Telangana University

M.Sc. Applied Statistics – 2 years

Syllabus

IDEPARTMENT OF APPLIED STATISTICS
TELANGANA UNIVERSITY, NIZAMABAD – 503 322

M.Sc. (APPLIED STATISTICS)

SCHEME OF INSTRUCTION AND EXAMINATION
WITH EFFECT FROM 2007 – 2008

SEMESTER I

Paper	Subject	Instruction Hrs/ Week	Duration of Exam In Hrs	Max. Marks
THEORY				
I	Linear Algebra and Linear Models (LA&LM)	4	3	100
II	Probability Theory (PT)	4	3	100
III	Distribution Theory and Estimation (DT&ET)	4	3	100
IV	Sampling Theory and Surveys (ST)	4	3	100
PRACTICALS				
V	C++ Programming (C++)	9	#	100
VI	Linear Algebra, Linear Models, Distribution Theory, Estimation and Sampling Theory (LA, LM, DT, ET, ST)	9	#	100
	Seminar	2		
Total		34+2		600

Note : # Examination will be at the end of Semester **II**

M.Sc. (Applied Statistics) Semester I
Paper I - Linear Algebra and Linear Models

UNIT – I

Vector spaces: vector spaces, sub spaces, linear dependence and independence, basis and dimension of a vector space with examples. 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 – Condition for the existence of homogenous and non homogenous linear equation.

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 (QFs), reduction and classification of QFs, index and signature. Extrema of QFs Simultaneous reduction two QFs. Cauchy-Schwartz and Hadamard inequalities for matrices.

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. Polynomial regression – use of orthogonal polynomials.

UNIT – IV

Derivation of multiple and partial correlations, 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.

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.

M.Sc. (Applied Statistics) Semester I
Paper II - Probability Theory

UNIT – I

Review axiomatic approach to Probability, Probability as a measure, conditional probability (and Baye's Theorem). Random Variable, distribution function and its properties. Statement of properties of Riemann – Stieltjes integrals; expectations of functions of random variables – moments. Chebychev, Markov, Holder, Minkowsky, Liapunov and Jensen Inequalities.

UNIT – II

Characteristic function and its properties, statement of uniqueness and inversion theorems and examples, sequences of random variables; Levy's continuity theorem (Statement only).(Functions which can not be Characteristic functions).

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

UNIT – III

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

Central Limit Theorem – Levy-Lindeberg form, Liapunov's form and Lindberg – Feller (Statement only) form – with examples.

UNIT – IV

Stochastic process, Markov process, stationary process, stationary sequence; Martingale sequence of random variables with examples.

Definition and examples of finite – dimensional distributions of a Markov Chain; time – homogeneity; transition probability matrix; marginal distribution. Classification of states – recurrent, transient, positive recurrent and null recurrent states. (Recurrent classes, canonical form of transition probability matrix).

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

ADDITIONAL REFERENCES

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

M.Sc. (Applied Statistics) Semester I
Paper III - Distribution Theory and Estimation

UNIT – I

Review of Univariate Discrete and Continuous distributions. 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, variance, Central t, F and χ^2, independence of X and S. 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 and quantile.

UNIT – III (Estimation)

Concepts of point estimation.

Estimation : MSE, unbiasedness, sufficient statistic, relative efficiency, consistency of point estimate. Statement of Neymann's factorization criterion with applications, MVUE, amount of information, CR lower bound and its applications. Rao – Blackwell theorem, completeness, Lehmann – Scheff's theorem.

UNIT – IV

Method of moments, minimum chi square, LS, MLE and its properties (only statements). 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.

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
Paper IV - Sampling Theory and Surveys

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. Hurwitz Thompson, Hansen – Hurwitz 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 estimators - 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, 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

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. Murthy, M.N. (1967) : Sampling theory, Tata McGraw Hill, New Delhi.

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. Cochran, W.C. (1977) : Sampling Techniques, Third Edition, Wiley Eastern.

M.Sc. (Applied Statistics) Semester I
Paper VI - Practicals (C++ Programming)

Concepts to be covered:

Principles of Object Oriented Programming, Tokens, Expressions and Control structures. Functions, classes and objects. Constructors and destructors. Operator overloading and type conversions, Inheritance, Pointers, Virtual functions and Polymorphism. Managing console I/O operations. Working with files. Object oriented system development. Templates and exception handling.

