ಕರ್ನಾಟಕ ರಾಜ್ಯ ಅಕ್ಕಮಹಾದೇವಿ ಮಹಿಳಾ ವಿಶ್ವವಿದ್ಯಾನಿಲಯ, ವಿಜಯಪುರ
(ಹಿಂದಿನ ಪದನಾಮ "ಕರ್ನಾಟಕ ರಾಜ್ಯ ಮಹಿಳಾ ವಿಶ್ವವಿದ್ಯಾನಿಲಯ, ವಿಜಯಪುರ")

Karnataka state Akkamahadevi Women's University, Vijayapura
(Formerly known as "Karnataka State Women's University, Vijayapura")

DEPARTMENT OF STATISTICS

Scheme of Teaching and Examinations and Syllabus of

Master of Statistics (M.Sc.)

(Two Year Programme)

As per CBCS regulations

w.e.f. 2022-23 and onwards

Approved in BoS in Statistics (PG) dated 18-08-2022

New Syllabus of M.A./M.Sc. Programme in Statistics under Choice Based Credit System (CBCS) w.e.f. from the academic year 2022-2023and onwards

MSc(Statistics) I semester w.e.f. 2022-23 and onwards										
Sl. 9[t No.	Course Code	Subject Title	Credits			No. of hrs / Week Theory / Practical	Examination			
							IA marks	Semester end Exams		Total marks
			L	T	P			Duration Hrs	Exam marks	
1.	22STHCT1.1	Probability Theory	4	0	0	4	30	3	70	100
2.	22STHCT1.2	Distribution Theory	4	0	0	4	30	3	70	100
3.	22STHCT1.3	Matrix Theory and Linear models	4	0	0	4	30	3	70	100
4.	22STSCT1.4	(a): Data base Techniques (b):Linear programming	4	0	0	4	30	3	70	100
5.	22STHCP1.5	Practical based on 21STHCT 1.3	0	0	4	4	30	3	70	100
6.	22STHCP1.6	Statistical Computing using R	0	0	4	4	30	3	70	100
7.	22STOEP1.1	Statistical Methods and Applications	4	0	0	4	30	3	70	100
Total			**28**							**700**

MSc(Statistics) II semester w.e.f. 2022-23 and onwards										
Sl. No.	Course Code	Subject Title	Credits			No. of hrs / Week Theory / Practical	Examination			
							IA marks	Semester end Exams		Total marks
			L	T	P			Duration Hrs	Exam marks	
1.	22STHCT2.1	Real Analysis	4	0	0	4	30	3	70	100
2.	22STHCT2.2	Statistical Inference-I	4	0	0	4	30	3	70	100
3.	22STHCT2.3	Design of Experiments	4	0	0	4	30	3	70	100
4.	22STSCT2.4	(a): Survival Analysis (b): Sampling Theory	4	0	0	4	30	3	70	100
5.	22STHCP2.5	(Based on 21STHCT 2.2 and 21STHCT 2.3)	0	0	4	4	30	3	70	100
6.	22STHCP2.6	(Based on 21STSCT 2.4(b)	0	0	4	4	30	3	70	100
7.	22STOEP2.1	Statistical Data Analysis	4	0	0	4	30	3	70	100
Total			**28**							**700**

MSc(Statistics) III semester w.e.f. 2022-23 and onwards										
Sl. No.	Course Code	Subject Title	Credits			No. of hrs / Week Theory / Practical	Examination			
							IA marks	Semester end Exams		Total marks
			L	T	P			Duration Hrs	Exam marks	
1.	22STHCT3.1	Statistical Inference II	4	0	0	4	30	3	70	100
2.	22STHCT3.2	Multivariate Analysis	4	0	0	4	30	3	70	100
3.	22STSCT3.3	(a): SQC & Reliability Theory (b):Bio Statistics (c) Stochastic Process	4	0	0	4	30	3	70	100
4.	22STHCP3.4	(Based on 21STHCT 3.1and 21STHCT 3.3)	0	0	4	4	30	3	70	100
5.	22STHCP3.5	(Based on 21STHCT 3.2)	0	0	4	4	30	3	70	100
6.	22STOEP3.1	Statistical Data Analyses using R	4	0	0	4	30	3	70	100
Total			**24**							**600**

MSc(Statistics) IV semester w.e.f. 2022-23 and onwards										
Sl. No.	Course Code	Subject Title	Credits			No. of hrs / Week Theory / Practical	Examination			
							IA marks	Semester end Exams		Total marks
			L	T	P			Duration Hrs	Exam marks	
1.	22STHCT4.1	Non-Parametric Methods	4	0	0	4	30	3	70	100
2.	22STHCT4.2	Statistical Machine Learning Algorithms Using Python	4	0	0	4	30	3	70	100
3.	22STSCT4.3	(a): Data Science (b):Genetics Algorithms (c) Time Series Analysis	4	0	0	4	30	3	70	100
4	22STHCP4.4	Project (Primary and secondary)	0	1	3	Dissertation 50	Presentation 25	Viva 25	--	100
5.	22STOEP4.1	Applied Statistics	4	0	0	4	30	3	70	100
Total			**20**							**500**

Graduate Attributes

- Have the ability to demonstrate advanced independent critical enquiry, analysis and reflection;
- Have a strong sense of intellectual integrity and the ethics of scholarship;
- Have in-depth knowledge of their specialist discipline(s);
- Reach a high level of achievement in writing, research or project activities, problem-solving and communication;
- Be critical and creative thinkers, with an aptitude for continued self-directed learning;
- Be able to examine critically, synthesizes and evaluate knowledge across a broad range of disciplines;
- Have a set of flexible and transferable skills for different types of employment; and
- Be able to initiate and implement constructive change in their communities, including professions and workplaces.

Master of Statistics (M.Sc.) programme has been designed to preparegraduates for attaining the following programme outcomes:

PO1: Inculcate critical thinking to carry out scientific investigation objectively without being biased with pre-conceived notions.
PO2: Equip the student with skills to analyze problems, formulate a hypothesis, evaluate and validate result, and draw reasonable conclusions thereof.
PO3: Prepare students for pursuing research or careers in industry in mathematical sciences and applied fields.
PO4: Imbibe effective scientific and/or technical communication in both oral and writing.
PO5: Continue to acquire relevant knowledge and skills appropriate to professional activities and demonstrate highest standards of ethical issues in mathematical sciences.
PO6: Create awareness to become an enlightened citizen with commitment to deliver one's responsibilities within the scope of bestowed rights and privileges.

Program Specific Outcomes for Master of Statistics (M.Sc.):

PSO1: Understanding of the fundamental axioms in mathematics and capability of developing ideas based on them.
PSO2: Inculcate mathematical reasoning.
PSO3: Prepare and motivate students for research studies in Statistics and related fields.
PSO4: Provide knowledge of a wide range of mathematical techniques and application of statistical methods /tools in other scientific and engineering domains.
PSO5: Provide advanced knowledge on topics in applied Statistics, empowering the students to pursue higher degree at reputed academic institutions.
PSO6: Strong foundation on algebraic topology and representation theory which have strong links and application in theoretical physics, in particular string theory.
PSO7: Good understanding of number theory which can be used in modern online Cryptographic technologies.
PSO8: Nurture problem solving skills, thinking, creativity through assignments, project work.
PSO9: Assist students in preparing (personal guidance, books) for competitive exams e.g. NET, GATE, etc.

Programme Pedagogy:

The various courses offered in the M.Sc. programme will have three major components such as Theory, Tutorial and Practical. Many courses have all the three components, some courses have only theory and tutorial/practical components and some courses have only theory components.So the nature of the course can be generally expressed as L:T:P model where L stands for lecture/theory, T stands for tutorial and P stands for practical.

The pedagogy to teach a particular course depends on the L:T:P model. In order to give a brief description about the pedagogy followed to teach a particular course, the courses with a particular L:T:P structure are grouped and the pedagogy followed to deliver the contents of the course is mentioned below:

For the courses that have theory and tutorial components (4:0:0), the theoretical concepts, principles and methods are explained with example analogy or use cases. Illustrative examples, theorem proving approaches, axioms, derivations, computing models and descriptions are used to effectively demonstrate the ideas and to convey the course. Conventional black boards/white boards are used for writing and explanation. Smart boards, ICT tools such as power point, spreadsheet, word processing, database management and graphics are used for illustrations and descriptions of the concept. Video clips and graphical illustrations are used whenever necessary to enhance the understanding of the concept. Group discussions, seminars and online demonstrations using specific tools are carried out to better understand the concepts.

For the courses that have theory and practical components (0:0:2), the theoretical concepts are taught as described in the previous paragraphs using conventional black/white board approach as well as smart ICT based approach. In addition, hands on experience will be provided through practical classes, where the students are allowed to use the computer and the related software tools to solve a particular problem, to provide a particular service as appropriate. With practical classes, students are exposed to current technology and gain an understanding how to solve a real time problem. A list of course specific assignments is used to practice and also to test the practical skills of the students.

