M.A./M.Sc.
(Statistics)

Prospectus No. 20091218

संत गाडगे बाबा अमरावती विद्यापीठ

SANT GADGE BABA AMRAVATI UNIVERSITY

विज्ञान विद्याशाखा
(FACULTY OF SCIENCE)

अभ्यासक्रमिका
वाङ्मय पारंगत/विज्ञान पारंगत (संख्याशास्त्र)
सत्र - १ ते ४

PROSPECTUS

OF
MASTER OF ARTS/MASTER OF SCIENCE
EXAMINATION IN STATISTICS
Semester -I, Winter 2008,
Semester -II, Summer 2009,
Semester -III, Winter 2009,
Semester -IV, Summer 2010

2008

visit us at www.sgbau.ac.in

Price Rs. 10/-

PUBLISHED BY
Dr.K.G.Khamare
Registrar
Sant Gadge Baba
Amravati University
Amravati-444602

Syllabus Prescribed for
M.A./M.Sc. Semester I to IV (Statistics) Examination
(Semester Pattern)

THE PREAMBLE

Following are the objectives of the post graduate course in Statistics :

(a) To Specialize students in Statistics and Statistical Techniques and Equipping them for higher studies in Statistics.

(b) To enable utilization of Statistics in other sciences and professions.

(c) To train students for advanced studies in Statistics leading to research.

(d) To inspire students to think originally in Statistics.

(e) To equip the students to handle different kinds of data through data mining and data processing.

(f) Developing Human Resources for ancillary jobs in Government Organization and Industries which require use of Statistics and Statistical Techniques.

The directives for implementing the Post Graduate Teaching Programme are as follows:

(i) The emphasis should be shifted from teaching to learning in order to enable learner to engage himself in creative and divergent thinking, problem solving and self learning using library.

(ii) Lectures should be supplemented by Tutorial and / or problems solving sessions constituting 25% of the Lecture Work Load.

(iii) Training should be given to the students to use various software packages to solve statistical problems.

(iv) Seminar, Practical / Project work and Educational Tour be the part of curriculum.

There shall be four theory papers and two practicals for each semester except Semester-IV. For Semester-IV, there will be one practical and a project. The maximum marks for each theory paper shall be 50 and each practical as well as project shall be of 40 marks. There shall be two internal assessments each of 10 marks which will be added in practicals respectively.

The practical examinations shall be of 4 Hrs duration. The distribution of marks for practical examination shall be as follows.

(a) Practical problem / Project 24 (03 Problems each of 08 marks)

(b) Viva-voce / oral exam. 10

(c) Practical records / Project 06

The internal assessment marks of practicals and Project Work shall be given on the basis of Home Assignment / Test Examination/ Seminar/field tour etc. Marks of seminar shall be given by the team of Faculty members consisting of the H.O.D., Seminar's guide, and one expert nominated by the Head.

Topic of the project work will be given by concern supervisor with prior approval of Head of the Department. There will be no duplication of the topic of the project work. Project will be based on research in the laboratory and / or field work. Project work will be allotted at the beginning of Semester-III and the student shall have to submit it at least 15 days before the commencement of practical examination of the IVth Semester. Project work will be evaluated by the external and internal examiners. Each theory paper shall be of three hours duration.

Structure of Four Semester M.A. / M.Sc. course in Statistics

Semester-I

Sr. No.	Paper /Practical No	Title of Paper
1	Paper I	Elements of Mathematics & Measure Theory
2	Paper II	Elementary Probability and Distribution Theory
3	Paper III	Estimation Theory
4	Paper IV	Sampling Theory
5	Practical I	Problems on Distribution and Estimation Theory
6	Practical II	Problems on Sampling Theory

Semester-II

Sr. No.	Paper /Practical No	Title of Paper
7	Paper V	Probability Theory
8	Paper VI	Stochastic Processes
9	Paper VII	Testing of Hypothesis
10	Paper VIII	Linear Models & Design of Experiments
10	Practical III	Problems on Stochastic Process and Testing of Hypothesis
12	Practical IV	Problems on Design of Experiments

Semester-III

Sr. No.	Paper /Practical No	Title of Paper
13	Paper IX	Decision Theory & Non-parametric Methods
14	Paper X	Multivariate Analysis
15	Paper XI	Elective Paper-I
16	Paper XII	Elective Paper-II
17	Practical V	Problems on Compulsory Papers
18	Practical VI	Problems on Elective Papers

List of Elective / Optional Paper for Semester-III :

1) E I/II : 1 Bioassay
2) E I/II : 2 Industrial Process and Quality Control
3) E I/II : 3 Demography
4) E I/II : 4 Econometrics-I
5) E I/II : 5 Data Mining

Semester-IV

Sr. No.	Paper /Practical No	Title of Paper
19	Paper XIII	Mathematical Programming
20	Paper XIV	Computational Statistics
21	Paper XV	Elective Paper-III
22	Paper XVI	Elective Paper-IV
23	Practical VII	Problems on Compulsory Papers
24	Practical VIII	Project

List of Elective / Optional Paper for Semester-IV :

1) E III/IV : 1 Survival Analysis & Reliability Theory
2) E III/IV : 2 Operational Research
3) E III/IV : 3 Statistical Genetics and Bio-informatics
4) E III/IV : 4 Clinical Trials
5) E III/IV : 5 Actuarial Statistics
6) E III/IV : 6 Econometrics-II
7) E III/IV : 7 Bayesian Inference
8) E III/IV : 8 Advanced Sampling Theory

Note : For selecting a particular Elective paper from the list of Elective papers of IVth Semester, the student must have studied the related Elective paper in Semester-III, given in the following table.

Sr. No.	Elective Paper of Semester-IV	Related Elective Paper of Semester-III
1	Survival Analysis & Reliability Theory	Industrial Process and Quality Control
2	Statistical Genetics and Bioinformatics or Clinical Trials	Bioassay
3	Actuarial Statistics Econometrics-II	Econometrics-I

SYLLABUS PRESCRIBED FOR
M.A./M.SC. PART I

SEMESTER-I

Paper-I : Elements of Mathematics & Measure Theory

Unit-I : Introduction to real number & n dimensional Euclidian space, open and closed intervals, compact sets, Bolzano -Weirstrass Theorem (Statement only), Heine-Borel Theorem (Statement only).

