SYLLABUS

STATISTICS

M.A./ M.Sc. (Previous) Examination 2016

M.A./M.Sc. (Final) Examination 2017

JAI NARAIN VYAS UNIVERSITY
JODHPUR

MASTER OF SCIENCE

General Information for Students

The examination for the degree of Master of Science will consist of two examinations: (i) The Previous Examination, and (ii) The Final Examination.

The subject of examination shall be one of the following:

Mathematics, Statistics, Physics, Electronics, Chemistry, Zoology, Geology, Botany and Home Science.

The examination will be through theory papers/practicals. Pass marks for the previous and final examination are 36% of the aggregate marks in all the theory papers and practicals and not less than 25% marks in an individual theory paper. A candidate is required to pass in the written and the practical examinations separately.

Successful candidates will be placed in the following division on the basis of the total marks obtained in previous and final examinations taken together.

First division 60%; Second division 48% and Third division 36%. No student will be permitted to register himself/herself simultaneously for more than one post-graduate course.

ATTENDANCE

1. For all regular candidates in the faculties of Arts, Education and Social Sciences, Science, Law and Commerce the minimum attendance requirement should be that a candidate should have attended atleast 70% of the lectures delivered and tutorials held taken together from the date of her/his admission.
2. The shortage of attendance upto the limits specified below may be condoned.
   (i) Upto 3% of the total (a) Lectures delivered and tutorials held (taken together), and (b) Practicals or Practicals and Sessionals subject-wise condonable by the Dean/Director/Principal on the recommendation of the Department concerned.
   (ii) Upto 6% including (i) above by the Syndicate on the recommendation of the Dean/Director/Principal.
   (iii) Upto 5% attendance in all subjects/papers/practicals and sessionals (taken together) by the Vice-Chancellor in special cases, on the recommendation of the Dean/Director/Principal.
3. The N.C.C. cadets sent out to parades and camps and such students who are deputed by the University to take part in games, athletics or cultural activities may, for purpose of attendance, be treated as present for the days of their absence in connection with the aforesaid activities and that period shall be added to their total attendance subject to the maximum of 20 days.
4. Advantage of fraction while calculating the attendance, shall be given to the candidate.

FACULTY OF THE DEPARTMENT AND THEIR RESEARCH/TEACHING INTEREST

Sr. No.	Name/Designation	Academic Qualification	Field of Specialization
	Professor		
01.	Dr. Chena Ram **(Head)**	M.Sc., Ph.D.	Special Functions, Fractional Calculus, Statistical Distributions.
02.	Dr. R.K.Yadav	M.Sc., Ph.D.	Special Functions, Integral Transforms, Fractional Calculus, Complex Analysis.
03.	Dr. Jeta Ram	M.Sc., Ph.D.	Integral Transform, Fractional Calculus, Special Functions
	Associate Professor		
04.	Dr. R.K.Gupta	M.Sc., Ph.D.	Special Functions, Fractional Calculus, Integral Transforms
05.	Dr. Vijay Mehta	M.Sc., Ph.D.	Fluid Dynamics and M.H.D.
06.	Dr. Aiyub Khan	M.Sc., Ph.D.	Computational Fluid Dynamics
	Assistant Professor		
07.	Dr. Ramdayal Pankaj	M.Sc., Ph.D.	Applied Mathematics
08.	Mr. Madan lal	M.Sc., B.Ed.	Operations Research

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There will be four theory papers as given below:

Paper I: Special Functions and Matrix Algebra

Paper II: Probability and Sampling Distributions

Paper III: Statistical Inference

Paper IV: Sampling Techniques and Design of Experiments

Each Paper will be of 100 marks.

Practical: The practical examination will be of 8 hours duration spread over two days. It will be conducted by two separate boards of examiners one for Part A and the other for Part B. Each board of examiners shall award marks out of 100. The marks shall be out of 200 for both the parts and shall be consolidated by the tabulators.

