

ACHARYA NAGARJUNA UNIVERSITY

CENTRE FOR DISTANCE EDUCATION

NAGARJUNA NAGAR,

GUNTUR

ANDHRA PRADESH



PROGRAM PROJECT

REPORT

138. MASTER OF SCIENCE (STATISTICS)

Master of Science (Statistics)

PROGRAMME CODE: 138

MISSION :

The programme is designed to provide with the specialist skills and knowledge which are central to the conduct of professional statistical work in government.

OBJECTIVES :

The objective of the program are as follows: To cultivate a mathematical attitude and nurture the interests,

To motivate for research in mathematical and statistical sciences,

To train computational scientists who can work on real life challenging problems.

RELEVANCE :

The M.Sc., Statistics programme offered through Open and Distance Learning mode is purely relevant and aligned with the goals and mission of CDE, ANU. This programme is structured in order to equip the learners with core competence in research and analytical aspects of scientific evolution there by new areas will be unfolded. This programme is helpful for enhancing the employability skills with the global perspective and conforming to the vision and mission of ANU.

NATURE OF PERSPECTIVE TARGET GROUP OF LEARNERS :

Aim of open and distance education is to enhance the academic competence in those who were deprived of higher education for various socio-economic reasons. This programme is designed for candidates which is helpful in their career advancement, updating the knowledge, upgrading their qualification for school teachers etc.

SKILLS AND COMPETENCE OF THE PROGRAMME :

In consideration of the huge gap in education and industry and also in skill development now it is imperative on the part of every university to reach out every nooc and corner of the country where the institutions with significant infrastructure are not availble in order to elevate the status of the marginalised sections of the society especcially living in rural areas of the country. The only solution appears to be "open and distance education" and Acharya Nagarjuna University takes initiative by reaching out those unreached by ICT enabled blended mode of distance learning programmes. M.Sc., Statistics programme is an innovative programme. The learning outcomes of this programme are as follows:

- Professional development of teachers.
- Incorporating generic transferrable skills and competencies
- To develop critical learning, anylitical skills and research skills.

INSTRUCTIONAL DESIGN: Course structure and detailed syllabi

ACHARYA NAGARJUNA UNIVERSITY : CENTRE FOR DISTANCE EDUCATION
Master of Science (Statistics) - Program code: 138

Program Structure

Program code	Program	Internal assessment	External exams	Max. Marks	credits
SEMESTER 1					
101ST24	Probability Theory and Distributions	30	70	100	4
102ST24	Statistical Computing Using R	30	70	100	4
103ST24	Estimation	30	70	100	4
104ST24	Sampling Theory	30	70	100	4
105ST24	PRACTICAL-I Statistical Software using R (Papers on 101ST24 and 102ST24)	--	--	100	4
106ST24	PRACTICAL-II (Papers on 103ST24 and 104ST24)	--	--	100	4
SEMESTER 2					
201ST24	Multivariate Analysis	30	70	100	4
202ST24	Testing of Hypothesis	30	70	100	4
203ST24	Theory of Linear Estimation and Analysis of Variance	30	70	100	4
204ST24	Linear Models and Applied Regression Analysis	30	70	100	4
205ST24	PRACTICAL-I Statistical Software using SPSS and R (Papers on 201ST24 and 202ST24)	--	--	100	4
206ST24	PRACTICAL-II (Papers on 203ST24 and 204ST24)	--	--	100	4
SEMESTER 3					
301ST24	Design of Experiments	30	70	100	4
302ST24	Statistical Quality Control	30	70	100	4
303ST24	Actuarial Statistics	30	70	100	4
304ST24	Reliability-I	30	70	100	4
305ST24	Practical-I Statistical Software using SPSS and R (Papers on 301ST24 and 302ST24)	--	--	100	4
306ST24	Practical-II (Papers on 303ST24 and 304ST24)	--	--	100	4
SEMESTER 4					
401ST24	Econometrics	30	70	100	4
402ST24	Acceptance Sampling Plans	30	70	100	4
403ST24	Operations Research	30	70	100	4
404ST24	Reliability-II	30	70	100	4
405ST24	Practical-I Statistical Software using SPSS and R (Papers on 401ST24 and 402ST24)	--	--	100	4
406ST24	Practical-II (Papers on 403ST24 and 404ST24)	--	--	100	4

Master of Science (Statistics) Syllabus

SEMESTER-I

101ST24: Probability Theory and Distributions

Unit I:

Classes of sets, fields, σ fields, minimal σ fields, sequence of sets, limit supremum and limit infimum of sequence of sets, measure, probability measure, properties of measure, axiomatic definition of probability, continuity theorem of probability, conditional probability, statistical independence of events, probability on finite sample spaces, geometrical probability.

Unit -II

Measurable functions, notation of random variable, distribution function, properties of distribution, vector of random variables, statistical independence, concepts of joint, marginal and conditional distributions, mathematical expectation, conditional expectation, characteristic function, its properties. Inversion formula, characteristic functions and moments. Moments inequalities-Markov, Schwartz, Jensen, Holder, Minkowski, Kolmogorov's, Hajek-Renyi.

Unit -III

Convergence of sequence of random variables-Type of convergence-in probability, almost sure, in mean square, in law- their interrelations. Law of large numbers-weak laws: Chebychev's form of W.L.L.N., Necessary and Sufficient Condition of W.L.L.N. Kintchine's form of W.L.L.N., Kolmogorov's S.L.L.N for i.i.d. random variables.

Unit -IV

Discrete distributions - Compound Binomial, Compound Poisson, multinomial, truncated Binomial, truncated Poisson distributions and their properties. Continuous distributions-Laplace, Weibull, Logistic and Pareto distributions and their properties.

UNIT-V

Order statistics- distribution function, probability density function (p.d.f.) of single order statistic, joint p.d.f. of order statistics. Distribution of range with applications in rectangular and exponential cases.

BOOKS FOR STUDY:

- 1) Modern probability theory by B.R. Bhat, Wiley Eastern Limited.
- 2) An introduction to probability theory and mathematical statistics by V.K.Rohatgi, John Wiley.
- 3) An Outline of statistics theory-I, by A.M.GOON, M.K. Gupta and B. Dasgupta, the World Press Private Limited, Calcutta.
- 4) The Theory of Probability by B.V. Gnedenko, MIR Publishers, Moscow.
- 5) Discrete distributions - N.L. Johnson and S. Kotz, John Wiley & Sons.
- 6) Continuous Univariate distributions, vol.1&2- N.L.Johnson and S.Kotz, John Wiley & Sons.
- 7) Mathematical Statistics - Parimal Mukopadhyay, New Central Book Agency (P) Ltd., Calcutta.

