M. Sc. PROGRAMME IN STATISTICS

TWO-YEAR FULL-TIME PROGRAMME
SEMESTERS I to IV

SCHEME OF EXAMINATION AND COURSE CONTENTS

Department of Statistics
School of Physical and Mathematical Sciences

CENTRAL UNIVERSITY OF HARYANA
MAHENDERGARH

2013

M. Sc. STATISTICS SCHEME OF EXAMINATION

First Year: Semester I			**Credits**
Core Courses & Codes			
Course	SPMSTA01101C2103	Analysis	3
Course	SPMSTA01102C2103	Probability Theory	3
Course	SPMSTA01103C2103	Statistical Methods	3
Course	SPMSTA01104C2103	Survey Sampling	3
Course	SPMSTA01105C2103	Practical-I comprising the following two parts: Part A: Statistical Computing-I Part B: Data Analysis-I (based on papers 103 and 104)	3
Elective Course			
Course	SPMSTA01101E2103	Linear Programming	3
Course	SPMSTA01102E2103	Operations Research	3
An elective from outside the Department			

First Year: Semester II			**Credits**
Core Courses			
Course	SPMSTA01201C2103	Linear Algebra	3
Course	SPMSTA01202C2103	Stochastic Processes	3
Course	SPMSTA01203C2103	Statistical Inference-I	3
Course	SPMSTA01204C2103	Design of Experiments	3
Course	SPMSTA01205C2103	Practical-II comprising the following two parts: Part A: Statistical Computing-II Part B: Data Analysis-II (based on papers 203 and 204)	3
Elective Course			
Course	SPMSTA01201E2103	Bio Statistics	3
Course	SPMSTA01202E2103	Game Theory and Non linear Programming	3
An elective from outside the Department			

Second Year: Semester III			Credits
Core Courses			
Course	SPMSTA01301C2103	Statistical Inference-II	3
Course	SPMSTA01302C2103	Multivariate Analysis	3
Course	SPMSTA01303C2103	Generalized Linear Models	3
Course	SPMSTA01304C2103	Bayesian Inference	3
Course	SPMSTA01305C2103	Practical-III comprising the following two parts: Part A: Problem Solving Using C Language-I (based on papers 301, 302 and 303) Part B: Problem Solving Using SPSS-I (based on papers 301, 302 and 303)	3
Elective Course			
Course	SPMSTA01301E2103	Non Parametric Inference	3
Course	SPMSTA01302E2103	Actuarial Statistics	3
An elective from outside the Department			3

Second Year: Semester IV			Credits
Core Courses			
Course	SPMSTA01401C2103	Econometrics and Time Series Analysis	4
Course	SPMSTA01402C2103	Demography, Statistical Quality Control and Reliability	4
Elective Course			
Course	SPMSTA01401E2103	Applied Stochastic Processes	3
Course	SPMSTA01402E2103	Order Statistics	3
Course	SPMSTA01403E2103	Information Theory	3
Course	SPMSTA01404E2103	Statistical Ecology	3
Course	SPMSTA01405E2103	Statistical Method in Epidemiology	3
An elective from outside the Department			3
Paper	SPMSTA01403C2103	Practical-IV comprising the following two parts: Part A: Problem Solving Using C Language-II (based on papers 401 and 402) Part B: Problem Solving Using SPSS-II (based on papers 401 and 402)	3

M. Sc. STATISTICS

Semester I: Examination 2013 and onwards

Course 101: Analysis

Monotone functions and functions of bounded variation. Absolute continuity of functions, standard properties. Uniform convergence of sequence of functions and series of functions. Cauchy's criterion and Weirstrass M-test. Conditions for term wise differentiation and term wise integration (statements only), Power series and radius of convergence.

Multiple integrals and their evaluation by repeated integration. Change of variable in multiple integration. Beta and gamma functions. Differentiation under integral sign. Leibnitz rule. Dirichlet integral, Liouville's extension.

Maxima-minima of functions of several variables, Constrained maxima-minima of functions.

Analytic function, Cauchy-Riemann equations. Cauchy theorem and Cauchy integral formula with applications, Taylor's series. Singularities, Laurent series. Residue and contour integration.

Fourier and Laplace transforms and their basic properties.

References:

1. Apostol, T.M. (1975). Mathematical Analysis, Addison- Wesley.
2. Bartle, R.G. (1976). Elements of Real Analysis, John Wiley & Sons.
3. Berbarian, S.K. (1998). Fundamentals of Real Analysis, Springer-Verlag.
4. Conway, J.B. (1978). Functions of one Complex Variable, Springer-Verlag.
5. Priestley, H.A. (1985). Complex Analysis, Clarenton Press Oxford.
6. Rudin, W. (1985). Principles of Mathematical Analysis, McGraw Hill.

Course 102: Probability Theory

Classes of sets, field, sigma field, minimal sigma field, Borel field, sequence of sets, limits of a sequence of sets, measure, probability measure, Integration with respect to measure.

Various definitions of Probability, Properties of probability function, Baye's Theorem, Independence of Events.

Random Variables and Distribution Functions, Two Dimensional Random Variables- Joint, Marginal and Conditional Distributions. Moments of Random Variables – Expectation, Variance, Covariance, Conditional and Marginal Expectation.

Probability Generating Function, Moment Generating Function and their Properties. Characteristic function, uniqueness theorem, continuity theorem, inversion formula.

Markov's, Holder's, Minkowski's and Jensen's inequalities.

Modes of Convergence: convergence in probability, almost surely, in the r^{th} mean and in distribution, their relationships.

Laws of large numbers, Chebyshev's and Khintchine's WLLN, necessary and sufficient condition for the WLLN, Kolmogorov's Strong law of large numbers and Kolmogorov's theorem.

Central limit theorem, Lindberg- Levy's and Liapunov forms of CLT. Statement of Lindberg-Feller's CLT and examples.

References:

1. Ash, Robert B. (2000). Probability and Measure Theory, Second Edition, Academic Press, New York.
2. Bhat, B.R. (1999). Modern Probability Theory, 3rd Edition, New Age International Publishers.
3. Billingsley, P. (1986). Probability and Measure, 2nd Edition, John Wiley & Sons.
4. Capinski, M. and Zastawniah (2001). Probability through problems, Springer.
5. Chung, K. L. (1974). A Course in Probability Theory, 2nd Edition, Academic Press, New York.
6. Feller, W. (1968). An Introduction to Probability Theory and its Applications, 3rd Edition, Vol. 1, John Wiley & Sons.
7. Goon, A.M., Gupta, M.K. and Dasgupta. B. (1985). An Outline of Statstical Theory, Vol. I, World Press.
8. Halmos, P.R. Measure Theory
9. Loeve, M. (1978). Probability Theory, 4th Edition, Springer-Verlag.
10. Rohatgi, V. K. and Saleh, A.K. Md. E. (2005). An Introduction to Probability and Statistics, Second Edn., John Wiley.

