Department of Statistics

KAKATIYA UNIVERSITY, WARANGAL

M.Sc (Statistics) CBCS Pattern with Semester system

SEMESTER -I

S.No	Paper Code	THEORY Title of Paper	No. of Credits	Marks External	Marks Internal	Marks Total
1	ST101T	Mathematical Analysis and Matrix Theory (MAMT)	**04**	**80**	**20**	**100**
2	ST102T	Probability Theory (PT)	**04**	**80**	**20**	**100**
3	ST103T	Distribution Theory (DT)	**04**	**80**	**20**	**100**
4	ST104T	Theory of Estimation (TOE)	**04**	**80**	**20**	**100**
		Practical				
5	ST105P	C-Lab	**04**	**100**	**----**	**100**
6	ST106P	MAMT + DT +TOE	**04**	**100**	**-----**	**100**
7	ST107S	Seminar	**01**	**----**	**25**	**25**
		TOTAL:	**25**	**520**	**105**	**625**

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Summary of all Semesters

S. No	Semester	No. of Credits	Marks
1	I	25	625
2	II	25	625
3	III	25	625
4	IV	25	625
	Total	**100**	**2500**

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M.Sc. (STATISTICS)
Semester-I
ST101T: PAPER- I

MATHEMATICAL ANALYSIS AND MATRIX THEORY (MAMT)

UNIT – I

Uniform Convergence of Sequences and Series of functions, Cauchy criterion for uniform convergence – M_n test and Weierstrass test, - uniform convergence and integration, statements on uniform convergence and continuity, uniform convergence and differentiation.

UNIT – II

Improper Integrals: Definition of improper integrals of first and second kind – statements of comparison tests for convergence - definitions and convergence of Beta and Gamma functions.

Integrals as functions of parameter: Definite integral as function of a parameter-inversion of differentiation and integration, inversion of the order of integration. Functions of Several Variables: Concept of partial derivatives – maximum and minimum values of functions of two variables – method of Lagrange multipliers.

UNIT – III

Multiple Integrals: Double and triple integrals – use of Jacobian in evaluation of multiple integrals.

Functions of Complex Variables : Concept of continuity and derivative of complex functions – Analytic functions – Cauchy-Reimann equations – Statements of Cauchy theorem, Cauchy integral formula, Statements of Taylor's and Laurent's series – Singular points – poles – Residues – Statement of Residue theorem – Evaluation of definite integrals.

UNIT – IV

Matrices: Quadratic forms in real field – rank and index – Classification of real quadratic forms – necessary and sufficient condition for a definite form.

Characteristic roots and Characteristic Vectors of a matrix – nature of characteristic roots of Hermitian and Orthogonal matrices.

Generalised Inverse of a Matrix: Definition of generalised inverse and its applications to solution of linear equations - The Moore – Penrose inverse – Least Squares solutions of inconsistent linear equations.

REFERENCES:

1. Principles of Mathematical Analysis – S.C. Malik
2. A Course of Mathematical Analysis – Shantinarayan
3. Advanced Calculus – Murray R. Spiegal (Schaum Series)
4. Text book of Matrices – Shantinarayan and Mittal (S. Chand)
5. First Course in Linear Algebra – P.B. Bhattacharya, S.K. Jain and S.R. Nagpal

(Wiley Eastern)

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M.Sc. (STATISTICS)
Semester-I
ST102T: PAPER-II

PROBABILITY THEORY (PT)

UNIT – I

Concepts of Probability: Probability as a measure defined on σ – field, Sample space, probability axioms, combinatorics: Probability defined on finite sample spaces, Conditional probability and Bayes theorem. Random Variables, Probability distribution of a Random variable, discrete and continuous random variables, functions of a random variable.

UNIT – II

Expectation of functions of random variables, Conditional Expectation and conditional variance, Generating functions: m.g.f., p.g.f. and their properties, Characteristics function of a random variable and its properties, Inversion theorem, Uniqueness theorem, Levy's Continuity theorem (Statement only), Moment inequalities: Chebychev, Markov, Cauchy-Schwartz, Jenson, Liapounou, Holder's and Minkowsky's inequalities.

UNIT – III

Sequence of random variables, Convergence in distribution, Convergence in probability, Convergence in quadratic mean, almost sure convergence and their interrelationships, Borel-Cantelli lemma (Borel 0 – 1 law), Kolmogorov 0 -1 law, Glevenco–Cantelli lemma (Statement only)

UNIT – IV

Law of large numbers, Weak law of large numbers, Bernoulli and Khinchen's WLLN's, Kolmogorov inequality, kolmogorov SLLN for independent variables and statement only for i.i.d. case.
Central Limit Theorems : Demoviere – Laplace, Lindberg – Levy, Liapounou CLT's, statement of Lindberg-Feller CLT.

REFERENCES:

1. Rohatgi, V.K. (1988): Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.
2. Bhat, B.R.: Modern Probability Theory, 3rd Edition, New Age India.
3. Feller, W: An Introduction to Mathematical Statistics.