Unit-II : Sequence and Series, and their convergence. Real valued functions, continuous function, Uniform continuity, sequences of functions, uniform convergence.

Unit-III : Maximal-Minima of functions, functions of several variables, constrained Max.-Min. of functions. Multiple integral (Without Problem) and their evaluation by repeated integration. Change of variables in multiple integration, differentiation under the sign of integral-Leibnitz rule.

Unit-IV : Classes of sets, fields, sigma fields, minimal sigma field, Borel sigma field. limsup & liminf, Measure, probability measure, properties of measure, Lebesque and Lebesque-Steljes measure.

Unit-V : Measurable functions, r.v.s., sequence of r.v.s., almost sure convergence, convergence in measure & in probability. Integration of a measurable function w.r.t. a measure, Monotone convergence theorem, Fatou's Lemma (Statement).

Reference :

(1) Apostal, T.M. (1985) : Mathematical Analysis, Narosa, Indian Ed.

(2) Courant, R. and John, F. (1965) : Introduction to Calculus and Analysis, Wiley.

(3) Miller, K.S. (1957) : Advanced Real Calculus, Harper, New York

(4) Ash, Robert (1972) : Real Analysis and Probability, Academic Press.

(5) Billing Sey, P. (1986) : Probability and Measure, Wiley.

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

Paper-II : Elementary Probability and Distribution Theory

Unit-I : Definition of Probability : Classical, relative, frequency, approach, axiomatic approach, conditional probability, independence of events, Bayes theorem and its

applications. Random variable, expectation of random variable, Brief review of basic distribution theory - concept of pmf, pdf, cdf, joint, marginal and conditional expectation.

Unit-II : Discrete Distributions : Binomial, Poisson, negative Binomial, Geometric, uniform, hypergeometric distributions.

Unit-III : Continuous Distributions : Normal, uniform, exponential, Beta, Gamma, Cauchy, Log-normal, Weibull, Laplace.

Unit-IV : Chi-square, t, f distributions and their properties, Markov, Jensen, Liaponov inequalities, approximating distributions of sample moments.

Unit-V : Compound, truncated and mixture distributions (only concepts) order statistics, their distributions and properties. Joint and marginal distribution of order Statistics, extreme values and their asymptotic distributions (Statement Only) with applications.

References:

(1) Johnson S. and Kotz (1972) : Distributions in Statistics Vol.-I,II and III.

(2) Rao C.R. (1973) : Linear Statistical Inference and its applications, Second Edition, Wiley.

(3) Rohatgi V.K. (1984) : An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.

Paper-III : Estimation Theory

Unit-I : Parametric Models, Probability of point estimation, consistent estimators, unbiased estimator, minimum variance unbiased estimator (MVUE). Likelihood function, Likelihood equivalence.

Unit-II : Methods of Estimation : Maximum likelihood, minimum Chi-square, method of moments, method of scoring, Cramer family. Cramer - Huzurbazar theorem, properties of maximum likelihood estimator.

Unit-III : Fisher information and information matrix, Cramer-Rao Inequality, sufficiency, Factorization theorem, minimal sufficiency, minimal sufficient statistics for exponential family & Pitman family.

Unit-IV : Rao-Blackwell theorem, completeness, bounded completeness, Lehman-Scheffe theorem and their use.

Unit-V : Interval Estimation, confidence level, construction of confidence intervals using pivots, shortest length C.I., Shortest expected length C.I.

References:

(1) E. L. Lechman (1986) : Theory of Point Estimation.
(2) B. K. Kale (1999) : First course on parametric inference.
(3) Rao C. R. (1973) : Linear Statistical inference and its applications.
(4) V. K. Rohatgi (1988) : An Introduction to Probability and Mathematical Statistics.

Paper-IV : Sampling Theory

Unit-I : Review of basic finite population sampling techniques (SRS, WR/WOR, Stratified, Systematic) and related results on estimation of population mean, total and variance, Allocation problem in Stratified Sampling, Comparison of systematic sampling with SRS and Stratified random sampling.

Unit-II : Unequal probability sampling : PPS, WR/WOR methods (including Lahiri's Scheme) and related estimators of a finite population mean (Hansen-Horvitz and Desraj estimators for a general sample size and Murthy's estimator for a sample of size two), Horvitz Thompson Estimator.

Unit-III : Use of supplementary information for estimation : Ratio and regression estimators based on SRSWOR, method of sampling.

Unit-IV : Cluster sampling with equal and unequal cluster sizes, Two stage sampling with equal number of second stage Units.

Unit-V : Double sampling for estimating Strata sizes in ratio and regression method of estimation, Randomized response technique. (Warner's Model : Related and unrelated questionnaire methods)

References :

(1) Sukhatme et al : Sampling theory of surveys with applications.
(2) Singh, D. and Chaudhari, F.S. : Theory and Analysis of Sample Survey designs.
(3) Murthy, M.N. : Sampling theory and methods.
(4) Des Raj and Chandak : Sampling Theory
(5) Cochran, W.G. : Sampling Techniques

Practical-I

List of Problems

(1) Fitting of Binomial distribution and testing the goodness of fit.

(2) Fitting of Poisson distribution and testing the goodness of fit.
(3) Fitting of Negative Binomial distribution and testing the goodness of fit.
(4) Fitting of Normal distribution and testing the goodness of fit.
(5) Fitting of Truncated Binomial distribution and testing the goodness of fit.
(6) Fitting of Truncated Poisson distribution and testing the goodness of fit.
(7) Applications of χ^2 distribution.
(8) Applications of t distribution.
(9) Applications of F distribution.
(10) Computation of MLE by the method of scoring.
(11) Above practicals using SPSS.

Practical-II

List of Problems :

(1) Estimation of mean and variance in SRSWR and SRSWOR.
(2) Comparison of systematic sampling with SRS and Stratified random sampling.
(3) Selection of sample with unequal probabilities and unbiased estimation of mean and variance.
(4) Des Raj estimator.
(5) Horvitz Thompson estimator.
(6) Ratio and Regression estimate of population mean and s.e.
(7) Cluster sampling
(8) Two stage sampling
(9) Double sampling for estimating strata sizes in Ratio and Regression method of estimation.