Course 103: Statistical Methods

Probability distributions: Binomial, Poisson, Multinomial, Hypergeometric, Geometric. Negative Binomial, Uniform, Exponential, Laplace, Cauchy, Beta, Gamma, Weibull and Normal (Univariate and bivariate) and Lognormal distributions.

Sampling distribution of Mean and Variance, Chi-square, Student's t, Snedecor's F and Fisher's-Z distribution and their applications. Chi-square test, Student's t- test and F test. Sample size determination for testing and estimation procedures. Non-central Chi-square, t and F distributions and their properties.

Order statistics - their distributions and properties. Joint and marginal distributions of order statistics. Extreme values and their asymptotic distributions (statement only) with applications. Tolerance intervals, coverage of $(X_{(r)}, X_{(s)})$.

Correlation: Product moment, Spearman's Rank and Intra-class Correlation, Correlation Ratio General theory of regression, multiple regression, Partial and Multiple Correlations.

References:

1. Arnold, B.C., Balakrishnan, N., and Nagaraja, H.N. (1992). A First Course in Order Statistics, John Wiley & Sons.
2. David, H.A., and Nagaraja, H.N. (2003). Order Statistics, Third Edition, John Wiley and Sons.
3. Dudewicz, E.J. and Mishra, S.N. (1988). Modern Mathematical Statistics, Wiley, International Students' Edition.
4. Johnson, N.L., Kotz, S. and Balakrishnan, N. (2000). Discrete Univariate Distributions, John Wiley.
5. Johnson, N.L., Kotz, S. and Balakrishnan, N. (2000). Continuous Univariate Distributions, John Wiley.
6. Rao, C.R. (1973). Linear Statistical Inference and Its Applications (Second Edition), John Wiley and Sons.
7. Rohatgi, V.K. (1984). Statistical Inference, John Wiley and Sons.
8. Rohatgi, V.K. and Saleh, A. K. Md. E. (2005). An Introduction to Probability and Statistics, Second Edition, John Wiley and Sons.

Course 104: Survey Sampling

Basic ideas and distinctive features of sampling; Probability sampling designs, sampling schemes, inclusion probabilities and estimation; Review of important results in simple and stratified random sampling

Sampling with varying probabilities (unequal probability sampling): PPSWR /WOR methods and related estimators of a finite population total or mean (Hansen – Hurwitz and Des Raj estimators for a general sample size and Murthy's estimator for a sample of size 2). Horvitz – Thompson Estimator (HTE) of a finite population total /mean. Non-negative variance estimation.
Ratio and Regression Estimators, Unbiased ratio type estimate due to Hartley and Ross, Ratio Estimate in stratified sampling.

Double (two-phase) sampling with special reference to the selection with unequal probabilities in at least one of the phases; Double sampling ratio and regression estimators of population mean.systematic sampling and its application to structured populations; Cluster sampling (with varying sizes of clusters); Two-stage sampling (with varying sizes of first-stage units).

Non-sampling error with special reference to non-response problems. Small Area Estimation. Super–population Models. Non-Existence Theorems and Optimality of Sampling Strategies in finite population sampling.

References:

1. Chaudhuri, A. (2010). Essentials of Survey Sampling. Prentice Hall of India.
2. Chaudhari, A. and Vos, J.W.E. (1988). Unified Theory and Strategies of Survey Sampling , North –Holland, Amsterdam.
3. Chaudhari, A. and Stenger, H. (2005). Survey Sampling Theory and methods, 2^{nd} Edn., Chapman and Hall.
4. Cochran, W.G. (1977). Sampling Techniques, John Wiley & Sons, New York

5. Hedayat, A.S., and Sinha, B.K. (1991). Design and Inference in Finite Population Sampling, Wiley, New York.
6. Levy, P.S. and Lemeshow, S. (2008). Sampling of Populations-Methods and Applications, Wiley.
7. Mukhopadhyay, Parimal (1997). Theory and Methods of Survey Sampling, Prentice Hall of India, New Delhi.
8. Murthy, M.N. (1967). Sampling Theory and Methods, Statistical Publishing Society, Calcutta.
9. Raj, D. and Chandhok, P. (1998). Sample Survey Theory. Narosa Publishing House.
10. Sukhatme, P.V., Sukhatme, B.V., Sukhatme, S. and Asok, C. (1984). Sampling Theory of Surveys with Applications, Iowa State University Press, Iowa, USA.
11. Thompson, Steven K. (2002). Sampling, John Wiley and Sons, New York.

Paper 105: Practical-I

Part-A: Statistical Computing I

Programming in C; Representation of numbers, Errors. Bitwise operators, Manipulations, Operators, Fields. The C Preprocessor, Macros, Conditional Compilation, Command-line Arguments.

Stacks and their implementation; Infix, Postfix and Prefix notations. Queues, Link list, Dynamic Storage Management. Trees– Binary trees, representations, traversal, operations and Applications. Graphs– Introduction, representation. Sorting– Introduction, bubble sort, selection sort, insertion sort, quick sort including analysis.

Random numbers: Pseudo-Random number generation, tests. Generation of non-uniform random deviates– general methods, generation from specific distributions.

References:

1. Gottfried, Byron S. (1998). Programming with C, Tata McGraw Hill Publishing Co.Ltd., New Delhi.
2. Kernighan, Brain W. and Ritchie, Dennis M. (1989). The C Programming Language, Prentice Hall of India Pvt.Ltd., New Delhi.
3. Knuth, Donald E. (2002). The Art of Computer Programming, Vol. 2/Seminumerical Algorithms, Pearson Education (Asia).
4. Rubinstein, R.Y. (1981). Simulation and the Monte Carlo Method, John Wiley & Sons.
5. Tenenbaum, Aaron M., Langsam, Yedidyah, and Augenstein, Moshe J. (2004). Data Structures using C, Pearson Education, Delhi, India.

Part B: Data Analysis-I

Computer-based data analysis of problems from the following areas:
Statistical Methodology and Survey Sampling.

