KANNUR UNIVERSITY

(Abstract)

M Sc Statistics Programme in the Department of Statistical Sciences, Mangattuparamba Campus - Revised Scheme (Distribution of credits of Four semesters) & Syllabus (1st Semester Only) - Approved- Implemented w.e f 2023 admission- Orders Issued

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ACADEMIC C SECTION

ACAD C/ACAD C3/22131/2023 Dated: 06.11.2023

Read:-1. UO No ACAD C/ ACAD C3/22373/2019 dated 12/09/2023
2. Circular No dated ACAD C/ ACAD C3/22373/2019 dated 12/09/2023
3. Email dated 05/10/2023 from the Head, Dept of Statistical Sciences, Mangattuparamba Campus
4. Minutes of the meeting of the Department Council dated 18/09/2023

ORDER

1. The revised Regulations for Post Graduate Programmes under Choice Based Credit and Semester System in the University Teaching Departments/ Schools were implemented w.e.f 2023 admissions vide paper read 1 above

2. As per paper read 2 above, Heads of all Teaching Departments were requested to submit the revised Syllabus in accordance with the approved Regulations along with a copy of the Department Council Minutes.

3. As per paper read 3 above, the Head, Department of Statistical Sciences Mangattuparamba Campus submitted the scheme (Distribution of credits of Four Semesters) and the Syllabus (1st Semester Only) of M.Sc Statistics Programme to be implemented in the University Teaching Department w.e.f 2023 admissions.

4. Department Council vide the paper read 4 above approved the aforementioned scheme and syllabus of M.Sc Statistics programme to be implemented in the Dept. of Statistical science of the University w.e.f.2023 admission.

5. The Vice Chancellor, after considering the matter in detail and in exercise of the powers of the Academic Council conferred under section 11(1), Chapter III of Kannur University Act 1996, ***approved the Scheme (Distribution of credits of Four Semesters) & Syllabus (1st Semester Only) of M.Sc Statistics Programme and accorded sanction to implement the same in the Department of Statistical Sciences, Mangattuparamba Campus w.e.f 2023 admissions, subject to reporting to the Academic Council***

6.The Scheme (Credit distribution of Four Semesters) and Syllabus (1st Semester Only) of M.Sc Statistics Programme under CBCSS implemented in the Department of Statistical Sciences, Mangattuparamba Campus with effect from 2023 admission, is appended and uploaded in the University website (www.kannuruniversity.ac.in)

7. Orders are issued accordingly.

Sd/-
Narayanadas K
DEPUTY REGISTRAR (ACAD)
For REGISTRAR

To: 1. Head, Department of Statistical Sciences, Mangattuparamba Campus
2. Convenor, Curriculum Committee

Copy To: 1.PS to VC/ PA to PVC/ PA to R
2. To Examination Branch (through PA to CE)
3. EP IV/ EXC I
4. Computer Programmer
5. Webmanager (to publish in the website)
6. SF/DF/FC

Forwarded / By Order

SECTION OFFICER

KANNUR UNIVERSITY

M.Sc. STATISTICS

SCHEME & SYLLABUS

(*Under Choice Based Credit & Semester System)*

2023 admission onwards

DEPARTMENT OF STATISTICAL SCIENCES

Mangattuparamba Campus

KANNUR UNIVERSITY

Post Graduate Programme in Statistics

M.Sc. Statistics programme is a two-year programme divided into four semesters. A student is required to complete 80 credits for the completion of programme and the award of degree.

DURATION: 2 Years (4 semesters)

INTAKE: **25**

OBJECTIVES OF THE COURSE:

1. To encourage and motivate the experimental scientists to use the modern methods of statistics and computing facilities.
2. To establish advanced facilities and promote research and technology development to solve statistical issues and problems.
3. To promote statistical and probabilistic reasoning and use of sound statistical practice avoiding superstitious beliefs.
4. To establish good networking of academic collaboration with national and international organizations, institutions, industries and exchange of faculty and students.
5. To offer statistical information, education and communication services.
6. The course contents will be abreast with the latest development in the area of study. The students have to do a full time institutional or industrial training/ project work for three months, enabling them to have valuable hands-on experience. The theory, practical, project work and training activities of this program prepare the student to acquire knowledge, skills and expertise on specified subjects along with the integrated knowledge of all relevant disciplines.

ELIGIBILITIES:

Candidates who have studied B.Sc. Statistics with minimum of 50% marks or equivalent grade in core course or B.Sc. Mathematics with Statistics as complementary course with 50% marks or equivalent grade in complementary (Statistics) course. The minimum requirement for admission

to a Post Graduate Program shall be Grade C or overall CGPA 1.5 under CCSS /Grade C+ or CGPA 2 in Part III under grading system subject to satisfying other eligibility criteria prescribed for postgraduate program of the Kannur University.

ADMISSION:

- The selection of the candidate is mainly based on the marks secured in the Degree Course/Admission test.
- The admission test will cover statistics and mathematics at the undergraduate level.

Relaxation & Weightage

- SC/ST Category: minimum pass marks in the relevant subjects or part of subjects is required for admission to PG Degree program..
- OEC/OBC Category: a relaxation of 5% of marks in the qualifying examination from the prescribed minimum is allowed.

