 Credits

Unit 1 Indices of development, human development index, Estimation of national income – product approach, income approach and expenditure approach.

(6 Lectures)

Unit 2 Population projection using Leslie matrix, Measuring inequality in incomes. Gini's coefficient, Theil's measure. Poverty measurement – different issues, measures of incidence and intensity, indices due to Kakwani, Sen etc.

(6 Lectures)

Unit 3 Ecological diversity, Species abundance curve, indices of diversity, richness and evenness.

(6 Lectures)

Unit 4 Harvesting renewable biological resources – maximum sustainable yield, Bionomic equilibrium

(6 Lectures)

Text Books

Bodkin, Daniel D. (1995). Environmental Science- Earth As a Living Planet, John Wiley & Sons, New York.

Clark, C.W. (1976). Mathematical Bioeconomics: Optimal Management of Renewable Resources, John Wiley and Sons, New York.

Gore, Anil and Paranjpe, S.A. (2000). A Course on Mathematical and Statistical Ecology, Kluwer.

Ludwig, J.A. and Judwig, J.F. (1988). Statistical Ecology, Wiley and Sons, New York.

Ray, Devraj (1998). Development Economics, Oxford University Press, Oxford.

Sen, A. (1997). Poverty and Inequality, Oxford University Press, Oxford.

Additional References

Pielou, E.C. (1997). An Introduction to Mathematical Ecology, John Wiley and Sons, New York.

Smith, J. M. (1982). Evolution and the Theory of Games, Cambridge University Press, Cambridge.

STA C 304 (Prac)

Design of Experiments

2 Credits

List of Practicals

1. Two way classification with equal number of observations
2. Two way classification with unequal number of observations
3. Analysis of Balanced Incomplete Block Design.
4. Analysis of covariance in one way and two way classified data
5. Analysis of 2^n factorial experiments- n=3, 4
6. Total confounding in 2^n, n= 3, 4
7. Partial confounding in 2^n, n= 3, 4
8. Analysis of 3^2 factorial experiments
9. Analysis of 3^3 factorial experiments
10. Total confounding in 3^n, n= 2,3
11. Partial confounding in 3^n, n= 2,3

Text Books

Cochran, W.G. and Cox, G.M. (1959). Experimental Designs, Asia Publishing House, Singapore.

Das, M.N. and Giri, N. (1979). Design and Analysis of Experiments, Wiley Eastern, New Delhi.

Federer, W.T. (1990) Experimental Design – Theory and Application, Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi.

Giri, N. (1986). Analysis of Variance, South Asian Publishers, New Delhi.

Joshi, D.D. (1987). Linear Estimation and Design of Experiments, Wiley Eastern, New Delhi.

Montgomery, C.D. (2001). Design and Analysis of Experiments, John Wiley, New York.

STA C 305 (Prac)

Statistical Inference II

2 Credits

List of Practicals

1. One and two sample Sign and Signed rank tests
2. One and two sample Kolmogorov-Smirnov tests - p – p plot
3. Wilcoxon-Mann-Whitney test
4. Normal Score Test
5. Kruskal-Wallis K Sample Test
6. Minimax estimation
7. Hypothesis testing: UMP, UMPU tests, its power function and plotting
8. Bayesian estimation under different priors and losses
9. Bayesian estimation of risk under different priors and losses
10. Sequential Probability Ratio Test

Text Books

Dudewicz, E.J. and Mishra, S.N. (1988). Modern Mathematical Statistics. John Wiley and Sons, New York.

Rohatgi V. (1988). An Introduction to Probability and Mathematical Statistics, Wiley Eastern, New Delhi

STA O 306

Introduction to Design and Analysis of Experiments

2 Credits

Unit 1 Analysis of variance for one way and two way classification under fixed, random and mixed effects model, model validation

(10 Lectures)

Unit 2 Need for design of experiments, fundamental principles of design, basic designs – CRD, RBD, LSD and their analysis. Split plot and split block experiments.

(8 Lectures)

Unit 3 Factorial experiments – 2^n designs, main effects and interaction effects, confounding in 2^3 designs.

(6 Lectures)

Text Books

Cochran, W.G. and Cox, G.M. (1959). Experimental Designs, Asia Publishing House, Singapore.

Das, M.N. and Giri, N. (1979). Design and Analysis of Experiments, Wiley Eastern, New Delhi.

Giri, N. (1986). Analysis of Variance, South Asian Publishers, New Delhi.
Joshi, D.D. (1987). Linear Estimation and Design of Experiments, Wiley Eastern, New Delhi.

Montgomery, C.D. (2001). Design and Analysis of Experiments, John Wiley, New York.

