GOVERNMENT ARTS COLLEGE (AUTONOMOUS)
COIMBATORE 641 018

LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK

(LOCF) for

M.Sc. STATISTICS
(With effect from 2021 – 2022 onwards)

POSTGRADUATE AND RESEARCH DEPARTMENT OF STATISTICS

MAY 2021

Table of Contents

Preamble:

Statistics is aggregate of facts. Statistical techniques are used to make many decisions that influence our day-to-day life. Statistics is a science of collecting, organizing, presenting, analyzing, and interpreting data to assist in making more effective decisions.

Post Graduate Studies in Statistics is the confluence of application and research in diverse fields of Statistics. The curriculum and syllabi of two year M.Sc. degree course in Statistics is scaffold by the expert committee. Over the past decades the higher education system of our country has undergone substantial structural and functional changes resulting in both quantitative and qualitative development of the beneficiaries. Such changes have gained momentum with the introduction of Choice Based Credit System (CBCS) which further expects learning outcome-based curriculum in order to maximize the benefits of the newly designed curriculum. The learning outcome-based curriculum will definitely help the teachers of the discipline to visualize the curriculum more specifically in terms of the learning outcomes expected from the students at the end of the instructional process. It is pertinent to mention here that the purpose of education is to develop an integrated personality of the individual and the educational system provides all knowledge and skills to the learner for this.

Tamil Nadu State Council for Higher Education (TANSCHE) has formed the State Integrated Boards of Studies, which, with great diligence and expertise has devised the mandatory areas that have to be covered for three-year undergraduation and two-year postgraduation courses to realize the facilitation of the mobility of faculty and students from one university to another and to easily solve the problem of equivalence among courses. Great care has been taken so that these areas would take 75% of the course content and the remaining 25% can be decided by the individual institutions. The areas that must be covered by the student that are mandatory for earning the degree to have due value has been worked out so that the student will gain enough depth of knowledge in the subject concerned. 25% percent of the syllabus should be designed by the institutions, and the areas covered under this also must have a weightage of 25%. This gives the autonomous institution seamless liberty on every Board of Studies (BOS) to innovate and experiment, and more importantly, it is here that the institution devises appropriate strategies by

which (i) to make creative and critical applications of what has been learnt in the mandatory components, and (ii) to meaningfully connect the learners to the career demands and expectations. It is essential that the theoretical subject knowledge of the students must be translated into practical hands-on experience.

One of the significant reforms in the undergraduate education is to introduce the Learning Outcomes-based Curriculum Framework (LOCF) which makes it student-centric, interactive and outcome-oriented with well-defined aims, objectives and goals to achieve. LOCF also aims at ensuring uniform education standard and content delivery across the country which will help the students to ensure similar quality of education irrespective of the institute and location. With initiatives of University Grants Commission (UGC) for nation-wide adoption and implementation of the LOCF for bachelor's programmes in colleges, universities and HEIs in general. A Core Expert Committee (CEC) was constituted to formulate the modalities for developing the LOCF in various subjects being taught in the undergraduate courses in sciences, humanities, commerce and professional courses. The CEC also constituted the Subject Expert Committees (SEC) in various subjects to prepare detailed guidelines for the LOCF in subjects concerned.

The key components of the planning and development of LOCF are given in terms of clear and unambiguous description of the Graduate Attributes (GA), Qualification Descriptors (QD), Program Learning Outcomes (PLO) and Course Learning Outcomes (CLO) to be achieved at the end of the successful completion of each undergraduate program to be offered by HEIs. In undergraduate education in Information Technology, the programme of study leading to the degree of B.Sc. in Information Technology is discussed herewith.

The Qualification Descriptors (QD), Program Learning Outcomes (PLO) and the Course Learning Outcomes (CLO) were also finalized keeping the broad requirement of the programme in view. The LOCF also gives general guidelines for the Teaching Learning Process (TLP) corresponding to each component of theory, experiment, tutorials, projects and industrial / field visits to be followed in order to achieve the stated outcomes for each component. Finally, some suggestions for using various methods in the assessment and evaluation of learning levels of students are also made. It is a student centric framework where they are expected to learn fundamentals of Information Technology along with the latest trends and techniques like Artificial Intelligence, Internet of Things, Machine Intelligence along with advanced skillsets that include Mobile Application Development, Object Oriented Programming among many other courses.

1. Introduction

M.Sc. Statistics programme consists of 90 credits spread over four semesters. This programme is focused on both theory and applied Statistics with an inculcation of practical and project. It is structured to provide advanced knowledge in Statistics and to develop computing skills. This may lead to employability of students in many fields of industries.

1.1 Types of courses and Course structure

Each program may have three types of courses namely Core courses, Eelective courses and Self-study/Skill-based courses

1.1.1 Core Courses

The Core courses are those courses whose knowledge is deemed essential for the students registered for a particular Master's degree program. Where feasible and necessary two or more programs may prescribe one or more common core courses.

- The core courses shall be mandatory for all the students registered for the master's degree program.
- The core courses shall be spread all the semesters of the program.

1.2.1 Elective courses

The elective courses can be chosen from a pool of papers. These courses are intended to

- allow the student to specialize in one or more branches of the broad subject area;
- help the student to acquire knowledge and skills in a related area that may have applications in the broad subject area;
- help the student to bridge any gap in the curriculum and enable acquisition of essential skills, for example, statistical, computational, language, communication skills etc.
- help the student to pursue area of interest
- The student may also choose additional elective courses offered by the college to enable him /her to acquire extra credits from the discipline or across the discipline

1.3.1 project work

A course (core/elective/self-study/skill based) may take the form of a project work.

2. Learning Outcomes Based Approach to Curriculum Planning

One of the significant reforms in the undergraduate education is to introduce the Learning Outcomes-based Curriculum Framework (LOCF) which makes it student-centric, interactive and outcome-oriented with well-defined aims, objectives and goals to achieve. Outcome based learning is the principal end of pedagogical transactions in higher education in today's world in the light of exponential changes brought about in science and technology, especially in mathematics, and the prevalent utilitarian world view of the society. The learning outcomes are attained by students through skills acquired during a programme of study. Programme learning outcomes will include subject-specific skills and generic skills, including transferable global skills and competencies. It would also focus on knowledge and skills that prepare students for further study, employment, and citizenship. They help ensure comparability of learning levels and academic standards across colleges/universities and provide a broad picture of the level of competence of graduates.

The quality education in a subject like Statistics is a very challenging task for Higher Education System in India. UGC has already taken an appropriate measure to define the minimum levels of learning for Statistics courses for post-graduate levels. The quality of higher education in Statistics should be improved in such a manner that young minds are able to compete in this field globally in terms of their knowledge and skills in the globalised era of the date. Also, there is an urgent need of sustained initiatives to be taken by colleges/institutes/universities for outcome-oriented higher education in Statistics so that graduates are enabled to enhance the chances of employability. Presently, the goal of higher education in Statistics may be achieved using the following measures:

i. Curriculum reform based on a learning outcomes-based curriculum framework (LOCF).

ii. Improving learning environment and academic resources.

iii. Elevating the quality of teaching and research.

iv. Involving students in discussions, problem-solving and out of box thinking about various ideas of Statistics and their applicability, which may lead to empowerment and enhancement of the social welfare at large.

v. Encouraging the learners to make use of LOCF to learn Statistics through distance education.

vi. Motivating the learners to understand various concepts of Statistics keeping in view the regional context.

vii. Enabling learners to create research atmosphere in Statistical sciences in their colleges/institutes/universities.

viii. Teach courses of mathematics based on Choice Based Credit System (CBCS).

One of the benchmarks to measure the progress of a country is the advancement of the knowledge of Statistics. Hence, innovative measures should be taken to improve the quality of mathematical knowledge in our society. This is also because Statistics has wide ranging applications in engineering, technology and a host of other areas.

2.1 Nature and Extent of the M.Sc. Statistics Programme

The M.Sc. Statistics Programme has some unique features such as Theory, practical and independent projects. Students are given practical training on realistic problems and extensive insight into Statistical Analysis using latest computer languages.

Students are given in hand training in Statistical Software such as SPSS, R and Python.

The course has been designed in such a way that besides the core courses, a student can opt for outcome based elective courses from the streams such as *Computer Programming, Database Development and Numerical Methods.*

The final semester project work is one of the major components of this programme and the students have liberty in choosing the area of specialization. M.Sc. Statistics programme is of two years duration, with semester pattern and have the following features.

- During the first semester, students will be given advanced knowledge in Probability and distributions.
- During the second semester it is focused on applied statistics and computing skills.
- The third semester**,** students are exposed Hypothesis Testing, Design of Experiments and Numerical analysis.
- During the final semesters, Advanced Operations Research, Practical and Project are entertained.

2.2 Aims of Master Degree Programme in Statistics

- To prepare post graduate students to fit into interdisciplinary areas such as Information Technology, Agriculture, Government, Business, Telecommunication and medicine. As a

result, they can pursue their future career either in the core field or in the applied field of Statistics.

- To coach students with computational techniques and software applications for Statistical Analysis.
- To expose students for competitive examinations.
- To train students in developing Statistical models for solving realistic problems.

3. Attributes in Statistics

- **Disciplinary Knowledge**: The proposed curriculum is expected to provide the students a sound knowledge of Statistics covering various aspects. As a result, they will not only appear appropriate for pursuing higher studies in the subject but also develop skill to apply the statistical knowhow to a variety of real life problems.

- **Critical Thinking**: The proposed course is designed to enrich the students with ability to examine the various statistical issues in a more logical and methodical manner. It is expected that the students will strengthen themselves both computationally and analytically.

- **Problem Solving**: The students will be able to critically examine various hypotheses and research queries, and will be able to identify and consult relevant resources to find their rational answers.

- **Analytical Reasoning**: The students are expected to develop capability to identify logical flaws and loopholes in the arguments of practicing Statisticians, analyse and synthesise data from a variety of sources and accordingly draw conclusions.

- **Research Related Skills**:The students should be able to develop original thinking for formulating new problems and providing their solutions. As a result, they will be able to develop research related skills for their own subject as well as for those who are practicing Statistics
- **Communication Skills and Team Work:** The students are expected to develop effective

and confident Communication skill after completion of the course. They will have an ability to work in a team as well as in isolation.

- **Moral and Ethical Awareness**: After completion of the course, the students are expected to develop ethical and social responsibility as well. As a result, the students will be able to identify ethical issues, avoid unethical behaviour such as fabrication, falsification or misrepresentation and misinterpretation of data.

- **Scientific Reasoning:** The students will be able to analyse, interpret and draw appropriate conclusions from both quantitative and qualitative data and critically evaluate ideas, evidence and experiences with an unbiased and consistent approach.

- **Reflective thinking:** The students should be sensitive to real experiences with respect to self, society and nation.

- **Information/Digital literacy:** The proposed course is expected to develop digital literacy among the students for using ICT in different learning situations. The students should be able to equip themselves with in depth programming and simultaneously use appropriate Statistical software for advanced Statistical computing with high level graphical interface.

- **Self-directed Learning:** The students are expected to be familiar with data collection, compilation, analysis and interpretation and writing of project reports independently.

- **Multicultural Competence:** The students are expected to be aware of values and beliefs of different cultures and have a global perspective by examining various forms of primary and secondary data resources.

- **Leadership Readiness/Qualities:** The students will be capable of mapping out the tasks of a team or an organization, formulating an inspiring vision, building a team for achieving the desired objectives, motivating and inspiring team members accordingly, and using management skills to guide people in the right direction smoothly and efficiently.

- **Lifelong Learning:** The proposed course is designed to develop independent, coherent and decisive thoughts among the students that will ultimately develop

4. Qualification Descriptors

Qualification descriptors for a Master Degree in Statistics:

The qualification descriptors for a Post Graduate Degree in Statistics will

- demonstrate (i) a systematic, extensive, coherent knowledge of an academic field of study and its applications, links to interdisciplinary areas of study with a critical knowledge of the subject and a number of emerging issues, (ii) procedural knowledge that creates professionals in the field of Statistics including research and development, teaching, government and public services, (iii) skills in areas related to specialization and current developments in Statistics.
- demonstrate skills in collection of relevant quantitative and/or qualitative data, analysis and interpretation of data using appropriate statistical methodologies.
- use knowledge, understanding and skills for critical assessment of a wide range of ideas and complex problems and issues relating to the chosen field of study.
- communicate the results of studies undertaken in statistics in a range of different contexts using the main concepts, constructs and techniques of the subject.
- address one's learning needs relating to current and emerging areas of study, making use of research, development and professional materials as appropriate, including those related to new frontiers of knowledge.
- apply one's statistical knowledge and skills to new contexts and to identify and analyse problems and issues and seek solutions to real-life problems.
- demonstrate subject-related skills that are relevant to some of the job trades and employment opportunities.

5. Programme Learning Outcomes in M.Sc. Statistics

The student graduating with the Degree M.Sc. Statistics should be able to

1. Demonstrate the ability to use skills in Statistics and its related areas of technology for formulating and tackling Statistical related problems and identifying and applying appropriate principles and methodologies to solve a wide range of problems associated with Statistics.

2. Acquire

(i) a fundamental/systematic or coherent understanding of the academic field of Statistics, its different learning areas and applications in Medical Statistics, Actuarial Statistics, Psychological Statistics, Agricultural Statistics, Industrial Quality control, Econometrics, etc.,

(ii) procedural knowledge that creates different types of professionals related to the disciplinary/subject area of Statistics, including professionals engaged in research and development, teaching and government/public service;

(iii) skills in areas related to one's specialization area within the disciplinary/subject area of Statistics and current and emerging developments in the field of Statistics.

