Department of Statistics, University College of Science, Osmania University

Two Year M.Sc. (Statistics) Programe w.e.f the Academic year 2018-2019

Scheme for Choice Based Credit System

Course : M.Sc. Statistics				Course : M.Sc. Statistics				Course : M.Sc. Statistics				Course : M.Sc. Statistics			
I Semester		**Teaching Hrs**	**Credits**	**II Semester**		**Teaching Hrs**	**Credits**	**III Semester**		**Teaching Hrs**	**Credits**	**IV Semester**		**Teaching Hrs**	**Credits**
1	Core (MA&LA)	4	4	1	Core (ST)	4	4	1	Core (NPI)	4	4	1	Core (SP)	4	4
2	Core (PT)	4	4	2	Core (PI)	4	4	2	Core (QC,OT)	4	4	2	Core (TS)	4	4
3	Core (DT)	4	4	3	Core (LM & DOE)	4	4	3	Elective - I	4	4	3	Elective – I	4	4
4	Core ET)	4	4	4	Core (MVA)	4	4	4	Elective - II	4	4	4	Elective - II	4	4
5	Practical – I **(Python)**	9	4	5	Practical – I (ST+PI)	9	4	5	Practical – I (NPI+QCOT+E-I+ E-II / NPI+QCOT+E-I***)**	9	4	5	Practical – I (SP+TS+E-I+ **E-II*)**	9	4
6	Practical – II (LA+DT+ET)	9	4	6	Practical – II (LM&DOE +MVA)	9	4	6	Practical – II (R+ TORA) / **E-II Project****	9	4	6	Practical –II (SPSS) / **E-II** Project******	9	4
Total		**34**	**24**	**Total**		**34**	**24**	**Total**		**34**	**24**	**Total**		**34**	**24**

Paper Titles:

Semester I :

Paper - I : Mathematical Analysis and Linear Algebra **(MA&LA)**

Paper - II: Probability Theory **(PT)**

Paper - III : Distribution Theory **(DT)**

Paper - IV : Estimation Theory **(ET)**

Semester II :

Paper - I : Sampling Techniques **(ST)**

Paper - II: Parametric Inference **(PI)**

Paper - III : Linear Models & Design of Experiments **(LM & DOE)**

Paper - IV : Multivariate Analysis **(MVA)**

Semester III:

Paper - I : Non-Parametric Inference **(NPI)**

Paper - II: Quality Control and Optimization Techniques (**QCOT)**

Elective – I:

1. Advance Design of Experiments **(ADE)**
2. Reliability Theory **(RT)**

Elective – II:

1. Statistical Techniques in Pattern Recognition **(STPR)**
2. Econometric Models **(EM)**
3. Data Modeling using Machine Learning Techniques **(DMMLT)**

Semester IV :

Paper - I : Stochastic Processes **(SP)**

Paper - II: Time Series **(TS)**

Elective – I:

1. Applied Regression Models **(ARM)**
2. Actuarial Science **(ASC)**

Elective – II:

1. Advanced Operations Research **(Adv. OR)**
2. Data Mining **(DM)**
3. Text Analytics **(TA)**

(*) Practical – I includes Elective-II practical's for those students who select STPR/EM as Elective – II in Semester – III.

(**) ***Students who select DMMLT as Elective – II have Project instead of Practical –II in Semester - III.***

(*) Practical – I includes Elective-II practical's for those students who select Adv. OR /DM as Elective – II in Semester- IV.

(**) ***Students who select TA as Elective – II have Project instead of Practical –II in Semester- IV.***

(***) ***Foreign students will do project instead of Practical – II (SPSS) in Semester – IV.***

Department of Statistics, University College of Science, Osmania University

Two Year M.Sc. (Applied Statistics) Programe **w.e.f the Academic year 2018-2019**

Scheme for Choice Based Credit System

Course : M.Sc. Applied Statistics				**Course : M.Sc. Applied Statistics**				**Course : M.Sc. Applied Statistics**				**Course : M.Sc. Applied Statistics**			
I Semester		**Teaching Hrs**	**Credits**	**II Semester**		**Teaching Hrs**	**Credits**	**III Semester**		**Teaching Hrs**	**Credits**	**IV Semester**		**Teaching Hrs**	**Credits**
1	Core (LA&LM)	4	4	1	Core (SI)	4	4	1	Core (OR-I)	4	4	1	Core (SQC)	4	4
2	Core (PT)	4	4	2	Core (ARA)	4	4	2	Core (FM)	4	4	2	Core (ASP)	4	4
3	Core (DT&ET)	4	4	3	Core (MDA)	4	4	3	Elective –I	4	4	3	Elective – I	4	4
4	Core (ST)	4	4	4	Core (DOE)	4	4	4	Elective – II	4	4	4	Elective - II	4	4
5	Practical – I (**Python**)	9	4	5	Practical – I (SI+ARA)	9	4	5	Practical – I (OR-I+FM+E-I + **E-II*)**	9	4	5	Practical – I (SQC +ASP+E-I+**E-II*)**	9	4
6	Practical – II (LA&LM +DT&ET+ST)	9	4	6	Practical – II (MDA+DOE)	9	4	6	Practical – II (R+ TORA) / **E-II Project****	9	4	6	Practical –II (SPSS) / Project******	9	4
Total		**34**	**24**	**Total**		**34**	**24**	**Total**		**34**	**24**	**Total**		**34**	**24**

Paper Titles:

Semester I :

Paper - I : Linear Algebra and Linear Models **(LA&LM)**

Paper - II: Probability Theory **(PT)**

Paper - III : Distribution Theory & Estimation Theory **(DT& ET)**

Paper - IV : Sampling Techniques (ST)

Semester III:

Paper - I : Operations Research **(OR-I)**

Paper - II: Forecasting Models **(FM)**

Elective – I:

1. Statistical Pattern Recognition **(SPR)**
2. Econometric Models **(EM)**

Elective – II:

1. Data Mining **(DM)**
2. Reliability Theory **(RT)**
3. Data Modeling using Machine Learning Techniques **(DMMLT)**

(*) Practical – I includes Elective-II practical's for those students who select DM/ RT as Elective – II in Semester – III.

(**) Students who select DMMLT as Elective – II have Project instead of Practical –II in Semester - III.

Semester II :

Paper - I : Statistical Inference **(SI)**

Paper - II: Applied Regression Analysis **(ARA)**

Paper - III : Multivariate Data Analysis **(MDA)**

Paper - IV : Design of Experiments **(DOE)**

Semester IV :

Paper - I : Statistical Process and Quality Control **(SPQC)**

Paper - II: Applied Stochastic Process **(ASP)**

Elective – I:

1. Operations Research -II **(OR-II)**
2. Actuarial Science **(ASC)**

Elective – II:

1. Artificial Neural Networks and Fuzzy Logic **(ANN & FL)**
2. Demography **(DGY)**
3. Text Analytics **(TA)**

(*) Practical – I includes Elective-II practical's for those students who select ANN & FL /DGY as Elective – II in Semester- IV.

(**) Students who select TA as Elective – II have Project instead of Practical –II in Semester- IV.

(***) Foreign students will do project instead of Practical – II (SPSS) in Semester – IV.