M.SC. PART-I

SEMESTER-II

Paper-V : Probability Theory

Unit-I : Axiomatic definition of Probability, Probability measure on a s-field, Probability space(definition only), Properties of probability measure. Independence of two events and n>2 events, mutual independence, sequence of independent events, Independent classes of events, Borel-Cantelli Lemma, Random Variable, Expectation of random variable, Linear properties of expectation.

Unit-II : Distribution functions and its properties, convergence of sequence of random variables, convergence almost-sure, convergence in probability, convergence in distribution, convergence in r^{th} mean, inter relations between different types of convergences.

Unit-III : Characteristic function, properties, inequalities, uniqueness theorem, Inversion theorem, continuity theorem.

Unit-IV : Weak law of large numbers, strong law of large numbers, Chebyshev's weak law of large numbers, Khinchin's weak law of large numbers, Kolmogorov's strong law of large numbers (statement only), Kolmogorov's inequality.

Unit-V : Central Limit Theorem, Demoivr's, Laplace, Lindeberg - Levy, Lindeberg - Feller (sufficiency only) and applications. Multivariate central limit theorem.

Reference :

(1) V.K.Rohatgi : Introduction to Probability theory
(2) Bhat, B.R. : Modern Probability theory
(3) Basu, A.K. : Measure theory & probability
(4) Fisz, M. : Probability theory & Mathematical Statistics.

Paper-VI : Stochastic Processes

Unit-I : Introduction to stochastic Processes (SP's) - Classification of SP's according to State space & time domain. Markov chain, countable state Markov chain, calculation of n-step transition probability & its limit.

Unit-II : Chapman-Kolmogorov equation, Stationary distribution, classification of states, criteria for various states, ergodic theorem. Application to biological & Physical sciences.

Unit-III : Random walk & gambler's ruin problem, absorbing and reflecting barriers, probability of eventual absorption, expected duration of game, random walk in 2 & 3 dimension.

Unit-IV : Discrete state space & continuous time Markov chain, Poisson process, properties of poisson process, pure birth, pure death, Birth and death process.

Unit-V : Continuous state space, continuous time Markov chain, Wiener process, Wiener process as a limit of random walk, differential equation of Wiener process, first passage problem in Wiener process.

List of References :

(1) Medhi, J. (1982) : Stochastic Processes, Wiley Eastern.

(2) Bhat, B.R. (2000) : Stochastic Models : Analysis and Applications, New Age International, India.
(3) Adke, S.R. & Manjunath, S.M. (1984) : An Introduction to finite Markov Processes, Wiley Eastern.

Paper-VII : Testing of Hypothesis

Unit-I : Test of Hypothesis, concept of critical region, test functions, two kinds of errors, size function, power function, level, p-value concept, MP and UMP test in the class of size level test, Neyman-Pearson lemma, MP test for simple hypothesis against simple alternative hypothesis.

Unit-II : UMP test for simple null hypothesis against one sided alternatives and for one sided null and one sided alternative in one parameter exponential family. Non-existence of UMP test for simple null against two sided alternative in one parameter exponential family.

Unit-III : Likelihood ratio test. Asymptotic distribution of LR test statistics (without proof) Wald's test, Rao's score test, Pearson's chi-square test for goodness of fit. Bartlett's test for homogeneity of variances (without proof)

Unit-IV : Sequential Testing, sequential probability ratio test. Relation among parameters. Application of SPRT for Binomial, Poisson, Normal distribution.

Unit-V : Generalized Neyman-Pearson lemma (Statement only), unbiased test, UMPU test and their existence in case of exponential family, similar test and test with Neyman structure.

References :

(1) Ferguson T.S. : Mathematical Statistics
(2) Goon, A.M., Gupta, Dasgupta : An Outline of Statistical Inference.
(3) H.C.Saxena, Surendran : Statistical Inference : S.Chand.
(4) Kale B.K. (1999) : A First Course in Parametric Inference, Narosa Publishing House.
(5) Lehman E.L. (1986) : Testing Statistical Hypothesis, Student Edition.
(6) Rao C.R. (1973) : Linear Statistical Inference
(7) Rohatgi V. (1988) : An Introduction to Probability and Mathematical Statistics, Wiley Eastern Ltd., New York.
(8) Zack S. (1971) : Theory of Statistical Inference, John Wiley and Sons, New York.

Paper-VIII : Linear Models and Designs of Experiments

Unit-I : Gauss-Markov Theorem, Analysis of variance, elementary concepts (one way and two way classified data) Introduction to designed experiments, General block design and its information matrix (c), criteria for connectedness, balance and orthogonality.

Unit-II : Review of Elementary designs (CRD, RBD, LSD), Missing plot technique in RBD and LSD with one and two missing values.

Unit-III : Elementary parametric relations and analysis of BIBD. Definitions and parametric relations of SBIBD, RBIBD, ARBIBD, PBIBD. Definition and analysis of Youden square design.

Unit-IV : Analysis of covariance of one way and two way classified data. Definition and analysis of split plot design.

Unit-V : General factorial experiments, factorial effects, best estimates and testing the significance of factorial effects, study of 2^3 and 2^4 factorial experiments in RBD.

Confounding in factorial experiments, complete and partial confounding, concept of generalized interaction.

References :

(1) Alok Dey (1986) : Theory of Block Designs - Wiley Eastern.

(2) Das, M.N. and Giri, N. (1979) : Design and Analysis of Experiments - Wiley Eastern.

(3) Joshi, D.D. (1987) : Linear Estimation and Design of Experiments, Wiley Eastern.

(4) Montgomery, D.C. (1976) Design & Analysis of Experiments, Wilay New York.

Practical-III

List of Problems

(1) Construction of MP test and power curve.

(2) MP test for families with MLR property.

(3) Construction of UMP test and power curve.

(4) Sequential probability ratio test for normal distribution.

(5) Sequential probability ratio test for binomial distribution.

(6) Sequential probability ratio test for Poisson distribution.

(7) Problems on likelihood ratio test.

(8) Construction UMPU test.

(9) Calculation of n step transition probabilities.

(10) Classification of states.