3. Recognize the importance of statistical modelling simulation and computing, and the role of approximation and mathematical approaches to analyze the real world problems.

4. Plan and execute Statistical related experiments or investigations, analyze and interpret data/information collected using appropriate methods, including the use of appropriate software such as programming languages and purpose-written packages, and report accurately the findings of the experiment/investigations while relating the conclusions/findings to relevant theories of Statistics.

5. Demonstrate relevant generic skills and global competencies such as

(i) problem-solving skills that are required to solve different types of Statistics-related problems with well-defined solutions, and tackle open-ended problems that belong to the disciplinary-area boundaries;

(ii) investigative skills, including skills of independent investigation of Statistics-related issues and problems;

(iii) communication skills involving the ability to listen carefully, to read texts and research papers analytically and to present complex information in a concise manner to different groups/audiences of technical or popular nature;
(iv) analytical skills involving paying attention to detail and ability to construct logical arguments using correct technical language related to Statistics and ability to translate them with popular language when needed;
(v) ICT skills;
(vi) personal skills such as the ability to work both independently and in a group.

6. Demonstrate professional behavior such as
(i) being objective, unbiased and truthful in all aspects of work and avoiding unethical, irrational behavior such as fabricating, falsifying or misrepresenting data or committing plagiarism;
(ii) the ability to identify the potential ethical issues in work-related situations;
(iii) appreciation of intellectual property, environmental and sustainability issues; and
(iv) promoting safe learning and working environment.

Program Educational Objectives (PEOs)	
On successful completion of the **M.Sc. Statistics** program, the students will be able to:	
PEO1	Get employment in Government, Public and Private sectors.
PEO2	Apply Statistical Techniques in diverse field
PEO3	Gain advanced knowledge and to focus on Research activities
PEO4	Develop Computing Skills through latest computer programming
PEO5	Store Data, View Data and to Interpret Data and can Serve as a good academician.
Program Specific Outcomes (PSOs)	
On successful completion of M. Sc. Statistics program, the students are expected to	
PSO1	Know the importance of Statistics in diverse fields
PSO2	Identify the advancement in Statistics
PSO3	To improve programming skills for data analysis and interpretation
PSO4	Apply statistical methods in experimental outcomes.
PSO5	Understand the advancements and novel Statistical methods.
Program Outcomes (POs)	
On successful completion of the M. Sc. Statistics program, students will be able to	
PO1	Possess adequate knowledge in theory and applications
PO2	Implement conceptual ideas, principles and methods in diversified fields of study
PO3	Utilize analytical skills for basic mathematical computation
PO4	Understand the conditions and limitations of statistical methods in application

PO5	Critically analyze statistical data and make interpretations
PO6	Utilize software skills for statistical computation
PO7	Gain effective skills to perform data analysis using statistical tools
PO8	Recognize the importance and value of statistical principles and approach for problem solving on a diversified disciplines
PO9	Prepare to participate in competitive examinations at the state and national level and job placements.
P10	Gain impetus to move for learning at higher level

6. Structure of M.Sc. Statistics Course

PG - SCHEME OF EXAMINATIONS: CBCS PATTERN
(For the students admitted during the academic year 2021-2022 and onwards)

Sub Code	Title of the Paper	Hrs (wk)	Internal (CA) Marks	External Marks	Total Marks	Ext– Min.	Total Pass Mark	Credits
Semester – I								
21MST11C	Core I : Real Analysis & Linear Algebra	6	50	50	100	25	50	5
21MST12C	Core II : Probability Theory	6	50	50	100	25	50	5
21MST13C	Core III : Distribution Theory	6	50	50	100	25	50	5
21MST14E	Elective I - Big Data Analytics using Python Programming	6	50	50	100	25	50	3
21MST25P	Core Practical I : Practical - I	3						-
21MST26P	Core Practical II : Practical - II (Using Python)	3						-
Semester – II								
21MST21C	Core IV: Sampling Theory	6	50	50	100	25	50	5
21MST22C	Core V : Statistical Estimation Theory	6	50	50	100	25	50	5
21MST23C	Core VI : Statistical Quality Control & Reliability Estimation	6	50	50	100	25	50	5
21MST24E	Elective -II: Introduction to Data Base Management System	6	50	50	100	25	50	3
21MST25P	Core Practical I : Practical - I	3	50	50	100	25	50	4
21MST26P	Core Practical II : Practical-II (Using Python)	3	50	50	100	25	50	4

Sub Code	Title of the Paper	Hrs (wk)	Internal (CA) Marks	External Marks	Total Marks	Ext– Min Pass Mark	Total Pass Mark	Credits
Semester – III								
21MST31C	Core VII : Testing Statistical Hypothesis	6	50	50	100	25	50	5
21MST32C	Core VIII: Linear Models & Design of Experiments	6	50	50	100	25	50	5
21MST33C	Core IX : Multivariate Analysis	6	50	50	100	25	50	5
21MST34E	Elective III : Numerical Analysis	6	50	50	100	25	50	3
21MST44P	Core Practical III : Practical - III	2						-
21MST45P	Core Practical IV : Practical–IV (Using SPSS)	2						-
21MST46C	Project / Dissertation	2						-
Semester – IV								
21MST41C	Core X : Stochastic Processes	6	50	50	100	25	50	5
21MST42C	Core XI : Econometrics	6	50	50	100	25	50	5
21MST43C	Core XII : Advanced Operations Research	6	50	50	100	25	50	5
21MST44P	Core Practical III : Practical - III	4	50	50	100	25	50	4
21MST45P	Core Practical IV : Practical–IV (Using SPSS)	4	50	50	100	25	50	4
21MST46C	Core: Project / Dissertation	4	50	50	100	25	50	5
	Total Hours 120					**Total Credits**		**90**

Cores & Electives -Include theory and practical. Includes 50 continuous Internal Assessment Marks for Theory and Practical papers respectively. Project 50 Marks Continuous Internal Assessment mark. Final Project evaluation done by both Internal (25) and External examiner (25) for a Total of 50 Marks.

Year	Sem	Subject Code	Title of the Paper	Hours/ Week
2021-2022 onwards	**I**	**21MST11C**	**CORE I: REAL ANALYSIS AND LINEAR ALGEBRA**	**6**

COURSE LEVEL OUTCOMES:

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

1. Explain the fundamental concepts of real and Linear Algebra and their role in modern mathematics and applied contexts.
2. Estimate certain theorems like Role's theorem, Lagrange's and Cauchy's mean value theorem
3. Discuss Riemann Integrability, Algebra of Integrable functions, Fundamental theorem of Integral Calculus, First and Second Mean value theorems.
4. Extend Riemann - Stieljtes integral, Algebra of RS integral functions and Relation between R-Integral and RS Integral.
5. Summarize Matrices, Rank of a matrix , inverse of a matrix , symmetric and orthogonal matrices, Characteristic roots of a vector and Cayley-Hamilton theorem
6. Discuss the concept of Quadratic form –Canonical reduction and orthogonal reduction of real quadratic forms
7. Generalize the Nature of quadratic forms. Sylvester's law of inertia. Simultaneous reduction of a pair of quadratic forms.

Unit - I

Limits - Algebra of limits-Continuity-Theorems on continuity-Differentiability-Progressive and Regressive derivatives - Necessary condition for the existence of finite derivatives - Darbouxproperty-Role's Theorem-Lagrange's Mean Value Theorem-Cauchy's Mean Value theorem.

Unit - II

Riemann Integral - Partitions and Sums –Upper and Lower R – Integrals – Riemann Integrability – Riemann's necessary and sufficient conditions for R – Integrability – Algebra of Integrable functions - Fundamental theorem of Integral Calculus – First and Second Mean value theorems.

Unit - III

Riemann Stieltjes Integral – Partitions – Lower and Upper RS sums and integrals. RS integral as a limit of sums- Algebra of RS integral functions- Relationship between R-Integral and RS Integral.

Unit - IV

Matrices – Rank of a matrix – inverse of a matrix – symmetric and orthogonal matrices – Characteristic roots of a vector – Cayley - Hamilton theorem. Minimum polynomial, similar matrices, algebraic and geometric multiplicities of a characteristic root - Spectral decomposition of a real symmetric matrix.

Unit - V

Quadratic form –Canonical reduction and orthogonal reduction of real quadratic forms - Nature of quadratic forms- Sylvester's law of inertia - Simultaneous reduction of a pair of quadratic forms.

PEDAGOGY STRATEGIES

- Lecturing
- Assignment
- Classroom Discussion
- Questioning
- Seminar
- Class Test
- Quiz & Drill Practice
- Providing feedback

REFERENCES:

1 J.N. Sharma and A.R.Vashista. (2014), Real Analysis, Krishna Series.

2 Shanti Narayan, Dr.M.D. Raisinghania, (2008), Elements of Real Analysis, S.Chand& company limited, New Delhi,.

3 K.B.Datta, (2011), Matrix and Linear Algebra, Prentice Hall of India

FURTHER READING:

1 A.R. Rao, andP. Bhimasankaran, (2000), Linear Algebra, Hindustan BookAgency, Hyderabad.

2 F.A. Graybill, (1983), Matrices and Applications in Statistics, Wadsworth Publishing Company, Belmont, California, USA.

3 R.R.Goldberg, (1976), Methods of Real Analysis,Oxford & IBH Publishing Company, New Delhi

4 T.M. Apostol, (1986), Mathematical Analysis, Addison-Wesley, New York.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1 **https://www.jirka.org/ra/realanal.pdf**

2 **http://synechism.org/primer/primer-real-analysis.pdf**

3 **http://www.astronomia.edu.uy/progs/algebra/Linear_Algebra,_4th_Edition__(2009)Lipschutz-Lipson.pdf**

4 **https://nptel.ac.in/courses/111/101/111101134/**

5 **https://nptel.ac.in/courses/111/106/1111060**

Programme Level Outcomes	Course Level Outcomes (CLO)						
	1	2	3	4	5	6	7
Disciplinary Knowledge	✓	✓	✓	✓	✓		
Communication Skills	✓	✓	✓				✓
Critical Thinking	✓	✓	✓			✓	
Research related Skills		✓	✓	✓		✓	
Analytical Reasoning			✓	✓	✓	✓	
Problem Solving	✓	✓	✓	✓	✓		✓
Team Work	✓	✓	✓				✓
Moral and Ethical Awareness	✓			✓		✓	✓
Multicultural competence		✓		✓	✓	✓	

Year	Sem	Subject Code	Title of the Paper	Hours/Week
2021-2022 onwards	**I**	**21MST12C**	**Core II : PROBABILITY THEORY**	**6**

COURSE LEVEL OUTCOMES:

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

1. Explain the basics of Probability space, Discrete and General probability space, Conditional probability space, Functions and Inverse Functions and Induced probability space by the Random variables
2. Extrapolate the concept of Independence- Kolmogorov 0-1 law - Borel – Cantelli lemma - Borel 0-1 law.
3. Identify the applications of inequalities in probability theory
4. Summarize the Mathematical Expectation and Conditional Expectation properties, Inequalities based on Expectation, Basic Inequality, Holder's Inequality, Markov Inequality, and Jenson's Inequality.
5. Recognise the Concepts of Convergence of sequence of random variables and Characteristic function, Definition and Properties of Inversion Theorem and Uniqueness Theorem.
6. Explore the application of law of large numbers and central limit theorems.
7. Discuss the concepts relating to law of large numbers Bernoulli's Weak Law of Large Numbers, Kolmogorov's Strong Law of Large Numbers, Central Limit Theorem, Liaponov's, Lindeberg Levy theorem, Lindeberg and Feller Central Limit Theorem for i.i.d. random variables.

Unit - I

Probability space – Discrete and General probability space- Conditional probability space- Functions and Inverse Functions - Random Variables – Induced probability space by the Random variables.

Unit - II

Distribution Function – properties - Decomposition theorem - Distribution function of vector random variables - Conditional distribution function - Concept of Independence- Kolmogorov 0-1 law - Borel – Cantelli lemma - Borel 0-1 law-Helly-Bray lemma.

Unit – III - Mathematical Expectation – properties - Conditional Expectation – properties - Inequalities based on Expectation - Basic Inequality - Holder's Inequality - Markov Inequality - Jenson's Inequality – Applications of Inequalities-simple problems.

Unit - IV

Convergence of sequence of random variables - mode of convergence and their relationships-Convergence in rth mean - monotone convergence theorem - Characteristic Function – Definition and Properties – Inversion Theorem — Uniqueness Theorem – Simple problems only.

Unit - V

Law of Large Numbers -Weak and Strong Law of Large Numbers – Bernoulli's Weak Law of Large Numbers - Kolmogorov's Strong law of large numbers – Central Limit Theorems - Lindeberg – Levy's central limit theorem - Liaponov's central limit theorem - Lindberg – Feller's central limit theorem (Statement only) – Application of Theorems.