DEPARTMENT OF STATISTICS
UNIVERSITY COLLEGE OF SCIENCE
OSMANIA UNIVERSITY, HYDERABAD – 500 007

M.Sc. STATISTICS
CB - SCHEME OF INSTRUCTION AND EXAMINATION
WITH EFFECT FROM 2018 – 2019

SEMESTER I

Paper	Sub. Code	Paper Title	Instruction Hrs/ Week	Duration of Exam (in Hrs)	Max. Marks	IA and Assign.	Credits
THEORY							
I	STS1-I	Mathematical Analysis and Linear Algebra (MA and LA)	4	3	80	20	4
II	STS1-II	Probability Theory (PT)	4	3	80	20	4
III	STS1-III	Distribution Theory (DT)	4	3	80	20	4
IV	STS1-IV	Theory of Estimation (ET)	4	3	80	20	4
PRACTICALS							
V	STS1-V	Practical – I Statistical methods using Python Programming	9	3	100	***	4
VI	STS1-VI	Practical – II Linear Algebra, Distribution Theory and Theory of Estimation (LA, DT, ET)	9	3	100	***	4
		Total	34	***	520	80	24
		Semester Total			600		

M. Sc. (Statistics) Semester I

STS1- I : Paper I - Mathematical Analysis and Linear Algebra (MA and LA)

UNIT–I

Functions of Bounded Variation (BV), Total variation and its additive Property. Functions of BV expressd as the difference of increasing functions.

Riemann-Steiltjes (R-S) Integral and its linear properties. Integration by parts, Euler's summation, Riemann's condition. Integrators of BV. Statements of necessary and sufficient conditions of R-S integral. Differentiation under the integral sign. Interchanging the order of integration.

UNIT–II

Complex derivatives. Cauchy-Riemann equations. Analytic functions. Statements of Cauchy theorem and integral formula. Power, Taylor's and Laurent's series. Zeroes and poles. Statement of Cauchy residue theorem. Cantour integration. Evaluation of real valued integrals by means of residues.

Functions of several variables-concepts of limit, continuity, directional derivatives, partial derivatives, total derivative, extreme and saddle points with examples. Taylor's expansion. Multiple Integration. Application of Jacobians in the evaluation of multiple integrals.

UNIT – III

Vector spaces with an inner product, Gram-Schmidt orthogonolization process, orthonormal basis and orthogonal projection of a vector.

Moore-Penrose and generalized inverses and their properties. Solution of matrix equations. Sufficient conditions for the existence of homogeneous and non-homogeneous linear equations.

UNIT – IV

Characteristic roots and vectors, Caley-Hamilton theorem, algebraic and geometric multiplicity of a characteristic root and spectral decomposition of a real symmetric matrix.

Real quadratic forms (QFs), reduction and classification of QFs, index and signature. Simultaneous reduction of two QFs. Extreme form of a QF. Cauchy-Schwartz and Hadamard inequalities for matrices.

REFERENCES

1. Apostol,T.M. (1985) : Mathematical Analysis, Narosa, Indian Ed.
2. Malik,S.C. (1984) : Mathematical Analysis, Wiley – Eastern.
3. Rudin,W. (1976) : Principles of Mathematical Analysis, McGraw Hill.
4. Graybill,F.A. (1983) : Matrices with applications in statistics, 2^{nd} ed, Wadsworth.
5. Rao,C.R. (1973) : Linear Statistical inference and its applications, 2^{nd} Ed, John Wiley & Sons Inc.
6. Searle,S.R. (1982) : Matrix algebra useful for statistics, John Wiley and Sons Inc.
7. Rao,C.R., Mithra,S.K. (1971) : Generalised inverse of matrices and its applications, John Wiley & Sons Inc.
8. Rao, A.R. and Bhimasankaram, P(1992) : Linear algebra, Tata – McGrawhill Publishing Co. Ltd.

M. Sc. (Statistics) Semester I

STS1- II : Paper II - Probability Theory (PT)

UNIT – I

Classes of sets, fields, sigma-fields, minimal sigma-fields, Borel sigma-fields in R, Measure, Probability Measure, Properties of a Measure, Caratheodory extension theorem (Statement only), measurable function, random variables, distribution function and its properties, expectation, statements and applications of monotone convergence theorem, Foatou's lemma, dominated convergence theorem.

UNIT – II

Expectations of functions of rv's, conditional expectation and conditional variance, their applications. Characteristic function of a random variable and its properties. Inversion theorem, uniqueness theorem (Functions which cannot be Characteristic functions). Levy's continuity theorem (Statement only). Chebychev, Markov, Cauchy-Schwartz, Jenson, Liapunov, Holder's and Minkowsky's inequalities.

UNIT – III

Sequence of Random variables, convergence in Probability, convergence in distribution, almost sure convergence, convergence in quadratic mean and their interrelationships, Slutskey's theorem, Borel-Cantelli lemma Borel 0-1 law, Kolmogorov 0-1 law (Glevenko – Cantelli Lemma -Statement only).

UNIT – IV

Law of large numbers, Weak law of large numbers, Bernoulli and Khintchen's WLLN's, Kolomogorov Inequality, Kolmogorov SLLN for independent random variables and statement only for i.i.d. case, statements of three series theorem.

Central Limit theorems : Demoviere - Laplace CLT, Lindberg-Levy CLT, Liapounou's CLT, Statement of Lindberg-Feller CLT, simple applications, statement of Cramer-Wald theorem, Asymptotic distribution of sample quantiles.

REFERENCES

1. Ash Robert (1972) : Real analysis and Probability, Academic Press
2. Bhat,B.R. : Modern probability Theory, 3rd Edition, New Age India
3. Rohatgi,V.K. : Introduction to Probability Theory and Mathematical Statistics
4. Milton and Arnold – Introduction to probability and Statistics (4th Edition)-TMH publication.

ADDITIONAL REFERENCES

1. Kingman,J.F.C. and Taylor, S.J. (1966) : Introduction of measure and probability, Cambridge University press
2. Basu,A.K. : Probability and Measure,Narosa (PHI)
3. W.Feller : An Introduction to Probability theory and its Applications Vol I and II, John Wiely.

M. Sc. (Statistics) Semester I

STS1- III : Paper III - Distribution Theory (DT)

UNIT – I

Normal, Lognormal, Weibull, Pareto and Cauchy distributions and their properties. Joint, Marginal and conditional pmf's and pdf's.

UNIT – II

Families of Distributions: Power series distributions, Exponential families of distributions. Functions of Random variables and their distributions (including transformation of rv's). Bivariate Normal, Bivariate Exponential (Marshall and Olkins form), Compound Binomial - Poisson, Gamma(α,β). Truncated (Binomial, Poisson, Normal and Lognormal) and mixture distributions -Definition and examples.

UNIT – III

Sampling Distributions of sample mean and variance, independence of $\overline{X}$ and s^2. Central and Non-central χ^2,t and F distributions.

UNIT – IV

Distributions of quadratic forms under normality and related distribution theory. Order statistics, their distributions and properties. Joint and marginal distributions of order statistics and Distribution of Range. Extreme values and their asymptotic distributions (statements only) with applications.

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, 2/e, Wiley Eastern
3. Milton and Arnold – Introduction to probability and Statistics (4^{th} Edition)-TMH publication.

ADDITIONAL REFERENCES

1. Pittman,J. (1993) : Probability, Narosa Publishing House
2. Johnson,S. and Kotz,(1972) : Distributions in Statistics,Vol. I,II and III, Houghton and Miffin.
3. Cramer, H. (1946) : Mathematical methods of statistics, Princeton.
4. Dudewicz,E.J., and Mishra, S.N. (1988) : Modern Mathematical statistics, Wiley International Students edition.

M.Sc. (Statistics) Semester I

STS1- IV : Paper IV - Theory of Estimation (ET)

UNIT – I

Point Estimation Vs. Interval Estimation, Advantages, Sampling distribution, Likelihood function, exponential family of distribution.