(11) Problems on pure birth process.

(12) Problems on pure death process.

Practical-IV

List of Problems

(1) Elementary Designs (CRD, RBD, LSD)

(2) Missing Plot Techniques in RBD and LSD with one and two missing values.

(3) BIBD

(4) Youden Square Design

(5) Analysis of Covariance (one way, two way classification)

(6) Split plot design.

(7) 2^3 and 2^4 factorial experiments in RBD (without confounding)

(8) 2^3 and 2^4 factorial experiments in RBD (with confounding)

M.SC. PART-II

SEMESTER-III

Paper-IX : Decision Theory and Non-parametric Methods

Unit-I : Decision problem, loss function, risk function, randomized and non-randomized decision rule. Decision principles (Conditional Bayes, Frequentist). Testing and estimation problem as decision problems. Optimal decision rule.

Unit-II : Concept of admissibility and completeness, Bayes rules, minimax decision rule. Admissibility of Bayes rules. Existance of Bayes decision rule.

Unit-III : Definition of non-parametric test, advantages and disadvantages of non-parametric tests. Single sample problems.

(a) Test of randomness

(b) Tests of goodness of fit : Empirical distribution function. Kolmogorov-Smirnov test, χ^2 test, comparison of χ^2 and KS test.

(c) Problem of location : Sign test, Wilcoxon's signed rank test, Wilcoxon paired sample signed rank test.

Unit-IV : Two Sample Problems : Different types of alternative, sign test, Wilcoxon two sample rank sum test, Wald-Wolfowitz run test, Mann-Whitney-Wilcoxon test, median test. K-S two sample test.

Unit-V : One sample U statistic, Kernel and symmetric Kernel, variance of U statistic, two sample U statistics, linear rank statistics and their distribution properties under null hypothesis.

References :

(1) Berges J.O. : Statistical Decision Theory and Bayesian Analysis.

(2) Ferguson T.S. : Mathematical Statistics - A decision theoretic approach.

(3) Fraser, D.A.J. (1957) : Non-parametric methods in Statistics, John Wiley and Sons

(4) Gibben J.D. : Non Parametric Statistical inference.

(5) Goon A.M., Gupta M.K., Dasgupta : An Outline of Statistical Inference.

(6) Randles, R.H. and Wolfe D.A. (1979) : Introduction to Non-parametric Statistics.

Paper-X : Multivariate Analysis

Unit-I : Multinomial and negative multinomial distribution, Multivariate normal distribution. Characteristics function, moments, marginal and conditional distribution. Maximum likelihood estimators of parameters. Distribution of sample mean vector.

Unit-II : Wishart Matrix. Its distribution (without proof) and properties. Distribution of sample generalized variance. Application in testing and interval estimation.

Unit-III : Null distribution of Hotelling's T^2 Statistics. Application in tests on mean vector for one and more multivariate populations and also on the equality of the components of a mean vector in a multivariate normal population. Application of T^2 Statistics and it's relationship with Mahalanobis D^2 statistics.

Unit-IV : Classification and discrimination : Procedures for discrimination between two multivariate normal populations. Fisher's discriminant function. Tests associated with discriminant function. Sample discriminant function, probabilities of misclassification and their estimation, classification into more than two multivariate populations.

Unit-V : Principal components, dimension reduction canonical variables and canonical correlation. Definition, uses, estimation and computation.

References :

(1) Anderson T.W. : An Introduction to Multivariate Statistical Analysis.

(2) Kshirsagar A.M. : Multivariate Analysis.

(3) Rao C.R. - Linear Statistical Inference and its applications.

(4) Applied Multivariate Statistical Analysis : Richard A. Johnson

(5) Statistical Inference : H.C. Saxena, A.U.Surendran.

Practical-V

(1) Problem on decision theory, loss function and risk function.

(2) Problem on Bayes decision rules.

(3) Problem on Minimax decision rules.

(4) Problem on run test for randomness and Wald Wolfowitz run test.

(5) Problems on Kolmogorov-Smirnov goodness of fit test.

(6) Problems on signed test and signed rank test.

(7) Problems on Mann Whitney U test.

(8) Problems on Median test.

(9) Problems on Kolmogorov-Smirnov two sample test.

(10) Drawing of random sample from Bivariate normal distribution.

(11) Estimation of parameters in case of random sample from P-variate normal distribution.

(12) Computation of Hotelling's T^2 and Mahalanobis D^2 statistics and their applications.

(13) Problems on Discriminatory analysis.

(14) Computation of Canonical correlation and Canonical variables.

(15) Computation of Principal component.

List of Elective Paper for IIIrd Semester

Elective I/II :1

Bioassay

Unit-I : Types of biological assays; Direct assays, Ratio Estimators, asymptotic distribution; Fieller's theorem. Regression approaches to estimating dose-response relationship quantal responses.

Unit-II : Logit and Probit approaches when dose-response cure for standard preparation is unknown.

Unit-III : Methods of estimation parameters; Estimation of extreme quantities; Dose allocation schemes; Polychotomous quantal response. Estimation of points on the quantal response function

Unit-IV : Sequential procedures. Estimation of safe doses.

Unit-V : ANOVA and Bayesian approach to Bioassay.

References :

(1) Z.Govindarajalu (2000) : Statistical Techniques in Bioassay, S.Kargar.

(2) D.J.Finney (1971) : Statistical Methods in Bioassay, Griffin.

(3) D.J.Finney (1971) : Probit Analysis (3rd Edn.), Griffin.

(4) G.B.Weatherile (1966) : Sequential Methods in Statistics, Methuan.

Elective I/II : 2

Industrial Processes and Quality Control

Unit-I : Basic concepts of process monitoring and control, process capability and process optimization. Review of control charts for attributes and variable data. O.C. and ARL of control charts. Moving average and exponentially weighted moving average charts. Cusum & V-masks charts.

Unit-II : Acceptance sampling plans for attributes inspection, single, double and sequential sampling plans and their properties. Plans for inspection by variables (one & two sided specifications) Mil Std & I.S. plans. Continuous sampling plans of Dodge type, Wald-Wolfiwitz type and their properties. Bayesian sampling plans.