Ross, S.M. (2004). Introduction to Probability and Statistics for Engineers and Scientist, Academic Press, USA.

STA O 307

Introduction to Econometrics

2 Credits

Unit 1 Nature of econometrics. The general linear model (GLM) and its extension. Ordinary least squares (OLS) estimation and prediction. Use of dummy variables and seasonal adjustment. Generalized least squares (GLS) estimation and prediction. Heteroscedastic disturbances. Pure and mixed estimation. Grouping of observations and of equations.

(8 Lectures)

Unit 2 Auto correlation, its consequences and tests. Theil BLUS procedure. Estimation and prediction. Multicollinearity problems, its implications and tools for handling the problem. Ridge regression.

(8 Lectures)

Unit 3 Linear regression with stochastic regressors. Instrumental variable estimation. Errors in variables. Autoregressive linear regression. Distributed lag models. Use of principal components, canonical correlations and discriminant analyses in econometrics.

(8 Lectures)

Text Books

Apte PG (1990). Test book of Econometrics, Tata McGraw Hill, New Delhi.

Johnston, J. (1984). Econometric methods, McGraw Hill, New York.

Ray, Devraj (1998). Development Economics, Oxford University Press, Oxford.

Additional References

CSO (1980). National Accounts Statistics – Sources and Health, New Delhi.

Intrulligator, M.D. (1980). Econometric models-Techniques and Applications, Prentice Hall of India, New Delhi.

Nagar, A.L. (1983). Basic Statistics, Oxford University Press, Oxford.

STA O 308

Biometry

2 Credits

Unit 1 An introduction to Biometry and Statistics : data collection and data presentation, frequency distribution, graphical representation, measures of central tendency, dispersion, skewness and kurtosis. Probability distribution : Binomial, Poisson and Normal distribution.

(6 Lectures)

Unit 2 Introduction to bivariate frequency data and its measurement : covariance, correlation, scatter diagram. Regression analysis : Linear regression, regression coefficient, fitting of regression equation by least square method.

(7 Lectures)

Unit 3 Population, sample. Statistic, standard error, estimation, confidence interval and confidence level, confidence interval estimate of proportion and mean. Hypothesis and its types, errors, level of significance. Test statistics : Student's Chi-square, F and Z-Statistics and their applications in testing of hypothesis.

(7 Lectures)

Unit 4 An introduction to Analysis of Variance (ANOVA),its definition, assumptions and uses. One way classification and statistical analysis of the model involved in it.

(4 Lectures)

Text Books

Hogg, R. V. & Tanis, E. A. (2002): Probability and Statistical Inference Pearson Education, Asia.

Mood, A. M., Graybill, F. A. and Boes D. C (1999): Introduction to the theory of Statistics. McGraw –Hill, New York.

Additional Reference

Arora, P. N and Malhan, P. K (2001): Biostatistics, Himalaya Publishing House, New Delhi.

Goon, A. M., Gupta, M. K. and Das Gupta, B. (2006): Basic Statistics, World Publication, Kolkata.

STA O 309

Survival Analysis

2 Credits

Unit 1 Concepts of time, order and random censoring, Types of censoring, likelihood in these cases survival Functions and Hazard rates, Life time distributions – Exponential, Gamma, Weibull, Lognormal, Linear Failure rate, Parametric Inference (point estimation, confidence intervals, Scores, LR, MLE tests) for these distributions.

(8 Lectures)

Unit 2 Life tables, mean residential life and their elementary properties, Aging classes and their properties, Bathtub Failure jute, Estimation of survival function – Actuarial method, Product-limit (Kaplan – Meier) estimator, Hazard function estimator.

(8 Lectures)

Unit 3 Two sample problem : Gehan test, Log rank test, Mantel – Hazenszel test, Tarone-Ware class of tests, Efron test, K-sample problems : Generalized Gehion test, Generalized Mantel – Haewszel test, Introduction to regression for failure rate.

(8 Lectures)

Text Books :

Cox, D.R. and Oakes, D.(1984) Analysis of Survival Data, Chapman and Hall, New York.

Kalbfleisch, J.D. and Prentice R.L. (2002), The Statistical Analysis of Failure Time Data, John Wiley & Sons, New York.

Miller, R.G. (1981) : Survival Analysis, John Wiley & Sons, New York

Additional References :

Klein, J.P. (2003). Survival Analysis : Techniques for Censored and Truncated Data. Springer, Germany

Kleinbaum, D. and Klein, M. (2005). Survival Analysis : A Self-Learning Text, Springer, Germany.

Lawless, J.F. (1982). Statistical Models and Methods for Lifetime Data, John Wiley & Sons, New York.