Elective Course 101: Linear Programming

Convex sets and functions with their properties. Programming problems. General linear programming problems: Formulation and their properties of solutions. Various forms of a LPP. Generation of extreme point solution. Development of minimum feasible solution. solution of LPP by graphical and simplex methods. Solution of simultaneous equations by simplex method.

Solution of LPP by artificial variable techniques: Big-M-method and Two Phase simplex method. Problem of degeneracy in LPP and its resolution. Revised simplex method and Bounded Variable Technique.

Duality in Linear Programming: Symmetric and Un-Symmetric dual Problems. Economic Interpretation of Primal and Dual Problems. Fundamental Duality Theorem. Dual simplex method. Complementary Slackness Theorem.

Sensitivity Analysis. Parametric linear programming. Integer linear programming: Gomory's cutting plane method, Branch and Bound method. Applications of Integer Programming.

Transportation Problems: balanced and unbalanced. Initial basic feasible solution of transportation problems by North West Corner Rule, Lowest Cost Entry Method and Vogel's Approximation Method. Optimal Solution of Transportation Problems.

Assignment problems and their solution by Hungarian assignment method. Reduction Theorem. Unbalanced assignment problem. Sensitivity in assignment problems.

Books Suggested:-

1.	Gass, S.I.	:	Linear Programming
2.	Kambo, N.S	:	Mathematical Programming
3.	Sharma, S.D.	:	Operations Research
4.	Hadley. G.	:	Linear Programming

Elective Course 102: Operations Research

Definition and scope of Operation Research, phases in Operation Research, different types of models, their construction and general methods of solution.

Replacement problem, replacement of items that Deteriorate, replacement of items that fails completely Individual Replacement policy : Motility theorems, Group replacement policy, Recruitment and promotion problems.

Inventory Management**:** Characteristics of inventory systems. Classification of items. Deterministic inventory systems with and without lead-time. All units and incremental discounts. Single period stochastic models.

Job Sequencing Problems; Introduction and assumption, Processing of n jobs through two machines(Johnson's Algorithm) Processing of n jobs through three machines and m machines, Processing two jobs through n machines(Graphical Method)

Simulation**:** Pseudorandom Number Generation, using random numbers to evaluate integrals. Generating discrete random variables: Inverse Transform Method, Acceptance-Rejection Technique, Composition Approach. Generating continuous random variables: Inverse Transform Algorithm, Rejection Method. Generating a Poisson process.

Theory of Network – PERT/CPM: development, uses and application of PERT/CPM Techniques, Network diagram representation .Fulkerson 1-J rule for labeling Time estimate and determination of critical Path on network analysis, PERT techniques, crashing.

Introduction to Decision Analysis: Pay-off table for one-off decisions and discussion of decision criteria, Decision trees.

References:

1. Churchman Method's of Operations Research
2. Hadley, G. and Whitin, T.M. (1963). Analysis of Inventory Systems, Prentice Hall.
3. Hillier, F.S. and Lieberman, G.J. (2001). Introduction to Operations Research, Seventh Edition, Irwin.
4. Ross, S. M. (2006). Simulation, Fourth Edition, Academic Press.
5. Taha, H. A. (2006). Operations Research: An Introduction, Eighth Edition, Prentice Hall.
6. Wagner, B.M. (1975). Principles of OR, Englewood Cliffs, N.J. Prentice-Hall
7. Waters, Donald and Waters, C.D.J. (2003). Inventory Control and Management, John Wiley & Sons.

Semester II: Examination 2014 and onwards

Course 201: Linear Algebra

Examples of vector spaces, vector spaces and subspace, independence in vector spaces, existence of a Basis, the row and column spaces of a matrix, sum and intersection of subspaces.

Linear Transformations and Matrices, Kernel, Image, and Isomorphism, change of bases, Similarity, Rank and Nullity.

Inner Product spaces, orthonormal sets and the Gram-Schmidt Process, the Method of Least Squares.

Basic theory of Eigenvectors and Eigenvalues, algebraic and geometric multiplicity of eigen value, diagonalization of matrices, application to system of linear differential equations.

Jordan canonical form, vector and matrix decomposition.

Generalized Inverses of matrices, Moore-Penrose generalized inverse.

Real quadratic forms, reduction and classification of quadratic forms, index and signature, triangular reduction of a reduction of a pair of forms, singular value decomposition, extrema of quadratic forms.

References:

1. Biswas, S. (1997). A Text Book of Matrix Algebra, 2nd Edition, New Age International Publishers.
2. Golub, G.H. and Van Loan, C.F. (1989). Matrix Computations, 2nd edition, John Hopkins University Press, Baltimore-London.
3. Nashed, M. (1976). Generalized Inverses and Applications, Academic Press, New York.
4. Rao, C.R. (1973). Linear Statistical Inferences and its Applications, 2nd edition, John Wiley and Sons.
5. Robinson, D.J.S. (1991). A Course in Linear Algebra with Applications, World Scientific, Singapore.
6. Searle, S.R. (1982). Matrix Algebra useful for Statistics, John Wiley and Sons.
7. Strang, G. (1980). Linear Algebra and its Application, 2nd edition, Academic Press, London-New York.

Course 202: Stochastic Processes

Poisson process, Brownian motion process, Two-valued processes. Model for system reliability.

Mean value function and covariance kernel of the Wiener and Poisson processes. Increment process of a Poisson process, Stationary and evolutionary processes.

Compound distributions, Total progeny in branching processes.

Recurrent events, Delayed recurrent events, Renewal processes. Distribution and Asymptotic Distribution of Renewal Processes. Stopping time. Wald's equation. Elementary Renewal Theorem. Delayed and Equilibrium Renewal Processes. Application to the theory of success runs. More general patterns for recurrent events.

One-dimensional, and two-dimensional random walks. Duality in random walk. Gambler's ruin problem.

Classification of Markov chains. Higher transition probabilities in Markov classification of states and chains. Limit theorems. Irreducible ergodic chain.

Martingales, Martingale convergence theorems, Optional stopping theorem.