BOOKS FOR REFERENCES:

- 1) Billingsley, P. (1986): Probability and Measure. Wiley.
- 2) Kingman, J F C and Taylor, S. J. (1966): Introduction to Measure and Probability. Cambridge University Press.
- 3) David, H.A (1981): Order Statistics, 2nd Ed, John Wiley.
- 4) David H. A. and Nagaraja H.N.(2003): Order Statistics, 3/e, John Wiley & Sons.
- 5) Feller, W (1966): Introduction to probability theory and its applications, Vol.II, Wiley.
- 6) Cramer H (1946): Mathematical Methods of Statistics, Princeton

Master of Science (Statistics) Syllabus

SEMESTER-I

102ST24: Statistical Computing Using R

UNIT – I:

Introduction to R language: Objects (Atomics) -Basic types, modes and attributes, comments, constants. R–Data Types: character, numeric, integer, logical, complex and raw data types. R–Operators: arithmetic, relational, logical, assignment and miscellaneous operators. R–Variables: variable assignment, data type, finding variables using ls()function, deleting Variables using rm() function, R-I/O console functions-scan(), print(), cat(), format(), setwd() and getwd() functions. R-vectors: creating vectors, vector assignment, manipulating vectors, arithmetic, generating regular sequences, logical vectors, and character vectors, index vectors, selecting and modifying subsets of a vector. Manipulating character vectors using strsplit(), paste(), grep(), gsub() functions; R-factors: creating factor variables, handling factor data, generating factor levels using gl() function.

UNIT – II:

R-Matrices: Creating matrices, arithmetic operators on matrices, matrix facilities, forming partitioned matrices, cbind() and rbind() functions, R-Lists: creating a list, naming, accessing and manipulating list elements, converting a list to a vector. R-Data frames: creation, adding rows and variables to data frame, attach() and detach(), working with data frames, data reshaping. Reading and getting data into R using files: reading data and writing data from / to files of type CSV, EXCEL, text and other data type files using the save(), load(), read.csv()and read.table(),write.csv() and write.table() functions. Retrieving files using file.choose(), function.

UNIT – III:

R – Control Structures: Decision making-if, if-else, ladder if-else, nested if-else, and switch statements. Loops-repeat, while and for statements. Loop control statements -- break and next. R – Functions: function definition, function components, built-in functions, user- defined function, syntax of a function, function arguments, arguments matching, scope and evaluation, calling a function, one-line functions, using default values in functions. Built in R-functions and writing own R-functions or R-codes for small standard statistical problems like finding summary statistics, correlation, one-sample t-test, two-sample t-test and paired samples t-test, etc. Group manipulation using apply family of functions - apply, sapply, lapply and tapply.

UNIT – IV:

R-Probability Distributions: Computing values of pdf, cdf, quantile and generating samples for binomial, poisson, normal, exponential, Weibull and other prominent distributions using Built in R – functions. Plotting density and cumulative density curves for the distributions. Built in R-syntaxes for the Shapiro-Wilk test of normality, Kolmogorov-Smirnov test for one-sample and two-sample cases, Wilcoxon Mann-Whitney one-sample and two-sample U- tests, chi-square tests for association and goodness of fit. Writing own R-functions or R- codes: Fitting of binomial, Poisson, normal, exponential, Weibull and logistic distributions based on a given frequency data and test for goodness of fit. Solving a non-linear equation using Newton-Raphson method.

UNIT – V:

R-Graphics: Use of high-level plotting functions for creating histograms, scatter plots, box-whisker plots, bar plot, dot plot, line charts using numeric data and categorical data, pie charts, bar Charts, Q-Q plot and curves. Controlling plot options using low-level plotting functions, adding lines, segments, points, polygon, grid to the plotting region; Add text using legend, text,

mtex; and modify/add axes, putting multiple plots on a single page. Built in R – syntaxes for one-way ANOVA, two- way ANOVA.

BOOKS FOR STUDY:

- 1) Dr. Mark Gardener (2012): *Beginning R – The Statistical Programming Language*, Wiley India Pvt Ltd.
- 2) W.N. Venables and D.M. Smith (2016): *An Introduction to R*
- 3) J.P. Lander (2014): *R for Everyone, Pearson Publications*
- 4) Garrett Golemund: *Hands-On Programming with R*

BOOKS FOR REFERENCES:

- 1) De Vries, A., and Meys, J. (2016). *R For Dummies*, Second Edition, John Wiley & Sons Private Ltd, NY
- 2) Crawley, M, J. (2007). *The R Book*, John Wiley and Sons Private Ltd., NY.

Master of Science (Statistics) Syllabus

SEMESTER-I

103ST24: Estimation

UNIT-I:

Concepts of population, parameter (scalar, vector), parametric space, sample, sample space, statistic, estimator, estimate, sampling distribution, standard error, etc. Problem of point estimation, properties of good estimator, sufficiency- concept with examples, distinction between joint density and likelihood function. Fisher Neyman Factorization theorem. Complete sufficiency-examples, Exponential class, Minimal sufficiency.

UNIT-II:

Unbiasedness-concept, examples, properties, LMVUE, UMVUE, regularity conditions, Cramer-Rao Inequality and condition(s) for existence equality, examples of construction of UMVUE using Cramer-Rao Inequality, Rao-Blackwell Theorem, Lehmann-Scheffe Theorem, Necessary and Sufficient condition for the existence of MVUE. Minimum Mean Square Error (MMSE) Estimation. Consistency-Concept and examples, necessary condition for the existence of consistent estimator, efficiency, asymptotic relative Efficiency (ARE), CAN, CAUN estimators.

UNIT-III:

Moment method of Estimation, ML method of Estimation, Percentile estimation, Minimum Chi-square and Modified Minimum Chi-square.

UNIT-IV:

Interval Estimation, Confidence level, Construction of Confidence intervals using pivots, shortest expected length, UMA, UMAU Confidence sets. Relationship between confidence estimation and testing of hypothesis. Priori and posteriori distributions, loss function, risk function, Minmax & Bayes Estimator.

UNIT-V:

Censored and truncated distributions: Type 1 and Type 2 Censoring for normal and exponential distributions and their MLE's. Interval estimation: Confidence Intervals, using pivots; shortest expected length confidence intervals.

BOOKS FOR STUDY:

- 1) Statistical Inference by H.C., Saxena & Surendran.
- 2) An Introduction to Probability and Statistics by V.K.Rohatgi and A.K.Md.E.Saleh(2001).
- 3) Mathematical Statistics- Parimal Mukopadhyay(1996), New Central Book Agency (P) Ltd., Calcutta.

BOOKS FOR REFERENCES:

- 1) An Outline of Statistical Theory, Vol.II by A.M.Goom, M.K. Gupta and B. Dasgupta (1980), World Press, Calcutta.
- 2) Linear Statistical Inference and its Application by C.R. RAO (1973), John Wiley.
- 3) A First Course on Parametric Inference by B.K. kale(1999) Narosa Publishing Co.,
- 4) Lehman, E. L., and Cassella, G. (1998). Theory of Point Estimation, Second Edition, Springer, NY.