The distribution of marks shall be as follows:

Part A: Practical exercises based on

Paper II and III	75 Marks
Record	15 Marks
Viva-voce	10 Marks
Total	**100 Marks**

Part B: Practical exercises based on

Paper IV	75 Marks
Record	15 Marks
Viva-voce	10 Marks
Total	**100 Marks**

For ex-students the total marks obtained in practical exercises and viva-voce will be converted out of 100 marks.

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Note: Each theory paper is divided in three parts i.e. Section – A, Section – B and Section – C
Section A: Will consist of 10 compulsory questions. There will be two questions from each unit and answer of each question shall be limited up to 30 words. Each question will carry 2.
Section B: Will consist of 10 questions. Two questions from each unit will be set and students will answer one question from each Unit. Answer of each question shall be limited up to 250 words. Each question will carry 7
Section – C: Will consist of total 05 questions. The paper setter will set one question from each Unit and Students will answer any 03 questions and answer of each question shall be limited up to 500 words. Each question will carry 15.

PAPER – I
Special Functions and Matrix Algebra

Duration of Paper : 3 Hours **Max. Marks: 100**

Unit 1 : Definition of hypergeometric series and functions. Properties of hypergeometric functions. Integral representation for the Gaussian hypergeometric function ${}_2F_1(.)$. Linear transformations and contiguous relations for ${}_2F_1(.)$.

Unit 2 : Linear relation between the solutions of hypergeometric differential equation. Kummer's Confluent hypergeometric function. Elementary properties of the generalized hypergeometric function ${}_pF_q(.)$.

Unit 3 : Legendre Polynomials and Bessel functions of first and second kind, their generating functions, orthogonal properties, recurrence relations.

Unit 4 : Definitions, Generating functions, orthogonality, Rodrigue's formula and recurrence relations related to the classical polynomials like: Legendre Polynomials, Hermite Polynomials and Laguerre Polynomials.

Unit 5 : Eigen value problem, Cayley-Hamilton theorem and its application to compute inverse of a matrix; Eigen vectors, Diagonalization of a matrix, sylvester's theorem, linear dependence and independence of vectors. Differentiation and integration of matrices. Computation of Eigen values by iteration (power) method. Deflation of a matrix, Wielandt's Deflation.

BOOKS RECOMMENDED

1. Rainiville, E.D.: Special Functions. Macmillan & Co. New York (1960).
2. Sneddon, I.N.: Special Functions of Mathematical Physics and Chemistry, Oliver and Byod (1961).
3. Labedev, W.N.: Special Functions and their Applications. Dover, (1972).
4. Saxena, R.K. and Gokhroo, D.C.: Special Functions, Jaipur Publishing House (2004).
5. Shanti Narayan, Matrices. S.Chand & Co.

Paper – II

PROBABILITY AND SAMPLING DISTRIBUTIONS

Duration of Paper : 3 Hours **Max. Marks : 100**

Unit 1: Axiomatic approach to the theory of probability, Random variable (Discrete and Continuous). Cumulative Probability Distribution Function, Probability mass function, probability density function, Joint conditional and marginal distributions, Mathematical expectation and moments, Chebyshev's and Schwartz's inequalities.

Unit 2: A detailed study of discrete probability distribution such as Bernoulli, Binomial, Poisson, Negative Binomial, Hypergeometric, Geometric and Multinomial distributions, Various properties of these distributions and applications.

Unit 3: Continuous probability Distributions: Normal, Lognormal, Beta type I, Beta type II, exponential, double exponential Gamma and Cauchy distribution, Central and non-central chi-square and F-distributions, Fisher's distributions.

Unit 4: Generating functions (m.g.f., c.g.f. and p.g.f.), characteristic functions, inversion theorem; Convergence in probability, Weak and Strong law of large numbers, Various forms of Central limit theorem.

Unit 5: The measure theoretic approach of probability, set-function, Continuity of set-function, additive set-function, measure, measure space, measurable sets, simple functions, elementary functions, measurable functions, measurability theorem.