References:

1. Bhat, B.R. (2000). Stochastic Models- Analysis and Applications, New Age International Publishers.
2 Feller, William (1968). An Introduction to Probability Theory and its Applications, Vol. 1 (Third Ed.), John Wiley.
3. Hoel, P.G., Port, S.C. and Stone C.J. (1972). Introduction to Stochastic Processes, Houghton Miffin & Co.
4. Karlin, S. and Taylor, H.M. (1975). A first course in Stochastic Processes, Second Ed. Academic Press
5. Medhi, J. (1994). Stochastic Processes, 2nd Edition, Wiley Eastern Ltd.
6. Parzen, Emanuel (1962). Stochastic Processes, Holden-Day Inc.
7. Prabhu, N.U. (2007). Stochastic Processes: Basic Theory and its Applications, World Scientific.
8. Ross, Sheldon M. (1983). Stochastic Processes, John Wiley and Sons, Inc.
9. Takacs, Lajos (1967). Combinatorial Methods in the Theory of Stochastic Processes, John Wiley and Sons, Inc.
10. Williams, D. (1991). Probability with Martingales, Cambridge University Press.

Course 203: Statistical Inference –I

Criteria of a good estimator – unbiasedness, consistency, efficiency and sufficiency, Minimal sufficiency and ancillarity, Invariance property of Sufficiency under one-one transformations of sample and parameter spaces. Exponential and Pitman family of distributions.

Minimum – variance unbiased estimators, Cramer-Rao lower bound approach to MVUE.

Lower bounds to variance of estimators, necessary and sufficient conditions for MVUE. Complete statistics, Rao Blackwell theorem. Lehman Schefe's theorem and it's applications in finding UMVB estimators, Cramer- Rao, Bhattacharya's Bounds. Fisher Information for one and several parameters models.

Method of estimation- Method of Maximum Likelihood and its properties, Methods of Moments and its properties, Method of Least Square and its properties. Method of minimum chi- square and modified minimum chi- square.

Neyman-Pearson fundamental lemma and its applications, MP and UMP tests. Non-existence of UMP tests for simple null against two-sided alternatives in one parameter exponential family. Families of distributions with monotone likelihood ratio and UMP tests.

Interval estimation, confidence level, construction of shortest expected length confidence interval, Uniformly most accurate one-sided confidence Interval and its relation to UMP tests for one-sided null against one-sided alternative hypotheses.

References:

1. Goon, A.M., M.K.Gupta, & B. Das Gupta(2002): Outline of Statistical Theory Vol-II World Press.
2. Kale, B.K. (1999). A First Course on Parametric Inference, Narosa Publishing House.
3. Lehmann, E.L. (1986). Theory of Point Estimation, John Wiley & Sons.
4. Lehmann, E.L. (1986). Testing Statistical Hypotheses, John Wiley & Sons.
5. Rao, C.R. (1973). Linear Statistical Inference and Its Applications, Second Edition, Wiley
   a. Eastern Ltd., New Delhi.
6. Rohatgi, V.K. and Saleh, A.K. Md. E. (2005). An Introduction to Probability and Statistics, Second Edition, John Wiley.
7. Zacks, S. (1971). Theory of Statistical Inference, John Wiley & Sons.

Course 204: Design of Experiments

Review of linear estimation and basic designs. ANOVA: Fixed effect models (2-way classification with unequal and proportional number of observations per cell), Random and Mixed effect models (2-way classification with m (>1) observations per cell). Tukey's test for non- additivity.

General theory of Analysis of experimental designs; Completely randomized design, randomized block design and latin square designs, Missing plot techniques in RBD and LSD.

Symmetrical factorial experiments (s^m, where s is a prime or a prime power), Confounding in s^m factorial experiments, s^{k-p} fractional factorial where s is a prime or a prime power. Analysis of covariance for CRD and RBD. Split plot and strip plot designs.

Incomplete Block Designs. Concepts of Connectedness, Orthogonality and Balance. Intrablock analysis of General Incomplete Block design. B.I.B designs with and without recovery of interblock information. PBIB Designs.

References:

1. Chakrabarti, M.C. (1962). Mathematics of Design and Analysis of Experiments, Asia Publishing House, Bombay.
2. Das, M.N. and Giri, N.C. (1986). Design and Analysis of Experiments, Wiley Eastern

Limited.

3. Dean, A. and Voss, D. (1999). Design and Analysis of Experiments, Springer. First Indian Reprint 2006.
4. Dey, A. (1986). Theory of Block Designs, John Wiley & Sons.
5. Hinkelmann, K. and Kempthorne, O. (2005). Design and Analysis of Experiments, Vol. 2: Advanced Experimental Design, John Wiley & Sons.
6. John, P.W.M. (1971). Statistical Design and Analysis of Experiments, Macmillan Co., New York.
7. Kshirsagar, A.M. (1983). A Course in Linear Models, Marcel Dekker, Inc., N.Y.
8. Montgomery, D.C. (2005). Design and Analysis of Experiments, Sixth Edition, John Wiley & Sons.
9. Raghavarao, D. (1970). Construction and Combinatorial Problems in Design of Experiments, John Wiley & Sons.

Paper 205: Practical-II Part A: Statistical Computing-II

Mathematical and Statistical problem solving using software package: Introduction, Plots in 2-D and 3-D. Numerical Methods: Vector and matrix operations, Interpolation. Numerical root finding, Matrix factorization. Eigenvalue and eigenvectors, Differentiation, Integration.

Generation of discrete and continuous random variables, Histograms and quantile-based plots. Parameter estimation– MLE, method of moments. Monte Carlo methods– Introduction, for Statistical inference, Bootstrap methods. Regression and curve fitting.

References:

1. Gentle, J.E., Härdle W. and Mori Y., (2004). Handbook of computational statistics — Concepts and methods, Springer-Verlag.
2. Knuth, Donald E. (2002). The Art of Computer Programming, Vol. 2/Seminumerical Algorithms, Pearson Education (Asia).
3. Monahan, J.M. (2001). Numerical Methods in Statistics, Cambridge.
4. Ross, S.M. (2002). Simulation, Academic press.
5. Rubinstein, R.Y. (1981). Simulation and the Monte Carlo Method, John Wiley & Sons.

Part B: Data Analysis-II

Computer-based data analysis of problems from the following areas:
Statistical Inference-I and Design of Experiments.

Elective Course 201 Bio-Statistics

Functions of survival time, survival distributions and their applications viz. exponential, gamma, weibull, Rayleigh, lognormal, death density function for a distribution having bath-tub shape hazard function. Tests of goodness of fit for survival distributions (WE test for exponential distribution, W-test for lognormal distribution, Chi-square test for uncensored observations). Parametric methods for comparing two survival distributions viz. L.R test, Cox's F-test.