PEDAGOGY STRATEGIES

- Lecturing
- Assignment
- Classroom Discussion
- Questioning
- Seminar
- Class Test
- Quiz & Drill Practice
- Providing feedback

REFERENCES:

1. B.R. Bhat (2015): Modern Probability Theory – An Introductory Text Book, Fourth Edition, New Age international (P) Ltd
2. K.N. Kapoor (2011), : A Text Book on Probability Theory, First Edition, International Book House Pvt. Ltd.,
3. V.K. Rohatgi and A.K. Md. EhranesSaleh (2009): An Introduction to Probability and Statistics, Second Edition, Wiley Student Edition, India,

FURTHER READING:

1. William Feller (2013): An Introduction to Probability Theory and its Applications, Volume II.
2. S.M. Ross (2010), A First Course in Probability, 2010, Pearson Prentice Hall.
3. Feller, W (2008). An Introduction to Probability Theory and its Applications, Volume II, John Wiley & Sons, New York.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1. **https://onlinecourses.nptel.ac.in/noc20_ma18/preview**
2. **https://nptel.ac.in/courses/111/102/111102111/**

Programme Level Outcomes	Course Level Outcomes (CLO)						
	1	2	3	4	5	6	7
Disciplinary Knowledge	✓	✓	✓	✓	✓		
Communication Skills	✓	✓	✓			✓	✓
Critical Thinking	✓	✓	✓				✓
Research related Skills		✓	✓	✓		✓	✓
Analytical Reasoning			✓	✓	✓		✓
Problem Solving	✓	✓	✓	✓	✓		
Team Work	✓	✓	✓			✓	✓
Moral and Ethical Awareness				✓	✓	✓	✓
Multicultural competence	✓	✓		✓		✓	✓

Year	Sem	Subject Code	Title of the Paper	Hours/ Week
2021-2022 onwards	**I**	**21MST13C**	**Core Paper III: DISTRIBUTION THEORY**	**6**

COURSE LEVEL OUTCOMES:

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

1. Explain the Random variables and its distributions
2. Derive properties of distributions
3. Demonstrate Moments of the distribution
4. Analyze Non-Central distributions
5. Discuss the concepts of Ordered Statistics and its distributions.
6. Derive probability distributions that are applied in real time situation.
7. Compute various measures of distribution.

Unit - I

Random Variables and Distributions – Theorems on Random Variables – Distribution Function – Properties of Distribution Function - Probability Mass Function – Probability Density Function – Two Dimensional Random Variables – Joint Distributions – Joint Densities – Marginal Densities – Conditional Densities – Transformation of one dimensional random variable – Fundamental Theorem – Transformation of two dimensional random variables - Distribution of sum, difference, product, quotient of random variables – Simple Problems.

Unit - II

Discrete Distributions – Binomial – Poisson – Geometric - Hyper-geometric - Negative Binomial - Multinomial distributions –Power Series distributions – limiting cases – Moments - Properties.

Unit - III

Continuous Distributions - Normal - Log normal distributions – Uniform distribution - Gamma distribution – Beta distribution of first kind - Beta distribution of second kind - Exponential distribution - Laplace (Single parameter) - Weibull distributions – Cauchy - Logistic Distributions.

Unit - IV

Non-central distributions – Non-central t - Non-central F - Non-central χ^2 distributions - Its Properties - Distribution of Sample correlation co-efficient for null case - Distribution of regression co-efficient.

Unit - V

Order statistics – Distribution of order statistics – Joint distribution of order statistics – Distribution of the smallest and largest order statistics –asymptotic distribution of r^{th} order statistics - Distribution of range - Mid-range - Median – Simple Problems.

PEDAGOGY STRATEGIES

- Lecturing
- Assignment
- Classroom Discussion
- Questioning
- Seminar
- Class Test
- Quiz & Drill Practice
- Providing feedback

REFERENCES:

1 Mood, A.M., F.A. Greybill& D.C. Boes, (2001), Introduction to the Theory of Statistics, Tata Mc Graw–Hill Education Pvt Limited, New Delhi.

2 Gupta, S.C., and V.K. Kapoor (2012), Fundamentals of Mathematical Statistics, Sultan Chand Sons Publishers, New Delhi.

FURTHER READING:

1 Rohatgi V.K. and A.K. Md. EhranesSaleh (2009), An Introduction to Probability and Statistics, Wiley Student Edition, India.

2 Hogg R.V., and A.T.Craig (2012), An Introduction to Mathematical Statistics, New York.

3. Johnson, N. L., Kotz, S., and Balakrishnan, N. (2004). Continuous Univariate Distributions. Vol.I, John Wiley and Sons (Asia), Singapore.

4. Johnson, N. L., Kotz, S., and Balakrishnan, N. (2014). Continuous Univariate Distributions, Vol. II. John Wiley and Sons (Asia), Singapore.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1 https://nptel.ac.in/courses/111/104/111104032/

2 **https://nptel.ac.in/courses/117/104/117104117/**

Programme Level Outcomes	Course Level Outcomes (CLO)						
	1	2	3	4	5	6	7
Disciplinary Knowledge	✓	✓	✓	✓	✓		
Communication Skills	✓	✓	✓			✓	✓
Critical Thinking	✓	✓	✓				✓
Research related Skills		✓	✓	✓		✓	
Analytical Reasoning			✓	✓	✓	✓	
Problem Solving	✓	✓	✓	✓	✓		
Team Work	✓	✓	✓				✓
Moral and Ethical Awareness		✓		✓	✓	✓	
Multicultural competence			✓		✓	✓	✓

Year	Sem	Subject Code	Title of the Paper	Hours/ Week
2021-2022 onwards	**I**	**21MST14E**	**Elective Paper I : BIG DATA ANALYTICS USING PYTHON PROGRAMMING**	**6**

COURSE LEVEL OUTCOMES:

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

1 Discuss the Big Data concepts and Structure of Data

2 Demonstrate the Visualization of Big Data using pyplot.

3 Appraise data, variables and declarations in Python

4 Explain Python Operators and Control Structures

5 Compute Strings and String Manipulations in Python

6 Describe about Lists, Tuples, Sets and Dictionary in Python.

7 Design Python Programs for Big Data Analytics.

Unit - I

Big Data Analytics – Big Data Definition – Data Sets in Big Data – Big Data in various fields – Dimensions of Big Data – Volume – Variety - Veracity - Velocity – Analysis - Categories of Big Data – Business Intelligence - Data Mining (Concept only) - Statistical Applications - Predictive analysis and Data Modeling – Categories of Data – Structured – Unstructured - Semi Structured – Sources of Big Data – Big Data Analytics using Python.

Unit - II

Introduction to Python – Key Features – Interactive Mode Programming – Script Mode Programming – Saving Python Script – Executing Python Script – Input and Output Functions – Comments (Documentation Section) – Indentation – Tokens of Python - Operators in Python – Data types – Lists – Tuples – Sets – Dictionary.

Unit - III

Control Structures in Python – Sequential Statement – if Statement – if-else Statement – if-elif Statement – Nested if-else Statement – Nested if-elif Statement. Iteration or looping constructs – While Loop – for Loop – Jump Statements – Break – Continue – Pass.

Unit - IV

Python Functions – Defining Functions – Types of Functions – User defined functions – Built-in functions – Lambda functions – Recursion functions – Block – Nested Block – Advantages of User defined functions – Calling a function – Passing Parameters in functions – Function Arguments – Anonymous Functions – Return Statement –Scope of Variables – Composition in functions – Recursive function.

Strings and Manipulation of Strings – Creating Strings – Accessing Characters in a String – Modifying and Deleting Strings – String Operators – Formatting Operators – Formatting Characters – The format() function – Escape Sequence – String functions.

Unit - V

Python Classes and Objects – Definition of class – Creating Objects – Accessing class members – Class methods – Constructor – Destructor – Public and Private Data members – Data Model – Hierarchical Model – Relational Model – Network Database Model – Object Model.

File operation in Python – open() – Python file modes – close() – reader functions – sorting function – writing functions - Big Data Visualization using Pyplot – Data Visualization Definition – Types of visualization– uses – Big Data Plots using Matplotlib and Clustering using Scikit-learn.

PEDAGOGY STRATEGIES

- Lecturing
- Assignment
- Classroom Discussion
- Questioning
- Seminar
- Class Test
- Quiz & Drill Practice
- Providing feedback

REFERENCES:

1 Seema Acharyaet.al (2018), Big Data Analytics using Python — McGraw Hill Education, India.

2 Frank Ohlhorst (2019), Big Data Analytics — Wiley & SAS Series.

FURTHER READING:

Wes McKinney – O-Reilly (2020), Python for Data Analysis – Oreilly Publisher.

1 Website: (http://oreilly.com/safari).

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1 https://nptel.ac.in/courses/106/107/106107220/

2 https://nptel.ac.in/courses/106/106/106106212/

COURSE LEVEL MAPPING OF PROGRAM LEVEL OUTCOMES

Course Level Outcomes

Program Level Outcomes (PLO)		CLO-1	CLO-2	CLO-3	CLO-4	CLO-5	CLO-6	CLO-7
	Disciplinary Knowledge	✓	✓	✓	✓	✓	✓	✓
	Communication Skills		✓		✓		✓	✓
	Critical Thinking			✓	✓	✓	✓	✓
	Research related Skills	✓	✓		✓		✓	✓
	Analytical Reasoning		✓		✓	✓	✓	✓
	Problem Solving		✓	✓	✓	✓	✓	✓
	Team Work	✓	✓	✓	✓	✓	✓	✓
	Moral and Ethical Awareness	✓			✓		✓	✓
	Multicultural competence			✓	✓		✓	✓

Year	Sem	Subject Code	Title of the Paper	Hours/ Week
2021-2022 onwards	**II**	**21MST21C**	**CORE IV: SAMPLING THEORY**	**6**

COURSE LEVEL OUTCOMES:

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

1. Associate the theory of Census and Sample surveys.
2. Distinguish Simple Random Sampling with and without replacement.
3. Generalize Stratified and Systematic Random sampling.
4. Predict PPS sampling with& without replacement.
5. Summarize Ratio Estimator and Regression Estimator.
6. Discuss Cluster Sampling.
7. Extrapolate Two and Three stage sampling.

Unit - I

Census and Sample surveys– Concept of Population- Sample- Sampling units – Merits and Limitations of Sampling technique -Principal steps in sample survey - Preparation of Questionnaire and Schedules - Concept of sampling and non-sampling errors.

Simple Random Sampling (with and without replacement) - Unbiased Estimate of Mean and Variance – Simple Random Sampling of Attributes – Estimation of mean and variance - Determination of sample size.

Unit - II

Stratified Random Sampling and systematic random sampling - Principles and Advantages of stratification- allocation of sample size in different strata- Estimation of mean and variance of Stratified Random Sampling and Systematic Random Sampling - Comparison of Simple Random Sampling, Stratified Random Sampling and Systematic Random Sampling.

Unit - III

Varying Probability Sampling- Introduction - Procedures of selecting a sample, Estimation in Probability proportional to size (PPS) sampling with replacement - population total and its variance - Gain due to PPS sampling with replacement - PPS sampling without replacement - Procedures of selection of a PPS sampling without replacement - Estimation in PPS sampling without replacement - Population total and its sampling variance.

Unit - IV

Ratio estimators - Introduction - Definition and notations - Bias of ratio estimators, approximate variance of ratio estimator-Ratio estimators in stratified sampling - comparison of separate and combined ratio estimator.

Regression estimators – Introduction - Difference estimator - regression estimator - Regression estimator in stratified sampling

Unit - V

Cluster sampling-Introduction-Notations-Equal cluster sampling –Estimation of mean and variance – Relative efficiency of cluster sampling – optimum cluster size –Cluster sampling for proportions.

Two stage sampling - with equal and unequal first stage units – Estimation of mean and variance. Three stagesampling - with equal probability - Estimation of mean and variance.

PEDAGOGY STRATEGIES

- Lecturing
- Assignment
- Classroom Discussion
- Questioning
- Seminar
- Class Test
- Quiz & Drill Practice
- Providing feedback

REFERENCES:

1. Daroga Singh and F.S.Chowdhary (2002), Theory and analysis of Sampling Survey Design, John Wiley & Sons, New Age International (P) Ltd., Publishers,New Delhi.
2. Wiiliam G. Cocharan(2011) , Sampling Techniques:, John Wiley & Sons.

FURTHER READING:

1. Des Raj (1978), Sampling Theory, Tata McGraw Hill, New Delhi
2. Murthy, M. N. (1967). Sampling Theory and Methods, Statistical Publishing Society, Calcutta.
3. Sampath, S. (2000). Sampling Theory and Methods, Narosa Publishing Company, New Delhi.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1. **https://nptel.ac.in/courses/111/104/111104073/**
2. **https://nptel.ac.in/content/storage2/courses/111104073/Module14/Lecture42.pdf**
3. **https://www.mooc-list.com/tags/sampling-methods**

Programme Level Outcomes	Course Level Outcomes (CLO)						
	1	2	3	4	5	6	7
Disciplinary Knowledge	✓	✓	✓	✓	✓		
Communication Skills	✓	✓	✓			✓	✓
Critical Thinking	✓	✓	✓				✓
Research related Skills		✓	✓	✓		✓	
Analytical Reasoning			✓	✓	✓		
Problem Solving	✓	✓	✓	✓	✓		
Team Work	✓	✓	✓				✓
Moral and Ethical Awareness		✓		✓	✓	✓	
Multicultural competence			✓		✓	✓	✓

Year	Sem	Subject Code	Title of the Paper	Hours/ Week
2021-2022 onwards	**II**	**21MST22C**	**CORE V : STATISTICAL ESTIMATION THEORY**	**6**

COURSE LEVEL OUTCOMES:

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

1 Discuss the concept of Characteristics of estimators and Minimal sufficient statistics.

2 Explain the procedures and demonstrate Unbiasedness – Cramer – Rao inequality – Minimum variance bound estimator – Bhattacharya bounds

3 Illustrate the Methods of Estimation and its properties.

4 Construct Interval Estimation and Shortest length confidence intervals.

5 Derive and estimate the Exponential family – location and scale family – Location invariant estimator – Scale invariant Estimator.