COURSE DETAILS:

A student must register for the required number of courses at the beginning of each semester. No students shall register for more than 24 credits and less than 16 credits per semester.

A total of 80 credits shall be the minimum for successful completion of the course in which a minimum of 60 credits for core course and 12 credits for electives are mandatory. Those who secure only minimum credit for core/ elective subjects has to supplement the deficiency for obtaining the minimum total credits required for successful completion of the program from the other divisions.

EVALUATION:

The faculty member who teaches the course shall do evaluation of the students for each course on the basis of Continuous Evaluation and End Semester Examination shall be evaluated by External Examiners. The proportion of the distribution of marks among the continuous evaluation and end semester examination shall be **40:60**.

Continuous Evaluation includes assignments, seminars, written examination and viva voce for each course. Weightage to the components of continuous evaluation shall be given for all theory papers of the course as follows:

Components of CE	Minimum Number	Weightage	Grade Popint	Practical Weightage	Grade Popint
Test paper	2	40	16	-	-
Assignments	1	20	08	--	--
Seminar/Viva Voce	1	40	16		--
Record	--	--	--	-	-

Test Paper: For each course there shall be at least two class tests during a semester.

Assignments: Each student shall be required to do one assignment for each course.

Seminar: Students are required to present a seminar on a selected topic in each paper. The evaluation of the seminar shall be done by the concerned teacher handling the course.

Viva Voce – End semester theory Viva Voce examination will be conducted for each paper before the commencement of public examination.

Attendance: Minimum attendance required for each paper shall be 75% of the total number of classes conducted for that semester. Those who secured the minimum requirement of attendance only be allowed to register/appear for End Semester Examination.

Condonation of attendance to a maximum of 10 days in a semester subject to a maximum of two times during the whole period of the PG program may be granted by the university as per university rules.

Conduct of Examination:

The vice chancellor will approve the panel of examiners submitted by the Head of the Department. All the teachers of the Department will be the members of the Board of examiners with Head of the Department as the Chairperson. There shall be a minimum of two external examiners. The panel approved by the Vice-Chancellor will be entrusted with the setting of question papers, conduct and evaluation of examination.

Research Project:

The students have to complete a minor research project during IV Semester in collaboration with any of the authorized research institutions located within or outside the state or within their own Department.

KANNUR UNIVERSITY

DEPARTMENT OF STATISTICAL SCIENCES

VISION

Motivated by optimism and responsibility, the vision is to develop an exemplary centre for studies, practice and research in Statistics which will be beneficial to the stakeholders and the society.

MISSION

To develop an excellent centre of quality teaching and research in Statistics

To develop an international centre for advanced statistical computing and data analysis.

PROGRAMME OUTCOMES

PO 1 : **Critical Thinking:** Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.

PO2 : **Problem Solving:** Identify, formulate, conduct investigations, and find solutions to problems based on in-depth knowledge of relevant domains.

PO 3 : **Communication:** Speak, read, write and listen clearly in person and through electronic media in English/language of the discipline, and make meaning of the world by connecting people, ideas, books, media and technology.

PO 4 : **Responsible Citizenship:** Demonstrate empathetic social concern, and the ability to act with an informed awareness of issues.

PO 5 : **Ethics**: Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.

PO 6 : **Self-directed and Life-long Learning:** Acquire the ability to engage in independent and life-long learning in the broadest context socio- technological changes.

PROGRAMME SPECIFIC OUTCOME

PSO 1: Expertise in the field of Statistical theory and its practical applications.

PSO 2: Expertise to take up responsibilities as efficient Statisticians/Statistical Officers/Research Officers/ Statistical Analytics.

PSO 3: Expertise on techniques of biostatistics and in the field of data analysis.

PSO 4: Make Awareness on recent trends in Statistical theory and applications.

PSO 5: Utilize statistical methods and tools to analyze data sets, draw meaningful conclusions, and make informed decisions based on Statistical inferences.

PSO6: Demonstrate proficiency in using statistical software such as R and SPSS, to perform statistical computations, visualize data, and facilitate Statistical analysis.

COURSE OUTCOME

CO1 : Demonstrate an in-depth understanding of advanced mathematical concepts, including advanced calculus, linear algebra, complex analysis, differential equations, and discrete mathematics.

CO 2 : Apply rigorous proof techniques to establish mathematical results, including theorems, lemmas, and propositions, and communicate mathematical arguments effectively.

CO 3 : Formulate mathematical models for real-world problems, analyze their properties, and interpret the results in the context of the original problem.

CO 4 : Apply numerical techniques and algorithms to approximate solutions of mathematical problems, analyze their accuracy, convergence, and stability.

CO 5 : Develop research skills, including literature review, problem formulation, data collection, experimental design, and statistical analysis, to conduct independent mathematical research.