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M.Sc. (STATISTICS)
Semester-I
ST103T: PAPER-III

DISTRIBUTION THEORY (DT)

UNIT – I

Discrete and continuous Distribution: Binomial, Poisson, Negative Binomial, Geometric, Hyper Geometric, Rectangular, Normal Exponential, Beta, Gamma, Log-normal, Weibull and Cauchy distributions and their properties.

UNIT – II

Families of Distributions: Power series distributions, Exponential family of distributions, Bivariate normal, Bivariate exponential, Compound Binomial and Compound Poisson distributions.

UNIT – III

Sampling Distributions: Joint distributions of , S^2 and their independence, Central and non-central χ^2, t and F distributions and their properties.

UNIT – IV

Order Statistics, their distribution and properties, Joint and marginal distributions of Order Statistics, Extreme values and their asymptotic distributions (statements only) with applications, distribution of sample quantiles.

REFERENCES

1. Rohatgi, V.K. (1984): An Introduction to probability Theory and Mathematical Statistics, Wiley Eastern.
2. Rao, C. R. (1972): Linear Statistical Inference and its Applications, 2nd Ed, Wiley Eastern.
3. Jhonson & Kotz (1972): Distributions in Statistics, Vol. I, II and III, Houghton and Miffin.
4. Pitman. (1973): Probability, Narosa Pub. House.

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M.Sc. (STATISTICS)
Semester-I
ST104T: PAPER-IV

THEORY OF ESTIMATION (TOE)

UNIT – I

Point Estimation vs Interval Estimation, advantages, sampling distribution, Likelihood function, Exponential family of distributions.

Desirable properties of a good estimator: Unbiased ness, Consistency, Sufficiency and Efficiency with examples, Neyman – Fisher factorization theorem, (Proof in the discrete case only) examples, UMVU Estimation, Rao – Blackwell theorem , Fisher Information, Cramer – Rao inequality and Bhattacharya bounds.

UNIT – II

Completeness, Lehman – Scheffe theorem, Median and modal unbiased estimation, Interval estimation, Confidence level, CI with shortest length, Confidence intervals for the parameters of Normal, Binomial and Poisson distributions.

UNIT – III

Methods of Estimation: Methods of moments and maximum likelihood method, properties of MLE: Consistency and asymptotic normality of the consistent solutions of likelihood equations, Definitions of BAN and CAN estimators.

UNIT – IV

Prior and Posteriori distributions, Baye's estimator, examples. Baye's confidence intervals, examples.

REFERENCES :

1. Rohatgi, V.K. (1988) : An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.
2. Goon, Gupta & Das Gupta : Outlines of Statistics, Vol-2, World Press, Calcutta.
3. Kale, B.K. (1999) : A First Course on Parametric Inference, Narosa Pub. House.

4. Rao, C.R. (1973) : Linear Statistical Inference and its Applications.
5. Kendall & Stuart : Advanced Theory of Statistics. Vol.II.

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M.Sc. (STATISTICS)
Semester-I
ST105P: Practical-I

PRACTICALS of C- Lab

***Theory to be covered*:**

Constants, Variables and data types, operators and expressions, Input and output operators, Decision making and Branching, Decision making and looping, Arrays. Handling of Character strings, User defined functions. Structures and Unions, Pointers, File management in C.

List of Practicals:

1. Factorial of a given number.
2. Fibonacci Series generation.
3. Evaluation of e^x , Sin (x) and cos (x) using series expansion.
4. Computation of mean, variance, standard deviation and coefficient of variation of a set of numbers.
5. Finding the correlation coefficient and fitting a straight line.
6. Sorting numbers by Bubble sort and find the median.
7. Multiplication of Matrices.
8. Preparation of frequency table using functions.
9. Generation of Pyramid of numbers.
10. Generation of Pascal triangle.

REFERENCES:

1. Balagurusamy. E. (1992) : Programming in Anci 'C'
2. Schaum's Series (1996) : Programming with 'C', 2nd Ed., (TMH)

3. Ravichandrn. D. (1996) : Programming in 'C', New Age

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M.Sc. (STATISTICS)
Semester-I
ST106P: Practical-II

PRACTICALS of Matrix Theory+DT+TOE

MATRIX THEORY

1. Inverse of a Matrix by partition method.
2. Solution of linear equations by sweep out method.
3. Solution of linear equations by Gauss – Doolittle method.
4. Computation of Moore – Penrose inverse by Penrose method
5. Computation of generalized inverse of matrix.
6. Formation of characteristic equation by using traces of successive powers.
7. Spectral decomposition of a square matrix of third order.
8. Simultaneous reduction of a pair of quadratic forms to diagonal and Canonical forms.

DISTRIBUTIONS

1. Fitting an appropriate distribution (Binomial, Poisson, Negative Binomial)
2. Fitting of Normal and Exponential distributions.
3. Fitting of Cauchy distribution.
4. Discrete Bivariate distributions.

ESTIMATION

1. MLE by Scoring method
2. Confidence interval for parameters of Normal distribution.
3. Large sample Confidence limits in case of Binomial, Poisson and Exponential distributions.