6 Describe the Concept of Bayesian Inference and Baye's Estimator.

7 Demonstrate the methods of estimating for different distributions.

Unit - I

Point Estimation – Characteristics of Estimators – Consistency – Sufficient condition for consistency – Sufficient statistics – Factorization theorem – Fisher's information – Minimal sufficient statistics.

Unit - II

Unbiasedness – Cramer – Rao inequality – Minimum variance bound estimator – Bhattacharya bounds – Chapman Robbins Inequality.

Efficient Estimator – UMVUE – Sufficient and Complete statistic – Rao-Blackwell theorem.

Unit – III

Methods of Point Estimation – Method of MLE – Method of Moments, Method of Minimum Chi-square – Method of Modified minimum Chi-square.

Unit IV

Interval Estimation – Confidence level and confidence co-efficient – Shortest length confidence intervals – Construction of Confidence intervals for Population Proportion-– Confidence intervals for mean, variance of a normal population – Confidence intervals for Difference between means- Confidence intervals for ratio of variances.

Unit - V

Exponential family – location and scale family – Location invariant estimator – Scale invariant Estimator – Pitman estimator for location and scale – Simple Problems- Principles of decision theory-Loss and Risk functions-Concept of Bayesian Inference - Baye's Estimator – Posterior Baye's Estimator (Concept Only).

PEDAGOGY STRATEGIES

- Lecturing
- Assignment
- Classroom Discussion
- Questioning
- Seminar
- Class Test
- Quiz & Drill Practice
- Providing feedback

REFERENCES:

1 M. Rajagopal and P. Dhanavandan (2012): "Statistical Inference ", PHI Learning Private Linited, New Delhi.

2 2. S.C.Gupta and V.K.Kapoor, (2013), "Fundamentals of Mathematical Statistics", Eleventh Edition, Sultan Chand & Sons, New Delhi.

3 Mood M, A. Greybill, C. Boes, (1974), Introduction to the Theory of Statistics, Tata Mc Graw – Hill Education Pvt Limited, New Delhi.

FURTHER READING:

1 Hogg .R.V. and A.T. Craig (2019) , An Introduction to Mathematical Statistics, Third Edition, Amerind, New York, London.

2 V.K. Rohatgi., A.K. Md. Ehsanes Saleh (2013), " An Introduction to Probability and Statistics", Wiley Series in Probability and Statistics, Texts and references section.

3 Goon A.M., M.K. Gupta and B. Das Gupta (1973) – An Outline of Statistical Theory, Volume 2, World Press Pvt Ltd., Calcutta.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1 https://nptel.ac.in/courses/111/105/111105043/

2 **https://nptel.ac.in/content/syllabus_pdf/117103018.pdf**

3 https://nptel.ac.in/content/syllabus_pdf/117103018.pdf

COURSE LEVEL MAPPING OF PROGRAM LEVEL OUTCOMES

		CLO-1	CLO-2	CLO-3	CLO-4	CLO-5	CLO-6	CLO-7
Program Level Outcomes (PLO)	Disciplinary Knowledge	✓	✓	✓	✓	✓	✓	✓
	Communication Skills		✓	✓			✓	✓
	Critical Thinking	✓	✓	✓	✓	✓	✓	✓
	Research related Skills	✓			✓	✓	✓	
	Analytical Reasoning	✓		✓	✓		✓	✓
	Problem Solving			✓		✓		
	Team Work		✓		✓	✓	✓	✓
	Moral and Ethical Awareness	✓			✓		✓	✓
	Multicultural competence	✓	✓	✓	✓	✓	✓	✓

Year	Sem	Subject Code	Title of the Paper	Hours/Week
2021-2022 onwards	**II**	**21MST23C**	**CORE PAPER VI : STATISTICAL QUALITY CONTROL AND RELIABILITY ESTIMATION**	**6**

COURSE LEVEL OUTCOMES:

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

1 Discuss the concept of Process Control, To Monitor Process, To develop Attribute control charts

2 Describe about variable control charts, CUSUM control charts for short run

3 Demonstrate attribute sampling plans, to derive various efficiency measures, to construct tables for applications

4 Analyze sampling plans for continuous production, Sequential sampling procedure, Selection of Sampling Plans from Mil-Std-105D and Mil-Std- 414.

5 Design Sampling Plans for variable quality characteristics, To determine the parameters of the sampling plans.

6 Assess Statistical Quality Control on Reliability Models – Model development – Data through Type I and Type II Censoring – Evaluating Reliability.

7 Derive MLE of Reliability and Reliability Estimation, Parallel and Series configuration – MTBF & MTTR – Availability and Maintainability.

Unit - I

Basics of control charts – Shewart control charts for Variable characteristics - $\bar{X}$& R Control Charts – OC and ARL of control charts - Shewart control charts for Attribute characteristics - p Chart – np Chart - C Chart and their uses – CUSUM Control Chart – concept and use of V-mask procedure - Tabular CUSUM Chart.

Unit - II

Control Charts for Individual Observations – Moving Range and Moving Average Charts - Exponentially Weighted Moving Average Charts – Process Capability Analysis.

Unit - III

Attribute Sampling Plans –Single Sampling Plan –conditions of applications – operation procedure – measures of performance – OC – ASN – AOQ - ATI functions of SSP – Double Sampling Plans - MIL STD 105-D(concept only) - Continuous Sampling Plans – CSP-1 Derivations Of OC Function (For CSP-1 Only)-CSP-2 and CSP-3 Plans(concepts only) – Sequential Sampling Plans By Attributes.

Unit - IV

Variable Sampling Plans –Single Sampling Plan - Operating Procedure – OC Function – Comparison of OC Curve with respective n and k - Determination of the parameters - Known & Unknown Sigma Plans for One Sided Specifications - MIL STD 414 (Concept Only).

Unit - V

Need For Reliability – Definitions of Reliability – Basic Elements of Reliability – Hazard Rate – Measurement Of Reliability – Exponential Model Hazard Rate – Mean Time Between Failure (MTBF)-Mean Time To Repair (MTTR)- Censored Samples – MLE of Reliability Under Type –I Censoring and Type –II Censoring In Exponential Case – Reliability for Series and Parallel Systems – k Out of m System - Maintainability (Concept Only).

REFERENCES:

1 DOUGLAS C. MONTGOMARY (2008), Introduction to Statistical Quality Control ,Wiley India(p) Ltd, fourth edition, New Delhi.

2 EDWARD G. SCHILLING (1982), Acceptance Sampling In Quality Control , Marcel Dekker, Inc, ASQC Quality Press, USA.

3 M.MAHAJAN (2009) - Statistical Quality Control, Dhanpat Rai& Co (P)Ltd,Delhi.

FURTHER READING:

1 DUNCAN, AJ (1985), Quality Control and Industrial statistics, Irwin Homewood

2 GUPTA S.C. and V.K.KAPOOR (2009), Fundamentals of Applied statistics, Fourth revised edition, Sultan Chand & Sons publishers, New Delhi

3 EUGENE L GRANT, RICHARD S LEAVENWORTH (2017), Statistical Quality Control, Tata McGraw Hill Publication, India.

4 BHISHAM C. GUPTA (2021) , Statistical Quality Control: Using MINITAB, R, JMP and Python

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1 https://nptel.ac.in/courses/112/107/112107259/

2 https://nptel.ac.in/courses/110/105/110105088/

COURSE LEVEL MAPPING OF PROGRAM LEVEL OUTCOMES

		CLO-1	CLO-2	CLO-3	CLO-4	CLO-5	CLO-6	CLO-7
Program Level Outcomes (PLO)	Disciplinary Knowledge	✓	✓	✓	✓	✓	✓	✓
	Communication Skills			✓			✓	✓
	Critical Thinking	✓	✓	✓	✓	✓	✓	✓
	Research related Skills	✓			✓	✓	✓	
	Analytical Reasoning	✓	✓	✓	✓	✓	✓	✓
	Problem Solving	✓	✓	✓	✓	✓	✓	✓
	Team Work	✓	✓	✓	✓	✓	✓	✓
	Moral and Ethical Awareness			✓	✓		✓	✓
	Multicultural competence	✓	✓	✓	✓	✓	✓	✓

Year	Sem	Subject Code	Title of the Paper	Hours /Week
2021-2022 onwards	**II**	**21MST24E**	**CORE PAPER X: INTRODUCTION TO DATABASE MANAGEMENT SYSTEM**	**6**

COURSE LEVEL OUTCOMES:

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

1. Describe the fundamentals of data models to conceptualize and to depict a database system using ER diagram.
2. Summarize the basics of SQL and construct queries using SQL
3. Discuss the basic concepts and the applications of database systems
4. Paraphrase the relational database design principles
5. Demonstrate the internal storage structures which will help in physical DB design.
6. Explain the fundamental concepts of transaction processing- concurrency control techniques and recovery procedure.
7. Recognize the database storage structures and access techniques

Unit - I

Database Management System - Introduction - Data Processing Vs. Data Management Systems - File Oriented Approach - Database Oriented Approach to Data Management - Characteristics of Database - Advantages and Disadvantages of a DBMS - Instances and Schemas - Database Languages - Database Architecture and Independence.

Unit - II

Data Modeling Using E-R Approach - Introduction to Database Design and Data Modeling - Entity-Relationship (E-R) Model - Entity types - Entity set - Attribute and key – Relationships - Relation types - Roles and structural constraints - Weak entities – Enhanced E-R and object modelling - Sub classes - Super classes – Inheritance.

Unit - III

Building Data Model – Steps - Developing the Basic Schema. **Relational Model** - Introduction - Concepts - Relational Model Constraints - Relational Languages - Relational Algebra - A Relational Database Management Systems - ORACLE - Data storage and Querying.

Unit - IV

SQL - Introduction, History and Commands of SQL - Data Definition Language (DDL) - Data Manipulation Language (DML) - Transaction Control Language (TCL) - Constraints – Indexes – Difference between SQL Vs No SQL Databases, Pros and Cons with examples. Introduction - Query Optimization - Heuristic in Query optimization - Basic Algorithms for Executing Query Operation.

Unit - V

Relational Database Design and Normalization - Introduction - Informal Design Guidelines for Relational Schemas - Functional Dependencies - Multivalued Dependencies - Relational Database - First Normal Form - Second Normal Form - Third Normal Form. Database Recovery Concepts. Current and Future Trends in DBMS – International certifications related to DBMS.

PEDAGOGY STRATEGIES

- Lecturing
- Assignment
- Classroom Discussion
- Questioning
- Seminar
- Class Test
- Quiz & Drill Practice
- Providing feedback

REFERENCES:

1 RAMEZ ELMASRI & SHAMKANT B. NAVATHE (2003), Fundamentals of Database Systems, Pearson Addison-Wesley, Boston San Francisco, New York, 4th edition.

2 ABRAHAM SILBERSCHATZ & HENRY F. KORTH (2013), Data Base System Concepts, McGraw Hill, 6th Edition.

FURTHER READING:

1 RAGHURAMA KRISHNAN & JOHANNES GEHRKE (2008), Data Base Management Systems, Tata McGraw Hill, 3rd Edition.
2 ABRAHAM SILBERSCHATZ, HENRY F & KORTH, S. SUDARSHAN, (2011) Database System Concepts, Tata McGraw Hill 6th Edition.
3 C.J. DATE, A.KANNAN & S.SWAMI NADHAN, (2004)An Introduction to Database systems, Pearson Addison-Wesley, Boston San Francisco, New York, 8th Edition.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1 https://www2.cs.sfu.ca/CourseCentral/354/zaiane/material/notes/contents.html
2 https://www.oracle.com/in/database/what-is-data-management/
3 https://www.guru99.com/introduction-to-database-sql.html
4 https://www.ibm.com/cloud/blog/sql-vs-nosql
5 https://www.mbmsoftware.com/blog/technology/6-trends-in-database-management-2985.html
6 https://www.quest.com/community/blogs/b/database-management/posts/5-dbms-trends-impacting-database-administration
7 https://www.guru99.com/database-interview-questions.html (Question Bank).
8 https://www2.cs.sfu.ca/CourseCentral/354/zaiane/material/notes/contents.html
9 https://www.oracle.com/in/database/what-is-data-management/

COURSE LEVEL MAPPING OF PROGRAM LEVEL OUTCOMES

		CLO-1	CLO-2	CLO-3	CLO-4	CLO-5	CLO-6	CLO-7
Program Level Outcomes (PLO)	Disciplinary Knowledge	✓	✓	✓	✓	✓	✓	✓
	Communication Skills			✓				
	Critical Thinking		✓	✓	✓			✓
	Research related Skills			✓	✓		✓	✓
	Analytical Reasoning	✓	✓	✓	✓			
	Problem Solving	✓	✓	✓	✓	✓	✓	✓
	Team Work	✓	✓	✓	✓	✓	✓	✓
	Moral and Ethical Awareness	✓	✓		✓	✓		
	Multicultural competence	✓	✓	✓	✓	✓	✓	✓

Year	Sem	Subject Code	Title of the Paper	Hours/Week
2021–2022 Onwards	**I & II**	**21MST25P**	**CORE PRACTICAL I : PRACTICAL - I**	**3**

COURSE LEVEL OUTCOMES:

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

1. Estimate the parameters using methods of estimation.
2. Estimate the Probability proportionate sampling with replacement, Probability proportionate sampling without replacement.
3. Fitting of the Binomial, Poisson, Normal, lognormal and logistic distributions.
4. Constructions of the Single sampling plans, Double sampling plans, Sequential Sampling plans
5. Design practical Problems to Sampling plans.
6. Estimate the parameters using method of moments and MLE.
7. Estimate the Cluster sampling. Ratio Estimation and Regression Estimation.