List of Practicals :

1) a) Factorial of a number b) Fibonacci series generation
2) a) Pascal triangle b) Pyramid of digits
3) Evaluation of a) e^x b) sin x c) cos x using series expansion.
4) Find a) mean b) variance c) standard deviation and d) coefficient of variation for a given set of data.
5) a) Finding correlation coefficient and b) fitting straight line regression and parabolic regression curve.
6) Sorting numbers by bubble sort and finding median and mode of the data.
7) Write a program for preparation of frequency tables using functions and computing mean, median, mode, variance and standard deviation of the frequency distribution.
8) Write a class to a) crate a vector b) modify the values of a given element c) to multiply by a scalar value and d) display the vector in the form of a row vector. Write a main program to test your class.
9) Display and addition of complex numbers and vectors by creating a complex and vector class , respectively.
10) Matrix addition, subtraction and multiplication of confirmable matrices by operator over loading.
11) Concatenation of two strings using operator overloading.
12) File opening, writing records, reading records and updating a file, prepare merit list of students for an entrance examination marks from a file. Write the merit list on some other file and display the same.
13) Define a base class ‘B’ containing one private data member ‘a’ and public data member ‘b’ and three public member functions get_ab ( ), get_ a (Void), show_a (void). Derive a class ‘D’ from the class ‘B’, ‘D’ should contain one private data member ‘C’ and two member functions Mul (void) and Display (void). Define a main program in which create an object for the class and test all the four member functions.
14) Generation of uniform random numbers using virtual functions.
15) Fitting of distributions _ Binomial , Poisson and Negative binomial based on relation between mean and variance.
16) Solution to simultaneous equations by Gauss - Siedal method.

REFERENCES

1. Balagurusamy, E.(1995) : Object – oriented Programming with C++, Tata Mc Graw Hill
2. Strousstroup, B.(1991) : The C++ Programming Language, 2nd edition, Addison-Wesley.

M.Sc.(Applied Statistics) Semester I
Paper VII

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

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.

LINEAR MODELS

1. Fitting of Multiple Regression models for Two and Three Independent variables.
2. Testing of Multiple regression parameters.
3. Computation of pure error and lack of fit test.
4. Computation and Testing of Multiple Correlation coefficients.
5. Computation and Testing of Partial Correlation Coefficients.

DISTRIBUTION THEORY AND ESTIMATION

1. Fitting of an appropriate discrete distribution
   - (i) Binomial
   - (ii) Poisson
   - (iii) Negative Binomial
2. Fitting of Normal Distribution
3. Fitting of
   - (i) Cauchy Distribution
   - (ii) Exponential Distribution
4. Method of MLE (Scoring Method)

SAMPLING THEORY

1. Simple Random Sampling wr/wor with unequal probabilities (pps)
2. Ratio Method: Comparison with SRS
3. Separate and combined ratio estimators – Comparison with St. R.S.
4. Regression Method – Comparison with SRS and the Ratio Method
5. Separate and combined Regression methods – Comparisons
6. Cluster sampling for equal sizes.
7. Sub sampling (Two – stage sampling with equal first stage units)

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M.Sc. (APPLIED STATISTICS)

SCHEME OF INSTRUCTION AND EXAMINATION
WITH EFFECT FROM 2007 – 2008

SEMESTER II

Paper	Subject	Instruction Hrs/ Week	Duration of Exams In Hrs	Max. Marks	Remarks
THEORY					
I	Statistical Inference (SI)	4	3	100	
II	Applied Regression Analysis (ARA)	4	3	100	
III	Multivariate Data Analysis (MDA)	4	3	100	
IV	Design of Experiments (DOE)	4	3	100	
PRACTICALS					
V	Statistical Inference and Applied Regression Analysis (SI, ARA)	9	3	100	
VI	Multivariate Data Analysis and Design of Experiments (MDA, DOE)	9	3	100	
	Seminar	2			
Total		34 + 2			
PRACTICALS SEMESTER I					
V	C++ Programming (C++)	-	3	100	#
VI	Linear Algebra, Linear Models, Distribution Theory, Estimation and Sampling Theory (LA, LM, DT, ET, ST)	-	3	100	#
Total				800	

Note : # Instruction during Semester I

M.Sc. (Applied Statistics) Semester II
Paper I - Statistical Inference

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. 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)

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
Paper II - Applied Regression Analysis

UNIT – I

The general regression situation, extra sum of squares principle, orthogonal columns in the X – matrix, partial and sequential F-tests. Testing a general hypothesis in regression situations, weighted least squares, bias in regression estimates.

