



# YOGI VEMANA UNIVERSITY: KADAPA

## APPROVED SYLLABUS BY BOS (With effect from 2019-20)

*M. Sc. Statistics -Choice Based Credit System*

<b>PAPER CODE</b>	<b>TITLE OF THE PAPER</b>
<b>SEMESTER - I</b>	
15151	Probability and Distributions
15152	Estimation Theory
15153	Sampling
15154	C-Programming
15151-P	Practical I
15152-P	Practical II
<b>SEMESTER - II</b>	
25151	Multivariate Analysis
25152	Testing of Hypothesis
25153	Stochastic process
25154	Design of Experiments
25151P	Practical III
25152P	Practical IV
Non core - 1	To be selected from other departments
<b>SEMESTER - III</b>	
35151	Operations Research I
35152	Demography and Official Statistics
35153	Knowledge Discovery and Data Mining
35154	Time Series Analysis
35151 P	Practical V
35152 P	Practical VI
Non core - 2	To be selected from other departments
<b>SEMESTER - IV</b>	
45151	Operations Research II
45152	Econometrics
45153	Computer programming – c++
45154	(A)Statistical process and Quality control (B)Reliability Theory
<b>The student has to choose one from A &amp; B</b>	
45151P	Practical VII
45152P	Practical VIII

## SEMESTER – I

### PROBABILITY AND DISTRIBUTIONS

#### UNIT- I

Classes of sets, field, sigma field, minimal sigma field, Borel field. Limit of a sequence of sets. Measure on field, extension of measure to sigma field, Lebesgue measure, Lebesgue-Stieltjes measures, Measurable functions, Borel function, induced sigma field.

#### UNIT- II

Random variable, convergence of random variables- convergence in probability, almost surely, in the  $r$ th mean and in distribution their relationships. Characteristic function, properties, inversion theorem, continuity theorem, Central Limit Theorem, Lindberg-Levy, Liapunoff forms.

#### UNIT- III

Mathematical expectation, Moments of random variable, conditional expectation, problem of moments. Basic Markov's, Chebycheff's, Holder's, Minkovski's and Jensen's inequalities. Law of large numbers. Chebycheff's and Kinchin's forms of WLLN, Kolmogorov's SLLN. Convergence theorems relating to  $X_{n+1} - Y_n$ ,  $X_n Y_n$  and  $X_n / Y_n$  Where  $X_n \rightarrow X$  and  $Y_n \rightarrow C$ . Weibull and Laplace distributions, their m.g.f., c.f. and other properties. Compound distributions – Poisson-Binomial. Sampling distributions .

#### UNIT- IV

Non-central chi-square, Non-central t and Non-central F distributions and their properties. Distribution of quadratic forms under normality and related distributions. Multivariate normal, bi-variate as a particular case, moments, c.f., conditional and marginal distributions. Distributions of order statistics from rectangular, exponential and normal distributions. Empirical distribution function, distribution of correlation coefficient, partial and multiple correlations, derivation formulae and inter relationships.

#### Text Books

- Bhat.B.R. . Modern probability theory. Wiley Eastern Ltd.  
 Rohatgi, V.K.(1984) . An introduction to Probability and Mathematical Statistics . Wiley Eastern  
 Goon, A.M., Gupta, M.K., Das Gupta, B. An outline of statistical theory, Vol. I. The World Press Pvt. Ltd., Kolkata.

#### References

- Billingsley, P.(1986) . Probability and Measure. Wiley  
 Kingman, J.F.C., and Taylor, S.J. (1966) . Introduction to Measure and Probability. Cambridge University Press. David, H.A. . Order Statistics  
 Feller, W. . Introduction to Probability Theory And Its Applications, Vol. II  
 Cramer, H. (1946). Mathematical Methods of Statistics. Princeton  
 Morrison, D. F.(1976). Multivariate Statistical Methods. 2<sup>nd</sup> ed., McGraw Hill Mardia  
 Anderson, T.W. (1983) . An Introduction to Multivariate Statistical Analysis. 2<sup>nd</sup> ed., Wiley.  
 Jhonson, R. and Wichern (1992). Applied Multivariate Statistical Analysis. 3<sup>rd</sup> ed., Prentice Hall.

## ESTIMATION THEORY

### UNIT- I

Point estimation. Concepts of unbiasedness, consistency, minimum variance unbiased estimation. Information in a sample, Cramer-Rao inequality, efficiency of an estimator, Chapman-Robin's inequality and Bhattacharya bounds, definition of CAN estimator.

### UNIT- II

Concept of sufficiency, single parameter and several parameter cases. Fisher-Neyman Factorization theorem, minimal-sufficient statistic, exponential families and Pitman families. Invariance property of sufficiency under 1-1 transformation of sample space and parameter space. Distributions admitting sufficient statistics, Rao-Blackwell theorem, completeness, Lehman-Scheffe theorem, joint sufficiency (regular case).

### UNIT- III

Method of maximum likelihood, CAN estimator for one-parameter Cramer family. Cramer-Huzurbazar theorem, solution of likelihood equations, method of scoring. Connection between MLEs and efficient estimators, MLEs and sufficient estimators.