Master of Science (Statistics) Syllabus

SEMESTER-I

104ST24: Sampling Theory

UNIT-I:

Systematic Sampling: Allocation problem in stratified sampling, gain in precision due to stratification, estimation of sample size with continuous data, stratified sampling for proportions, Methods of populations with linear trend: Yates end correction, Modified systematic sampling, balanced systematic sampling, centrally located sampling, circular systematic sampling.

UNIT-II:

Varying probability and Cluster sampling: Cluster sampling with equal and unequal cluster sizes, optimum cluster size for fixed cost. PPS sampling with and without replacements, procedures of selection of a sample, estimator of population total and its sampling variance in PPS with replacement, Des Raj and Murthy's estimator (for sample size two), Horvitz-Thomson estimator, Grundy's estimator, Midzuno-Sen Sampling Scheme.

UNIT-III:

Two-stage sampling: Two-stage sampling with equal number of second stage units, estimation of population mean, its variance and estimation of variance. Double sampling (two phase sampling) for stratification, variance of the estimated mean, optimum allocation in double sampling.

UNIT-IV:

Multiphase Sampling: Introduction, Double sampling for Difference estimation. Double sampling for ratio estimation. Double sampling for regression estimator, Optimum allocation varying probability sampling. Non sampling errors: Sources and types of non Sampling errors, Non response errors, techniques for adjustment of non response, Hansen and Hurwitz Technique, Deming's Model.

UNIT-V:

Ratio Estimator: Introduction, Bias and Mean square error, Estimation of variance, confidence interval, comparison with mean per unit estimator, Ratio estimator in stratified random sampling. Difference estimator and Regression estimator: Introduction, Difference estimator, Difference estimator in stratified sampling. Regression estimator, Comparison of regression estimator with mean per unit estimator and ratio estimator. Regression estimator in stratified sampling.

BOOKS FOR STUDY:

- 1) Sampling techniques by W.G. Cochran, John Wiley
- 2) Sampling theory by Singh & Chaudhary
- 3) Sampling Theory, Narosa Publication by Des Raj and Chandok (1998)
- 4) Sampling Theory and Methods, Narosa Publishers by S. Sampath (2001)
- 5) Theory and Analysis of Sample Survey Designs, F.S. Chaudhary: New Age International Publishers, Delhi.

BOOKS FOR REFERENCES:

- 1) Sampling Theory & Methods by M.N. Murthy.
- 2) Sampling theory of surveys with Applications: P.V.Sukhatme & B.V. Sukhatme.
- 3) Theory and methods of survey sampling. Mukhopadhyay(1988).

**Master of Science (Statistics) Syllabus
SEMESTER-I**

**105ST24: PRACTICAL-I Statistical Software using R
(Papers on 101ST24 and 102ST24)**

**Master of Science (Statistics) Syllabus
SEMESTER-I**

106ST24: PRACTICAL-II (Papers on 103ST24 and 104ST24)

Master of Science (Statistics) Syllabus
SEMESTER-II
201ST24: Multivariate Analysis

UNIT-I:

The multivariate normal distribution and estimation: The multivariate normal distribution and its properties. Characteristic function of multivariate normal distribution. Sampling from multivariate normal distribution and maximum likelihood estimation, sampling distributions of Sample mean and sample covariance matrix.

UNIT-II:

Inference: Wishart's distribution and its properties. Definition of Hotelling's T^2 - distribution (statistic). Invariance property of Hotelling's T^2 -statistic. Application of T^2 statistic in tests of mean vector(s) in case of one and two multivariate normal populations.

The likelihood ratio principle. Mahalanobis D^2 -statistic and its relation with T^2 -statistic. Multivariate analysis of variances (MANOVA) for one way classification.

Commented [D1]:

UNIT-III:

Discriminant Analysis: Classification and discrimination procedures for discrimination between two multivariate normal populations, Fisher's discriminant function—separation of two multivariate populations. Classification with several multivariate normal populations. Fisher's method for discrimination among several multivariate populations.

UNIT-IV:

Cluster Analysis: Similarity measures, Euclidian distance and Mahalanobis squared distance- D^2 between two p-dimensional observations (items). Hierarchical Clustering methods - Single Linkage, Complete Linkage, Average Linkage, Ward's method and Centroid Linkage methods. Non-Hierarchical Clustering methods-K-Means method. Multidimensional scaling.

UNIT-V:

Special topics: Principle components analysis - definition, derivation, properties and Computation. Canonical variates and canonical correlations - definition, derivation and computation. Factor Analysis - Orthogonal factor model, Methods of estimating factor loadings - the principal component method and maximum likelihood methods of estimation. Factor rotation: orthogonal factor rotation, varimax rotation.

BOOKS FOR STUDY:

- 1) Anderson, T.W.(2000). *An Introduction to Multivariate Statistical Analysis*, 3rd Edition, Wiley Eastern
- 2) Johnson, A. and Wichern, D.W.(2001). *Applied Multivariate Statistical Analysis*, Prentice Hall and International Mardia, K.V. *Multivariate Analysis*

BOOKS FOR REFERENCES:

- 1) Gin. N. C. (1977): *Multivariate Statistical Inference*. Academic Press
- 2) Seber, G. A. F. (1984): *Multivariate Observations*. Wiley
- 3) Kshirsagar, A. M. (1972): *Multivariate Analysis*, Marcel Dekker
- 4) Morrison. D. F. (1976): *Multivariate Statistical Methods*, 2nd Ed. McGraw Hill
- 5) Muirhead, R. J. (1982): *Aspects of Multivariate Statistical Theory*, J. Wiley
- 6) Rao, C. R. (1973): *Linear Statistical Inference and its Applications*, 2nd ed. Wiley
- 7) Sharma. S. (1996): *Applied Multivariate Techniques*, Wiley
- 8) Srivastava, M. S. and Khatri, C. G. (1979): *An Introduction to Multivariate Statistics*, North Holland.

**Master of Science (Statistics) Syllabus
SEMESTER-II**

202ST24: Testing of Hypothesis

UNIT-I:

Tests of hypotheses, concept of critical region, critical function, two kinds of errors, power function, level of significance, MP and UMP tests, Neyman Pearson lemma, Randomized and Non Randomized tests.

UNIT-II:

Generalized NP-lemma, UMP tests for simple null hypothesis against one sided alternatives, and for one sided null against one sided alternative in one parameter exponential family, extension of these results to distributions with MLR property, nonexistence of UMP test for simple null against two sided alternatives in one parameter exponential family.

UNIT-III:

UMP unbiased tests and LMP tests. Similar regions, Neyman structure, Likelihood ratio test, properties of LR test, asymptotic distribution of LR test.