UNIT – II

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, outliars.

UNIT – III

Introduction of selecting the best regression equation, all possible regressions: backward, stepwise regression procedures. Variations on these methods. Ridge and robust regression procedures.

UNIT – IV

Probit and logit analysis, Introduction to non-linear regression model building, least squares in non-linear case, estimating the parameters, non-linear growth models.

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

M.Sc (Applied Statistics) Semester II
Paper III - Multivariate Data Analysis

UNIT – I

Motivation to take up multivariate data analysis; concept of random vector, its expectation, and variance-covariance matrix, marginal and joint distributions, stochastic independence of random vectors, conditional distributions. Multinomial Distribution, Multivariate normal distributions marginal and conditional distributions. Sample mean vectors and its distribution. Maximum likelihood estimates of parameters. Sample dispersion matrix, statement of Wishart distribution and its simple properties.

UNIT – II

Hotelling's T^2 and Mahalanobis D^2 statistics, null distribution of Hotellings' T^2, wilks λ criterion and statement of its properties. Concepts of discriminant analysis, computation of linear discriminant function, classification between K ($\geq$2), multivariate normal populations based on LDF and Mahalanobis D^2.

UNIT - III

Path analysis and computation of path coefficients, introduction to multidimensional scaling. Classical solution: some theoretical results, similarities, metric and non-metric scaling methods. Concepts of analysis of categorical data.

UNIT – IV

Principal component analysis, factor analysis and simple factor model (brief mention of multi-factor model). Canonical variables and canonical correlations, Introduction to cluster analysis: similarities and dissimilarities, Hierarchical clustering: Single and Complete linkage method.

REFERENCES

1. Johnson, R.A, and Dean W. Wichem: 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
Paper IV - Design of Experiments

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 & 2^6 designs. 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.

Reference

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 Reference

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
Paper V

PRACTICALS IN STATISTICAL INFERENCE AND APPLIED REGRESSION ANALYSIS

STATISTICAL INFERENCE

1. Wilcoxon Mannwhitney test
2. Kolmogorov – Smirnov one sample, two sample tests
3. L.R. Tests
4. Ansari – Bradley test for two sample dispersion
5. Krusakal Walli's test for one way layout
6. Friedman test for two way layout
7. Normal Scores test
8. Kendall's Tau
9. SPRT procedures for
   (i) Binomial
   (ii) Poisson
   (iii) Normal and computation of their OC function.

APPLIED REGRESSION ANALYSIS

1. Testing of general linear hypothesis.
2. Computation of bias in regression estimates.
3. Computation of residuals and their plots.
4. Computation and testing of Serial Correlation.
5. Computation of Partial F for two variable regression model.
6. Computation of all possible regression.
7. Computation of Robust regression.
8. Computation of Logistic regression by Odds Ratio for two and three variables.

M.Sc.(Applied Statistics) Semester II
Paper VI

PRACTICALS IN MULTIVARIATE DATA ANALYSIS AND DESIGN OF EXPERIMENTS

MULTIVARIATE DATA ANALYSIS

1. Computation Path coefficients.
2. Computation of Hotellings T^2 and Mahalanobis D^2
3. Classification between two normal populations by discriminant analysis.
4. Computation of Principle Components.
5. Computation of canonical correlations
6. Estimating the factor loading in single factor model.
7. Computation of single linkage method.
8. 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 experiments.
3. Analysis of Total and partial confounding of 2^3 and 2^4 factorial designs.
4. Analysis of Total and Partial confounding of 3^2 factorial design.
5. Analysis of one-half replication 2^4 design and one-quarter replication of 2^5 design.
6. Analysis of Split-plot Design
7. Intra-block analysis of BIBD
8. Intra-block analysis of PBIBD(2)
9. Analysis of Youden-square design
10. Analysis of Simple Lattice design