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Department of Statistics

KAKATIYA UNIVERSITY, WARANGAL

M.Sc (Statistics) CBCS Pattern with Semester system

SEMESTER -II

S.No	Paper Code	THEORY Paper Title	No. of Credits	Marks		
				External	Internal	Total
1	ST201T	Sampling Techniques (ST)	**04**	**80**	**20**	**100**
2	ST202T	Operations Research- I (OR-I)	**04**	**80**	**20**	**100**
3	ST203T	Linear Models & Regression Analysis (LMRA)	**04**	**80**	**20**	**100**
4	ST204T	Multivariate Analysis (MA)	**04**	**80**	**20**	**100**
		Practical				
5	ST205P	ST +OR-I	**04**	**100**	**----**	**100**
6	ST206P	LMRA + MA	**04**	**100**	**-----**	**100**
7	ST207S	Seminar	**01**	**----**	**25**	**25**
		TOTAL:	**25**	**520**	**105**	**625**

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Summary of all Semesters

S. No	Semester	No. of Credits	Marks
1	I	25	625

2	II	25	625
3	III	25	625
4	IV	25	625
Total		**100**	**2500**

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M.Sc. (STATISTICS)
Semester-II
ST201T: PAPER-I

SAMPLING TECHNIQUES (ST)

UNIT – I

Simple random sampling with and without replacement, Estimators of population mean and population total, estimated variances, Determination of sample size, stratified random sampling, Estimators of population mean and population total, proportional and optimum allocations, Collapsed strata, systematic sampling, estimator of population mean and variance formulae for estimated mean.

UNIT – II

Unequal probability sampling: pps wr / wor methods (including Lahiri's scheme) and related estimators of a finite population mean. Horwitz – Thompson, Hansen – Horwitz and Yate's and Grundy estimators for population mean/total and their variances.

UNIT – III

Ratio method of Estimation: concept of ratio estimators, Ratio estimators in SRS, estimators their bias, variance / MSE. Ratio estimator in stratified random sampling, separate and combined ratio estimators, their variances / MSE's.

Regression Method of Estimation: concept, Regression estimators in SRS with pre-assigned value of regression coefficient (Difference Estimator), their bias, variance/MSE. Regression estimators in stratified random sampling – separate and combined regression estimators their variance/MSE.

UNIT – IV

Cluster Sampling: Cluster Sampling with clusters of equal sizes, Estimator of mean per unit, its variance in terms of intra –cluster correlation coefficient, determination of optimum

sample and cluster sizes for a given cost, Cluster sampling with unequal clusters, estimator of population mean and its variance /MSE.

Sub-sampling (Two-stage only): Equal first stage units, estimator of the population mean, its variance/MSE, estimator of variance. Unequal first stage units - estimator of the population mean and its variance/MSE.

REFERENCES :

1. Conchran, W.G (1977) : Sampling Techniques, 3rd Edition, Wiley Eastern.
2. Murthy, M.N (1967) : Sampling Theory and Methods, Statistical Publishing Society, Calcutta.
3. Sukhatme, Etal (1984) : Sampling Survey Methods and its Applications, Indian Society of Agricultural Statistics, New Delhi.
4. Des Raj (1976) : Sampling Theory, TMH, New Delhi.
5. Mukhopadhyaya, P (1998) : Sampling Theory and Surveys.
6. Singh, D and Choudhary: Theory and Analysis of Sample Survey Designs.

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M.Sc. (STATISTICS)
Semester-II
ST202T: PAPER-II

OPERATIONS RESEARCH-I (OR-I)

UNIT – I

Definitions of convex set, hyper plane, hyper sphere, convex function with simple examples, formulation of linear programming problem, graphical solution of LPP, various types of solutions to an LPP and their properties. (Th.3.1 to 3.8 of book 1) Simplex method, Charnes Big-M method, two-phase simplex method.

Concepts of primal and dual LPP, fundamental properties of duality, solution of LPP using its dual, dual simplex method with examples.

UNIT – II

Matrix form of transportation problem, TP as a particular case of LPP, loops and their properties, different methods of IBF solutions to TP, its optimum solution, degenerate and unbalanced transportation problems.

Assignment problems, Assignment problem as a particular case of TP and of LPP, solution of AP using assignment algorithm, various cases of AP's, concept of Routing and traveling salesman problems and their solutions.

UNIT - III

Introduction to Integer programming problem, all and mixed IPP's Gomery's all IPP algorithm, Branch and bound technique, zero-one programming.

Dynamic programming, solution of simple dynamic programming problems. Concept of sequencing problem, problems of 'n' jobs on 'm' ($m \geq 2$) machines.

UNIT – IV

Concepts of a game, strategies, game as a special case of LPP, two-person zero-sum finite games, pay-off matrix, maximin-minimax principle, saddle point, pure and mixed strategies, games without saddle points and their solutions using graphical method, Dominance property techniques and algebraic method.

REFERENCES :

1. Kanti Swarup, Gupta and Manmohan : Operations Research.
2. Hardy A. Taha : Operations Research.
3. Guass, S.I. (1975) LP Methods and Applications, Mc Grawhill.
4. Churchman Ackoff : Introduction to Operations Research.