Analysis of epidemiologic and clinical data: Studying association between a disease and a characteristic (a) Types of studies in epidemiology and clinical research (i) Prospective study (ii) Retrospective study (iii) cross sectional data, (b) Dichotomous response and Dichotomous risk factor: 2X 2 Tables (c) Expressing relationship between a risk factor and a disease (d) Inference for relative risk and Odd's Ratio for 2X2 table , Sensitivity Specificity and Predictivities, Cox Proportional Hazard Model, Type I, Type II and progressive or random censoring with biological examples, Estimation of mean survival time and variance of the estimator for type I and type II censored data with numerical examples. Competing risk theory, Indices for measurement of probability of death under competing risks and their inter-relations. Estimation of probabilities of death under competing risks by maximum likelihood and modified minimum Chi-square methods. Theory of independent and dependent risks. Bivariate normal dependent risk model. Conditional death density functions.

Stochastic epidemic models: Simple and general epidemic models (by use of random variable technique).

Planning and design of clinical trials, Phase I, II, and III trials. Consideration in planning a clinical trial, designs for comparative trials, Sample size determination in fixed sample designs.

References:

1. Biswas, S. (1995): Applied Stochastic Processes. A Biostatistical and Population Oriented Approach, Wiley Eastern Ltd.

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

3. Elandt, R.C. and Johnson (1975): Probability Models and Statistical Methods in Genetics, John Wiley & Sons.

4. Ewens, W. J. (1979) : Mathematics of Population Genetics, Springer Verlag.

5. Ewens, W. J. and Grant, G.R. (2001): Statistical methods in Bio informatics.: An Introduction, Springer.

6. Friedman, L.M., Furburg, C. and DeMets, D.L. (1998): Fundamentals of Clinical Trials, Springer Verlag.

7. Gross, A. J. And Clark V.A. (1975) : Survival Distribution; Reliability Applications in Biomedical Sciences, John Wiley & Sons.

8. Lee, Elisa, T. (1992) : Statistical Methods for Survival Data Analysis, John Wiley & Sons.

9. Li, C.C. (1976): First Course of Population Genetics, Boxwood Press.

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

Elective Course 202 Game Theory and Non-Linear Programming

Theory of Games: Characteristics of games, minimax (maximin) criterion and Optimal Strategy. Solution of games with saddle point. Equivalence of rectangular game and Liner Programming. Fundamental Theorem of Game Theory. Solution of mxn games by Linear Programming Method. Solution of 2X2 games without saddle point. Principle of dominance. Graphical solution of (2xn) and (mx2) games.

Non-Linear Programming Problems (NLPP): Kuhn-Tucker necessary and sufficient conditions of optimality, Saddle points. Formulation of NLPP and its Graphical Solution.

Quadratic Programming: Wolfe's and Beale's Method of solutions. Separable programming and its reduction to LPP. Separable programming algorithm. Geometric Programming: Constrained and unconstrained. Complementary geometric programming problems.

Fractional programming and its computational procedure. Dynamic programming: Balman's principle of optimality. Application of dynamic programming in production, Linear programming and Reliability problems. Goal Programming and its formulation .Stochastic programming.

Books Suggested:-

1. Kambo, N.S. : Mathematical Programming.
2. Bellman, R. : Dynamic Programming (Princeton University Press, Princeton N.J. (1957)
3. Bellman, R. And Dreyfus, S. : Applied Dynamic Programming (Princeton University Press, Princeton, N.J. 1963)
4. Sharma, S.D. : Operations Research.

Semester III: Examination 2014 and onwards

Course 301: Statistical Inference-II

Consistency and asymptotic relative efficiency of estimators. Consistent asymptotic normal (CAN) estimator. CAN estimator for one parameter Cramer family, Cramer-Huzurbazar theorem. Solutions of likelihood equations, Fisher lower bound to asymptotic variance. MLE in Pitman family and double exponential distribution.

Similar tests, Neyman structure, UMPU tests for composite hypotheses, Invariance tests and UMP invariant tests, Likelihood ratio test, Asymptotic distribution of LRT statistic, Consistency of large sample test, Asymptotic power of large sample test.

Sequential tests-SPRT and its properties, Wald's fundamental identity, OC and ASN functions. Sequential estimation.

Non- parametric methods-estimation and confidence interval, U-statistics and their asymptotic properties, UMVU estimator, non parametric tests-single sample location, location-cum-symmetry, randomness and goodness of fit problems; Rank order statistics, Linear rank statistics, Asymptotic relative efficiency.

References:

1. Gibbons, J.D. and Chakraborti, S. (1992). Nonparametric Statistical Inference, Marcel Dekker.
2. Kale, B.K. (1999). A First Course on Parametric Inference, Narosa Publishing House.
3. Lehmann, E.L. (1986). Theory of Point Estimation, John Wiley & Sons.
4. Lehmann, E.L. (1986). Testing Statistical Hypotheses, John Wiley & Sons.
5. Randles, R.H. and Wolfe, D.S. (1979). Introduction to the Theory of Non-parametric Statistics, John Wiley & Sons.
6. Rao, C.R. (1973). Linear Statistical Inference and Its Applications, Second Ed., Wiley Eastern Ltd.,
7. Rohatgi, V.K. and Saleh, A.K. Md.E. (2005). An Introduction to Probability and Statistics, Second Edition, John Wiley.
8. Sinha, S. K. (1986). Probability and Life Testing, Wiley Eastern Ltd.
9. Zacks, S. (1971). Theory of Statistical Inference, John Wiley & Sons.

Course 302: Multivariate Analysis

Multivariate normal distribution, its properties and characterization. Random sampling from a multivariate normal distribution. Maximum likelihood estimators of parameters. Distribution of sample mean vector. Inference concerning the mean vector when the covariance matrix is known. Matrix normal distribution. Multivariate central limit theorem.

Wishart matrix. its distribution and properties. Distribution of sample generalized variance. Hotelling's T^2 statistic its distribution and properties. Applications in tests on mean vector one and more multivariate normal populations and also on symmetry of organs. Mahalanobis' D^2.

Likelihood ratio test criteria for testing (1) independence of sets of variables, (2) equality of covariance matrices, (3) identity of several multivariate normal populations, (4) equality of a covariance matrix to a given matrix, (5) equality of a mean vector and a covariance matrix to a given vector and a given matrix.

Multivariate linear regression: model estimation of parameters and their properties, Distribution of the matrix of sample regression coefficients and the matrix of residual sum of squares and cross products. Rao's U-statistic, its distribution and applications.