Semester IV

STA C 401

Applied Multivariate Analysis

3 Credits

Unit 1 Multiple regression, multiple and partial correlation coefficients. MLEs of the parameters of multivariate normal distribution and their sampling distributions, Wishart distribution and its properties. Tests of hypothesis about the mean vector of a multinormal population, Hotelling's T^2 – statistic, its distribution and applications.

(12 Lecturers)

Unit 2 Classification and discrimination for two known populations : Bayes, Minimax and Likelihood Rati procedures. Mahalobis D^2 - Statistic and its application, Sample discriminant function and discrimination based on Fisher's method. Cluster Analysis and evaluation of clusters.

(12 Lecturers)

Unit 3 Introduction to principal component analysis, canonical correlation analysis, factor analysis. Methods and applications of MANOVA (without derivation of the distribution of Wilk's λ)

(12 Lecturers)

Text Book

Anderson, T.W. (1983). An Introduction to Multivariate Statistical Analysis, Wiley Eastern, New Delhi.

Johnson, R. and Wychern, D.W. (2002). Applied Multivariate Statistical Analysis, Pearson Education, Delhi.

Rao, C.R. (1995), Linear Statistical Inference, Wiley Eastern, New Delhi.

Sharma, S. (1996). Applied Multivariate Techniques. John Wiley, New York.

Singh, B.M. (2002). Multivariate Statistical Analysis, South Asian Publishers, New Delhi.

Additional References

Giri, N.C. (1977). Multivariate Statistical Inference. Academic Press, New York.

Kshirsagar, A.M. (1972). Multivariate Analysis, Marcel Dekker, New York.

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

Seber, G.A.F. (1984). Multivariate Observations, John Wiley, New York.

STA C 402

Time Series Analysis & Forecasting

2 Credits

Unit 1 Stationary time Series, Auto correlation and Partial auto correlation function, Correlogram analysis, Spectral properties of stationary models, periodogram analysis, spectral density function.

(8 lectures)

Unit 2 Exponential & moving average smoothing and forecasting, Detail study of stationary process: moving average, autoregressive, autoregressive moving average and autoregressive integrated moving average process, Box – Jenkins models

(8 Lectures)

Unit 3 Discussion (without proof) of estimation of mean, auto covariance and auto correlation function under large sample theory, choice of AR and MA periods, Estimation of ARIMA model parameters, forecasting with Box – Jenkins model, Residual analysis and diagnostic checking.

(8 lectures)

Text Books

Anderson, T.W. (1971). The Statistical Analysis of Time Series, John Wiley, New York.

Box, G.E.P., Jenkins, G.M. and Reinsel, G.C (2004). Time Series Analysis- Forecasting and Control, Pearson Education, Singapore.

Kendall, Sir Maurice and Ord, J.K. (1990), Time Series, Edward Arnold, London.

Additional References

Brokwel, P.J and Davis. R.A (1987). Time Series: Theory and Methods, Springer – Verlag, New York.

Fuller, W.A. (1976). Introduction to Statistical Time Series, John Wiley, New York.

Granger, C.W.J. and Newbold (1984). Forecasting Econometric Time Series, Academic Press, New York.

Montgomery, D.C. and Johnson, L.A. (1977)Forecasting and Time Series Analysis, McGraw Hill, New York.

Shumway , R. H. and Stoffer, David S. (2006) Time Series Analysis and Its Applications: With R Examples. Springer-Verlag.

STA C 403

Stochastic Processes

2 Credits

Unit 1 Introduction to stochastic processes (sp's).; classification of sp's according to state space and time domain. Countable state Markov chains (MC's), Chapman-Kolmogorov equations; calculation of n-step transition probability and its limit. Stationary distribution, classification of states; transient MC; random walk and gambler's ruin problem; Applications from social, biological and physical sciences.

(10Lectures)

Unit 2 Discrete state space continuous time MC: Kolmogorov- Feller differential equations; Poisson process, birth and death process; Applications to queues and storage problems. Introduction to Wiener process.

(8 Lectures)

Unit 3 Inference in Markov chains, estimation of transition probabilities, testing for order of a Markov chain, estimation of functions of transition probabilities, Parametric models and their goodness of fit.

(6 Lectures)

Text Books

Adke, S. R. and Manjunath, S. M. (1984): An Introduction to Finite Markov Processes, Wiley Eastern.

Minh, D.L. (2000) Applied Probability Models, Duxbury Press.

Prakasa Rao, B.L.S. and Bhat, B.R.(1996) Stochastic Processes and Statistical Inference, New Age International Publishers, New Delhi.

Ross, S.M. (2005): First Course in Probability, Pearson Academic,.