UNIT-IV:

Chi-square and kolmogorov Smirnov tests for goodness of fit, Kendall's tau statistic, Kruskal-Wallis test, Friedman's two-way analysis of variance by ranks, Bartlett's test for homogeneity of variances, chi-square test for homogeneity of correlation coefficients, F-test for homogeneity of regression coefficients, variance stabilizing transformation and large sample tests.

UNIT-V:

Notion of sequential tests, SPRT, Wald's fundamental identity, relation between the quantities A,B, alpha and beta, OC and ASN functions of SPRT, application to binomial, Poisson and normal distributions, efficiency of a sequential test.

BOOKS FOR STUDY:

- 1) Statistical Inference by H.C, Saxena & Surendran
- 2) An outline of Statistical Theory vol.2 by A.M. Goon and B. Das Gupta.
- 3) An Introduction to probability and Mathematical Statistics by V.K. Rohatgi.
- 4) Mathematical Statistics- Parimal Mukopadhyay(1996), New Central Book Agency (P)Ltd., Calcutta.

BOOKS FOR REFERENCES:

- 1) Advanced Theory of Statistics VOL.II by M.G. Kendall & A. Stuart.
- 2) Introduction to Mathematical Statistics by R.V. Hogg & A.T. Craig.
- 3) Linear Statistical Inference and applications by C.R. Rao.

Master of Science (Statistics) Syllabus

SEMESTER-II

203ST24: Theory of Linear Estimation and Analysis of Variance

UNIT-I:

Matrix algebra- Fundamental definitions, determinants, rank of a matrix, inverse of a matrix, orthogonal matrix, idempotent matrix, characteristic roots and vectors of a matrix. Numerical computation of characteristic roots and vectors for a positive definite matrix. Reduction of a positive definite matrix to a diagonal form using an Orthogonal matrix and non-singular matrix. Cauley-Hamilton theorem, trace of a matrix. Quadratic forms, reduction of quadratic forms using orthogonal transformation, statement of Cochran's theorem for quadratic forms.

UNIT-II:

Theory of linear estimation, linear models, estimability of linear parametric function, best linear unbiased estimator, Gauss-Markov set-up, Gauss-Markov theorem, generalized linear model, generalized Gauss-Markov theorem (Atken's theorem).

UNIT-III:

Decomposition of sum of squares in analysis of variance one way classification, two way classification with equal and unequal number of observations per cell. Multiple comparisons; Fisher's least significance difference test and Duncan's multiple range test, Fixed, random and mixed effect models.

UNIT-IV:

Analysis of covariance of one way and two way classification, applications to standard designs- CRD, RBD missing plot technique- general theory and applications to RBD and LSD.

UNIT-V:

Model Adequacy checking: Test for Normality, Test for equality of Variances (Bartlett test, Modified Levene Method). Multiple comparison tests: Turkey's test, The Fisher Least significant Difference (LSD) method, Duncan's Multiple range test.

BOOKS FOR STUDY:

- 1) Montgomery, D.C. (1976), Design and Analysis of experiments., John Wiley & sons.
- 2) Joshi, D.D.(1987), Linear Estimation and Design of experiments., Wiley Eastern Ltd.
- 3) Das, M.N. and Giri, N.C. (1986), Design and An Analysis of Experiments, Wiley Eastern Ltd.

BOOKS FOR REFERENCES:

- 1) Datta, K.B. (2000)., Matrix and Linear Algebra
- 2) Rangaswamy, R, (1995), A text book of Agricultural Statistics., New Age international Publishers Limited.
- 3) Kempthorne, O, (1951)., The design and Analysis of Experiments., Wiley Eastern Private Limited.
- 4) Rao, C.R, (1983)., Linear Statistical inference and its applications., Wiley Eastern Ltd.
- 5) Raghavarao, D.(1987), statistical Techniques in Agricultural and Biological Research., Oxford & IBH publishing Company Private limited.
- 6) Federer, W.t (1967), Experimental Design Theory and Application, Oxford & IBH publishing company.
- 7) Biswas, S. (1984). Topics in Algebra of Matrices, Academic Publication.

**Master of Science (Statistics) Syllabus
SEMESTER-II
204ST24: Linear Models and Applied Regression Analysis**

UNIT-I

Gauss-Markov set-up, Normal equations and Least squares estimates, variances and covariances of least squares estimates, estimation of error variance.

UNIT-II

Estimation with correlated observations, least squares estimates with restriction on parameters, simultaneous estimates of linear parametric functions.

UNIT-III

Tests of hypotheses for one and more than one linear parametric functions, confidence intervals and regions. Analysis of Variance.

UNIT-IV

Simple linear regression, multiple regression, fit of polynomials and use of orthogonal polynomials.

UNIT-V

Multicollinearity, Ridge regression and principal component regression, subset selection of explanatory variables.

BOOKS FOR STUDY:

- 1) Graybill, F.A. (1983): Matrices with Applications in Statistics. Wadsworth.
- 2) Draper, N.R. and Smith, H (1998): Applied Regression Analysis. 3rd Edition. Wiley-Blackwell.
- 3) Douglas C. Montgomery, Elizabeth A. Peck and G. Geoffrey Vining (2012): Introduction to Linear Regression Analysis – 5th Edition. Wiley
- 4) Goon, Gupta and Das Gupta (2003): An outline of Statistical Theory. Volume II. The World Press Pvt. Ltd.

BOOKS FOR REFERENCES:

- 1) Bapat.R.B. (2012): Linear Algebra and Linear Models. 3rd Edition. Springer.
- 2) Cook, R.D. and Weisberg, S. (1983): Residual and Influence in Regression. 1st Edition. Chapman and Hall.
- 3) Johnson, J. (1996): Econometric Methods, 4th Edition. McGraw Hill.
- 4) Rao, C.R. (2002): Linear Statistical Inference and Its Applications. 2nd Edition. Wiley-Blackwell.
- 5) Weisberg, S. (2013): Applied Linear Regression. 4th Edition. Wiley.

**Master of Science (Statistics) Syllabus
SEMESTER-II**

**205ST24: PRACTICAL-I Statistical Software using SPSS and R
(Papers on 201ST24 and 202ST24)**

**Master of Science (Statistics) Syllabus
SEMESTER-II**

206ST24: PRACTICAL-II (Papers on 203ST24 and 204ST24)

**Master of Science (Statistics) Syllabus
SEMESTER-III**

301ST24: Design of Experiments

UNIT-I:

General factorial experiments, factorial effects, best estimates and testing the significance of factorial effects, estimation of main effects, interaction and analysis of 2^n factorial experiments in general with particular reference to $n=2,3$. 3^2 and 3^3 factorial experiments.

Total and partial confounding in case of 2^n (for $n=2,3$), 3^2 and 3^3 factorial designs.

UNIT-II

Incomplete block designs; balanced Incomplete block designs (BIBD), parametric relations, intra block analysis, simple methods of constructions of BIBD, resolvable and affine resolvable designs, Partially Balanced Incomplete Block Designs (PBIBD) with two associate classes, parametric relations, intra block analysis.