### UNIT- IV

Censored and truncated distributions. Type I and Type II censoring for normal and exponential distributions and their MLEs. Interval estimation. confidence intervals using pivots, shortest expected length confidence intervals.

### Text Books

Goon, A.M., Gupta, M.K., Das Gupta, B. An Outline of Statistical Theory. Vol. II, The World Press PVT. Ltd., Kolkata.  
 Rohatgi, V. (1998). An Introduction to Probability and Mathematical Statistics. Wiley Eastern Ltd., New Delhi.  
 Kale, B.K. (1999). A First Course on Parametric Inference. Narosa Publishing House.

### References

Lehmann, E.L.(1986). Theory of Point Estimation.  
 Rao, C.R. (1973). Linear Statistical Inference.  
 Dudewicz, E.J. and Misra, S.N(1988) . Modern Mathematical Statistics. Student's Edition, Wiley.  
 Lawless, J.F., Statistical Models and Methods for Lifetime Data. John Wiley & Sons.

## SAMPLING

### UNIT- I

Selection with varying probabilities, PPS sampling, Horvitz and Thomson estimator, Yates' and Grundy's estimator, Midzuno-Sen sampling scheme. Systematic sampling. Estimation of population mean and its variance, Methods for populations with linear trend. Yates correction, modified systematic sampling, balanced systematic sampling, centrally located sampling, circular systematic sampling.

### UNIT- II

Cluster sampling. Estimation of population mean and its variance, efficiency of cluster sampling, determination of optimal cluster size, estimation of proportion, cluster sampling with varying sizes. Two-stage sampling . Two-stage sampling with equal first stage UNIT----s. Estimation of mean and its variance. Optimum allocation. Three-stage sampling with equal probabilities. Two-stage pps sampling.

### UNIT- III

Ratio estimation: Introduction. Bias and mean square error, estimation of variance, confidence interval, comparisons 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.

### UNIT- IV

Multi-phase 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 Harvitz technique, Deming's model.

### Text Books

F.S.Chaudhary . Theory and Analysis of Sample Survey Designs, New Age International Publishers, Delhi.

Des Raj . Sampling Theory.

Cochran, W.G. Sampling Techniques.

Murthy, M.N. . Sampling Theory Techniques.

Parimal Mukhopadhyay. Theory and Methods of Survey Sampling. Prentice-Hall of India Pvt. Ltd., New Delhi.

Sukhatme, P.V. and Sukhatme, B.V. . Sampling Theory of Survey with Applications

## C – PROGRAMMING

### UNIT- I

Identifiers and key words, data types, constants, variables and arrays, declarations, expressions, statements, symbolic constants. Operators and expressions . Arithmetic, unary, relational and logical, assignment, conditional operators. Library functions.

### UNIT- II

Data input and output. getchar, putchar functions, scanf, printf, gets, puts functions. Control statements. while, do-while, for nested loops, if-else, switch, break, continue, exit operator, goto statement. Functions. Definitions, accessing a function, passing arguments to a function, specifying argument types, function prototypes and recursion.

### UNIT- III

Program structure. Storage classes, automatic, external and static variables. Arrays. Definition, processing an array, passing arrays to a function, multi-dimensional arrays,

arrays and strings. Pointers. Fundamentals, pointer declarations, passing pointers to a function, pointers and multi-dimensional arrays, operations on pointers arrays of pointers, passing functions to other functions.

### UNIT- IV

Structures and Unions. Definitions, processing, typedef, structures and pointers, passing structures to a function, self-referential structures. Data Files. Opening and closing a data file, creating, processing a data file, unformatted data files.

### Text Books

Balaguruswamy, E. . Programming in C. Tata McGraw Hill.  
Somasekharan, M.T. . Programming in C. Prentice Hall, India.  
Brain, W., Karnighan and Dennis, M. Reitech. Prentice Hall India Ltd.  
Byron, S.Gottfried. Programming with C. Tata McGraw Hill.  
Kochan, S.G. . Programming in C.

***Practical – I : Consisting of 24 practicals exercises covering at least 3 exercises from each unit of Paper I and Paper-II.***

***Practical – II : Consisting of 24 practicals exercises covering at least 3 exercises from each unit of Paper III and Paper-IV.***

## SEMESTER II

### MULTIVARIATE ANALYSIS

#### UNIT- I

Definition of Wishart matrix and its properties, Mahalanobis distance, null 2 distribution of Hotelling's T statistic. Its Application . tests on mean vector for one and more multivariate normal populations , equality of the components of a mean vector in a multivariate population.

#### UNIT- II

Classification and discrimination procedures: Procedures for discriminating between two multivariate normal populations, sample discriminant function, tests associated with discriminant functions, probability of misclassification and their estimation. Classification into more than two multivariate populations. K-nearest neighbour classification.

#### UNIT- III

Principle components, dimension reduction. Canonical variables and canonical correlation. Definition, use, estimation and computation. Factor analysis: Orthogonal factor model, methods of estimating factor loadings – principle component method, principle factor method, iterated principle factor method. Maximum likelihood estimation. Factor rotation, orthogonal factor rotation – varimax, quartimax rotations, oblique rotation criteria for determining number of common factors. Factor scores.