For the courses that have all the three components i.e. Theory, Tutorial and Practical components, a blended mode of teaching, which includes conventional classroom teaching using black/white boards, smart classroom teaching using ICT tools, demonstrations through experiments and simulations followed by hands on experience with practical classes.

For the dissertation course, any real time/live projects will be selected and based on the nature of the project, field works for data collection, bridge courses for learning tools and technology needed to implement the solution to the problem undertaken are carried out.

Note: Part of Syllabus

1. Industrial Tour relevant to the Statistical applications and models for second year students.

SEMESTER I

22STHCT1.1	Probability Theory	
Credits: L:4	Teaching: 4Hrs/week Total Teaching Hours : 52	Max. Marks: 100 **C1: 15; C2: 15; C3: 70**

Course Outcomes:

CO1: A person successfully completing the Course will acquire basic knowledge of axiomatic Probability Theory.
CO2: This basic course is a prerequisite to an advanced course as well as to understand topics in Mathematical Statistics.
CO3: Knowledge gained about Chebyachev's WLLN.
CO4: Knowledge gained about Kolmogorov's inequality.

Unit 1 **13 Hrs**

Sets – functions - Sigma field – Measurable space – Sample space – Measure– Probability as a measure - Inverse function - Measurable functions –Random variable - Induced probability space - Distribution function of a random variable: definition and properties.

Unit 2 **13 Hrs**

Expectation and moments: Definition and properties – Probability generating function - Moment generating functions - Moment inequalities: Markov's, Chebychev's, Holder, Jenson and basic inequalities - Characteristic function and properties (idea and statement only).

Unit 3 **16 Hrs**

Random vectors – joint distribution function – joint moments – Conditional probabilities - Randon-Nikodym Theorem (Statement only) - Bayes' theorem– conditional distributions – independence - Conditional expectation and its properties . Modes of convergence: Convergence in probability, in distribution, in r^{th} mean, almost sure convergence and their inter-relationships – Convergence theorem for expectation

Unit 4 **10 Hrs**

Law of large numbers - Convergence of series of independent random variables - Weak law of large numbers (Kninchine's and Kolmogorov's) -Kolmogorov's strong law of large numbers - Central limit theorems for i.i.d random variables: Lindberg-Levy and Liaponov's CLT.

Reference Books

1. Rohatgi, V.K. and Salah, A.K.E, (2015), An Introduction to Probability and Statistics, 3rd Ed., John Wiley & Sons.
2. Bhat, B.R, (2014), Modern Probability Theory, 4th Ed., New Age International.
3. Feller W, (2008), An Introduction to Probability Theory and its Applications, Volume I , 3rd Ed., Wiley Eastern.
4. Feller W, (2008), An Introduction to Probability Theory and its Applications, Volume II,3rd Ed., Wiley Eastern.
5. Billingsley, P. (2008). Probability and measure. John Wiley & Sons.
6. Basu A.K, (2012), Measure Theory and Probability, 2nd Ed., PHI.

22STHCT1.2	Distribution Theory	
Credits: L:4	Teaching: 4Hrs/week Total Teaching Hours : 52	Max. Marks: 100 **C1: 15; C2: 15; C3: 70**

Course Outcomes:

CO1: A person successfully completing the Course will acquire basic knowledge of axiomatic distribution Theory.
CO2: This basic course is a prerequisite to an advanced course as well as to understand topics in Mathematical Statistics.
CO3: Competency developed on Applications of various distributions.
CO4: Competency developed on Applications of Characteristic function of various distributions.

Unit 1 **12 Hrs**

Modified power series family and properties - Binomial – Negative binomial, Poisson, geometric, Logarithmic series, Lagrangian distributions etc. and their properties as special cases of the results from modified power series family.

Unit 2 **12 Hrs**

Pearsonian system of distributions - Beta, Gamma, Pareto and Normal as special cases of the Pearson family and their properties - Exponential family of distributions.

Unit 3 **13 Hrs**

Sampling distributions of the mean and variance from normal population -independence of mean and variance - chi-square, students t and F distribution and their non-central forms, Order statistics and their distributions.

Unit 4 **15 Hrs**

Bivariate Poisson, Multinomial distribution - Multivariate normal (definition only) - bivariate exponential distribution of Gumbel - Marshall and Olkin distribution - Dirichlet distribution. Quadratic forms in normal variables: distribution and properties – Cochran's theorem: applications.

Reference Books:

1. Rohatgi, V.K. and Salah, A.K.E. (2015) An Introduction to Probability and Statistics, 3rd Ed., John Wiley & Sons.
2. Krishnamoorthy, K. (2016). Handbook of statistical distributions with applications. CRC Press.
3. Johnson N.L, Kotz S and Kemp A.W (2005) Univariate discrete distributions, 3rd Ed., John Wiley.
4. Johnson N.L, Kotz S and Balakrishnan N (2017) Continuous univariate distributions I& II, John Wiley.
5. Johnson N.L, Kotz S and Balakrishnan N (2000) Multivariate Distribution, 2nd Ed., John Wiley.
6. Arnold B.C, Balakrishnan N and Nagaraja H.N (2012) A first course in order statistics.

22STHCT1.3	Matrix Theory and Linear Models	
Credits: L:4	Teaching: 4Hrs/week Total Teaching Hours : 52	Max. Marks: 100 **C1: 15; C2: 15; C3: 70**

Course Outcomes:

CO1: A person successfully completing the Course will acquire basic knowledge of Matrix Theory and linear models.
CO2: This basic course is a prerequisite to an advanced course as well as to understand topics in Mathematical Statistics.
CO3: Knowledge gained about matrix applications.

Unit 1 **15 Hrs**

Matrix operations - Linear equations - row reduced and echelon form - Homogenous system of equations - Linear dependence . Algebra of linear transformations - Matrix representations - rank nullity theorem - determinants – eigenvalues and eigenvectors - Cayley-Hamilton theorem - Jordan canonical forms – orthogonalization process - orthonormal basis.

Unit 2 **12 Hrs**

Vectors- Operations on vector space - subspace – nullspace and columnspace - Linearly independent sets - spanning set - bases - dimension - rank -change of basis.

Unit 3 **12 Hrs**

Reduction and classification of quadratic forms - Special matrices: symmetric matrices - positive definite matrices - idempotent and projection matrices - stochastic matrices - Gramian matrices - dispersion matrices.

Unit 4 **13 Hrs**

Fitting the model - ordinary least squares - estimability of parametric functions - Gauss – Markov theorem - applications: regression model -analysis of variance.

Text Books And Reference Books:

1. David C. Lay, Steven R. Lay, Judi J. McDonald (2016) Linear algebra and its applications. Pearson.
2. Lipschutz, S., & Lipson, M. L. (2018). Schaum's Outline of Linear Algebra. McGraw-Hill Education.
3. Searle, S. R., &Khuri, A. I. (2017). Matrix algebra useful for statistics. JohnWiley& Sons.
4. Rencher, A. C., &Schaalje, G. B. (2008). Linear models in statistics. JohnWiley & Sons.

22STHCT1.4(a)	Data Base Techniques	
Credits: L:4	Teaching: 4Hrs/week Total Teaching Hours : 52	Max. Marks: 100 **C1: 15; C2: 15; C3: 70**

Course Outcomes:

CO1: A person successfully completing the Course will acquire basic knowledge of Data structure and warehousing.

CO2: This basic course is a prerequisite to an advanced course as well as to understand topics in Mathematical Statistics.

CO3: Helps to build career in industry.

Unit 1 **12 Hrs**

Concept and Overview of DBMS, Data Models, Database Languages,Database Administrator, Database Users, Three Schema architecture ofDBMS. Basic concepts, Design Issues, Mapping Constraints, Keys, Entity-Relationship Diagram, Weak Entity Sets,

Unit 2 **10 Hrs**

Functional Dependency,Different anomalies in designing a Database, Normalization: usingfunctional dependencies, 1NF, 2NF, 3NF and Boyce-Codd Normal Form

Unit 3 **14 Hrs**

SQL Basic Structure - DDL, DML, DCL-Integrity Constraints – DomainConstraints, Entity Constraints - Referential Integrity Constraints,Concept of Set operations, Joins, Aggregate Functions, Null Values, ,assertions, views, Nested Subqueries – procedural extensions – storedprocedures – functions- cursors – Intelligent databases – ECA rule – DataIntegration – ETL Process

Unit 4 **16 Hrs**

Data Warehousing - Defining Feature – Data warehouses and data marts–Metadata in the data warehouse – Data design and Data preparation -Dimensional Modeling - Principles of dimensional modelling – The starschema – star schema keys – Advantages of the star schema – Updates tothe dimension tables – The snowflake schema – Aggregate fact tables –Families Oo Stars – MDX queries – Reporting services.