STATISTICAL ESTIMATION THEORY

1. MLE and Standard error of MLE of Poisson.
2. MLE and Standard error of MLE of Binomial.
3. MLE and Standard error of MLE of Normal.
4. Minimum Chi-Square method of estimation.

SAMPLING THEORY

5. Probability proportionate sampling with replacement.
6. Probability proportionate sampling without replacement
7. Cluster sampling.
8. Ratio Estimation.
9. Regression Estimation.

DISTRIBUTION THEORY

10. Fitting Poisson distribution.
11. Fitting Binomial distribution.
12. Fitting Normal distribution.
13. Fitting lognormal distribution.
14. Fitting logistic distribution

STATISTICAL QUALITY CONTROL & RELIABILITY

15. Single sampling plans.
16. Double sampling plans.
17. Sequential Sampling plans.
18. CUSUM control chart.
19. Reliability of Type – I censoring.
20. Reliability of Type – II censoring.

PEDAGOGY STRATERGIES:

1. Lecturing
2. Assignment
3. Classroom Discussion
4. Questioning
5. Seminar
6. Class Test
7. Quiz

REFERENCES:

1 Myer, P.L. (1970): Introductory Probability and Statistical Applications, Oxford &IBH Publishing, New Delhi

2 Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.

3 Johnson, R.A. and Bhattacharya, G.K. (2001): *Statistics-Principles and Methods*, 4th Edn. John Wiley and Sons.

4 Mood, A.M., Graybill, F.A. and Boes, D.C. (2007): *Introduction to the Theory of Statistics*, 3rd Edn. (Reprint).Tata McGraw-Hill Pub. Co. Ltd.

5 Gupta, S.C &Kapoor, V.K. (2013): Fundamentals of Applied Statistics, Sultan & Sons, Delhi.

FURTHER READING:

1 Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata

2 Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.

3 Hogg, R.V. and Tanis, E.A. (2009): *A Brief Course in Mathematical Statistics*. Pearson Education.

4 Rohatgi V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics. 2ndEdn. (Reprint) John Wiley and Sons

5 Montogomery, D. C. (2009): Introduction to Statistical Quality Control, 6th Edition, Wiley India Pvt. Ltd.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1 http://www.stats.ox.ac.uk/~dlunn/b8_02/b8pdf_8.pdf

2 https://nptel.ac.in/content/storage2/courses/103106120/LectureNotes/Lec3_3.pdf

3 https://nptel.ac.in/content/storage2/courses/103106120/LectureNotes/Lec5_3.pdf

4 https://nptel.ac.in/content/syllabus_pdf/111102112.pdf

COURSE LEVEL MAPPING OF PROGRAM LEVEL OUTCOMES

		CLO-1	CLO-2	CLO-3	CLO-4	CLO-5	CLO-6	CLO-7
Program Level Outcomes (PLO)	Disciplinary Knowledge	✓	✓	✓	✓	✓	✓	✓
	Communication Skills			✓			✓	✓
	Critical Thinking	✓	✓	✓		✓	✓	
	Research related Skills	✓			✓	✓	✓	
	Analytical Reasoning	✓			✓		✓	✓
	Problem Solving			✓		✓		
	Team Work		✓		✓		✓	✓
	Moral and Ethical Awareness				✓	✓	✓	✓
	Multicultural competence	✓	✓		✓	✓	✓	✓

Year	Sem	Subject Code	Title of the Paper	Hours/ Week
2021-2022 onwards	**I & II**	**21MST26P**	**CORE PRACTICAL II - PRACTICAL II - USING PYTHON PROGRAMMING**	**3**

COURSE LEVEL OUTCOMES:

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

1 Apply the theory through practical oriented training.

2 Perform the Visualization of Big data.

3 Design Python Programming Scripts for Descriptive Statistics.

4 Write Python Programs to fit Probability Distributions.

5 Compute Model fitting by developing python programs.

6 Perform Computations for Correlation and Regression Equations

7 Develop computing skills for Big Data Analytics.

LIST OF EXPERIMENTS

1. Visualization of Big Data.
2. Program to find total and average marks using class and methods.
3. Program using tuples, list, dictionary & sets.
4. Program using function to find area of geometry.
5. Program to use arithmetic, relational, logical and conditional operators
6. Program to Grade the students according to the average marks using nested if.
7. Fitting Binomial Distribution and Poisson Distributions.
8. Fitting Normal and Gamma Distributions.
9. Calculation of Probabilities under Normal Distribution & drawing cumulative curve.
10. Partial and Multiple Correlation Coefficients
11. Simple and Multiple Regression Coefficients
12. Fitting Linear Trend by Least Square method and Forecasting
13. Finding mean vector and covariance matrix
14. Construction of control charts for Mean and Range
15. Probability of Acceptance & drawing OC Curve using Poisson distribution

16. Finding Expected values of Random Variables.
17. t-test for single and two means.
18. Chi-square test for independence of attributes and goodness of fit
19. One way and two way ANOVA.
20. Factorial Experiments with two factors 2^2 and 3^2 .

REFERENCES:

1 Seema Acharyaet.al (2018), Big Data Analytics using Python — McGraw Hill Education, India.

2 Frank Ohlhorst (2019), Big Data Analytics — Wiley & SAS Series.

FURTHER READING:

1 Wes McKinney – O-Reilly (2020), Python for Data Analysis – Oreilly Publisher.

Free Website: (http://oreilly.com/safari).

related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1 https://nptel.ac.in/courses/106/107/106107220/

COURSE LEVEL MAPPING OF PROGRAM LEVEL OUTCOMES

		CLO-1	CLO-2	CLO-3	CLO-4	CLO-5	CLO-6	CLO-7
Program Level Outcomes (PLO)	Disciplinary Knowledge	✓	✓			✓	✓	
	Communication Skills		✓	✓		✓	✓	
	Critical Thinking	✓	✓		✓	✓		
	Research related Skills			✓	✓	✓	✓	✓
	Analytical Reasoning	✓	✓	✓	✓	✓	✓	✓
	Problem Solving	✓	✓	✓	✓	✓	✓	✓
	Team Work	✓	✓	✓	✓	✓	✓	✓
	Moral and Ethical Awareness	✓	✓			✓	✓	
	Multicultural competence	✓	✓	✓	✓	✓	✓	✓

Year	Sem	Subject Code	Title of the Paper	Hours/ Week
2021-2022 onwards	**III**	**21MST31C**	**CORE VII : TESTING STATISTICAL HYPOTHESIS**	**6**

COURSE LEVEL OUTCOMES:

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

1 Demonstrate testing of statistical hypothesis, basic terms of testing of statistical hypothesis and Monotone Likelihood Property.

2 Explain the procedures for Uniformly Most Powerful Unbiased Test and Similar test.

3 Analyze Likelihood Ratio Test based on some important distributions. That should be followed in statistical inference.

4 Describe how to establishment and interpreted to Non-Parametric Tests based on one Sample and Two Sample Problems

5 Derive Monotone Likely Ratio Property and established Sequential Probability Ratio Test. Discuss the concept of Hypothesis Testing for Bayesian Approach.

6 Apply Mann-Whitney 'U' Test (One Sample and Two Sample Problems) - Kolmogorov's Smirnov One Sample Test- Kruskal Wallis Test.

7 Design test on the analysis of OC and ASN functions in Sequential Probability Ratio test.

Unit - I

Test of hypothesis - Simple and Composite hypothesis – Types of Errors – Critical Regions – Randomized and Non-Randomized tests – Generalized Neyman – Pearson Lemma Power function – Most powerful test – Uniformly Most Powerful Test- Neyman – Pearson Lemma – Monotone Likelihood Ratio property.

Unit - II

Unbiased test - Uniformly Most Powerful Unbiased Test – Similar test – UMP similar test – Unbiased test for one parameter exponential family – Test with Neyman Structure.

Invariant test – Uniformly Most powerful invariant tests- Maximal Invariant Test.

Unit – III

Likelihood Ratio test – Construction- LR test for Standard Distributions (Binomial, Poisson, Normal and Exponential distributions) – Asymptotic distribution of LRT – Consistency of LRT- Bartlett test for homogeneity of variances.

Unit – IV

Non-parametric tests - Definition - Advantages and Disadvantages – One sample tests – Kolmogorov – Smirnov test – test for randomness – Sign test- Wilcoxon's signed rank test – Two sample tests – Run test, Median test, K-S test and Mann -Whitney U tests- More than two Sample test - Kruskal-Wallis H test.

Unit - V

SPRT - Basic structure – Determination of the constants A and B – Derivation of OC function– ASN function – Derivations based on Binomial, Poisson, Normal and Exponential distributions - Power function. Hypothesis Testing for Bayesian Approach (Concept only).

PEDAGOGY STRATEGIES

- Lecturing
- Assignment
- Classroom Discussion
- Questioning
- Seminar
- Class Test
- Quiz & Drill Practice
- Providing feedback

REFERENCES:

1 M. Rajagopalan& P. Dhanavandan (2012), Statistical Inference, Prentice Hall.

2 Goon A.M, Gupta M.K and Das Gupta B (2013)., An Outline of Statistical Theory, Volume 2, World Press Pvt Ltd., Calcutta.

FURTHER READING:

1 Hogg R.V. and Craig A.T., (1978) An introduction to Mathematical Statistics, Third Edition, Amerind, New York, London.

2 Rohatgi V.K., (1976), Introduction to Probability theory and Mathematical Statistics, Wiley Eastern Limited, New Delhi.

3 Lehmann E.L., (2005), Testing Statistical Hypothesis, 2nd Edition, Springer.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1 https://nptel.ac.in/content/storage2/courses/103106120/LectureNotes/Lec3_1.pdf

2 **https://nptel.ac.in/content/storage2/courses/103106120/LectureNotes/Lec1_3.pdf**

3 https://freevideolectures.com/course/3499/statistical-inference

4 http://www.stats.ox.ac.uk/~dlunn/b8_02/b8pdf_8.pdf

COURSE LEVEL MAPPING OF PROGRAM LEVEL OUTCOMES

		CLO-1	CLO-2	CLO-3	CLO-4	CLO-5	CLO-6	CLO-7
Program Level Outcomes (PLO)	Disciplinary Knowledge	✓	✓	✓	✓	✓	✓	✓
	Communication Skills		✓	✓			✓	✓
	Critical Thinking	✓	✓	✓	✓	✓	✓	✓
	Research related Skills	✓			✓	✓	✓	
	Analytical Reasoning	✓		✓	✓		✓	✓
	Problem Solving		✓	✓		✓		✓
	Team Work		✓		✓	✓	✓	✓
	Moral and Ethical Awareness		✓		✓		✓	✓
	Multicultural competence	✓	✓	✓	✓	✓	✓	✓

Year	Sem	Subject Code	Title of the Paper	Hours/ Week
2021-2022 onwards	**III**	**21MST32C**	**CORE PAPER VIII – LINEAR MODELS AND DESIGN OF EXPERIMENTS**	**6**

COURSE LEVEL OUTCOMES:

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

1. Describe the theoretical underpinning of the linear model, analysis of variance and design of experiments.
2. Identify the type of any given experiment and the type of design apt for its analysis.
3. Explain the structure and applications of Randomized designs
4. Reproduce the advanced models in various designs
5. Apply various designs of experiments in several practical situations and evaluate its results.
6. Make further analyses which are specific to the objectives of any experiment.
7. Create new types of designs as per the requirements and study their behavior while proceeding to the research.

Unit - I

Linear Models - Assumptions on Error Components - Fixed/Mixed and Random effect Models – Generalized linear model - Gauss-Markov setup – Estimation of parameters – Least square method – MLE method - Gauss-Markov theorem-BLUE – Linear parametric function and the condition for its estimability -Test for Linear Hypothesis.

Unit - II

Experimental Design - Basic Principles of Experimentation – Experimental Error – Review of CRD & RBD - LSD – Applications – Layout of LSD – Advantages and Disadvantages of LSD – Statistical Analysis of LSD – Least Square Estimates of parameters – Multiple comparison methods – Least Significant Difference method – DMRT and Tukey's Test.

Unit - III

Factorial Experiments – Introduction –Advantages and limitations – Main effects and interaction effects– Statistical Analysis of 2^2 and 2^3 Factorial Experiments – Yates method of computing 2^2 and 2^3 factorial totals. Analysis of 2^n Factorial Experiment - 3^2 Factorial Experiment - Confounding – Partial confounding and complete Confounding.

Unit - IV

Split Plot Design – Introduction – model description – Statistical Analysis – Advantages and Disadvantages. - Analysis of Covariance with one Concomitant variable – model – Least Square Estimates for parameters – Estimation of variance – Statistical analysis in CRD & RBD.