Unit-III : Use of design of experiments in SPC, factorial experiments, fractional factorial designs, construction of such designs and analysis of data.

Unit-IV : Capability indices Cp, Cpk and Cpm, estimation, confidence intervals and tests of hypothesis relating to capability indices for normally distributed characteristics. Multivariate quality control : Use of control ellipsoid and of utility functions.

Unit-V : Quality Systems : ISO 9000 standards, QS 9000 standards, concept of six sigma and define-measure-analyze-Improve-Control Approach. Precision and accuracy in measurement systems. Estimation of measurement uncertainty. Total Quality management.

References :

(1) Montgomery D.C. (1985) : Introduction to Statistical Quality Control, Wiley.

(2) Montgomery D.C. (1985) : Decign and Analysis of Experiments, Wiley.

(3) Wetherill G.B. (1977) : Sampling Inspection & Quality Control, Halsted Press.

(4) Wetherill G.B. & Brown D.W. (.....) : Statistical Process Control, Theory and Practices, Chapman & Hall.

(5) Logothetis N. (1992) : Managing Total Quality, Prentice Hall of India.

(6) Oakland J.S. (1989) : Total Quality Management; Butterworth-Heinemann.

(7) Mittog H.J. and Rinne H. (1993) : Statistical Methods of Quality Assurance.

Elective I/II : 3

Demography

Unit-I : Definition and Scope : Development of demography as a interdisciplinary discipline, Basic demographic concept and components of population dynamics. Coverage and content errors in demographic data, use of balancing equations and chandrasekharan Deming formula to check completeness of registration data. Adjustment of

age data. Use of whipple, myer and UN indices. Population composition, dependency ratio.

Unit-II : Measure of Fertility : Stochastic models for reproduction, distribution of time to first birth, inter live birth intervals and of number of births (for both homogeneous and non-homogeneous groups of women), estimation of parameters, estimation of parity pregression ratios from open birth interval data.

Unit-III : Measure of Mortality : Various measures of mortality, infant mortality rate, cause specific death rate and standardised death rates. Construction of a bridge life table. Distribution of life table functions and their estimation.

Unit-IV : Migration : Migration Rates and Ratios : Indirect measures of net-internal migration. National growth rate method. Stochastic models for migration and for Social and occupational mobility based on Markov chains. Estimation of Measures of Mobility.

Unit-V : Measurement of Population Change : Linear, Geometric, exponential, Gompretz, Logistic Population growth models. Methods of population projection, use of Leslie matrix.

Stable and Quasi Stable populations, intrinsic growth rate. Models for population growth and their fitting to population data. Stochastic models for population growth.

References :

(1) Benjamin, B. (1969) : Demographic Analysis, George, Allen & Unwin.

(2) Cox P.R. (1970) : Demography, Cambridge University Press.

(3) Keyfitz N. (1977) : Applied Mathematical Demography, Springer Verlag.

(4) Spiegelman M. (1969) : Introduction to Demographic Analysis, Harvard University Press.

(5) Bartholomew D.J. (1982) : Stochastic Models for Social Processes, John Wiley.

Elective I/II : 4

Econometrics-I

Unit-I : Theory of Consumer Behavior, utility, indifference curves. Elasticity of demand, supply and substitution. Partial elasticities and relation between them. Slutsky equation.

Unit-II : Econometric Methods and Application :- Problems of Single Equation Regression models, multicollinearity, heteroscadasticity & tools for handling the problem.

Unit-III : Auto-correlation, their nature, consequence detection & remedial measures. Errors of measurement.

Use of dummy variables and seasonal adjustment.

Unit-IV : The General linear model (GLM) & its extensions. Ordinary least squares (OLS) estimation & prediction.

Autoregressive and distributed lag models. Koych approach to distributed lag models. Instrumental variable estimation.

Unit-V : Simultaneous linear equations models. Identification problem. Restrictions on structural parameters - rank & order conditions. Recursive model, indirect least squares. Two stage least squares.

References:

(1) J.M.Henderson and R.E.Quandt (.....) : Micro-Economic Theory.

(2) A.M.Goon, M.K.Gupta, & Das Gupta : Fundamentals of Statistics-Vol.-II

(3) Damodar Gujrathi : Basic Econometrics.

(4) Kotsoyiannis A. : Modern Micro-economics.

(5) A.A.Walter : An Introduction to Econometrics.

(6) Fridman M.A. : A Theory of Consumer Function.

(7) Johnston : Econometric Methods.

(8) Christ : Econometric Models and Methods.

(9) D.Bose : Mathematical Economics.

(10) Henri Theil : Introduction to Econometrics

(11) Apte P.G. : Text Book of Econometrics.

Elective I/II : 5

Data Mining

Unit-I : Introduction to object oriented programming concepts and design. Introduction to Web Programming (Simple example in Java) and the concept of byte codes.

Unit-II : Review of classification methods from multivariate analysis; classification and decision trees. Clustering methods from data mining view points.

Unit-III : Vector quantization, unsupervised learning from univariate and multivariate data, dimension reduction and feature selection.

Unit-IV : Supervised learning from moderate to high dimensional input spaces, artificial neural networks and estensions of regression models, regression trees.

Unit-V : Introduction to database including simple relational databases, data ware houses, introduction to online analytical data processing. Data attributes, applications to electronic commerce.

References:

(1) A.Borson and S.J.Smith (1997) : Data Ware Housing, Data Mining and OLAP, McGraw Hill.

(2) Breiman, J.H.Friedman, R.A.Olsher and C.J.Stone (1984) : Classification and Regression Trees, Wordsworth & Brooks / Cole.

(3) J.Han and M.Kamber (2000) : Data Mining Concepts and Techniques, Morgan Gaufmann.

(4) T.M.Mitchell (1997) : Machine Learning McGraw Hill.

(5) P.Naughton (1996) : The Java Handbook, Tata McGraw Hill.

(6) W.J.Savich (2001) : Problem Solving with C++ : The Object of Programming (3rd Edn.) Addison Wesley, Longman.

Practical-VI

8 to 10 problems based on Elective Papers.

M.Sc.Part-II

Semester-IV

Paper-XIII : Mathematical Programming (OR-I)

Unit-I : L.P. : Simplex method, variants of simplex method, duality in L.P., duality theorem, complementary slackness theorem, dual simplex method, transportation and assignment problems, method of solving transportation and assignment problems.