BOOKS RECOMMENDED

Parimal Mukhopadhyay: Mathematical Statistics, Pub. Books & Allied (P) Ltd.,

Mood, Graybill and Boes: Introduction to the Theory of Statistics, III Edition

Hogg, K.V. and Craig, A.T.: Introduction to Mathematical Statistics

Loeve, M.: Probability Theory

Pitt, L.R.: Integration, Measure and Probability

Kingman and Taylor: Introduction to Probability and Measure

PAPER III

STATISTICAL INFERENCE

Duration of Paper : 3 Hours **Max. Marks : 100**

Unit 1: The general set-up of Statistical decision problem: Concepts of loss function, risk function, admissible decision function. Bayes estimation, Bayes risk, Bayes rule, minimax principle, minimax estimate.

Unit 2: Point estimation, unbiased and consistent estimators, concept of efficient estimators, Cramer-Rao inequality and its use to obtain UMVU estimators, Examples to show-that C-R bound may not be attained. Definition of Sufficiency through conditional distributions and through factorization theorem. Proof of equivalence of the two definitions, Rao-Black-well theorem, jointly sufficient statistics.

Unit 3: Methods of estimation: Maximum likelihood, Method of moments. Parametric Interval estimation: Confidence intervals, one sided confidence interval, Pivotal quantity. Sampling from the Normal distributions. C.I. for mean and variance. *Simultaneous confidence region for the mean and variance. C.I. for difference in means. Methods of finding confidence intervals: Pivotal quantity methods, statistical method, large samples, confidence intervals.

Unit 4: Bivariate Normal distribution and its properties. Linear Models: Linear statistical models under normality and non-normality assumptions, point estimation, Gauss-Markov theorem, Tests of hypothesis concerning the parameters of linear regression model.

Unit 5: Testing of hypothesis: Critical region, level of significance, power function, Neyman-pearson Lemma, Large and small tests. The X^2-test for goodness of fit. X^2-test for independence in contingency tables. The Fisher-Irwin test for 2x2 table Non-parametric tests: Sign, run, median, Kolmogorov-Smirnov tests, Wilcoxon signed rank test, Mann-Whitney U-test (Only test procedures and their applications).

BOOKS RECOMMENDED

Kendall, M.G. and Stuart, A: Advanced Theory of Statistics, Vol. I,II

Mukhopadhayay, P.: Mathematical Statistics, Pub. Books & Allied (P.Ltd.,)

Mood, A.M., Graybill and Boes: Introduction to Theory of Statistics, III Ed.

Rotagi, V.K.: Statistics Inference (Wiley and Sons).

PAPER IV
SAMPLING TECHNIQUES AND DESIGN OF EXPERIMENTS

Duration of Paper : 3 Hours **Max. Marks : 100**

Unit 1: Simple Random Sampling: Estimation of proportions for k(>2) classes, Inverse sampling, Quantitative and Qualitative characteristics, estimation of the sample size. Sampling with varying probabilities with replacement; Sampling with pps: cumulative and Lahiri's methods, estimation of population mean, its variance and estimation of variance.

Unit 2: Stratified Random Sampling; Effects of deviation from optimum allocation, estimation of proportions, post-stratification, inaccuracy in strata sizes construction of strata, combined and separate ratio estimators, their variances and estimation of variances. Linear regression estimation with pre assigned and estimated.

Unit 3: Ratio method of Estimation: Product estimator, Hartley and Ross unbiased ratio type estimation, Quenouille's technique of bias reduction, Multivariate extension. Cluster sampling (Unequal clusters). Estimates of the mean and their variances, sampling with replacement and unequal probabilities.

Unit 4: Concepts of experiments, determination of number of replications, contrasts, Models of analysis of variances, analysis of two-way orthogonal data with m observations per cell, missing plot techniques.