UNIT-III:

Youden square design, simple lattice design, split plot design, strip plot design and their analysis, Gracoco latin square design.

UNIT-IV:

Concept of response surface methodology (RSM), response surface designs, linear response surface designs, second order response surface designs, variance of estimated second order response surface, Rotatable designs; conditions for second order rotatable designs, construction of second order rotatable designs using central composite designs, Balanced incomplete block designs.

UNIT-V:

Taguchi Method, Taguchi Philosophy, Loss Functions, Signal-to-Noise Ratio and Performance Measures, Critique of S/N Ratios. Experimental Design in the Taguchi Method. Parameter Design in the Taguchi Method.

BOOKS FOR STUDY:

- 1) M.N. Das and N.C. Giri. (1986), Designs and Analysis of Experiments, Wiley Eastern Ltd.
- 2) Montgomery, D.C. (1976)., Design and Analysis of Experiments, John Wiley & sons.
- 3) D.D.Joshi. (1987), Linear Estimation and Design of Experiments, Wiley Eastern Ltd.
- 4) Taguchi Engineering by Philippe ross.

BOOKS FOR REFERENCES:

- 1) Raghavarao, D. (1971), Constructions and Combinatorial Problems in Design of Experiments, John Wiley & Sons, Inc.
- 2) W.G. Cochran and G.M. Cox, (1957), Experimental designs, A wiley International Edition.
- 3) Box, G.E.P. and Draper, N.R. (1986), Empirical Model- Building and Response surfaces, John Wiley & Sons.
- 4) R.H. Myers. (1976), Response Surface Methodology, Allyn and Bacon, Boston
- 5) Aloke Dey. (1986), Theory of Block Designs, Wiley Eastern Limited.
- 6) Oscar Kempthorne (1951), The Design and Analysis of Experiments., Wiley Eastern Private Limited.
- 7) Walter T.Federer (1967)., Experimental Design Theory and Application., Oxford & IBH Publishing Company.

**Master of Science (Statistics) Syllabus
SEMESTER-III
302ST24: Statistical Quality Control**

UNIT – I:

The \bar{X} and S control charts with variable sample size. The S^2 control chart. The Shewart Control Chart for individual measurements. Control charts for multiple stream process and group control charts. Economic design of control charts: designing a control chart, process characteristics, cost parameters, early work & semi-economic designs and an economic model of the \bar{X} control chart.

UNIT – II:

The Cumulative Sum (CUSUM) control chart - Basic principles, the tabular or algorithmic CUSUM for monitoring the process mean, recommendations for CUSUM design. The standardized CUSUM, rational subgroups, one sided CUSUMs, CUSUM for monitoring process variability, CUSUMs for other sample statistics. The V-Mask procedure. The exponentially weighted moving average (EWMA) control chart - Design of a EWMA control chart, rational sub group, robustness of the EWMA to non-normality, extension of the EWMA. The moving average control chart.

UNIT – III:

Statistical process control for short production runs - \bar{X} and R charts for short production runs, attribute control charts for short production runs. Modified and acceptance control charts - modified control limits for \bar{X} chart, acceptance control charts, control chart for a “Six-Sigma” process.

UNIT – IV:

The multivariate process monitoring and control: description of multivariate data, the multivariate normal distribution, the sample mean vector and covariance matrix. The Hotelling T^2 control chart. The multivariate exponential weighted moving average (EWMA) control chart. Control chart for monitoring variability. Latest structure methods: principal component and partial least squares.

UNIT – V:

Tools and Techniques of Total Quality Management (TQM), techniques for analyzing a quality process, SPC as a tool of quality management, Quality systems – ISO 9000 standards, QS-9000 standards, Bench marking practices and Quality Auditing Notion of Six – sigma and its uses.

BOOKS FOR STUDY:

- 1) R.C. Guptha(2001): Statistical Quality Control. 9th Edition. Khanna Publishers.
- 2) Duncan Acheson (1986): Quality Control and Industrial Statistics. 5th Edition. Irvin.
- 3) Statistical Quality Control – 7th edition, E.L. Grant & R.S. Leavenworth; McGraw Hill, New York.

BOOKS FOR REFERENCES:

- 1) Cowden D J (1957): Statistical Methods in Quality Control. 1st Edition. Prentice-Hall Inc.
- 2) Mittag and Rinne (1993): Statistical Methods for Quality Assurance. 2nd Edition. Chapman and Hall Ltd.
- 3) Montgomerv. D.C (2012): Introduction to Statistical Quality Control. 7th Edition. John Wiley and Sons

Master of Science (Statistics) Syllabus
SEMESTER-III
303ST24: Actuarial Statistics

UNIT-I:

Effective Rate of interest - Nominal rate of interest - Force of interest Effective rate of interest corresponding to Nominal rate of interest and Force of interest - Accumulation of 1 unit corresponding to the given rate of interest present value of 1 unit due at the end of n years corresponding to the given rate of interest, effective rate of discount-Nominal rate of discount – Force of interest varying continuously.

UNIT-II:

Definition of Annuity - Present value and Accumulation of an Immediate annuity - Annuity due - Present value and Accumulation of an Annuity – due - Present value and Accumulation of a Perpetuity and Perpetuity - due-Increasing and Decreasing Annuities. Annuities where payments are in A.P. Annuities where payments are made continuously.

UNIT-III:

Analysis of Annuity payments - Loan installment - Principal and interest portions of a typical loan installment – General Expression for principal and interest portion – Purchase price of an annuity net of tax. Independent annual interest rates - Mean and Variance of the accumulation of a single investment, viz $E(S_n)$ and $V(S_n)$ – Mean and Variance of the accumulation of a series of investments, viz $E(A_n)$ and $V(A_n)$ - Mean and Variance of a present value of unit due at the end of n years, viz $E(V_n)$ and $V(V_n)$. Dependent annual interest rates and simple problems.

UNIT-IV:

Net present value (NPV) - Internal rate of return (IRR)- Interpretation of NPV and IRR- Comparison of two investment projects - Discounted Payback Period - The effect of inflation on IRR- Money weighted rate of return (MWRR) - Time weighted rate of return (WRR) - linked internal rate of return(LIRR).

UNIT-V:

Multiple life functions, joint life and last survivor status, insurance and annuity benefits through multiple life functions, evaluation for special mortality laws. Multiple decrement models, deterministic and random survivorship groups, associated single decrement tables, central rates of multiple decrements, central force assumptions for multiple decrements. Uniform distribution assumption for multiple decrements.