Ross, S.M. (2007): Introduction to Probability Models (IXth edition). Elsevier, USA.

Additional References

Basawa, I.V. and Prakasa Rao, B.L.S.(1980) Statistical Inference for Stochastic Processes, Academic Press, London.

Cinlar, E. (1975): Introduction to Stochastic Processes, Prentice Hall.

Feller, W. (1968): Introduction to Probability and its Applications, Vol.1, Wiley Eastern, New Delhi

Guttorp, P.(1995) Stochastic Modelling for Scientific Data, Springer.

Karlin, S. and Taylor, H. M. (1975): A First Course in Stochastic Processes, Vol.1, Academic Press.

Parzen, E. (1962): Stochastic Processes, Holden- Day. San – Francisco

STA C 404 (Prac)

Applied Multivariate Analysis

2 Credits

List of Practicals :

1. Multiple and partial correlation coefficients.
2. Generating random sample from multi normal population
3. Estimation of mean and dispersion matrix
4. Application of Hotelling's T^2 – statistic for single and two sample problems
5. Discrimination between two multivariate normal populations with unknown parameters and common dispersion matrix
6. Application of D^2 - Statistic
7. Extraction of clusters (hierarchical methods)
8. Extraction of principal components and summarization of sample variations
9. Canonical correlation analysis
10. Factor analysis
11. MANOVA (one way)

Text Books

Johnson, R. and Wychern, D.W. (2002). Applied Multivariate Statistical Analysis, Pearson Education, Delhi.

Seber, G.A.F. (1984). Multivariate Observations, John Wiley, New York.

STA C 405 (Prac)

Time Series Analysis and Forecasting

2 Credits

List of Practicals:

1. Correlogram Analysis and Interpretation
2. Periodogram Analysis and Interpretation
3. Smoothing and Forecasting
4. Forecasting with MA models
5. Forecasting with AR models
6. Forecasting with ARMA models
7. Forecasting with ARIMA models
8. Numerical exercises on Box – Jenkins model.
9. Residual Analysis
10. Diagnostic checking

Text Books

Anderson, T.W. (1971). The Statistical Analysis of Time Series, John Wiley, New York.

Box, G.E.P. and Jenkins, G.M. (1976). Time Series Analysis- Forecasting and Control, Holden-day, San Francisco.

Granger, C.W.J. and Newbold (1984). Forecasting Econometric Time Series, Academic Press, New York.

STA C 406 (Project)

Project Work

2 Credits

Guidelines for the project work:

1. A project work may be undertaken individually or by a group not exceeding 2 students. However the project report shall be submitted by each member of the group separately.
2. A project work shall be supervised by a faculty member assigned by the Department.
3. A project work shall be assessed on the basis of Project Report, Presentation and Viva.
4. There shall be a board of examiners consisting of external examiner and an internal examiner/s (preferably the supervisor) for evaluation of the project work.
5. A project work should encourage a student to be able to interact with the end user.
6. A project work should be chosen so that there is enough scope to apply and demonstrate the statistical techniques learnt during P.G. Program.
7. A project report shall clearly state the problem addressed, the methodology adopted, the assumptions and hypotheses formulated, any previous references to the study undertaken, statistical analyses performed and the broad conclusion drawn.

STA C 407

Operations Research

3 Credits

Unit 1 Definition and scope of operations research; phases in operations research, models and their solutions, decision-making under uncertainty and risk, use of different criteria

(4 Lectures)

Unit 2 Review of linear programming (LP) problems - duality theorem, transportation and assignment problems; sensitivity analysis; non-linear programming; Kuhn Tucker conditions, Wolfe's and Beale's algorithms for solving quadratic programming problems.

(12 Lectures)

Unit 3 Analytical structure of inventory problems; Economic order quantity (EOQ) formula of Harris, its sensitivity analysis and extension allowing quantity discounts and shortages. Multi-item inventory subject to constraints. P and Q- systems with constant and random lead items.

(10 Lectures)

Unit 4 Queueing models; specifications and effectiveness measures. Steady-state solutions of M/M/1 and M/M/c models with associated distributions of queue length and waiting time. M/G/1 queue and Pollazcek Khinchin result. Steady state solutions of M/Ek/1. Simulation.

(10 Lectures)

Text Books

Kanti, S., Gupta, P.K. and Singh, M.M. (1995). Operations Research, Sultan Chand & Sons, New Delhi.

Taha, H.A. (1982). Operational Research: An Introduction, Macmillan, New York.

Wagner, H.M. (1994). Principles of Operations Research, Prentice Hall of India, New Delhi.