DistributionofGradesfortheMSc StatisticsProgrammewitheffectfrom2023-24Onwards									
	1	2	3	4	5	6	7	8	TotalCredits
	DisciplineSpecific		Electives						
Semester	CoreCourses(DSC)	Electives(DSE)	Interdisciplinary/ Multidisciplinary Elective	AEC 2 Credits	SEC(SEC) 2Credits	VAC /MOOC 2Credits	Internship /FieldVisit /MinorProject /Institutional /IndustrialVisit 2Credits	Dissertation / MajorProject	
1	MSSTA01DSC01(4C) MSSTA01DSC02(4C) MSSTA01DSC03(4C) MSSTA01DSC04(4C)	**PoolA** MSSTA01DSE01 MSSTA01DSE02							**19**
	16Credits	**3Credits**							
2	MSSTA02DSC05(4C) MSSTA02DSC06(4C) MSSTA02DSC07(4C) MSSTA02DSC08(4C)	**PoolB** MSSTA02DSE03 MSSTA02DSE04		Offered byotherDepartments	Offeredby otherDepartments				**23**
	16Credits	**3 Credits**		**2 Credits**	**2Credits**				
3	MSSTA03DSC09(4C) MSSTA03DSC10(4C)	**PoolC** MSSTA03DSE05 to11	Offered byotherDepartments			MSSTA03DSC12	MSSTA03DSC11		**23**
	8Credits	**3Credits x 3= 9 credits**	**4Credits Each**			**2* Credits**	**2Credits**		
4		**ElectiveIII(PoolD)** MSSTA04DSE06 to12 **4Credits x 3=12 credits**						MSSTA04DSC14(8C)	**20**
		12Credits						**8Credits**	
	TotalCreditforMSc StatisticsProgram								**85**

*Credits for MOOC is over and above the credit requirements

Sl No	Course Code	Title of Paper	Contact Hours/Week			Marks			
			L	T/S	P	ESE	CE	Total	Credits
FIRST SEMESTER									
DISCIPLINE SPECIFIC CORE COURSES (DCE)									
1.1	MSSTA01DSC01	Measure and Probability	4	1		60	40	100	4
1.2	MSSTA01DSC02	Mathematical Methods for Statistics	4	2		60	40	100	4
1.3	MSSTA01DSC03	Distribution Theory	4	1		60	40	100	4
1.4	MSSTA01DSC04	Sampling Theory	4	2		60	40	100	4
DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE)									
1.5	MSSTA01DSEXX	Elective-I-DSE (Pool A)		2	6	60	40	100	3
Total			**16**	**8**	**6**	**300**	**200**	**500**	**19**

L=Lecture, T/S=Tutorials/Seminar, P/I=Practical/Internship, CE =Continuous Evaluation, ESE = End Semester Evaluation

Sl No	POOL A:- List of Courses for Elective -I DISCIPLINE SPECIFIC ELECTIVES (DSE)								
1.5a	MSSTA01DSE01	Statistical Computing Using R(**Practical**)		2	6	60	40	100	3
1.5b	MSSTA01DSE02	Statistical Computing Using SPSS (**Practical**)		2	6	60	40	100	3

FIRST SEMESTER M.Sc. STATISTICS PROGRAMME

DISCIPLINE SPECIFIC CORE COURSES

Course Code & Title	**MSSTA01DSC01-MEASURE AND PROBABILITY**
Course Description	This course is intended to provide the foundations necessary for a Statistics student. Mathematical concepts like elementary measure theory and probability are included. The development of modern probability theory through the measure theoretic approach is portrayed in this course.
Course Objectives	The Course aims • To introduce students the inter-link between measure and probability. • Understand the concepts of measure and probability and properties. • Understand convergence of sequence of sets, sequence of measurable functions and sequence of integrals. • Understand convergence of sequence of random variables. • Understand the inequalities involving moments.

Modules	**Content**	**Module Outcome**
Module I: Measure and Measurable Function (**15 Hours**)	Class of sets, limits of sequence of sets, fields and σ-fields, minimal σ-fields and Borel field, Measurable space, measure, measure space, Lebesgue measure and counting measure, measurable functions and their properties. Limit of a sequence of measurable functions, simple functions, non-negative measurable functions, limit of simple functions.	Students are able to: • Recall the fundamentals of the measure theory. • Understand the characteristics and properties of measurable functions. • Limits of simple functions
Module II: Integral and Convergence of Sequence of Integrals	Integral of a simple function, integral of a measurable function, integral of real valued function, positivity and linearity of integral, Limit of a sequence of integrals of measurable functions, The monotone	• Understand the integral of simple function and measurable function. • State and prove

(**15 Hours**)	convergence theorem, Fatou's lemma. Bounded convergence theorem, Lebesgue dominated convergence theorem.	monotone convergence theorem. • State and prove Fatou's lemma • State and prove Lebesgue dominated convergence theorem.
Module III: Probability Measure and Random Variables (**15 Hours**)	Axiomatic approach to probability, probability space, conditional probability space, independence of events and sigma fields, Bayes theorem. Real and vector valued random variables, distribution function, density function and properties, expectation of a random variable and properties. Sequence of random variables and different modes of convergence: in probability, in distribution, in r^{th} mean and almost sure, their mutual implications.	• Understand axiomatic approach of probability • State and prove Bayes theorem. • Articulate random variables, density function and its properties. • Explain different modes of convergence. • Explain their mutual implications.
Module IV: Expectation and Inequalities (**15 Hours**)	Expectation of a function of random variable as Riemann- Stieltjes integral, moments of a random variable. Inequalities involving moments, Cr-inequality, Jenson's inequality, basic inequality, Markov inequality and their applications.	• Explain moments of random variables. • Articulate inequalities involving moments. • Markov inequality and its applications

Text Books

1. Bhat, B.R. (2004). ***Modern Probability Theory***, New Age Publishers, New Delhi.
2. Robert G. Bartle (1995). ***The Elements of Integration and Lebesgue Measure.*** John Wiley &Sons, New York.