Unit 5: Factorial experiments with factors at two and three levels, complete and partial confounding, split plot design and its analysis, BIBD, construction of simple BIBD.

BOOKS RECOMMENDED

Mukhopadhaya, P.: Theory and Methods of Survey Sampling, Pub. Prentice-Hall of India Pvt. Ltd.,

Sukhatme, P.V. et al.: Sampling Theory of Surveys with Applications

Cochran, W.G.: Sampling Techniques, 3rd ed.

Goon, Gupta and Das Gupta: Fundamentals of Statistics, Vol.II

Joshi, D.D.: Design of Experiments

Goulden: Statistical Methods.

PRACTICALS

(A) PRACTICAL EXERCISES BASED ON PAPERS II AND III

1. Fitting of distributions such as:
   Binomial, Poisson, negative binomial, geometric normal, lognormal and exponential distributions.
2. Fitting of curves such as:
   Polynomials, logarithmic and exponential curves
3. Tests of significance based on Barlett-test and Fisher's Z-Transformation.
4. Tests of significance of sample correlation and regression coefficients.
5. Non-parametric tests such as:
   Sign test, run test, median test, Wilcoxon signed rank test, Mannwhitney U-test and Kolmogorov-Smirnov Test.

(B) PRACTICAL EXERCISES BASED ON PAPER – IV

1. Analysis of variance with one-way classifications with single and multiple observations per cell.
2. Analysis of RBD and LSD with missing observations.
3. Analysis of BIBD.
4. Analysis of factorial experiments.
5. Analysis of split plot in RBO
6. Drawing of random samples from finite populations and binomial and normal populations.
7. Estimation of mean and variance in using combined and separate ratio estimators.
8. Gain in precision due to stratification.
9. Estimation of population mean using Linear Regression estimator.
10. Estimation of population mean and variance of sample mean in cluster sampling for equal and unequal probabilities.
11. Estimation of population mean and variance of sample mean and total by ratio product and regression methods of estimation.
12. Drawing of pps samples using cumulative and Lahiri's methods and estimation of population mean and total.

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

Examination 2017

There will be two compulsory and two optional papers.

COMPULSORY PAPERS

Paper I: Statistical Inference and Multivariate Analysis

Paper II: Sample Surveys

Paper III:& IV: Optional (Any two of the following):

(i) Operations Research
(ii) Non-parametric Statistical Inference and Sequential Analysis
(iii) Advanced Theory of Design of Experiments
(iv) Stochastic Processes
(v) Mathematical Economics and Econometrics

Each paper will of be 100 marks.

PRACTICALS

The practical examination will be of eight hours (8) duration spread over two days. The distribution of marks will be as follows:

Part (A)	(i)	Practical exercises based on Multivariate Analysis, Statistical Inference and Sampling Theory	75 Marks
	(ii)	Record	15 Marks
	(iii)	Viva-voce	10 Marks
	Total		**100 Marks**

For ex-students the total of marks obtained in A (i) and A (iii) will be converted out of 100 marks.

Part B In this part the students will be given a comprehensive theoretical and practical training on computer applications. The distribution of marks will be as follows:

(i)	Writing programs	60 Marks
(ii)	Running programs on Computer	15 Marks
(iii)	Record	15 Marks
(iv)	Viva-voce	10 Marks
	Total	**100 Marks**

For ex-students the total of marks obtained in B (i), B (ii) and B (iv) will converted out of 100 marks.

Total marks for practical including Part A and Part B both = 200 marks.

Note: Each theory paper is divided in three parts i.e. Section – A, Section – B and Section – C
Section A: Will consist of 10 compulsory questions. There will be two questions from each unit and answer of each question shall be limited up to 30 words. Each question will carry 2.
Section B: Will consist of 10 questions. Two questions from each unit will be set and students will answer one question from each Unit. Answer of each question shall be limited up to 250 words. Each question will carry 7
Section – C: Will consist of total 05 questions. The paper setter will set one question from each Unit and Students will answer any 03 questions and answer of each question shall be limited up to 500 words. Each question will carry 15.