Desirable properties of a good estimator: Unbiasedness, consistency, efficiency and sufficiency - examples. Neyman 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 and Lehmann-Scheffe theorem. Median and modal unbiased estimation. Estimation of bias and standard deviation of point estimation by the Jackknife, the bootstrap methods with examples.

UNIT III

Methods of estimation, method of moments and maximum likelihood method, examples. Properties of MLE. Consistency and asymptotic normality of the consistent solutions of likelihood equations. Definition of CAN and BAN, estimation and their properties, examples.

UNIT IV

Concept of U statistics and examples. Statement of Asymptotic distributions of U – statistics. Interval estimation, confidence level CI using pivots and shortest length CI. Confidence intervals for the parameters for Normal, Exponential, Binomial and Poisson Distributions. Confidence Intervals for quintiles. Concept of tolerance limits and examples.

REFERENCES

1. Goon, Gupta and Das Gupta : Outlines of Statistics, Vol. 2, World Press, Calcutta.
2. Kale, B.K. (1999): A first course on parametric inference, Narosa publishing house.
3. Rohatgi, V.K.: An introduction to Probability theory and mathematical statistics, Wiley Eastern.

ADDITIONAL REFERENCES

1. Rao, C.R.: Linear Statistical Inference and its applications, John Wiley
2. Gray and Schucany : Generalized Jackknife; Marcel Decker
3. Bradely Efron and Robert J. Tibshirani : An Introduction to the Bootstrap, Chapmen and Hall.
4. Lehman, E.L. (1983) : Theory of point estimation, John Wiley
5. Gray, Schncory and Watkins : Generalized Jacknife, Dovenpul

M.Sc. (Statistics) Semester I

STS1- V : Paper V - Practical – I Statistical methods using Python Programming

Concepts to be covered: Introduction to Python Programming, Input, Processing and Output, Displaying Output with the Print Function, Comments, Variables, Reading Input from the Keyboard, Performing Calculations Operators. Type conversions, Expressions; *Decision Structures and Boolean Logic*: if, if-else, if-elif-else Statements, Nested Decision Structures, Comparing Strings, Logical Operators, Boolean Variables; *Repetition Structures*: recursion and non recursion, while loop, for loop, calculating a Running Total, Input Validation Loops, Nested Loops; Python-syntax, statements, functions, Built-in-functions and Methods, Modules in Python, Exception Handling. *Functions*: Defining and Calling a Void Function, Designing a Program to Use Functions, Local Variables, Passing Arguments to Functions, Global Variables and Global Constants, Value-Returning Functions, Generating Random Numbers, Writing Our Own Value-Returning Functions, The math Module, Storing Functions in Modules. *File and Exceptions*: Introduction to File Input and Output, Using Loops to Process Files, Processing Records, Exceptions. Finding Items in Lists with in-Operator, List Methods and Useful Built-in Functions, Copying Lists, Processing Lists, Two-Dimensional Lists, tuples. Strings: Basic String Operations, String Slicing, Testing, Searching, and Manipulating Strings **(25% weight for Theory).**

List of practical's using Python Programming: (75% weight for practical implementation)

1. Program to examine the given number is a prime number or not.
2. Program to find the Factorial of positive integer.
3. Program to find the largest among the given three numbers.
4. Program to generate Fibonacci sequence up to given number n.
5. Program for finding the roots of a quadratic equation.
6. Program to construct a Pascal Triangle.
7. Program to find the value of e^x, Sin x and Cos x using series expansion
8. Program to find the sum of two matrices $[A]_{mxp}$ and $[B]_{mxp}$
9. Program to find the product of two matrices $[A]_{mxp}$ and $[B]_{pxr}$.
10. Program to sort the given set of numbers using bubble sort and finding median.
11. Program with a function that accepts a string as an argument and returns the no. of vowels that the string contains. Another function to return number of consonants.
12. Program that opens specified text file and then displays list of all unique words found in the file.
13. Program to find the Median, Mode for the given of array of elements.
14. Program to find the first four Central & Non-central moments to the given array of elements.
15. Program to generate random numbers from Uniform, Binomial, Poisson, Normal, Exponential.
16. Program for preparation of frequency tables and computing mean, median, mode, variance and standard deviation of the frequency distribution.
17. Program to Fitting of Binomial distribution for the given frequency distribution (recursive)
18. Program to Fitting of Poisson distribution for the given frequency distribution (recursive)
19. Program to Fitting of Negative Binomial distribution for the given frequency distribution (recursive).
20. Program to Fitting of Exponential Distribution for the given frequency distribution (recursive)
21. Program for finding the Correlation and regression lines for the given bivariate data.
22. Solution to simultaneous equations by Gauss - Siedal method (minimum 3 variables)

References:

1. Tony Gaddis, Starting Out With Python (3e)
1. Kenneth A. Lambert, Fundamentals of Python
2. Clinton W. Brownley, Foundations for Analytics with Python
3. James Payne, Beginning Python using Python 2.6 and Python 3
4. Charles Dierach, Introduction to Computer Science using Python
5. Paul Gries, Practical Programming: An Introduction to Computer Science using Python 3

M.Sc. (Statistics) Semester I

STS1-VI : Paper VI Practical (LA, DT, ET)

PRACTICALS IN LINEAR ALGEBRA, DISTRIBUTION THEORY AND ESTIMATION

LINEAR ALGEBRA

1. Inverse of a matrix by partition method
2. Solutions of linear equations by sweep-out method
3. Solutions of linear equations by Doolittle Method
4. Computation of Moore-Penrose inverse by Penrose method
5. Computation of generalized inverse of a 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.
9. Finding orthonormal basis by Gram – Schmidt process.

DISTRIBUTION THEORY

1. Discrete Bivariate distributions
2. Fitting of Cauchy distributions
3. Fitting of Gamma distribution with two parameters
4. Fitting of Lognormal Distribution
5. Fitting of Weibull Distribution
6. Fitting of Pareto distribution.

ESTIMATION THEORY

1. Computation of Jackknife estimates
2. Computation of Boot-strap estimates
3. MLE by Scoring method
4. Confidence limits for parameters of normal population
5. Large sample confidence limits in case of Binomial, Poisson, Exponential distributions.

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M.Sc. STATISTICS
CB - SCHEME OF INSTRUCTION AND EXAMINATION
WITH EFFECT FROM 2018 – 2019

SEMESTER II

Paper	Sub. Code	Paper Title	Instruction Hrs/ Week	Duration of Exam (in Hrs)	Max. Marks	IA and Assign.	Credits
THEORY							
I	STS2-I	Sampling Techniques (ST)	4	3	80	20	4
II	STS2-II	Parametric Inference (PI)	4	3	80	20	4
III	STS2-III	Linear Models and Design of Experiments (LM and DOE)	4	3	80	20	4
IV	STS2-IV	Multivariate Analysis (MVA)	4	3	80	20	4
PRACTICALS							
V	STS2-V	Practical – I Sampling Techniques and Parametric Inference (ST, PI)	9	3	100	***	4
VI	STS2-VI	Practical – II Linear Models, Design of Experiments and Multivariate Analysis (LM, DOE, MVA)	9	3	100	***	4
		Total	34	***	520	80	24
		Semester Total			600		

M.Sc. (Statistics) Semester II

STS2 - I : Paper I - Sampling Techniques (ST)

UNIT – I

Review of SRSWR/WOR, Stratified random sampling and Systematic Sampling.