BOOKS FOR STUDY:

- 1) Fundamentals of Actuarial Mathematics, Promislow, S.D(2006): John Wiley, Chapters 2-11 &14.
- 2) Newton L. Bowers, Jr, Hans U. Gerber, James C. Hickmann, Donald A. Jones and Cecil J. Nesbitt (1997): Actuarial Mathematics, The Society of Actuaries.
- 3) Compound Interest and Annuities certain by D.W.A. Donald, Heinemann, London.
- 4) An Introduction to Mathematics of Finance, Butter Worth & Heinemann by J. J. McCutcheon and W.F.Scott.
- 5) Gnana Deep Study Maeraials.

BOOKS FOR REFERENCES:

- 1) Actuarial mathematics by N.L. Bowers, H.U. Gerber, J.C. Hickman, D.A. Jones and C.J. Nesbitt – Published by society of Actuaries, Ithaca, Illinois, U.S.A. Second Edition (1997) Chapters: 1,2,3,4,5,9 &10
- 2) Life Contingencies, by Spurgeon – Cambridge University Press.
- 3) Life Contingencies, Heinemann. Neill, A. (1977).
- 4) An Introduction to Actuarial Studies, Atkinson and Dickson (2011): Edward Publishing.
- 5) Life Contingencies by A. Neile – Published by Heineman.
- 6) Modern Actuarial Theory and Practice, Philip, M. et. al (2004): Chapman and Hall.

Master of Science (Statistics) Syllabus

SEMESTER-III

304ST24: Reliability-I

UNIT-I

Importance of reliability, definition of reliability and its measures, concept of failure. General provision of a reliability specification, Methods of achieving reliability, Broad functions of reliability. Bath tub curve, causes of early failure and methods to avoid them.

UNIT-II

Life distributions; reliability function, hazard rate, Common failure distributions: exponential, weibull, truncated normal, log normal - their properties and uses and Estimation of parameters and tests in these models.

UNIT-III

Series, parallel and r-out of n configurations; their block diagram, reliability graph and determination of reliability through combinatorial methods. Events space, cut set and tie set, Multistate models.

UNIT-IV

System reliability with exponential components in series, parallel and r- out of - n system. Usefulness of redundancy and improvement factor. MTF, MTBF, Equivalents MTBF of series and parallel system. Cold and hot redundancy, reliability of stand-by system. Weakest link model, chain model, stress-strength model, non-parametric estimation of reliability.

UNIT-V

Problem of life testing, estimation of parameters and reliability in standard probability models (Exponential, Weibull, Normal) using complete samples. Probability plotting and graphical procedures for estimating the parameter and testing validity of model by some standard statistical tests.

BOOKS FOR STUDY:

- 1) Probability Distributions Used in Reliability Engineering, Andrew N.O'Connor
Mohammad Modarres, Ali Mosleh; Published by the Center for Risk and Reliability
- 2) Statistical Analysis of Reliability and Life-Testing Models, Bain, L.J, Dekker, New York
- 3) Statistical Models and Methods for Lifetime Data, Lawless, J.F., Wiley, New York
- 4) Bayesian Reliability Analysis, Martz, H.E. & Weller, A., Wiley New York
- 5) Statistical Theory of Reliability and Life Testing Probability Models, Barlow R.E.&
Proschan, F., Holt, Rinehart and Winston, New York
- 6) Reliability and Life Testing, Sinha, S.K., Wiley Eastern Limited

BOOKS FOR REFERENCES:

- 1) Applied Life Data Analysis, Nelson, W. (1982);, John Willey
- 2) Software Engineering: Design, Reliability and Management, Shooman, M.L., McGraw-Hill, New York
- 3) Reliability in Engineering Design, Kapur, K.C. and Lamberson, L.R., John Wiley, N.York
- 4) J.V. Deshpande and Sudha G. Purohit (2005) Life time data: Statistical Models and Methods World Scientific
- 5) Introduction to Reliability Analysis, Zacks S (1992), Springer - Verlag, New York
- 6) Applied Reliability 3rd Edition by Paul A. Tobias, CRC Press Taylor & Francis Group.

**Master of Science (Statistics) Syllabus
SEMESTER-III**

**305ST24: PRACTICAL-I Statistical Software using SPSS and R
(Papers on 301ST24 and 302ST24)**

**Master of Science (Statistics) Syllabus
SEMESTER-III**

306ST24: PRACTICAL-II (Papers on 303ST24 and 304ST24)

Master of Science (Statistics) Syllabus
SEMESTER-IV
401ST24: Econometrics

UNIT-I

Simple Regression Analysis: What is Econometrics? Methodology of Econometrics. Simple linear model and assumptions, Least-Squares Estimators and their properties. ML estimation of the parameters. Statistical Inference and prediction with the simple regression model. Regression analysis versus Correlation analysis, Regression analysis and ANOVA. Other functional forms of regression models –Log-linear, Semilog, reciprocal and logarithmic reciprocal models.

UNIT-II

Multiple Regression Analysis: The general linear model (GLM) and assumptions of the model, ordinary least squares (OLS) and ML estimation, properties of OLS estimators (Gauss-Markov theorem). The coefficient of determination R^2 , and Adjusted R^2 or \bar{R}^2 .

Inferences about regression model, problems of prediction. Linear restrictions-- restricted least squares.

UNIT-III

Testing the structural change in regression models, Chow test for testing the equality of two regression equations. The use of dummy variables in multiple regression. The problem of multicollinearity - nature, sources, consequences, diagnostics (variance inflation factors and condition index) and remedies (Ridge regression and principle component regression methods). Aitken's generalized least squares (GLS) method.

UNIT-IV

The problem of heteroscedasticity— nature, sources, consequences, detection (Glejser Test, Goldfeld-Quandt test, Breusch-Godfrey Test, Breusch-Pagan-Godfrey Test, White's test) and remedies. The problem of auto correlation— nature, sources, consequences, detection (Durbin-Watson d-test and Breusch-Godfrey (LM) Test,) and remedies (Cochrane-Orcutt iterative procedure, C-O two-step and D-W two-step methods).

UNIT-V

Special Topics: Non-Linear Regression Models, Polynomial regression models, Qualitative Response Regression Models-The LOGIT (Logistic regression) and the PROBIT models. Errors in Variables, Instrumental Variables, Autoregressive and Distributed Lag models-Koyak, Stock adjustment and partial adjustment models.

BOOKS FOR STUDY:

- 1) Gujarathi, D.N., Porter, D.C. and Gunasekar, S. (2011): *Basic Econometrics*, 5th Edition, McGraw Hill
- 2) Johnston, J. and DiNardo, J.(1997). *Econometric Methods*, 4th Ed., McGraw Hill
- 3) Montgomery, D.C., Peck, E.A. and Geoffrey Vininig, G. (2003). *Introduction to Linear Regression Analysis*, 3rd Ed., Wiley
- 4) Koutsoyiannis, A (1979): *Theory of Econometrics*, Macmillan Press
- 5) Theil. H (1982): *Introduction to the Theory and Practice of Econometrics*, John Wiley.