Multivariate analysis of variance [MANOVA] of one-way classified data. Wilk's lambda criterion.

Classification and discrimination procedures for discrimination between two multivariate normal populations — sample discriminant function, tests associated with discriminant functions, classification into more than two multivariate normal populations.

Principal components, canonical variables and canonical correlations. Elements of factor analysis and cluster analysis.

References:

1. Anderson, T.W. (2003). An Introduction to Multivariate Statistical Analysis, Third Edition, John Wiley & Sons.
2. Arnold, Steven F. (1981). The Theory of Linear Models and Multivariate Analysis, John Wiley & Sons.
3. Giri, N.C. (1977). Multivariate Statistical Inference, Academic Press.
4. Johnson, R.A. and Wichern, D.W. (2007). Applied Multivariate Statistical Analysis, Sixth Edition, Pearson & Prentice- Hall.
5. Kshirsagar, A.M. (1972). Multivariate Analysis, Marcel Dekker.
6. Lawley, D.N. and Maxwell, A.E. (1971). Factor Analysis as a Statistical Method, Second Edition, London Butterworths.
7. Muirhead, R.J. (1982). Aspects of Multivariate Statistical Theory, John Wiley & Sons.
8. Rao, C.R. (1973). Linear Statistical Inference and its Applications, Second Edition, John Wiley & Sons.
9. Rencher, A.C. (2002). Methods of Multivariate Analysis, Second Edition, John Wiley & Sons.
10. Sharma, S. (1996). Applied Multivariate Techniques, John Wiley & Sons.
11. Srivastava, M.S. and Khatri, C.G. (1979). An Introduction to Multivariate Statistics, North Holland.

Course 303: Generalized Linear Models

Logistic and Poisson regression: logistic regression model for dichotomous data with single and multiple explanatory variables, ML estimation, large sample tests about parameters, Goodness-of-Fit tests (Concept of deviance), analysis of deviance, Lack-of-Fit tests in Logistic regression. Concept of over dispersion in logistic regression. Introduction to Poisson regression, MLE for Poisson regression, Applications in Poisson regressions.

Log linear models for contingency tables: interpretation of parameters, ML estimation of parameters, likelihood ratio tests for various hypotheses including independence, margin0al and conditional independence, partial association.

Family of Generalized Linear Models: Exponential family of distributions, Formal structure for the class of GLMs, Likelihood equations, Quasi likelihood, Link functions, Important distributions for GLMs, Power class link function.

References:

1. Agresti, A. (2002). Categorical Data Analysis, Second Edition, Wiley.
2. Christensen, R. (1997). Log-linear Models and Logistic Regression, Second Edition, Springer.
3. Collett, D. (2003). Modeling Binary Data, Second Edition, Chapman and Hall, London.
4. Dobson, A.J. and Barnett, A.G. (2008). Introduction to Generalized Linear Models, Third Edition, Chapman and Hall/CRC. London.
5. Green, P.J. and Silverman, B.W. (1994). Nonparametric Regression and Generalized Linear Models, Chapman and Hall, New York.
6. Hastie, T.J. and Tibshirani, R.J. (1990). Generalized Additive Models. Second Edition, Chapman and Hall, New York.
7. Hosmer, D.W. and Lemeshow, S. (2000). Applied Logistic Regression, Second Edition. Wiley, New York.
8. Lindsey, J. K. (1997). Applying generalized linear models, Springer-Verlag, New York.
9. McCullagh, P. and Nelder, J.A. (1989). Generalized Linear Models, Second Edition, Chapman and Hall.
10. McCulloch, C.E. and Searle, S.R. (2001). Generalized, Linear and Mixed Models, John Wiley & Sons, Inc. New York.
11. Myers, R.H., Montgomery, D.C and Vining, G.G. (2002). Generalized Linear Models with Applications in Engineering and the Sciences, John Wiley & Sons.

Course 304 Bayesian Inference

Subjective interpretation of probability in terms of fair odds; Subjective prior distribution of a parameter; Bayes theorem and computation of posterior distribution.

Natural conjugate family of priors for a model. Conjugate families for exponential family models, and models admitting sufficient statistics of fixed dimension. Mixtures from conjugate family, Jeffreys' invariant prior. Maximum entropy priors.

Utility function, expected utility hypothesis, construction of utility function, St. Petersburg Paradox. Loss functions: (i) bilinear, (ii) squared error, (iii) 0-1 loss, and (iv) Linex. Elements of Bayes Decision Theory, Bayes Principle, normal and extensive form of analyses.

Bayes estimation under various loss functions. Evaluation of the estimate in terms of the posterior risk, Pre-posterior analysis and determination of optimal fixed sample size. Linear Bayes estimates. Empirical and Hierarchical Bayes Methods of Estimation.

Bayesian interval estimation: Credible intervals, HPD intervals, Comparison with classical confidence intervals.

Bayesian testing of hypotheses, specification of the appropriate form of the prior distribution for a Bayesian testing of hypothesis. Prior and posterior odds. Bayes factor for various types of testing hypothesis problems. Lindley's method for Significance tests, two sample testing problem for the parameters of a normal population. Finite action problem and hypothisis testing under "O-K_i" loss, function. Large sample approximation for the posterior distribution. Lindley's approximation of Bayesian integrals.

Predictive density function, prediction for regression models, Decisive prediction, point and internal predictors.

References:

1. Aitchison, J. and Dunsmore, I.R. (1975). Statistical Prediction Analysis, Cambridge University Press.
2. Bansal, A. K. (2007). Bayesian Parametric Inference, Narosa Publishing House, New Delhi.
3. Berger, J.O. (1985). Statistical Decision Theory and Bayesian Analysis, Springer Verlag, New York.
4. Box, G.E.P. and Tiao, G.C. (1973). Bayesian Inference in Statistical Analysis, Addison & Wesley.
5. De. Groot, M.H. (1970). Optimal Statistical Decisions, McGraw Hill.
6. Leonard, T. and Hsu, J.S.J. (1999). Bayesian Methods, Cambridge University Press.
7. Lee, P. M. (1997). Bayesian Statistics: An Introduction, Arnold Press.
8. Robert, C.P. (2001). The Bayesian Choice: A Decision Theoretic Motivation, Second Edition, Springer Verlag, New York.

Course 305: Practical – III Part A: Problem Solving using C language -I

Developing programs in C-language to analyse data from the following areas: Statistical Inference-II, Multivariate Analysis and Generalized Linear Models.