Unequal probability Sampling: ppswr/wor methods (including Lahiri's scheme) and related estimators of a finite population mean. Horowitz – Thompson, Hansen – Horowitz and Yates and Grundy estimators for population mean/total and their variances.

UNIT – II

Ratio Method Estimation: Concept of ratio estimators, Ratio estimators in SRS, their bias, variance/MSE. Ratio estimator in Stratified random sampling – Separate and combined estimators, their variances/MSE.

Regression method of estimation: Concept, Regression estimators in SRS with pre – assigned value of regression coefficient (Difference Estimator) and estimated value of regression coefficient, their bias, variance/MSE, Regression estimators in Stratified Random sampling – Separate and combined regression estimators, their variance/ MSE.

UNIT – III

Cluster Sampling: Cluster sampling with clusters of equal sizes, estimator of mean per unit, its variance in terms of intracluster correlation, and determination of optimum sample and cluster sizes for a given cost. Cluster sampling with clusters of unequal sizes, estimator - population mean its variance/MSE.

Sub sampling (Two – Stage only): Equal first stage units – Estimator of population mean, variance/MSE, estimator of variance. Determination of optimal sample size for a given cost. Unequal first stage units – estimator of the population mean and its variance/MSE.

UNIT – IV

Non – Sampling errors: Sources and treatment of non-sampling errors. Non – sampling bias and variance.

Randomized Response Techniques (for dichotomous populations only): Warner's model, unrelated question model.

Small area estimation : Preliminaries, Concepts of Direct Estimators, Synthetic estimators and Composite estimators.

REFERENCES

1. Parimal Mukhopadhyay (1998) : Theory and methods of Survey sampling, Prentice – Hall of India, New Delhi.
2. Murthy, M.N. (1967): Sampling Theory and methods, Statistical Publishing Society, Calcutta.

ADDITIONAL REFERENCES

1. Des Raj (1976) : Sampling Theory, Tata McGraw Hill, New Delhi.
2. Sukhatme etal (1984) : Sampling Survey methods and its applications, Indian society of Agricultural Statistics.
3. Cochran, W.C. (1977) : Sampling Techniques, Third Edition, Wiley Eastern.

M.Sc. (Statistics) Semester II

STS2 - II : Paper II - Parametric Inference (PI)

Unit–I

Fundamental notions of hypothesis testing–Statistical hypothesis, statistical test, Critical region, types of errors, test function, randomised and non–randomised 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 and invariance of tests. Likelihood Ratio tests, statement of the asymptotic properties of LR statistics with applications (including homogeneity of means and variances). Relation between confidence interval estimation and testing of hypothesis. Concept of robustness in estimation and testing with example. ML Estimation and testing of Transition Probability Matrix.

Unit–III

Concept of sequential estimation, sequential estimation of a normal population. 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 associate OC and ASN functions. Statement of optimality of SPRT.

Unit–IV

Concepts of loss, risk and decision functions, admissible and optimal decision functions, Estimation and testing viewed as decision problems, apriori and aposteriori distributions, conjugate families, Bayes and Minmax decision functions with applications to estimation with quadratic loss.

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

M.Sc. (Statistics) semester II

STS2 - III : Paper III - Linear Models and Design of Experiments (LM & DOE)

UNIT– I (LM)

Formulation of a linear model through examples. Estimability of a linear parametric function. Gauss-Markov linear model, BLUE for linear functions of parameters, relationship between BLUE's and linear Zero-functions. Gauss-Markov theorem, Aitkin's generalized least squares, Concept of Multi-collinearity.

UNIT– II

Simple linear regression, examining the regression equation, Lack of fit and pure error. Analysis of Multiple regression models. Estimation and testing of regression parameters, sub-hypothesis. Introduction of residuals, overall plot, time sequence plot, plot against Yi, Predictor variables X_{ij}, Serial correlation among the residual outliers. The use of dummy variables in multiple regression, Polynomial regressions –use of orthogonal polynomials. Derivation of Multiple and Partial correlations, tests of hypothesis on correlation parameters.

UNIT– III (DOE)

Analysis of Covariance: One-way and Two-way classifications.
Factorial experiments: Estimation of Main effects, interaction and analysis of 2^k, factorial experiment in general with particular reference to k = 2, 3 and 4 and 3^2 factorial experiment. Multiple Comparisons: Fishers least significance difference (LSD) and Duncan's Multiple Range test (DMR test).

UNIT – IV

Total and Partial Confounding in case of 2^3, 2^4 and 3^2 factorial designs. Concept of balanced partial confounding.
Fractional replications of factorial designs: One half replications of 2^3 and 2^4 factorial designs, one-quarter replications of 2^5 and 2^6 factorial designs. Resolution of a design. Split – Plot design.

REFERENCES

1. Searles S.R.(1971):Linear statistical Models.
2. Draper and Smith: Applied Regression Analysis
3. Montogomery,D.C.:Design and Analysis of Experiments, John Wiley
4. Giri, N.C.:Analysis of Variance

ADDITIONAL REFERENCES

1. Kshirasagar A.M.(1972): A course in Linear Models.
2. Graybill F.A(1966): An introduction to linear statistical models- Vol.I
3. Gultman (1982): Linear Models - An Introduction.
4. Rao A.R and Bhimsankaram P: Linear Algebra – Hindustan Agency.
5. Kempthrone: Design and Analysis of Experiments.
6. Cochran and Cox: Experimental Designs.

M.Sc. (Statistics) Semester II

STS2 - IV : Paper IV - Multivariate Analysis (MVA)

UNIT – I

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

UNIT – II

Wishart matrix – its distribution and properties. Distribution of sample generalized variance. Null distribution of simple correlation coefficients. Null distribution of partial and multiple correlation coefficients. Distribution of sample regression coefficients. Application in testing and interval estimation.

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 the components of a mean vector in a multivariate normal population.

Mahalanobi's D^2 statistic. Wilk's Λ - criterion and statement of its their properties with simple applications. Classification and discrimination procedures for discrimination between two multivariate normal populations – sample discriminant function, tests associated with discriminant functions, probabilities of misclassification and their estimation, classification into two multivariate normal populations with equal covariance matrices.

UNIT – IV

Principal components, Dimension reduction, graphical of Principal Components, canonical variables and canonical correlation – definition, use, estimation and computation.

Concepts of cluster analysis and multi – dimensional scaling.

Introduction to Factor analysis, orthogonal factor model.

REFERENCES

1. Anderson, T.W. (1983) : An Introduction to multivariate statistical analysis, 2nd Edition, Wiley.
2. Kshirasagar, A.M. (1972) : Multivariate Analysis, Marcel Decker.
3. Johnson, R.A.W.: Applied Multivariate Analysis.

ADDITIONAL REFERENCES

1. Giri, N.C. (1977): Multivariate statistical inference, Academic Press
2. Morrison, D.F. (1976): Multivariate Statistical Methods, 2nd Edition, McGraw Hill
3. Muirhead, R.. (1982) : Aspects of multivariate statistical theory, J. Wiley.

M.Sc. (Statistics) Semester II

STS2 - V : Paper V Practical - I (ST and PI)

PRACTICALS IN SAMPLING TECHNIQUES AND PARAMETRIC INFERENCE

SAMPLING TECHNIQUES

1. PPS sampling with and without replacements.
2. Ratio estimators in SRS , comparison with SRS
3. Separate and combined ratio estimators, Comparison.
4. Regression estimators in SRS, Comparison with SRS and Ratio estimators
5. Separate and combined Regression estimators, Comparison.
6. Cluster sampling with equal cluster sizes.
7. Sub sampling (Two–stage sampling) with equal first stage units.