BOOKS FOR REFERENCES:

- 1) Apte P.G. (1990): *Textbook of Econometrics*. Tate McGraw Hill
- 2) Intrilligator, M.D. (1980): *Econometric models – Techniques and Applications*, Prentice Hall of India.
- 3) Klein, L.R.(1962): *An introduction to Econometrics*, Prentice Hall of India
- 4) Mai Invaud, E (1966): *Statistical Methods of Econometrics*, North Holland.

Master of Science (Statistics) Syllabus
SEMESTER-IV
402ST24: Acceptance Sampling Plans

UNIT – I:

Attribute Sampling Plans: Introduction, advantages and disadvantages of sampling, Producer's risk and Consumer's risk, Operating Characteristic curve, evaluating sampling plans using average out going quality limit, average sample number. Lot-by-Lot attribute sampling plans: Single sampling plans – The OC curve, design of single sampling plans, double sampling plans, The OC curve , ASN curve, design of double sampling plan sequential sampling plan, standard sampling plans-Military Standard 105E and Dodge – Roming sampling plan.

UNIT – II:

Acceptance sampling plans for variables, Introduction, advantages and disadvantages of sampling, variable sampling plans for a process parameter – Estimating process average – Single specification limit and known process standard deviation, estimating process average –double specification limits and known process standard deviation, estimating process average
– Single specification limit and unknown process standard deviation. Standardized plans – MIL-STD-414, Sequential sampling plan by variables.

UNIT – III:

Acceptance sampling procedures – importance, procedures, advantages and disadvantages of Chain sampling plan, Skip-lot sampling plan, Continuous sampling – CSP-1, CSP-2, CSP-3 and multi-level plans, Military standard sampling plan –MIL STD 1235b.

UNIT – IV:

Industrial Experimentation, Fractional factorial experiments, Response surface methodology, Six sigma in process improvement and product development. Wald-Wolfwitz type and their properties.

UNIT – V:

Rectifying inspection by Lot-By-Lot Sampling: Rectifying Inspection Plans Calling for 100 Percent inspection of Rejected Lots. Rectifying Inspection Plans with less than 100 Percent inspection of Rejected Lots.

BOOKS FOR STUDY:

- 1) Introduction to Statistical Quality Control, Montgomery, D.C., John Wiley (Asia) 2001.
- 2) Modern Methods for Quality Improvement, H.M.Wadsworth, K.S.Stephens A.B.Godfrey, Second Edition; 2004, John Wiley and sons.
- 3) The Essence of TQM, John Bank, Printice,- Hall of India Pvt Ltd (1998).
- 4) Statistics of Quality Control – Sampling Inspection and Reliability by S.Biswas, Newcentral book agency Pvt Ltd (2003).

BOOKS FOR REFERENCES:

- 1) R.C. Guptha (2001): Statistical Quality Control. 9th Edition. Khanna Publishers.
- 2) Duncan Acheson (1986): Quality Control and Industrial Statistics. 5th Edition. Irvin.
- 3) Statistical Quality Control – 7th edition, E.L. Grant & R.S. Leavenworth; McGraw Hill, New York.

Master of Science (Statistics) Syllabus
SEMESTER-IV
403ST24: Operations Research

UNIT-I:

Games as decision problems, Two-person Zero-Sum game, Pure and mixed Strategies, maximum criterion, dominance, minimax theorem. Solutions of 2×2 , $2 \times m$, $n \times 2$ games and 3×3 games (using simplex algorithm).

UNIT-II:

Inventory control, models of inventory-purchase model with instantaneous replenishment and without shortages, Manufacturing model without shortages, Purchase model with instantaneous Replenishment and with shortages. Manufacturing model with shortages, Operation of inventory system, Quantity Discount - Price breaks - Purchase Inventory Model with one price break, two price breaks and any number of price breaks.

UNIT-III:

Queueing models - Characteristics of Queueing Systems, Classification of Queues. Steady-state solution of $M/M/1/\infty/FCFS$, $M/M/1/N/FCFS$, $M/E_k/1$ models and $M/G/1$ queue - length Pollazek - Khinchine result.

UNIT-IV:

Replacement and maintenance analysis-Types of maintenance, Types of replacement problems, Determination of economic life of an asset, Basics of interest formulae – Present- worth factor (P/F , i , n), Equal payment series capital recovery factor (A/P , i , n). Simple probabilistic model for items which completely fail.

UNIT-V:

Project management; CPM and PERT; probability of project completion, crashing.

BOOKS FOR STUDY:

- 1) Hillier, F.S. and Leiberman(2017)G.J. ,Holden Dev, Introduction to Operations Research.
- 2) Sharma, J.K.,2003, Operations Research Theory and Applications,. Macmillan, India
- 3) Kantiswarup, Gupta, P.G. and Man Mohan, Operations Research, Sultan Chand & Sons
- 4) S.D. Sharma, Operations Research, Kedar Nath Ram Nath & Co, Meerut
- 5) Panneerselvam. R, Operations Research, Printice Hall of India, Pvt Ltd.
- 6) Churchman, C.W., Ackoff, R.L. and Amoff, E.L. (1957). Introduction to OperationsResearch.

BOOKS FOR REFERENCES:

- 1) Philips D.T. Ravindran A and Sal berg J., Operations Research, Principles and practice,John Wiley
- 2) Donald Gross and Carl M.Harris, Fundamentals of Queueing Theory, John Wiely
- 3) Leonard Kleinrock, Queueing System, volume 1. Wiley Inter science
- 4) Taha, HA. (1982). Operational Research
- 5) Philips, D.T., Ravindran, A. and Solberg, J. Operations Research, Principles and Practice

Master of Science (Statistics) Syllabus
SEMESTER-IV
404ST24: Reliability-II

UNIT-I:

(i) Non-Repairable System:

Single element-non repairable, two element-non-repairable system; solution through Laplacetransform. Poisson process, Stand-by system.

(ii) Repairable System:

Reliability and availability function of one and two components system, up-time and down-time ratio, steady state probabilities.

UNIT-II:

Coherent System and its Structural Properties: Systems with independent components, coherent system, path sets and cut sets, reliability of coherent system, bounds on system reliability, Relative importance of components, Modular decomposition of coherent system and improved bounds for system reliability. Concept of associated random variables.

UNIT-III:

Fault Tree Analysis: Event tree, simple fault tree and its construction, Mathematics of FTA, Efficiency of FTA formats, FTA, Event space method, Monte-Carlo technique, Min-cut set algorithm, FMEA, Carrying out FMEA with practical example.

UNIT-IV:

Life distributions – reliability function; hazard rate; common life distributions- Exponential, Gamma, Weibull, Lognormal, Pareto. Estimation of parameters and tests in these models. Life tables, mean residual life and their elementary properties.

UNIT-V:

Notions of Ageing classes – IFR, IFRA, NBU, DMRL and NBUE and their duals. Estimation of survival function-Actuarial Estimator, Kaplan–Meier Estimator, Semi–parametric regression for failure rate–Cox’s proportional hazards model with one and several covariates.