Part B: Problem Solving using SPSS-I

Based on

(i) knowledge of Software

(ii) application of Software for data analysis in the following areas: Statistical Inference-II, Multivariate Analysis and Generalized Linear Models.

An elective from outside the Department (Course content as per the elective offered by the concerned Department).

Semester IV: Examination 2015 and onwards

Course 401: Econometrics

General linear regression model, assumptions, estimation of parameters by least squares and maximum likelihood methods, tests of linear hypothesis, confidence estimation for regression coefficients, R^2 and adjusted R^2.

Estimation of parameters by generalized least squares in models with non-spherical disturbances, Use of extraneous information in terms of exact and stochastic linear restrictions, restricted restriction and mixed regression methods and their properties, tests for structural change, use of dummy variables,

Multicollinearity, its effects and detection, Remedial methods including the ridge regression. Specification error analysis, Heteroscedasticity of disturbances, estimation under heteroscedasticity and tests of heteroscedasticity, Autocorrelation, tests for auto correlation, estimation under autocorrelated disturbances, Errors in variable models, inconsistency of least squares method, instrumental variables: estimation, consistency property, asymptotic variance of instrumental variable estimators.

Distributed lag models: Finite polynomial lags, determination of the degree of polynomial. Infinite distributed lags, determination of lag length. Methods of estimation.

Simultaneous equations models: Identification problem. Restrictions on structural parameters-rank and order conditions. Restrictions on variances and covariances. Estimation in simultaneous equations models. Recursive systems, 2SLS estimators, Limited information estimators, k-class estimators, Instrumental variable method of estimation. 3-SLS estimation.

References:

1. Johnston, J. (1991): Econometric Methods, (Mc Graw Hill)
2. Kmenta, J. (1986). Elements of Econometrics, Second Edition, Mac millan.
3. Greene, W.H. (2003) Econometric Analysis(Prentice Hall)
4. Damodar N. Gujarati(2004) Basic Econometrics, Fourth Edition (McGraw−Hill)
5. Koutsyannis, A (2004) Theory of Econometrics
6. Judge, G.C., Hill, R,C. Griffiths, W.E., Lutkepohl, H. and Lee, T-C. (1988): Introduction to the Theory and Practice of Econometrics (Second Edition), John Wiley & Sons.

Course 402: Demography, Statistical Quality Control and Time Series Analysis

Demography: Measures of mortality, description of life table, construction of complete and abridged life tables, maximum likelihood, MVU and CAN estimators of life table parameters.

Measures of fertility, models for population growth, intrinsic growth rate, stable population analysis, population projection by component method and using Leslie matrix.

Quality control and Sampling Inspection: Basic concepts of process monitoring and control, General theory and review of control charts, O.C and ARL of control charts, CUSUM charts using V-mask and decision intervals, economic design of $\bar{X}$ chart.

Review of sampling inspection techniques, single, double, multiple and sequential sampling plans and their properties, methods for estimating (n, c) using large sample techniques, curtailed and semi-curtailed sampling plans, Dodge's continuous sampling inspection plans for inspection by variables for one-sided and two-sided specifications.

Time series as discrete parameter stochastic process. Auto covariance and auto correlation functions and their properties. Moving average (MA), Auto regressive (AR), ARMA and ARIMA models. Box-Jenkins models. Choice of AR and MA periods. Estimation of ARIMA model parameters. Smoothing, spectral analysis of weakly stationary process. Periodogram and correlogram analysis. Filter and transfer functions. Problems associated with estimation of spectral densities. Forecasting: Exponential and adaptive Smoothing methods

References:

1. Biswas, S. (1996). Statistics of Quality Control, Sampling Inspection and Reliability, New Age International PublishersEastern Ltd.
2. Chiang, C.L. (1968). Introduction to Stochastic Processes in Bio statistics, John Wiley.
3. Keyfitz, N. (1971). Applied Mathematical Demography, Springer Verlag.
4. Montgomery, D.C. and Johnson, L.A. (1976). Forecasting and Time Series Analysis, Mc Graw Hill, New York .
5. Montgomery, D. C. (2005). Introduction to Statistical Quality Control, 5^{th} Edn., John Wiley & Sons.
6. Peter J. Brockwell and Richard A. Daris (2002). Introduction to time Series and Forecasting, Second Edition. Springer-Verlag, New York, Inc. (Springer Texts in Statistics).
7. Spiegelman, M. (1969). Introduction to Demographic Analysis, Harvard University Press.
8. Wetherill, G. B. (1977). Sampling Inspection and Quality Control, Halsted Press.

Elective Courses: Paper 403 & Paper 404: Any two of the following:

(i) Applied Stochastic Processes

Markov processes in continuous time. Kolmogorov equations. Forward and backward equations for homogeneous case. Random variable technique, Homogeneous birth & death processes. Divergent birth process. The effect of immigration. The general birth and death process. Multiplicative processes. Simple non-homogeneous processes. Polya process. The effect of immigration for non-homogeneous case.

Queueing processes. Equilibrium theory. Queues with many servers. First passage times. Diffusion. Backward Kolmogorov diffusion equation. Fokker- Planck equation. Application to population growth. Epidemic and Counter models. Bulk input queue. Bulk service queuing model, Priority queue discipline. Priority queue with no preemptive rule.

Non Markovian queues, Embedded Markov processes. Stationary distribution of state probabilities of M/G/1, GI/M/1 and M/G(a,b)/1 model. Supplementry variable technique.

Some multi-dimensional prey and predator and non- Markovian processes, Renewal processes- ordinary, modified, equilibrium. Renewal functions. Integral equation of renewal theory. Distribution of the number of renewals. The elementary renewal theorem.

References:

1. Bailey, Norman T.J. (1964). The Elements of Stochastic Processes, John Wiley and Sons.
2. Bartlett, M.S. (1966). An Introduction to Stochastic Processes, Cambridge University Press.
3. Cox. D. R. and Miller, H. D. (1965). The theory of Stochastic Processes, Mathuen & C0., London.
4. Gross, D., Shortle J.F., Thompson J.M. and Harris, C.M. (2008). Fundamentals of Queueing

Theory, John Wiley & Sons.

5. Hoel, P.G., Port, S.C. and Stone, C.J. (1972). Introduction to Stochastic Processes, Houghton Miffein Company.
6. Karlin, S. and Taylor, H.M. (1975). A First Course in Stochastic Processes (Second Ed.), Academic Press.
7. Medhi, J. Stochastic Processes
8. Ross, S. M. (1983). Stochastic Processes. John Wiley & Sons.