PARAMETRIC INFERENCE

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, Exponential)
6. Determination of Bayes and Minimax decision rules (Finite no. Of actions and finite no. of states of n atoms)

M.Sc. (Statistics) Semester II

STS2 – VI : Paper VI Practical - II (LM & DOE and MVA)

Practicals in Linear Models, Designs of Experiments and Multivariate Analysis

Linear Models and Designs of Experiments

1. Computation of BLUE and testing their parameters.
2. Computation of Pure error and Lack of fit.
3. Computation of residuals and their plots for two and three variables.
4. Computation of Multiple Correlation coefficient
5. Computation of Partial Correlation coefficient
6. Testing of Multiple and Partial Correlation Coefficients.
7. Analysis of 2^3, 2^4 and 3^2 factorial experiments.
8. Analysis of total confounding and partial confounding of 2^3 design.
9. Analysis of one–half fraction of 2^4 designs and one–quarter fraction of 2^5 designs.
10. Analysis of Split-Plot design.

Multivariate Analysis

1. MLE of Mean vector and variance covariance Matrix from Normal population.
2. Hotelling's T^2 and Mahalanobi's D^2.
3. Computation of Principal components.
4. Classification between two normal populations by discriminant analysis.
5. Cluster analysis.
6. Computation of Canonical variables and correlation.

DEPARTMENT OF STATISTICS
UNIVERSITY COLLEGE OF SCIENCE
OSMANIA UNIVERSITY, HYDERABAD – 500 007

M.Sc. APPLIED STATISTICS
CBCS - SCHEME OF INSTRUCTION AND EXAMINATION
WITH EFFECT FROM 2018 – 2019

SEMESTER I

Paper	Sub. Code	Paper Title	Instruction Hrs/ Week	Duration of Exam (in Hrs)	Max. Marks	IA and Assign.	Credits
THEORY							
I	STAS1-I	Linear Algebra and Linear Models (LA and LM)	4	3	80	20	4
II	STAS1-II	Probability Theory (PT)	4	3	80	20	4
III	STAS1-III	Distribution Theory and Estimation Theory (DT and ET)	4	3	80	20	4
IV	STAS1-IV	Sampling Theory and Surveys (ST)	4	3	80	20	4
PRACTICALS							
V	STAS1-V	Statistical methods using Python Programming	9	3	100	***	4
VI	STAS1-VI	Linear Algebra, Linear Models, Distribution Theory, Estimation Theory and Sampling Theory and surveys (LA, LM, DT, ET, ST)	9	3	100	***	4
		Total	34	***	520	80	24
		Semester Total			600		

M.Sc. (Applied Statistics) Semester I

STAS1- I : Paper I - Linear Algebra and Linear Models (LA and LM)

UNIT – I

Vector Spaces with an inner product, Gram –Schmidt orthogonalization process.Orthonormal basis and orthogonal projection of a vector. Moore penrose and generalized inverses and their properties. Solution of matrix equations. Sufficient conditions for the existence of homogeneous and non – homogeneous linear equations.

UNIT–II

Characteristic roots and vectors, Caley–Hamilton theorem algebraic and geometric multiplicity of a characteristic root and spectral decomposition of a real symmetric matrix. Real quadratic forms, reduction and classification of quadratic forms, Index and signature .Simultaneous reduction of two quadratic forms, Extreme of a quadratic form. Matrix Inequalities: Cauchy- Schwartz and Hadamard Inequalities.

UNIT – III

Formulation of a linear model through examples. Estimability of a linear parametric function. Guass-Markov linear model, BLUE for Linear functions of parameters, relationship between BLUEs and linear Zero-functions. Gauss Markov theorem, Aitkens generalized least squares. Concept of Multicollinearity.

UNIT – IV

Simple Linear regression – precision of the estimated regression, examining the regression equation - lack of fit and pure error. Analysis of multiple regression model, estimation and testing of regression parameters, Sub-hypothesis. Testing a general linear hypothesis, Multiple and partial correlations - derivation and testing. Use of dummy variables in multiple regression. Polynomial regression- Use of orthogonal polynomials

REFERENCES

1. Graybill, F.A. (1983) : Matrices with applications in Statistics, 2nd ed., Wards worth.
2. Searle, S.R.(1982) : Matrix Algebra useful for Statistics, John Wiley & Sons.
3. Rao, C.R. and Mithra, S.K.(1971) : Generalized inverse of matrices and its applications, John Wiley & Sons.
4. Rao, A.R. and Bhimasankaram, P. (1992) : Linear Algebra, Tata McGraw Hill Publishing Co. Ltd.
5. Draper and Smith:Applied Regression Analysis ,John Wiley
6. Montgomery :Introduction to Linear Regression Analysis .John Wiley.
7. Searle, S.R.(1982) : Linear models, John Wiley & Sons.
8. Kshirsagar.A.M. (1972) : A Course in Linear Models.

M.Sc. (Applied Statistics) Semester I

STAS1-II : Paper II - Probability Theory (PT)

UNIT – I

Review axiomatic approach to Probability, Probability as a measure, conditional probability (and Baye's Theorem). Random Variable, distribution function and its properties. Riemann – Stieltjes integration, Statement of properties of Riemann – Stieltjes integrals, Examples. Expectations of functions of random variables – moments. Conditional expectation and conditional variances, applications (A list model, random graph, uniform priors, Polyas' urn model and Bose-Einstein distribution, mean time for patterns, the compound Poisson identity, the k-record values of discrete random variables).

UNIT – II

Characteristic function and its properties, Uniqueness theorem and Inversion theorem, examples. (Functions which can not be Characteristic functions). Statement of Levy's continuity theorem. Probability and moment inequalities **:** Chebychev's, Markov, Cauchy-Schwartz, Holder, Minkowsky, Liapunov and Jensen Inequalities.

UNIT – III

Sequence of random variables – Borel-Cantelli Lemma; Borel 0-1 law. Convergence of sequence of random variables – convergence in law; convergence in probability; convergence in quadratic mean; convergence with probability one (almost sure convergence); Their implications and/or counter implications; Slutzky's theorem and its applications. Statement of Glivenko-Cantelli lemma.

UNIT – IV

Weak law of large numbers – Bernoulli and Khintchine's WLLNs. Kolmogorov inequality. Strong law of large numbers – Borel's SLLNs. Kolmogorov's SLLNs for independent random variables and i.i.d. random variables, examples.

Central Limit Theorem – Demoviere-Laplace form of CLT, Levy-Lindeberg form of CLT, Liapunov's form of CLT and Statement of Lindberg – Feller form of CLT – examples.

REFERENCES

1. Bhat, B.R. (1985) : Modern Probability Theory – Wiley Eastern.
2. Rohatgi, V.K. (1993): An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern
3. Ross, S.M (2004) : Introduction to Probability Models, 8th Edition (Chapter 3) – Academic Press
4. Chandra, T.K. and Chatterji D (2001) : A First Course in Probability, Narosa Publishing House
5. Milton and Arnold – Introduction to probability and Statistics (4th Edition)-TMH publication.

ADDITIONAL REFERENCE

1. Karlin, S and Taylor, S.J. (1975) : A First course in Stochastic Processes, Academic Press.

M.Sc. (Applied Statistics) Semester I

STAS1- III : Paper III - Distribution Theory and Estimation Theory (DT and ET)

UNIT – I

Cauchy, Lognormal, Weibull, Pareto, Laplace distributions and their properties. Compound distributions (Binomial and Poisson only). Truncated distributions (Poisson, Exponential and Normal distributions). Mixture Distributions. Bivariate Normal distribution.