Unit-II : I.L.P.P. : Pure and mixed ILPP, methods for solving pure and mixed ILPP, Gomory's cutting plane method, Branch & Bound method.

Unit-III : N.L.P.P. : General N.L.P.P, convex and concave functions, test for concavity & convexity, local optimum, global optimum, Lagrange's method for optimality, KT conditions, Q.P.P., Wolfe's & Beale's method for solving Q.P.P.

Unit-IV : Dynamic Programming : Dynamic Programming approach for solving optimization problems, forward & backward recursion formula. Multicriterion and Goal programming, Stochastic Programming & two stage programming.

Unit-V : Game Theory : Two-person zero-sum game, pure and mixed strategies, saddle point of a matrix game, matrix game without saddle point, methods for solving matrix game without saddle point, 2x2, mxn, mx2, & 2xn matrix games.

Dominance principle, use of dominance principle in game theory, solving game problems by simplex method.

References :

(1) Taha H.A. : Operations Research : An Introduction.

(2) Hiller F.S. and Leiberman G.J. : Introduction to Operations Research.

(3) Kanti Swarup, Gupta P.K. & Singh M.M. : Operations Research

(4) Hadley G. : Non Linear and Dynamic Programming

(5) Philips D.T., Ravindran A. & Solberg J. : Operations Research, Principles and Practice.

Paper-XIV : Computational Statistics

Unit-I : Exploratory data analysis : Components of E.D.A., transforming data, clustering : Similarity measures, similarity coefficients, Hierarchical clustering methods : Single, complete and average linkage methods. Graphical Methods : Quintile plots, Box Plots, Histogram, stem and leaf diagram, Q-Q plots, P-P plots.

Unit-II : Stochastic Simulation : Generating random variables from discrete and continuous distributions, simulation. bivariate /multivariate distributions, simulating stochastic processes such as simple queues.

MCMC methods : Essence of MCMC methods, time reversible MC, Law of large numbers for MC. Metropolis-Hastings algorithm, Gibbs sampling.

Unit-III : Simulated annealing for optimization, simulated annealing for M.C., Simulated based testing : Simulating test statistics and power functions, permutations (randomization tests)

Unit-IV : Resampling paradigms : Jackknife and Boot strap : Delete one J-K pseudo values, Bias and S.E., Efron's bootstrap, Bootstrap C.I., Bootstrap C.I. for linear regression parameters.

Unit-V : EM Algorithm : Applications to missing and incomplete data problems, mixture models. Smoothing with Kernels : Density Estimation, Kernel Deurity estimator for univariate data, Bandwidth selection and cross validation.

References :

(1) Efron B. and Tibsirani J.R. : An Introduction to Bootstrap
(2) Jun S.Liu : Monte Carlo Strategies in Scientific Computing, Springer Series in Statistics, 2001
(3) Ross S.M. : Applied Probability Models.

Practical-VII :

Practicals based on Compulsory Papers.

List of Practicals :

(1) Solution of LPP by simplex method.
(2) Solution of LPP by dual simplex method.
(3) Solution of transportation problem using Modi method.
(4) Solution of assignment problem using Hungarian method.
(5) IPP using cutting plane algorithm.
(6) IPP using branch and bound algorithm.
(7) Solution of NLPP using Lagrangian multiplier.
(8) Solution of NLPP using K-T conditions.
(9) Solution of games (pure and mixed strategies)
(10) Solution of game by dominance principle.
(11) Problems on graphical method of clusting.
(12) ML estimators for exponential family.
(13) Problems on non-linear regression (estimation, hypothesis testing & goodness of fit)
(14) Problems based on EM algorithm.
(15) Smoothing problems using Kernel.
(16) MCMC method based problems.
(17) Problems on Jackknife method.
(18) Problems on Bootstrap method.

List of Elective Papers for 4th Semester

Paper MST 4E01

Elective III/IV : 1 Survival Analysis and Reliability Theory

Unit-I : Concept of time, order and random censoring, likelihood in these cases. Life distributions (Exponential, Gamma, Weibull, Lognormal, Pareto). Parametric Inference (point estimation, confidence intervals, LR, MLE tests (Rao-Wilks-Wald) for these distributions.

Unit-II : Life tables, failure rate, mean residual life and their elementary properties. Ageing classes and their properties, Bath tube failure rate. Estimation of survival function. Acturial estimator, Kaplan-Meier estimator, Estimation under the assumption of IFR / DFR.

Unit-III : Test of Exponentiality against non parametric classes, total time on test, Deshpande test. Two sample problem. Gehan test, Log rank test. Mantel-Haensgel test, Tarone-Wane tests.

Unit-IV : Reliability concepts and Measures : Components & systems, coherent systems, reliability of coherent systems, cuts and paths, modular decomposition, bounds on system reliability, structural and reliability importance of components. Reliability function, hazard rate.

Unit-V : Stress-strength reliability and its estimation. Maintenance and replacement policies, availability of repairable systems, modeling of a repairable system by NHPP. Reliability growth models, probability plotting techniques.

References :

(1) Cox D.R. and Oakes D. (1984) : Analysis of Survival Data, Chapman and Hall, New York.
(2) Elandt-Johnson R.E., Johnson N.L. : Survival Models and Data Analysis, John Wiley and Sons.
(3) Miller R.G. (1981) : Survival Analysis, John Wiley.
(4) Barlow R.E. and Proschan F. (1985) : Statistical Theory of Reliability and Life Testing, Rinehart and Winston.
(5) Lawless J.F. (1982) : Statistical Models and Methods of Life Time Data, John Wiley.
(6) Bain L.J. and Engelhardt (1991) : Statistical Analysis and Reliability and Life Testing Models, Marcel Dekker.

Elective III/IV : 2 Operations Research

(Inventory, Queues & Network Analysis)

Unit-I : Inventory Problems : Structure of inventory problem, EOQ formula, EOQ model with uniform rate of demand & having no shortages, EOQ model with different rate of demand in different cycles having no shortages, EOQ model with uniform rate of demand & finite rate of replenishment having no shortages.'