#### UNIT- IV

Cluster analysis : Hierarchical clustering - single, complete and average linkage methods, centroid and Ward's methods. Non-hierarchical methods – K-means algorithm. Multi-dimensional scaling.

*Note :Practical exercises must be based on statistical packages only.*

#### Text Books

- Anderson, T.W. (1983) . An Introduction to Multivariate Statistical Analysis. 2<sup>nd</sup> ed., Wiley.  
 Seber, G.A.F. (1984). . Multivariate observations. Wiley.  
 Johnson, R. and Wichern (1992) . Applied Multivariate Statistical Analysis. Prentice-Hall, 3<sup>rd</sup> ed.

#### References

- Gin, N.C. (1977). Multivariate Statistical Inference. Academic Press.  
 Kshirasagar, A.M. (1972). Multivariate Analysis. Marcel Dekker.  
 Morrison, D.F. (1976). Multivariate Statistical Methods. 2<sup>nd</sup> ed. McGraw Hill.  
 Muirhead, R.J. (1982). Aspects of Multivariate Statistical Theory. John Wiley.  
 Rao, C.R. (1973). Linear Statistical Inference and its Applications. 2<sup>nd</sup> ed., Wiley.  
 Sharma, S. (1996). Applied Multivariate Techniques. Wiley.  
 Srivastava, M.S. and Khatri, C.G. (1979). An Introduction to Multivariate Statistics. North Holland.

## TESTING OF HYPOTHESIS

### UNIT- I

Neyman-Pearson theory. Lemma using critical functions. Uniformly most powerful tests, their relation with sufficient statistics

### UNIT- II

Monotone likelihood ratio and UMP tests for one-sided hypothesis, composite hypothesis. Unbiased tests, uniformly most powerful unbiased tests. Type-A and Type-A regions.

### UNIT- III

Likelihood ratio criterion, its asymptotic distribution, one sample, two sample and k-sample problems. Linear hypothesis. Wald's SPRT. Proof that it terminates in a finite number of steps with probability 1. O.C and A.S.N. functions. Examples of binomial and normal cases for testing hypothesis on  $\mu$  and  $\sigma^2$ .

### UNIT- IV

Notion of non-parametric test, different NP tests. Run test, sign test, Wilcoxon and Mann-Whitney test, Median test, derivations of the mean and variance of the above test statistics when null hypothesis is true. Chi-square test for goodness of fit, its asymptotic distribution, description of Kolmogorov-Smirnov test, tests involving rank correlation (Kendall's and Spearman's).

### Text Books

Rohatgi, V.K. . Statistical Inference, John Wiley and Sons.  
Gibbons, J.D. . Non-parametric Inference, McGraw Hill  
Wald. Sequential Analysis, John Wiley and Sons.  
Goon, Gupta and Das Gupta . An Outline of Statistical Theory. Vol. 2, The World Press Pvt. Ltd., Kolkata.

### References

Lehmann, E.L. . Testing of Statistical Hypothesis. John Wiley and Sons.  
Rao, C.R.. Linear Statistical Inference and its Applications. John Wiley and Sons.  
Sidney Siegel . Non-parametric Statistics for the Behavioural Sciences.



## STOCHASTIC PROCESSES

### UNIT- I

Introduction to stochastic processes(sps), classification of sps' according to state space and time domain. Countable state Markov Chains(MCs), Chapman-Kolmogorov equations, calculation of n-step transition probability and its limit. Classification of states, period of state, stationary distribution of MC.

### UNIT- II

Random walk and gambler's ruin problem. Random walk in one and two dimensions. Gambler's ruin problem, probability of ultimate ruin, expected duration of the game. Discrete state space continuous time MC. Poisson process and its properties, birth process, death process, birth and death process.

### UNIT- III

Weiner process as a limit of random walk, elementary properties of Weiner process. Branching process. G-W branching process, probability of ultimate extinction, distribution of population size.

### UNIT- IV

Renewal Theory. Elementary renewal theorem and applications. Study of residual and excess life times and their distributions. Stationary process. Weakly stationary process and strongly stationary process.

### Text Books

- Medhi, J. (1982). Stochastic Processes. Wiley Eastern.  
 Bhat, B.R.(2002). Stochastic Models- Analysis and Applications. New Age International, India.  
 Basu, A.K. . Introduction to Stochastic Process.  
 Srinivasan and Mehta. Stochastic Processes.

### References

- Adke, S.R. and Manjunath, S.M. (1984). An introduction to Finite Markov Processes, Wiley Eastern.  
 Cinlar, E. (1975) . Introduction to Stochastic Processes. Prentice-Hall.  
 Feller, W. (1968). Introduction to Probability and Applications. Vol. I, Wiley Eastern.  
 Hoel, P.G., Port, S.G. and Stone, C.J. (1972). Introduction to Stochastic Processes. Houghton Mifflin and Co.  
 Karlin, S. and Taylor, H.M. (1975) . A First Course in Stochastic Processes. Vol. I  
 Parzen, E. (1962). Stochastic Processes. Holden-Day.