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M.Sc. (STATISTICS)
Semester-II
ST203T: PAPER-III

LINEAR MODELS AND REGRESSION ANALYSIS (LMRA)

UNIT – I

Formulation of a linear model through examples, Estimability of linear parametric function, Gauss-Markov linear model, BLUE for linear functions of parameters, Gauss-Markov theorem, Aitken's generalized least squares.

UNIT – II

Derivation of multiple and partial correlation coefficients, tests of hypothesis on correlation parameters, concept of multicollinearity, analysis of multiple regression models, estimation and testing of regression parameters, sub-hypothesis. The use of dummy variables in multiple regression.

UNIT – III

Introduction of residuals overall plot, time sequence plot, plot against Y_{ij} , predictor variables X_{ij}, correlation and serial correlations among the residuals, outliers.

UNIT – IV

Introduction of selecting the best regression equation, all possible regressions, backward elimination, step wise regression procedures and the variations on these methods, Ridge regression and robust regression procedures.

REFERENCES:

1. Kshirsagar, A.M.. (1972) : A Course in Linear Models.
2. Graybill, F.A. (1968): An Introduction to Linear Statistical Models, Vol-I
3. Searls, S.R. (1971) : Linear Statistical Models.
4. Glutman. (1982) : Linear Models – An Introduction.
5. Draper, N.R. & Smith, H. (1998) : Applied Regression Analysis, 3rd edition, Wiley Eastern.
6. Rao, C.R. (1973): Linear Statistical Inference and its Applications, Wiley Eastern.

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M.Sc. (STATISTICS)
Semester-II
ST204T: PAPER-IV

MULTIVARIATE ANALYSIS (MA)

UNIT – I

Multinomial distribution, multivariate normal distribution, marginal and conditional distributions, Independence of multivariate vectors. Random sampling from a multivariate normal distribution, maximum likelihood estimators of parameters. Distribution of sample mean vector, independence mean vector and variance-covariance matrix.

UNIT – II

Wishart matrix, its distribution and properties, distribution of sample generalized variance, null and non-null distribution of sample correlation coefficients, null distribution of partial and multiple correlation coefficients, distribution of sample regression coefficients, applications in testing problems.

UNIT – III

Null distribution of Hotelling's T^2 statistic, application in tests on mean vector for one and more multivariate normal populations and also on equality of components of a mean vector in multivariate normal distribution, Mahalanobi's D^2 – statistic, Wilk's ^ - criterion and statements of its properties.

UNIT – IV

Principal components, dimension reduction, graphing of principal components, canonical variables and canonical correlations, definition, use, estimation and their computations introduction to factor analysis, orthogonal factor model.

REFERENCES:

1. Anderson, T.W. (1983): An Introduction to Multivariate Statistical Analysis, 2nd ed, Wley.
2. Giri, N.C. (1977) : Multivariate Statistical Inference, Academic press.
3. Kshirsagar, A.M. (1972): Multivariate Analysis, Marcel Dekker.
4. Morrison, D.F. (1976): Multivariate Statistical Methods, 2nd ed, Mc. Grawhill.

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M.Sc. (STATISTICS)
Semester-II
ST206P: Practical-I

PRACTICALS of ST + OR-I

SAMPLING TECHNIQUES:

1. Simple random sampling wr/wor
2. Stratified random sampling
3. Systematic sampling
4. Simple random sampling wr/wor with unequal probabilities (pps)
5. Ratio Method : Comparison with SRS
6. Separate and combined Ratio estimators – Comparison with St.R.S.
7. Regression Method – Comparison with SRS and Ratio Method.
8. Separate and combined Regression estimators – Comparisons.
9. Cluster sampling for equal sizes.
10. Sub-sampling (Two-stage sampling with equal first stage units).

OPERATIONS RESEARCH-I:

1. Mathematical formulation of LPP.
2. Graphical method of solving an LPP.
3. Simplex method, Big-M method.
4. Two-phase simplex method.
5. Solution of LPP using dual.
6. Dual simplex method.
7. Solution of Games.
8. Gomery's all IPP method.
9. Branch and Bound technique of solving IPP.
10. Solution of Sequencing problems of n-jobs with m ($m \geq 2$) machines.
11. Optimum solution of balanced and unbalanced Transportation problems.
12. Solution of traveling salesman problem.
13. Solution of Assignment problems (both cases)

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M.Sc. (STATISTICS)
Semester-II
ST207P: Practical-II

PRACTICALS of LMRA + MA

LINEAR MODELS AND REGRESSION ANALYSIS

1. Computation of Partial Correlation Coefficient.
2. Computation of Multiple Correlation Coefficient.
3. Testing of Multiple and Partial Correlation Coefficients.
4. Computation of Multiple Regression for three variables.
5. Testing of Multiple regression parameters.
6. Computation of BLUE and test their parameters.
7. Computation of Residuals and their plots.

MULTIVARIATE ANALYSIS

1. Hotelling's T^2.
2. Mahalanobi's D^2.
3. Computation of Principal components.
4. Computation of Canonical Variables and Correlation.