Text Books And Reference Books:

1. Davy Cielen, Arno D. B. Meysman, Mohamed Ali (2016),Introducing Data Science, Manning Publications Co.
2. Thomas Cannolly and Carolyn Begg, (2007), DatabaseSystems, A Practical Approach to Design, Implementation andManagement", 3rd Edition, Pearson Education.

22STHCT1.4(b)	Linear Programming	
Credits: L:4	Teaching: 4Hrs/week Total Teaching Hours : 52	Max. Marks: 100 **C1: 15; C2: 15; C3: 70**

Course Outcomes:

CO1: A person successfully completing the Course will acquire basic knowledge of graphs of feasible and simplex method.

CO2: This basic course is a prerequisite to an advanced course as well as to understand topics in Mathematical Statistics

CO3: Knowledge gained about scope of operation research .

Unit 1 **10 Hrs**

Introduction to optimization – convex set and convex functions – simplex method: iterative nature of simplex method – additional simplex method: duality concept -dual simplex method – generalized simplex algorithm -revised simplex method: revised simplex algorithm –development of the optimality and feasibility conditions.

Unit 2 **10 Hrs**

Branch and bound algorithm – cutting plane algorithm –transportation problem: north-west method, least-cost method, vogel's approximation and method of multipliers– assignment problem: mathematical statement, Hungarian method, variations of assignment problems.

Unit 3 **20 Hrs**

Introduction – unimodal function – one dimensional optimization: Fibonacci method – golden Section Method –quadratic interpolation methods - cubic inter-polation methods – direct root method: newton method and quasi-newton method – Multidimensional unconstrainedoptimization: univariate method – Hooks and Jeevesmethod – Fletcher – Reeves method - Newton's methodand quasi newton's method. Unconstrained minimization problem – solution of an unconstrained geometric programming problem using arithmetic-geometric inequality method – primal dual relationship - constrained minimization programming

Unit 4 **12 Hrs**

Single variable optimization – multivariable optimization with no constraints: semi-definite case and saddle point –multivariable optimization with equality constraints: direct substitution – method of constrained variation – method of Lagrange multipliers - Kuhn-Tucker conditions – constraint qualification – convex programming problem. . dynamic programming: Dynamic programming algorithm – solution of linear programming problem by dynamic programming.

Text Books And Reference Books:

1. H. A. Taha (2017), Operations Research – An Introduction, 10th Edition, Prentice – Hall of India, New Delhi.
2. S. S. Rao (2019), Engineering Optimization, 5th Edition, New Age International Pvt. Ltd., Publishers, Delhi.
3. J.K. Sharma (2010), Quantitative Techniques for Managerial Decisions, Macmillan.
4. Hadley, G. (2002), Linear Programming, Addison Wesley.
5. G. Srinivasan (2007), Operations Research: Principles &Applications, Prentice

22STHCT1.5	**Practical (Based on 21STHCT 2.2 and 21STHCT 2.3)**	
Credits: L:4	Teaching: 4Hrs/week Total Teaching Hours : 52	Max. Marks: 100 **C1: 15; C2: 15; C3: 70**

22STHCT1.6	**Practical based on Statistical Computing using R**	
Credits: L:4	Teaching: 4Hrs/week Total Teaching Hours : 52	Max. Marks: 100 **C1: 15; C2: 15; C3: 70**

22STOEP1.1	**Statistical Methods and Applications**	
Credits: L:4	Teaching: 4Hrs/week Total Teaching Hours : 52	Max. Marks: 100 **C1: 15; C2: 15; C3: 70**

Course Outcomes:
C01: A person successfully completing the Course will be exposed to basic statistical methods used to analyze data and enough applications of such methods.
C02: Basic ideas about statistical linear programming.
C03: Basic ideas about Competitive exams and Statistics.
CO4: Helps to build careers in Industry.

Unit 1: **14 Hours**
Descriptive Statistics: Data presentation by charts and tables, measures of central tendency, Measures of dispersion, Skewness and kurtosis.

Unit 2: **14 Hours**
Correlation and regression Analysis, Scatter plot, Karl-Pearson's coefficient of correlation, Spearman's rank correlation, Simple regression Analysis.

Unit 3: **14 Hours**
Basic s of testing of hypothesis, Test for proportions (one sample and two sample problems), Test for mean, test for variance (one sample and two sample problems), Chi-Square test of independence.

Unit 4: **10 Hours**
Linear programming problems (LPP), Solution by graphical method, Transportation, Assignment and sequencing (Feasible solutions only).

Books for Reference:
1. Medhi J (1994), Stochastic Processes, 2nd edn., Wiley Eastern Ltd., New Delhi.
2. Bhattacharya, G.K. and Johnson, R.A. Statistical concepts and methods. Wiley Eastern. Calcutta, Bombay and Delhi.

3. Goon A.M., Gupta, M.K. and Das Gupta B: Fundamental of Statistics Vol.1 and II. World Press Pvt. ltd., Calcutta.

SEMESTER II

22STHCT2.1	Real Analysis	
Credits: L:4	Teaching: 4Hrs/week Total Teaching Hours : 52	Max. Marks: 100 **C1: 15; C2: 15; C3: 70**

Course Outcomes:

CO1: A person successfully completing the Course will have enough knowledge of Real Analysis including standard techniques used in proofs of results in Real Analysis.
CO2: Standard skills to solve problems in Analysis are learnt in the Course and these are useful to understand topics in Probability Theory and Mathematical Statistics.
CO3: Apply to obtain results and solve problems in these subjects.

Unit 1 **10 Hrs**

Elements of set theory, Sets in Euclidean space of k-dimensional R^k rectangles, neighbourhood, interior point and limit point, open and closed sets, Bolzano-Weierstrass theorem in R^2, Real valued functions continuity and uniform continuity.

Unit 2 **12 Hrs**

Sequences and Series of constants-Limit superior, limit inferior and limit -properties. Cesaro sequences. Series of positive terms -Tests for convergence, divergence. Integral and Order tests and Kummers' test (statement only of all the tests)-Ratio and Raabe's tests as special cases of Kummers'

Unit 3 **14 Hrs**

Sequences of functions-Uniform convergence and point wise convergence, Series of functions-uniform convergence-Weierstrass' M test. Power series and radius of convergence. Riemann-Stieltjes integration-continuous integrand and monotonic / differentiable integrator.

Unit 4 **16 Hrs**

Functions of two variables-partial and directional derivatives. Maxima and minima of functions, maxima-minima under constraints (Lagrange's multipliers). Parametric functions. Uniform convergence of improper integrals, Differentiation Under integrals. Double integrals and repeated integrals. Change of variables under double integration-statement of the theorems without proof and solution of problems.

Books for reference:

1. Apostol, T.M. (1985): Mathematical Analysis, Narosa India Ltd.
2. Courant, R. and John, F. (1965): Introduction to Calculus and Analysis, Wiley.
3. Goldberg, R.R.(1970): Methods of Real Analysis, Oxford Publishing Co.
4. Khuri, A.T. (1993): Advanced Calculus with Applications in Statistics, John Wiley.
5. Rudin, W. (1976): Principles of Mathematical Analysis, Mc Graw Hill.
6. Shantinarayan (1950) : A course of Mathematical analysis, Sultan Chand and Co.

22STHCT2.2	Statistical Inference I	
Credits: L:4	Teaching: 4Hrs/week Total Teaching Hours : 52	Max. Marks: 100 **C1: 15; C2: 15; C3: 70**

Course Outcomes:

CO1: A person successfully completing the Course will acquire knowledge of many topics in basics of mathematical statistics which is a prerequisite to advanced topics in mathematical statistics.
CO2: Knowledge gained about estimation and confidence intervals.
CO3: Knowledge gained about Exponential family.

Unit 1 **16 Hrs**

Sufficiency, completeness, Uniformly minimum variance unbiased estimators, C-R inequalities, exponential class of densities and its properties, some special classes of distributions admitting complete sufficient statistics, extensions of these results to multi-parameter situation.

Unit 2 **12 Hrs**

Test function, Neyman- Pearson lemma for test functions. Uniformly most powerful tests for one sided alternative for one parameter exponential class of densities and extension to the distributions having monotone likelihood ratio property.

Unit 3 **12 Hrs**

Confidence Intervals, shortest expected length confidence intervals, relations with testing of hypotheses, uniformly most accurate confidence intervals.

Unit 4 **12 Hrs**

Bayesian estimation, prior distributions, posterior distribution, loss function, principle of minimum expected posterior loss, quadratic and other common loss functions, conjugate prior distributions. Common examples. Bayesian HPD confidence intervals.