Additional References

Hillier, F.S. and Leiberman, G.J. (1962). Introduction to Operations Research, Holden-day, San Francisco.

STA C 408 (Prac)

Operations Research

2 Credits

List of Practicals

1. Decision problems under uncertainty and risk.
2. Solving linear Programming Problem using graphical method.
3. Solving linear Programming Problem using simplex method.
4. Use of big – M method.
5. Use of two – phase method.
6. Solving Transportation problems.
7. Solving Assignment problems.
8. Use of Wolfe's method for solving Quadratic programming problem.
9. Deterministic Inventory problems.
10. Queueing models M/M/1 and M/M/c.

Text Books

Kanti, S., Gupta, P.K. and Singh, M.M. (1995). Operations Research, Sultan Chand & Sons, New Delhi.

Taha, H.A. (1982). Operational Research: An Introduction, Macmillan, New York.

STA C 409

Reliability Theory

3 Credits

Unit 1 Reliability concepts and measures; components and systems, coherent systems; reliability coherent systems, cuts and paths, modular decomposition, bounds and system reliability; structural and reliability importance components.

(10 Lectures)

Unit 2 Life distributions; reliability function, hazard rate, common life distributions; exponential, weibull, gamma etc. Estimation of parameters and tests in these models.

(6 Lectures)

Unit 3 Notions of ageing; increasing failure rate (IFR), increasing failure rate average (IFRA), not better than used (NBU), decreasing mean residual life (DMRL) and not better than used in expectation (NBUE). Classes and their duals; loss of memory property of the exponential distribution; closures of these classes under formation of coherent systems, convolutions and mixtures.

(10 Lectures)

Unit 4 Univariate shock models and the distributions arising out of them; bivariate shock models, common bivariate exponential distributions and their properties. Reliability estimation based on failure times in variously censored life tests and in tests with replacement of failed items; stress-strength reliability and its estimation.

(10 Lectures)

Text Books

Bain L.J. (1991) Statistical Analysis of Reliability and Life Testing Models, Marcel Dekker, New York.

Barlow R.E. and Proschan, F. (1985). Statistical Theory of Reliability and Life Testing, Holt Rinehart and Winston, New York.

Additional References

Lawless, J.F. (1982). Statistical Models and Methods of Life Time Data, John Wiley, New York.

Nelson, W. (1982). Applied Life Data Analysis, John Wiley, New York.

STA C 410 (Prac)

Reliability Theory

2 Credits

List of Practicals:

1. Hazard rate estimation for exponential and Gamma distribution (complete sample).
2. Hazard rate estimation for Weibull distribution (complete sample).
3. Hazard rate estimation for exponential and Gamma distribution (censored sample).
4. Hazard rate estimation for Weibull distribution (censored sample).
5. Estimation of Parameters of exponential and Gamma distribution (complete sample).
6. Estimation of Parameters of Weibull distribution (censored sample).
7. MLE and UMVE estimation of Reliability in different life distribution.
8. MLE and UMME estimation of hazard rate for different life distribution.
9. Reliability and Hazard rate estimation in Normal distribution
10. Testing of hypothesis about the reliability function and its confidence interval for exponential and gamma.
11. Testing of hypothesis about the reliability function and its confidence interval for Weibull distribution.

Text Books

Bain L.J. (1991) Statistical Analysis of Reliability and Life Testing Models, Marcel Dekker, New York.

Nelson, W. (1982). Applied Life Data Analysis, John Wiley, New York.

STA C 411

Statistical Ecology

3 Credits

Unit 1 Introduction to Ecology and evolution. Population dynamics: Single species – monomolecular, logistic and Gompertz models, Leslie matrix model for age and stage structured population.

(10 Lectures)

Unit 2 Survivorship curves – Constant, monotone and bathtub shaped hazard rates. Abundance estimation: nearest neighbour, line transect sampling, forest sampling with satellite remote sensing.

(10 Lectures)

Unit 3 Ecological Diversity: Species abundance curve, indices of diversity (Simpson's index, Shannon – Wiener index). Diversity as average rarity. Harvesting renewable biological resources – Maximum sustainable yield, Usher's approach. Forestry management – Faustmann model.

(10 Lectures)

Unit 4 Game theory in ecology – Evolutionarily stable strategy, its properties, simple games such as Hawk – Dove game. Foraging theory: Optimal foraging, diet choice, mean variance trade- off.

(6 Lectures)

Text Books

Clark, C.W. (1976). Mathematical Bioeconomics: Optimal Management of Renewal Resources, John Wiley, New York.

Gore, Anil and Paranjpe, S.A. (2000). A Course on Mathematical and Statistical Ecology, Kluwer, Norwell, USA.