Unit - V

Incomplete Block Designs – Introduction – Balanced Incomplete Block Designs – Parametric Relationships – Symmetric BIBD – Statistical Analysis of Balanced Incomplete Block Designs (Intra Block only) - Partial BIBD.

PEDAGOGY STRATEGIES

- Lecturing
- Assignment
- Classroom Discussion
- Questioning
- Seminar
- Class Test
- Quiz & Drill Practice
- Providing feedback

REFERENCES:

1 S.C. Gupta and V.K. Kapoor (2015) : Fundamental of Applied Statistics – Sultan Chand & Sons.

2 Paneerselvam, R. (2012). Design and Analysis of Experiments, PHI Learning Private Ltd., New Delhi

3 M.N. Das and N.P. Giri (2008) : Design and Analysis of Experiments, New Age International.

FURTHER READING:

1 Graybill, F.A. (1961): An Introduction to Linear Statistical Models, McGraw Hill Co., London.

2 Montgomery (2009) : Design and Analysis of Experiments, John Wiley & Sons (p) Ltd.

3 Das, M. N., and Giri, N. C. (2011). Design and Analysis of Experiments, Second Edition, New Age International Private Ltd., New Delhi

ELATED ONLINE CONTENTS [MOOC, SWAYAM, NPTEL, Websites etc.]

1 **https://nptel.ac.in/courses/110/105/110105087/**

COURSE LEVEL MAPPING OF PROGRAM LEVEL OUTCOMES

			Course Level Outcomes (CLO)						
			1	2	3	4	5	6	7
Program Level Outcomes (PLO)	1	Disciplinary Knowledge	✓	✓	✓	✓	✓		
	2	Communication Skills	✓	✓	✓		✓	✓	✓
	3	Critical Thinking	✓	✓	✓		✓		
	4	Research related Skills		✓	✓	✓		✓	
	5	Analytical Reasoning			✓	✓	✓	✓	✓
	6	Problem Solving	✓	✓	✓	✓	✓		
	7	Team Work	✓	✓	✓				✓
	8	Moral and Ethical Awareness			✓	✓		✓	✓
	8	Multicultural competence	✓	✓			✓	✓	

Year	Sem.	Subject Code	Title of the Paper	Hours/ Week
2021-2022 onwards	**III**	**21MST33C**	**CORE IX: MULTIVARIATE ANALYSIS**	**6**

COURSE LEVEL OUTCOMES:

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

1 Derive the Bi-variate and Multivariate normal distribution and estimate the mean vector and Covariance matrix.
2 Expertise on linear combination of random variables and Maximum Likelihood estimation of parameters of the multivariate normal distribution.
3 Discuss the Characteristic function and properties of Wishart distribution and know the derivation of generalized T-square distribution.
4 Assess Multiple Regression Analysis and its expansion.
5 Familiarize the multivariate statistical methods that include Factor Analysis and its application in diversified fields.
6 Describe the objectives and assumption on discriminant analysis and the problem of classification.
7 Possess through knowledge on Cluster analysis and its applications.

Unit - I

Multivariate Analysis: Introduction - Application of Multivariate techniques – Organisation of Multivariate data –Derivation of Bi-variate and multivariate normal distributions and its properties - Determination of mean vector and covariance matrix of Multivariate Normal Distribution - The mean vector and covariance matrix for Linear combinations of Random Variables – The maximum likelihood estimators of the mean vector and covariance matrix of Multivariate Normal Distribution.

Unit - II

Wishart Distribution: Introduction - Characteristic function and properties of Wishart Distribution. Generalized T-Square Statistic: Introduction – Derivation of the Generalized T-Square Statistic (Hotelling T Square) distribution – uses – applications. Hotelling T Square and Likelihood Ratio Tests.

Unit - III

Multiple Linear Regression: Introduction –Classical Linear Regression Model – Least Square Estimators - Inferences about the Regression Model – Inferences from the Estimated Regression Function – Model Checking and Other Aspects of Regression – Multivariate Multiple Regression.

Unit - IV

Principal Components: Objectives – Population Principal Components – Extraction of Principal Components.

Factor Analysis: Introduction – Model Description (The Orthogonal Factor Model) – Methods of estimation – Factor rotation - Factor Scores – Perspectives and a strategy for Factor Analysis.

Unit - V

Discriminant Analysis: Objectives and assumptions - Fisher's Discriminant Function - Problem of Classification with Two or More Populations.

Cluster Analysis: Objectives – Assumptions - Research design – Formation of clusters – Clustering algorithm.

PEDAGOGY STRATEGIES

- Lecturing
- Assignment
- Classroom Discussion
- Questioning
- Seminar
- Class Test
- Quiz & Drill Practice
- Providing feedback

REFERENCES:

1 Richard A. Johnson & Dean W. Wichern, (2012) Applied Multivariate Statistical Analysis: PHI Learning Private Limited, New Delhi (Sixth Edition).

2 Lawrence S. Meyers & Glenn Gamst & Guarino A.J, (2005), Applied Multivariate Research Design and interpretation: Sage Publications, New Delhi.

FURTHER READING:

1 Anderson T.W, (2011), An Introduction to Multivariate Statistical Analysis: Wiley India Pvt.Ltd, New Delhi (Third Edition).

2 Hair, Black, Babin& Anderson & Tatham, (2005), Multivariate Data Analysis: Pearson Education (5th Edition).

RELATED ONLINE CONTENTS

1 https://nptel.ac.in/courses/111/104/111104024/

2 https://nptel.ac.in/courses/111/105/111105091/

3 https://nptel.ac.in/courses/106/106/106106139/

4 https://www.udemy.com/topic/Multivariate-Analysis

COURSE LEVEL MAPPING OF PROGRAM LEVEL OUTCOMES

		CLO-1	CLO-2	CLO-3	CLO-4	CLO-5	CLO-6	CLO-7
Program Level Outcome (PLO)	Disciplinary Knowledge	✓	✓		✓	✓	✓	✓
	Communication Skills	✓	✓	✓		✓		✓
	Critical Thinking	✓			✓	✓	✓	
	Research related Skills		✓	✓	✓	✓		
	Analytical Reasoning	✓	✓	✓		✓		
	Problem Solving	✓	✓		✓		✓	✓
	Team Work	✓	✓	✓		✓		
	Moral and Ethical Awareness		✓	✓	✓	✓		✓
	Multicultural competence	✓	✓			✓	✓	

Year	Sem	Subject Code	Title of the Paper	Hours/ Week
2021-2022 onwards	**III**	**21MST34E**	**ELECTIVE III: NUMERICAL ANALYSIS**	**6**

COURSE LEVEL OUTCOMES:

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

1 Discuss the types of errors in computation
2 Compute the various types of errors
3 Solve the Algebraic and Transcendental equations
4 Compute System of linear equations
5 Determine the numerical solution of initial value problems and boundary value problems.
6 Solve partial differential equations.
7 Know the applications of numerical Analysis

Unit - I

Errors in computation - Introduction –rules for estimating errors – Error propagation – Error and their Computations - Errors in the approximation of a function – Error in series approximation – order of approximation – growth of error. Application of numerical analysis in real life situations.

Unit - II

Solution of Algebraic and Transcendental equations – Bisection Method – Method of False position – Iteration method – Newton-Raphson method – Horner's method.

Unit - III

Solution of Linear system of equations – Gauss - elimination method – Gauss-Jordon method – Iterative methods – Gauss - Jacobi and Gauss – Seidal methods – Inverse of a matrix by Gauss – Elimination method

Unit - IV

Initial value problems for Ordinary Differential Equations – Introduction – Taylor series method – Euler's method – Modified Euler's method – Runge-Kutta methods – Predictor – Corrector methods – Adam's and Milne's method.

Unit - V

Numerical solution for Partial Differential Equations – Introduction – Finite Difference approximations to derivatives – Laplace's equation – Parabolic equations

PEDAGOGY STRATEGIES

- Lecturing
- Assignment
- Classroom Discussion
- Questioning
- Seminar
- Class Test
- Quiz & Drill Practice
- Providing feedback

REFERENCES:

1 Dr. B.S. Grewal (2000) - Numerical Methods in Engineering & Science, Fifth Edition, , Khanna Publishers, New Delhi.

2 S.S. Sastry (2013)- Introductory methods of Numerical Analysis, Fifth Edition, PHI Learning Pvt Ltd, New Delhi.

FURTHER READING:

1 Dr. M.K. Venkataraman (2001) - Numerical Methods in Science and Engineering, Fifth Edition, The National Publishing Company, Chennai.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1 **https://www.ukessays.com/essays/computer-science/study-on-the-applications-of-numerical-analysis-computer-science-essay.php**

2 **https://nptel.ac.in/courses/111/107/111107063/**

COURSE LEVEL MAPPING OF PROGRAM LEVEL OUTCOMES

		CLO-1	CLO-2	CLO-3	CLO-4	CLO-5	CLO-6	CLO-7
Program Level Outcome (PLO)	Disciplinary Knowledge	✓	✓	✓	✓	✓	✓	✓
	Communication Skills	✓	✓	✓	✓	✓	✓	✓
	Critical Thinking		✓			✓	✓	✓
	Research related Skills		✓	✓		✓	✓	✓
	Analytical Reasoning	✓	✓	✓	✓	✓	✓	✓
	Problem Solving		✓	✓			✓	✓
	Team Work		✓	✓		✓	✓	
	Moral and Ethical Awareness	✓		✓	✓		✓	
	Multicultural competence	✓	✓	✓	✓	✓	✓	✓

Year	Sem	Subject Code	Title of the Paper	Hours/ Week
2021-2022 onwards	**IV**	**21MST41C**	**CORE PAPER X : STOCHASTIC PROCESSES**	**6**

COURSE LEVEL OUTCOMES:

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

1. Compute n-step transition probability matrix and its long run probabilities.
2. Distinguish the states of a Markov chain.
3. Discuss the concept of branching process and to compute extinction probabilities.
4. Describe the concept of renewal process and its applications.
5. Forecast using various stationary time series techniques.
6. Identify the real-life situations where to apply the random processes.
7. Interpret the results of the random process studied.

Unit - I

Introduction to Stochastic Processes – Definition – Classification of Stochastic Processes According to State Space and Time Domain – Markov Process – Markov Chain – Countable State Markov Chain –Transition Probability Matrix – Chapman- Kolmogrov Equations – Calculation of ‘n’ Step Transition Probability Matrix.

Unit - II

Classification of States of a Markov Chain – Recurrent and Transient states – Criteria for Classification of the States – Random Walk with Absorbing and Reflecting Barriers – Probability of Absorption – Duration of Random Walk – Gambler’s Ruin Problem.

Unit - III

Continuous Time Markov Chain- Kolmogrov's Differential Equations – Poisson Process – Pure Birth process - Birth and Death Process – Queuing Systems – Birth and Death Processes in Queuing Theory.

Unit - IV

Branching Process (one dimension only) – Definition – Generating Functions – Properties of Generating Functions of Branching Process. Brownian Motion - Concept of Weiner Process – Weiner Process as a Limit of Random Walk – Differential equations for a Weiner Process.

Unit - V

Renewal Process – Renewal Function and its Properties – Elementary Renewal Theorem – Strict and Wide Sense Stationary Processes with Examples – Basic Ideas of Time Series – Auto-Regressive and Moving Average Processes - Autoregressive Integrated Moving Average Processes.

PEDAGOGY STRATEGIES

- Lecturing
- Assignment
- Classroom Discussion
- Questioning
- Seminar
- Class Test
- Quiz & Drill Practice
- Providing feedback

REFERENCES:

1 MEDHI. J (1994), Stochastic Processes, Wiley Eastern limited, New Delhi, Second Edition.

2 KARLIN & TAYLOR (1975), A first course in Stochastic Processes, Vol. No.1, Second Edition, Academic Press, New York.

3 HANKE, J.E & WICHERN, D.W. (2009), Business Forecasting, PHI Learning Pvt Limited, 8th edition, New Delhi.

FURTHER READING:

1 HYDE SHELDON M. ROSS (1995), Stochastic Processes, Wiley Series in Probability and Statistics, Second Edition.

2 BHAT. B. R. (2004), Stochastic Models - Analysis and Applications: New Age international (P) Limited, New Delhi.

3 Adke, S. R., and Manjunath, S. A. (1984): An Introduction to Finite Markov Processes, Wiley Eastern, New Delhi.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1 https://nptel.ac.in/courses/111/103/111103022/ Stochastic Processes–IIT Guwahati

2 https://ocw.mit.edu/courses/mathematics/18-445-introduction-to-stochastic-processes-spring-2015/lecture-notes/

3 https://www.stat.auckland.ac.nz/~fewster/325/notes/325book.pd

COURSE LEVEL MAPPING OF PROGRAM LEVEL OUTCOMES

			Course Level Outcomes (CLO)						
			1	**2**	**3**	**4**	**5**	**6**	**7**
Program Level Outcomes (PLO)		Disciplinary Knowledge	✓	✓	✓	✓	✓		
		Multicultural Competence	✓		✓			✓	✓
		Self-directed learning	✓	✓			✓		✓
		Reflective thinking		✓	✓	✓		✓	
		Analytical Reasoning				✓	✓	✓	✓
		Problem Solving	✓	✓	✓	✓	✓		✓
		Cooperation / Team work		✓	✓		✓	✓	
		Moral and ethical awareness		✓	✓		✓	✓	✓
		Multicultural competence	✓	✓	✓		✓	✓	✓

Year	Sem	Subject Code	Title of the Paper	Hours/ Week
2021-2022 onwards	**IV**	**21MST42C**	**CORE XI – ECONOMETRICS**	**6**

COURSE LEVEL OUTCOMES:

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

1 Describe the concepts of Econometrics, methodology and scope of Econometrics

2 Derive Generalized Least Square estimators and its properties.

3 Address the problem of basic assumptions of GLS.

4 Focus on the problem of Identification and its conditions.

5 Find the solution for structural and reduced form models.

6 Obtain reliable and optimal solution under simultaneous equation models.

7 Classify and explore the econometric models in planning.

Unit - I

Preliminaries on Econometrics - Definition and Scope of Econometrics - Goals and Division of Econometrics - Specification and Estimation of the model - Evaluation of the parameter estimates - Forecasting power of the model - Desirable properties of an econometric model.