UNIT – II

Functions of random variables and their distributions using Jacobian of transformations and Characteristic function. Sampling Distributions of Sample mean and variance, independence of $\bar{X}$ and S^2. Central t, F and χ^2 distributions and their properties. Non-central χ^2, t and F distributions and their properties (Statements only). Distributions of Quadratic forms under normality. Joint and Marginal Distributions of order statistics. Distributions of sample range.

UNIT – III

Concepts of point estimation – Criterion for good estimator, MVUE, Fisher's information, Cramer-Rao lower bound and its applications. Rao–Blackwell theorem, completeness, Lehmann – Scheff's theorem. Estimation of bias and standard deviation of point estimation by the Jackknife and Bootstrap methods with examples.

UNIT – IV

Method of moments, MLE and its properties (statements only). Consistency and asymptotic normality of the consistent solutions of likelihood equations. Definition of CAN and BAN estimators and their properties, related examples, Concepts of loss, risk and decision functions, admissible and optimal decision functions, estimation and testing viewed as decision problems, apriori, aposteriori distributions, conjugate families, Baye's and minimax decision functions with applications to estimation with quadratic loss.

REFERENCES

1. Rohatgi,V.K. (1984) : An Introduction to Probability theory and Mathematical Statistics, Wiley Eastern.
2. Dudewicz,E.J. and Mishra,S.N. (1988) : Modern Mathematical Statistics, Wiley International, Students Edition.
3. Parimal Mukhopadhya: Mathematical Statistics.
4. Milton and Arnold – Introduction to probability and Statistics (4th Edition)-TMH publication.

ADDITIONAL REFERENCES

1. Ferguson, T.S. (1967) : Mathematical Statistics, A decision theoretic approach, Academic Press.
2. Rao,C.R.(1973) : Linear Statistical Inference and its applications,2/e, Wiley Eastern.
3. Johnson,S. and Kotz (1972) : Distribution in Statistics, Vol. I,II and III.
4. Lehman, E.L. (1983) : Theory of Point Estimation, John Wiley and Sons.

M.Sc. (Applied Statistics) Semester I

STAS1- IV : Paper IV - Sampling Theory and Surveys (ST)

UNIT – I

Review of SRSWR, SRSWOR, Stratified random sampling and Systematic Sampling.
Unequal probability Sampling – Probability proportional to size (PPS) sampling with and without replacements (ppswr / wor) methods - drawing samples using Cumulative total and Lahiri's methods. Horwitz -Thompson, Hansen – Horwitz and Yates and Grundy estimators for population mean, total and their variances.

UNIT – II

Ratio Method of Estimation - Concept of ratio estimators, Ratio estimators in SRS, their bias, variance/MSE. Ratio estimators in Stratified random sampling – Separate and combined estimators, their variances/MSE.

Regression method of estimation – Concept Regression estimators, Regression estimators in SRS with pre–assigned value of regression coefficient (Difference Estimator) and estimated value of regression coefficient, their bias, variance/MSE, Regression estimators in Stratified Random sampling – Separate and combined regression estimators, their variances/ MSE.

UNIT – III

Cluster Sampling - Cluster sampling with clusters of equal sizes, estimator of mean per unit, its variance in terms of intracluster correlation coefficient, determination of optimum sample and cluster sizes for a given cost. Cluster sampling with clusters of unequal sizes, estimator of population mean and its variance/MSE.

Sub sampling (Two–Stage only) - Equal first stage units – Estimator of population mean, variance/MSE, estimator of variance. Determination of optimum sample size for a given cost.Unequal first stage units – estimator of population mean and its variance/MSE.

UNIT – IV

Planning of Sample Surveys - Methods of data collection, problem of sampling frame, choice of sampling design, pilot survey, processing of survey data.

Non-sampling errors - Sources and treatment of non-sampling errors. Non – sampling bias and variance.

REFERENCES

1. Parimal Mukhopadhyay (1998) : Theory and methods of Survey sampling, Prentice – Hall of India, New Delhi.
2. Cochran, W.C. (1977) : Sampling Techniques, Third Edition, Wiley Eastern.
3. Daroga Singh and Chowdary (1986) : Theory and Analysis of Sample Survey Designs – Wiley Eastern Ltd.

ADDITIONAL REFERENCES

1. Des Raj (1976) : Sampling Theory, Tata McGraw Hill, New Delhi.
2. Sukhatme et. Al (1984): Sampling Survey methods and its applications, Indian society of Agricultural Statistics.
3. Murthy, M.N. (1967) : Sampling theory, Tata McGraw Hill, New Delhi.

M.Sc. (Applied Statistics) Semester I

STS1- V : Paper V - Practical – I Statistical methods using Python Programming

Concepts to be covered: Introduction to Python Programming, Input, Processing and Output, Displaying Output with the Print Function, Comments, Variables, Reading Input from the Keyboard, Performing Calculations Operators. Type conversions, Expressions; *Decision Structures and Boolean Logic*: if, if-else, if-elif-else Statements, Nested Decision Structures, Comparing Strings, Logical Operators, Boolean Variables; *Repetition Structures*: recursion and non recursion, while loop, for loop, calculating a Running Total, Input Validation Loops, Nested Loops; Python-syntax, statements, functions, Built-in-functions and Methods, Modules in Python, Exception Handling. *Functions*: Defining and Calling a Void Function, Designing a Program to Use Functions, Local Variables, Passing Arguments to Functions, Global Variables and Global Constants, Value-Returning Functions, Generating Random Numbers, Writing Our Own Value-Returning Functions, The math Module, Storing Functions in Modules. *File and Exceptions*: Introduction to File Input and Output, Using Loops to Process Files, Processing Records, Exceptions. Finding Items in Lists with in-Operator, List Methods and Useful Built-in Functions, Copying Lists, Processing Lists, Two-Dimensional Lists, tuples. Strings: Basic String Operations, String Slicing, Testing, Searching, and Manipulating Strings **(25% weight for Theory).**

List of practical's using Python Programming: (75% weight for practical implementation)

1. Program to examine the given number is a prime number or not.
2. Program to find the Factorial of positive integer.
3. Program to find the largest among the given three numbers.
4. Program to generate Fibonacci sequence up to given number n.
5. Program for finding the roots of a quadratic equation.
6. Program to construct a Pascal Triangle.
7. Program to find the value of e^x, Sin x and Cos x using series expansion
8. Program to find the sum of two matrices $[A]_{mxp}$ and $[B]_{mxp}$
9. Program to find the product of two matrices $[A]_{mxp}$ and $[B]_{pxr}$.
10. Program to sort the given set of numbers using bubble sort and finding median.
11. Program with a function that accepts a string as an argument and returns the no. of vowels that the string contains. Another function to return number of consonants.
12. Program that opens specified text file and then displays list of all unique words found in the file.
13. Program to find the Median, Mode for the given of array of elements.
14. Program to find the first four Central & Non-central moments to the given array of elements.
15. Program to generate random numbers from Uniform, Binomial, Poisson, Normal, Exponential.
16. Program for preparation of frequency tables and computing mean, median, mode, variance and standard deviation of the frequency distribution.
17. Program to Fitting of Binomial distribution for the given frequency distribution (recursive)
18. Program to Fitting of Poisson distribution for the given frequency distribution (recursive)
19. Program to Fitting of Negative Binomial distribution for the given frequency distribution (recursive).
20. Program to Fitting of Exponential Distribution for the given frequency distribution (recursive)
21. Program for finding the Correlation and regression lines for the given bivariate data.
22. Solution to simultaneous equations by Gauss - Siedal method (minimum 3 variables)