Ludwig, John A. and Reynolds, James F. (1988). Statistical Ecology, John Wiley, New York.

Pielou, E.C. (1979). An Introduction to Mathematical Ecology, John Wiley, New York.

Smith, J. Maynard (1982). Evolution and the Theory of Games, Cambridge University Press, UK.

Additional References

Seber, G.A. F. (1982). Estimation of Animal Abundance and Related Parameters, Charles Griffin, London.

Stephens, D.W. and Krebs, J.R. (1986). Foraging Theory, Princeton University Press, New Jersey.

STA C 412 (Prac)

Statistical Ecology

2 Credits

List of Practicals :

1. Fitting of Growth models: Monomolecular, logistic and Gompertz
2. Population projection using Leslie matrix model
3. Fitting of survivorship curves: monotone and bathtub shaped hazard functions.
4. Abundance estimation
5. Computation of diversity indices: Simpson's, Shannon-Wiener
6. Linear programming approach for optimal harvesting
7. Harvesting under matrix model: Leslie and Usher's approach
8. Estimation of maximum sustainable yield
9. Application of Game theory: Hawk and Dove
10. Estimation of optimal foraging

Text Books

Gore, Anil and Paranjpe, S.A. (2000). A Course on Mathematical and Statistical Ecology, Kluwer, Norwell, USA

Ludwig, John A. and Reynolds, James F. (1988). Statistical Ecology, John Wiley, New York

Pielou, E.C. (1979). An Introduction to Mathematical Ecology, John Wiley, New York

STA C 413

Statistical Computing

3 credits

Unit 1 Introduction to object-oriented programming in C++, simple syntax, data types and operations, functions and parameters, classes, input/output, control statements, loops, pointers and arrays, libraries, linking to databases.

(6 Lectures)

Unit 2 Introduction to S-PLUS/R environment, basics of S language, objects and classes, connections, data manipulations, expressions/assignments, functions, control structures, array and matrix operations, graphics and their control.

(10 Lectures)

Unit 3 Writing programs in C++/S/R for: matrix computations, solutions of linear system of equations, computation of eigen values and eigen vectors, simple hypothesis tests, analysis of variance, linear regression, random number generation, simulation and Monte-Carlo technique.

(10 Lectures)

Unit 4 Exposure to statistical packages S-PLUS/R/SPSS/SYSTAT, analysis of interesting data sets using one or more of packages, graphics, descriptive statistics, representation of multivariate data, simple hypothesis tests, analysis of variance, linear and nonlinear regression, principal component, discriminant and cluster analysis, analyses of time series data.

(10 Lectures)

Text Books

Dalgaad, P.(2002). Introductory Statistics with R. Springer, New York.

Decker, R. and Hirshfield, S.(1998). The Object Concept: An Introduction to Computer Programming using C++. PWS Publishing.

Krause, A. and Olson, M.(2002). The Basics of S and S-PLUS. Third Edition. Springer, New York.

Lippmann, S.B. and Lajoie, J. and Moo, B. (2005). C++ Primer. 4th Edition, Pearson Education, Singapore.

Additional References

Venuables, W.N. and Ripley, B.D.(2002). Modern Applied Statistics with S. Fourth Edition. Springer, New York.

STA C 414 (Prac)

Statistical Computing

2 Credits

(Exploratory Data Analysis using the theoretical techniques taught in the core courses)

List of Practicals

1. Matrix Computations for data transformations
2. Solution of linear system of normal equations(linear statistical model)
3. Computation of eigen values and eigen vectors of dispersion/correlation/distance matrices
4. Testing of simple hypothesis
5. Random number generation and simulation
6. Graphical representation of multivariate data
7. Multiple linear regression analysis
8. Non-linear regression analysis
9. Principal component analysis
10. Linear discriminant analysis
11. Cluster analysis
12. Analysis of time series data
13. Analysis of data sets using packages

Text Books

Hand, D. J., Duly, F., McConway, K., Lumn, D. and Ostrowski, E. (1994). A Handbook of Small Data Sets, Chapman & Hall, London

Tukey, John (1977): Exploratory Data Analysis, Addison-Wesley, Boston

Venables, W.N. and Ripley, B.D. (2002). Modern Applied Statistics with S, Fourth Edition, Springer Science + Buisness Media, Inc., New York

STA C 415

Population Dynamics and Demography

3 Credits

Unit 1 Introduction to Population: Meaning of Population, Size, structure, distribution of population, the structure of demographic rates. Age-sex pyramids. Demographic data: Census, Registration system, Indian SRS, and surveys. NFSH- 1, 2. Evaluation of Quality of demographic data: Chandrasekaran-Deming formula, accuracy of data on sex and age: Whipple's, Myer's and UN indices.