## DESIGN OF EXPERIMENTS

### UNIT- I

Principles of designs, analysis of variance and analysis of co-variance, fixed and random effect models. Contrasts. Model adequacy checking. Test for normality, test for equality of variances (Bartlett test, Modified Levene method)

### UNIT- II

C.R.D., R.B.D., estimation of parametric functions and tests of hypothesis, comparison of their efficiencies. Missing plot techniques, testing the equality of subsets of block effects or treatment effects. Multiple comparisons tests . Tukey's , Fisher's Least Significant Difference (LSD) method, Duncan's multiple range test.

### UNIT- III

L.S.D., orthogonality in L.S.D. Missing plot technique, Analysis of split plot design. Factorial designs. Analysis of 2 and 3 designs. Estimation of factorial effects, testing their significance. Total and partial confounding.

### UNIT- IV

Youdin design, intra block analysis. B.I.B.D., P.B.I.B.D., their analysis, estimation of parameters, testing of hypothesis.

### Text Books

Das, M.N. and Giri, N.C.. Design and Analysis of Experiments. New Age International Pvt. Ltd.

Montgomery, D.C. . Design and Analysis of Experiments. John Wiley and Sons, New York.

### References

Cochran and Cox . Experimental Designs. Asia Publishing House, Bombay.

Kemp Thorne. Design and Analysis of Experiments, Wiley Eastern Pvt. Ltd., New Delhi.

*Practical – III: Consisting of 24 practicals exercises covering at least 3 exercises from each unit of Paper I and Paper-II.*

*Practical – IV : Consisting of 24 practicals exercises covering at least 3 exercises from each unit of Paper III and Paper-IV.*

## **Statistics Students have to choose one Non-Core paper from other Departments**

### **NON CORE 1: STATISTICAL METHODS**

#### *For Other Than Statistics Department Students*

**Emphasis is on the concepts and applications. No mathematical derivations and proofs.**

#### **UNIT - I**

Descriptive Statistics-Collection, diagrammatic and graphical representation of data, Summarization of data -Frequency distributions, graphical representation, Ogive. Concepts of central tendency, dispersion, skewness and kurtosis.

#### **UNIT - II**

Descriptive measures of Statistics-Measures of central tendency, relative merits and demerits, measures of dispersion, skewness and kurtosis, moments of a distribution,  $\beta_1, \beta_2, \gamma_1, \gamma_2$  coefficients. Elements of probability: Concepts of mutually exclusive and equally likely events, classical definition of probability. -Random variable, mathematical expectation.

#### **UNIT - III**

Distributions-Population and sample distribution function, Bernoulli trials, Binomial and Poisson distributions, Normal distribution. Statement and uses of Chi-square, t and F distributions. Correlation and Regression: Dicate frequency distributions, correlation coefficient limitations, correlation ratio, concept of regression – regression lines. Multiple regression: Concepts of multiple and partial correlations (3 variate distributions only).

#### **UNIT - IV**

Basic ideas in sampling: Population, parameter, statistic, notion of sampling, Random numbers, their use, sampling with and without replacement from finite populations. Simple random sampling, stratified random sampling, systematic random sampling, their specific uses, comparisons.

#### **Text Books**

Yule and Kendall: Introduction to the Theory of Statistics, Chapman Griffen

G.W, Snedecor and W. G.Cochran: Statistical Methods.

Daniel: Bio-Statistics, Wiley

S.C, Gupta: Statistics

Cochran, W.G: Sampling Techniques

J.Medhi: Statistical Methods, Wiley Eastern

**SEMESTER III**  
**OPERATIONS RESEARCH I**

**UNIT- I**

Definition and scope of Operations Research (O.R). Phases in OR. Models and their solutions. Linear Programming (LP). Graphical, simplex, revised simplex methods. Duality and sensitivity analysis. Transportation and assignment problems.

**UNIT- II**

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 routings.

**UNIT- III**

Analytical structure of inventory problems, EOQ formula of Harris, its sensitivity analysis and extensions allowing quantity discounts and shortages. Multi-item inventory subject to constraints. Models with random demand, static risk model, P and Q systems with constant and random lead times. S-s policy for inventory and its derivation in the case of exponential demand, multi-echelon inventory models.

**UNIT- IV**

Queuing models : specifications and effectiveness measures. Steady state solutions of M/M/1 and M/M/C with associated distributions of queue length and waiting time. M/G/1 queue and Pollaczek –Kinchine result. Steady state solutions of M/E<sub>k</sub>/1 and E<sub>k</sub>/M/1 queues. Machine interference problem. Bulk queues (bulk arrival and bulk service), finite queues, queues in tandem, GI/G/1 queue and its solution, simulation of queues.

**Text Books**

Kanti Swarup, Gupta, P.K. and Man Mohan (1985) . Operations Research, Sultan Chand and Sons.  
Sharma, J.K. (2003). Operations Research Theory and Applications. Macmillan, India.  
Sharma, S.D. . Operations Research. Kedarnath Ramnath Publishers, Meerut.

**References**

Taha, H.A.(1982) .Operations Research: An Introduction. Macmillan.  
Hillier, F.S. and Lieberman, G.J. . Introduction to Operations Research. Holden Dev.  
Churchman, C.W., Ackoff, R.L., and Arnoff, E.L. (1957) . Introduction to Operations Research. John Wiley.  
Gross, D. and Harris, C.M. (1974) . Fundamentals of Queuing Theory. John Wiley.

