THE MADURA COLLEGE (Autonomous), MADURAI – 625 011

(AFFILIATED TO MADURAI KAMARAJ UNIVERSITY)

RE-ACCREDITED (3rd Cycle) WITH "A" GRADE BY NAAC

PROGRAMME: M.Sc., Statistics **COURSE CODE : 19P1SMC1**

COURSE TITLE : Real Analysis and Linear Algebra **QN.NO : 1501**

TIME : 3 Hours **MAX.MARKS :75**

Learning Objectives:

- To get an overview of real numbers and analysis.
- To understand the concept of Limits and Convergence.
- To understand the concept of algebra that will useful in Statistics.

Learning out comes:

- Understand continuity, derivability of real valued functions.
- Differentiate between Riemann Integral and Riemann – Stieltjes integral.
- Grasp the concept of Linear algebra.

Unit I - Sequences and Infinite Series

Bounded ness and limit of a sequence - Convergence of sequences and series of real numbers – absolute and conditional convergence – Point - wise and uniform convergence – Tests for absolute, conditional and uniform convergence – Properties of uniform convergence.

Unit II - Real valued functions

Limits, continuity and uniform continuity of functions – Algebra of continuous functions - Differentiability – Algebra of Derivatives - Maxima and Minima of functions – Mean value theorems - Taylor's theorem – Functions of several variables.

Unit III -Rieman-Stieljtes (R-S) intergral

Upper and lower R-S integrals - Necessary and sufficient condition for R-S integrability - Algebra of R-S integrable functions - Class of R-S integrable functions - Integration by parts - First mean value theorem and Cauchy's mean value theorem for R-S integrals.

Unit IV - Vector Spaces

Vector Spaces - Examples of Vector Spaces - Linear Combinations - Spanning Sets - Subspaces - Linear Spans - Row Space of a Matrix - Linear Dependence and Independence - Basis and Dimension - Linear transformation - Orthogonality – Orthonormal basis.

P.T.O.

Unit V- Matrices

Matrices – Rank and inverse of matrices – properties – Idempotent and partitioned matrices –Generalized Inverse - Polynomials of Matrices - Characteristic Polynomial – Cayley-Hamilton Theorem - Characteristic roots and characteristic vectors - Quadratic forms – Reduction and classification of quadratic forms – Cochran's theorem.

Books for Study and Reference

1. A Basic Course in Real Analysis by Ajit Kumar and Kumaresan, S, Chapman and Hall/CRC Press(2014).
2. Real Analysis by Arora, S,Satya Prakashan Mandir, New Delhi(1988).
3. Methods of Real Analysis by Goldberg R R, Oxford & IBH Publishing Company, New Delhi(1976).
4. Mathematical Analysis by Malik SC and Arora S, Second Edition, New Age International, New Delhi(2009).
5. Principles of Mathematical Analysis by Rudin, W, McGraw-Hill, New York(1985).
6. Linear Algebra by Lipschutz, S and Lipson ML, Schaum's Outline Series, McGraw Hill, New York(2009).
7. Linear Algebra by Rao, AR and Bhimasankaram P, Second Edition, Hindustan Book Agency, Hyderabad(2000).
8. Real Analysis by Sharma JN and Vasishtha A R, Krishna Prakashan Media (P) Ltd - , Meerut(2008).

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RE-ACCREDITED (3rd Cycle) WITH "A" GRADE BY NAAC

PROGRAMME: M.Sc., Statistics **COURSE CODE : 19P1SMC2**

COURSE TITLE : Probability Theory **QN.NO : 1502**

TIME : 3 Hours **MAX.MARKS :75**

Learning Objectives:

- To explain the concept of Probability Theory.
- To understand the concept like random variables, Probability measure and expectation etc., under stochastic situation.
- To understand the applications of central limits theorems in statistical theory.

Learning out comes:

- Grasp the fundamentals of Probability theory.
- Have an idea of random variables, expectation and probability measure etc., - under stochastic situation.
- Understand the convergence in Probability, Weak Law of Large numbers and different theorems applicable in research.

Unit I – Probability

Functions and Inverse Functions - Random Variables – Limits of Random Variables – Definition of Probability – Simple Properties – Discrete Probability Space – General Probability Space – Induced Probability Space.

Unit II - Distribution Function

Distribution Function of a Random Variable – Decomposition of Distribution functions – Jordan Decomposition Theorem – Distribution Functions of Vector Random Variables - Mathematical Expectation – Properties of Expectation – Moments – MGF – Holder's Inequality – Minkowski Inequality - Basic Inequality - Markov Inequality.

Unit III - Convergence of Random Variables

Convergence in Probability - Almost Sure Convergence - Convergence in Distribution - Convergence in Mean - Relationships - Monotone Convergence Theorem.

Unit IV - Characteristic Function

Characteristic Function of a random variable - Properties – Uniqueness theorem - Inversion Formula – Problems – Borel-Cantelli Lemma - Borel 0 - 1 Law – Helly-Bray Lemma.

P.T.O..

Unit V - Law of Large Numbers

Weak and Strong Law of Large Numbers – Bernoulli's Law of Large Numbers – Khintchine's law of large numbers – Kolmogorov's strong law of large numbers - Simple problems - Central Limit Theorems: *de*-Moivre – Laplace central limit theorem - Lindeberg – Levy's central limit theorem - Liaponov's form of central limit theorem - Lindberg – Feller Central Limit Theorem (Statement only).

Books for Study and Reference

1. Modern Probability Theory – An Introductory Text Book by Bhat B R,Third Edition (Reprint), New Age International Private Ltd - , New Delhi(2009).
2. Modern Mathematical Statistics by Dudewicz, EJ and Mishra S N, John Wiley & Sons, New York(1988).
3. Mathematical Statistics by Mukhopadhyay, P, Third Edition, Books and Allied (P) Limited, Kolkata(2006).
4. Introduction to Probability Theory and Mathematical Statistics by Rohatgi VK, John Wiley & Sons, NY(1976).
5. An Introduction to Probability and Statistics by Rohatgi V K and Saleh, AKME,Third Edition, John Wiley & Sons, NY(2015).

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RE-ACCREDITED (3rd Cycle) WITH "A" GRADE BY NAAC

PROGRAMME: M.Sc., Statistics **COURSE CODE : 19P1SMC3**

COURSE TITLE : Distribution Theory **QN.NO : 1503**

TIME : 3 Hours **MAX.MARKS :75**

Learning Objectives:

- To study the probability distributions.
- To provide concepts underlying the Multivariate techniques.
- To identify the applications of mutilator analysis.

Learning out comes:

- Derive the truncated probability distributions relevant to functions of random variable.
- Derive Non-central χ^2, t and F distribution from normal distribution and derive the Sampling distributions of sample correlation coefficient and regression coefficient.
- Perform Statistical tests of the mean(s) vectors of a multivariate normal distribution.
- Use principal component, Factor analysis, Classification theorem and Canonical correlation for typical problems.

Unit I - Discrete Probability Distributions

Bernoulli, Binomial, Geometric, Negative Binomial, Hypergeometric, Multinomial, Poisson and Uniform Distributions – Properties.

Unit II - Continuous Probability Distributions

Uniform, Normal, Exponential, Gamma, Beta, Cauchy, Laplace, Log-normal, Logistic and Weibull Distributions – Properties.

Unit III - Truncated Distributions

Binomial, Poisson and Normal Distributions – Properties - Power Series Distributions, Compound Distributions, Logarithmic Distributions – Properties.

P.T.O.

Unit IV - Sampling Distributions

Central and Noncentral t, Chi-square and F Distributions – Properties.

Unit V - Order statistics

Distribution of rth order statistics – Joint distribution of two or more order statistics - Distribution of sample range and median - Quadratic forms: Distribution of quadratic forms - Cochran's theorem - Independence of quadratic forms.

Books for Study and Reference

1. Modern Mathematical Statistics by Dudewicz, EJ and Mishra S N, John Wiley & Sons, New York(1988).
2. Introduction to Mathematical Statistics by Hogg RV, McKean J W and Craig AT, , Seventh Edition, Pearson Education, London(2012).
3. Univariate Discrete Distributions by Johnson N L, Kemp AW and Kotz S, Third Edition, John Wiley and Sons, New York(2005).
4. Continuous Univariate Distributions - Vol - I by Johnson N L, Kotz S and Balakrishnan N, John Wiley and Sons (Asia), Singapore(2004).
5. Continuous Univariate Distributions, Vol - II by Johnson N L, Kotz S and Balakrishnan N, John Wiley and Sons (Asia), Singapore(2014).
6. Introduction to the Theory of Statistics byMood AM, Graybill, FA and Boes DC, Third Edition, McGraw-Hill International Edition(2017).
7. Mathematical Statistics by Mukhopadhyay P, Books and Allied (P) Limited, New Delhi(2002).
8. Introduction to Probability Theory and Mathematical Statisticsby Rohatgi VK, John Wiley & Sons, NY(1976).
9. An Introduction to Probability and Statistics Second Editionby Rohatgi VK and Saleh, A KMd E, John Wiley and Sons, New York(2011).

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DEPARTMENT OF STATISTICS

Class: I M.Sc. (Statistics) **Marks: 75**

Subject: Distribution Theory **Time: 3 hrs**

Subject Code: 19P1SMC3 **Semester: I**

Blue Print

PART – A (Answer all the questions) **(10 X 1 = 10)**

1. One question from Unit – I
2. One question from Unit – I
3. One question from Unit – II
4. One question from Unit – II
5. One question from Unit – III
6. One question from Unit – III
7. One question from Unit – IV
8. One question from Unit – IV
9. One question from Unit – V
10. One question from Unit – V

Part – B (Answer all the questions) (Either or Pattern) **(5 X 7 = 35)**

11. (a) One question from Unit – I

(OR)

(b) One question from Unit – I

12. (a) One question from Unit – II

(OR)

(b) One question from Unit – II

13. (a) One question from Unit – III

(OR)

(b) One question from Unit – III

14. (a) One question from Unit – IV

(OR)

(b) One question from Unit – IV

15. (a) One question from Unit – V

(OR)

(b) One question from Unit – V

Part – C (Answer any THREE questions) **(3 X 10 = 30)**

16. One question from Unit – I
17. One question from Unit – II
18. One question from Unit – III
19. One question from Unit – IV
20. One question from Unit – V

THE MADURA COLLEGE (AUTONOMOUS), MADURAI – 11
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DEPARTMENT OF STATISTICS

MODEL QUESTION PAPER

Class: I M.Sc. (Statistics) **Marks: 75**

Subject: DISTRIBUTION THEORY **Time: 3 hrs**

Subject Code: 19P1SMC3 **Semester: I**

PART –A

Choose the best answer (10 x 1 =10)

1. The Negative Binomial distribution may be regarded as the generalization of _____ distribution.
   a) Poisson b) Binomial c) Geometric d) Normal
2. Let $X_1, X_2 \ldots . X_n$ be independent Poisson random variables with $X_k \sim P(\lambda_k), k = 1,2 \ldots n$ then $S_n = X_1, X_2 \ldots . . X_n$ is a _____ random variable.
   a) $P(\lambda_1, \lambda_2 \ldots \ldots . \lambda_n)$ b) $P(\lambda_1, \lambda_2 \ldots \ldots . \lambda_k)$ c) $P(S_1, S_2 \ldots \ldots . S_n)$ d) $P(S_1, S_2 \ldots \ldots . S_k)$
3. If $X_1, X_2 \ldots . X_n$ are $i.i.d\ N(0,1)$ random variables then $n^{-1}S_n$ is also an _____ random variable.
   a) $N(0,1)$ b) $N(\mu, \sigma^2)$ c) $N(0, \sigma^2)$ d) $N(\mu, \sigma)$
4. Let $X \sim U(0,1)$ then $Y = -2logX$ is _____.
   a) $\chi^2_{(2)}$ b) $U(0,1)$ c) $\chi^2_{(n)}$ d) $\chi_{(n)}$
5. Let $X \sim B(n, p)$ the mean of the binomial distribution truncated at $X = 0$ is _____.
   a) $\frac{np}{1-q}$ b) $\frac{np}{q}$ c) $\frac{np}{1-q^n}$ d) $\frac{np}{q^n}$
6. The moment generating function of power series distribution is _____.
   a) $\frac{f(ze^t)}{f(z)}$ b) $\frac{f(z)}{f(ze^t)}$ c) $f(ze^t)$ d) $f(z^t)$
7. If $X\ and\ Y$ are two independent variable where $X \sim \chi^2_{(r)}$ and $Y \sim \chi^2(1, \lambda)$ then $Z = X + Y$ follows a _____.
   a) $\chi^2(r + 1, \lambda)$ b) $\chi^2(r, \lambda)$ c) $\chi^2(1, \lambda)$ d) $\chi^2(\lambda)$
8. If $F \sim F(m, n)$ then $\frac{1}{F} =$ _____.
   a) $F(m)$ b) $F(n)$ c) $F(mn)$ d) $F(n.m)$

9. The distribution of area under the density function between any two ordered observations is _____of the form of the density function.
   a) Dependent b) independent c) more d) less
10. The cumulative distribution function of the smallest order statistics $X_{(1)}$ is _____-.
   a) $1-[1-F(x)]^n$ b) $[1-F(x)]^n$ c) $1-[1-F(x)]$ d) $1-[1-F(x)]^{n-1}$

PART – B
(Answer all the question) (5x 7=35)

11. a) Define Poisson distribution and hence find its mean and variance.

Or

   b) Let X and Y be independent random variables with PMF $P(\lambda_1)$ and $P(\lambda_2)$ respectively. Then the conditional distribution of X given $X+Y$ is binomial.

12. a) Find the median of the Log normal distribution.

Or

   b) State and prove the additive property of Gamma distribution.

13. a) Find the mean and variance of the binomial distribution truncated at 0.

Or

   b) Derive the mean and variance of truncated Poisson distribution truncated at 0.

14. a) Derive cumulants of non-central chi square distribution.

Or

   b) Derive the probability density function of student t distribution.

15. a) Define order statistics and give and examples of order statistics

Or

   b) Obtain the distribution function of sample range.

PART – C
(Answer any THREE) (3x10=30)

16. What is the MGF of Negative Binomial distribution and hence find its mean and variance.
17. Define Laplace distribution and obtain its median and mean deviation about mean.
18. Obtain the mean and variance of a standard Cauchy distribution truncated at both ends with relevant range of variation as $(-\beta, \beta)$.
19. Derive the pdf of Non –Central F distribution.
20. Obtain the distribution of sample median.

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RE-ACCREDITED (3rd Cycle) WITH "A" GRADE BY NAAC

PROGRAMME: M.Sc., Statistics **COURSE CODE : 19P1SMC4**

COURSE TITLE : Operations Research **QN.NO : 1504**

TIME : 3 Hours **MAX.MARKS :75**

Learning Objectives:

- To understand of the concepts of LPP duality principles and decision making.
- To understanding the concepts in Inventory models.
- To understand Dynamic programming and Non Linear Programming problems.