EOQ model with uniform rate of demand, infinite rate of replenishment having shortages which are to be fulfilled, EOQ model with uniform rate of demand, & finite rate of replenishment and having shortages which are to be fulfilled.

Unit-II : EOQ model with single and double price breaks, P & Q systems with constant & random lead times, multi-item inventory subject to constraints. Single period probabilistic inventory models with-

(i) Instantaneous demand & discrete units.
(ii) Instantaneous demand & continuous units.
(iii) Continuous demand & discrete units.
(iv) Continuous demand & continuous units.

Unit-III : Sequencing Problems :
Processing n jobs through 2 machines.
Processing 2 jobs through m machines.
Processing n jobs through m machines.

Unit-IV : Queuing models : M / M/ I : ∞ / FCFS & its generalization.
M / M/ I : N / FCFS, M / M/ C : ∞ / FCFS
M / G / I : ∞ / FCFS & pollazeck khinchine result.
Machine interference problem.

Unit-V : Networking : Basic steps in PERT & CPM, methods of solving PERT problem, crashing the network, updating (PERT & CPM).

References :

(1) Tata H.A. : Operations Research
(2) Hiller F.S. & Leiberman G.J. : Introduction to Operations Research
(3) Kanti Swarup, Gupta P.K. & Singh M.M. : Operations Research
(4) Gross D. & Harris C.M. : Fundamentals of Queuing Theory

Paper MST 4E03

Elective III/IV : 3 Statistical Genetics and Bio-informatics

Unit-I : Basic biological concepts in genetics. Mendel's law, Hardy Weinberg equilibrium. Mating tables, estimation of allele frequency (dominant / co dominant cases).

Unit-II : Approach to equilibrium for X-linked gene, Natural selection, mutation, genetic drift, equilibrium when both natural selection and mutation an operative.

Unit-III : Non random mating, inbreeding, phenotypic assortative mating.

Unit-IV : Analysis of family data, (a) Relative pair data, I. T. O matrices, identity of descent, (b) family data - estimation of segretation ratio under ascertainment bias, (c) Pedigree data - Elston-Estewart algorithum for calculation of likelihood's. Linkage, Estimation of recombination fraction, inheritance of quantitative traits, models and estimation of parameters.

Unit-V : Sequence similarity, homology and alignment. Algorithms for (a) Pair wise sequence alignment, (b) multiple sequence alignment. Construction of Phylogenetic trees, UPGMA, Neighbour joining, maximum parsimony and maximum likelihood algorithms. Bayesian approach to Bio-informatics.

References :

(1) C.C.Li. (1976) : First Course on Population genetics, Boxwood Press, California.
(2) W.J.Ewens (1979) : Mathematical Population Genetics, Springer Verlag.
(3) T.Nagylaki (1992) : Introduction to Theoretical Population genetics, Springer Verlag.
(4) R.Durbin, S.R.Eddy, A.Krogh, G.Mitchinson (1998) : Biological sequence Analysis : Probabilistic Models of Proteins and Nucleic Acids.

Elective III/IV : 4 Clinical Trials

Unit-I : Introduction to clinical trials : the need and Ethics of clinical trials, bias and random error in clinical studies. Conduct of clinical trials, overview of Phase-I to IV trials, multi-center trials.
Data Management: Data definitions, case report forms, data base design, data collection systems for good clinical practice.

Unit-II : Design of clinical trials : Parallel Vs cross over designs, cross sectional Vs longitudinal designs, review of factorial designs, objectives and end points of clinical trials.

Unit-III : Design of Phase I trials, design of single-stage and multistage phase II trials, design and monitoring of Phase III trials with sequential stopping, design of bio-equivalence trials.

Unit-IV : Reporting and Analysis : Analysis of categorical out comes from Phase-I to III trials, analysis of survival data from clinical trials.

Unit-V : Surrogate end Points : Selection and design of trials with surrogate end points, analysis of surrogate end point data, Meta analysis of clinical trials.

Paired and unpaired tests, significance of clinical tests.

Reference :

(1) S.Pianta Dosi (1997) Clinical Trials : A Methodological Perspective, Wiley & Sons.

(2) C.Jennison and B.W.Turnbull (1999) : Group Sequential Methods with Applications to Clinical Trials, CRC Press.

(3) L.M.Friedman, C.Furburg, D.L.Demets (1998) : Fundamental of Clinical Trials, Springer Verleg.

(4) J.L.Fleiss (1989) : The design and Analysis of Clinical Experiments, Wiley & Sons.

(5) E.Marubeni & M.G.Valsecchi (1994) : Analyzing Survival Data from clinical trials and observational studies, Wiley & Sons.

Elective III/IV : 5 Actuarial Statistics

Unit-I : Utility theory, insurance and utility theory, models for individual claims and their sums, survival function, curtale future lifetime, force of mortality.

Life table and its relation with survival function, examples, assumptions for fractional ages, some analytical laws of mortality, select and ultimate tables.

Unit-II : Multiple life functions, joint life and last survivor status, insurance and annuity benefits through multiple life functions, evaluation for special mortality laws.

Multiple decrement models, deterministic and random survivorship groups, associated single decrement tables, central rates of multiple decrement, not single premiums and their numerical evaluations.

Unit-III : Distributions of aggregate claims, compound poisson distribution and its applications.

Principles of Compound Interest : Nominal and Effective rates of interest and discount, force of interest and discount, compound interest, accumulation factor, continuous compounding.

Life Insurance : Insurance payable at the moment of death and at the end of the year of death-level benefit insurance, endowment insurance, differed insurance and varying benefit insurance, recursions, commutation functions.

Unit-IV : Life Annuities : Single payment, continuous life annuities, discrete life annuities, life annuities with monthly payments, commutation functions, varying annuities, recursions, complete annuities - immediate and apportion able annuities-due.

Net Premiums : Continuous and discrete premiums, payment premiums, true monthly payment premiums, apportion able premiums, commutation functions, accumulation type benefits.

Unit-V : Net premium reserves : Continuous & discrete net premium reserves on a semi continuous basis, reserves based on true monthly premiums, reserves on apportion able or discounted continuous basis, reserves at fractional durations, allocations of loss to policy years, recursive formula and differential equations for reserves, commutation functions.