## DEMOGRAPHY AND OFFICIAL STATISTICS

### UNIT I

**Demographic data** – sources, coverage and content errors in demographic data. Use of balancing equations and Chandrasekaran Deming formula. Vital Registration system – Adjustment of age data - use of Whipple, Myer and UN Indices – Smoothing of age data. Population composition, dependency ratio.

### UNIT II

**Study of census in India** – Methodology and characteristics of census; Nature of information collected in 1971, 1981, 1991 and 2001 census in India; National Family Health Survey 1 and 2 and Rapid Household Survey; changing characteristics of population in India; Population growth rates, trends and regional variations in sex ratio; Age structure of population, foetal, infant and child mortality rates; Maternal mortality rates; Life expectancy; Appraisal of Kerala model; Pattern of Migration and Urbanization in India.

### UNIT III

**Introduction to Indian and International Statistical System** - role, function activities of Central and State Statistical Organizations; Organization of large scale sample surveys; Role of National sample survey organization; General and special data dissemination systems; Principal publications containing such statistics on the topics - population, agriculture industry, trade, price, labour and employment transport and communications, and finance; Educational and Psychological statistics:- Scaling individual test items, scaling of scores on a test, different types of scores and scaling, scaling of ranking and rating in terms of normal curve, Reliability of test scores, Rulon and Kuder Richardson methods, Reliability of a test, validity, comparison between reliability and validity, Intelligence coefficient.

### UNIT IV

**Indian Official Statistics** - Present official statistical system in India, Methods of collection of official statistics, their reliability and limitations. Role of Ministry of Statistics & Program Implementation (MoSPI), Central Statistical Office (CSO), National Sample Survey Office (NSSO), and National Statistical Commission. Government of India's Principal publications containing data on the topics such as population, industry and finance.

#### **Text Book**

Ramakuar, R. and Gopal, Y.S. (1986): Technical Demography. Wiley Eastern Ltd

#### **Reference Books**

Chattopadhyay, & Saha, A.K. (2012): Demography: Techniques & Analysis, Viva Books

Rogers, A. (1975) Introduction to Mathematical Demography, John Wiley, New York

Guide to current Indian Official Statistics, Central Statistical Office, GOI, New Delhi.

**KNOWLEDGE DISCOVERY AND DATA MINING****UNIT-I**

Review of classification methods from multivariate analysis; classification and decision trees. Clustering methods from both statistical and data mining viewpoints; vector quantization.

**UNIT-II**

Unsupervised learning from univariate and multivariate data; dimension reduction and feature selection.

**UNIT-III**

Supervised learning from moderate to high dimensional input spaces; regression trees.

**UNIT-IV**

Introduction to databases, including simple relational databases; data warehouses and introduction to online analytical data processing. Association rules and prediction; data attributes.

**Text Books**

A.Berson and S.J. Smith (1997): Data Warehousing, Data Mining and OLAP. McGraw-Hill.

L.Breiman, J.H. Friedman, R.A. Olshen, and C.J.Stone (1984): Classification Regression Trees. Taylor Francis.

J.Han and M. Kamber (2006): Data Mining; Concepts and Techniques. 2<sup>nd</sup> Edition. Morgan Kaufmann.

T.M. Mitchell (2011): Machine Learning. Springer.

**Reference Book**

B.D.Ripley (2008): Pattern Recognition and Neural Networks. Cambridge University Press

## TIME SERIES ANALYSIS

### UNIT- I

Time series as discrete parameter stochastic process. Auto covariance and auto-correlation function, their properties. Exploratory time series analysis. Tests for trend and seasonality. Exponential and moving average smoothing. Holt and Winters smoothing. Forecasting based on smoothing, adaptive smoothing

### UNIT- II

Detailed study of the stationary processes: Moving Average (MA), Auto Regressive (AR), ARMA and AR Integrated MA (ARIMA) models.

### UNIT- III

Box-Jenkins models: Discussion (without proof) of estimation of mean, auto covariance and auto-correlation functions under large sample theory. Choice of AR and MA periods. Estimation of ARIMA model parameters. Forecasting, residual analysis and diagnostic checking.

### UNIT- IV

Spectral analysis of weakly stationary process. Periodogram and correlogram analyses. Computations based on Fourier transform.

### Text Books

Box, G.E.P. and Jenkins, G.M. (1976). Time Series Analysis – Forecasting and Control. Holden Day, San Francisco.  
 Anderson, T.W. (1971). The Statistical Analysis of Time Series. Wiley, N.Y. Makridakis, Wheelwright and McGee. Forecasting. Methods and Applications. John Wiley & Sons.  
 Montgomery, D.C. and Johnson, L.A. (1977). Forecasting an Time Series Analysis. McGraw Hill.

### References

Fuller, W.A. (1976). Introduction to Statistical Time Series. John Wiley, N.Y. Granger, C.W.J. and Newbold (1984). Forecasting Econometric Time Series. 3<sup>rd</sup> ed., Academic Press.  
 Priestley, M.B. (1981). Spectral Analysis and Time Series. Griffin, London.  
 Kendall, S.M. and Ord, J.K. (1990). Time Series Analysis. 3<sup>rd</sup> ed., Edward.  
 Kendall, M.G. and Stuart, A. (1966). The Advanced Theory of Statistics. Vol.3, Charles Griffin, London  
 Blooinfield, P.(1976). Fourier Analysis of Time Series-An Introduction, Wiley.  
 Granger, C.W.J. and Hatanka, M.(1964). Spectral Analysis of Economic Time Series. Princeton Univ. Press, N.Y.  
 Koopmans, L.H.(1974). The Spectral Analysis of Time Series. Academic Press.