PAPER I
STATISTICAL INFERENCE AND MULTIVARIATE ANALYSIS

Duration of Paper : 3 Hours **Max. Marks : 100**

Unit 1: Proof of the properties of maximum likelihood estimators, scoring method. Generalization of Cramer-Rao-Inequality for multi parameter cases, Complete family of probability distributions, Complete statistics and minimal sufficiency, Lehmann-Scheffe theorem on minimum variance and its applications.

Unit 2: Testing of Hypothesis: Composite hypotheses, Generalized likelihood Ratio-Test, Uniformly Most Powerful Test, Monotone likelihood ratio, Unbiasedness, Tests of hypothesis sampling from normal population. Tests for means and variances.

Unit 3: Multivariate normal distribution and its properties, Density function, marginal and conditional distribution, Distribution of quadratic form.

Unit 4: Maximum likelihood estimators of the mean vector and variance, covariance matrix. Null and non-null distributions of partial and multiple correlation coefficient.

Unit 5: Hotelling's T^2 distribution and its properties, Mahalanobis D^2, classification of observations, Wishart distribution.

BOOKS RECOMMENDED

Kendall, M.G. and Stuart, A.: Advanced Statistical Inference, Vol.II

Mood, Grabill and Boes: Introduction to the Theory of Statistics

Anderson, T.W.: An Introduction to Multivariate Statistical Analysis, Second Edition.

PAPER II

SAMPLE SURVEYS

Duration of Paper : 3 Hours **Max. Marks : 100**

Unit 1: Super Population Models & Model Based Approach: Predictive estimation, p-unbiasedness, e-unbiasedness, Anticipated mean square error, optimality of ratio and regression estimators, Comparison of PPSWR with SRS Double sampling ratio and regression estimators and their variances, cost function. Successive sampling: estimation of mean and its variance (for h = 2).

Unit 2: Concepts of sufficiency, Rao-Blackwelliation, Admissibility and likelihood function in Survey Sampling. Estimator based on distinct units and its variance. Non-existence of uniformly Minimum Variance unbiased estimator. Two stage sampling (equal f.s.u.) estimation of the population mean, its variance and estimate of the variance. Two stage sampling (unequal f.s.u.): Unbiased and biased (excluding ratio estimator) estimators of population mean and their mean square errors.

Unit 3: Ordered estimator: Des Raj's ordered estimator and estimate of the variance (General case), variance of the estimator (for n = 2). Unordered estimator: Murthy's unordered estimator, variance and estimate of the variance. Rao-Hartley Cochran's sampling procedure. Unbiased estimator, its variance and estimate of the variance.

Unit 4: Sampling with unequal probabilities wor: The Narain-Horvitz-Thompson's estimator and its variance, optimal properties of the NHT's estimator, Yates and Grundy's estimate of variance, its non-negativity under Midzuno system of sampling. Small Area Estimation: Direct Estimators, Design based synthetic and composite estimators (under SRSWOR, Stratified Sampling).

Unit 5: Non- sampling errors: Incomplete samples, effects of non-response, Hansen and Hurvitz Technique, Demming's model, Politz and Simon's technique, Randomized response technique, Warner's method.

BOOKS RECOMMENDED

Mukhopadhyay, P.: Theory & Methods of Survey Sampling, Pub., Prentice-Hall of India, New Delhi.

Sukhtme, P.Y. et al.: Sampling Theory of Surveys with Applications.

Cochran, W.G.: Sampling Techniques, III ed.

Murthy, M.N.: Sampling Theory and Methods

Cassel, C.M., Sarndal, C.C. and Wretman, J.H.: Foundations of Inference in Survey Sampling.