Reference books

1. Basu, A. K. (1999). ***Measure Theory and Probability***, Prentice-Hall.
2. Billingsley, P. (1986). ***Probability and Measure****, Second Edition*, John Wiley.
3. Parthasarathy, K. R. (2005). ***Introduction to Probability and Measure*****,** Hindustan Book Agency.
4. Royden, H. L. (1988). ***Real Analysis****, Third Edition,* McMillain Publishing Company, New-York.

Course Outcomes	After successful completion of this course, student will be able to: 1. Understand the concepts of measure and probability and properties. 2. Understand convergence of sequence of sets, sequence of measurable functions and sequence of integrals. 3. Understand convergence of sequence of random variables. 4. Understand the inequalities involving moments.

TEACHING LEARNING STRATEGIES

- **Lecturing, Visualization, Team Learning**

MODE OF TRANSACTION

- **Lecture, Seminar, Discussion, Questioning and Answering**

Sample Questions to Test Outcomes:

1. Define limit of sequence of sets. Give an example of a sequence of sets for which limit does not exist.

2. Define a sigma field. Show that the intersection of arbitrary number of sigma fields is a sigma field and union of arbitrary number of sigma fields need not be a sigma field.
3. What do you mean by an indicator or characteristic function of a set? Show that indicator function of a measurable set is measurable.
4. State and prove Cauchy-Schwarz inequality.
5. State and prove dominated convergence theorem.
6. Show that the set of discontinuity points of a distribution function is at most countable.

DISCIPLINE SPECIFIC CORE COURSE

Course Code & Title	**MSSTA01DSC02 - MATHEMATICAL METHODS FOR STATISTICS**
Course Description	This course is intended to provide the basic mathematical foundations necessary for a Statistics student. Expertise in mathematical analysis and linear algebra are inevitable for a statistics student and this course offer such an avenue. Concepts in advanced calculus and linear algebra are also included.
Course Objectives	• To get a clear understanding of Metric space, compact set, perfect set. • To learn the mean value theorem and its implications. • Describe the properties of Riemann- Stieltjes integral. • Explain the concept of sequence and series of real numbers. • Explain improper integrals, beta and gamma functions. • State Taylor's theorem with applications. • Describe optima of functions using examples. • To achieve ideas on vector space, subspaces, independence of vectors, basis and dimension. • State and prove Cayley-Hamilton theorem. • Establish the relation between algebraic and geometric multiplicity. • To achieve ideas on quadratic forms and reduction of quadratic forms and gets ability for solving problems in these areas. • Define Moore-Penrose g-inverse and derive its properties.

Modules	Content	Module Outcome
Module I: Limit and Continuity of Functions (**15 hours**)	Metric spaces, compact set, perfect set, connected set. Limit of functions, continuous function, continuity and compactness, continuity and connectedness, discontinuities. Monotone functions, derivative of a real valued function, mean value theorem. Reimann - Stieltjes integral and properties.	Students are able to: • Explain metric space, compact set, and perfect set. • State and prove mean value theorem. • Articulate Reiman-Stieltjes integral and its properties.
Module II: Sequence of Functions and Functions of Several variables (**15 hours**)	Sequences and series of functions, Uniform convergence. Uniform convergence and continuity, uniform convergence and integration, uniform convergence and differentiation, Weirstrass theorem (statement only), improper integrals, the Beta and Gamma functions. Functions of several variables, limits and continuity. Taylor's theorem and its applications. Conditions for the optima of multivariate functions.	• Explain point wise and uniform convergence of functions. • Explain improper integrals, beta and gamma functions. • Find limit and continuity of a sequence of function. • To find local and global optima of functions.
Module III: Vector Spaces and Matrices (**15 hours**)	Vector space, sub spaces, linear dependence and independence, basis and dimensions, direct sum and compliment of a subspace, inner product and orthogonality. Algebra of matrices, linear transformations, different type of matrices. Row and column space of a matrix, inverse of a matrix, rank, factorization of a matrix, elementary operations and reduced forms.	• To be familiar with vector space, subspace and its examples. • Explain linear dependence and independence. • Understand the concept of determinants and its properties. • Solve the system of linear equations.