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Department of Statistics

KAKATIYA UNIVERSITY, WARANGAL

M.Sc (Statistics) CBCS Pattern with Semester system

SEMESTER-III

S.No	Paper Code	THEORY	No. of Credits	Marks		
		Title of Paper		External	Internal	Total
1	ST301T	Testing of Hypothesis (TOH)	**04**	**80**	**20**	**100**
2	ST302T	Operations Research-II (OR-II)	**04**	**80**	**20**	**100**
3	ST303T	Design and Analysis of Experiments (DAE)	**04**	**80**	**20**	**100**
4	ST304T	Statistical Process and Quality Control (SPQC)	**04**	**80**	**20**	**100**
		Practical				

6	ST305P	TOH + OR-II	**04**	**100**	**---**	**100**
7	ST306P	DAE + SPQC	**04**	**100**	**---**	**100**
8	ST307S	Seminar	**01**	**---**	**25**	**25**
		TOTAL:	**25**	**520**	**105**	**625**

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Summary of all Semesters

S. No	Semester	Total No. of Credits	Total Marks
1	I	25	625
2	II	25	625
3	III	25	625
4	IV	25	625
	Total:	**100**	**2500**

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M.Sc. (STATISTICS)
Semester-III
ST301T: PAPER-I

TESTING OF HYPOTHESIS (TOH)

UNIT – I

Fundamental notions of hypothesis testing – Statistical hypothesis, statistical test, Critical region, types of errors, test function, randomized and non-randomized tests, level of significance, power function, most powerful test, Neyman – Pearson fundamental lemma, MLR families and uniformly most powerful tests for one parameter exponential families.

UNIT – II

Concepts of Consistency, Unbiased UMPU and LMPU tests. Similar regions and tests of composite hypothesis, Neyman Structure. Likelihood Ratio tests, statement of the asymptotic properties of LR Statistics with applications.

UNIT- III

Notions of sequential versus fixed sample size techniques. Wald's sequential probability Ratio test (SPRT) procedure for testing simple null hypothesis against simple alternative. Termination property of SPRT. SPRT procedures for Binomial, Poisson, Normal and Exponential distributions and associated OC and ASN functions statement of optimality of SPRT.

UNIT- IV

Testing the equality of several variances, correlation coefficients, regression coefficients and proportions. Relation between confidence interval estimation and testing of hypothesis. Concepts of robustness in estimation and testing of hypothesis with examples.

REFERENCES:

1. Rohatgi.V.K: An Introduction to probability theory and Mathematical Statistics (Wiley Eastern Ltd.)
2. Wald. A: Sequential Analysis, Dover publications.
3. Ferguson. R.S: Mathematical Statistics, a decision theoretic approach (Academic Press).
4. Rao. C.R: Linear Statistical Inference and its applications, John wiley.
5. Medhi. J: Stochastic processes , New age Publications.

ADDITIONAL REFERENCES:

1. Lehman. E.L: Testing Statistical Hypothesis, John wiley
2. Mark Fisz: Probability theory and Mathematical Statistics.
3. Parimal Mukhopadhyay: Mathematical Statistics.

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M.Sc. (STATISTICS)
Semester-III
ST302T: PAPER-II

OPERATIONS RESEARCH-II (OR-II)

UNIT- I

Inventory: Analytical structure & inventory problems ABC analysis, EOQ problem with and without Shortages with a) production is instantaneous b) Finite constant rate c) shortages permitted random models where demand follows uniform distribution. Multi-item inventory subject to constraints.

UNIT – II

Queueing theory: Description of queueing problem, characteristics of queueing process, steady state conditions of queueing, (M/M/1): (FIFO) queueing system, Poisson queues with exponential service times, traffic intensity ratio, average queue length, waiting time distribution, Average waiting time of an arrival, queueing system as Birth – Death process.

UNIT – III

Non –linear programming problem – formulation, generalized Lagrange multiplier technique, Kuhn- Tucker necessary and sufficient conditions for optimality of an NLPP. Wolfe's and Beale's algorithms for solving QPP separate programming problem; Piecewise linearization method.

UNIT- IV

Stochastic programming, analysis of chance constrained linear programming under zero order, Non-randomized decision rule, deterministic equivalents of chance constraints with reference to normal and Cauchy distributions.

Networks: Basic concepts, constraints in Networks, construction of Networks, Time calculation in Networks, PERT, CPM, Network Problems.

REFERENCES:

1. Taha, H.A. (1982): Operations Research: An Introduction : Macmillan.
2. Hiller. F.S. and Liberman. G.J. (1962): Introduction to Operations Research, Holdon Day.
3. Kantiswarup, Gupta. P.K. and Manmohan (1985): Operations Research, Sultan Chand & Sons.
4. Sharma. S.D: Operations Research

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M.Sc. (STATISTICS)
Semester-III
ST303T: PAPER-III

DESIGN AND ANALYSIS OF EXPERIMENTS (DAE)

UNIT- I

Statement of Cochran's theorem for quadratic forms, Analysis of variance for two-way classification with one and more than one (equal) observations per cell with interaction. Analysis of Covariance: one-way and two-way classifications. Multiple comparisons – Fisher's least significance Difference test (LSD) and Duncan's Multiple range test (DMRT).

UNIT-II

Estimation of main effects, interactions and analysis of 2^k factorial experiment in general with particular reference to k=2, 3 and 3^2 and 3^3 factorial experiments.