PAPER III & IV

(i) OPERATIONS RESEARCH

Duration of Paper : 3 Hours **Max. Marks : 100**

Unit 1: Definition and scope of OR, different types of OR models, Linear Programming, convex set and basic feasible solutions of a L.P. model, the geometrical and simplex methods, duality theorem, transporation and assignment problems

Unit 2: Inventory control: Elementary inventory models, economic lot size formulae of Harria in case of known demand and its extension allowing shortages, the case of probabilities demand, discrete and continuous cases.

Unit 3: Replacement problems; replacements of items that depreciate, that fail accounting to probability law, elementary life-testing and estimation techniques of Epstein, staffing problems.

Unit 4: Theory of games; fundamental definitions, strategies minimax solution criterion of two person zero sum games with and without saddle point.

Unit 5: Queueing Theory: The queue with poisson and exponential input, Enlaogian, regular and general service times, the queue length, busy period and waiting time (steady state case), transient solution of MMP.

BOOKS RECOMMENDED

Churchman, Ackoff and Arnoff: Introduction to Operations Research

Sasini, Yaspal and Fiedmen: Operations Research Methods and Problems

Saaty, T.L.: Mathematical Methods of Operation Research

Mckimey: Introduction to Theory of Games.

PAPER III & IV

(ii) NON-PARAMETRIC STATISTICAL INFERENCE AND SEQUENTIAL ANALYSIS

Duration of Paper : 3 Hours **Max. Marks : 100**

Unit 1: Distribution free and non-parametric methods, order statistics, joint distribution of order statistics, marginal distribution of order Statistics, distribution of median and range, exact moments, confidence interval estimates for population quantities.

Unit 2: Exact null distribution of R, moments of the null distribution of R, tests based on 'total number of runs, chi-square goodness of fit test, empirical distribution-function, Kolmogorov-Smirnov one sample test and its merits and demerits.

Unit 3: Ordinary sign test, Wilcoxon signed rank test, Kolmogorov-Smirnov two sample test, median test.

Unit 4: Sequential analysis: Wald's SPR test, properties of SPRT, OC and ASN functions of SPRT.

Unit 5: Applications of SPRT, Testing of mean of a binomial distribution, testing of mean of a normal distribution with known and unknown standard deviations.

BOOKS RECOMMENDED

Seigel, S.: Non-Parametric Statistics for Behavioural Sciences, Mc-Graw Hill.

Wald, A.: Sequential Analysis

Gibbons, J.D.: Non-Parametric Statistical Inference, McGraw Hill.

(iii) ADVANCED THEORY OF DESIGN OF EXPERIMENTS

Duration of Paper : 3 Hours **Max. Marks : 100**

Unit 1: Theory of linear estimation, B.I.B.D., construction and analysis with and without recovery of interblock in formation.

Unit 2: P.B.I.B.D. Two associate clssses. P.B.I.B.D. Group divisible designs, triangular designs, Latin square type designs.

Unit 3: Confounding in factorial experiments, confounding in more than two blocks, partial confounding, experiments with factors at three levels, asymmetrical factorials designs, confounded asymmetrical factorial, constructions of balanced confounded asymmetrical factorials.

Unit 4: Orthogonal latin squares, construction of orthogonal latin squares, lattice designs, weighing designs, method of estimation, incomplete block designs as weighing designs.

Unit 5: Analysis of covariance for completely randomized design, randomized block designs and latin square design for non-orthogonal data in two-way classifications and with missing observations.

BOOKS RECOMMENDED

Chakrabarti, M.C.: Mathematics of Design of Experimetns

Joshi, D.D.: Design of Experiments, Wiley Eastern

(iv) STOCHASTIC PROCESSES

Duration of Paper : 3 Hours **Max. Marks : 100**

Unit 1: Discrete stochastic processes, convolutions compound distribution, recurrent events, delayed recurrent random walk models, absorbing, reflecting and elastic barriers.

Unit 2: Gambler's ruin problems and limiting diffusion processes, Markoff chains, transition probability, classification of states and chains, irreducible chains.

Unit 3: Spectral resolution of a matrix, evaluation of p(n) discrete branching process.