References:

1. Tony Gaddis, Starting Out With Python (3e)

1. Kenneth A. Lambert, Fundamentals of Python

2. Clinton W. Brownley, Foundations for Analytics with Python

3. James Payne, Beginning Python using Python 2.6 and Python 3

4. Charles Dierach, Introduction to Computer Science using Python

5. Paul Gries, Practical Programming: An Introduction to Computer Science using Python 3

M.Sc.(Applied Statistics) Semester I

STAS1-VI : Paper VI - Practical (LA, LM, DT, ET, ST)

PRACTICALS IN LINEAR ALGEBRA, LINEAR MODELS, DISTRIBUTION THEORY, ESTIMATION AND SAMPLING

LINEAR ALGEBRA

1. Inverse of a matrix by partition method.
2. Solutions of linear equations by sweep-out method.
3. Computation of Moore-Penrose inverse by Penrose method.
4. Computation of Generalized inverse of a matrix.
5. Formation of characteristic equation by using traces of successive powers.
6. Spectral decomposition of a square matrix of third order.

LINEAR MODELS

1. Fitting of a simple linear regression model - Computation of Pure error and lack of fit.
2. Fitting of Multiple Regression models with Two and Three Independent variables. and testing of regression parameters
3. Computation and Testing of Multiple Correlation coefficient.
4. Computation and Testing of Partial Correlation Coefficients.

DISTRIBUTION THEORY AND ESTIMATION

1. Distributions: Fitting of
   - (i) Lognormal
   - (ii) Weibull
   - (iii) Cauchy
   - (iv) Gamma with parameters
2. Estimation:
   - a. Computation Jackknife estimator
   - b. Computation of Bootstrap estimator
   - c. Method of MLE (Scoring Method)
   - d. Computation of Bayes estimator (Binomial)

SAMPLING THEORY

1. PPS sampling with and without replacements.
2. Ratio estimators in SRS , comparison with SRS
3. Separate and combined ratio estimators, Comparison.
4. Regression estimators in SRS, Comparison with SRS and Ratio estimators
5. Separate and combined Regression estimators, Comparison.
6. Cluster sampling with equal cluster sizes.
7. Sub sampling (Two–stage sampling) with equal first stage units.

DEPARTMENT OF STATISTICS

UNIVERSITY COLLEGE OF SCIENCE

OSMANIA UNIVERSITY, HYDERABAD – 500 007

M.Sc. APPLIED STATISTICS

CBCS - SCHEME OF INSTRUCTION AND EXAMINATION

WITH EFFECT FROM 2018 – 2019

SEMESTER II

Paper	Sub. Code	Paper Title	Instruction Hrs/ Week	Duration of Exam (in Hrs)	Max. Marks	IA and Assign.	Credits
THEORY							
I	STAS2-I	Statistical Inference (SI)	4	3	80	20	4
II	STAS2-II	Applied Regression Analysis (ARA)	4	3	80	20	4
III	STAS2-III	Multivariate Data Analysis (MDA)	4	3	80	20	4
IV	STAS2-IV	Design of Experiments (DOE)	4	3	80	20	4
PRACTICALS							
V	STAS2-V	Statistical Inference and Applied Regression Analysis (SI, ARA)	9	3	100	***	4
VI	STAS2-VI	Multivariate Data Analysis and Design of Experiments (MDA, DOE)	9	3	100	***	4
Total			34	***	520	80	24
Semester Total					600		

M.Sc. (Applied Statistics) Semester II

STAS2 – I : Paper I - Statistical Inference (SI)

UNIT – I

Concepts of Hypothesis, Types of errors, Statistical test, critical region, test functions, randomized and non–randomized tests. Concepts of MP and UMP tests, Neymann – Pearson lemma and its applications to one parameter exponential family of distributions.

UNIT – II

Concepts of unbiased and consistent tests. Likelihood Ratio Criterion with simple applications (including homogeneity of variances). Statements of asymptotic properties of LR test. Confidence Intervals (based on fixed sample size and distributions for the parameters of Normal, exponential, Binomial, Poisson distributions). Relationship between confidence intervals and hypothesis testing. The concept of robustness in testing.

UNIT – III

Concepts of non – parametric estimation. Non- parametric methods for one-sample problems based on Run test and Kolmogorov – Smirnov test. Wilcoxon Signed rank test for one sample and paired samples. Two sample problems based on Wilcoxon Mann Whitney test. Kolmogorov test (expectation and variances of above test statistics except for Kolmogorov – Smirnov test). Statements about their exact and asymptotic distributions, Wald Wolfowitz Runs test and Normal scores test. Kendall's Tau, Ansari – Bradley test for two-sample dispersion, Kruskal – Wallis test for one – way layout. (k- samples). Friedman test for two-way layout (randomized block).

UNIT – IV

Notions of sequential vs. fixed sample size techniques. Wald's sequential probability Ratio Test (SPRT) for testing Simple null Hypothesis vs. simple alternative. Termination property of SPRT. SPRT procedures for Binomial, Poisson, Normal and exponential distributions and associated OC and ASN functions. Statement of optimality properties of SPRT.

REFERENCES

1. Rohatgi, V.K.: An Introduction to Probability Theory and Mathematical Statistics (Wiley Eastern)
2. Gibbons : Non Parametric Statistical Inference,(Tata Mc Graw Hill)
3. Myles Hooander and Douglas A. Wolfe – Non parametric Statistical methods (John Wiley and sons)
4. Wald,A. : Sequential Analysis (Dover Publications)
5. Milton and Arnold – Introduction to probability and Statistics (4^{th} Edition)-TMH publication.
6. Lehman, E. L. : Testing of hypothesis, John Wiey
7. Goon, Gupta and Das Gupta : Outlines of Statistics, Vol. II, World Press.

ADDITIONAL REFERENCES

1. C.R. Rao – Linear Statistical Inference (John Wiley)
2. W.J. Conovar – Practical Non parametric Statistics (John Wiley)

M.Sc (Applied Statistics) Semester II

STAS2 – II : Paper II - Applied Regression Analysis (ARA)

UNIT – I

Review of the general regression situation, extra sum of squares principle, orthogonal columns in the X – matrix, partial and sequential F-tests. Bias in regression estimates. Weighted least squares. Introduction to examination of residuals, overall plot, time sequence plot, plot against Y_i, predictor variables X_{ij} .Correlations and serial correlations among the residuals, Durbin Watson Test. Concept of outliers, Detecting of outliers, standardized residuals. Testing of outliers in linear models.

UNIT – II

Introduction of selecting the best regression equation, all possible regressions: backward, stepwise regression procedures. Variations on these methods. Stagewise regression procedures. Polynomial regression –use of orthogonal Polynomials. Ridge regression: Introduction, basic form of ridge regression, ridge regression on a selection procedure.

Robust regression: Introduction, Least absolute deviation regression(L_1-regression),M-Estimation Procedure, Least Median squares regression, ranked residuals regression(RREG).

UNIT – III

Logistic regression model – Introduction, Fitting the Logistic regression model, testing for the significance of the coefficients, Introduction to multiple Logistic regression, the multiple Logistic regression models, fitting the multiple logistic regression model, testing for the significance of the model.

Interpretation of the fitted Logistic regression model – Introduction, Dichotomous independent variable. Probit Analysis: Introduction, Analysis of Biological data, sigmoid curve, fitting a Probit Regression line through least squares method.