(10 Lectures)

Unit 2 Mortality: concepts and rates, measures of infant mortality rate. Force of mortality. Mortality laws-Gompertz and Makeham. Life table and its construction: complete and abridged. Greville's, Reed-Merrel's and Chiang's methods

(10 Lectures)

Unit 3 Fertility and Reproduction: Period and cohort measures. P/F ratio and own children method. Reproductive measures. Nuptiality rates. Gross and net nuptiality tables. Internal and international Migration: concept and rates. Uses of place of birth and duration of residence data.

(6 Lectures)

Unit 4 Theory of stable population model (one sex), quasi and stationary population. Lotka's stable population model. The equations characterizing a stable population, the effect of changes in fertility and mortality on age structure, growth rates, birth rates and death rates. Momentum of population growth. Population projection: Mathematical curves viz., growth curves, modified exponential, logistic curves and its properties, and their fitting, component method and matrix method of population projection.

(10 Lectures)

Text Books:

Samuel H. Preston (2001). Demography: measuring and modeling population processes. Blackwell.

Shryock, H.S. (1976).The methods and Materials of Demography. Academic Press, New York.

Additional References:

International Institute of Population Sciences (1995). National Family Health Survey, 1992-93, Mumbai, IIPS.

International Institute of Population Sciences (2002). National Family Health Survey, 1998-99, Mumbai, IIPS

International Institute for Population Science (IIPS) and Macro International (2007). National Family Health Survey (NFHS – 3) 2005-06, Mumbai, IIPS

Keyfitz, N. and Caswell, H. (2005). Applied Mathematical Demography, Third Edition, Springer, New York.

Krishnan Namboodiri. (1996). A primer of Population Dynamics. Plenum.

Mishra, B.D (1995). An Introduction to The Study of Population. South Asian Publications, New Delhi.

Ram Kumar (1986).Technical Demography. Wiley Eastern, New Delhi.

STA C 416 (Prac)

Population Dynamics and Demography

2 Credits

List of Practical

1. Construction of age-sex Pyramid
2. Construction of Whipple's, Myer's and UN indices
3. Computation of mortality rates: CDR. ASDR, SDR
4. Fitting of Gompertz and Makheham curves
5. Construction of life tables: Complete and abridged
6. Computation of fertility rates: CBR, GFR, TFR, Child Woman Ratio
7. Computation of Reproduction rates: GRR and NRR
8. Estimation of Intrinsic growth rate
9. Population projections: Fitting of Modified Exponential and Logistic curves
10. Population projections: matrix method
11. Introduction and familiarity with statistical packages for analysis of population dynamics and demographic data

Text Books:

International Institute of Population Sciences (1995). National Family Health Survey, 1992-93, Mumbai, IIPS.

International Institute of Population Sciences (2002). National Family Health Survey, 1998-99, Mumbai, IIPS

International Institute for Population Science (IIPS) and Macro International (2007). National Family Health Survey (NFHS – 3) 2005-06, Mumbai, IIPS.

Srinivasan, K. (1998). Basic Demographic Techniques and Applications. Sage Publications, New Delhi.

STA C 417

Advanced Sample Survey

3 Credits

Unit 1 General notions of sampling designs and sampling schemes and their equivalence [statement only]; fixed effective sample size and variable effective sample size sampling designs; inclusion probabilities of first and second orders and their inter-relations for fixed effective sample size sampling designs; mean and variance of varying effective sample sizes and their relationship with the inclusion probabilities of first two orders; notion of design-unbiasedness; unbiased estimation of linear and quadratic functions of population quantities; unbiased estimation of a finite population total and finite population variance. Illustrative examples.

(10 Lectures)

Unit 2 Horvitz-Thompson Estimator [HTE] of a finite population total; expression for variance of the HTE for a general sampling design and its alternative expression for fixed effective sample size sampling designs; necessary and sufficient conditions on the sampling designs for existence of unbiased variance estimators and study of their non-negativity. Illustrative examples. Concept of a super-population; model-expectation and model-variance. Godambe's result on optimality of the HTE. Optimum allocation under super population model

(12 Lectures)

Unit 3 Stratified sampling, systematic sampling, cluster sampling and two-stage sampling designs viewed as special cases of general sampling designs; discussions on existence / non-existence of variance estimators for unbiased estimators of finite population totals; post-census survey methodologies [brief discussion only].

(8 Lectures)

Unit 4 Large-scale surveys conducted by various rounds of NSSO related to (i) agricultural production, (ii) industrial production, (iii) trade, (iv) services sectors, (v) socio-economic statistics, (vi) price statistics and (vii) national accounts statistics – with special reference to coverage and periodicity and responsible organizations.