Learning out comes:

- Develop the knowledge about the dual simplex problems and decision analysis and decision trees and its application.
- Solvesensitive analysis and inventory control with decision making problems.
- Find a solution of project activities using pert and cpm.
- Develop the knowledge about the dynamic problems to shortest route, goal programming and its application.
- Simulate the real life queuing and inventory problems.

Unit I - Linear programming problems (LPP)

Formulation - Graphical and simplex methods of solving LPP - Use of artificial variables - Two-phase method and Big-M method - Degeneracy in LPP - Duality – Interpretation of duality - Dual Simplex Method.

Unit II - Integer programming problem (IPP)

Integer programming problem (IPP) – Pure and mixed IPP - Gomory's constraints and cutting plane algorithm - Mixed IPP – Branch and Bound technique - Dynamic programming problem (DPP) - Principle of optimality – Recursive equation approach - Characteristics of DPP.

Unit III - Inventory control

Inventory control: Analytic structure of Inventory Problems, Concept of economic order quantity - Sensitivity analysis and extensions allowing quantity discounts and shortages - Deterministic and probabilistic inventory models - Models with random demand, and static risk models - Multi-item deterministic inventory problems.

Unit IV - Queueing theory

Queueing systems, queueing models, classification of models - M/M/1, M/M/C and M/C/1 queues and their steady state solutions, Waiting Time Distributions for M/M/1 and M/M/C Models.

Unit V - Sequencing and Scheduling Models

Sequencing problems with 2 machines n jobs and 3 machines n jobs - Network scheduling: Basic components, PERT, CPM, determination of flows and critical path.

Books for Study and Reference

1. Introduction to Operations Researchby Hillier F Sand Leiberman GJ, Fifth Edition, McGraw-Hill, NY(1990).
2. Operations Researchby Kanti Swarup, Gupta, P K and Man Mohan, Sultan Chand & Sons,Nineteenth Edition, New Delhi(2017).
3. Operations Research: An Introduction by Taha, H, Third Edition, McMillan Publishing Co - , Inc - , London(1982).
4. Operations Research: Theory, Methods and Applicationsby Sharma SD, Kedar Nath, Ram Nath and Co, Meerut(2017).
5. Principles of Operations Research with Application toManagerial Decisionsby Wagner H M, Second Edition, Prentice Hall India Learning Private Limited and New Delhi(1980).

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RE-ACCREDITED (3rd Cycle) WITH "A" GRADE BY NAAC

PROGRAMME: M.Sc., Statistics **COURSE CODE : 19P1SME1(A)**

COURSE TITLE : Official statistics **QN.NO : 1505**

TIME : 3 Hours **MAX.MARKS :75**

Learning Objectives:

- To introduce Indian and international statistical systems.
- To understand about the system of collection of agricultural statistics, impact of irrigations.
- To study about present official statistical systems in India, banking and finance.

Learning out comes:

On completion of the course, students should be able to

- Describe basic statistical systems related to population census of India.
- Understand about agricultural statistical system Industrial statistic, Inflation.
- Analyze methods of collection of official statistics, their reliability and limitations, labour and employment.

Unit I

Introduction to Indian and International statistical systems - Role, function and activitiesof Central and State statistical organizations - Organization of large scale sample surveys - Role of National Sample Survey Organization - General and special data dissemination systems.

Unit II

Population growth in developed and developing countries - Evaluation of performance of family welfare programmes - Projections of labour force and manpower - Scope and content of population census of India.

Unit III

System of collection of Agricultural Statistics - Crop forecasting and estimation - Productivity, fragmentation of holdings - Support prices - Buffer stocks - Impact of irrigation projects.

Unit IV

Statistics related to industries - Foreign trade - Balance of payment - Cost of living – Inflation - Educational and other social statistics.

Unit V

Indian official statistics : Present official statistical system in India - Methods of collection of official statistics, their reliability and limitations - Principal publications containing data on the topics such as population, agriculture, industry, trade, prices, labour and employment, transport and communications - Banking and finance - Various official agencies responsible for data collection and their main functions.

Books for Study and Reference

1. Basic Statistics Relating to the Indian Economy - India - Central Statistical Organization(1990).
2. Statistical System in India - India - Central Statistical Organization(1995).
3. Guide to Official StatisticsIndia - Central Statistical Organization(1999).
4. Family Welfare Yearbook - Annual Publication of D/o Family Welfare.
5. Monthly Statistics of Foreign Trade in India, DGCIS, Calcutta and other Govt - Publications.
6. Panse, V - G - (1964) - Estimation of Crop Yields (FAO), Food and Agriculture Organization of the United Nations.
7. Principles and accommodation of National Population Censuses, UNESCO.

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RE-ACCREDITED (3rd Cycle) WITH "A" GRADE BY NAAC

PROGRAMME: M.Sc., Statistics **COURSE CODE : 19P2SMC5**

COURSE TITLE : Sampling Theory **QN.NO : 1507**

TIME : 3 Hours **MAX.MARKS :75**

Learning Objectives:

- To explain necessity of sampling.
- To give an account of the sampling techniques useful in survey methodology in collection and its efficiency.
- To explain different estimators of sampling methods and two stage sampling techniques.

Learning out comes:

- Appreciate the uses of sampling.
- Get an overview of Simple random Sampling, Stratified random sampling and other estimation techniques.
- Know the difference and efficiency of different sampling method.
- Have knowledge about Ratio and Regression estimators.

Unit I - Population and Sample

Population and Sample – Census and sample survey – sampling – sampling unit, sampling frame, sampling distribution, standard error, questionnaire and schedule, sampling design – sampling and non-sampling errors – non-response and its effects – sample surveys – principles of sample survey - principal steps in sample survey - limitations of sampling.

Unit II - Simple Random Sampling (with and without replacement)

Notations and terminology - Estimates of population total, mean and their variances and standard errors – Pooling of estimates - Determination of sample size - Simple random sampling for attributes.

Unit III - Stratified random sampling

Estimates of population total, mean and their variances - Related properties – Allocation of sample sizes – Neyman's proportional and optimum allocations - Comparison of stratified sampling with simple random sampling - Estimation of proportion under stratified random sampling.

Unit IV - Systematic sampling

Estimates of population total, mean, and their variances and standard errors – systematic sampling with linear trend – comparison of systematic sampling with stratified and simple random sampling – circular systematic sampling - Two stage sampling with equal number of second stage units and cluster sampling.

Unit V - Varying Probability Sampling

Probability proportional to size (PPS) sampling (with and without replacement) - Selection procedures – Ordered and unordered estimates – Horwitz – Thompson estimates - Ratio Estimates – Methods of estimation, approximate variance of the Ratio Estimate - Regression Estimators – Difference Estimators, Regression Estimators in Stratified Sampling.

Books for Study and Reference

1. Sampling Techniquesby Cochran,WG, Third Edition, John Wiley & Sons, NY(1977).
2. Sampling Theoryby Des Raj (1978), Tata-McGraw Hill, New DelhiSampling Theory.
3. Applied Statistics by Mukhopadhyay P, Books and Allied (P) Limited, New Delhi(2005).
4. Sampling Theory and Methodsby Murthy M N, Statistical Publishing Society, Calcutta(1967).
5. Theory and Analysis of Sample Survey Designby Singh D and Chowdhary FS, New Age International Private Ltd - , New Delhi(2018).
6. Sampling Theory of Surveys with Applicationsby Sukhatme PV and Sukhatme BV , Asia Publishing House, New Delhi(1970).

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RE-ACCREDITED (3rd Cycle) WITH "A" GRADE BY NAAC

PROGRAMME: M.Sc., Statistics **COURSE CODE : 19P2SMC6**

COURSE TITLE : Statistical Estimation Theory **QN.NO : 1508**

TIME : 3 Hours **MAX.MARKS :75**

Learning Objectives:

- To introduce concepts and terminologies in estimation theory.
- To acquire knowledge in methods of estimation with its properties.
- To understand the complete family of distribution.
- To know about the Estimation and its methods.
- To apply in the real life situations.

Learning out comes:

- Have the knowledge about the estimators and its properties.
- Understand the theorems and its applications.
- Able to estimate the parameters based on methods of estimation.
- Apply the interval estimation and Bayesian estimation in real life problems.

Unit I - Introduction

Estimation - Point estimator – Choice of estimator – Amount of concentration - Mean squared error and variance - Sufficiency – Factorization Theorem – Minimal sufficiency, likelihood equivalence – Completeness.

Unit II - Unbiased estimator

Unbiased estimator – Estimable function – Rao-Blackwell's theorem - uniformly minimum variance unbiased estimator – Lehmann-Scheffe's theorem - Fisher's information measure Cramer-Rao inequality, Bhattacharya inequality, Chapman-Robbins inequality.

Unit III - Methods of point estimation

Methods of point estimation - Maximum likelihood method (asymptotic properties of ML estimators are not included), method of moments, method of minimum chi-square and modified minimum chi-square.

Unit IV - Consistency and CAN estimators

Consistency and CAN estimators - Asymptotic properties of maximum likelihood estimators - Example of consistent but not asymptotic normal estimators from Pitman family - Fisher's lower bound for asymptotic variance - Asymptotic relative efficiency - Method of least squares.

Unit V - Interval estimation

Confidence level and confidence coefficient - Duality between acceptance region of a test and a confidence interval - Pivotal quantity method - Shortest length confidence intervals - Construction of confidence intervals for population proportion (small and large samples) and between two population proportions (large samples) - Confidence intervals for mean, variance of a normal population, difference between mean and ratio of two normal populations.

P.T.O.

Books for Study and Reference

1. Modern Mathematical Statistics by Dudewicz E J and Mishra S N, John Wiley & Sons, NY(1988).
2. An Outline of Statistical Theory-Vol - IIby Goon A M, Gupta MK and Dasgupta B, World Press, Calcutta(1989).
3. A First Course on Parametric Inferenceby Kale B K, Narosa Publishing House, New Delhi(1999).
4. Introduction to the Theory of Statistics by Mood AM, Graybill FA and Boes, DC , Third Edition, McGraw-Hill International Edition(2017).
5. Statistical Inferenceby Rajagopalan Mand Dhanavanthan P, PHI Learning Pvt - Ltd -, New Delhi(2012).
6. Introduction to Probability Theory and Mathematical Statistics by Rohatgi V K, John Wiley & Sons, NY(1976).
7. An Introduction to Probability and Statisticsby Rohatgi VK and Saleh A K Md E, Second Edition, John Wiley and Sons, New York(2011).

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RE-ACCREDITED (3rd Cycle) WITH "A" GRADE BY NAAC

PROGRAMME: M.Sc., Statistics **COURSE CODE : 19P2SMC7**

COURSE TITLE : Demography **QN.NO : 1509**

TIME : 3 Hours **MAX.MARKS :75**

Learning Objectives:

- To achieve knowledge about the size, composition, organization and distribution of the population .
- To undertake demographic analysis for the measurement of fertility, mortality, migration and population change under different models.
- To estimate birth and death process using stochastic process.
- To impart the knowledge about life table and derive its function.
- Know the types of migration and apply methods of estimating net migration.

Learning out comes:

- Identify different source of data for measuring mortality andMorbidity.
- Explain some of the problems relating to the completeness and Quality of data.
- Obtain fertility measures and models under different conditions, also identify causes of fertility changes and its implications.
- Project the population growth and have knowledge in migrationApply the concepts of stochastic processes to real life situations On Birth and Death process.

Unit I - Population Theories

Coverage and content errors in demographic data, use of balancing equations and Chandrasekharan - Deming formula to check completeness of registration data - Adjustment of age data, use of Myer and UN indices, Population composition, dependency ratio.

Unit II - Measurements of Mortality

Introduction and sources of collecting data on vital statistics, errors in census and registration data - Measurement of population, rate and ratio of vital events - Measurements of Mortality: Crude Death Rate (CDR), Specific Death Rate (SDR), Infant Mortality, Rate (IMR) and Standardized Death Rates.

Unit III - Life (Mortality) Tables

Stationary and Stable population, Central Mortality Rates and Force of Mortality - Life (Mortality) Tables: Assumption, description, construction of Life Tables and Uses of Life Tables.

Unit IV - Measurements of Fertility

Crude Birth Rate (CBR), General Fertility Rate (GFR), Specific Fertility Rate (SFR) and Total Fertility Rate (TFR) - Measurement of Population Growth: Crude rates of natural increase, Pearl's Vital Index, Gross Reproduction Rate (GRR) and Net Reproduction Rate (NRR).

P.T.O.

Unit V- Special Distribution of Population

Special Distribution of Population – Basic concepts – Measurements and Models of Migrations - Components of Population Growth and Change – Methods of Projection – Logistic Equation – Component Method of Projection.

Books for Study and Reference

1. Techniques of Population Analysisby Barclay G W, John Wiley and Sons, New York(1958).
2. Principles of Demographyby Bogue D J, Wiley, New York(1969).
3. Applied General Statisticsby Croxton F E, Cowden D J and Klein S, Third Edition, Prentice Hall of India Pvt - Ltd(1973).
4. Fundamentals of Statistics, Vol - IIby Goon A M, Gupta MK and Dasgupta B, Ninth Edition, World Press, India(2008).
5. Applied Mathematical Demographyby Keyfitz NandCaswell H, Springer - Verlag, New York(2005).
6. An Introduction to the Study of Populationby Mishra B D, South Asian Publishers Pvt - Ltd, New Delhi(1980).
7. Applied Statisticsby Mukhopadhyay P, Second Edition, Books and Allied (P) Ltd - , India(2011).
8. Fundamentals of Applied Statisticsby Gupta SC and Kapoor VK, Sultan Chand & Sons Pvt–Ltd., New Delhi(2017).

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RE-ACCREDITED (3rd Cycle) WITH "A" GRADE BY NAAC

PROGRAMME: M.Sc., Statistics **COURSE CODE : 19P2SMC8**

COURSE TITLE : Programming in C **QN.NO : 1510**

TIME : 3 Hours **MAX.MARKS :75**

Learning Objectives:

- To enrich the students to have a good foundation and practical knowledge on programming in C.

Learning out comes:

On satisfying the requirement of the is course, students will have the knowledge and skills to

- Write a C program for simple applications of real life using structures and files.
- Implement programs with pointer arrays.
- Design an algorithmic solution for a given problem.

Unit I - Overview of C

Introduction - Importance of C – Basic structure of C programs – Programming style – Executing a C program - Constants, Variables, Data types: Character set - C tokens – Keywords and identifiers – Constants – Variables – Data types – Declaration of variables – Assigning values to variables – Defining symbolic constants.

Unit II - Operators and expressions

Arithmetic operators - Relational and logical operators – Assignment operators – Increment and decrement operators – Conditional operators – Bitwise operators - C expressions – Evaluation of expressions - Hierarchy of operators precedence and order of evaluation – Type conversion in expressions - Managing input and output operators: Reading and writing character – Formatted input and output.

Unit III - Decision making and branching

Simple IF statement – IF ELSE statement – Nesting of IF ELSE statement – ELSE IF ladder – SWITCH statement - ?: operator – GOTO statement - Decision making and looping: WHILE statement – Do statement – FOR statement – Jumps in loop.