Unit – II - Ordinary Least Squares and Its Properties - Simple Linear Regression Model: OLS method of estimating the parameters - properties of OLS estimators. Multiple Regression: Model with two explanatory variables.

Unit – III - Auto correlation and Multicollinearity - Auto correlation - Assumptions of serial independence - Sources and Consequences of Auto correlation – Tests for Auto correlation. Multi-collinearity: Meaning - Consequences of Multi-collinearity - Tools for handling Multi-collinearity – Heteroscedasticity.

Unit - IV

Simultaneous Linear Equation Models - Identification - The problem of identification - Formal rules for identification - Identifying restrictions - Single and Simultaneous Equation methods - Estimation of parameters – Indirect Least Squares - Two - Stage Least Squares.

Unit - V

Econometric Models in Planning - Asymptotic properties of Two - Stage Least Square Estimator - Limited Information Maximum Likelihood - Econometric Models in Planning - Harrod's growth model - Assumptions - Domar's model - Assumptions - Mathematical or equational form – Similarities and dissimilarities between Harrod and Domar Models.

PEDAGOGY STRATEGIES

- Lecturing
- Assignment
- Classroom Discussion
- Questioning
- Seminar
- Class Test
- Quiz & Drill Practice
- Providing feedback

REFERENCES:

1 A. Koutsoyiannis, (1977) - Theory of Econometrics, Second Edition, PALGRAVE, Replica Press Pvt. Ltd, India.

2 Johnson, J - (1997)Econometric Methods, Fourth Edition,McGraw Hill.

FURTHER READING:

1 Damodar N. Gujarati and Sangeetha (2015) -Basic Econometrics, Fourth Edition, Tata McGraw Hill Private Limited, New Delhi.

2 S.P.Singh, Anil K. Parashar&H.P.Singh (1997) - Econometrics and Mathematical Economics, Seventh Edition, S. Chand & Company Ltd, Ramnagar, New Delhi - 110 055.

3 Wooldridge (2008) - Introductory Econometrics, Fourth Edition, Cengage Learning, India

ELATED ONLINE CONTENTS [MOOC, SWAYAM, NPTEL, Websites etc.]

1 **https://swayam.gov.in/nd2_cec20_ma10/preview**

2 **https://swayam.gov.in/nd1_noc19_ma29/preview**

3 **https://nptel.ac.in/courses/112/106/112106131/**

4 **https://nptel.ac.in/courses/112/106/112106134/**

COURSE LEVEL MAPPING OF PROGRAM LEVEL OUTCOMES

		Course Level Outcomes (CLO)						
		CLO-1	CLO-2	CLO-3	CLO-4	CLO-5	CLO-6	CLO-7
Program Level Outcomes (PLO)	Disciplinary Knowledge	✓	✓	✓	✓	✓	✓	✓
	Communication Skills	✓		✓	✓	✓	✓	✓
	Critical Thinking		✓	✓			✓	
	Research related Skills	✓		✓		✓	✓	
	Analytical Reasoning	✓	✓		✓			✓
	Problem Solving		✓	✓		✓	✓	
	Team Work	✓	✓	✓	✓	✓	✓	✓
	Moral and Ethical Awareness	✓			✓		✓	✓
	Multicultural competence		✓		✓	✓	✓	

Year	Sem	Subject Code	Title of the Paper	Hours/ Week
2021-2022 onwards	**IV**	**21MST43C**	**CORE PAPER XII – ADVANCED OPERATIONS RESEARCH**	**6**

COURSE LEVEL OUTCOMES:

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

1 Formulate a LPP for a given resources and able to solve it.

2 Compute the optimal solution for the industrial situations.

3 Apply the Non linear programming problem and arrive the optimal solution.

4 Solve the Queueing problems raised in various situations

5 Simulate the current events and predict the future behavior of the events

6 Identify the events and activities and solve it by Network analysis

7 Discuss the different decision making environment and make optimal decisions

Unit - I

Linear Programming Problem - Artificial variable techniques – Big M method - Two phase method – Concept of Duality – Primal and Dual relationships - Duality and Dual solution – Dual Simplex algorithm – Concept and Simple problems

Unit - II

Non-linear Programming - Introduction – General NLPP – Constrained optimization with equality constraints – Necessary and Sufficient conditions for a General NLPP - Constrained optimization with inequality constraints - Kuhn-Tucker Necessary and Sufficient conditions for General NLPP with m (< n) constraints – Graphical solution

Unit - III

Queuing Theory - Introduction – Queuing system – Elements and Operating characteristics of Queuing system – Pure Birth process – Pure Death process – Classification of Queuing models - Problems from Single Server: Infinite Population Model (M/M/1): (FCFS/∞/∞) and Finite Population Model (M/M/1): (FCFS/N/∞) - Problems from Multi Server: Infinite Population Model (M/M/C): (FCFS/∞/∞) and Finite Population Model (M/M/C): (FCFS/N/∞)

Unit - IV

Network Analysis - Network and Basic components – Logical Sequencing – Rules of Network construction – Fulkerson's rule – Critical Path Method – Total Float, Free Float and Independent Float - PERT algorithm – Differences between PERT and CPM – Cost considerations in PERT and CPM - Crashing.

Unit - V

Decision Analysis - Decision making environment – Decisions under uncertainty – Decisions under Risk – EMV, EOL and EVPI approach – Decision-Tree analysis.

Simulation - Introduction - Advantages and Disadvantages – Monte-Carlo method – Algorithm – Application of Simulation in Inventory and Queuing problems – Simple problems.

PEDAGOGY STRATEGIES

- Lecturing
- Assignment
- Classroom Discussion
- Questioning
- Seminar
- Class Test
- Quiz & Drill Practice
- Providing feedback

REFERENCES:

1 KantiSwarup, P.K. Gupta and Manmohan (2009)- Operations Research Sultan Chand & Sons, New Delhi,

2 V. Sundaresan, K.S. Ganapathy Subramanian, K. Ganesan (2000)- Resource Management Techniques, A.R. Publications, Tamil Nadu, New Revised Edition.

FURTHER READING:

1 Taha, H. A. (1982). Operations Research: An Introduction, 3rd Edition, McMillan Publishing Co., Inc., London

2 Sharma, S. D. (2017). Operations Research: Theory, Methods and Applications, KedarNath, Ram Nath and Co, Meerut.

3 J.K. Sharma (2007) - Operations Research - Theory & Applications – Macmillan India Ltd.

ELATED ONLINE CONTENTS [MOOC, SWAYAM, NPTEL, Websites etc.]

1 **https://nptel.ac.in/courses/111/107/111107128/**

2 **https://nptel.ac.in/courses/112/106/112106134/**

3 **https://onlinecourses.swayam2.ac.in/cec20_ma10/preview**

COURSE LEVEL MAPPING OF PROGRAM LEVEL OUTCOMES

			Course Level Outcomes (CLO)						
			1	2	3	4	5	6	7
Program Level Outcomes (PLO)		Disciplinary Knowledge	✓	✓	✓	✓	✓		
		Communication Skills	✓	✓	✓				✓
		Critical Thinking	✓	✓	✓			✓	✓
		Research related Skills		✓	✓	✓		✓	
		Analytical Reasoning			✓	✓	✓		
		Problem Solving	✓	✓	✓	✓	✓		
		Team Work	✓	✓	✓		✓	✓	✓
		Moral and Ethical Awareness	✓	✓		✓	✓		
		Multicultural competence	✓	✓		✓	✓		

Year	Sem	Subject Code	Title of the Paper	Hours/ Week
2021-2022 onwards	**III& IV**	**21MST44P**	**CORE PRACTICAL – III :** **PRACTICAL – III**	**3**

COURSE LEVEL OUTCOMES:

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

1 Apply the logical skills for performing statistical analysis
2 Solve numerical problems using different methods
3 Analyze and interpret the various design of experiments
4 Perform various tests of significance using multivariate data
5 Analyze the appropriate tests of significance.
6 Evaluate the critical region and power curves
7 Solve network and queuing problems
8 Simulate using monte-carlo technique

DESIGN OF EXPERIMENTS

1. Latin Square Design
2. 2^3 Factorial experiments
3. 3^2 Confounding factorial experiments
4. Balanced Incomplete Block Design

NUMERICAL ANALYSIS

5. Newton Raphson Method
6. Gauss Elimination Method
7. Gauss Jacobi Method
8. Taylor Series
9. Runge-Kutta Method

MULTIVARIATE ANALYSIS

10. Estimation of Mean Vector and Covariance matrices
11. Hotelling's T^2 statistic – testing for mean vector

12. Hotelling's T^2 statistic – Testing for equality of means
13. Fisher's discriminant function
14. Principal component analysis

STATISTICAL INFERENCE – II (Testing of Hypothesis)

15. Critical regions and power curves concerning testing of hypothesis of the Normal distribution
16. Critical regions and power curves concerning testing of hypothesis of
17. Exponential distribution
18. Median test
19. Run test
20. Non-parametric test: Kolmogorov-Smirnov test – one and two samples
21. Mann-Whitney U test

ADVANCED OPERATIONS RESEARCH

22. Critical Path Method
23. Program Evaluation and Review Technique
24. Queuing model: (M/M/1) : (FCFS/N/∞)
25. Monte Carlo Simulation
26. Critical Path Method

REFERENCES:

1 S.C. Gupta and V.K. Kapoor (2015)- Fundamental of Applied Statistics, Fourth Edition, Sultan Chand &Sons ,New Delhi.

2 Anderson T.W, (2011), An Introduction to Multivariate Statistical Analysis, Third Edition, Wiley India Pvt. Ltd, New Delhi.

3 P. Kandasamy, V. Thilagavathy, K. Gunavathi (2016)- Numerical Methods , S.Chand& Company Ltd, New Delhi.

4 S.P. Gupta (2011) – Statistical Methods, fortieth Revised Edition, Sultan Chand & Sons, New Delhi.

5 KantiSwarup, Gupta, P. K., and Man Mohan (2017) – Operations Research, Nineteenth Edition, Sultan Chand & Sons, New Delhi.

FURTHER READING

1 Taha, H. A. (1982). Operations Research: An Introduction, Third Edition, McMillan Publishing Co., Inc., London.

2 R. Panneer Selvam (2012)- Design And Analysis of Experiments, Prentice Hall.

3 Richard A. Johnson & Dean W. Wichern (2012) - Applied Multivariate Statistical Analysis, Sixth Edition, PHI Learning Private Limited, New Delhi

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

https://nptel.ac.in/courses/110/105/110105087/

https://nptel.ac.in/courses/111/107/111107063/

https://www.udemy.com/topic/Multivariate-Analysis

https://freevideolectures.com/course/3499/statistical-inference

COURSE LEVEL MAPPING OF PROGRAM LEVEL OUTCOMES

		CLO-1	CLO-2	CLO-3	CLO-4	CLO-5	CLO-6	CLO-7	CLO-8
Program Level Outcome (PLO)	Disciplinary Knowledge	✓	✓	✓	✓	✓	✓	✓	✓
	Communication Skills	✓	✓	✓	✓	✓	✓	✓	✓
	Critical Thinking		✓	✓	✓	✓	✓	✓	✓
	Research related Skills		✓	✓	✓	✓	✓	✓	✓
	Analytical Reasoning	✓	✓	✓	✓	✓	✓	✓	✓
	Problem Solving	✓	✓	✓	✓	✓	✓	✓	✓
	Team Work	✓	✓		✓	✓			
	Moral and Ethical Awareness	✓	✓	✓	✓		✓	✓	
	Multicultural competence	✓	✓	✓	✓	✓	✓	✓	✓

Year	Sem	Subject Code	Title of the Paper	Hours/ Week
2021-2022 onwards	**III & IV**	**21MST45P**	**Core Practical – IV : PRACTICAL – IV (Using SPSS)**	**3**

COURSE LEVEL OUTCOMES:

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

1. Apply the theory through practical oriented training.
2. Perform the basic operations of SPSS Package.
3. Utilize the SPSS package for Data Analytics.
4. Compute Parametric and Non-parametric Tests.
5. Fit the important probability distributions.
6. Analyse the given data using Correlation, Regression measures.
7. Perform analyses for various designs of experiment.