UNIT-III

Total and partial confounding of 2^3, 3^2 and 3^3 factorial designs. Concept of balanced partial confounding. Fractional replications of factorial designs, one-half replication of 2^3 factorial design. Concepts of Resolution III, IV and V designs.

UNIT-IV

Concepts of fixed, mixed and random effects models, variance components estimation, Analysis of variance method. Split plot and strip plot designs.

REFERENCES:

1. Montgomery D.C.: Design and analysis of Experiments, John Wiley
2. Parimal Mukhopadhyay : Applied Statistics, New central book Agencies
3. Das, M.N. and Giri N : Design and analysis of Experiments, Wiley Eastern
4. Giri, D.D : Analysis of Variance

ADDITIONAL REFERENCES:

1. Joshi,D.D. : Linear Estimation and design of Experiments
2. Kempthorne : Design and analysis of Experiments, John Wiley
3. Cochran and Cox : Experimental Designs, John Wiley

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M.Sc. (STATISTICS)
Semester-III
ST304T: PAPER-IV

STATISTICAL PROCESS AND QUALITY CONTROL (SPQC)

UNIT – I

Basic concepts of process monitoring and control, process capability and process optimization. Theory and construction of control charts for , R, S, P, median and mid-range, O.C and A. R. L of , R, S and P charts.

UNIT – II

Moving average and exponentially weighted moving average charts, cu-sum charts using V-marks and decision intervals.

UNIT – III

Acceptance sampling plans for attribute inspection: single, double and sequential sampling plans and their properties, Rectifying sampling plans for attributes, AOQ, AOQL, designing R.S.P. for specified AOQL and LTPD, MIL-STD-105 E and Dodge-Romig tables. Plans for inspection by variables for one-sided and two-sided specifications. MIL/standard 414.

UNIT – IV

Process capability analysis: capability indices C_p, C_{pk} and Cpm. estimation, confidence intervals and tests of hypothesis relating to capability indices for normally distributed characteristics.

REFERENCES:

1. Montgomery, D.C. (1985) : Introduction to statistical quality control, John wiley.
2. Ott, E.R. (1975) : Process quality control, Megrastill New york
3. Phadke, M.S. (1989) : Quality Engineering through Robust design, prentice hall
4. Wetherill, G.B. (1977) : Sampling inspection and Quality control, Halsted press
5. Wetherill, G.B and Brown, D.W : Statistical process control: Theory and practice Chapman and hall.

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M.Sc. (STATISTICS)
Semester-III
ST305P: Practical-I

PRACTICALS of TOH + OR-II

TESTING OF HYPOTHESIS

1. Type -I and type - II error probabilities.

2. MP and UMP tests.
3. Likelihood Ratio tests.
4. Large sample tests for means, proportions and correlation coefficient.
5. Sequential probability Ratio test and computation of OC and ASN function (Binomial, Poisson, Normal and Exponential).
6. Tests for several variances.
7. Tests for several correlation coefficients and several regression coefficients.

OPERATIONS RESEARCH – II

1. NLPP-wolfe's method.
2. NLPP-Beale's method.
3. Separable programming problem.
4. Net-Works.
5. Queueing problems
6. Inventory problems

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M.Sc. (STATISTICS)
Semester-III
ST306P: Practical-II

PRACTICALS of DAE + SPQC

DESIGN AND ANALYSIS OF EXPERIMENTS

1. Analysis of variance of two-way classification with more than one (equal) observations per cell.
2. Analysis of 2^2 and 2^3 factorial experiments.
3. Analysis of 3^2 factorial experiments.
4. Analysis of total and partial confounding of 2^3 factorial designs.
5. Analysis of one-half and one-quarter replications of 2^4 and 2^5 designs respectively.
6. Analysis of split plot design.

STATISTICAL PROCESS AND QUALITY CONTROL

1. Construction of , R and S-charts and OC curves for and R charts
2. Construction of p-chart (with constant and variable sample sizes) OC curve for constant sample size.
3. Construction of cusum charts, V-marks and ARL curves.
4. Designing single sampling plans for specified (plans – designing for specified)

   1, 2, and
5. OC and ASN curves for double sampling plans – designing for specified 1, 2, and
6. Construction of AOQ and ATI curves for CSP-I.
7. Computation of process capability indices.

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SEMESTER-IV

S.No	Paper Code	Theory Title of Paper	No. of Credits	Marks External	Internal	Total
1	ST401T	Non-Parametric Inference (NPI)	**04**	**80**	**20**	**100**
2	ST402T	Advanced Design and Analysis of Experiments (ADAE)	**04**	**80**	**20**	**100**
3	ST403T(A)	Reliability Theory (RT)	**04**	**80**	**20**	**100**
	ST403T(B)	Econometrics (ECS)				
4	ST404T	Programming in C ++ (CPP)	**04**	**80**	**20**	**100**
		Practical				
5	ST405P	NPI + ADAE + RT	**04**	**100**	**----**	**100**
6	ST406P	C++ Lab	**04**	**100**	**-----**	**100**
7	ST407S	Seminar	**01**	**----**	**25**	**25**
		TOTAL:	**25**	**520**	**105**	**625**

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Summary of all Semesters

S. No	Semester	Total No. of Credits	Total Marks
1	I	25	625
2	II	25	625
3	III	25	625
4	IV	25	625
	Total:	**100**	**2500**

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M.Sc. (STATISTICS)
Semester-IV
ST401T: PAPER-I

NON PARAMETRIC INFERENCE (NPI)

UNIT-I

Concepts of Non-parametric estimation: Density estimates, Survey of existing methods. Rosenblatt's naive density estimator, its bias and variance. Consistency of Kernel density estimators and its MSE. Non-parametric methods for one Sample problems based on sign test, Wilcoxon signed Rank test, run test and Kolmogorov-Smirnov test.