Unit IV - Arrays

One-dimentional, two-dimensional and multidimensional arrays - Handling of strings: Declaring and initializing string variables - Reading and writing strings – Arithmetic operations on characters – Comparisons of two strings – String handling functions - User defined functions: Need for user defined functions – Form of C functions – Return values and their types – Calling a function – Category of functions – Nesting of functions – Recursion – Functions with arrays - Scope and life time of variables in functions.

Unit V - Structures

Structures - Array of structures – Structure and functions – Unions - Pointers – Pointer expressions – Pointers and arrays – Pointers and strings – Pointers and functions – Pointers and structures – File management in C: Definitions – Input and output operations on files – Error handling during I/O operations – Random access to files – Command line arguments.

P.T.O.

Books for Study and Reference

1. Programming in ANSI Cby Balagurusamy E, Fourth Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi(2007).
2. Theory and Problems of Programming with Cby Gottfried B S, Schaum's Outline Series, McGraw - Hill Publishing Company, New York(1997).
3. C - The complete Reference by Schildt H, Fourth Edition, McGraw – Hill Education, New York(2017).
4. Let Us C, Kanetkar Y P, Twelveth Edition, BPB Publications(2017).
5. The C Programming Language by Kernighan BW and Ritchie D M, Second Edition, Prentice Hall(1998).

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RE-ACCREDITED (3rd Cycle) WITH "A" GRADE BY NAAC

PROGRAMME: M.Sc., Statistics **COURSE CODE : 19P2SME2(B)**

COURSE TITLE : Actuarial Statistics **QN.NO : 1514**

TIME : 3 Hours **MAX.MARKS :75**

Learning Objectives:

- To understand the concept of Measures of Mortality.
- To study about the concepts of Management, social security scheme.

Learning out comes:

- Apply the concept of present value and future value in real life problems.
- To understand Insurance and utility theory joint life status, survival status and control risk.

Unit I - Measures of Mortality

Life tables and its relation with survival function – Life table function at non integer age (fractional ages) – Analytical laws of mortality - Gompertz and Makeham's laws of mortality – Select, ultimate and aggregate mortality tables.

Unit II - Abridged life tables

Abridged life tables – construction of abridged life tables – methods by Read and Merrell, Greville's, Kings and JIA method - Insurance and Utility Theory.

Unit III - Annuities

Pure endowments - Annuities – Accumulations – Assurances - Varying annuities and assurances - Continuous annuities - Family income benefits - Models for individual claims and their sums – Multiple life function – Joint life status and last survival status.

Unit IV - Policy Values

Nature of reserve - Prospective and retrospective reserves - Fractional premiums and fractional durations - Modified reserves – Continuous reserves - Surrender values and paid up policies - Industrial assurance - Children's deferred assurances.

Unit V - Contingent Functions

Contingent probabilities - Contingent assurances - Reversionary annuities – Multiple decrement table - Forces of decrement - Construction of multiple decrement tables - Pension Funds: Capital sums on retirement and death - Widow's pensions – Sickness benefits - Benefits dependent on marriage.

Books for Study and Reference

1. Techniques of Population Analysis by Barcley GW, Wiley, New York(1970).
2. Financial and Actuarial Statistics: An Introduction by Borowiak DS and Shapiro AF, CRC Press, London(2013).
3. Compound Interest and Annuities-certain by Donald, DWA, For The Institute of Actuaries and the Faculty of Actuaries at the University Press(1970).
4. Life Contingenciesby Spurgeon ET,Cambridge University Press, Cambridge(2011).
5. Life and other contingenciesby Hooker PF, Longley L H, Cook, Cambridge(1957).
6. Life Contingenciesby Alistair N, Heinemann Professional Publishing, Portsmouth(1977).
7. Introductory Statistics with Applications in General Insurance by Hossack IB, Pollard J H and Zehnwirth, B, Cambridge University Press, Cambridge(1999).

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PROGRAMME: M.Sc., Statistics **COURSE CODE : 19P3SMC9**

COURSE TITLE : Testing Statistical Hypotheses **QN.NO : 1515**

TIME : 3 Hours **MAX.MARKS :75**

Learning Objectives:

- To describe real life examples to explain the motivation behind hypothesis testing.
- To be able to construct the appropriate null and alternative hypothesis
- To identify the steps in the structure of hypothesis testing.
- To Understand problem of statistical inference, problem of testing of hypothesis

Learning Outcomes:

On completion of the course, students should be able to

- Construct Most Powerful test using NP Lemma and understand situation when UMP test exists
- Construct Uniformly Most Powerful test in one parameter exponential family
- Explain Likelihood ratio test for categorical data.
- Construct SPRT in case of Binomial, Poisson, Normal Distribution
- Application ofone sample non-parametric test and two parametric non –parametric test.
- Understand Sequential testing. Sequential probability ratio test.

Unit-I

Randomized and non-randomized tests.Neyman – Pearson fundamental lemma, Most Powerful test, Uniformly most powerful test, Uniformly most powerful test - monotone likelihood ratio

Unit-II

Generalization of fundamental lemma.-UMP Unbiased tests for one-parameter exponential family - Uniformly most powerful similar tests. UMP Unbiased tests for multi-parameter exponential family - Locally most powerful tests.

Unit-III

Likelihood Ratio tests -Asymptotic distribution of the likelihood ratio tests. - likelihood ratio tests for categorical data –Test Consistency- Invariant tests – maximal invariants - uniformly most powerful invariant tests

Unit-IV

Empirical distribution function - Kernel and symmetric kernel.U statistic and its properties.One sample non-parametric tests – Kolmogorov–Smirnov test, The Sign test, Wilcoxon's Signed Rank test, Test for randomness. Two-sample non-parametric tests-

Wald-Wolfowitz runs test, Mann-Whitney U test, Kolmogorov-Smirnov test, Median test. K-sample non-parametric tests – Kruskal-Wallis Test and Friedman's test

Unit-V

Sequential test –Sequential Probability Ratio Test (SPRT).OC and ASN functions of SPRT and their derivation. Optimum properties of SPRT.

Book for study

1. Rajagopalan, M. and Dhanavanthan, P. (2012).Statistical Inference.PHI Learning Pvt. Ltd., New Delhi.

Books for Reference

1. Srivastava, M. K. and Srivastava,N. (2009) Statistical Inference: Testing of Hypotheses, PHI Learning, New Delhi.
2. Lehmann E.L. and Casella, G.(1998) Testing statistical hypotheses,2/e, Springer , New York.
3. Rao, C.R. (1998) Linear Statistical Inference and its applications, Wiley Eastern, New Delhi.
4. Casella, G. and Berger, R.L. (2002).Statistical Inference (Second Edition). Thompson Learning, New York. (Reprint, 2007).
5. Conover, W. J. (1999). Practical Nonparametric Statistics (Third Edition). John Wiley & Sons, New York. (Reprint, 2007).
6. Gibbons, J. D., and Chakraborti, S. (2010). Nonparametric Statistical Inference (Fifth Edition).Taylor & Francis, New York.
7. Kale, B. K. (2005).A First Course in Parametric Inference (Second Edition).Narosa Publishing House, New Delhi. (Reprint, 2007).
8. Rohatgi, V.K. and Saleh, A.K.MD.E. (2011) An Introduction to Probability and Statistics, 2/e,Wiley, New York.
9. Goon, A.M., Gupta, M. K., and Dasgupta, B. (1989).An Outline of Statistical Theory, Vol. II, World Press, Kolkata.

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RE-ACCREDITED (3rd Cycle) WITH "A" GRADE BY NAAC

PROGRAMME: M.Sc., Statistics **COURSE CODE : 19P3SMC10**

COURSE TITLE : Multivariate Statistical Analysis **QN.NO : 1516**

TIME : 3 Hours **MAX.MARKS :75**

Learning Objectives:

- To focuses on the standard methods of multivariate statistical analysis. Many essential data analysis techniques, such as principal component analysis and discriminant analysis.
- To equip students with the necessary skills for being data analysts.

Learning Outcomes:

On completion of the course, students should be able to

- Describe the nature and the properties of Multivariate Normal Distribution.
- Account for important theorems and concept in Multivariate Analysis
- Formulate and solve inference problems that use one or a combination of the following multivariate statistical procedures: correlation and partial correlation.
- Compute the maximum likelihood estimates of the principal components and canonical correlation analysis.

Unit-I

The Multivariate Normal Distributions – The Distributions of linear combinations of normally – distributed variates, independence of variates, marginal distributions – conditional distributions and multiple correlation coefficient – the characteristic function: moments –estimation of the mean vector and the covariance matrix: Introduction - The maximum likelihood estimators of the mean vector and the covariance matrix.

Unit-II

The distributions and uses of sample correlation coefficients : Introduction –Correlation coefficient of a bivariate sample – partial correlation coefficients, conditional distributing – The generalized T^2-statistic

Unit-III:

Classification of observations: The problem of classification – standards of good classification – procedures of classification into one of two populations with known probability distributions – classification into one of two known multivariate normal populations– classifications into one of two multivariate normal distributions when the parameters are estimated – probabilities of misclassification – classification into one of several multivariate normal populations – an example of classification into one of several multivariate normal populations – classification into one two known multivariate covariance matrices.

Unit-IV:
The distribution of the sample covariance matrix and the sample generalized variance: Introduction – The wishart distributions – some properties of the Wishart Distributions –Co-Charan's Theorem – The generalized variance – distributions of the set of correlation coefficients when the population covariance matrix is diagonal the inverted Wishart distribution and Bayes Estimation of the covariance matrix – improved estimation of the covariance matrix – elliptically contoured distributions.

Unit-V:
Principal components: Introduction – definition of principal component in the population– maximum likelihood estimators of the principal components and their variance – computation of the maximum likelihood estimates of the principal components canonical Correlation and correlation and variates in the population – estimation of canonical correlations and variates of statistical inference

Book for Study

1. T.W. Anderson, In Introduction to Multivariate Statistical Analysis, Wile Eastern Ltd, (2003)

Books for Reference

1. Morrison, D.F. Multivariate Statistical Methods (Fourth Edition). Duxbury Press, New York.(2004)
2. Johnson, R.A. and D.W. Wichern. Applied Multivariate Statistical Analysis (Sixth Edition), Pearson New International Edition. .(2013)
3. Kendall, M.G., Stuart, A. and Ord, K.J. The Advanced Theory of Statistics. (Fourth Edition), Vol. 2, Charles Griffin company Ltd.(1973).
4. Kotz, S., Balakrishnan, N. and Johnson, N.L, Continuous Multivariate Distribution Models and Applications (Second Edition). Volume 1, Wiley - Inter science, New York.(2000).
5. Mardia, K.V., Kent, J. T and Bibby, J. M. Multivariate Analysis. Academic Press, New York(1979).
6. Rao, C.R. Linear Statistical Inference and its Applications (Second Edition), Wiley-Inter Science, New York.(2001)

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PROGRAMME: M.Sc., Statistics **COURSE CODE : 19P3SMC11**

COURSE TITLE : Statistical Quality Control and Reliability **QN.NO : 1517**

TIME : 3 Hours **MAX.MARKS :75**

Learning Objectives:

- To Understand the performance advantage of CUSUM and EWMA control charts relative Shewhart control charts
- Know how to design single-sampling, double-sampling, and sequential-sampling plans for attributes

Learning Outcomes:

On completion of the course, students should be able to

- Design various types of control charts such as CUSUM , EWMA and Moving average
- Draw a single, double and multiple sampling with specified OC Curve/
- Derive the OC curve and the parameters of the plan
- Explain the concept of three level continuous sampling plan.
- Explain concepts of reliability and maintainability

Unit-I

Modified control limits – the use of control limits for moving average – difference control charts – Mid range and Median charts - design of cumulative charts and V-mask. The Exponentially Weighted Moving Average Control Chart - The Exponentially Weighted Moving average Control Chart for Monitoring the Process Mean - Design of an EWMA Control Chart - Robustness of the EWMA toNon-normality -Moving-average control chart

Unit-II

Acceptance sampling - Advantages and Disadvantages of Sampling - Types of Sampling Plans - lot formation – sampling inspection by attributes – single sampling plans for attributes – OC function – Designing a Single-Sampling Plan with a Specified OC Curve - rectifying inspection - Double and multiple sampling plans – OC, ASN, ATI and AOQ functions – the Dodge – Roming sampling plans - AOQL, LTPD

Unit-III

Acceptance sampling by variables –concept, advantage and limitations – the Shanin lot method - known and unknown sigma variables sampling plan - merits and demerits of variables sampling plan - derivation of OC curve and the parameters of the plan.

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Unit-IV

Continuous sampling plans by attributes - CSP-1 and its modifications - concept of AOQL in CSPs - Multi-level continuous sampling plans - Operation of multi-level CSP of

Lieberman and Solomon - Wald-Wolfowitz continuous sampling plans - Sequential Sampling Plans by attributes - OC and ASN functions.

Unit-V

Reliability – Definition – basic elements of reliability – bath tub curve – achievement of reliability – designing for reliability – measuring of reliability –cost of reliability – maintenance and reliability – mean time between failures (MTBF) – Mean time repair (MTTR) – Failure mode, effect and critically analysis (FMECA) – Total productive maintenance (TPM) – Hazard analysis – failure rate and hazard function – constant hazard model – linear hazard model –MTTF – system and component –parallel system-reliability of switches.

Books of Study

1. Mahajan, M, Statistical Quality Control,3/e, Dhanpat Rai and Co., Delhi. (2002)
2. Montgomery, D.C. Introduction to Statistical Quality Control,6/e, Wiley India, New Delhi.(2009)

Books for Reference:

1. Bowker, A.H. and Lieberman, G.J. Engineering Statistics,2/e, Prentice Hall, New Delhi(1982).
2. Grant, E.L. and Leavenworth, R.S. Statistical Quality Control,7/e, Tata McGraw Hill, New Delhi(2000).
3. Juran, J.M. and De Feo, J.A. Juran's Quality control Handbook – The Complete Guide to Performance Excellence,6/e, Tata McGraw-Hill, New Delhi (2010).
4. Schilling, E. G. and Nuebauer, D.V. Acceptance Sampling in Quality Control, 6/e, CRC Press, New York (2009).
5. Wetherill, G.B, Sampling Inspection and Quality Control, 2/e, Chapman and Hall, London. . (1977)
6. Lawless, J.F, Statistical models and methods of Lifetime Data, Wiley, New York. .(1972)
7. John T. Burr, Elementary Statistical Quality Control (Second Edition), Marcel Dekker New York, (2004).
8. Duncan, A.J. Quality Control and Industrial Statistics, Irwin - Illinois. (2006)

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RE-ACCREDITED (3rd Cycle) WITH "A" GRADE BY NAAC

PROGRAMME: M.Sc., Statistics **COURSE CODE : 19P3SMC12**

COURSE TITLE : Programming in R **QN.NO : 1518**

TIME : 3 Hours **MAX.MARKS :75**

Learning Objectives

- To enrich the students to have a good foundation and practical knowledge on programming in R
- To know how to compute basic statistics and statistical models through R.

Learning Outcomes

On completion of the course, students should be able to

- Understand the concept of R programming and apply it in simple tasks.
- Create R programs for statistical analysis.
- Perform and interpret the statistical data using a computer package;

Unit-I

Data types in *r* numeric/character/logical; real/integer/complex strings and the paste command matrices, data frames, lists, setwd, read, table, read, csv, write. matrix, write. csv, creation of new variables, categorization, cut, factor; round, apply, creation of patterned variables - saving output to a file; source; print -saving workspace / history.

