Annamalai University

(Accredited with 'A+' Grade by NAAC)

Faculty of Science

Department of Statistics

M.Sc. STATISTICS

Regulations, Curriculum and Syllabus
2023-24 OnwardS

M.SC.,
STATISTICS

2023-2024 ONWARDS

ANNAMALAI UNIVERSITY

Annamalai University

Faculty of Science

DEPARTMENT OF STATISTICS

M.Sc. STATISTICS

Programme Code:SSTA21

These rules and regulations shall govern the Two year post graduate studies leading to the award of degree of **Master of Science in Statistics** in the Faculty of Science. These academic Regulations shall be called "**Annamalai University, Faculty of Science Two year M.Sc. Statistics Regulations 2023-24**". .They shall come into force with effect from the academic year 2023 – 24 Onwards.

1. Definitions and Nomenclature

1.1 **University** refers to Annamalai University.

1.2 **Department** means any of the academic departments and academic centers at the University.

1.3 **Discipline** refers to the specialization or branch of knowledge taught and researched in higher education. For example, Botany is a discipline in the Natural Sciences, while Economics is a discipline in Social Sciences.

1.4 **Programme** encompasses the combination of courses and/or requirements leading to a Degree. For example, M.A., M.Sc.

1.5 **Course** is an individual subject in a programme. Each course may consist of Lectures/ Laboratory /Seminar/Project work/viva-voce etc. Each course has a course title and is identified by a course code.

1.6 **Curriculum** encompasses the totality of student experiences that occur during the educational process.

1.7 **Syllabus** is an academic document that contains the complete information about an academic programme and defines responsibilities and outcomes. This includes course information, course objectives, policies, evaluation, grading, learning resources and course calendar.

1.8 **Academic Year** refers to the annual period of sessions of the University that comprises two consecutive semesters.

1.9 **Semester** is a half-year term that lasts for a minimum duration of 90 days. Each academic year is divided into two semesters.

1.10 **Choice Based Credit System**: A mode of learning in higher education that enables a student to have the freedom to select his/her own choice of elective courses across various disciplines for completing the Degree programme.

1.11 **Core Course** is mandatory and an essential requirement to qualify for the Degree.

1.12 **Elective Course** is a course that a student can choose from a range of alternatives.

1.13 **Value-added Courses** are optional courses that complement the students' knowledge and skills and enhance their employability.

1.14 **Credit** refers to the quantum of course work in terms of number of class hours in a semester required for a programme. The credit value reflects the content and duration of a particular course in the curriculum.

1.15 **Credit Hour** refers to the number of class hours per week required for a course in a semester. It is used to calculate the credit value of a particular course.

1.16 **Programme Outcomes** (POs) are statements that describe crucial and essential knowledge, skills and attitudes that students are expected to achieve and can reliably manifest at the end of a programme.

1.17 **Programme Specific Outcomes** (PSOs) are statements that list what the graduate of a specific programme should be able to do at the end of the programme.

1.18 **Learning Objectives** are statements that define the expected goal of a course in **Course Objectives** in terms of demonstrable skills or knowledge that will be acquired by a student.

1.19 **Course Outcomes** (COs) are statements that describe what students should be able to achieve/demonstrate at the end of a course. They allow follow-up and measurement of learning objectives.

1.20 **Grade Point Average** (GPA) is the average of the grades acquired in various courses that a student has taken in a semester. The formula for computing GPA is given in section 11.3

1.21 **Cumulative Grade Point Average**(CGPA) is a measure of overall cumulative performance of a student over all the semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters. is given in section11.4.

1.22 **Letter Grade** is an index of the performance of a student in a particular course. Grades are denoted by the letters S, A, B, C, D, E, RA, and W.

2. Programme Offered and Eligibility Criteria:

The Department of Statistics offers a Two-Year M.Sc. in Statistics programme.

The candidate must possess any one of the following have to be admitted in M. Sc., Statistics programme.

2.1 A pass in B.Sc. (Statistics) with not less than 45% of marks in Part–III.

2.2 A pass in B.Sc. (Mathematics) (or) B.Sc. (Computer Science) with not less than 50% of marks in Part-III along with an ancillary paper in Statistics.

3. Reservation Policy:

Admission to the various programmes will be strictly based on the reservation policy of the Government of Tamil Nadu.

4. Programme Duration

4.1 The Two-Year Master's Programme consist of two academic years.

4.2 Each academic year is divided into two semesters, the first being from July to November and the second from December to April.

4.3 Each semester will have 90 working days (18 weeks).

5. Programme Structure

5.1 The Two-Year Master's Programme consists of Core Courses, Elective Courses and Project.

5.2 Core courses

5.2.1 These are a set of compulsory courses essential for each programme.

5.2.2 The core courses include both Theory (Core Theory) and Practical (Core Practical) courses.

5.3 Elective courses

5.3.1 **Core Course** is mandatory and an essential requirement to qualify for the Degree.

5.3.2 **Elective Course: Generic/Discipline Centric** is a course that a student can choose from a range of alternatives.

5.3.3 **Skill Enhancement Course: SEC** is a course designed to provide value-based or skill-based knowledge. The main purpose of this course is to provide students with skills in the hands-on-mode to increase their employability.

5.3.4 **Industry/Entrepreneurship**

This course is to introduce students to the activity of setting up a business or businesses, taking on financial risks in the hope of profit.

5.4 Internship/Industrial Activity (Experiential Learning)

5.4.1 Experiential learning in the form of internship/industrial activity provides opportunities to students to connect principles of the discipline with real-life situations.