Module IV: Spectral Decomposition and Quadratic Forms (**15 hours**)	Eigen values and eigen vectors, spectral representation and singular value composition, Cayley-Hamilton theorem, algebraic and geometric multiplicities, Jordan canonical form. Linear equations, generalized inverses and quadratic forms, rank nullity theorem, generalized inverses, Moore-Penrose inverse, computation of g-inverse. Quadratic forms, classification of quadratic forms, rank and signature, positive definite and non-negative definite matrices, simultaneous diagonalization of matrices.	• Determine the Eigen values and Eigen vectors of the given matrix • Obtain the diagonal form and triangular form of a given matrix. • Write down the spectral decomposition of the given matrix • Explain different types of quadratic forms. • Explain generalized inverse and how to find it.
References	***Text Books*** 1. Rudin. W. (2013). ***Principles of Real Analysis*** *(3rdEd.),* McGraw Hill. 2. Mathai, A. M. and Haubold, H. J. (2017). ***Linear Algebra – A course for Physicists and Engineers***, De Gruyter, Germany. ***Reference Books*** 1. Ramachandra Rao and Bhimasankaran (1992). ***Linear Algebra***. Tata McGraw Hill, New-Delhi. 2. Malik, S.C & Arora,S. (2006). ***Mathematical Analysis***, *Second Edition,* New-age International Publishers. 3. Apsostol, T. M. (1974). ***Mathematical Analysis***, *Second Edition*. Norosa, New Delhi. 4. Lewis, D.W. (1995). ***Matrix theory***, Allied publishers, Bangalore. 5. Rao, C. R. (2002). ***Linear Statistical Inference and Its Applications,****Second Edition*, John Wiley and Sons, New York. 6. Seymour Lipschupz, MarcLipson (2005). ***Schaum's Outline Series-Linear Algebra*** *(3rd edition).* Tata McGrawHill.	
Course Outcomes	After successful completion of this course, student will be able to:	

	1. Understand the concepts of limit and continuity of functions and their properties 2. Understand Reimann–Stieltjes integral and its properties. 3. Understand convergence of sequences and series of functions. 4. Understand the vector space, matrices and its properties 5. Understand the properties of quadratic forms and generalized inverses

TEACHING LEARNING STRATEGIES

- **Lecturing, Visualization, Team Learning**

MODE OF TRANSACTION

- **Lecture, Seminar, Discussion, Questioning and Answering**

ASSESSMENT RUBRICS

Components	**Weightage**
EndSemesterEvaluation	**60**
ContinuousEvaluation	
Tests	16
Assignment	08
Seminar	16
Total	**40**

Sample Questions to Test Outcomes:

1. Define compact set. Show that compact subset of a metric space are closed.

2. State and prove mean value theorem.

3. Distinguish between uniform convergence and point-wise convergence.

4. Define improper integrals and discuss the convergence of integrals of unbounded functions with finite limits of integration.
5. Explain the extreme values of functions of several variables.
6. Explain different types of quadratic form. State and prove the necessary and sufficient condition for a quadratic form to be positive definite.

DISCIPLINE SPECIFIC CORE COURSE

Course Code & Title	**MSSTA01DSC03- DISTRIBUTION THEORY**
Course Description	This course is designed to equip the students with the theory of standard probability distributions and their diverse characterizations. The knowledge about the probability distributions facilitates the understanding of various applications of statistical methods like statistical inference and multivariate analysis.
Course Objectives	This course aims to: • Understand and derive generating functions and its properties. • Define and derive the properties of several distributions. • Define and derive joint, marginal and conditional distributions and functions of random variables using Jacobean transformations. • Define and derive the properties of multivariate distributions. • Define and derive the properties of sampling distributions. • Derive the order statistics.

Modules	Content	Module Outcome
Module I: Univariate Discrete Distributions (**15 hours**)	Discrete probability models, Moments and moment generating functions, probability generating functions, characteristic function. Discrete uniform, binomial, Poisson, geometric, negative binomial, hyper geometric and power series distributions. Properties and fitting of these distributions.	• Understand generating functions and their properties. • Derive generating functions of various distributions. • Derive characterizations of discrete distributions. • Derive the various properties of discrete distribution.
Module II: Univariate Continuous Distributions (**15 hours**)	Continuous probability models, Uniform, exponential, Gamma, Weibull, Pareto, beta, Normal, Laplace, logistic, Cauchy and log-normal distributions. Interconnections among these distributions. Properties and fitting of these distributions.	• Define various continuous distributions. • Derive the properties of each distribution.
Module III: Bivariate and Multivariate Distributions (**15 hours**)	Joint, marginal and conditional distributions, independence, covariance and correlations, functions of random variables and their distributions. Jacobin of transformations, bivariate normal distribution, multinomial distribution and their marginal and conditional distributions.	• Find out join, marginal and conditional distributions. • Find out the distribution of functions of random variables using jacobian transformation.

Module IV: Sampling Distributions (**15 hours**)	Basic concepts of sampling distributions from infinite populations, sampling from normal distributions, properties of sample mean and sample variance. Chi-square, t-distribution and F-distributions, properties and applications. Non-central Chi-square, t and F-distributions. Basic concepts of order statistics and their distributions. Distribution of r^{th} order statistics, distribution of sample median and range (for Uniform(0,1) distribution only).	• Define sampling distributions for central and non-central cases. • Derive the properties of central sampling distributions. • Define and derive density and distribution functions of order statistics and systematic statistics. • Derive joint and marginal distributions of order statistics. • Find out distribution of order statistic for various distributions.
References	***Text Books*** 1. Rohatgi, V.K. (2001). ***An Introduction to Probability and Statistics***, *2nd Edition.* John Wiley and Sons. 2. Krishnamurthy, K. (2006). ***Handbook of Statistical Distributions with Applications***. Chapman &Hall/CRC, New-York. ***Reference books*** 1. Johnson, N.L., Kotz, S. and Balakrishnan, N. (1995). ***Continuous Univariate Distributions***, *Vol. I &Vol. II,* John Wiley and Sons, New-York. 2. Johnson, N.L., Kotz. S. and Kemp. A.W. (1992). ***Univarite Discrete Distributions,***John Wiley and Sons, New York. 3. Stuart, A. Ord, A. (1994). ***Kendall's Advanced Theory of Statistics, Distribution Theory,*** *6th Edition.* Wiley-Blackwell. 4. Gupta, S.C. and Kapoor, V.K. (2000). ***Fundamentals of***	