Unit-II

Graphics in *r* - the plot command, histogram, bar plot, box plot - points, lines, segments, rows, paste - inserting mathematical symbols in a plot, pie diagram, customization of plot-setting graphical parameters - text and mtext, the pairs command, colours and palettes, saving to a file ; graphical parameters such asmar/ mai/ mfrow, xlab/ ylab/ las/ xaxp / yaxp/ xlim/ ylim/ cex/ axis/ tck/ srt, main/ title/ legend/ locator, identify.

Unit-III

Basic statistics - *r* help-command help, help.search(), *r*mailing list - contributed documentation on cran - one and two sample *t* tests, Bartlett's test for variance, *f* - test for equality of variances, multi sample means, non-parametric tests, chi- squared tests - randomness, homogeneity, independence, exact tests and confidence intervals, checking the assumptions, distribution fitting.

Unit-IV

Vector matrix operations - matrix operations - addition, subtraction, multiplication, linear equations and eigenvalues, matrix decomposition - lu, qr and svd and inverse, the linear model and qr decomposition, determinant, finding rank.

Unit-V

Linear models - models, the summary function, goodness of fit measures, predicted values and residuals; residual plots, the ANOVA table, creating factors - *r* functions - random number generation and simulations - *r* libraries.

Books for Study and Reference

1. Purohit, S. G., Gore, S. D., and Deshmukh, S. R. Statistics Using R, Narosa Publishing House, New Delhi. (2009).
2. Quick, J. M. Statistical Analysis with R, Packt Publishing Ltd., UK(2010).
3. Everitt, B. S., and Hothorn, T. A, Handbook of Statistical Analyses Using R, Second Edition, Chapman and Hall, CRC Press.. (2010)

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RE-ACCREDITED (3rd Cycle) WITH "A" GRADE BY NAAC

PROGRAMME: M.Sc., Statistics **COURSE CODE : 19P3SME3(A)**
(2019)

COURSE TITLE : Econometrics **QN.NO : 1520**

TIME : 3 Hours **MAX.MARKS :75**

Learning Objectives:

- To forecast business cycles in the capitalist economy
- To study the effect of certain economic decision
- To give empirical context to a prior reasoning in economics

Learning Objectives:

On completion of the course, students should be able to

- Explain the concept of econometrics
- Explain the nature and the results of heteroscedasticity.

Unit-I

Meaning, scope and limitation of Econometrics –The theory of demand and supply - the law of demand - demand function – properties of demand function – Elasticity of demand - Price, Cross and income elasticity of demand – Mathematical relationship between elasticities - Supply function and elasticity of supply – The theory of consumer behavior.

Unit-II

Generalized least squares model: Introduction - estimation – implication of GLS - Single equation problems - Heteroscedasticity - Multi collinearity - Proxy variables in regression – Dummy variables in regression.

Unit-III

Autoregressive models – Lag Models – Adjustment lag models – Expectational lag models – Combination of adjustment and Expectational lag models – Bias of lag models – Distributed lag model - Autocorrelation: consequences of simple least squares in the presence of auto-correlation – The Durbin - Watson of statistic.

Unit-IV

Identification and Simultaneous equations problems –Bias in Simultaneous equations models - Indirect least square - Identification –Exact identification – Over identification - Rank and order conditions of identifiability –Methods of estimation- method, two-stage least squares method of estimation and Estimation of Limited Information Maximum Likelihood (LIML).

Unit-V

Simultaneous equations system - Simple least square method (SLS) – Indirect least square (ILS) - Least variance rate (LVR) method - Full Information Maximum Likelihood (FIML).

Book for Study

1. Agarwal H.S, Introduction to Econometrics, Lakshmi Narain Agarwal Educational Publishers, Agra (1976).

Books for Reference

1. Castle, J. and Shephard, N. The Methodology and Practice of Econometrics. Oxford University Press, London (2009).
2. Goldberger, A.S. Econometrics theory, Wiley, New York (1964).
3. Kelejion, H. H. and Oates, W. E Introduction to Econometrics, Principles and Applications. Harper and Row, New York. (1988).
4. Maddala, G.S. and Kajal Lagari. Introduction to Econometrics, Wiley, New York (2009).
5. Madnani, G.M.K. Introduction to Econometrics: Principles and Applications. Oxford and IBH, New Delhi (2008).
6. Wooldridge, J Introduction Econometrics: A Modern Approach. Cengage Learning, New Delhi. (2012).
7. Gujarati, D. N., Dawn C Porter and Sangeetha Kunasekar, Basic Econometrics, Fifth Edition, McGraw Hill Publisher, New York(2016).
8. Johnston, J., and J. Di Nardo. Econometric Methods, McGraw-Hill,.(1997).
9. Khotsoyiannis, A.. Theory of Econometrics. Second Edition, Macmillan(1977)

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RE-ACCREDITED (3rd Cycle) WITH "A" GRADE BY NAAC

PROGRAMME: PG NME - Statistics **COURSE CODE : 19P3SNM 1**

QN.NO : 1522

COURSE TITLE : Elements of Operations Research

TIME : 3 Hours **MAX.MARKS :75**

Learning Objectives

- To understand the concepts of linear programming problem
- To understanding the concepts of Transportation and Assignment problems

Learning Outcomes

On completion of the course, students should be able to

- Explain and solve Linear programming problem using simplex method and Big M-Method
- Solve transportation problems to obtain optimum solution.
- Solve assignment problems to obtain optimum solution.
- Understand the concept of sequential problems with 2 and 3 machines n jobs

Unit-I

Formulation - Graphical and simplex methods of solving LPP - Use of artificial variables - Two-phase method and Big-M method.

Unit-II

Transportation problem: Transportation problem formulation- North-West Corner, Least cost, Vogel's Approximation method – UV-method.

Unit-III

Assignment problem - Hungarian Method - Travelling Salesman Problem.

Unit-IV

Network analysis by CPM/PERT: Basic Concept – Constraints in Network – Construction of the Network – Time calculations – Concept of slack and float in Network Analysis – Network crashing

Unit-V

Sequencing problems with 2 machines n jobs and 3 machines n jobs

Books for Study

1. Operations Research by Kanti Swarup, Gupta, P K and Man Mohan, Sultan Chand & Sons, Nineteenth Edition, New Delhi (2017).
2. Operations Research: An Introduction by Taha, H, Third Edition, McMillan Publishing Co - , Inc - , London (1982).

P.T.O.

Books and Reference

1. Introduction to Operations Research by Hillier F S and Leiberman GJ, Fifth Edition, McGraw-Hill, NY (1990).
2. Operations Research: Theory, Methods and Applications by Sharma SD, Kedar Nath, Ram Nath and Co, Meerut (2017).
3. Principles of Operations Research with Application to Managerial Decisions by Wagner H M, Second Edition, Prentice Hall India Learning Private Limited and New Delhi(1980).

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RE-ACCREDITED (3rd Cycle) WITH "A" GRADE BY NAAC

PROGRAMME: M.Sc., Statistics **COURSE CODE : 19P4SMC13**

COURSE TITLE : Linear Models and Design of Experiments **QN.NO : 1523**

TIME : 3 Hours **MAX.MARKS :75**

Learning Objectives:

- To get the knowledge on linear models.
- To understand the concept of higher level design of experiments models and describe it purpose, important and benefits.

Learning Outcomes:

On completion of the course, students should be able to

- Defines the terms associated with Design of Experiments and explain how to construct the models.
- Show how to calculate the main and interaction effect and interpret these models.

Unit-I

Linear models - Classification - Linear Estimators - Least square estimates - BLUE - Gauss-Markov theorem - Test of linear hypothesis.

Unit-II

Confounding in factorial experiments - Total and partial confounding in 2kand 3k factorial designs – Confounding 2k factorial designs in 2p blocks – Single replicate of 2k design – n x p factorial design.

Unit-III

Two-level fractional factorial designs - one-half and one-quarter fraction of 2k Design - Resolution III, IV and V designs.

Unit-IV

Incomplete block designs - Definitions and analysis of balanced incomplete block designs - partially balanced incomplete block designs with 2 associate classes - Lattice designs.

Unit-V

Split-plot, Split-split plot, Strip-plot and Strip-split-plot Designs, Youden square design.

Books for Study

1. Montgomery, D. C, Design and Analysis of Experiments, 8th edition, John Wiley and Sons Inc. New York. (2013)
2. Das, M.N and Giri, N.C, Design and Analysis of Experiments, Wiley Eastern, New Delhi. C (1979)
3. Searle, Linear Models, John Wiley and Sons, New York (1971).

Books for Reference

1. Mann, H. B, Analysis and Design of Experiments, Dover Publications, U.S.A (1949).
2. Federer, W. T, Experimental Designs – Theory and Applications, McMillan Co. New York (1963).
3. Kempthorne, O, Design and Analysis of Experiments, Wiley Eastern (1965).
4. Rao, C. R, Linear Statistical Inference and its Applications, 2nd edition, Wiley Eastern Ltd.(1973)
5. Johnston, J ,Econometric Methods, 3 rd edition, McGraw Hill Pub.(1984)

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RE-ACCREDITED (3rd Cycle) WITH "A" GRADE BY NAAC

PROGRAMME: M.Sc., Statistics **COURSE CODE : 19P4SMC14**

COURSE TITLE : Stochastic Processes **QN.NO : 1524**

TIME : 3 Hours **MAX.MARKS :75**

Learning Objectives:

- To gain the knowledge in the field of uncertainty time factor.

Learning Outcomes:

On completion of the course, students should be able to

- Understand the theoretical concept of stochastic nature problems.
- Solve the problems related to the stochastic phenomena.

Unit-I

Notion of Stochastic Processes - Different types of Stochastic Processes - Markov Chains - Classifications of states-Limit theorems - Stationary distribution - Types of random walks.

Unit-II

Definition and transition function - Differentiability of transition function - Kolmogorov differential difference equation - infinitesimal generators - Birth and death process - Yule Process.

Unit-III

Renewal equation - stopping time - Wald's equation-Renewal theorems - Central limit theorem for renewal theory.

Unit-III

Definition-Properties of generating functions - Probability of extinction - Distribution of total number of progeny – Continuous parameter branching process.

Unit-V

Diffusion Process - Kolmogorov backward and forward diffusion equations - Wiener Process.

Book for Study

1. Basu, A. K, Introduction to Stochastic Process, Narosa Publishing House, New Delhi.(2001)

Books for Reference

1. Bhatt, U. N, Elements of Applied Stochastic Processes, John Wiley, New York (1984).
2. Karlin, S and Taylor, H. M, A First Course in Stochastic Processes, Academic Press, New York (1975).
3. Medhi. J, Stochastic Processes, 2nd Edition, Reprint 2008, New age international Publisher (2008).
4. Papoulis, A Probability random variable and stochastic processes Tata McGraw – Hill (1991)
5. Ross, S. M, Stochastic Processes, , 2nd edition , John Wiley and Sons, New York (2006).
6. Srinivasan, S. Kand Mehata, K.M, Stochastic processes, 2nd Edition, Tata McGraw – Hill (1978).

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RE-ACCREDITED (3rd Cycle) WITH "A" GRADE BY NAAC

PROGRAMME: M.Sc., Statistics **COURSE CODE : 19P4SMC15**

COURSE TITLE : Programming in Python **QN.NO : 1525**

TIME : 3 Hours **MAX.MARKS :75**

Learning Objectives:

- To acquire knowledge in core python.
- To know how to compute basic statistics and statistical models through python packages.

Learning Outcomes:

On completion of the course, students should be able to

- Understand the concept of python programming and apply it in simple tasks.
- Create own python programs for statistical analysis.

Unit-I

Introduction to Python – Features of Python **–** Installing Python for windows – Installing packages – Writing and executing a Python Program – Getting help in Python. Data types in Python – Comments – Build-in data type – Bool data type – Sequences in Python – Sets – Literals – Determining the data type of variables – User-defined data type – Constants, Identifier and Reserved words – Name conversions in Python.

Unit-II

Operators in Python – Mathematical functions – Input and output statements – Control Statements – if, if…else and if…elif…else statements – Loops – While – for – infinite – nested. Else Suite – Break – Continue – Pass – Assert – return statements.

Unit-III

Array - Creating an array – Importing the array module – Indexing and slicing on array - Processing the array – Types of Array – Working with arrays using numpy – Creating arrays – Mathematical operations on array – Comparing, Aliasing, viewing and copying array – Dimension – Attributes of array – Multidimensional array.

Unit-IV

String and characters - Functions – Defining, calling function - Returning results – Arguments – Recursive function – Creating own models – lists - Special features of Lists – Tuples – Creating - Assessing basic operations and function to process Tuples – Operations on Tuples – Dictionaries.

Unit-V

Files in Python – Files types – Opening and closing files. Importing packages – importing data from text and excel files – Creating plots – Histogram – Scatter plot - bar and pie – Statistical analysis – Descriptive: mean – median – mode – variance and standard deviation – Inferential: t test – ANOVA – correlation and regression (only python codes).

Books for Study

1. NageswaraRao, R, Core Python Programming, 2nd edition, Dreamtech Press, New Delhi (2018).
2. Haslwanter, T, An Introduction to Statistics with Python with Application in the Life Sciences, Springer, Switzerland (2016).

Books for References

1. Wesley J. Chun, Core Python programming, 2/e, Pearson education (2010).
2. Mark Lutz, Programming Python, 4/e, O'Reilly Media (2010).
3. Mark Summerfield, Programming in Python 3, Pearson Education (2009).

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THE MADURA COLLEGE (Autonomous), MADURAI – 625 011

(AFFILIATED TO MADURAI KAMARAJ UNIVERSITY)

RE-ACCREDITED (3rd Cycle) WITH "A" GRADE BY NAAC

PROGRAMME: M.Sc., Statistics **COURSE CODE : 19P4SME4(A)**

COURSE TITLE : Applied Regression Analysis **QN.NO : 1528**

TIME : 3 Hours **MAX.MARKS :75**

Learning Objectives

- To obtain a good foundation in using regression-based Statistical models to analysis the real data.

Learning Outcomes

On completion of the course, students should be able to

- Develop the deeper understanding of the linear and logistic regression model and its limitations.
- Demonstrate familiarity with the assumption associated with different statistical models.
- Critically evaluate the results of these analyses and apply remedial measures as needed.
- Interpret and discuss the results of those analyses in a broader scientific context.
- Use and understand generalizations of the linear model to binary and count data.

Unit-I

Introduction – Steps in regression Analysis – Simple linear regression model – Parameters Estimation – Test of Hypothesis – Confidence Intervals – Predictions – Measuring the quality of Fit. Multiple Linear Regressions - Parameter Estimation – Interpretations of regression - Centering and Scaling – Properties of the least square estimation – Multiple Correlation Coefficient – Inference – test of Hypotheses in a linear model.

Unit-II

Detection of model violations – Standard regression assumptions – Various types of residuals – Checking for linearity and normality assumptions – Leverage, Influence and outliers – Measure of Influence.