Books for Reference:

1. Kale, B.K. (2005). A First Course on Parametric Inference.Second Edition.Narosa.
2. Casella, G. and Berger, R. L. (2002). Statistical Inference.2nd Edition, Duxbury Advanced series.
3. Dudewicz, E. J. and Mishra, S.N.(1988). Modern Mathematical Statistics, John Wiley.
4. Roussas, G. G. (1973). First Course in Mathematical Statistics, Addison Wesley.
5. Silvey, S. D. (1975). Statistical Inference, Chapman and Hall.
6. Wilks, S. S. (1962). Mathematical Statistics, John Wiley.
7. Lehmann, E. L. (1986). Testing of Statistical hypothesis, John Wiley.
8. Lehmann, E. L. (1988). Theory of Point Estimation, John Wiley.

22STHCT2.3	Design and Analysis of experiments	
Credits: L:4	Teaching: 4Hrs/week Total Teaching Hours : 52	Max. Marks: 100 **C1: 15; C2: 15; C3: 70**

Course Outcomes:

CO1: A person successfully completing the Course will acquire a good foundation on designing and analysing statistical experiments and can independently carry out advanced statistical modelling of several types of data using designs.

CO2: Knowledge gained about Tests of hypotheses for one and more than one linear parametric functions.

CO3: Knowledge gained about Factorial experiments.

Unit 1 **16 Hrs**

Introduction to designed experiments; General block design and its information matrix, criteria for connectedness, balance and orthogonality; Intrablock analysis (estimability, best point estimates/interval estimates of estimable linear parametric functions and testing of linear hypotheses) of BIBD-recovery of interblock information.

Unit 2 **14 Hrs**

Youden design -intrablock analysis. Analysis of covariance in a general Gauss-Markov model, applications to standard designs. Missing plot technique -general theory and applications.

Unit 3 **12 Hrs**

Fixed, mixedand random effects models; Variance components estimation -study of various methods; General factorial experiments, factorial effects: best estimates and testing the significance of factorial effects; study of 2^M and 3^M factorial experiments in randomized blocks.

Unit 4 **10 Hrs**

Complete and partial confounding. Fractional replication for symmetric factorials. Response surface experiments.

Books for Reference:

1. AlokeDey (1986): Theory of Block Designs, Wiley Eastern.
2. Angela Dean and Daniel Voss (1999): Design and Analysis of Experiments, Springer.
3. Chakrabarti,M.C.(1962): Mathematics of Design and Analysis of Experiments, Asia.
4. Cocharan and Cox,D.R.(1957): Experimental Designs, John Wiley.
5. Das, M.N. and Giri, N.(1979): Design and Analysis of Experiments, WileyEastern.
6. Giri, N.(1986): Analysis of Variance, South Asian Publishers.
7. John, P.W.M.(1911): Statistical Design and Analysis of Experiments, Macmillan.

22STHCT2.4(a)	Survival Analysis	
Credits: L:4	Teaching: 4Hrs/week Total Teaching Hours : 52	Max. Marks: 100 **C1: 15; C2: 15; C3: 70**

Course Outcomes:

CO1: A person successfully completing the Course will be exposed to specialized statistical methods used to analyze life time data and to model life time data practically.
CO2: Knowledge gained about Failure rates.
CO3: Knowledge gained about estimation of survival function.

Unit 1 **12 Hrs**

Concepts of Time, Order and Random Censoring. Life distributions - Exponential Gamma, Weibull, Lognormal, Pareto, Linear Failure rate. Parametric inference Point estimation, Confidence Intervals, Scores, tests based on LR , MLE

Unit 2 **12 Hrs**

Life tables, Failure rate, mean residual life and their elementary properties. Ageing classes - IFR, IFRA, NBU, NBUE, NBUE and their duals, Bathtub Failure rate.

Unit 3 **10 Hrs**

Estimation of survival function - Actuarial Estimator, Kaplan - Meier Estimator, Estimation under the assumption of IFR/DFR.

Unit 4 **18 Hrs**

Tests of exponentiality against non-parametric classes - Total time on test, Deshpande test. Two sample problem - Gehan Test, Log rank test. Mantel - Haenszel Test, Tarone - Ware tests. Semi-parametric regression for failure rate - Cox's proportional hazards model with one and several covariates.

Books for Reference:

1. Cox, D.R. and Oakes, D. (1984). Analysis of Survival Data, Chapman and Hall, New York.
2. Gross, A. J. and Clark, V. A. (1975). Survival Distributions: Reliability Applications in the Biomedical Sciences, John Wiley and Sons.
3. Elandt - Johnson, R.E., Johnson, N.L. (1980). Survival models and Data Analysis, John Wiley and Sons. 4. Miller, R.G. (1981). Survival Analysis, Wiley.
4. Zacks, S. Reliability.

22STHCT2.4(b)	Sampling Theory	
Credits: L:4	Teaching: 4Hrs/week Total Teaching Hours : 52	Max. Marks: 100 **C1: 15; C2: 15; C3: 70**

Course Outcomes:

CO1 : A person successfully completing the Course will acquire a very good knowledge of standard sampling designs and a comprehensive knowledge of Statistics used in study of National Development and the Course also has Practical problem solving and data analysis techniques.
CO2: Knowledge gained about Basic Definitions and Applications of SRS (WR/WOR), Strs.
CO3: Skills gained about Estimation of National Income - product approach, income approach and expenditure approach

Unit 1 **10 Hrs**

Basic finite population sampling techniques (SRS WR/ WoR, stratified, systematic), related problems of population mean estimation, allocation problems in stratified sampling.

Unit 2 **18 Hrs**

Unequal probability sampling: PPS WR / WoR methods (including Lahiri's scheme) and related estimators of a finite population mean (Hansen-Hurvitz and Desraj estimators for a general sample size and Murthy's estimator for a sample of size 2). Ratio and regression estimators based on SRS WoR method of sampling, two-stage sampling with equal. Number of second stage units, double sampling, cluster sampling.

Unit 3 **16 Hrs**

Economic development: growth ip. per capita income distributive justice. Indices of development, Human Development Index. Estimation of National Income - product approach, income approach and expenditure approach. Population growth in developing and developed countries. Population projection using Leslie matrix. Labour force projection. Measuring inequality of incomes, Gini coefficient, Theil's measure. Poverty measurement- different issues, measures of incidence and intensity, combined measures, eg. Indices due to Kakwani, Sen. etc.

Unit 4 **8 Hrs**

Women's Empowerment Index: 1) Determinants of empowerment like education, employment, access to health, access to media, access to finance, involvement in decision making process at family and at office/organization . 2) Various measures of women's empowerment index based on sex, geographical region and time etc.

Books for Reference:

1. Choudhary, A and Mukherjee, R (1989): Randomized Response techniques, Marcel Decker.
2. Cochran, W. G. (1977): Sampling techniques, Third Edition, Wiley.
3. Des Raj and Chandok (1998): Sampling Theory, Narosa.
4. Murthy, M. N. (1977): Sampling Theory and Methods, Statistical Publishing Society, Calcutta.
5. Singh,D. and Choudhary, F. S. (1986): Theory and Analysis of Sample Survey Designs, New Age International.
6. Sukhatme et al. (1984): Sampling Theory of Surveys with Applications, Iowa State University Press.
7. C.S.O. (1980): National Accounts Statistics- Sources and Health.

22STHCT2.5	Practical based on 21STHCT 2.3	
Credits: L:4	Teaching: 4Hrs/week Total Teaching Hours : 52	Max. Marks: 100 **C1: 15; C2: 15; C3: 70**

22STHCT2.6	Practical (Based on 21STSCT 2.4(b)	
Credits: L:4	Teaching: 4Hrs/week Total Teaching Hours : 52	Max. Marks: 100 **C1: 15; C2: 15; C3: 70**

22STOEP2.1	Statistical Data Analysis	
Credits: L:4	Teaching: 4Hrs/week Total Teaching Hours: 52	Max. Marks: 100 **C1: 15; C2: 15; C3: 70**

Course Outcomes:
C01: A person successfully completing the Course will be exposed to basic statistical methods used to analyze data and enough applications of such methods.
C02: Basic knowledge about the statistical analysis and probability.

Unit 1 **12Hrs**
DESCRIPTIVE STATISTICS: Collection of data, Tabular and graphical representation of data. Attribute and Variable discrete and continuous. Analysis of data -Frequency distribution, histogram and Ogive.

Unit 2 **12Hrs**
Measures of location, dispersion/scale and skewness. Bivariate data -scatter diagram. Product moment correlation and linear regression, Spearman's rank correlation.