	***Mathematical Statistics**, 10 th Revised Edition.* Sultan Chand & Sons, New Delhi.
Course Outcomes	After successful completion of this course, student will be able to: 1. Understand the concepts of discrete and continuous distributions. 2. Understand the normal distribution and various non-normal distributions, their properties and applications for scientific research. 3. Understand the concept of multivariate distributions and their marginal and conditional distributions. 4. Understand the idea of sampling and sampling distributions from infinite populations.

TEACHING LEARNING STRATEGIES

- **Lecturing, Visualization, Team Learning**

MODE OF TRANSACTION

- **Lecture, Seminar, Discussion, Questioning and Answering**

ASSESSMENT RUBRICS

Components	**Weightage**
EndSemesterEvaluation	**60**
ContinuousEvaluation	
Tests	16
Assignment	08
Seminar	16
Total	**40**

Sample Questions to test Outcomes:

1. Distinguish between characteristic function and moment generating functions. Find the moment generating function and characteristic function of a standard Laplace distribution.
2. Define probability generating function. Can it be used to obtain the expected value of X? Explain how.
3. Derive the probability density function of ratio of two independent standard normal variates.
4. If X_1, X_2, X_3 and X_4 are independent standard normal variates, find the distribution of

$Y = X_1X_2 - X_3X_4$

5. Define bivariate normal distribution. Obtain its marginal and conditional distributions.
6. Define order statistics. Obtain the distribution of maximum order statistics based on a random sample of size n from exponential distribution with mean 10.

DISCIPLINE SPECIFIC CORE COURSE

Course Code & Title	MSSTA01DSC04- SAMPLING THEORY
Course Description	This course deals with the survey sampling procedures which is the backbone of applied statistics. Fundamentals of survey sampling methodology are covered by this course. The theory and practice of survey sampling methodology is included in this course.
Course Objectives	• Distinguish between Probability and Non-Probability Sampling • Apply the sampling methods: simple random sampling, systematic sampling, stratified sampling and cluster sampling. • Estimate the population parameters for variables and attributes under the above procedures. • Estimate the population parameters concerning the study variables under auxiliary information (Ratio and regression methods) • Discuss probability proportional to size (PPS) sampling strategies. • Explain the concepts of ordered and unordered estimators and its properties.

Modules	Content	Module Outcome
Module I: Simple Random Sampling and Systematic Random Sampling **(15 hours)**	Census and sampling-basic concepts, probability sampling and non-probability sampling, simple random sampling with and without replacement, estimation of population mean and total, estimation of sample size, estimation of proportions. Systematic sampling, linear and circular systematic sampling, estimation of mean and its variance, estimation of mean in populations with linear and periodic trends.	• Recall the basics of sample surveys • Understand the technique of simple random sampling and systematic sampling. • Estimate the parameters under simple random sampling and systematic sampling.

Module II: Stratified Random Sampling and Auxiliary Variable Techniques **(15 hours)**	Stratification and stratified random sampling. Optimum allocations, comparisons of variance under various allocations. Auxiliary variable techniques, Ratio method of estimation, estimation of ratio, mean and total. Bias and relative bias of ratio estimator. Mean squared error of ratio estimator. Unbiased ratio type estimator. Regression methods of estimation. Comparison of ratio and regression estimators with simple mean per unit method. Ratio and regression method of estimation in stratified population.	• Explain stratified random sampling. • Explain various allocations and derive variance under various allocations. • Articulate ratio and regression method.
Module III: Varying Probability Sampling **(15 hours)**	Varying probability sampling – pps sampling with and without replacements. Des-Raj ordered estimators, Murthy's unordered estimator, Horwitz –Thompson estimators, Zen-Midzuno scheme of sampling, PPS sampling.	• Explain PPS sampling with and without replacement. • Explain ordered and unordered estimators.
Module IV: Cluster, Multi Stage and Multi-Phase Sampling **(15 hours)**	Cluster sampling with equal and unequal clusters. Estimation of mean and variance, relative efficiency, optimum cluster size, varying probability cluster sampling. Multi-stage and multiphase sampling. Non-sampling errors.	• Articulate cluster sampling with equal and unequal clusters. • Difference between multi stage and multi phase sampling. • Explain different non-sampling errors.