Unit-III

Transformation of variables - Transformation to achieve linearity - Transformation to stabilize variance – Detection and removal of Hetrosecedastic – Weighted least Square – Logarithmic and Power transformation. Autocorrelation – Durbin-waston Statistics – Removal of autocorrelation by transformation – limitations of the Durbin-waston Statistics.

Unit-IV

Analysis of collinear data – effects of collinear on Inference and forecasting – Detection of Collinearility – Variance Inflation factors - Searching of linear functions of regression coefficients - Ridge method - Selection of variables - Forward selection procedure - Backward elimination procedure - Stepwise method (algorithms only).

Unit-V

Introduction to Logistic regression – Fitting the logistic regression model – testing for significance of the coefficient – Confidence Interval Estimation – Interpretation of the fitted logistic model – Dichotomous independent variables.

Books for Study

1. Chatterjee, S and Hadi, A, S, Regression Analysis by Example, John Wiley and Sons, New York (2012).
2. Hosmer, D.W, Lemeshow, S., and Sturdivant, R. X., Applied Logistic Regression, Third Edition, John Wiley and Sons (2013).

Books for Reference

1. Belsley, D.A., Kuth, E. and Welsch, R.E. (2004) Regression Diagnostics- Identifying Influential Data and Sources of Collinearity, Wiley, New York.
2. Draper, N. R and Smith, H (1998), Applied Regression Analysis, 3rd edition, John Wiley and Sons, USA.
3. Kleinbaum, D. G and Klein, M (2010). Logistic Regression A Self – Learning Text, Third Edition, Springer, New York.
4. Neter, J., Wasserman, W., and Kutner, M. H. (1989). Applied Linear Statistical Models, Second Edition, Irwin.

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RE-ACCREDITED (3rd Cycle) WITH "A" GRADE BY NAAC

PROGRAMME : M.Sc., Statistics **COURSE CODE : 21P1SMC1**

COURSE TITLE : Real Analysis and Linear Algebra **QN.NO : 12501**

TIME : 3 Hours **MAX.MARKS :75**

Course Objectives:

The main objectives of this course are to:

1. Expose the students to get knowledge on real analysis and linear algebra.
2. Grasp the concepts of convergence of sequence and series of real numbers.
3. Develop the ability of proving theorems and solving the problems in real analysis and linear algebra.

Unit	Description	Hours	K-Level	CLO(s)
1	Introduction to n-dimensional Euclidean space and metric space – Countability, supremum and infimum of sets of real numbers – Bolzano-Weirstrass theorem. Convergence of sequences and series of real numbers – absolute and conditional convergence – Point-wise and uniform convergence – Tests for absolute, conditional and uniform convergence – Properties of uniform convergence.	18	K2	1
2	Real valued functions - Limits and continuity and uniform continuity – Differentiability – Maxima and Minima of functions – mean value theorem, Taylor's theorem – functions of several variables.	13	K3	2
3	Riemann-Stieltjes sums – Riemann-Stieltjes integral – Properties and Evaluation – Fundamental theorem – Differentiation under integral sign – Leibnitz's rule - Improper integrals - Multiple integrals and their evaluation by repeated integration.	15	K3	3
4	Vector Space - sub-space, basis of vector space – Gram-Schmidt orthogonalization. Linear transformation (LT) and its properties – matrix of linear transformation – matrix of inverse transformation – change of basis, orthogonal transformation, dual space.	13	K4	4
5	Linear equations – Generalized inverse of a matrix. Eigenvalues and eigenvectors of a LT –Diagonalizable LT, Cayley-Hamilton theorem and minimum polynomial for a LT – Eigenvalues of matrix polynomials. Quadratic forms and their classifications- Sylvester's law of inertia – reduction involving the eigen-values of the matrix.	16	K4	5

Books for Reference:

1. Malik, S.C., and Arora, S, (2009), Mathematical Analysis, Second Edition, New Age International, New Delhi.
2. Arora, S, (1988), Real Analysis, SatyaPrakashanMandir, New Delhi.
3. Rudin, W. (2016), Principles of Mathematical Analysis, Fourteenth reprints McGraw-Hill, New Delhi.
4. Kenneth Hoffman and Ray Kanze 2nd Edition (1971) Linear Algebra PHI publisher, New Jersey
5. Goldberg, R.R. (1976) Methods of Real Analysis, Oxford & IBH, New Delhi.
6. Apostol, T.M. (1997) Mathematical Analysis, Narosa, New Delhi.
7. Somasundaram,D. (2002) Mathematical Analysis, Narosa, New Delhi.
8. Datta, K.E. (1991) Matrix and Linear Algebra, Prentice-Hall, New Delhi.
9. Rao, C.R. (1973) Linear Statistical Inference and its Applications, Wiley Eastern, New Delhi.
10. Searle, S.R. (1973) Linear Models, Wiley, New York.
11. Ramachandra Rao, A. and Bhimasankaran, P.(1992) LinearAlgebra, Tata McGraw Hill, New Delhi.
12. Ajit Kumar and Kumaresan, S, (2014), A Basic Course in Real Analysis, Chapman and Hall/CRC Press.

Web references:

1. Euclidean space and metric space:
   https://www.math.uci.edu/~gpatrick/source/205b06/chapviii.pdf
2. Mean value theorem
   https://byjus.com/jee/mean-value-theorem/
   https://www.youtube.com/watch?v=xYOrYLq3fE0
3. Taylors theorem
   https://www.youtube.com/watch?v=LEspaisjDFE
4. Riemann-Stieltjes integral
   https://www.youtube.com/watch?v=TpKIeWgcmC8
5. Vector space
   https://www.youtube.com/watch?v=1XlT3Y2oyAU
6. Linear transformation and matrix
   https://amsi.org.au/ESA_Senior_Years/SeniorTopic8/8a/8a_2content_3.html
7. Linear algebra
   https://www.commonlounge.com/discussion/efdfcf2937b94fbeb7a3e1a309381d85

Rationale for Nature of the course

This course will enable the students to comprehend the theoretical and applied concepts of Real analysis and Linear Algebra which enables to apply for the statistical concepts.

Pedagogy:

Chalk and Talk, PPT, Assignments, Seminar, Problem solving.

Lecture Schedule

Unit	Topics	Hours	Mode
I	Introduction to n-dimensional Euclidean space and metric space	2	Chalk and Talk, PPT, problem solving and Assignments
	Countability, supremum and infimum of sets of real numbers	3	
	Bolzano-Weirstrass theorem	2	
	Convergence of sequences and series of real numbers	3	
	absolute and conditional convergence	2	
	Point-wise and uniform convergence	2	
	Tests for absolute, conditional and uniform convergence	3	
	Properties of uniform convergence	1	
II	Real valued functions - Limits and continuity and uniform continuity	3	Chalk and Talk, PPT, problem solving and Assignments
	Differentiability – Maxima and Minima of functions	2	
	Mean value theorem	3	
	Taylor's theorem	2	
	Functions of several variables	3	
III	Riemann-Stieltjes sums	2	Chalk and Talk, PPT, problem solving, Assignments and Seminar
	Riemann-Stieltjes integral	2	
	Properties and Evaluation	1	
	Fundamental theorem	2	
	Differentiation under integral sign	2	
	Leibnitz's rule	2	
	Improper integrals	2	
	Multiple integrals and their evaluation by repeated integration	2	
IV	Vector Space - sub-space, basis of vector space	2	Chalk and Talk, PPT, problem solving, Assignments and Seminar
	Gram-Schmidt orthogonalization	2	
	Linear transformation and its properties	2	
	Matrix of linear transformation	3	
	Matrix of inverse transformation	2	
	Change of basis, orthogonal transformation, dual space	2	

V	Linear equations – Generalized inverse of a matrix	**2**	Chalk and Talk, PPT, problem solving, Assignments and Seminar
	Eigenvalues and eigenvectors of a linear transformations	**2**	
	Diagonalizable linear transformations	**2**	
	Cayley-Hamilton theorem and minimum polynomial for a linear transformations	**3**	
	Eigenvalues of matrix polynomials	**2**	
	Quadratic forms and their classifications	**2**	
	Sylvester's law of inertia	**2**	
	Reduction involving the eigen-values of the matrix	**1**	

Course Learning Outcomes

On the successful completion of the course, students will be able to

CLO's	Course Learning Outcomes	Knowledge Level
CLO-1	Understand the meaning of converges in sequences and series of real numbers.	Up to K2
CLO-2	Identify the given functions are continuous or discontinuous.	Up to K3
CLO-3	Understand the conditions for integrability of real valued functions.	Up to K3
CLO-4	Describe the fundament concepts of vector and linear transformations.	Up to K4
CLO-5	Determine the characteristic roots, eigen vector, the nature and reduction of quadratic forms.	Up to K4

MAPPING CLOs WITH PSOs

#	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CLO-1	2	3	2	1		2	2
CLO-2	2	2	2	2	1	2	1
CLO-3	3	1	2	1		2	1
CLO-4	2	2	1		1		1
CLO-5	2	3	2		2	3	2

Advance application – 3; Intermediate level – 2; Basic level – 1

CIA-I–BluePrint

CLO's	K-Level	Section – A Short Answer		Section B Either / Or type		Section C Open Choice	
		No. of Questions	K Level	No. of Questions	K Level	No. of Questions	K level
CLO 1	Up to K2	2	K1, K1	2	K2, K2	1	K2
CLO 2	Up to K3	3	K2, K2, K3	2	K3 , K3	2	K3, K3
No. of questions to be asked		5		4		3	
No. of question to be answer		5		2		2	
Marks for each question		2		5		10	
Total marks for each section		10		10		20	

CIA-I: Distribution of section wise marks with K-levels

K Levels	Section A (No choice)	Section B (Either/ or)	Section C (Open choice)	Total marks	% of marks without choice	Consolidated
K1	4	-	-	4	6.67	46.67%
K2	4	10	10	24	40	
K3	2	10	20	32	53.33	53.33%
K4	-	-	-	-	-	-
Total marks	10	20	30	60	100	100

CIA-II Blue Print

CLO's	K-Level	Section – A Short Answer		Section B Either / Or type		Section C Open Choice	
		No. of Questions	K Level	No. of Questions	K Level	No. of Questions	K level
CLO 3	Up to K3	2	K1, K1	2	K2, K3	2	K2, K3
CLO 4	Up to K4	3	K2, K2, K3	2	K3, K4	1	K4
No. of questions to be asked		5		4		3	
No. of question to be answer		5		2		2	
Marks for each question		2		5		10	
Total marks for each section		10		10		20	

CIA-II: Distribution of section wise marks with K-levels

K Levels	Section A (No choice)	Section B (Either/ or)	Section C (Open choice)	Total marks	% of marks without choice	Consolidated
K1	4	-	-	4	6.67	38.33%
K2	4	5	10	19	31.66	
K3	2	10	10	22	36.67	36.67%
K4	-	5	10	15	25.00	25.00%
Total marks	10	20	30	60	100	100

Summative Examination -Blue Print

Units	CLOs	K- Level	SectionA MCQs		SectionB ShortAnswers		SectionC (Either/or Choice)	SectionD (OpenChoice)
			No.of Question	K- Level	No.of Questions	K-Level		
1	CLO1	Up to K2	2	K1& K1	1	K1	2(K1&K1)	1(K2)
2	CLO2	Up to K3	2	K2& K3	1	K1	2(K3&K3)	1(K3)
3	CLO3	Up to K3	2	K2& K3	1	K2	2(K2&K2)	1(K3)
4	CLO4	Up to K4	2	K3& K4	1	K2	2(K4&K4)	1(K4)
5	CLO5	Up to K4	2	K3& K4	1	K3	2(K4&K4)	1(K4)
No. of Questions to be asked			10		5		10	5
No.of Questions to be answered			10		5		5	3
Marks for each question			1		2		5	10
Total Marks for each section			10		10		25	30

Distribution of Marks with K Level for Summative Examination

K - Level	Section A (MCQ)	Section B (Short Answer Questions)	Section C (Either / Or Choice)	Section D (Open Chioce)	Total Marks	% of (Marks without Choice)	Consolidated
K1	2	4	10	-	16	13.33	35%
K2	2	4	10	10	26	21.67	
K3	4	2	10	20	36	30.00	30%
K4	2	-	20	20	42	35.00	35%
K5	-	-		-			
Total	10	10	50	50	120	100	100

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THE MADURA COLLEGE (Autonomous), MADURAI – 625 011

(AFFILIATED TO MADURAI KAMARAJ UNIVERSITY)

RE-ACCREDITED (3rd Cycle) WITH "A" GRADE BY NAAC

PROGRAMME : M.Sc., Statistics **COURSE CODE : 21P1SMC2**

COURSE TITLE : Distribution Theory **QN.NO : 12502**

TIME : 3 Hours **MAX.MARKS :75**

Course Objectives:

1. To equip the students with knowledge of various probability distributions
2. Create and apply customized probability distributions

Unit	Description	Hours	K-level	CLO(s)
I	(*Basic probability distributions – Binomial, Poisson, negative binomial, hypergeometric, multinomial, normal, uniform* – ***Only for introduction purpose not for examination***) Gamma, Beta distributions and their applications. Logarithmic and power series distributions – compound distribution – compound Binomial and compound Poisson distributions – Lognormal distribution – Cauchy distribution.	19	K2	1
II	Truncated distributions – left truncated binomial – left truncated Poisson – left and right truncated Normal distributions –Non-central *Student's t*, χ^2 and F distributions.	16	K3	2
III	Bivariate Normal distribution – Moment generating function –marginal and conditional distributions. Moments – Distribution of correlation coefficient when population correlation coefficient is equal to zero – Distribution of Regression coefficients.	13	K4	3
IV	Distributions of order statistics - median, range and mid-range. Distribution of Quantiles– Sample cumulative distribution function and its properties.	13	K3	4
V	Distribution of quadratic forms in normal random variables, their mean and variance, independence of quadratic forms, independence of linear and quadratic forms, Fisher-Cochran's theorem.	14	K4	5

Books for Reference:

1. Rohatgi, V.K. and Saleh, A.K.MD.E. (2011) An Introduction to Probability and Statistics, Wiley, New Delhi.
2. Johnson, N. L., Kemp, A.W., and Kotz, S. (2005). Univariate Discrete Distributions, Third Edition, John Wiley and Sons, New York.
3. Johnson, N. L., Kotz, S., and Balakrishnan, N. (2004).Continuous Univariate Distributions.Vol.I, John Wiley and Sons (Asia), Singapore.
4. Johnson, N.L Kotz, S. and Balakrishnan, N. (2014) Continuous Univariate Distributions, Vol. II.Wiley , Singapore.
5. Mukhopadhyay, P, (2002), Mathematical Statistics, Book and Allied Publishers, New Delhi.
6. David, H.A. (1971): Order Statistics, Wiley ,New York.
7. Bhuyan, K. C (2010), Probability Distribution Theory and Statistical Inference, New Central Book agency private ltd, Reprint, 2015
8. Mood, A.M., Graybill, F.A., and Boes, D.C, (1974), Introduction to the Theory of Statistics, Third Edition, McGraw-Hill International Edition.
9. Dudewicz, E.J., and Mishra, S. N. (1988).Modern Mathematical Statistics, John Wiley & Sons, New York.
10. Rao, C. R. (2009). Linear Statistical Inference and Its Applications, Second Edition, John Wiley and Sons, New York.
11. Karian, Z.A., and Dudewicz, E.J. (2011).Handbook of Fitting Statistical Distributions with R, Chapman and Hall.