Using SPSS the students have to draw / analyze the given data using the following statistical techniques

1. Diagrammatic Representation (Multiple Bar, Pie-chart)

2. Descriptive Measures: Mean, Median, Mode, SD and Correlation Coefficient
3. Construction of Regression Equations – SPSS
4. Chi-square test for independence of attributes
5. Factor Analysis
6. One-way ANOVA
7. Two-way ANOVA
8. 2^3-Factorial Design
9. t-test for means
10. F-test for two variances
11. χ^2- test for Independence of Attributes
12. Fitting Binomial Distribution
13. Fitting Poison Distribution
14. Fitting Normal Distribution
15. Partial and Multiple Correlation Coefficients
16. Construction of Multiple Regression Equation
17. Fitting Linear Trend by Least Square method
18. Finding mean vector and covariance matrix
19. Construction of control charts for Mean and Range
20. Probability of Acceptance & drawing OC Curve using Poisson distribution
21. Kolmogorov – Smirnov's one sample test
22. Kruskal-Wallis Test – Independent samples.
23. Wilcoxon's signed rank test
24. Sign Test for Two Samples
25. Freedman's test 2-way ANOVA

Books for Further study:

1. Landau, S., and Everitt, B.S. (2004). A Handbook of Statistical Analyses using SPSS, Chapman & Hall/CRC Press, New York
2. Almquist, Y. B., Ashir, S., and Brännström, L. A Guide to SPSS: The Basics, Version 1.0.1, Stockholm University, Sweden.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1. https://nptel.ac.in/courses/110/107/110107113/
2. NPTEL :: Mathematics - NOC: Non-parametric Statistical Inference

COURSE LEVEL MAPPING OF PROGRAM LEVEL OUTCOMES

			Course Level Outcomes (CLO)						
			1	**2**	**3**	**4**	**5**	**6**	**7**
Program Level Outcomes (PLO)		Disciplinary Knowledge	✓	✓	✓		✓		
		Multicultural Competence	✓		✓			✓	✓
		Self-directed learning	✓	✓					✓
		Reflective thinking		✓		✓		✓	
		Analytical Reasoning				✓		✓	
		Problem Solving	✓	✓	✓	✓	✓	✓	✓
		Cooperation / Team work	✓	✓	✓	✓	✓	✓	✓
		Moral and ethical awareness		✓	✓		✓		✓
		Multicultural competence		✓	✓		✓		✓

M.C.A. Degree Course

(For the students admitted during the academic year 2021-2022 and onwards)

Sub Code	Title of the Paper	Hrs (wk)	Internal (CA) Marks	External Marks	Total Marks	Ext– Min.	Total Pass Mark	Credits
Semester – I								
21MCA25C	CORE PAPER V – **PROBABILITY AND STATISTICS**	4	50	50	100	25	50	5

Year	Sem.	Subject Code	Title of the Paper	Hours/Week
2021-2022 onwards	**II**	**21MCA25C**	**CORE PAPER V – PROBABILITY AND STATISTICS**	**4**

COURSE LEVEL OUTCOMES:

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

1 Distinguish between different types of probability concepts.

2 Demonstrate an understanding of the basic concepts of random variables.

3 Discuss the concept of expectation and joint probability distribution of random variables.

4 Describe the main properties of probability distributions and its applications.

5 Exhibit different types of probability distributions with real life problems.

6 Apply the test of significance concept for large and small sample theories.

7 Identify the applications of z-test, t-test and Chi-Square test with appropriate examples.

UNIT - I

Probability - Basic Definitions - Mathematical Probability - Statistical Probability - Axiomatic Approach to Probability - Addition Theorem - Multiplication Theorem - Independent Events – Conditional Probability - Baye's Theorem - Simple Problems.

UNIT - II

Random Variables - Discrete Random Variable - Probability Mass Function – Continuous Random Variable - Probability Density Function - Simple Problems.

UNIT– III

Mathematical Expectation of a Random Variable – Properties of Expectation - Moment Generating Function - Joint Probability Distribution of Two-Dimensional Random Variables - Marginal and Conditional Distributions - Simple Problems.

UNIT– IV

Discrete Distributions - Binominal and Poison Distributions - Results and it's Applications – Continuous Distributions – Rectangular (Uniform) and Normal Distributions - Results and it's Applications - Simple Problems. (No derivations).

UNIT- V

Tests of Significance for Large Samples - Basic Definitions - Normal Test of Single Mean and Difference of Means - Tests of Significance for Small Samples - t-Test for Single Mean and Difference of Means - Chi-Square Test for Independence of Attributes.

PEDAGOGY STRATEGIES

- Lecturing
- Classroom Discussion
- Questioning
- Seminar
- Assignment
- Class Test
- Quiz & Drill Practice
- Providing feedback

REFERENCES:

1 Gupta,S.C.and Kapoor, V.K. (2018)- Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi, 11th revisedEdition.

2 Kapoor J. N. and Sexena H. C. (2011) – Mathematical Statistics - Sultan Chand & Sons.

FURTHER READING:

1 HoggR.V and craig A.H. (2012) – Introduction to Mathematical Statistics,SeventhEdition,PearsonEducation.

2 Gupta, S.P.(2014)-StatisticalMethods,SultanChand&Sons,NewDelhi,44th Thoroughly RevisedEdition.e

3 Rohatgi. V.K. – An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern, New Delhi.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1 https://nptel.ac.in/courses/111/105/111105041/

2 https://nptel.ac.in/courses/111/106/111106112/

3 https://www.dcpehvpm.org/E-Content/Stat/FUNDAMENTAL%20OF%20MATHEMATICAL%20STATISTICS-S%20C%20GUPTA%20&%20V%20K%20KAPOOR.pdf

COURSE LEVEL MAPPING OF PROGRAM LEVEL OUTCOMES

		CLO-1	CLO-2	CLO-3	CLO-4	CLO-5	CLO-6	CLO-7
Program Level Outcomes (PLO)	Disciplinary Knowledge	✓	✓	✓	✓	✓	✓	✓
	Communication Skills			✓	✓	✓		✓
	Critical Thinking			✓	✓	✓	✓	
	Research related Skills		✓	✓		✓		✓
	Analytical Reasoning		✓	✓		✓	✓	
	Problem Solving	✓	✓	✓	✓	✓	✓	✓
	Team Work	✓	✓	✓	✓		✓	✓
	Moral and Ethical Awareness		✓	✓		✓		✓
	Multicultural competence		✓		✓	✓		✓

Teaching Learning Processes

The teaching learning processes play the most important role in achieving the desired aims and objectives of the postgraduate programs in Statistics as elaborated in detail in the Learning Based Curriculum Framework (LOCF). Statistics is the science which deals with data collection, analysis and interpretation of numerical data. While such ideas and concepts originate in the minds of the genius, anywhere and anytime in the universe, their verifications and confirmations have to be done in the data analysis. To achieve this goal, the appropriate training of young individuals to become competent statisticians in future has to be accomplished. For this purpose, a competitive postgraduate program in Statistics is focused.

We have:

- Necessary and sufficient infrastructural facilities for the class rooms, laboratories and libraries, equipped with adequate modern and modular furniture and other requirements.
- Modern and updated computer laboratory equipment are needed for the undergraduate programme.
- Recent reference and text books for the libraries are to be updated
- Sufficient infrastructure for ICT and other facilities needed for technology-enabled learning like computer facilities, PCs, laptops, Wi-Fi and internet facilities with all the necessary software.
- Sufficient number of teachers in permanent position to do all the class room teaching and perform and supervise the computer laboratory experiments to be done by the students.
- All the teachers should be qualified as per the UGC norms and should have good communication skills.
- Sufficient number of technical and other support staff to run the laboratories, libraries, equipment and maintain the infrastructural facilities like buildings, electricity, sanitation, cleanliness etc.
- Teachers should make use of all the approaches for an efficient teaching-learning process i.e.,

(i) Class room teachings with lectures using traditional as well as electronic boards,

ii) Use of smart class rooms for simulation and demonstration for conveying the difficult concepts and tools of Statistics in class room teaching and laboratories,

(iii) Tutorials must be an integral part of all the theory and laboratory courses. Theory courses

should have 1-2 tutorials every week depending upon the nature of the course,

(iv) Teaching should be complimented with student's seminar to be organized very frequently,

(v) Guest lectures and seminars/workshops should be arranged by eminent teachers to be invited by the concerned college/university/HEI,

vi) Open-ended project work should be given to all students individually or in group to 2-3 students depending upon the nature of the course,

(vii) Special attempts should be made by the institution to develop problem-solving skills and design of Statistics projects for demonstration at the UG level. For this purpose, a mentor system may be evolved where 3-4 students may be assigned to each faculty member,

(viii) Teaching load should be managed such that the teacher has enough time to interact with the students to encourage an interactive/participative learning.

8. Assessment Methods

In the PG education of Statistics leading to the M.Sc. Statistics degree, the assessment and evaluation methods focus on testing the conceptual understanding of the Advanced Techniques, development of Statistical skills and experimental techniques retention and ability to apply the knowledge acquired to explain with analysis and reason what has been learnt and to solve new problems and communicate the results and findings effectively. Since the learning objectives are defined clearly for each course in detail, it is easier to design methods to monitor the progress in achieving the learning objectives during the course and test the level of achievement at the end of the course.

- The courses offered in the M.Sc. Statistics are the advanced courses at the college/ University level, the priority is given to Formative Assessment for monitoring the progress towards achieving the Learning Objectives while keeping its weightages lower than Summative Assessments. This is to assure that the students know their strengths and weaknesses periodically through the results of Formative Assessments and make amends for the gaps in their knowledge without affecting their final grades in any significant way.
- In this context it is suggested that 25-30% weightage be given to Formative Assessments in case of theory components while 30-40% weightage be given to the Laboratory/Field work/Projects/Case Study/Dissertation components of the various courses.
- Some of the methods suggested for Theory Component with regard to Formative

Assessment are i) Regular Tutorial assignments ii) Seminar presentations iii) Performance in group discussions iv) Problem based longer assignments (other than tutorials) v) True/False Tests vi) Multiple Choice Tests vii) Short Answer Tests viii) viva-voce tests ix) Any other innovative tests in the context of the course.

- In the case of substantive Summative Assessment for the theory papers, can be a combination of the following i) Mid-Semester test ii) Seminar Report iii) Individual /Team Project report iv) Oral Presentations of Seminar/Projects v) Viva -Voce Examination on the above reports.
- End Semester closed book examination in the pattern of a) Multiple Choice b) Short Answer c) Long Answer. End Semester Open Book Examination in the form of a) Peer review by a group of experts by written and oral examinations, b) Any other innovative method depending upon the nature of the course.
- Laboratory Experiments / Field work / Projects / Case Study / Dissertation can be assessed for Formative Assessment through i) Regular evaluation of Lab. experiments regarding written report of each experiment and Viva-Voce on each experiment, ii) Mid semester examination.

MODEL QUESTION PAPER FOR ENDSEMESTER EXAMINATIONS

Government Arts College (Autonomous)
Coimbatore -641018
PG and Research Department of Statistics
I M.Sc Statistics
Real Analysis and Linear Algebra

Max.Marks:50

Part A (5 x 1 =5)

(i) Choose the best Answer (5 x 1 =5)

Answer All questions

1. A function f is said to be right hand limit
   a. $\lim_{x\to c-} f(x) = l$ b. $\lim_{x\to c+} f(x) = l$ c. $\lim_{x\to c} f(x) = l$ d.$\lim f(x) = l$

2. If P_1 and P_2 are two partitions of $P_1 U P_2$ is called a _____of P_1 and P_2
   a. Upper sum b. Common refinement c. Norm d. Lower sum

3. U (P, f, α) is
   a. $\sum_{i=1}^{n} M\Delta\propto_i$ $b.\sum_{i=1}^{n} m\Delta\propto$ $c.\sum_{i=1}^{n} M\Delta\propto$ $d.\sum_{i=1}^{n} Mm\Delta\propto$

4. A square matrix A of order n is similar to a diagonal matrix D Iff A has a linearly independent
   a. Eigen values b. Eigen space c. Eigen vectors d. Euclidean space

5. If P and P^T are non-singular, then congruent matrices have the _____rank
   a.Different b. unequal c. identity d. Same

(ii) Short answer (3 x 2 =6)

Answer any Three questions

6. Define Derivative at a point

7. Define Upper and Lower Darboux sum.

8. Define Riemann Stieltjes integral.

9. Define Eigen Values and Eigen vectors.

10. Write down the classification of Quadratic forms.

Part B (5 x 3 = 15)

Answer All questions

11. a)State and prove necessary condition for the existence of a finite integral. (or)

    b) State and prove that the limit of a sum is equal to the sum of the limits.

12. a)State and prove first mean value theorem of R-Integral.
    (or)

    b) What is Refinement of a partition and Oscillatory sum?

13. a) State and prove that the lower RS-Integral cannot exceed the Upper RS-Integral.
    (or)

    b) What I upper and lower Riemann Stieltjes integral.

14. a) State and prove that the eigen space for a matrix is a subspace. (or)
    b) State any three properties of Eigen values.

15. a) Let $A=\begin{matrix}1 & 2 & 3\\ 2 & 5 & -4\\ -3 & -4 & 8\end{matrix}$ Find a non-singular matrix P such that $D= P^{T}AP$ is diagonal.(or)
    b) State and prove Sylvester's law of inertia.

Part c (3 x 8 = 24)

Answer any Three questions

16. State and prove First and second mean value theorem.

17. State and prove the Necessary and Sufficient condition for integrability.

18. State and prove RS-Integral of f relative to g on [a, b] is equal to the R-integral of fg' on [a, b].

19. State and Prove Cayley Hamilton Theorem.

20. Let A = $\begin{matrix} 2 & -2 \\ -2 & 5 \end{matrix}$ be a real symmetric matrix. Find an Orthogonal matrix P such that $P^{-1}AP$ is diagonal.