References	***Text books*** 1. Singh, D. and Chowdhary, F.S. (1986). ***Theory and Analysis of Sample Survey Designs***, New Age International, New Delhi. 2. Cochran. W.G. (2007). ***Sampling Techniques***, John Wiley & Sons, NewYork ***Reference books*** 1. Des Raj, D. and Chandhok, P. (1998). ***Sample Survey Theory***, Narosa Publishing House, New Delhi. 2. Gupta and Kapoor(2010). ***Fundamentals of Applied Statistics***. Sulthan Chand & Sons. 3. Murthy, M.N. (1967). ***Sampling Theory & Methods***. Statistical Publishing Society, Calcutta. 4. Parimal Mukopadhyay (2012)**.** ***Theory & Methods of Survey Sampling***, PHI Learning, New Delhi.
Course Outcomes	After successful completion of this course, student will be able to: 1. Understand the concepts of probability and non-probability sampling. 2. Understand the estimation methods for population mean, total and proportion under various sampling schemes. 3. Understand the use of auxiliary information for the estimation of various population parameters.

TEACHING LEARNING STRATEGIES

- **Lecturing, Visualization, Team Learning**

MODE OF TRANSACTION

- **Lecture, Seminar, Discussion, Questioning and Answering**

ASSESSMENT RUBRICS

Components	Weightage
End Semester Evaluation	**60**
Continuous Evaluation	
Tests	16
Assignment	08
Seminar	16
Total	**40**

Sample Questions to test Outcomes:

1. Distinguish between probability sampling and non probability sampling. Give an example in each case.
2. Derive the variance of sample mean in stratified random sampling.
3. Explain circular systematic sampling.
4. What do you mean by pps sampling? Expalin briefly Horwitz –Thompson estimator.
5. Distinguish between ratio estimators and regression estimators.
6. Explain the difference between the methods of SRS and varying probability scheme.

SEMESTER I

DISCIPLINE SPECIFIC ELECTIVES

Course Code & Title	**MSSTA01DSE01- STATISTICAL COMPUTING USING R (Practical)**
Course Description	This is a practical course deals with the basic statistical computational techniques and graphics using R. R software is most popular among statisticians and this course gives a cutting edge technology for data analysis using R. Hands on training on statistical methods using R is provided.
Course Objectives	• Define the basic concepts of R software and R packages • Describe various concepts required for developing the R Language • Build our new functions in R • Illustrate different R-Graphics facilities • Find rank and inverse using R software • Describe different sampling methods using R software. • Apply SPSS software to develop different statistical tools. • Interpretation of results using SPSS software.

Modules	**Content**	**Module Outcome**
Module I: Basic Concepts of R Programming (**25 hours**)	Introduction to R- Objects and their classes, operators, vectors and matrices, list and data frames, indexing and accessing data, importing and exporting data. Common built-in functions. Simple applications - Descriptive statistics. R-Graphics- Histogram, Box-plot, Stem and leaf plot, Scatter plot, Q-Q plot. Looping-For loop, repeat loop, while loop, if command, if else command.	• Define basic concepts of statistical software R such as Basic operations in R, Mathematical functions used in R, Assign values to variables etc. • Demonstrate the important data structures such as arrays, matrix, data frames, Class function etc.

		• Design an overview of the R Language such as Expressions, Objects, Symbols, Functions, Special Values.
Module II: Matrices and Standard Probability Distributions (**20 hours**)	Topics from linear algebra:- Matrices, rank, determinants and inverse. Eigen values and vectors, power of matrices, g-inverse, system of linear equations, roots of algebraic and transcendental equations. Writing own R functions, installation of new packages, different data sets available in R packages.	• How to find rank and inverse using R software. • How to solve system of linear equations using R software. • .How to install l new packages
Module III: Sampling Methods (**25 hours**)	Plotting of cdf and pdf for different values of the parameters of standard distributions. Generations of random samples from standard distributions, demonstrations of the sampling distributions of the standard statistics and functions of random variables-distribution of sample mean and sample variance, illustration of laws of large numbers, central limit theorems.	• .Plotting pdf and cdf curve of different distributions • Random number generation in R • Understanding the Sampling distributions of v statistics

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<td>Module IV:
Data Analysis Using SPSS

(20 hours)</td>
<td>Random sample selections, estimation of mean proportion, variance, confidence interval and efficiency under SRS, stratified random sampling, Various kind of allocation, stratification, estimators based on ratio and regression methods pps sampling, two stage cluster sampling, and systematic sampling.</td>
<td>• How to draw random samples using different sampling techniques
• PPS sampling techniques using R software.
• Ratio and regression methods using R software</td>
</tr>
<tr>
<td>References</td>
<td colspan="2">Text Books
1. Maria D.U., Ana F.M. and Alan T.A. (2008): Probability and Statistics with R.CRC Press.
2. Dalgaard, P. (2008): Introductory Statistics with R, (Second Edition), Springer.
Reference books
1. Purohit, S.G, Ghore, S. D and Deshmukh, S. R. (2004): Statistics Using R. Narosa.
2. Maria L. Rizzo (2019). Statistical Computing with R, Second Edition, Chapman & Hall, CRC Press.</td>
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<td>Course Outcomes</td>
<td colspan="2">After successful completion of this course, student will be able to:
1. Understand various built in functions in R programming for statistical data analysis.
2. Understand different functions in R programming for writing compute r programmes and develop compute R programmes for different problems.
3. Understand the usage of packages in R for drawing various diagrams and computing descriptive statistics, the comparison of means, ANOVA, non-parametric tests, simple correlation and regression procedures and apply for real data sets.</td>
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TEACHING LEARNING STRATEGIES

- **Lecturing, Visualization, Team Learning**

MODE OF TRANSACTION

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ASSESSMENT RUBRICS

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End Semester Evaluation	**60**
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Tests	16
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Total	**40**

Sample Questions to Test Outcomes:

1. Write an R programme to show that sample mean is unbiased estimate of mean of a normal population. Also show graphically that sample mean follows a normal distribution.