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M.Sc. (APPLIED STATISTICS)
SCHEME OF INSTRUCTION AND EXAMINATION
WITH EFFECT FROM 2008 – 2009

SEMESTER III

Paper	Subject	Instruction Hrs/ Week	Duration of Exam In Hrs	Max. Marks
THEORY				
I	Operations Research – I (OR – I)	4	3	100
II	Statistical Process and Quality Control (SPQC)	4	3	100
III	Forecasting Models (FM)	4	3	100
IV	JAVA Programming (JAVA)	4	3	100
PRACTICALS				
V	Operations Research – I & Statistical Process and Quality Control (OR–I, SPQC)	9	#	100
VI	Forecasting Models and JAVA Programming (FM, JAVA)	9	#	100
	Seminar	2		
Total		34+2		600

Note : # Examinations at the end of Semester **IV**

M.Sc. (Applied Statistics) Semester III
Paper – I : Operations Research–I

Unit–I

Definition and scope of OR: Phases in O.R.; Models and their solutions; decision making under uncertainty and risk.

Duality and complementary slackness theorem, primal dual relation; dual simplex algorithm; revised simplex algorithms.

Unit–II

Sensitivity Analysis: Introduction, definition of sensitivity analysis; discrete changes in requirement and cost vectors.

Parametric Programming: Introduction, parameterisation of cost and requirement vectors.

Sequencing and scheduling Problems: 2 machine n-job and 3 machine n-job problems with identical machine sequence for all jobs; 2-job n-machine problem with different machine problem with different routings.

Unit–III

Inventory: Analytical structure of 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 the demand follows uniform distribution. Multi item inventory subject to constraints.

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

Unit–IV

Integer Programming Problem: Gomory's cutting plane algorithm for pure and mixed IPP; Branch and bound Technique.

Stochastic Programming problem; analysis of chance constrained linear programming under zero order, non randomised decision rule, deterministic equivalents of chance constraints with reference to Normal and Cauchy distributions.

REFERENCES

1. Kantiswarup; Gupta P.K. and Singh,M.N.(1985):Operations Research; Sultan Chand
2. Sharma,S.D.: Operations Research
3. Taha, H.A.(1982): Operations Research: An Introduction; MacMillan
4. Gillet.: Introduction to O. R.

ADDITIONAL REFERENCES

1. Hillier F.S. and Leiberman,G.J.(1962) : Introduction to Operations Research; Holdon Day.
2. Philips, D.T.,Ravindran,A. and Solbeg,J.(2000) : Operations Research principles and practice.

M.Sc. (Applied Statistics) Semester III
Paper - II: Statistical Process and Quality Control

Unit–I

Basic concept of process monitoring, control, process capability and process optimisation.

General theory and review of control charts for attribute and variable data: O.C. and A.R.L. of control charts, control by gauging.

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Unit–II

Moving Average and exponentially weighted moving average charts, Cu-sum charts using V-Masks and decision intervals, Economic design of X bar chart.

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 of R.S.P. for specified AOQL and LTPD. Plans for inspection by variables for one–sided and two–sided specifications; Mil Standard 414 plans; Dodges Continuous sampling Plan–I and its properties modifications over CSP–I.

Unit–IV

Process Capability Analysis: Capability indices Cp, Cpk and Cpm, estimation, confidence intervals and tests of hypotheses relating to capability indices for normally distributed characteristics.

Multivariate quality control, use of control ellipsoid and of utility functions. Concept of TQM, Six sigma.

REFERENCES

1) Montgomery, D.C.(1985) : Introduction to Statistical Quality Control, Wiley
2) Wetherill, G.B. (1977): Sampling Inspection and Quality Control, Halsted Press.

ADDITIONAL REFERENCES

1. Ott,E.R. (1975) : Process Quality Control, McGraw Hill
2. Phadke, M.S. (1989): Quality Engineering through Robust Design, Prentice Hall.
3. Wetherill, G.B., and Brown, D.W : Statistical Process Control : Theory and Practice, Chapman and Hall.