***Practical – V : Consisting of 24 practicals exercises covering at least 3 exercises from each unit of Paper I and Paper-II.***

***Practical – VI : Consisting of 24 practicals exercises covering at least 3 exercises from each unit of Paper III and Paper-IV.***

*Statistics Students have to choose one Non-Core paper from other Departments*

**NON CORE 1I**

**ELEMENTS OF STATISTICAL INFERENCE**

*For Other Than Statistics Department Students*

**Emphasis is on the concepts and applications. No mathematical derivations and proofs.**

**UNIT –I**

Sampling distributions, examples,  $\bar{X}, S^2$  (without proof), concepts of point and interval estimation. Criteria of good estimate: Consistency, Unbiasedness, sufficiency and efficiency, various estimates of parameters in Binomial, Poisson and Normal distributions.

**UNIT-II**

Methods of estimation: Maximum likelihood, least squares and other methods of estimation, properties of M.L.E's of parameters in Binomial, Poisson and Normal distributions. Tests of significance: Notion of test of significance, Null-hypothesis, alternative hypothesis, critical region, Type I and II errors.

**UNIT –III**

Exact tests: tests for the mean of a Normal with known and unknown variances, test for the variance of a normal with known mean, test for the equality of means in two samples with known and unknown variances, tests for the correlation coefficient, multiple and partial correlations. Chi-Square statistic as a test for goodness of fit. Test for the independence of attributes, Yates correction for continuity. Analysis of Variance: One-way classification and two-way classification.

**UNIT –IV**

Non-parametric tests: advantages and disadvantages. Test of randomness, one sample and two sample run tests, median test, Wilcoxon-Mann-Whitney test. Notion of sequential test, properties (without proof) of the S.P.R.T procedure, Sequential test for the mean of Normal population.

**Text Books**

Goon, A.M. Gupta, M.K. and Das Gupta: Fundamentals of Statistics  
Hoel, P.G: Introduction to Mathematical Statistics  
Yule and Kendall, M.G: An Introduction to the Theory of Statistics



## SEMESTER IV OPERATIONS RESEARCH II

### UNIT- I

Decision Theory: Decision theory approach, decision theory under uncertainty, under risk, posterior probabilities and Bayesian analysis, decision tree analysis, decision making with utilities.

### UNIT- II

Game theory: two-person games, pure and mixed strategies, existence of solution and uniqueness of value in zero-sum games, finding solutions in  $2 \times 2$ ,  $2 \times m$  and  $m \times n$  games. Dynamic programming.

### UNIT- III

Integer programming: Branch and Bound algorithm and cutting plane algorithm. Multi-criterion and goal programming. Replacement problems: block and age replacement policies, replacement of items with long life.

### UNIT- IV

Project management: CPM, PERT, probability of project completion, crashing. Information theory: Communication process, entropy, channel capacity, efficiency, redundancy. Shannon-Fano encoding procedures. Non-linear programming: Kuhn-Tucker conditions, Wolfe and Beale's algorithms for solving quadratic programming problems.

### Text Books

Kanti Swarup, Gupta, P.K. and Man Mohan (1985) . Operations Research, Sultan Chand and Sons.  
Sharma, J.K. (2003). Operations Research Theory and Applications. Macmillan, India. Sharma, S.D. . Operations Research. Kedarnath Ramnath Publishers, Meerut

### References

Taha, H.A.(1982) .Operations Research-An Introduction. Macmillan.  
Hillier, F.S. and Lieberman, G.J. . Introduction to Operations Research. Holden Dev. Churchman, C.W., Ackoff, R.L., and Arnoff, E.L. (1957) . Introduction to Operations Research. John Wiley.  
Gross, D. and Harris, C.M. (1974) . Fundamentals of Queuing Theory. John Wiley.

## ECONOMETRICS

### UNIT- I

Nature and scope of econometrics. General Linear Model. assumptions, OLS method of estimation, tests of hypothesis, confidence intervals, prediction, estimation subject to linear restrictions, maximum likelihood estimation.

### UNIT- II

Tests of structural change: dummy variables and seasonal adjustments, equality of two regression equations, specification errors. Estimation methods.

### UNIT- III

Generalized least squares: Aitken estimators. Heteroscedasticity. Goldfeld-Quandt test, Park test, weighted least square method of estimation. Auto-correlation. detection by Durbin-Watson statistic, estimation methods. Cochran, Orcutt and Durbin's. SUR system of equations.

### UNIT- IV

Lagged variables: distributed lag models- Koyck approach, adaptive expectations model, stock adjustments models, Almon's approach. Errors in variables.

Simultaneous equation models: structural form, reduced form and recursive form. Identification problem, order and rank conditions. Methods of estimation. 1LS, 2SLS, IV, LIML and 3SLS.