Unit 4: Continuous stochastic process, Markoff process in continuous times, Poisson Process, Weiner process, Kolmogorov equations random variable techniques.

Unit 5: Homogeneous birth and death process, divergent birth process, the effect of immigration, the general birth and death process.

BOOKS RECOMMENDED

Feller, W.: Introduction to Theory of Probability, Vol. J, Chaps, XI, XV.

Bailey, N.T.J.: Introduction to Stochastic Processes

Takacs, M.: Stochastics Process, Chapts. I and II.

(v) MATHEMATICAL ECONOMICS AND ECONOMETRICS

Duration of Paper : 3 Hours **Max. Marks : 100**

Unit 1: The theory of consumer behavior: Utility and indifference curve analysis. Demand functions, elasticity of demand, income and leisure, linear expenditure system, theory of relealed preference, composite commodities, situations involving risk, behavior under uncertainty

Unit 2: The theory of firm, production function, Cobb Douglas functions. CES production functions, Elasticity of substitution; input demands, cost function, Euler's theorem, Duality in production, production under uncertainty

Unit 3: Econometrics: Simple two variable models, ordinary least square estimates, maximum likelihood estimates, Multivariate least square regression.

Unit 4: Important single equation problems, errors in variables. Auto-correlation, multi-collinearity, Heterosced Sticity, Dummy variables.

Unit 5: Simultaneous equation model, need, problem of identification estimation of exactly identified equation, indirect least squares, estimation of over identified equations. Two-Stage least squares

BOOKS RECOMMENDED

(Henderson and Quandt: Micro Economic Theory, 3rd Ed., Chps. 2 and 3).

(Henderson and Quandt: Micro Economic Theory, Chaps. 4 and 5).

(from Unit 3 to 5, Johnston: Econometric Method (II ed.): Chaps. 1 to 3, 5, 6, 7, 8, 9, 10 and 12).

PRACTICALS

List of practical exercise for Part A:

1. Estimation of mean: vector and covariance matrix.
2. Estimation and testing of partial and multiple correlation coefficients.
3. One sample and two sample problems using Hotelling's T^2 statistics.
4. Exercise based on Mahalnobis D^2 Statistics.
5. Exercises based on MLE using Rao's scoring method.

6. Narain-Horvitz-Thompson estimator and its variance.
7. Estimate of the Variance of NHT's estimator due to Horvitz and Thompson Yates and Grundy.
8. Des Raj's ordered and Murthy's unordered estimators and the estimate of their variances.
9. R.H.C. sampling procedures.
10. Double sampling for ratio and regression methods of estimation.
11. Estimation of the mean on the current occasion and its estimate of variance for n = 2.
12. Exercises based on two stage sampling.
13. Exercises based on small area estimation.

Details of Practical Work to be done in Part B:

(i) The following theoretical portions will be taught:
Fortran Preliminaries; classes of data, Type specification statements, implicit statements, Arithmetic operations, substring operations, logical operations, Assignment Statement, unformatted input output statement, STOP and END statements.

Relational Expressions: Logical expression, Arithmetic expressions, GO TO and computed GO TO statements.

Logical IF statements, nested Block IF structure, Repetitive structures, IF loop, DO loop, Nested DO loop, Format directed input and output.

Subscripted variables, Dimension, Statement, Additional data types complex type, Subprogrammes: Functions, Subroutines, Recursion, Call Statement, Common Data and Save Statements, file processings: Opening and closing files, file input and output, input and ouput using Array Name, Do loop and implied Do loop, Programme statement. Pause statement, assigned GO TO statement, Equivalence statement.

(ii) The programmes on the following topics will be run on the computer:

Forming the frequency distribution (Univariate and Bivariate) from the raw data stored in a file.
Calculating the different measures from raw data and grouped data

Fitting the curves using method of least squares

Fitting of distributions

Calculating simple correlation coefficient partial and multiple correlation coefficients, computation of regression equations in two and multivariables.