Some Practical Considerations : Premiums that include expenses - general expenses, types of expenses, per policy expenses.

Claim amount distributions, approximating the individual model, stop loss insurance.

References :

(1) N.L.Bowers, H.U.Gerber, J.C.Hikman, D.A. Jones and C.J.Nesbitt (1986) : Acturial Mathematics, Society of Acturia, Ithaca, Illiois, USA (2nd Ed.)

(2) Spurgeon E.T. (1972) : Life Contingencies, Cambridge University.

(3) Neill, A. (1977) : Life Contingencies, Heineman.

*****

Elective III/IV : 6 Econometrics-II

Unit-I : Theory of Production : Production function, properties of homogeneous production function. Cob-Douglas and C.E.S. production function.

Unit-II : Forms of market structures. Equilibrium under pure and perfect competition. Cob-web model. Monopoly and monopolistic competition.

Unit-III : Duopoly, oligopoly, cornet solution, kinked demand curve solution, stake berg solution. Market share solution. Necessary conditions for price discrimination.

Unit-IV : Macro-economics :- Consumption, saving and investment functions. Elementary ideas of keynes theory of income determination. Samuelson-Hicks model. Metzler's inventory cycle.

Unit-V : Capital accumulation, problems of stability. Technical progress. Simple growth models. Harrod-Domar, Neoclassical, Kaldar models.

References:

(1) J.M.Henderson and R.E.Quandt : Micro-economic Theory.
(2) R.G.D.Allen : : Micro-economic Theory
(3) A.A.Walter : An Introduction to Economics.
(4) Damodar Gujarathi : Basic Econometrics
(5) Kotsoyiannis A. : Modern Micro-Economics.
(6) Henry Theil : Introduction to Econometrics.
(7) Oskar Lange : Introduction to Econometrics.
(8) Mehta & Mehta : An Introduction to Econometrics.
(9) R.G.D.Allen : An Introduction to Macro-econometrics.
(10) D.Bose : Mathematical Economics.

Elective III/IV : 7 Bayesian Inference

Unit-I : Subjective interpretation of probability in terms of fair odds. Evaluation of (i) Subjective probability of an event using a subjective unbiased coin, (ii) Subjective prior distribution of a parameter. Bayes theorem and computation of posterior distribution.

Natural conjugate family of priors for a model. Hyper parameters of a prior from conjugate family. Conjugate families for (i) Exponential models, (ii) Models admitting sufficient statistics of fixed dimension.

Unit-II : Non informative, improper and invariant priors. Jeffrey's invariant priors.

Bayesian point estimation : As a prediction problem from posterior distribution. Bayes estimators for (i) absolute error, (ii) squared error, (iii) 0-1 loss functions. Generalization to convex loss functions. Evaluation of the estimate in terms of the posterior risk.

Unit-III : Bayes Interval Estimation :(Credible intervals, HPD regions). Interpretation of the confidence & efficient of an interval and its comparison with the interpretation of the confidence coefficient for a classical confidence interval.

Bayesian Testing : Specification of the appropriate form of the prior distribution for a Bayesian Testing & Hypothesis problem. Prior & Posterior odds, Bayes factors for various types of testing Hypothesis problems depending upon whether the null hypothesis and the alternative hypothesis are simple or composite. Specification of Bayes tests in these cases**.**

Unit-IV : Lindley's paradox for testing a point hypothesis for normal mean against the two sided alternative hypothesis. Bayesian prediction problems. Large sample approximations for the posterior distribution with examples.

Unit-V : Bayesian calculations for non conjugate priors :

(i) Importance sampling, (ii) obtaining a large sample of parameters values from the posterior distribution using acceptance-Rejection methods, MCMC and other simulation methods.

References:

(1) Berger J.D. (1985) : Statistical Decision Theory and Bayesian Analysis, Springer Verlag.,2nd Ed.
(2) Robert C.P. and Casella G. (1999) : Monte Carlo Statistical Methods, Springer Verlag.
(3) Leonard T. and Hsu J.S.J.(1999) : Bayesian Methods, Cambridge University Press.
(4) Degroot M.H. (1970) : Optimal Statistical Decision, McGraw Hill.
(5) Bernardo & Smith (1994) : Bayesian Theory, John Wiley and Sons.
(6) Gemerman D. (1997) : Markov Chain Monte Carlo : Stochastic Simulation for Bayesian Inference, Chapman Hall.

Elective III/IV : 8 Advanced Sampling Theory

Unit-I : Two stage sampling with unequal number of second stage units. Issues in stratified sampling : Allocation problems involving several study variables, stratum boundary, determination problems. Double sampling.

Unit-II : Introduction to Unified theory of finite population sampling, population, sample (ordered and unordered). Sample space, sampling design, parameters of sampling design & their properties sampling algorithm. Hanurao existence theorem. Parametric function, Estimability of parametric function. Classes of estimators (as suggested by Horvitz-Thompson)

Unit-III : Horvitz-Thompson estimator (HTE) of a finite population total / mean. Expression for variance of H-T estimator and its unbiased estimator. Concept of sufficiency in survey sampling and use of Rao-Blackwell theorem. Likelihood function. Generalization of H-T estimator, difference estimator.

Unit-IV : IPPS schemes of sampling due to Midzuno-sen, Brewer, Durbin and JNK Rao (Sample size 2 only). Rao-Hartley Cochran sampling. Schemes for sample size n with random grouping.

Unit-V : Super population models, design unbiasedness & model unbiasedness. Criteria for comparison prediction approach.

Reference :

(1) P.Mukhopadhyay : Theory and Methods of Survey Sampling.
(2) Daroga Singh and Choudhary : Theory and analysis of sample survey designs.
(3) Murthy M.N. : Sampling Theory and Methods.
(4) Cochran W.G. : Sampling Techniques.
(5) Des-Raj and Chandak : Sampling Theory
(6) Sukhatma P.V. & B.V. : Sampling Theory of Surveys with Applications.
(7) Cassel, Sarandal & Wretman : Foundation course in survey sampling for finite population.

*****

INDEX

M.Sc.Part-I & Part-II (Semester I to IV) Examinations in Statistics
(Prospectus No.20091218)