M.Sc.(Applied Statistics) Semester III
Paper - III : Forecasting Models

Unit–I

Forecasting: The role of forecasting in decision-making, forecasting techniques. Smoothing Techniques: Simple Moving Averages, exponential smoothing and Winter's linear and seasonal exponential smoothing.

Stationary stochastic processes, Autocovariance and Autocorrelation functions and their estimation. Standard error of autocorrelation estimates. Bartlett's approximation (without proof). Periodgram, power spectrum and spectral density functions. Simple examples of autocorrelation and spectral density functions. Link between sample spectrum and auto-correlation function.

Unit–II

Linear Stationary Models: Two equivalent forms for the general linear process. Autocovariance generating function and spectrum. Stationarity and invertibility conditions for a linear process. Autoregressive and moving average processes, autocorrelation function (ACF), partial autocorrelation function (PACF). Spectrum for AR processes up to 2. Moving average process, stationarity and invertibility conditions. ACF and PACF for M.A.(q) spectrum for M.A. processes up to order 2, Duality between autoregressive and moving average processes. Mixed AR and MA (ARMA) process. Stationarity and invertibility properties, ACF and spectrum of mixed processes. The ARMA(1,1) process and its properties.

Unit–III

Linear Non-Stationary Models–Autoregressive integrated and moving average (ARIMA) processes. The three explicit forms for the ARIMA models viz., difference equation, random shock and inverted forms.

Model Identification: Stages in the identification procedures, use of autocorrelation and partial auto–correlation functions in identification. Standard errors for estimated auto correlations and partial autocorrelations. Initial estimates of parameters of MA, AR and ARMA processes and residual variance.

Model estimation: Least squares and Maximum likelihood estimation and interval estimation of parameters.

Unit–IV

Model diagnostic checking–Checking the stochastic model. Diagnostic checks applied to residuals.

Forecasting-minimum: Mean square error forecasts and their properties, derivation of the minimum mean square error forecasts, calculating and updating forecasts, probability limits of the forecasts at any lead time.

REFERENCES

1) Weel Wright, S.C. and Makridakis,S. (1973) : Forecasting methods for Management, John–Wiley & sons, New York.
2) Box, G.E.P. and Jankins,G.M.(1970) : Time series Analysis (Forecasting and control), Holden day publication.

ADDITIONAL REFERENCES

1. Anderson, T.W.(1971) : The statistical analysis of Time series, John Wiley, New York.
2. Brockwell,P.J. and Davis, R.A. : Time Series : Theory and methods(Second Edition), Springer-Verlag.

M.Sc. (Applied Statistics) Semester III
Paper - IV : JAVA Programming

Unit–I

Genesis and overview of Java, Data types, Variables and arrays, operators, control statements, classes and methods

Unit–II

Inheritance, packages and Interfaces, Exception handling and Multithreading

Unit–III

String handling, java.lang, java.util and exploring java.io

Unit–IV

Applets with simple examples in Statistics, Event Handling and AWT

REFERENCES

Schildt, H.(2001) : Java 2 : The Complete Reference, Fourth Edition, Tata McGraw Hill, New Delhi.

M.Sc. (Applied Statistics) Semester III
Paper VI

Practicals in Operations Research–I and Statistical Process and Quality Control

Operations Research–I

1. Problems in Dual LPP
2. Dual Simplex
3. Revised Simplex
4. Sensitivity Analysis
5. Parametric Programming Problem
6. Sequencing problem
7. Networking Problem
8. Integer Programming Problem

Statistical Process and Quality Control

1. Construction of $\overline{X}$, R and σ - charts and OC curves for $\overline{X}$ and R charts
2. Construction of p – chart (with constant and variable sample size) – OC curve for constant sample size
3. Construction of C–chart and U–chart and OC curve for C–Chart
1. Construction of CUSUM charts V – Mark.
4. Designing Single Sampling Plans for specified p_1, p_2, α and β
5. OC, ASN Curves for double sampling plans – designing for specified p_1, p_2, α and β
6. Construction of AOQ and AFI curves for CSP–I
7. Computation of process capability indices