Web references:

1. Basic probability distributions
   https://www.cse.iitk.ac.in/users/piyush/courses/pml_fall17/material/probabilty_tutorial.pdf
   https://www.colorado.edu/amath/sites/default/files/attached-files/lesson3_probdistns.pdf
   http://www.ams.sunysb.edu/~linli/teaching/ams-310/lecture-notes-3.pdf
2. Continuous Distribution
   http://www.utstat.utoronto.ca/~radford/sta247.F11/IPSUR6.pdf
   https://www.patnauniversity.ac.in/e-content/science/stat/MScStatistics7.pdf
3. Truncated Distribution
   http://parker.ad.siu.edu/Olive/ch4.pdf

4. Non-central distribution
   http://pages.stat.wisc.edu/~shao/stat609/stat609-13.pdf
5. Bivariate Normal distribution
   https://www.bauer.uh.edu/rsusmel/phd/sR-5.pdf
   http://www1.maths.leeds.ac.uk/~sta6ajb/math2715/lec19-20.pdf
6. Order Statistics
   https://www2.stat.duke.edu/courses/Spring12/sta104.1/Lectures/Lec15.pdf
   http://www.math.ntu.edu.tw/~hchen/teaching/LargeSample/notes/noteorder.pdf
7. Distribution of quadratic forms http://www.math.louisville.edu/~rsgill01/668/Ch_5_Notes.html
   http://users.stat.umn.edu/~sandy/courses/8311/handouts/ch05.pdf

Rationale for Nature of the course

This course facilitates the student to identify the nature of data and suitable distribution to be fitted. Student is able to apply the real time data by fitting a suitable distribution.

Activities having direct bearing on Skill development / Employability / Entrepreneurship

Exercise problems on distributions given on realtime situations

Pedagogy

Chalk and Talk, PPT, Seminar, Interaction, Problem solving.

Lecture Schedule

Unit	Topics	Hours	Mode
I	Basic probability distributions – Binomial, Poisson, negative binomial, hypergeometric, multinomial, normal, uniform	6	PPT, Chalk and Talk and Assignments
	Gamma, Beta distributions and their applications	4	
	Logarithmic and power series distributions	4	
	Compound distribution – compound Binomial and compound Poisson distributions	3	
	Lognormal distribution – Cauchy distribution	2	
II	Truncated distributions – left truncated binomial – left truncated Poisson	5	PPT, Chalk and Talk and Assignments
	left and right truncated Normal distributions	4	
	Non-central *Student's t*, χ^2 and F distributions.	7	
III	Bivariate Normal distribution – Moment generating function –marginal and conditional distributions. Moments	5	PPT, Chalk and Talk, Assignments and seminar
	Distribution of correlation coefficient when population correlation coefficient is equal to zero	4	
	Distribution of Regression coefficients	4	
IV	Distributions of order statistics - median, range and mid-range	7	PPT, Chalk andTalk, Assignments and seminar
	Distribution of Quantiles– Sample cumulative distribution function and its properties.	6	
V	Distribution of quadratic forms in normal random variables, their mean and variance,	5	PPT, Chalk and Talk, Assignments and seminar
	independence of quadratic forms, independence of linear and quadratic forms	5	
	Fisher-Cochran's theorem	4	

Course Learning Outcomes

On the successful completion of the course, students will be able to

CLO's	Course Learning Outcomes	Knowledge Level
CLO-1	Identify the type of statistical situation to which different distributions can be applied.	Up to K2
CLO-2	Acquire knowledge of various discrete and continuous probability distributions and their applications in real life problems.	Up to K3
CLO-3	Develop the properties of bivariate probability distributions	Up to K4
CLO-4	Define order statistics and obtain their sampling distributions	Up to K3
CLO-5	Use distribution of quadratic forms to solve statistical problems.	Up to K4

MAPPING CLOs WITH PSOs

#	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CLO-1	2	1	3	3	3		1
CLO-2	2	1	3	3	3	1	1
CLO-3	3	1	3	2	3		1
CLO-4	2	1	3	2	3		1
CLO-5	3	1	3	2	3		1

Advance application – 3; Intermediate level – 2; Basic level – 1

CIA I – Blue Print

Units	CLOs	K- Level	Section A		Section B		Section C	
			Short Answers		(Either/or Choice)		(Open Choice)	
			No. of Questions	K- Level	No. of Questions	K- Level	No. of Questions	K- Level
1	CLO 1	Up to K2	2	K1 , K1	2	K1,K1	1	K2
2	CLO 2	Up to K3	3	K2, K2,K3	2	K2,K2	2	K3, K3
No. of Questions to be asked			5		4		3	
No. of Questions to be answered			5		2		2	
Marks for each question			2		5		10	
Total Marks for each section			10		10		20	

CIA-I :: Distribution of section wise marks with K levels.

CIA II – Blue Print

K Levels	Section B (Short Answers)	Section C (Either/ or)	Section D (Open choice)	Total marks	% of marks without choice	Consolidated
K1	4	10	-	14	23.33	63.33%
K2	4	10	10	24	40.00	
K3	2	-	20	22	36.67	36.67%
K4	-	-	-	-	-	-
K5	-	-	-	-	-	-
Total marks	10	20	30	60	100	100

Units	CLOs	K- Level	Section A		Section B		Section C	
			Short Answers		(Either/or Choice)		(Open Choice)	
			No. of Questions	K- Level	No. of Questions	K- Level	No. of Questions	K- Level
1	CLO 3	Up to K4	3	K1,K2, K3	2	K3, K4	2	K3, K4
2	CLO 4	Up to K3	2	K1, K2	2	K3 , K4	1	K3
No. of Questions to be asked			5		4		3	
No. of Questions to be answered			5		2		2	
Marks for each question			2		5		10	
Total Marks for each section			10		10		20	

CIA-II :: Distribution of section wise marks with K levels.

K Levels	Section B (Short Answers)	Section C (Either/ or)	Section D (Open choice)	Total marks	% of marks without choice	Consolidated
K1	4	-	-	4	6.67	13.34%
K2	4	-	-	4	6.67	
K3	2	10	20	32	53.33	53.33%
K4	-	10	10	20	33.33	33.33%
K5	-	-	-	-	-	-
Total marks	10	20	30	60	100	100

Summative Examination -Blue Print

S. No.	CLOs	K Level	Section A		Section B		Section C (Either/or Choice)	Section D (Open Choice)
			MCQs		Short Answers			
			No. of questions	K Level	No. of questions	K level		
1	CLO 1	Up to K2	2	K1 & K1	1	K1	2(K1 & K1)	1(K2)
2	CLO 2	Up to K3	2	K2 & K3	1	K1	2(K2 & K2)	1(K3)
3	CLO 3	Up to K4	2	K3 & K4	1	K3	2(K4 & K4)	1(K4)
4	CLO 4	Up to K3	2	K2 & K3	1	K2	2(K3 & K3)	1(K3)
5	CLO 5	Up to K4	2	K3 & K4	1	K2	2(K4 & K4)	1(K4)
No. of Questions to be asked			10		5		10	5
No. of Questions to be answered			10		5		5	3
Marks for each question			1		2		5	10
Total Marks for each Section			10		10		25	30

Distribution of section wise marks with K levels for Summative Examination

K Levels	Section A MCQs	Section B (Short Answers)	Section C (Either/ or)	Section D (Open choice)	Total marks	% of marks without choice	Consolidated
K1	2	4	10	-	16	13.33	
K2	2	4	10	10	26	21.67	35%
K3	4	2	10	20	36	30	30%
K4	2	-	20	20	42	35	35%
K5	-	-	-	-	-	-	-
Total marks	10	10	50	50	120	100	100%

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THE MADURA COLLEGE (Autonomous), MADURAI – 625 011

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RE-ACCREDITED (3rd Cycle) WITH "A" GRADE BY NAAC

PROGRAMME : M.Sc., Statistics **COURSE CODE : 21P1SMC3**

COURSE TITLE : Operations Research **QN.NO : 12503**

TIME : 3 Hours **MAX.MARKS :75**

Course Objectives:

1. To introduce students the statistical and mathematical formulations for handling a range of business based problems.
2. To develop a broad appreciation of different types of decision-making environments.

Unit	Description	Hours	K-level	CLO(s)
I	(Linear Programming problem – Simplex and Dual Simplex methods. Transportation and assignment problems and their solution. Sensitivity Analysis – Variation in cost vector 'c' – Variation in the requirement vector 'b' – Addition and Deletion of single variable – Addition and Deletion of single constraint.	17	K2	1
II	Parametric Programming – parameterization of the cost vector 'c' – Parameterization of requirement vector 'b' – All integer programming problem – Mixed integer programming problem – Branch and Bound techniques.	16	K3	2
III	Non-linear programming problem (NLPP) – Kuhn-Tucker condition – Wolfe's and Beale's algorithms for solving quadratic programming problem.	11	K3	3
IV	Inventory models – Structure of Inventory system – General deterministic problem for one item, one level – Inventory models with and without shortage – Multi item deterministic problem – one level model with one break.	16	K4	4
V	Queuing theory – Basic characteristics of queuing models – Arrival and service distribution – Steady state solution of M/M/1 and M/M/C models with associated distribution of queue length and waiting time – M/G/I queue and Pollazeck-Khinchin result.	15	K4	5

Books for Reference:

1. Gass, S.I. (1985) Linear Programming, Methods and Applications.Courier Dover, New York.
2. Gupta, P.K. and Man Mohan. (1979) Operations Research: Linear Programming and Theory of Games,3/e, Sultan Chand &Sons, New Delhi.
3. Hadley, G (1963) Linear Programming. Addison Wesley,
4. Hillier, F.S. and Lieberman, G.J. (2005) Introduction to Operations Research,9/e, McGraw Hill, New York.
5. Sharma, J.K. (2013) Operations Research: Problems and Solutions,5/e,Macmillan India, New Delhi.
6. Sharma, S.D. (2010) Operations Research,KedarnathRamnath, Meerut.
7. Swarup, K. Mohan, M. and Gupta, P.K. (2001) Operations Research, Sultan Chand & Sons, New Delhi.
8. Taha, H.A .(2011) Operations Research- An Introduction.9/e,. Prentice Hall, New Delhi.
9. Rao S.S. (1972), Optimization: Theory and Applications, Wiley Eastern (P) Ltd., New Delhi

Web Resources:

1. Linear Programming Simple, Transportation and Assignment Problems:
   http://www.phpsimplex.com/en/simplex_method_example.htm
   https://www.youtube.com/watch?v=-YBlR1UF-UY

2. Sensitivity analysis:
   https://www.youtube.com/watch?v=DNZpiOCdC6w
   http://web.mit.edu/15.053/www/AMP-Chapter-03.pdf
3. Inventory models
   http://ecoursesonline.iasri.res.in/mod/resource/view.php?id=90023
   https://www.youtube.com/watch?v=y2m3-dgtWG0
4. Queuing theory:
   http://ecoursesonline.iasri.res.in/mod/page/view.php?id=2969
   https://www.youtube.com/watch?v=7EB5A3Iv-xk

Rationale for Nature of the course

This course enables the students to gain in-depth knowledge on advance level of optimization technique problems in both theoretical and application orientation.

Activities having direct bearing on Skill development / Employability / Entrepreneurship

Seminars / Assignments on industry based problems related to optimization

Pedagogy

Chalk and Talk, PPT, Seminar, Interaction, Problem solving.

Lecture Schedule

Unit	Topics	Hours	Mode
I	(Linear Programming problem – Simplex and Dual Simplex methods. Transportation and assignment problems and their solution.	4	PPT, Chalk and Talk and Assignments
	Sensitivity Analysis	3	
	Variation in cost vector ‘c’	2	
	Variation in the requirement vector ‘b’	3	
	Addition and Deletion of single variable	2	
	Addition and Deletion of single constraint	3	
II	Parametric Programming – parameterization of the cost vector ‘c’	3	PPT, Chalk and Talk and Assignments
	Parameterization of requirement vector ‘b’	3	
	All integer programming problem	3	
	Mixed integer programming problem	3	
	Branch and Bound techniques	4	
III	Non-linear programming problem (NLPP) – Kuhn-Tucker condition	5	PPT, Chalk and Talk , seminar and Assignments
	Wolfe’s and Beale’s algorithms for solving quadratic programming problem	6	
IV	Inventory models – Structure of Inventory system	3	PPT, Chalk and Talk , Assignments and Seminar
	General deterministic problem for one item, one level	3	
	Inventory models with and without shortage	5	
	Multi item deterministic problem	3	
	one level model with one break	2	
V	Queuing theory – Basic characteristics of queuing models	3	PPT, Chalk and Talk , Assignments and Seminar
	Arrival and service distribution	2	
	Steady state solution of M/M/1 and M/M/C models with associated distribution of queue length and waiting time	5	
	M/G/I queue and Pollazeck-Khinchin result	5	

Course Learning Outcomes

CLO's	Course Learning Outcomes	Knowledge Level
CLO-1	Perform sensitivity analysis to identify the direction and magnitude of change of a linear programming model's optimal solution as the input data change.	Up to K2
CLO-2	Describe the theoretical workings of the solution methods for parametric programming and integer linear programming problems and demonstrate them by solving the problems.	Up to K3
CLO-3	Capability to develop non-linear programming problems.	Up to K3
CLO-4	Explains various cost related to inventory models and develop, extent various deterministic inventory problems to analysis real world systems.	Up to K4
CLO-5	Deep understanding of the theoretical background of queuing systems, apply and extend queuing models to analyse real world systems.	Up to K4

On the successful completion of the course, students will be able to

MAPPING CLOs WITH PSOs

#	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CLO-1	2	3	3	2		2	2
CLO-2	2	2	1	2		2	2
CLO-3	1	2	1	2		2	2
CLO-4	1	2	2	2		2	3
CLO-5	2	2	2	2	2	1	2

Advance application – 3; Intermediate level – 2; Basic level – 1

CIA-I–BluePrint

CLO's	K-Level	Section – A Short Answer		Section B Either / Or type		Section C Open Choice	
		No. of Questions	K Level	No. of Questions	K Level	No. of Questions	K level
CLO 1	Up to K2	2	K1, K1	2	K2, K2	1	K2
CLO 2	Up to K3	3	K2, K2, K3	2	K3 , K3	2	K3, K3
No. of questions to be asked		5		4		3	
No. of question to be answer		5		2		2	
Marks for each question		2		5		10	
Total marks for each section		10		10		20	

CIA-I :: Distribution of section wise marks with K levels

K Levels	Section A (No choice)	Section B (Either/ or)	Section C (Open choice)	Total marks	% of marks without choice	Consolidated
K1	4	-	-	4	6.67	46.67%
K2	4	10	10	24	40.00	
K3	2	10	20	32	53.33	53.33%
K4	-	-	-	-	-	-
Total marks	10	20	30	60	100	100