Unit 3 **10Hrs**
PROBABILITY THEORY: Concepts of Probability, Standard Probability Distributions -Binomial Poisson, Geometric, Exponential normal t, F and Chi-square and properties.
SAMPLING:

Unit 4 **18Hrs**
Population and sample -simple random sampling. drawing random samples using random tables. Concepts of stratified random sampling. Standard error of sample mean and sample proportion.
STATISTICAL INFERENCE: Testing for means, proportions and variance in one sample and two sample problems. Chi-square test for attributes. Analysis of variance -principles -one way and two way classification models

Books for Reference:

1. Goon A.M., Gupta, M.K. and Das Gupta B: Fundamental of Statistics Vol.1 and II. World Press Pvt. ltd.,Calcutta.
2. Bhattacharya, G.K. and Johnson, R.A. Statistical concepts and methods. Wiley Eastern. Calcutta, Bombay and Delhi.
3. Levin, R.I. : Statistics for Management, Prentice Hall of India, New Delhi.
4. Hines, W. W. and Montgomery, D.C: Probability and Statistics -In Engineering and Management Science. Royal Press, New York.
5. Medhi J: Statistical Methods. Wiley Eastern Limited, New Delhi.

SEMESTER III

22STHCT3.1	Statistical Inference II	
Credits: L:4	Teaching: 4Hrs/week Total Teaching Hours : 52	Max. Marks: 100 **C1: 15; C2: 15; C3: 70**

Course Outcomes:
C01: A person successfully completing the Course will acquire knowledge of many advanced topics in basics of Mathematical Statistics including tests of hypotheses and nonparametric tests.
C02: Understanding the concepts of Basu's Theorem and it's Applications.
C03: Applications of Method of scoring.

Unit 1 **16 Hrs**

Consistency and asymptotic normality (CAN) of real and vector parameters. Invariance of consistency under continuous transformation. Invariance of CAN estimators under differentiable transformations, generation of CAN estimators using central limit theorem.

Unit 2 **12 Hrs**

Method of moments, method of maximum likelihood, Special cases such as exponential class of densities and multinomial distribution, Cramer-Huzurbazar theorem, method of scoring.

Unit 3 **12 Hrs**

Tests based on MLEs. Likelihood ratio tests, asymptotic distribution of log likelihood ratio, Wald Test, Score Test, locally most powerful tests. Applications to categorical data analysis, three dimensional contingency tables, Pearson's chi-square test and LR test.

Unit 4 **12 Hrs**

Asymptotic comparison of tests. Asymptotic Relative Efficiency (Pitman's). Introduction to Nonparametric Methods, one sample tests; Kolmogorov-Smirnov test, sign test, Wilcoxon –signed rank test. Wilcoxon rank sum test for two sample problem**.**

Books for Reference:

1. Casella, G. and Berger, R. L. (1990). *Statistical Inference*. Pacific Grove, CA:Wadsworth/Brooks Cole.
2. Cramer, H.(1974). Mathematical Methods in Statistics, Princeton Univ. Press.
3. Ferguson, T.S. (1996). A Course in Large Sample Theory, Chapman and Hall.
4. Gibbons,J.D., Chakraborti,S (2003).Nonparametric Statistical Inference, Fourth edition, CRC press.
5. Kale B.K. (2005). A First Course on Parametric Inference. Second Edition, Narosa

22STHCT3.2	Multivariate Analysis	
Credits: L:4	Teaching: 4Hrs/week Total Teaching Hours: 52	Max. Marks: 100 **C1: 15; C2: 15; C3: 70**

Course Outcomes:

C01: A person successfully completing the Course will acquire knowledge in analyzing multivariate data and learn special techniques that are used to analyses multivariate data.
C02: testing linear hypothesis about regression coefficients.
C03: Application in testing and interval estimation.

Unit 1 **12 Hrs**

Random sampling: limn multivariate normal distribution, maximum likelihood estimators of parameters, distribution of sample mean vector Wishart distribution (statement only) and its properties; distribution of sample generalized variance. Null distributions of sample correlation coefficient, partial. And multiple Correlation coefficients, distribution of sample regression coefficients. Application in testing and interval estimation.

Unit 2 **10 Hrs**

Hotellings- T^2, Null distribution of Hotelling's T^2 statistic, Application in test on mean vectors for single and several multivariate normal populations.

Unit 3 **12 Hrs**

Multivariate linear regression model, estimation of parameters, testing linear hypothesis about regression coefficients. Likelihood ratio test criterion. Multivariate analysis of variance of one- and two-way classified data.

Unit 4 **18 Hrs**

Classification and discrimination procedures for discrimination into one of two multivariate normal populations. Sample discriminant function, tests associated, with discriminant function, probabilities of misclassification and their estimation, classification into more than two mul1ivariate normal populations.

Principal components. Dimension reduction, canonical correlations and canonical variable - definition, use, estimation and computation.

Books for Reference:

1. Anderson, T.W. (1983): An. Introduction to Multivariate Statistical Analysis, Second Edition, Wiley.
2. Giri, N. C. (1977): Multivariate Statistical Inference, Academic Press.
3. Johnson and Wichern (1986) : Applied Multivariate Analysis, Wiley.
4. Kshirsagar,. A.M. (1972): .Multivariate Analysis, Marcel-Dekker. .
5. Morrison, D.F. (1976): Multivariate Statistical Methods, Second Edition, McGraw Hill.
6. Muirhead, R.J. (1982): Aspects of Multivariate Stalistica1 Theory, Wiley.
7. Rao, C. R. (1973). Linear Statistical Inference and its Applications, Second Edition, Wiley Eastern.
8. Seber, G.A.F. (1984) : Multivariate Observations, Wiley.
9. Sharma, S. (1996). Applied Multivariate Techniques, Wiley.

22STSCT3.3(a)	SQC and Reliability Theory	
Credits: L:4	Teaching: 4Hrs/week Total Teaching Hours: 52	Max. Marks: 100 **C1: 15; C2: 15; C3: 70**

Course Outcomes:

C01: A person successfully completing the Course will acquire knowledge in the theory of statistical SQC and reliability analysis along with learning special techniques to analyse positive valued data.

C02: Use of sequential runs in constructing control limits.

C03: Reliability Theory: Life distributions, survival functions, failure rate, Integrated hazard function, residual life time, mean residual life time.

Unit 1 **12 Hrs**

Process Control: Control charts for □x and s, demerits, extreme values. Moving average control charts, geometric moving average control charts, group control charts, multivariate quality control charts, sloping control lines.

Use of sequential runs in constructing control limits, CUSUM charts and its relation with SPRT. Control charts versus ANOVA and Chi-square tests.

Unit 2 **10 Hrs**

Product Control: single, double and multiple sampling plans for attributes, curtailed sampling plans. OC, AOQ, ASN and ATI functions for these plans. Designing single and double sampling plans. Chain sampling plans. Sampling plans by variables, Continuous sampling plans CSP1, CSP2, CSP3 and multilevel sampling plans.

Unit 3 **12 Hrs**

Reliability Theory: Life distributions, survival functions, failure rate, Integrated hazard function, residual life time, mean residual life time. Common Life Distributions: binomial, negative binomial, Poisson, exponential, Weibull, gamma, Pareto and log-normal distributions. Notion of aging: IFR, IFRA, DMRL, NBU, NBUE classes of life distributions and their dual.

Unit 4 **18 Hrs**

System reliabilities: Series, parallel, k-out-of-n, standby redundant systems and their reliabilities.

Maintenance policies: Age replacement policy and Block replacement policies and their characteristics. Reliability modelling: Introduction to shock models, stress-strength models and proportional hazard models.

Inference in Reliability: Type I and Type II Censoring schemes, likelihood functions based on these sampling schemes for exponential distribution. Reliability estimation (complete and censored samples) for exponential distribution, testing reliability hypotheses (exponential distribution).

Books for Reference:

1. Montgomery D.C. (1996) Introduction to Statistical Quality Control, Wiley, New York.
2. Grant E.L. (1980) Statistical Quality Control McGraw Hill, New York.
3. Weetherhill G.B. and Brow D.W. (1991) Statistical Process Control. Chapman and Hall, London.
4. Barlow R.E. and Proschan F (1975) Statistical Theory of Reliability and Life Testing. Holt-Rinhart and Winston, New York.
5. Sinha S.K. and Kale B.K. (1990) Life Testing and Reliability Estimation. Wiley Eastern, New Delhi.
6. Mann N.R, Schaffer R.F and Singpurwalla N.D. (1974) Methods for Statistical Analysis of Reliability and Life Data. Wiley New York.
7. Zacks S (1992) Introduction to Reliability Analysis. Springer - Verlag, New York.

22STSCT3.3(b)	Bio-Statistics	
Credits: L:4	Teaching: 4Hrs/week Total Teaching Hours: 52	Max. Marks: 100 **C1: 15; C2: 15; C3: 70**

Course Outcomes:

C01: A person successfully completing the Course will be exposed to a variety of methods used in biostatistics and the practical component helps in understanding and solving problems in biostatistics.
C02: Knowledge about the medical analysis data and clinical trails.
C03: Knowledge about the biological statistics.