M.Sc. (Applied Statistics) Semester III
Paper VII

Practicals in Forecasting Models and JAVA Programming

Forecasting Models

2. Moving Averages and exponential smoothing
3. Generation of Time series by means of simple time series models
4. Sample and theoretical correlograms
5. Periodogram analysis
6. Writing the models in B notation and stationarity and invertibility of the models
7. Classification of ARIMA models and computation of weights
8. Identification AR, MA and ARMA models
9. Estimation of parameters in AR, MA and ARMA models
10. Computation of forecasts, updating and probability limits for forecasts

JAVA Programming

1. Factorial of a given number
2. Fibonacci series generation
3. Sorting of numbers
4. Basic Statistics
5. Correlation Coefficient
6. Fitting a straight line
7. Preparation of frequency table
8. T–test for mean(s)
9. F–test for variances
10. Chi-square test for independence of attributes
11. Interpolation by Lagrange's Method
12. Solution of non-linear equations by Newton – Raphson's Method

DEPARTMENT OF APPLIED STATISTICS
TELANGANA UNIVERSITY, NIZAMABAD – 503 322

M.Sc. (APPLIED STATISTICS)
SCHEME OF INSTRUCTION AND EXAMINATION
WITH EFFECT FROM 2008 – 2009

SEMESTER IV

Paper	Subject	Instruction Hrs/ Week	Duration of Exam In Hrs	Max. Marks	Rem arks
THEORY					
I	Operations Research–II (OR–II)	4	3	100	
II	Applied Stochastic Processes (ASP)	4	3	100	
III	Elective I - Statistical Pattern Recognition (SPR)	4	3	100	
IV	Elective II - Reliability Theory (RT)	4	3	100	
PRACTICALS					
V	Operations Research – II, Applied Stochastic Processes, Statistical Pattern Recognition and Reliability Theory (OR–II, ASP, SPR, RT)	9	3	100	
VI	Statistical Package (SPSS)	9	3	100	
	Seminar	2	-		
Total		(34+2)			
PRACTICALS SEMESTER III					
V	Operations Research – I & Statistical Process and Quality Control (OR–I, SPQC)	-	3	100	#
VI	Forecasting Models and JAVA Programming (FM, JAVA)	-	3	100	#
Total				800	

Note : # Instruction during Semester III

Electives: Any two of the following courses may be taken as electives, subject to the administrative convenience of the Department.

1. Statistical Pattern Recognition (SPR) 2. Reliability Theory (RT)
3. Econometrics (E)

M.Sc. (Applied Statistics) Semester IV
Paper I - Operations Research – II

Unit–I

Non-linear Programming problem – Formulation Generalised 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–II

Dynamic Programming, Principle of optimality, solution of LPP by Dynamic Programming technique, Knapsack problem by Dynamic Programming Technique. General goal Programming model and formulation of its objective function. Solutions to linear goal programming and linear integer goal programming.

Unit–III

Game Theory : 2 person zero sum game, pure strategies with saddle point, mixed strategies with saddle point, principles of dominance and games without saddle point.

Introduction to simulation, generation of random numbers for Uniform, Normal, Exponential, Cauchy and Poisson Distributions. Estimating the reliability of the random numbers, Simulation to Queuing and Inventory problem.

Unit–IV

s-S policy for inventory and its derivation in the case of exponential demand; Models with variable supply and models for perishable Items.

Replacement Problems; Introduction, block and age replacement policies, replacement of items with long life. Machine interference problems.

REFERENCES

1. Taha, H.A.(1982): Operations Research : An Introduction; McMillan
2. Kantiswarup;Gupta P.K. and Singh,M.N.(1985) : Operations Research; Sultan Chand.
3. Sharma,S.D.: Operations Research.
4. U. N. Bhat: Introduction to Applied Stochastic Process.

ADDITIONAL REFERENCES

1. Hillier F.S. and Leiberman,G.J.(1962) : Introduction to Operations Research; Holdon Day
2. Philips, D.T.,Ravindran,A. and Solbeg,J.(2000) : Operations Research principles and practice.

M.Sc. (Applied Statistics) Semester IV
Paper II - Applied Stochastic Processes

Unit–I

Markov Chains: Classification of states, canonical representation of transition probability matrix. Probabilities of absorption and mean times for absorption of the Markov Chain from transient states into recurrent classes. Limiting behaviour of Markov chain: Stationary distribution

Unit–II

Continuous–time Markov Processes: Kolmogorov–Feller differential equations, Poisson process and birth and death processes.