(ii) Order Statistics

Basic distribution theory. Order statistics for a discrete parent. Distribution-free confidence intervals for quantiles and distribution-free tolerance intervals. Conditional distributions, Order Statistics as a Markov chain. Order statistics for independently and not identically distributed (i.ni.d.) variates. Moments of order statistics. Large sample approximations to mean and variance of order statistics. Asymptotic distributions of order statistics. Recurrence relations and identities for moments of order statistics. Distibution-free bounds for moments of order statistics and of the range.

Random division of an interval and its applications. Concomitants. Order statistics from a sample containing a single outlier. Application to estimation and hypothesis testing.

Rank order statistics related to the simple random walk. Dwass' technique. Ballot theorem, its generalization, extension and application to fluctuations of sums of random variables.

References:

1. Arnold, B.C. and Balakrishnan, N. (1989). Relations, Bounds and Approximations for Order Statistics, Vol. 53, Springer-Verlag.
2. Arnold, B. C., Balakrishnan, N. and Nagaraja H. N. (1992). A First Course in Order Statistics, John Wiley & Sons.
3. David, H. A. and Nagaraja, H. N. (2003). Order Statistics, Third Edition, John Wiley & Sons.
4. Dwass, M. (1967). Simple random walk and rank order statistics. Ann. Math. Statist. 38, 1042-1053.
5. Gibbons, J.D. and Chakraborti, S. (1992). Nonparametric Statistical Inference, Third Edition, Marcel Dekker.
6. Takacs, L. (1967). Combinatorial Methods in the Theory of Stochastic Processes, John Wiley & Sons.

(iii) Information theory

Introduction : communication process, communication system, measure of information, unit of information. Memoryless finite scheme: Measure of uncertainty and its properties, sources and binary sources. Measure of information for two dimensional discrete finite probability scheme: conditional entropies, Noise characteristics of a channel, Relations among different entropies

Measure of Mutual information, Shannon's fundamental inequalities, Redundancy, Efficiency and channel capacity, capacity of channel with symmetric noise structures, BSC and BEC, capacity of binary channels, Binary pulse width communication channel, Uniqueness of entropy function

Elements of enconding : separable binary codes, Shannon-Fano encoding, Necessary and sufficient conditions for noiseless coding. Theorem of decodibility, Average length .of encoded messages; Shannon's Binary Encoding.

Fundamental theorem of discrete noiseless encoding, Huffman's minimum redundancy code, Gilbert-Moore encoding. Error detecting and Error correcting codes, Geometry of binary codes, Hammings single error correcting code

References:

1. Reza, F.M. : An Introduction to Information Theory, Mc Graw Hill Book:Company Inc.
2. Feinstein, A. (I) : Foundations of Information Theory, McGraw Hill Book Company Ioc.
3. Kullback, S. (I) : Information Theory and Statistic., John Wiley and Sons.
4. Middleton, D. : An Introduction to Statistical Communication Theory,

(IV) Statistical Ecology

Population Dynamics: Single species -exponential logistic and Gompertz models, two species competition and competitive exclusion, Predator-pray interaction, Lotka- Volteria equations.

Estimation of Abundance: Capture-recapture method, Line transect methods, nearest neighbour and nearest individual distance methods.

Analysis of bird ring recovery data, open and closed populations. Survivorship Models: Discrete case-life table, Leslie matrix. Continuous case survivorship curve, hazard rate, life distribution with monotone and non-monotone hazard rates.

Ecological community: Species abundance curve, broken stick model. Diversity and its measures. Renewable Resources': Maximum sustainable yield, maximum economic yield, optimal harvesting strategy.

Referenes:

1. Begin M, and Mortiner, M. : Population Ecology, Blackwell Science.
2. Clark, C.W : Bioeconomic Modelling and Fisheries Management
3. Hallan, T.G. and Levin, S.A. : Mathematical Ecology, Springer
4. Kapur, J.N : Mathematical Models in Biology and Medicine, Affiliated East-West Press
5. Pielou, E.C : Mathematical Ecology, John Wiley & Sons Inc.
6. Clark, C.W. : Mathematical Bioeconomics--the Optimal Management of Renewable Resources, Wiley-Inter Science.
7. Seber, G.A.F. : The Estimation of Animal,Abundance; The Blackburn Press

v) Statistical Methods in Epidemiology

Measures of disease frequency: Mortality/Morbidity rates, incidence, rates, prevalence rates. Sources of mortality/Morbidity statistics-hospital records, vital statistics records. Measures of accuracy or validity, sensitivity index, specificity index.

Epidemiologic concepts of diseases, Factors which determine the occurrence of diseases, models of transmission of infection, incubation period, disease spectrum and herd immunity. Observational studies in Epidemiology: Retrospective and prospective studies. Measures of association :Relative risk, odds ratio, attributable risk.

Statistic techniques used in analysis: Cornfield and Garts' method, Mantel.Haenszel method. Analysis of data from matched samples, logistic regression approach.
Experimental Epidemiology: clinical and community trials. Statistical Techniques: Methods for comparison of the two treatments. Crossover design with Garts and Mc Nemars test. Randomization in a clinical trial, sequential methods in clinical trials. Clinical life tables,

Assessment of survivability in clinical trials. Mathematical Modelling in Epidemiology: simple epidemic model, Generalized epidemic models, Reed First and Green wood models, models for carrier borne and host vector diseases.

References:

1. Lilienfeld and LiJenfeld : Foundations of Epidemiology, Oxford University Press.
2. Lanchaster, H.O. : An Introduction to Medical Statistics, John Wiley & Sons Inc.
3. FIeiss, J.L. : Statistical Methods for Rates and Proportions, Wiley Inter Science.
4. Armitage : Sequential Medical Trials, Second Edition,Wiley Blackwell.
5. Bailey, N.T.J. : The mathematical theory of infectious disease and Applications, Griffin.

Paper 405:- Practical – IV

Part A: Problem Solving using C language -II

Developing programs in C-language to analyse data from the following areas: Econometrics, Demography, Statistical Quality Control, Reliability Theory, Survival Analysis, Time Series and Forecasting.

Part B: Problem Solving using SPSS-II

Based on

(i) knowledge of Software

(ii) application of Software for data analysis in the following areas:

Econometrics, Demography, Statistical Quality Control, Reliability Theory, Survival Analysis, Time Series and Forecasting