Unit 1 **12 Hrs**

Definition, agent, host and environment, mode of transmission; incubation period, spectrum of disease, herd immunity, classification of cause, of death, measures of mortality, studies of mortality. Measures of morbidity, I1lOIbidity surveys, issues and problems. Risk, cause and bias. Observational studies: retrospective, cross sectional and prospective studies.

Unit 2 **12 Hrs**

Clinical trials: Methods of randomization, ethical issues, cross over trials. Sequential and group sequential trials. Interim analysis, multiple testing and stopping rules. Equivalence trials.

Unit 3 **12 Hrs**

Clinical Epidemiology: Definition, reliability, validity, sensitivity, specificity, predictive values, likelihood ration test, selection and interpretation of diagnostic test. Deciding on the best therapy.

Unit 4 **16 Hrs**

ROC curves, multiple and parallel test. Screening for disease, critical appraisal, Meta analysis. Epidemiologic Models -Pedometric studies-Deterministic epidemic models: Simple, General, Recurrent.

Time Series (Epidemic or others) Applications of Time series analysis in epidemiology -Simple descriptive techniques for detecting seasonal, Cyclical, secular and random variations

Books for Reference:

1. Lilienfeld, A.M. and Lilienfeld, D.C. Foundations of epidemiology, Second Edition, Oxford Univ. Press, New York, 1980.
2. Fletcher, R.H., Fletcher, S. W. and Wagner, E.H. Clinical Epidemiology -the essentials, II ed., 1982.
3. Harold A Hahn, Christopher T. Sempos.Statistical Methods in Epidemiology, Oxford Univ. Press, New York, 1989.
4. David G.Kleinbaum, Lawrence L.Kupper and Hall Morgenstem. Epidemiologic Research, Van Nostrand, USA, 1982.
5. Chatfield, C. The Analysis of Time Series -An Introduction. III Ed.Chapman and Hall, London, 1984.
6. Bailey N.T.J. The Mathematical Approach to Biology and Medicine.

22STSCT3.3(c)	Stochastic Process	
Credits: L:4	Teaching: 4Hrs/week Total Teaching Hours: 52	Max. Marks: 100 **C1: 15; C2: 15; C3: 70**

Course Outcomes:

C01: A person successfully completing the Course will acquire fundamental and advanced knowledge in stochastic processes which should be help apply these models to modelling random processes.

C02: Elementary renewal theorem and applications.

C03: Poisson process, pure birth process, Yule – Furry process, birth and death processes.

Unit 1 **14 Hrs**

Introduction to stochastic processes (SP's); classification of SP's according to state space and time domain. Countable state Markov chains, (MC's). Chapman -Kolmogorov equations; calculation of n-step transition probability and its limit, Stationary distribution, classification of states; transient MC; Random walk., and gambler's ruin problem. Applications from social, biological and physical sciences.

Unit 2 **14 Hrs**

Discrete state space continuous time MC: Kolmogorov-Feller differential equations; Poisson process, birth and death process; Applications to queues and storage problems. Wiener process as a limit of random walk first -passage time and other problems.

Unit 3 **12 Hrs**

Renewal theory: Elementary renewal theorem and applications. Statement and uses of key renewal theorem; study of residual life time process. Stationary process: weakly stationary and strongly stationary. processes: Moving average and auto regressive processes.

Unit 4 **12 Hrs**

Branching processes: Galton-Watson branching process, probability of ultimate extinction, distribution of population size. Martingale in discrete time, inequality, Convergence and smoothing properties. Statistical inference in MC and Markov processes.

Books for References:

1. Adke S. R. and Manjunath, S. M. (1984): An Introduction to Finite, Markov Processes, Wiley Eastern.
2. Bhat,B. R (2000): Stochastic Models: Analysis and Applications, New Age International, India.
3. Cinlar, E. (1975): Introduction to Stochastic Processes, Prentice Hall.
4. Feller, W. (1968): Introduction to Probability and its Applications, Vol.1, Wiley Eastern.
5. Harris T.E (1963): The Theory of Branching Processes, Springer Verlag.
6. Hoel, P.G, Port S.C. and Stone, C.J. (1972): Introduction to Stochastic Processes, Houghton Miffin and Co.
7. Jagers, P. (1974): Branching Processes with Biological Applications, Wiley.
8. Karlin, S. and Taylor,H.M. (1975): A First course in Stochastic Processes, Vol.1,Academic Press.
9. Medhi, J. (1982): Stochastic Processes, Wiley Eastern.
10. Parzen, E. (1962): Stochastic Processes, Holden-Day.

22STHCT3.4	**Practical (Based on 21STHCT 3.1and 21STHCT 3.3)**	
Credits: L:2	Teaching: 4Hrs/week Total Teaching Hours : 52	Max. Marks: 100 **C1: 15; C2: 15; C3: 70**

22STHCT3.5	**Practical (Based on 21STHCT 3.2)**	
Credits: L:2	Teaching: 4Hrs/week Total Teaching Hours: 52	Max. Marks: 100 **C1: 15; C2: 15; C3: 70**

22STOEP3.1	Statistical Data Analyses using R	
Credits: L:4	Teaching: 4Hrs/week Total Teaching Hours : 52	Max. Marks: 100 **C1: 15; C2: 15; C3: 70**

Course Outcomes:
C01: A person successfully completing the Course will be exposed to basic statistical methods used to analyze data using R and enough applications of such methods.
C02: Basic ideas about statistical software using analysis the data.
C03: Basic ideas about probability and inference.
CO4: Helps to build careers in Industry.

Unit-1: Basic Statistics: 12Hrs

Types of data: Discrete and continuous data, Different types of scales, Primary data (designing a questionnaire and schedule), Secondary data (major sources including some government publications). Diagrammatic and graphical representations of data, frequency and cumulative frequency distribution and their applications, Histogram, frequency polygon, ogives, stem and leaf chart, box plot.
Concept of central tendency, Partitioned values, Dispersion and relative dispersion, Sample moments, skewness, kurtosis and their measures, Correlation and Linear Regression.

Unit-2: Basic concepts of Probability and inference: 12Hrs

Basic probability theory –definitions and consequences. Bayes' theorem (statement only) and applications. Conditional probability.
Discrete and Continuous distributions-Bernoulli, Binomial, Geometric, Poisson, Uniform, Exponential, Normal distributions.
Basics of Point and Interval Estimation and Testing of hypotheses-Estimation methods, tests for mean, proportion, goodness-of-fit

Unit-3 : Computational techniques using R-Package: 12Hrs

Introduction and preliminaries: The R environment, R commands, Simple manipulations; numbers and vectors, Objects, their modes and attributes, Arrays and matrices, Lists and data frames, Reading data from files.Probability distributions: Computation of probabilities for various discrete and continuous distributions.

Unit-4: Simple Programming using R: 16Hrs

Programming using R: Grouping, loops and conditional execution.
Graphics : Different graphic commands like plot etc.,
Statistical models in R: Defining statistical analysis; formulae, One and two sample t-tests, chi-squared tests, F- test for equality of variance, checking the assumptions of normality, Q-Q plots, P-P plots. test of goodness of fit, test of independence.

Books for reference:

1. Medhi, J. (1992): Statistical Methods -an introductory text, New Age International Publishers.
2. Hogg, Robert V., Tanis, Elliot, A.Tanis and Rao, M.Jagan Mohan (2010): Probability and Statistical Inference, Pearson education.
3. Purohit, Sudha G., Gore, Sharad D. and Deshmukh, Shailaja R.(2008): Statistics using R. Narosa publications.
4. Crawley, Michael (2007): The R book, John Wiley publications.

SEMESTER IV

22STHCT4.1	Non-Parametric Methods	
Credits: L:4	Teaching: 4Hrs/week Total Teaching Hours : 52	Max. Marks: 100 **C1: 15; C2: 15; C3: 70**

Course Outcomes:

C01: A person successfully completing the Course will acquire knowledge in using nonparametric methods to analyze data.

C02: Knowledge about which data have analysis for non-parametric test and data in case not normal distribution.

C03: Basic ideas about the non-parametric where its used.

Unit 1 **16 Hrs**

Empirical distribution function, Glivenko-Cantelli theorem, Kolmogorov goodness of fit test.One sample U-statistics, Kernel and symmetric kernel, two sample U-statistics. asymptotic distribution of U-statistics. UMVUE property of U-statistics, asymptotic distribution of linear function of order statistics.

Unit 2 **12 Hrs**

Rank tests, locally most powerful rank test, linear rank statistics and their distributional properties under null hypothesis, Pitman's asymptotic relative efficiency.