BOOKS FOR STUDY:

- 1) Reliability Engineering Theory and Practice, A. Birolini, Fourth Edition, Springer Int.
- 2) Bayesian Reliability Analysis, Martz, H.E. & Weller, A., Willey New York
- 3) Reliability and Life Testing, Sinha, S.K., Wiley Eastern Limited
- 4) Probability Distributions Used in Reliability Engineering, Andrew N.O’Connor
Mohammad Modarres, Ali Mosleh; Published by the Center for Risk and Reliability
- 5) Statistical Analysis of Reliability and Life-Testing Models, Bain, L.J, Dekker, New York
- 6) Statistical Models and Methods for Lifetime Data, Lawless, J.F., Wiley, New York

BOOKS FOR REFERENCES:

- 1) Statistical Theory of Reliability and Life Testing Probability Models, Barlow R.E.& Proschan, F., Holt, Rinehart and Winston, New York.
- 2) Introduction to Reliability Analysis, S. Zacks, Springer Verlag, N.Y.
- 3) Gross A.J. and Clark, V.A.(1975) Survival Distributions: Reliability Applications in the Biomedical Sciences, John Wiley and sons.
- 4) Cox, D.R. and Oakes, D. (1984) Analysis of Survival Data, Chapman and Hall, New York
- 5) Elandt-Johanson, R.E.Johnson N.L. (1980) Survival models and Data Analysis, John Wiley and Sons.
- 6) Miller, R.G. (1981) Survival Analysis (Wiley).

**Master of Science (Statistics) Syllabus
SEMESTER-IV**

**405ST24: PRACTICAL-I Statistical Software using SPSS and R
(Papers on 401ST24 and 402ST24)**

**Master of Science (Statistics) Syllabus
SEMESTER-IV**

406ST24: PRACTICAL-II (Papers on 403ST24 and 404ST24)

Duration of the Programme:

Minimum: Two Academic Years from the year of joining of the course (Four Semesters).

Maximum: Five Academic Years from year of joining of the course for securing First Class or Second Class.

INSTRUCTIONAL DESIGN :

Instructional delivery mechanism: University has its own faculty for M.Sc. Statistics department and all the faculty members will act as resource persons. Our University has blended mode delivery mechanism i.e., ICT and Conventional modes.

Media of delivery mechanisms:

- **Printing:** The study material delivery media include Printing of books which are issued to the students who are enrolled for the programme.

- **Online:** On line PDF format content is also given access to the students who wish to study through online mode.

- **Interactive sessions, and Discussion boards:** In distance Education, face to face contact between the learners and their tutors is relatively less and therefore interactive sessions are conducted. The purpose of such interactive session is to answer some of the questions and clarify doubts that may not be possible in other means of communication. This programme provides an opportunity to meet other fellow students. The Counsellors at the study centres are expected to provide guidance to the students. The interactive sessions are conducted during week ends and vacations to enable the working students to attend.

- **Student support services:** Student support services include Internet enabled student support services like e-mails, SMS and even an app is planned. Student feed back mechanism is created and feed back is designed. Student Learning Management System (LMS) is customized to every student. For every student customized examination management system (EMS) is also created facilitating self evaluation, demo tests, model question papers and periodical Internal Assessments.

- **Credit System:** University has adopted Choice Based Credit System (CBSE) under semester mode from 2013. The same has been approved by relevant Statutory boards in Distance mode also.

- **Admission procedure:** In M.Sc., Statistics programme candidates can take admission directly. For this purpose, CDE, ANU will advertise for admissions. Then candidates should apply in prescribed format of the CDE after publication of the advertisement.

- **Eligibility Criteria:** The eligibility for admission into this course is a pass in B.A. or B.Sc. with Mathematics and Statistics as two of three subjects.

- **Fee Structure:** The total course fee is Rs. 30,700/-.

- **Policy of programme delivery:** Our University has blended mode delivery mechanism i.e., ICT and Conventional modes. In conventional mode printed material is given and also online mode of delivery with learning management system is adopted.

- **Activity planner:** There is an yearly academic plan and as per plan interactive sessions, assignments, examinations etc are conducted to the candidates.

• **Evaluation System:** Periodical progress of learning is evaluated by web based feed back mechanism in the Learning Management System. Evaluation of learner progress is conducted as follows:

- (i) The examination has two components i.e., continuous evaluation by way of assignments (30 %) and term end University Examination (70 %).
- (ii) Each student has to complete and submit assignment in each of the theory paper before appearing to the term end examination. The term end examination shall be of 3 hours duration.
- (iii) Minimum qualifying marks in each paper is 40 % individually in internal and term end examination. The candidates who get 60 % and above will be declared as pass in First Division, 50 % to below 60 % as Second Division and 40 % to below 50 % as Third Division.
- (iv) The Centre for Distance Education, Acharya Nagarjuna University will conduct the examinations, evaluations and issue certificates to the successful candidates.
- (v) All the term end examinations will be conducted at the examination centres fixed by the CDE.
- (vi) Qualitatively the examinations conducted for the students of the Distance Education are on par with the examinations conducted for the regular University students.

LIBRARY SUPPORT AND LIBRARY RESOURCES :

The M.Sc., Statistics program is based on the theory and practical papers. Laboratory support is available to students. Further, entire University Library is accessible to all the students of distance education. Additionally every department in the University has a well equipped library which is accessible to all the students. CDE also provides a compendium of web resources to every student to support learning.

COST ESTIMATE :

The Programme fee for I year is Rs.14,300/-, and II year is Rs. 16,400/-. The university will pay the remuneration to Editors and lesson writers as per university norms. DTP charges, Printing of books and Examination fees will be paid by the ANUCDE as per prescribed norms. This institution is providing high quality programmes at low cost.

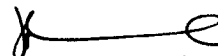
QUALITY ASSURANCE :

Quality assurance comprises the policies, procedures and mechanisms which that specified quality specifications and standards are maintained. These include continuous revision and monitoring activities to evaluate aspects such as suitability, efficiency, applicability and efficacy of all activities with a view to ensure continuous quality improvement and enhancement. The programme is designed with a focus on the proposed learning outcomes aimed at making the learner industry ready also for career advancement, enterpreneurial development, and as wealth creators. There is a continuous evaluation of learning and of competence internally and also by ICT enabled feed back mechanism and Centre for Internal Quality Assurance (CIQA). The University ensures maintaining quality in education provided through open and distance learning mode. As per the need of the information society and professional requirement, the University ensures to change the mechanism from time to time along with enhancement of standard in course curriculum and instructional design. Therefore, the outcomes of the programme can meet the challenges in the changing society.



DIRECTOR

Centre for Distance Education
Acharya Nagarjuna University
Nagarjuna Nagar,
GUNTUR-522 510.



REGISTRAR

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