### Text Books

Gujarathi, D.(1979). Basic Econometrics, McGraw Hill.

Johnston, J.(1984). Econometric Methods. 3<sup>rd</sup> ed., McGraw Hill.

Koutsoyiannis, A.(1979). Theory of Econometrics. Macmillan Press.

Theil, H.(1982). Introduction to the Theory and Practice of Econometrics. John Wiley.

### References

Apte, P.G. (1990). Text Book of Econometrics. Tata McGraw Hill.

Cramer, J.S. (1971). Empirical Econometrics. North Holland.

Intrilligator, M.D.(1980). Econometric Models-Techniques and Applications. Prentice Hall of India.

Klien, L.R. (1962). An Introduction to Econometrics. Prentice Hall of India.

Mallnvand, E (1966). Statistical Methods of Econometrics. North Holland.

Srivastava, V.K. and Gile, D.A.E. (1987). Seemingly Unrelated Regression Equation Models. Marcel and Dekker.

Walters, A. (1970). An Introduction to Econometrics. McMillan & co.

## COMPUTER PROGRAMMING - C++

### UNIT- I

Object oriented programming principles, declaration of classes, array of classes, pointer to classes, constructors and destructors.

### UNIT- II

Friend functions, inline function, static class members, this pointer. Single, multiple inheritance. Types of derivation such as public, private, protected inheritance and member access controls, ambiguity in inheritance.

### UNIT- III

Virtual base class, container classes. Function overloading. Operator Overloading. overloading of assignment, binary and unary operators.

### UNIT- IV

Polymorphism, early binding, virtual functions, late binding, pure virtual functions, abstract base classes, constructor under inheritance, destructor under inheritance, virtual destructors. Templates and exception handling. Data file operations, structures and file operations, classes and file operations.

### Text Books

Deital & Deital . C++. Prentice-Hall Inc.  
Sinan Si Alhir . UML. Orielly.  
Sarang . Object Oriented Programming with C++. Prentice-Hall.  
Balaguruswamy, E. . Programming in C++. Tata McGraw Hill.

### References

Decker, R. and Hirshifield, S. (1998). The Object Concept. An Introduction to Computer Programming using C++. PWS Publishing.  
Lippmann, S.B. and Lajoie, J. (1998). C++ Primer. 3<sup>rd</sup> ed. Addison-Wesley.  
Nauhaton, P.(1996). The Java Handbook. Tata McGraw Hill.  
Sawitch, W.J. (2001). Problem Solving with C++ . The Object of Programming. 3<sup>rd</sup> ed. Addison-Wesley, Longman.

**(A): STATISTICAL PROCESS AND QUALITY CONTROL****UNIT-I**

Introduction to SPC: Concept of quality, Quality control and Quality improvement; Role of SPC in this context, Concept of variation due to common and assignable causes; meaning of control, expected benefits of SPC.

**UNIT-II**

Process Capability Analysis: a. Process capability Analysis, process capability and machine capability indices ( $C_p$ ,  $P_p$ ,  $C_{pk}$ ,  $P_{pk}$ ) b. Estimation of process capability indices for live data by statistical software (like Minitab, SPSS, Systat, Statistica, JMP etc)

**UNIT-III**

Brief history of Quality Control– causes of Variation – Statistical Basis for Control Charts - Principles of Shewart's control chart.

**Control Charts for variables** – Introduction -  $\bar{X}$  and R Chart: Statistical Basis of the charts - development and use of  $\bar{X}$  and R Charts - OC Curve of  $\bar{X}$  and R chart.

**Control charts for Attributes** – Development and Operation of 'p' and 'np' charts with constant and variable sample size, C and U charts – Operating Characteristic curve.

**UNIT-IV**

**Special Control Charts for variables:** Notion of ARL – CUSUM chart – Comparison of CUSUM charts with Shewart's control charts, V mask and decision interval methods – Control chart for Mid Ranges – Moving Averages & Moving ranges – Groups control and modified control charts – Exponential Weighted Average (EWMA) charts.

**Text book**

Acheson J Duncan, **Quality Control and Industrial Statistics**, R. D. Irwin; 4<sup>th</sup> Edition (1974).

**Reference Books**

Montgomery, Douglas C., **Introduction to Statistical Quality Control**, Sixth Edition. John Wiley(2009).

Eugene Grant, **Statistical Quality Control**, McGraw Hill Education; 7<sup>th</sup> Edition (2017)

Burr, I. W., **Statistical Quality Control Methods**, Volume 16, New York: Marcel Dekker, Inc (1976).

J.M. Juran, Frank M. Gryna, **Juran's Quality Control Handbook**, Mcgraw-Hill; 4<sup>th</sup> Edition (1988).

**(B) – RELIABILITY THEORY****UNIT-I**

Reliability concepts and measures – life testing problems and procedures – chance and wear out failures and corresponding failure density function – Hazard functions and reliability function.

**UNIT-II**

Estimation of Failure Density Parameters Interval Estimation of Reliability Function – General failure distributions – Exponential, Normal, Log-Normal, Gamma and Weibull laws – Estimation of parameters and tests in these models.

**UNIT-III**

Reliability estimation based on failure times in various censored life tests and in tests with replacement of failure items.