CIA-II–BluePrint

CLO's	K-Level	Section – A Short Answer		Section B Either / Or type		Section C Open Choice	
		No. of Questions	K Level	No. of Questions	K Level	No. of Questions	K level
CLO 3	Up to K3	2	K1, K1	2	K2, K3	2	K2, K3
CLO 4	Up to K4	3	K2, K2, K3	2	K3, K4	1	K4
No. of questions to be asked		5		4		3	
No. of question to be answer		5		2		2	
Marks for each question		2		5		10	
Total marks for each section		10		10		20	

CIA-II :: Distribution of section wise marks with K levels

K Levels	Section A (No choice)	Section B (Either/ or)	Section C (Open choice)	Total marks	% of marks without choice	Consolidated
K1	4	-	-	4	6.67	38.33%
K2	4	5	10	19	31.66	
K3	2	10	10	22	36.67	36.67%
K4	-	5	10	15	25	25.00%
Total marks	10	20	30	60	100	100%

Summative Examination -Blue Print

Units	CLOs	K- Level	SectionA		SectionB		Section C (Either/or Choice)	SectionD (Open Choice)
			MCQs		ShortAnswers			
			No.of Questions	K- Level	No.of Questions	K-Level		
1	CLO1	Up toK2	2	K1& K1	1	K1	2(K1&K1)	1(K2)
2	CLO2	Up toK3	2	K2& K2	1	K1	2(K2&K2)	1(K3)
3	CLO3	Up toK3	2	K3& K3	1	K2	2(K3&K3)	1(K3)
4	CLO4	Up toK4	2	K3& K4	1	K2	2(K4&K4)	1(K4)
5	CLO5	Up toK4	2	K3& K4	1	K3	2(K4&K4)	1(K4)
No.of Questions to be asked			10		5		10	5
No.of Questions to be answered			10		5		5	3
Marks for each question			1		2		5	10
Total Marks for each section			10		10		25	30

Distribution of Marks with K Level for Summative Examination

K - Level	Section A (MCQ)	Section B (Short Answer Questions)	Section C (Either / Or Choice)	Section D (Open Chioce)	Total Marks	% of (Marks without Choice)	Consolidated
K1	2	4	10	-	16	13.33	35%
K2	2	4	10	10	26	21.67	
K3	4	2	10	20	36	30.00	30%
K4	2	-	20	20	42	35	35%
K5	-	-	-	-	-	-	-
Total	10	10	50	50	120	100	100

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THE MADURA COLLEGE (Autonomous), MADURAI – 625 011

(AFFILIATED TO MADURAI KAMARAJ UNIVERSITY)

RE-ACCREDITED (3rd Cycle) WITH "A" GRADE BY NAAC

PROGRAMME : M.Sc., Statistics **COURSE CODE : 21P1SME1(A)**

COURSE TITLE : Actuarial Statistics **QN.NO : 12504**

TIME : 3 Hours **MAX.MARKS :75**

Course Objectives:

- To impart basic concepts and terminologies related to actuarial studies
- To develop a greater understanding of statistical principles and their application in actuarial science.

Unit	Description	Hours	K-level	CLO(s)
I	Measures of Mortality:- Life tables and its relation with survival function - life table function at non integer age (fractional ages) – analytical laws of mortality - Gompertz and Makeham's laws of mortality – Select, ultimate and aggregate mortality tables.	16	K2	1
II	Abridged life tables – construction of abridged life tables – methods by Read and Merrell, Greville's, Kings and JIA method. Utility Theory – Insurance and Utility Theory.	16	K4	2
III	Models for individual claims and their sums – multiple life function – joint life status and last survival status.	15	K3	3
IV	Policy Values: Nature of reserve - prospective and retrospective reserves - fractional premiums and fractional durations - modified reserves - Continuous reserves - Surrender values and paid up policies - Industrial assurance - Children's deferred assurances - Joint life and last survivorship.	16	K4	4
V	Pension Funds: Capital sums on retirement and death- widow's pensions - Sickness benefits - Benefits dependent on marriage.	12	K3	5

Books for Reference

1. Barcley G.W. (1970) Techniques of Population Analysis, Wiley, New York.
2. Borowiak, D.S. and Shapiro, A.F. (2013) Financial and Actuarial Statistics: An Introduction, CRC Press, London.
3. Donald, D.W.A. (1970) Compound Interest and Annuities-certain, For The Institute of Actuaries and the Faculty of Actuaries at the University Press.
4. Spurgeon, E.T. (2011) Life Contingencies, Cambridge University Press, Cambridge.
5. Hooker,P.F. Longley, L.H Cook (1957) Life and other contingencies, Cambridge.
6. Alistair Neill (1977) Life contingencies, Heinemann Professional Publishing, Portsmouth.
7. Hossack, I.B. Pollard, J.H. and Zehnwirth, B.(1999) Introductory statistics with

Web references:

1. Measure of Mortality: Life tables
   https://www.lkouniv.ac.in/site/writereaddata/siteContent/20200403224023557 7Anupama_Singh_Mortality_and_its_measures.pdf
2. Gompertz and Makeham's laws of mortality
   https://en.wikipedia.org/wiki/Gompertz%E2%80%93Makeham_law_of_mortality
   https://web.stanford.edu/~jhj1/teachingdocs/Jones-mortmodel2005.pdf
3. Abridged life tables – construction of abridged life tables
   https://www.cdc.gov/nchs/data/series/sr_02/sr02_004.pdf
   https://www.statsdirect.com/help/survival_analysis/abridged_life_table.htm
4. Policy Values
   https://www.math.umd.edu/~slud/s470/BookChaps/01Book.pdf
5. https://www.actuariayfinanzas.net/images/sampledata/FundamentalsofActuarialMathematics_S.DavidPromislow2015.pdf

Rationale for Nature of the course

Provides a grounding in mathematical and statistical methods it equips with knowledge of statistical distributions and methods to summarize data.

Activities having direct bearing on Skill development / Employability / Entrepreneurship

Problem solving on Life tables & premium of insurance

Pedagogy

Chalk and Talk, PPT, Seminar, Interaction, Problem solving.

Lecture Schedule

Unit	Topics	Hours	Mode
I	Measures of Mortality:- Life tables and its relation with survival function - life table function at non integer age.	5	PPT, Chalk and Talk and Assignments
	analytical laws of mortality	6	
	Gompertz and Makeham's laws of mortality – Select, ultimate and aggregate mortality tables.	5	
II	Abridged life tables – construction of abridged life tables	5	PPT, Chalk and Talk and
	Methods by Read and Merrell, Greville's, Kings and JIA method.	6	
	Utility Theory – Insurance and Utility Theory.	5	
III	Models for individual claims and their sums	5	PPT, Chalk and Talk, Assignments and seminar
	Multiple life function	5	
	Joint life status and last survival status.	5	
IV	Policy Values: Nature of reserve - prospective and retrospective reserves - fractional premiums and fractional durations - modified reserves - Continuous reserves	4	PPT, Chalk andTalk, Assignments and seminar
	Surrender values and paid up policies	4	
	Industrial assurance	4	
	Children's deferred assurances - Joint life and last survivorship.	4	
V	Pension Funds: Capital sums on retirement and death	6	PPT, Chalk and Talk, Assignments and seminar
	widow's pensions - Sickness benefits - Benefits dependent on marriage.	6	

Course Learning Outcomes

On the successful completion of the course, students will be able to

CLO's	Course Learning Outcomes	Knowledge Level
CLO-1	Acquire the knowledge of different lifetime random variables.	Up to K2
CLO-2	Know how to construct life tables and understand different types of insurances.	Up to K4
CLO-3	Knowledge about models for individual claims and their sums.	Up to K3
CLO-4	Calculate quantities such as premiums and reserves using actuarial techniques	Up to K4
CLO-5	Describe, explain and apply the fundamental theories of actuarial science as they apply in pension funds	Up to K3

MAPPING CLOs WITH PSOs

#	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CLO-1			3		3	2	1
CLO-2		2			3	3	
CLO-3	2		2		3		2
CLO-4		2	2		3		
CLO-5	2	2			2	3	

CIA I – Blue Print

Units	CLOs	K- Level	Section A		Section B		Section C	
			Short Answers		(Either/or Choice)		(Open Choice)	
			No. of Questions	K- Level	No. of Questions	K- Level	No. of Questions	K- Level
1	CLO 1	Up to K2	2	K1 & K2	2	K2,K2	1	K2

2	CLO 2	Up to K4	3	K1 ,K2, K3	2	K3, K4	2	K3,K4
No. of Questions to be asked			5		4		3	
No. of Questions to be answered			5		2		2	
Marks for each question			2		5		10	
Total Marks for each section			10		10		20	

CIA-I :: Distribution of Section-wise Marks with K levels

K Levels	Section A (No choice)	Section B (Either/ or)	Section C (Open choice)	Total marks	% of marks without choice	Consolidated
K1	4	-	-	4	6.67	46.67%
K2	4	10	10	24	40	
K3	2	5	10	17	28.33	28.33%
K4	-	5	10	15	25	25%
K5	-	-	-	-	-	-
Total Marks	10	20	30	60	100	100%

CIA II – Blue Print

Units	CLOs	K- Level	Section A		Section B		Section C	
			Short Answers		(Either/or Choice)		(Open Choice)	
			No. of Questions	K- Level	No. of Questions	K- Level	No. of Questions	K- Level
1	CLO 3	Up to K3	3	K1,K1, K2	2	K2,K3	2	K2, K3
2	CLO 4	Up to K4	2	K2, K3	2	K3, K4	1	K3
No. of Questions to be asked			5		4		3	
No. of Questions to be answered			5		2		2	
Marks for each question			2		5		10	
Total Marks for each section			10		10		20	

CIA-II :: Distribution of Section-wise Marks with K levels

K Levels	Section A (No choice)	Section B (Either/ or)	Section C (Open choice)	Total marks	% of marks without choice	Consolidated
K1	4	-	-	4	6.67	38.34%
K2	4	5	10	19	31.67	
K3	2	10	20	32	53.33	53.33%
K4	-	5	-	5	8.33	8.33%
K5	-	-	-	-	-	-
Total Marks	10	20	30	60	100	100%

Summative Examination– Blue Print

Unit	CLOs	K Level	Section A		Section B		Section C (Either/or Choice)	Section D (Open Choice)
			MCQs		Short Answers			
			No. of questions	K Level	No. of questions	K level		
1	CLO 1	Up to K2	2	K1 & K1	1	K1	2(K1 & K1)	1(K2)
2	CLO 2	Up to K4	2	K3 & K4	1	K2	2(K4 & K4)	1(K4)
3	CLO 3	Up to K3	2	K2 & K3	1	K1	2(K2 & K2)	1(K3)
4	CLO 4	Up to K4	2	K3 & K4	1	K3	2(K4 & K4)	1(K4)
5	CLO 5	Up to K3	2	K2 & K3	1	K2	2(K3 & K3)	1(K3)
No. of Questions to be asked			10		5		10	5
No. of Questions to be answered			10		5		5	3
Marks for each question			1		2		5	10
Total Marks for each Section			10		10		25	30

Distribution of section wise marks with K levels for Summative Examination

K Levels	Section A MCQs	Section B (Short Answers)	Section C (Either/ or)	Section D (Open choice)	Total marks	% of marks without choice	Consolidated
K1	2	4	10	-	16	13.33	
K2	2	4	10	10	26	21.67	35%
K3	4	2	10	20	36	30	30%
K4	2	-	20	20	42	35	35%
Total marks	10	10	50	50	120	100	100%

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THE MADURA COLLEGE (Autonomous), MADURAI – 625 011

(AFFILIATED TO MADURAI KAMARAJ UNIVERSITY)

RE-ACCREDITED (3rd Cycle) WITH "A" GRADE BY NAAC

PROGRAMME : M.Sc., Statistics **COURSE CODE : 21P1SME1(B)**

COURSE TITLE : Data Mining **QN.NO : 12505**

TIME : 3 Hours **MAX.MARKS :75**

Course Objectives:

1. To teach principles, concepts and applications of data warehousing and data mining
2. To introduce the task of data mining as an important phase of knowledge recovery process
3. Characterize the kinds of patterns that can be discovered by association rule mining

Unit	Description	Hours	K-level	CLO(s)
I	Introduction: Data mining - Kinds of data – Data mining Functionalities - Classification of Data mining Systems - Major Issues on Data mining - Introduction to OLAP - OLAP technology for Data Mining - Data warehousing - Data warehousing to Data mining - Optimizing Data for mining - Data preprocessing	16	**K3**	**1**
II	Data Mining Primitives: Data mining Query language - Association Rules in large - Data mining - KDD Process - Fuzzy sets and logic - Classification and Prediction**:** Information retrieval - Dimensional Modeling of Data - Pattern Matching - Estimation Error- EM and MLE.	15	**K2**	**2**
III	Models based on Summarization: Bayes Theorem - Chi squared Statistics - Regression - Decision Tree - Neural Networks - Genetic Algorithms - Cluster Analysis – Outlier - Cluster Vs Classification - Clustering Issues - Impact of Outliers on clustering- Clustering problems - Clustering Approaches.	17	**K3**	**3**
IV	Clustering Algorithms: Hierarchical algorithm – Single Link- MST Single Link - Complete Link - Average Link- Dendrogram - Partitional Algorithm – MST - Squared Error - K-Means - Nearest Neighbor – PAM – BEA – GA - Categorical algorithm - Large Database.	12	**K4**	**4**
V	Web Mining: Introduction - Web data - Web Knowledge Mining Taxonomy - Web Content mining - Web Usage Mining Research - Ontology based web mining Research - Web mining Applications.	15	**K4**	**5**

Books for Reference:

1. Berry, J.A. and Linoff, G.S. (2011) Data Mining Techniques (3/e),Wiley, New York.
2. Chattamvelli, R. (2009) Data mining Methods,Alpha Science International,Oxford.
3. Dunham, M.H. (2006) Data mining: Introductory and Advanced Topics, Pearson, New Delhi .
4. Gorunescu, F. (2010) Data mining Concepts, Models and Techniques.Springer, New York.
5. Han, J. and Kamber, M (2001) Data Mining Concepts and Techniques,Morgan Kaufmann Publications, Massachusetts.
6. Hand, D.Mannila, H. and Smyth, P (2001) Principles of Data mining, MIT Press,Cambridge.
7. Larose, D.T. (2005) Discovering Knowledge in Data: An Introduction to Data Mining,Wiley,Toronto.
8. Pujari, A.K. (2001) Data Mining Techniques, Universities Press, Hyderabad.
9. Sivanandam S.N. and Sumathi,S (2006) Data Mining Concepts, Tasks and Techniques, Springer, New Delhi.
10. Brieman, L. Friedman, J.H.Olshen, R.A. and Stone,C.J.(1984) Classification and regression trees, Wadsworth & Brooks, California.