Unit 3 **12 Hrs**

One sample location problem, sign test and signed rank test, two sample Kolmogorov Smirnov tests. Two sample location and scale problems. Wilcoxon-Mann-Whitney test, normal score test, ARE of various test based linear rank statistics. Kruskal-Wallis K sample test.

Unit 4 **12 Hrs**

Cox's proportional hazards model, rank test (partial likelihood) for regression coefficients, concepts of jackknifing method of Quenneville for reducing bias, bootstrap methods, confidence intervals.

Books for Reference:

1. Cox, D.R. and Oakes, D. (1983). Survival Analysis, Chapman and Hall.
2. Davison, A.C. and Hinkley, D.V. (1991). Boo-:strap methods and their application, Cambridge University Press.
3. Fraser, D.A.S. (1957). Nonparametric methods in Statistics, John Wiley.
4. Gibbons, J.D. (1985). Nonparametric Statistical Inference. Second Edition, Marcel-Dekker.
5. Hajek, J. and Sidak, Z. (1961): Theory of Rank Tests, Academic Press.
6. Puri, M.L and Sen, P.K (1971). Nonparametric methods in multivariate analysis, Wiley.
7. Randles, R.H and Wolfe, D.A. (1979). Introduction to the theory of nonparametric statistics, Wiley.

22STHCT4.2	Statistical Machine Learning Algorithms Using Python	
Credits: L:4	Teaching: 4Hrs/week Total Teaching Hours : 52	Max. Marks: 100 **C1: 15; C2: 15; C3: 70**

Course Outcomes:

C01: A person successfully completing the Course will acquire knowledge in using python to analyse the data.

C02: Knowledge about the Visualization Using Seaborn and Matplotlib.

CO3: Helps to build the careers in Industry.

Unit 1 **16 Hrs**

Installing Python - basic syntax - interactive shell - editing, saving and running a script. The concept of data types - variables - assignments - mutable type - immutable types –
arithmetic operators and expressions - comments in the program- understanding error messages - Control statements - operators.

Unit 2 **12 Hrs**

Introduction to functions - inbuilt and user defined functions -functions with arguments and return values - formal vs actual arguments - named arguments - Recursive functions – Lambda function - OOP Concepts - classes - objects – attributes and methods - defining classes - inheritance - polymorphism.

Unit 3 **12 Hrs**

Introduction to Pandas -Pandas data series - Pandas data frames -data handling - grouping - Descriptive statistical analysis and Graphical representation.

Unit 4 **12 Hrs**

Hypothesis testing - data modelling - linear regression models - logistic regression model.
Visualization Using Seaborn and Matplotlib
Line graph - Bar chart - Pie chart - Heat map - Histogram -Density plot - Cumulative frequencies - Error bars - Scatterplot - 3D plot.

Books for Reference:

1. Lambert, K. A. (2018). Fundamentals of Python: first programs. Cengage Learning.
2. Haslwanter, T. (2016). An Introduction to Statistics with Python. Springer International Publishing.
3. Unpingco, J. (2016). Python for probability, statistics, and machine learning, Vol.1, Springer International Publishing
4. Anthony, F. (2015). Mastering pandas. Packet Publishing Ltd.

22STSCT4.3(a)	Data Science	
Credits: L:4	Teaching: 4Hrs/week Total Teaching Hours : 52	Max. Marks: 100 **C1: 15; C2: 15; C3: 70**

Course Outcomes:

C01: A person successfully completing the Course will acquire knowledge about data science.
C02: Knowledge about data modeling, big data analysis and menu plating.
C03: Basic ideas about the SQL and data models.
CO4: Helps to build the careers in Industry.

Unit 1 **12Hrs**

Introduction – Big Data and Data Science – Data science Hype Getting Past the Hype – The Current Landscape – Role of Data Scientist – Exploratory Data Analysis – Data Science Process Overview – Defining goals – Retrieving data – Data preparation –Data exploration – Data modelling – Presentation. –Problems in handling large data – General techniques for handling large data –Big Data and its importance, Four Vs, Drivers for Big data, Bigdata analytics, Big data applications, Algorithms using map-reduce, Matrix-Vector Multiplication by Map Reduce. Steps inbig data – Distributing data storage and processing with Frameworks – Data science ethics – valuing different aspects of privacy – The five C's of data.

Unit 2 **12Hrs**

Machine learning – Modelling Process – Training model – Validating model – predicting new observations – Supervised learning algorithms –Unsupervised learning algorithms. Introduction to deep learning – Deep Feed Forward networks – Regularization – Optimization of deep learning– Convolutional networks – Recurrent and recursive nets – applications of deep learning.

Unit 3 **12Hrs**

Concept and Overview of DBMS, Data Models, Database Languages, Database Administrator, Database Users, Three Schema architecture of DBMS. Basic concepts, Design Issues, Mapping Constraints, Keys, Entity-Relationship Diagram, Weak Entity Sets, Functional Dependency, Different anomalies in designing a Database, Normalization: using functional dependencies, 1NF, 2NF, 3NF and Boyce-Codd Normal Form.

Unit 4 **16Hrs**

SQL Basic Structure - DDL, DML, DCL-Integrity Constraints - Domain Constraints, Entity Constraints - Referential Integrity Constraints, Concept of Set operations, Joins, Aggregate Functions, Null Values, assertions, views, Nested Subqueries – procedural extensions – stored procedures – functions- cursors – Intelligent databases – ECA rule – Data Integration – ETL Process

Text Books and Reference Books:

1. Davy Cielen, Arno D. B. Meysman, Mohamed Ali (2016), Introducing Data Science, Manning Publications Co.
2. Thomas Cannolly and Carolyn Begg, (2007), Database Systems, A Practical Approach to Design, Implementation and Management", 3rd Edition, Pearson Education.
3. Thomas Cannolly and Carolyn Begg, (2007), Database Systems, A Practical Approach to Design, Implementation and Management", 3rd Edition, Pearson Education.
4. D J Patil, Hilary Mason, Mike Loukides, (2018), Ethics and Data Science, O'Reilly.

22STSCT4.3(b)	Genetics Algorithms	
Credits: L:4	Teaching: 4Hrs/week Total Teaching Hours : 52	Max. Marks: 100 **C1: 15; C2: 15; C3: 70**

Course Outcomes:
C01: A person successfully completing the Course will acquire knowledge about Genetics algorithms.
C02: Basic knowledge about segregation and linkage and systematic forces.
C03: Knowledge about genetic variance, association and selection index.

Unit-1 **12Hrs**

Segregation and Linkage Physical basis of inheritance - Analysis of segregation -Detection and Estimation of linkage for qualitative characters - Amount of information about linkage -Combined estimation - Disturbed segregation.

Unit-2 **12Hrs**

Equilibrium law and Sex-Linked gene Gene and genotypic frequencies - Random mating and Hardy-Weinberg law - Application and extension of the equilibrium law - Fisher's fundamental theorem of natural selection - Disequilibrium due to linkage for two pairs of genes - Sex - Linked genes.

Unit-3 **08Hrs**

Systematic forces Forces affecting gene frequency: Selection - Mutation and Migration - Equilibrium between forces in large populations - Polymorphism.

Unit-4 **20Hrs**

Genetic variance and its partitioning and Association and Selection index :
Polygenic system for quantitative characters - Concepts of breeding value and Dominance deviation - Genetic variance and its partitioning, Correlation between relatives – Heritability – Repeatability and Genetic correlation - Response due to selection -Selection index and its applications in plants and animals' improvement Programme - Correlated response to selection- Restricted selection index - Inbreeding and crossbreeding- Changes in mean and variance.

Text Books and Reference Books:

1. Jain, J.P. (2017). Statistical Techniques in Quantitative Genetics. Tata McGraw
2. 1.Laird N.M and Christoph, L. (2011). The Fundamental of Modern Statistical Genetics. Springer.
3. Balding DJ, Bishop, M. and Cannings, C. (2001). Handbook of Statistical Genetics. John Wiley.
4. Shizhong Xu.(2013). Principles of Statistical Genomics. Springer.
5. 4.Falconer, D.S. (2009). Introduction to Quantitative Genetics. English Language Book Society. Longman. Essex.

22STSCT4.3(c)	Time Series Analysis	
Credits: L:4	Teaching: 4Hrs/week Total Teaching Hours : 52	Max. Marks: 100 **C1: 15; C2: 15; C3: 70**

Course Outcomes:

C01: A person successfully completing the Course will be exposed to specialized techniques to analyse data on time series and the practical component aids in understanding fitting of suitable time series models to time series data.

C02: Knowledge about the forecasting system.

Unit 1 **10 Hrs**

Time series as discrete parameter stochastic process, auto-covariance and auto-correlation functions and, their properties.