UNIT – IV

Non-linear regression – Introduction to non-linear regression model, some commonly used families of non-linear regression functions, statistical assumptions and inferences for non-linear regression, linearizable models, determining the Least squares estimates, The Gauss – Newton method, ML estimation, (D and S), Statements of asymptotic properties, Non–linear growth models – Types of models – the Logistic model, the Gompertz model.

REFERENCES

1. Draper and Smith: Applied Regression Analysis- John Wiley
2. Dennis Cook. R and Sanford Weisberg (1999) Applied Regression Including Computing and Graphics –John Wiley
3. Galton: Applied Regression Analysis
4. Regression Analysis: Concepts and Applications, Franklin A. Graybill and Hariharan K. Iyer
5. Applied Regression Analysis, linear models and related methods: John Fox
6. Non–linear Regression Analysis and its Applications: Douglas M. Bates and Donald G. Watts
7. Applied Logistic Regression: David W. Hosme and Stanley Lemeshow.
8. Linear Models for unbalanced Data: Shayler Searle
9. Residuals and Influence in Regression: R. Dennis Cook and Sanford Weisberg
10. Log–linear models and Logistic Regression: Ronald Christensen.

M.Sc (Applied Statistics) Semester II

STAS2 – III : Paper III - Multivariate Data Analysis (MDA)

UNIT – I

Concept of Bivariate and multivariate random variables, concept of random vector, its expectation, and variance-covariance matrix, marginal and joint distributions, stochastic independence of random vectors, conditional distributions.

Multinomial Distribution and its properties (Marginal, Conditional, MGF, Ch.F, Correlation), Multivariate normal distributions and its properties (Marginal, Conditional, MGF, Ch.F, Correlation), Distribution of sample mean vector, Independence of sample mean vector and sample variance-covariance matrix, Maximum likelihood estimates of parameters (Mean vector and covariance matrix).

UNIT – II

Sample dispersion matrix, statement of Wishart distribution and its simple properties; Wilk's λ criterion and its distribution, statements of its properties; Hotelling's T^2 statistic, Null distribution of Hotellings' T^2 and Applications of Hotelling T^2 Statistic (single and two sample mean vector cases), Mahalanobis D^2 statistic,

UNIT - III

Concepts of Discriminant analysis, Computation of linear discriminant function using likelihood ratios based on Multivariate normal populations and Fisher's Linear Disciminent Function, Bayes Mis-classification, Relationship between Discriminant function and Mahalanobis D^2 statistic.

Path analysis and computation of path coefficients. Correspondence analysis. Introduction to multidimensional scaling, some related theoretical results, similarities, metric and non-metric multidimensional scaling methods.

UNIT – IV

Principal component analysis: Introduction, Derivation of Principal components and statements of its properties; Factor analysis: Introduction, simple factor model, Orthogonal factor model construction. Canonical variables and canonical correlations, Cluster analysis: Introduction, similarities and dissimilarities, Single, Complete and average linkage methods.

REFERENCES

1. Johnson, R.A, and Dean W. Wichern: Applied Multivariate Statistical Analysis.
2. Morrison, D: An Introduction to Multivariate Analysis.
3. Seber : Multivariate Observations
4. Anderson: An Introduction to Multivariate Analysis.
5. Bishop: Analysis of Categorical data.

M.Sc. (Applied Statistics) Semester II

STAS2 – IV : Paper IV - Design of Experiments (DOE)

UNIT – I

Analysis of co-variance: one–way and two–way classifications. Estimation of main effects, interactions and analysis of 2^k factorial experiment in general with particular reference to k = 2,3 and 4 and 3^2 factorial experiments. Multiple comparisons, Fisher Least Significance Difference (L.S.D) test and Duncan's Multiple range test (DMRT).

UNIT – II

Total and partial confounding in case of 2^3, 2^4 and 3^2 factorial designs. Concept of Balanced partial confounding. Fractional replications of factorial designs – one-half replication of 2^3 & 2^4 design, one-quarter replication of 2^5 and 2^6 designs. Resolution of a design, Split – plot design.

UNIT – III

Balanced incomplete block design (BIBD) – parametric relations, intra-block analysis, recovery of inter-block information. Partially balanced incomplete block design with two associate classes PBIBD (2) – Parametric relations, intra block analysis. Simple lattice design and Youden-square design.

UNIT – IV

Concept of Response surface methodology (RSM), the method of steepest ascent. Response surface designs. Design for fitting first – order and second – order models. Variance of estimated response. Second order rotatable designs (SORD), Central composite designs(CCD): Role of CCD as an alternative to 3^k design, Notatability of CCD.

REFERENCES

1. Das, M.N. and Giri,N.: Design and Analysis of Experiments, Wiley Eastern.
2. Montogomery, D.C. : Design and Analysis of Experiments, John Wiley.
3. Draper and Smith : Applied Regression Analysis, John Wiley.
4. Parimal Mukhopadhyay : Applied Statistics, New Central Book Agency.

ADDITIONAL REFERENCES

1. Cochran and Cox : Experimental designs, John Wiley.
2. Kempthrone : Desing and Analysis of Experiments, John Wiley.
3. Kapoor and Gupta : Applied Statistics, Sultan Chand.
4. Alok Dey : Theory of Block Desings, Wiley Eastern.

M.Sc. (Applied Statistics) Semester II

STAS2 – V : Paper V Practical (SI and ARA)

PRACTICALS IN STATISTICAL INFERENCE AND APPLIED REGRESSION ANALYSIS

STATISTICAL INFERENCE

1. Type I and Type II errors
2. MP tests
3. UMP tests
4. L.R. Tests
5. Wilcoxon Signed rank test
6. Wilcoxon Mann-Whitney test
7. Kolmogorov – Smirnov one sample, two sample tests
8. Ansari – Bradley test for two sample dispersion
9. Krusakal Walli's test for one way layout
10. Friedman test for two way layout
11. Normal Scores test
12. Kendall's Tau
13. SPRT procedures for
    - (i) Binomial
    - (ii) Poisson
    - (iii) Normal and computation of their OC function.

APPLIED REGRESSION ANALYSIS

1. Computation of residuals and their plots.
2. Computation and testing of Serial Correlation.
3. Computation of all possible regression for three variables using R^2.
4. Probit and Logit analysis
5. Step wise Regression for four variables
6. Forward selection for four variables
7. Backward elimination for four variables

M.Sc.(Applied Statistics) Semester II

STAS2 – VI : Paper VI Practical (MDA and DOE)

PRACTICALS IN MULTIVARIATE DATA ANALYSIS AND DESIGN OF EXPERIMENTS

MULTIVARIATE DATA ANALYSIS

1. MLE of parameters of multivariate normal distribution.
2. Computation of Hotellings T^2 and Mahalanobis D^2.
3. Computation Path coefficients.
4. Classification between two normal populations by discriminant analysis.
5. Computation of Principle Components.
6. Computation of canonical correlations
7. Estimating the factor loading in single factor model.
8. Computation of single linkage method.
9. Single linkage dendogram for dissimilarity matrix.

DESIGN OF EXPERIMENTS

1. Analysis of 2^3 and 2^4 factorial experiments.
2. Analysis of 3^2 factorial experiment.
3. Analysis of Total and partial confounding of 2^3 factorial design.
4. Analysis of one-half fraction of 2^4 design and one-quarter fraction of 2^5 design.
5. Analysis of Split-plot Design
6. Intra-block analysis of BIBD
7. Intra-block analysis of PBIBD(2)
8. Analysis of Youden-square design
9. Analysis of Simple Lattice design