(6 Lectures)

Text Books:

Chaudhuri, A. and Stenger, H. (1992): Survey Sampling, Theory and Methods, Marcel Dekker, Inc., New York.

Hedayat, A.S. and Sinha, B.K. (1991): Design and Inference in Finite Population Sampling., John Wiley and Sons, Inc.

Mukhopadhyay, P.(1998). Theory and Methods of Survey Sampling, Prentice Hall of India, New Delhi.

Murthy, M.N. (1967): Sampling Theory and Methods, Statistical Publishing Society, Collate.

Raj. D., and Chandhok, P. (1998): Sample Survey Theory, Narosa Publishing House, New Delhi.

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, New Delhi.

Additional References:

Central Statistical Organization, (2002): Statistical Abstracts, Ministry of Statistics and Program Implementation, Govt. of India, New Delhi.

Cassel, C.M. Sarndal, C.E., Wretman, J.H.(1977):Foundations of Inferences in Survey Sampling, John Wiley & Sons, New York, London.

Chaudhuri, A and Vos, J.W.E. (1988), Unified theory and strategies of survey sampling, North-Holland Publishers, Amsterdam.

Fowler, F.J., (2002): Survey Research Methods, Sage Publications, USA.

Lohr, S.L. (1999): Sampling: Design and Analysis, Duxbury Press, New York.

Pamela, L. Alreck & Robert B. Settle (2004): The Survey Research Handbook , Mc Graw-Hill Irwin. 3rd Edition, USA.

Rao, P.S.R.S.. (2000), Sampling Methodologies with Applications; Chapman & Hall, London, New York.

Thompson, M.E. (1997): Theory of Sample Surveys, Chapman& Hall, London.

STA C 418 (Prac)

Advanced Sample Survey

2 Credits

List of Practicals

1. Implementation of sampling designs / sampling schemes
2. Computations of first and second order inclusion probabilities
3. Computation of mean and variance of effective sample size
4. Computation of HTE and its variance estimate
5. Verification of non-negativity of variance estimate for HTE
6. Optimum allocation under super-population model
7. Familiarity with Statistical Abstract & its contents; practicals based on NSS rounds
8. Application of Post-Census methodologies
9. Estimation in Cluster Sampling (unequal cases)
10. Estimation in Two-stage sampling (unequal cases)
11. Introduction and familiarity with statistical packages for analysis of sample survey data

Text Books:

Mukhopadhyay, P. (1998). Theory and Methods of Survey Sampling, Prentice Hall of India, New Delhi.

Murthy, M.N. (1967): Sampling Theory and Methods, Statistical Publishing Society, Collate.

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, New Delhi.

Singh, D. and Chaudhury, F.S. (1986): Theory and Analysis of Sample Survey Designs, New Age International Publishers, New Delhi.

DEPARTMENT OF STATISTICS
TIME TABLE FOR SEMESTER II
2009

Time / Day	9.30-10.30	10.45-11.45	12.00-13.00	13.00-13.30	13.30 – 14.30	14.30 – 16.30
Monday	STA O 206 (SKJ)	STA O 207 (GD)	STA C 202 (SKJ)	B	STA C 201 (BKG)	STA C 204 (BKG)
Tuesday	STA O 208 (SKJ)	STA O 207 (GD)	STA C 201 (BKG)	R	STA C 202 (SKJ)	STA C 205 (SKJ)
Wednesday	STA O 206 (SKJ)	To be decided	STA C 202 (SKJ)	E	STA C 205 (GD)	STA C 205 (GD)
Thursday	To be decided	STA O 208 (SKJ)	STA C 203 (GD)	A	STA C 204 (BKG)	STA C 204 (BKG)
Friday	STA C 201 (BKG)	STA C 203 (GD)	STA C 202 (SKJ)	K	STA C 203 (GD)	Library

STA C – 201 : Sample Surveys.
STA C – 202 : Statistical Inference-I.
STA C – 203 : Linear Models and Regression Analysis.
STA C – 204 (Prac) : Sample surveys.
STA C – 205 (Prac) : Statistical Inference-I & Regression Analysis
STA O 206 : Introduction to Probability Theory and Distributions
STA O 207 : Introduction to Sample Survey
STA O 208 : Linear Programming

GD : Prof. G. Das
BKG : Mr. B. K. Gupt.
SKJ : Dr. S. K. Jha.

CLASSES WILL COMMENCE FROM 19.02.2009

(Dr. T. K Chakrabarty)
Head, Department of Statistics
NEHU, Shillong.