Unit 2 **16 Hrs**

Detailed study of the stationary processes: (i) moving average (MA), (ii) auto-regressive (AR), (iii) ARMA, and, (iv) AR integrated MA (ARIMA) models. Box-Jenkins models. Discussion (without proof) of estimation of mean, auto-covariance and auto-correlation functions under large sample theory.

Unit 3 **10 Hrs**

Choice of AR and MA orders. Estimation of ARIMA model parameters. Forecasting. Residual analysis and diagnostic checking.

Unit 4 **16 Hrs**

Spectral analysis of weakly stationary process, periodogram and correlogram analysis, computation based on Fourier transforms, Spectral decomposition of weakly AR process and representation as a one-sided MA process -necessary and sufficient conditions.

Implication of spectral decomposition in prediction problems. State space representation of time series. Kalman filter techniques.

Books for Reference:

1. Anderson. T.W. (1971). The Statistical Analysis of Time Series. Wiley.
2. Bloomfield, P. (2000). Fourier Analysis of Time Series: An Introduction. Second Edition, Wiley.
3. Box, G.E.P., Jenkins, G. W. and Reinsel, G.C. (1994). Time Series Analysis:Forecasting and Control Prentice Hall.
4. Box, G.E.P. and Jenkins, G.M (1976). Time Series Analysis -Forecasting and Control Holden-day, San Francisco.
5. Chatfield, C. Analysis of Time Series -Theory and Practice, Chapman and Hall.
6. Chow, C.G. (1985). Econometrics.. Mc Graw Hill.
7. Findley, D.F..ed., (1981). Applied Time Series Analysis II. Academic. Press.
8. Fuller, W.A. (1976). Introduction to Statistical Time series. Wiley.

22STHCP4.4	Project (Primary and Secondary)	
Credits: L:4	Teaching: 4Hrs/week Total Teaching Hours : 52	Max. Marks: 100 **C1: 15; C2: 15; C3: 70**

22STOEP4.1	Applied Statistics	
Credits: L:4	Teaching: 4Hrs/week Total Teaching Hours : 52	Max. Marks: 100 **C1: 15; C2: 15; C3: 70**

Course Outcomes:

C01: A person successfully completing the Course will be exposed to basic statistical methods used to analyse data using R and enough applications of such methods.
C02: Basic ideas about statistical software using analysis the data.
C03: Basic ideas about probability, time series and index numbers.
CO4 : Helps to build careers in Industry.

Unit 1: **12Hrs**

Basic Probability: Introduction, Conditional probability, Bayesian theorem, Permutation and Combinations, Random Variables and distributions. Expectations and moments.

Unit-2: **12Hrs**

Matrix operations, linear equations, Matrix representation- Rank, Determinants, Eigen value and Eigen vectors.

Unit-3 : **14Hrs**

Time Series: Introduction, use of time series, Components of time Series, Mathematical Model for time series, Moving average method, measurement of trend, Seasonal Variations, Cyclic variations and Irregular movements.

Unit-4 : **14Hrs**

Index Number: Introduction, basic problems involved in the construction of Index numbers, Construction of Index numbers: Simple (Unweighted) aggregate method, weight aggregate method, average of price relatives, chain base method (Chain Indices).

Books for reference:

1. Medhi, J. (1992): Statistical Methods -an introductory text, New Age International Publishers.
2. Hogg, Robert V., Tanis, Elliot, A.Tanis and Rao, M.Jagan Mohan (2010): Probability and Statistical Inference, Pearson education.
3. Purohit, Sudha G., Gore, Sharad D. and Deshmukh, Shailaja R.(2008): Statistics using R. Narosa publications.
4. Crawley, Michael (2007): The R book, John Wiley publications.

Continuous Assessment Scheme

C1:	Test	: 10 marks
	Seminar/assignment	: 05 marks
C2:	Test	: 10 marks
	Seminar/assignment	: 05 marks

Semester End Examination (C3)

Theory Question Paper Pattern

Time: 3 Hrs. Max. Marks: 70

Instruction to Candidates: Part A: All questions are Compulsory

Part B: Answer any five full questions

PART –A

Q1 (10*1=10)

a)
b)
c)
d)
e)
f)
g)
h)
i)
j)

PART-B

(5*12=60)

Q 2 a) 6M

b) 6M

Q 3 a) 6M

b) 6M

Q 4 a) 6M

b) 6M

Q 5 a) 6M

b) 6M

Q 6 a) 6M

b) 6M

Q 7 a) 6M

b) 6M

Q 8 a) 6M

b) 6M

COs-POs Mapping

SEMESTER I

	22STHCT1.1	Probability Theory				
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	—	—	—	—	√	—
CO2	—	—	√	—	—	—
CO3	—	—	—	—	√	—
CO4	—	—	—	—	√	—

	22STHCT1.2	Distribution Theory				
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	—	—	—	—	√	—
CO2	—	—	√	—	—	—
CO3	—	—	—	—	√	—
CO4	—	—	—	—	√	—

	22STHCT1.3	Matrix Theory and Linear Models				
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	—	—	—	—	√	—
CO2	—	—	√	—	—	—
CO3	—	—	—	—	√	—

	22STSCT1.4(a)	Data Base Techniques				
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	—	—	—	—	√	—
CO2	—	—	√	—	—	—
CO3	—	—	√	—	—	—

	22STSCT1.4(b)	Linear Programming				
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	—	—	—	—	√	—
CO2	—	—	—	—	√	—
CO3	—	—	—	—	√	—

	22STOEP 1.1	Statistical Methods and Applications				
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	—	√	—	—	—	—
CO2	—	—	—	—	√	—
CO3	—	—	—	—	√	—
CO4	—	—	√	—	—	—

SEMESTER II

	22STHCT2.1		Real Analysis			
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	—	—	—	—	√	—
CO2	—	—	—	—	√	—
CO3	—	√	—	—	—	—

	22STHCT2.2		Statistical Inference I			
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	—	—	—	—	√	—
CO2	—	—	—	—	√	—
CO3	—	—	—	—	√	—

	22STHCT2.3		Design and Analysis of experiments			
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	—	√	—	—	—	—
CO2	—	—	—	—	√	—
CO3	—	—	—	—	√	—

	22STSCT2.4(a)		Survival Analysis			
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	—	√	—	—	—	—
CO2	—	—	—	—	√	—
CO3	—	—	—	—	√	—

	22STSCT2.4(b)		Sampling Theory			
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	—	√	—	—	—	—
CO2	—	—	—	—	√	—
CO3	—	—	—	—	√	—

	22STOEP 2.1		Statistical data analysis			
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	—	√	—	—	—	—
CO2	—	—	√	—	—	—

SEMESTER III

	22STHCT3.1	Statistical Inference II				
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	—	√	—	—	—	—
CO2	—	√	—	—	—	—
CO3	—	—	—	—	√	—

	22STHCT3.2	Multivariate Analysis				
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	—	√	—	—	—	—
CO2	—	√	—	—	—	—
CO3	—	—	—	—	√	—

	22STSCT3.3(a)	SQC and Reliability Theory				
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	—	√	—	—	—	—
CO2	—	—	—	—	√	—
CO3	—	—	—	—	√	—

	22STSCT3.3(b)	Bio-Statistics				
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	—	√	—	—	—	—
CO2	—	—	—	—	√	—
CO3	—	—	—	—	√	—

	22STSCT3.3(c)	Stochastic Process				
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	—	√	—	—	—	—
CO2	—	—	—	—	√	—
CO3	—	—	—	—	√	—

	22STOEP3.1	Statistical data analyses Using R				
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	—	√	—	—	—	—
CO2	—	—	—	—	√	—
CO3	—	—	—	—	√	—
CO4	√	—	—	—	—	—

SEMESTER IV

	22STHCT4.1	**Non-Parametric Methods**				
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	—	√	—	—	—	—
CO2	—	—	—	—	√	—
CO3	—	—	—	—	√	—

	22STHCT4.2	**Statistical Machine Learning Algorithms Using Python**				
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	—	√	—	—	—	—
CO2	—	—	—	—	√	—
CO3	—	—	√	—	—	—

	22STSCT4.3(a)	**Data Science**				
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	—	—	—	—	√	—
CO2	—	—	—	—	√	—
CO3	—	—	—	—	√	—
CO4	—	—	√	—	—	—

	22STSCT4.3(b)	**Genetics Algorithms**				
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	—	—	—	—	√	—
CO2	—	—	—	—	√	—
CO3	—	—	—	—	√	—

	22STSCT4.3(c)	**Time Series Analysis**				
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	—	√	—	—	—	—
CO2	—	—	—	—	√	—

	22STOEP4.1	**Applied Statistics**				
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	—	√	—	—	—	—
CO2	—	—	—	—	√	—
CO3	—	—	—	—	√	—
CO4	√	—	—	—	—	—