2. Let the population be set of numbers 1,2,…10. Write a R programme to obtain a pps sample of size 20 with probability vector (0.2,0.1,0.05,0.05, 0.3,0.1,0.15,0.5)

3. Let $A = (a_{ij})$be a 3x5 matrix such that $a_{ij} = i^2 - 2j$. Write R programme to obtain its rank and Moore - Penrose inverse.

4. Write R programme to generate a random sample of size 1000 from a standard normal distribution and to estimate $P(|X| > \sqrt{2})$. Also obtain the bias and standard error of this estimate.

5. Write an R programme to generate a random sample of size 20 from discrete random variable taking values -4,-2,0,1,3 with corresponding probablities 0.2,0.3, 0.4, 0.1. also obtain the barplot

6. Generate a random sample of size 1000 from a bivariate normal population $\binom{X}{Y}$ with mean vector $(5,10)$ and covariance matrix $\begin{pmatrix} 3 & 2 \\ 2 & 8 \end{pmatrix}$. Obtain an estimate of $P(Y > 2X)$ and obtain the bias of the estimate.

DISCIPLINE SPECIFIC ELECTIVES

Course Code & Title	MSSTA01DSE02-STATISTICAL COMPUTING USING SPSS
Course Description	This practical course covers the topics in statistical computations using the popular social science package SPSS. Knowledge in SPSS caters the required skill enhancement for the MSc students. This course is intended to bridge the theory and applications in a smooth way of demonstrations using the modules of SPSS.
Course Objectives	This course aims to: • Define the basic concepts of SPSS software • Build our new functions in SPSS • Illustrate different SPSS-Graphics facilities • Describe different sampling methods using SPSS software. • Apply SPSS software to develop different statistical tools. • Interpretation of results using SPSS software.

Modules	Content	Module Outcome
Module I: SPSS Environment, Basic Concepts of SPSS Programming **(20 Hours)**	Introduction to SPSS- Starting SPSS, Working with data file, SPSS windows, Menus, Dialogue boxes. Preparing the Data file, Creating data file and entering data, Defining the variables, Entering data, modifying data file, import file. Variable types in SPSS and Defining variables – Creating a Codebook in SPSS. Screening and cleaning data, Manipulation of data.	▪ Understand the installation and familiar with toolboxes of SPSS. ▪ Data management and modifications of data.

Module II: Preliminary Analysis in SPSS **(25 Hours)**	Computing Variables- Recoding (Transforming) Variables: Recoding Categorical String Variables using Automatic Recode - Sorting Data - Grouping or Splitting Data. Categorical variables, continuous variables. The Explore procedure - Frequencies Procedure – Descriptive - Compare Means - Frequencies for Categorical Data, different statistical distributions	▪ Working with Data types ▪ Recoding and sorting ▪ Descriptive statistics ▪ Explore procedure, graphics in SPSS
Module III: Inferential Statistics **(25 Hours)**	Pearson Correlation, Chi-square Test of Independence – Inferential Statistics for Comparing Means: One Sample t Test, Paired Samples T Test, Independent Samples T Test, One-Way ANOVA. Two way ANOVA, Multivariate ANOVA.	▪ Compute and interpret correlation coefficients ▪ Learn how to conduct various statistical tests using SPSS ▪ Preparing ANOVA
Module IV: Non-Parametric statistics **(20 Hours)**	Independent Chi square Test, Mann- Whitney test , Wilcoxon signed rank test, Kruskal- Wallis test. Interpreting the output of tests, p-value computation.	▪ Learn how to perform non parametric tests ▪ Get p value of various tests ▪ Interpretation of test results

References	***Text Books*** 1. Hinton P. R., Brownlow C, Mc Murray, I. and Cozens, B. (2004): ***SPSS Explained,*** Routledge, Taylor and Francis group, New York. ***Reference books*** 1. Field, A. (2011); ***Discovering Statistics Using SPSS,*** Sage Publications.
Course Outcomes	After successful completion of this course, student will be able to: 1. Understand various built in functions in SPSS for statistical data analysis. 2. Understand different functions in SPSS for analyzing given data set. 3.Understand the usage of menus in SPSS window for drawing various diagrams and computing descriptive statistics, the comparison of means, ANOVA, non-parametric tests, simple correlation and regression procedures and apply for real data sets.

TEACHING LEARNING STRATEGIES

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Sample Questions to Test Outcomes:

1. Use the SPSS data set saved in the file name "student_data". Plot the necessary graphs to summarize the data.

2. Conduct t-test and a non parametric analogue for testing whether the average BMI of boys and girls are same.

3. Perform an appropriate ANOVA for the given data (use "student_data").

4. Obtain correlation matrix and scatter plots for the marks of the students .

5. Create a cross tab and check whether the variables are independent.

6. Fit a linear regression equation to predict the degree marks knowing marks in SSLC and Plus Two. Also test the significance of regression coefficients and obtain p-values.