UNIT-II

Two sample problems based on sign test, Wilcoxon signed Rank test of paired comparisons, Wilcoxon Mann-Whitney test, Kolmogorov-Smirnov test, (Expectations and variances of above test statistics expect for Kolmogorov - Smirnov test, statement about their exact and asymptotic distributions) Wald – Wolfowitz Run test and Normal scores test.

UNIT-III

Chi-square test of goodness of fit and independence in contingency tables. Tests for independence based on Spearman's Rank correlation and Kendall's Tau - Ansari-Bradley test for two sample dispersions. Kruskal – Wallis test for one way layout (k- samples). Friedman test for two way layout (Randomised block)

UNIT-IV

Asymptotic Relative Efficiency (ARE) and Pitman's Theorem. ARE of one sample, paired sample and two sample locations tests. The concept of Rao's second order efficiency and Hodges –Lehman's deficiency with illustrative examples.

REFERENCES ::

1. Ferguson, T.S. : Mathematical Statistics, A decision theoretic approach (Academic press 1967)
2. Gibbons : Non –parametric statistical inference (1978)
3. Myles Hollander and Douglas A. Wolfe: Non parametric statistical methods (John Wiley and sons)
4. Silverman: Density estimation for Statistics and data analysis.

ADDITIONAL REFERENCES:

1. W.J. Conover : Practical Non parametric statistics (John Wiley)
2. Sidney Siegel :Non parametric statistics for Behavioral science, Mc. Graw Hill

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M.Sc. (STATISTICS)
Semester-IV
ST402T: PAPER-II

ADVANCED DESIGN AND ANALYSIS OF EXPERIMENTS (ADAE)

UNIT – I

Concept of General block design and its information matrix (C). Balanced in complete block design (BIBD) – Parametric relations, intra block analysis, recovery of inter block information. Concept of symmetric, resolvable and Affine resolvable BIBDS, Construction of BIBDS using MOLS. Youden square design and its analysis.

UNIT – II

Partially balanced in complete block design with two – associate classes PBIBD(2), parametric relations, intra – block analysis, different association schemes Lattice designs – Balanced lattice design, simple lattice design and their analysis.

UNIT – III

Concept of response surface methodology (RSM), the method of steepest ascent. Response surface designs – Designs for fitting first – order and second –order models, variance of estimated response. Second order rotatable design (SORD), Central compositive designs (CCD) – roll of CCD as alternative to 3^k designs, Rotatability of CCD.

UNIT – IV

Experiments with mixtures –Simple lattice designs, first – order and second – order mixture models and analysis. Optimum designs – various optimality criteria and their interpretations. Repeated measurement designs. Cross-Over designs and Row – Column designs.

REFERENCES:

1. Montgomery, D.C. : Design and analysis of experiments
2. Parimal Mukhopadhyay : Applied statistics
3. Das. M.N and Giri, N: Design and analysis of experiments
4. Norman Draper and Harry Smith : Applied Regression analysis

ADDITIONAL REFERENCES:

1. Joshi, D.D. : Linear estimation and design of experiments
2. Myers. R.H.: Response surface methodology
3. Aloke Dey : Theory of Block design
4. Cornell. M.: Mixture Experiments
5. Gardiner, W.P. and Gettinlsy, G: Experimental design techniques in statistical practice.

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M.Sc. (STATISTICS)
Semester-IV
ST403T(A) : PAPER-III(A)

RELIABILITY THEORY (RT)

UNIT – I

Coherent systems, Reliability concepts – systems of components, series and parallel systems, Coherent structures and their representations in terms of paths and cuts, Modular decomposition.

UNIT – II

Reliability of coherent systems, Reliability of independent components, Association of random variables, Bound on systems reliability and improved bounds on system reliability under modular decomposition.

UNIT – III

Life distribution, Survival function – Notion of aging. IFR, DFR, DFRA, NBU and NBUE classes, Exponential distributions and its no aging property, Aging property of other common life distribution.

UNIT – IV

Maintenance and replacement policies, Relevant renewal theory, Availability Theory, Reliability estimation: Estimation of two and three parameter Gamma, Weibull and log-normal distributions.

REFERENCES:

1. Barlow, R.E and Proschen, F (1975) : Statistical Theory of Reliability and life testing (halt, Reinhart and Willston INC)
2. Barlow, R.E. and Proschen, F (1965) Mathematical Theory of Reliability, John Wiley
3. Balaguruswamy: Reliability Engineering, TMH.
4. Sinha, S.K. and Kale, B.K. (1980): Life testing and Reliability Estimation, Wiley Eastern.