Renewal Processes: Renewal process when time is discrete and renewal process with time is continuous, with examples. Renewal function, renewal density, limiting behaviour. Statement of elementary and basic renewal theorems.

Branching Processes: Examples of natural phenomena that can be modelled as a branching process. Probability of extinction; Statement of fundamental theorem of branching processes.

Note: Emphasis is only on statements of theorems and results and their applications.

Unit–III

Stochastic Processes in Biological Sciences: Markov models in population genetics; Recovery, relapse and death due to disease; cell survival after irradiation; compartmental analysis.

Stochastic Processes in communication and information systems: Markov models in storage requirements for unpacked messages; buffer behaviour for batch arrivals; loop transmission systems; a probabilistic model for hierarchical message transfer.

Stochastic Processes in traffic–flow theory; some traffic flow problems; pedestrian traffic on a side–walk; free–way traffic; parking lot traffic; intersection traffic; left–turning traffic; pedestrian delay; headway distribution

Unit–IV

Stochastic Processes in social and behavioural sciences; Markov chain models in the study of social mobility; industrial mobility of labour; educational advancement; labour force planning and management; diffusion of information.

Stochastic Processes in Business Management: Markov models in marketing and accounting; consumer behaviour; selecting a port–folio of credit–risks; term structure; human resource management; income determination under uncertainty.

REFERENCE

1. Bhat, U.N., (1984): Elements of Applied Stochastic Processes, John Wiley

ADDITIONAL REFERENCE

1. Ross, S. (1996): Stochastic Processes, Second Edition, John Wiley.
2. J. Medhi: Stochastic Processes.

M.Sc.(Applied Statistics) Semester IV
Paper V

Practical in Operations Research–II, Applied Stochastic Processes, Statistical Pattern Recognition And Reliability Theory

Operations Research–II

1. Wolfe and Beale's methods
2. Separable Programming problem
3. Dynamic Programming Problem
4. Goal Programming Problem
5. Game Theory
6. Simulation

Applied Stochastic Processes

1. Computation of higher order transition probability matrix in a two–state Markov chain using spectral decomposition
2. Classification of states of a Markov chain, determination of periods of states and mean recurrence times of recurrent states.
3. Determination of stationary distribution(s) and evaluation of the same.
4. Probabilities of absorption and mean time for absorption from each transient state into recurrent class.

Statistical Pattern Recognition

1. Linear Classifiers using LDF
2. Binary outputs using LDF
3. Probability of Errors – Normal distribution with equal covariance matrix
4. Hidden Markov Model
5. Feature relation using P.C.A.

Reliability Theory

1. Finding Minimal path sets and Minimal cutsets and their representations
2. Computation of System reliability – parallel, Series and k out of n system
3. Computations of reliability of Structures when components are independent
4. Computation of estimated reliability and hazard rates
5. Graphing the reliability function of the systems when the life times of components are exponentially distributed

M.Sc. (Applied Statistics) Semester IV
Paper VI

Practicals in Statistical Packages

Data Analysis with respect to the following topics will be carried out using SPSS

1. Charts
2. Basic Statistics
3. Design of Experiments
4. Multivariate Analysis
5. Time Series
6. Parametric tests
7. Non–Parametric tests
8. Operations Research
9. Statistical Quality Control
10. Regression Analysis

M.Sc.(Applied Statistics) Semester IV
Elective I - Statistical Pattern Recognition

Unit–I

Basic concepts of pattern recognition. Fundamental problems in pattern recognition. Linear classifiers (Statistical approximation), Linear discriminant function for minimum squared error, L.D.F. for binary outputs; perception learning algorithm.

Unit–II

Nearest neighbour decision rules: description convergence, finite sample considerations, use of branch and bound methods.

Unit–III

Probability of errors: Two classes, Normal distribution, equal covariance matrix assumptions, Chernoff bounds and Bhattacharya distance, estimation of probability of error. Introduction to Hidden Markov Models (H.M.M.) and its applications.