Web References:

1. Types of Sources of Data in Data Mining
   https://www.geeksforgeeks.org/types-of-sources-of-data-in-data-mining/

2. Introduction to OLAP - OLAP technology for Data Mining
   https://www.tutorialspoint.com/dwh/dwh_olap.htm
3. Data mining Primitives
   http://www.brainkart.com/article/Data-mining-primitives_8311/
4. Neural Network https://www.getsmarter.com
5. Web Mining
   https://www.techopedia.com/definition/15634/web-mining

Rationale for Nature of the course

Analyzes massive volumes of data to discover business intelligence that helps companies solve problems, mitigate risks, and seize new opportunities.

Activities having direct bearing on Skill development / Employability / Entrepreneurship

Seminars / Assignments on different algorithms in current scenario

Pedagogy

Chalk and Talk, PPT, Seminar, Interaction, Problem solving.

Lecture Schedule

Unit	Topics	Hours	Mode
I	Introduction, Data mining, Kinds of data, Data mining Functionalities	3	PPT, Chalk and Talk and Assignments
	Classification of Data mining Systems, Major Issues on Data mining	3	
	Introduction to OLAP - OLAP technology for Data Mining	3	
	Data warehousing, Data warehousing to Data mining	4	
	Optimizing Data for mining, Data preprocessing	3	
II	Data mining Query language , Association Rules in large	3	PPT, Chalk and Talk and Assignments
	Data mining, KDD Process, Fuzzy sets and logic	3	
	Classification and Prediction, Information retrieval	3	
	Dimensional Modeling of Data, Pattern Matching	3	
	Estimation Error, EM and MLE	3	
III	Bayes Theorem , Chi squared Statistics	3	PPT, Chalk and Talk, Assignments and seminar
	Regression, Decision Tree, Neural Networks	3	
	Genetic Algorithms , Cluster Analysis , Outlier	3	
	Cluster Vs Classification , Clustering Issues	3	
	Impact of Outliers on clustering	2	
	Clustering problems , Clustering Approaches	3	
IV	Clustering Algorithms, Hierarchical algorithm, single link	2	PPT, Chalk and Talk, Assignments and seminar
	MST Single Link - Complete Link - Average Link	2	
	Dendrogram - Partitional Algorithm	2	
	MST - Squared Error - K-Means	2	
	- Nearest Neighbor – PAM – BEA – GA -	2	
	Categorical algorithm - Large Database	2	
V	Web Mining Introduction , Web data	3	PPT, Chalk and Talk, Assignments and seminar
	Web Knowledge Mining Taxonomy	3	
	Web Content mining	3	
	Web Usage Mining Research	3	
	Ontology based web mining Research, Applications	3	

Course Learning Outcomes

On the successful completion of the course, students will be able to

CLO's	Course Learning Outcomes	Knowledge Level
CLO-1	Explain the concepts of data warehouse and Analyze OLAP tool Analyze the basic functions of data warehouse and data mining.	Up toK3
CLO-2	Compare and evaluate different data mining techniques like classification, prediction and association rule mining	Up toK2

CLO-3	Categorize and carefully differentiate between situations for applying different data-mining techniques: Chi square, Regression, cluster, and outlier analysis.	Up to K3
CLO-4	Evaluate the performance of different data-mining algorithms.	Up to K4
CLO-5	Describe complex data types with respect to web mining	Up to K4

MAPPING CLOs WITH PSOs

#	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CLO-1				3			2
CLO-2		3	1				
CLO-3		1				2	
CLO-4	3	2	3				
CLO-5						1	3

CIA I – Blue Print

Units	CLOs	K- Level	Section A		Section B		Section C	
			Short Answers		(Either/or Choice)		(Open Choice)	
			No. of Questions	K- Level	No. of Questions	K- Level	No. of Questions	K- Level
1	CLO 1	Up to K3	3	K2, K2,K3	2	K3,K3	2	K3, K3
2	CLO 2	Up to K2	2	K1, K1	2	K2,K2	1	K2
No. of Questions to be asked			5		4		3	
No. of Questions to be answered			5		2		2	
Marks for each question			2		5		10	
Total Marks for each section			10		10		20	

CIA-I :: Distribution of Section-wise Marks with K levels

K Levels	Section A (No choice)	Section B (Either/ or)	Section C (Open choice)	Total marks	% of marks without choice	Consolidated
K1	4	-	-	4	6.67	46.67%
K2	4	10	10	24	40.00	
K3	2	10	20	32	53.33	53.33%
K4	-	-	-	-	-	-
K5	-	-	-	-	-	-
Total Marks	10	20	30	60	100	100%

CIA II – Blue Print

Units	CLOs	K- Level	Section A		Section B		Section C	
			Short Answers		(Either/or Choice)		(Open Choice)	
			No. of Questions	K- Level	No. of Questions	K- Level	No. of Questions	K- Level
1	CLO 3	Up to K3	3	K1,K1, K2	2	K3, K3	2	K3, K3
2	CLO 4	Up to K4	2	K2, K3	2	K4, K4	1	K4
No. of Questions to be asked			5		4		3	
No. of Questions to be answered			5		2		2	
Marks for each question			2		5		10	
Total Marks for each section			10		10		20	

CIA-II :: Distribution of Section-wise Marks with K levels

K Levels	Section A (No choice)	Section B (Either/ or)	Section C (Open choice)	Total marks	% of marks without choice	Consolidated
K1	4	-	-	4	6.67	13.34%
K2	4	-	-	4	6.67	
K3	2	10	20	32	53.33	53.33%
K4	-	10	10	20	33.33	33.33%
K5	-	-	-	-	-	-
Total Marks	10	20	30	60	100	100%

Summative Examination – Blue Print

Units	CLOs	K Level	Section A		Section B		Section C (Either/or Choice)	Section D (Open Choice)
			MCQs		Short Answers			
			No. of questions	K Level	No. of questions	K level		
1	CLO -1	Up to K3	2	K2 & K3	1	K1	2(K2 & K2)	1(K3)
2	CLO -2	Up to K2	2	K1 & K1	1	K1	2(K1 & K1)	1(K2)
3	CLO -3	Up to K3	2	K2 & K3	1	K2	2(K3 & K3)	1(K3)
4	CLO -4	Up to K4	2	K3 & K4	1	K3	2(K4 & K4)	1(K4)
5	CLO -5	Up to K4	2	K3 & K4	1	K2	2(K4 & K4)	1(K4)
No. of Questions to be asked			10		5		10	5
No. of Questions to be answered			10		5		5	3
Marks for each question			1		2		5	10
Total Marks for each Section			10		10		25	30

Distribution of section wise marks with K levels for Summative Examination

K Levels	Section A MCQs	Section B (Short Answers)	Section C (Either/ or)	Section D (Open choice)	Total marks	% of marks without choice	Consolidated
K1	2	4	10	-	16	13.33	
K2	2	4	10	10	26	21.67	35%
K3	4	2	10	20	36	30	30%
K4	2	-	20	20	42	35	35%
K5	-	-	-	-	-	-	-
Total marks	10	10	50	50	120	100	100%

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THE MADURA COLLEGE (Autonomous), MADURAI – 625 011

(AFFILIATED TO MADURAI KAMARAJ UNIVERSITY)

RE-ACCREDITED (3rd Cycle) WITH "A" GRADE BY NAAC

PROGRAMME : NME - Statistics **COURSE CODE : 21P1SNM1**

COURSE TITLE : Introduction to Non – Parametric Statistics **QN.NO : 12508**

TIME : 3 Hours **MAX.MARKS :75**

Course Objectives:

1. To explore knowledge in the advanced methods of nonparametric inference.
2. To derive inference for samples drawn from distribution free population.

Unit	Description	Hours	K-level	CLO(s)
I	Introduction - Fundamental statistical concept - Run test for randomness, χ_2 goodness of fit test. Kolmogrov – Smirnov one sample test, Kolmogrov – Smirnov two sample test, Binomial test , Point estimator and confidence interval for probability of success.	8	K2	1
II	One sample location problems – Wilcoxon signed rank test. Fishers sign test. Asymptotic test of symmetry – Estimators and confidence interval.	6	K2	2
III	Two sample problems – Wilcoxon rank sum test for location parameter (Mann – Whitney). Test for dispersion parameter – Rank test, Rank like test (Moses), Millers asymptotic test based on Jackknife.	4	K2	3
IV	One way layout – Kruskal Wallis test - Test for ordered alternatives, Multiple comparison based on Kruskal Wallis rank sums. Two way layout - Friedman's rank sums test. Test for ordered alternatives , multiple comparisons.	6	K2	4
V	Kendals test for independence - Theil's test for regression coefficients - Hollander's test for parallelism of two regression lines.	6	K2	5

Books for References:

1. Gibbons (2003), Non parametric Statistical Inference, McGraw –Hill Kogakusha, Ltd.
2. Hollander Myles & Wolfe D.A.(1973) , Non parametric Statistical Methods, John Wiley & Sons.

Web Pages:

1. Introduction of non-Parametric methods:
   https://corporatefinanceinstitute.com/resources/knowledge/other/nonparametric-tests/
   https://www.yourarticlelibrary.com/statistics-2/non-parametric-tests-concepts-precautions-and-advantages-statistics/92360
   https://statisticsbyjim.com/hypothesis-testing/nonparametric-parametric-tests/
   https://www.statisticshowto.com/probability-and-statistics/statistics-definitions/parametric-and-non-parametric-data/
2. Theil's test:
   https://www.youtube.com/watch?v=OqBFv_omR1E
3. Hollander's test for parallelism of two regression lines
   https://ufdc.ufl.edu/AA00025285/00001

Rationale for Nature of the course

In this course, the basic non-parametric statistical tests are introduced. Explained when non-parametric test should be used and equivalent non-parametric test for most widely used parametric tests

such as t – test, ANOVA, correlation etc., and other useful non-parametric test are demonstrated with practical application for real time data.

Activities having direct bearing on Skill development / Employability / Entrepreneurship

Problem solving sessions with the sample real time data

Pedagogy

Chalk and Talk, PPT, Interaction, Problem solving.

Lecture Schedule

Unit	Topics	Hours	Mode
I	Introduction - Fundamental statistical concept	1	PPT , Chalk and Talk, Problem solving Interaction
	Run test for randomness, χ^2goodness of fit	3	
	Kolmogrov – Smirnov one and two sample test	1	
	Binomial test,	2	
	Point estimator and confidence interval for probability of success.	1	
II	Wilcoxon signed rank test	1	PPT , Chalk and Talk, Problem solving Interaction,
	Fishers sign test	1	
	Asymptotic test of symmetry	2	
	Estimators and confidence interval	2	
III	Wilcoxon rank sum test	1	PPT , Chalk and Talk, Problem solving Interaction
	Rank test, Rank like test	1	
	Millers asymptotic test based on Jackknife	2	
IV	Kruskal Wallis test	2	PPT , Chalk and Talk, Problem solving Interaction,
	Kruskal Wallis rank sums	2	
	Friedman's rank sums test	2	
V	Kendals test for independence	2	PPT , Chalk and Talk, Problem solving
	Theil's test for regression coefficients	2	
	Hollander's test for parallelism of two regression lines	2	

Course Learning Outcomes

On the successful completion of the course, students will be able to

CLO's	Course Learning Outcomes	Knowledge Level
CLO-1	Solve hypothesis testing problems where the assumptions for the parametric inferential tools to be applied are not fulfilled. .	Up toK2
CLO-2	Understand the problem associated with skewed data.	Up toK2
CLO-3	Formulate, test and interpret various hypothesis tests for location, scale, and independence problems.	Up toK2
CLO-4	Characterize, compare, and contrast different nonparametric hypothesis tests.	Up toK2
CLO-5	Present and communicate, both orally and in written-form, the results of statistical analyses of nonparametric data	Up toK2

MAPPING CLOs WITH PSOs

#	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CLO-1	2	2	2	2		2	2
CLO-2	2	2	3	2		2	2
CLO-3	1	2	2	2		2	3
CLO-4	1	1		2	2	2	1
CLO-5	2	1	2	2		2	1

Advance application – 3; Intermediate level – 2; Basic level – 1

CIA-I–BluePrint

CLOs	K- Level	Section A		Section B		Section C	
		Short Answers		(Either/or Choice)		(Open Choice)	
		No. of Questions	K- Level	No. of Questions	K- Level	No. of Questions	K- Level
CLO 1	Up to K2	1	K1	1	K2/K2	1	K1
CLO 2	Up to K2	2	K1	1	K2/K2	2	K1
No. of Questions to be asked		3		2		3	
No. of Questions to be answered		3		2		2	
Marks for each question		2		7		10	
Total Marks for each section		**6**		**14**		**20**	

CIA-I :: Distribution of Section-wise Marks with K levels

K Levels	Section A (No Choice)	Section B (No Choice)	Section C (Either/or)	Total Marks	% of Marks without choice	Consolidated %
K1	6	-	30	**36**	56.25	**100**
K2	-	28	-	**28**	43.75	
K3	-	-	-	**-**	-	**-**
K4	-	-	-	**-**	-	**-**
Total Marks	**6**	**14**	**30**	**64**	**100.00**	**100%**

CIA-II – Blue Print

CLOs	K- Level	Section A		Section B		Section C	
		Short Answers		(Either/or Choice)		(Open Choice)	
		No. of Questions	K- Level	No. of Questions	K- Level	No. of Questions	K- Level
CLO 3	Up to K2	1	K1	1	K2/K2	1	K1
CLO 4	Up to K2	2	K1	1	K2/K2	2	K1
No. of Questions to be asked		3		2		3	
No. of Questions to be answered		3		2		2	
Marks for each question		2		7		10	
Total Marks for each section		**6**		**14**		**20**	

CIA-II :: Distribution of Section wise Marks with K levels

K Levels	Section A (No Choice)	Section B (No Choice)	Section C (Either/or)	Total Marks	% of Marks without choice	Consolidated %
K1	6	-	30	**36**	56.25	**100**
K2	-	28	-	**28**	43.75	
K3	-	-	-	**-**	-	**-**
K4	-	-	-	**-**	-	**-**
Total Marks	**6**	**14**	**30**	**64**	**100.00**	**100%**

CLO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination -Blue Print

Units	CLOs	K-Level	Section – A		Section – B		Section – C	
			Short Answers		(Either / or Choice)		(Open Choice)	
			No. of Questions	K-Level	No. of Questions	K-Level	No. of Questions	K-Level
1	CLO 1	Up to K2	1	K1	1	K2/K2	1	K1
2	CLO 2	Up to K2	1	K1	1	K2/K2	1	K1
3	CLO 3	Up to K2	1	K1	1	K2/K2	1	K1
4	CLO 4	Up to K2	1	K1	1	K2/K2	1	K1
5	CLO 5	Up to K2	1	K1	1	K2/K2	1	K1
No. of Questions to be asked			5		5		5	
No. of Questions to be answered			5		5		3	
Marks for each question			2		7		10	
Total Marks for each section			10		35		30	

Distribution of Marks with K Level for Summative Examination

K Levels	Section A (No Choice)	Section B (No Choice)	Section C (No Choice)	Total Marks	% of Marks (without choice)	Consolidated
K1	10	-	50	60	46.15	100
K2	-	70	-	70	53.85	
K3	-	-	-	-	-	-
K4	-	-	-	-	-	-
Total Marks	**10**	**35**	**50**	**130**	**100.00**	**100**

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