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M.Sc. (STATISTICS)
Semester-IV
ST403T(B) : PAPER-III(B)

ECONOMETRICS(ECS)

UNIT – I

Meaning and scope of econometrics. Concepts of dummy variables and proxy variables Problems and methods of estimation in single equation regression models.

Multicollinearity: Consequence of multicollinearty, tests to detect its presence and solutions to problems of multicollinearty.

UNIT – II

Heteroscedasticity: Consequences of heteroscedastic disturbances- test to detect its presence and solutions to the problem of Heteroscedasticity.

Auto correlation: consequence of auto correlated disturbances, Durbin – Watson test – Estimation of auto correlation coefficient (for a first order auto regressive scheme).

UNIT – III

Distributed Lag models: Study of simple finite lag distribution models – Estimation of the coefficient of koyek geometric lag model.

UNIT – IV

Errors in variables: Problem of errors in variables simple solutions using instrumental variables technique. Simulation equation models and methods of estimation: Distinction between structures and model-Exogenous and Endogenous Variables – Reduced form of a model.

REFERENCES:

1. Johnston: Econometrics methods (2nd edition) : Chapter 1, chapter 7 : section 7-1, 7-3, chapter 9 : section 9-3, 9-4, chapter 12: section : 12-2, 12-3, chapter 13: section :13-2, 13-6.
2. G.S. Maddala : Econometrics
   Chapter 1, chapter 9: section 9-2, 9-6, chapter 10: section 10-1,10-2, chapter 16: section 16-1,16-2.
3. A. Koutsoyiennis :Theory of Econometrics.
   Chapter 9: section 9-3.1, 9-3.3, 9-3.4, 9-3.5
   Chapter 10: section 10-1, 10-2, 10-3, 10-4, 10-5, 10-6.2, 10-7, 10-8.3, 10-8.4
   Chapter 11: section 11-4.2

Chapter 12: section 12-1, 12-1.3, 12-1.4
Chapter 16: section 16-1.1, 16-1.2, 16-3.1, 16-3.2

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M.Sc. (STATISTICS)
Semester-IV
ST404T: PAPER-IV

PROGRAMMING IN C++ (CPP)

UNIT – I

Tokens, Expressions and control Structures.

UNIT – II

Functions in C ++, Classes and Objects

UNIT – III

Constructors and Distructors, Operator Overloading and Type Conversions. Inheritance: Extending Classes

UNIT – IV

Pointers, Virtual Functions and Polymorphism.

REFERENCES:

1. Object Oriented Programming with C ++ : E. Balaguruswamy
   (Tata Mc Graw-Hill Publishing Company Ltd)
2. Object-oriented Programming with Ansi & Turbo C ++ : Ashok N. Kamthane

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M.Sc. (STATISTICS)
Semester-IV
ST405P: Practical-I

PRACTICALS of NPI + ADAE +RT/ECS

NON-PARAMETRIC INFERENCE:

1. Sign test and Wilcoxon Signed Rank test (Including paired comparison).
2. Run test for randomness.
3. Two samples:
    a) Wilcoxon Mann-whitney test.
    b) Kolmogorov – Smirnov test.
    c) Wald Wolfowitz test.
4. Goodness of fit: Chi-Square and Kolmogorov- Smirnov test.
5. Normal scores test.
6. Kruskal – Wallis for one–way layout.
7. Friedman test for two-way layout.
8. Tests for independence in contingency tables: Spearman's rank correlation, Kendall's Tau.
9. Ansom Bradley test for two sample dispersions.

ADVANCED DESIGN AND ANALYSIS OF EXPERIMENTS:

1. Analysis of BIBD.
2. Analysis of Youden square design.
3. Analysis of PBIBD(2).
4. Analysis of Balanced lattice design.
5. Analysis of Simple lattice design.
6. Analysis of Mixture Experiments.

RELIABILITY THEORY:

1. Finding Minimal path sets and Minimal cut sets and their representations
2. Computation of System Reliability-parallel, Series and k out of n System
3. Computation of reliability of structure when components are independent
4. Computation of Estimated Reliability and Lazard rates
5. Graphing the Reliability function of the systems when the life times of components are exponentially distributed.

ECONOMETRICS:

1. Use of dummy variables (dummy variable trap) and seasonal adjustment.
2. Tests for Heteroscedasticity.
3. Test for Auto correlations.
4. Estimation with Lagged dependent variable.

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M.Sc. (STATISTICS)
Semester-IV
ST406P: Practical-II

PRACTICALS of C++

1. Processing of shopping list.
2. Arranging the given values in ascending and descending order.
3. Swapping private data of classes.
4. Addition of two complex numbers.
5. A program on constructors.
6. Fitting of Binomial Distribution.
7. Fitting of poisson Distribution.
8. Creation of database of employees of an educational institution using classes and functions.
9. Finding mean, variance and S.D. of given data.
10. Finding correlation coefficient of a bi-variate data.
11. Fitting of straight line y = a+bx to the given bi-variate data by using method of least squares.

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