Unit–IV

Feature selection and extraction: Interclass distance measures, discirmanant analysis, Probabilistic distance measures, Principal Components.

REFERENCES

1) R.O. Duda & H.E. Hart(1978): Pattern Recognition and scene analysis, Wiley
2) J.T. Ton and R.C. Gonzalez (1974) : Pattern Recognition Principles, Addison Wesley Publishing Company
3) G.J. McLactilan (1992): Discriminant Analysis and Statistical Pattern Recognition, Wiley
4) B.D. Ripley (1996) : Pattern Recognition & Neural Networks, Cambridge University Press.
5) Duda, Hast & Strok: Pattern Recognition.

M.Sc. (Applied Statistics) Semester IV
Elective II - Reliability Theory

Unit–I

Coherent Systems: Reliability concepts – Systems of components. Series and parallel systems – Coherent structures and their representation in terms of paths and cuts, Modular decomposition.

Unit–II

Reliability of coherent systems – Reliability of Independent components, association of random variables, bounds 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-ageing property, ageing properties of other common life distribution, closures under formation of coherent structures, convolutions and mixtures of theses cases.

Unit–IV

Maintenance and replacement policies, relevant renewal theory, availability theory, maintenance through spares and repair.

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 Winston Inc.

Chapter I – Section 1 to 4
II – Section 1 to 4
III – Section 1,2,4 and 5
IV – Section 1 to 4
VI – Section 1 to 3
VII – Section 1 to 3, Section 4.1,4.2

Additional References:

1. Barlow and Proschen (1965): Mathematical Theory of Reliability, John Wiley
2. Balaguru Swamy – Reliability Engineering
3. L.J. Bain: Statistical analysis of Reliability and like testing Marcel Decker.
4. Sinha, S.K., and Kale, S.K., (1980): Life testing and Reliability estimation, Wiley Eastern.

M.Sc.(Applied Statistics) Semester IV
Elective: Econometrics

Unit–I

Meaning and scope of econometrics. Concepts of dummy variables and proxy variable.

Problems and methods of estimation in single equation regression Models

Multicollinearity: Consequences of multicollinearity, tests to detect its presence and solutions to the problem of multicollinearity.

Generalised Least Squares: Estimates of regression parameters – Properties of these estimates

Unit–II

Heteroscedasticity: Consequences of hetroscedastic disturbances – test to detect its presence and solutions to the problem of heteroscedasticity.

Auto Correlation: Consequences of auto correlated disturbances, Durbin – Watson test – Estimation of autocorrelation coefficient (for a first order autoregressive scheme)

Unit–III

Distributed lag models: study of simple finite lag distribution models – Estimation of the coefficients of Koyek geometric lag model.

Instrumental Variable: Definition – derivation of instrument variable estimates and their properties.

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 structure and Model–Exogenous and Endogenous variables – Reduced form of a model

Problem of identification – Rank and order conditions and their application.

Methods of estimation: Indirect least squares. Two stages least squares, three stages least squares. A study of merits and demerits of these methods.

REFERENCES

1. Johnston – Econometrics Methods (2^{nd} 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: 12-1,12-1.3,12-1.4, Chapter 16: Section 16-1.1,16-1.216-3.1,16-3.2

M.Sc.(Applied Statistics) IV Semester
Elective Papers

Practicals in Statistical Pattern Recognition

6. Linear Classifiers using LDF
7. Binary outputs using LDF
8. Probability of Errors – Normal distribution with equal covariance matrix
9. Hidden Markov Model
10. Feature relation using P.C.A.

Practicals in Reliability Theory

6. Finding Minimal path sets and Minimal cutsets and their representations
7. Computation of System reliability – parellel, Series and k out of n system
8. Computations of reliability of Structures when components are independent
9. Computation of estimated reliability and hazard rates
10. Graphing the reliability function of the systems when the life times of components are exponentially distributed

Practicals in Econometrics

1. Use of dummy variables (dummy variable trap) and seasonal adjustment
2. GLS estimation and predictors
3. Tests for heteroscedasticity
4. Tests for Autocorrelations
5. Instruments variable estimation
6. Estimation with lagged dependent variable
7. Identification problems – Checking rank and order condition
8. Two SLS estimation