**UNIT-IV**

System Reliability – Series and Parallel configurations – k-out-of-n system – Markov models for System Reliability – Maintainability – System Availability measures – Reliability Allocation.

**Text book**

E.Balaguruswamy : Reliability Engineering, TMI Publications

**Reference Books**

RosanFlatt John Ramp : Statistical theory of Reliabilities, John Wiley

Shooman M.I : Probabilistic Reliability, an Engineering approach, Academic Press

B.K.Kale&S.K.Sinha : Reliability and life testing, Wiley Eastern

L.S.Sreenath : Reliability Engineering.

*Practical – VII : Consisting of 24 practicals exercises covering at least 3 exercises from each unit of Paper I and Paper-II.*

*Practical – VIII: Consisting of 24 practicals exercises covering at least 3 exercises from each unit of Paper III and Paper-IV.*

PAPER CODE:

**M.Sc. Degree Examination, Month – Year  
I / II / III / IV Semesters**

**M.Sc. Statistics**

(With effect from under CBCS 2019-20 )

**Time: 3Hours**

**Max.Marks:75**

**(No additional Sheet will be supplied)**

**Part –A**

**5 x 3 = 15**

Answer *any five* Questions

Each Question carries *three (3)* Marks

1. Unit - I
2. Unit - I
3. Unit - II
4. Unit - II
5. Unit - III
6. Unit - III
7. Unit - IV
8. Unit - IV

**Part – B**

**15 x 4 = 60**

Answer *any four (4) of the following*  
Each Question carries *Fifteen (15) Marks*

**Unit-I**

9.

{OR}

10

**Unit-II**

11.

{OR}

12.

**Unit – III**

13.

{OR}

14.

**Unit – IV**

15.

{OR}

16.

**M.Sc., Mathematics Degree Examinations**  
**Second / Third Semesters**  
**STATISTICAL METHODS / ELEMENTS OF STATISTICAL INFERENCE**

**M.Sc. Statistics**  
(No additional sheet will be supplied)  
**(NON-CORE SUBJECT)**

Time : 3 hours

Max. Marks : 75Marks

**Part-A**

$5 \times 3 = 15$  Marks

Answer **Any Five (5)** of the following  
Each question Carries **Three (3) marks**

1. Unit - I
2. Unit - I
3. Unit - II
4. Unit - II
5. Unit - III
6. Unit - III
7. Unit - IV
8. Unit - IV

**Part-B**

$4 \times 15 = 60$  Marks

Answer **ALL** The Questions.  
Each question Carries **15 Marks**

9. Unit-I  
{OR}
10. Unit-II  
{OR}
11. Unit-III  
{OR}
12. Unit-IV  
{OR}
13. Unit-I  
{OR}
14. Unit-II  
{OR}
15. Unit-III  
{OR}
16. Unit-IV  
{OR}



# YOGI VEMANA UNIVERSITY: KADAPA

APPROVED SYLLABUS BY BOS (With effect from 2019-20)

*M. Sc. Statistics - Choice Based Credit System*

<b>Semester – I</b>						
<b>Max. Marks :100</b>						
<b>Code</b>	<b>Title of the paper</b>	<b>No of Credits</b>	<b>Hours per week</b>	<b>Internal</b>	<b>External</b>	<b>Exam time (Hrs)</b>
15151	Probability and Distributions	4	4	25	75	3
15152	Estimation Theory	4	4	25	75	3
15153	Sampling	4	4	25	75	3
15154	C-Programming	4	4	25	75	3
15151-P	Practical I	4	8	100		3
15152-P	Practical II	4	8	100		3
<b>Semester – II</b>						
<b>Max. Marks :100</b>						
25151	Multivariate Analysis	4	4	25	75	3
25152	Testing of Hypothesis	4	4	25	75	3
25153	Stochastic process	4	4	25	75	3
25154	Design of Experiments	4	4	25	75	3
25151P	Practical III	4	8	100		
25152P	Practical IV	4	8	100		
Non core - 1	To be selected from other departments			25	75	3
<b>Semester – III</b>						
<b>Max. Marks :100</b>						
35151	Operations Research I	4	4	25	75	3
35152	Demography and Official Statistics	4	4	25	75	3
35153	Knowledge Discovery and Data Mining	4	4	25	75	3
35154	Time Series Analysis	4	4	25	75	3
35151 P	Practical V	4	8	100		3
35152 P	Practical VI	4	8	100		3
Non core - 2	To be selected from other departments			25	75	3
<b>Semester – IV</b>						
<b>Max. Marks :100</b>						
<b>Theory</b>						
45151	Operations Research II	4	4	25	75	3
45152	Econometrics	4	4	25	75	3
45153	Computer programming – c++	4	4	25	75	3
45154	(A)Statistical process and Quality control (B)Reliability Theory	4	4	25	75	3
<b>The student has to choose one from A &amp; B</b>						
45151P	Practical VII	4	8	100		
45152P	Practical VIII	4	8	100		
<b>Total for core</b>		<b>96</b>	<b>128</b>	<b>2400</b>		
<b>Total for Non-core papers</b>				<b>200</b>		
<b>Grand Total</b>		<b>96</b>	<b>128</b>	<b>2600</b>		