5.4.2 In-plant training/field trip/internship/industrial visit fall under this category.

5.4.3 Experiential learning is categorized as non-core course.

5.5 **Extension Activity** The basic objective of extension activity is to create social awareness among the students by providing the opportunities to work with people and also to create an awareness and knowledge of social realities to have concern for the welfare of the community and engage in creative and constructive societal development.

5.5.1 It is mandatory for every student to participate in extension activity.

5.5.2 All the students should enroll under NSS/NCC/CYRC/RRC or any other service organization in the University.

5.5.3 Students should put a minimum attendance of 40 hours in a year duly certified by the Programme Co-Ordinator.

5.5.4 Extension activity shall be conducted outside the class hours.

5.5.5 Extension activity is categorized as non-core course.

5.6 Project

5.6.1 Each student shall undertake a Project and submit a dissertation as per guidelines in the final semester.

5.6.2 The Head of the Department shall assign a Research Supervisor to the student.

5.6.3 The Research Supervisor shall assign a topic for research and monitor the progress of the student periodically.

5.6.4 Students who wish to undertake project work in recognized institutions/industry shall obtain prior permission from the Department. The Research Supervisor will be from the host institute.

5.7 Value Added Course (VAC)

5.7.1 Students may opt to take Value Added Course beyond the minimum credits required for the award of the degree. VACs are outside the normal credit paradigm.

5.8 Online Courses

5.8.1 The Heads of Departments shall facilitate enrolment of students in Massive Open Online Courses (MOOCs) platform such as SWAYAM to provide academic flexibility and enhance the academic career of students.

5.8.2 Students who successfully complete a course in the MOOCs platform shall be exempted from one elective course of the programme.

5.9 **Credit Distribution:** The credit distribution is organized as follows:

Component	Course	Credits
Part A	**Core (Theory)**	**45**
	Core (Practical)	**12**
	Project with Viva voce	**7**
Part B (i)	**Elective (Generic/Discipline Centric)**	**18**
Part B (ii)	**Internship/Industrial Visit**	**02**
Part B (iii)	**Skill Enhancement Course/Professional Competency Skill**	**06**
Part C	**Extension Activity**	**01**
	TOTAL CREDITS	**91**

Part A component and Part B (i) will be taken into account for CGPA calculation for the post graduate programme and the other components of Part B and Part C will not be included for CGPA calculation and have to be completed during the duration of the programme as per norms, to be eligible for obtaining the PG degree.

5.10 Credit Assignment

Each course is assigned credits and credit hours on the following basis:

1 Credit is defined as

1 Lecture period of one hour duration per week over a semester

1 Tutorial period of one hour duration per week over a semester

1 Practical/Project period of two hours duration per week over a semester.

6 Attendance

6.1 Each faculty handling a course shall be responsible for the maintenance of Attendance and Assessment Record for candidates who have registered for the course.

6.2 The Record shall contain details of the students' attendance, marks obtained in the Continuous Internal Assessment (CIA) Tests, Assignments and Seminars. In addition the Record shall also contain the organization of lesson plan of the Course teacher.

6.3 The record shall be submitted to the Head of the Department and Dean once a month for monitoring the attendance and syllabus coverage.

6.4 At the end of the semester, the record shall be placed in safe custody for any future verification.

6.5 The Course teacher shall intimate to the Head of the Department at least seven calendar days before the last instruction day in the semester about the attendance particulars of all students.

6.6 Each student shall have a minimum of 75% attendance in all the courses of the particular semester failing which he or she will not be permitted to write the End-Semester Examination. The student has to redo the semester in the next year.

6.7 Relaxation of attendance requirement up to 10% may be granted for valid reasons such as illness, representing the University in extracurricular activities and participation in NCC/NSS/YRC/RRC.

7 Mentor-Mentee System

7.1 To help the students in planning their course of study and for general advice on the academic programme, the Head of the Department will attach certain number of students to a member of the faculty who shall function as a Mentor throughout their period of study.

7.2 The Mentors will guide their mentees with the curriculum, monitor their progress, and provide intellectual and emotional support.

7.3 The Mentors shall also help their mentees to choose appropriate electives and value-added courses, apply for scholarships, undertake projects, prepare for competitive examinations such as NET/SET, GATE etc., attend campus interviews and participate in extracurricular activities.

8 Examinations

8.1 The examination system of the University is designed to systematically test the student's progress in class, laboratory and field work through Continuous Internal Assessment (CIA) Tests and End-Semester Examination (ESE).

8.2 There will be two CIA Tests and one ESE in each semester.

8.3 The Question Papers will be framed to test different levels of learning based on Bloom’s taxonomy viz. Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation/Creativity.

8.4 Continuous Internal Assessment Tests

8.4.1 The CIA Tests shall be a combination of a variety of tools such as class tests, assignments and seminars. This requires an element of openness.

8.4.2 The students are to be informed in advance about the assessment procedures.

8.4.3 The pattern of question paper will be decided by the respective faculty.

8.4.4 CIA Tests will be for one or two hours duration depending on the quantum of syllabus.

8.4.5 A student cannot repeat the CIA Test-I and CIA Test-II. However, if for any valid reason, the student is unable to attend the test, the prerogative of arranging a special test lies with the teacher in consultation with the Head of the Department.

8.4.6 For the CIA Tests, the assessment will be done by the Course teacher

8.5 End Semester Examinations (ESE)

8.5.1 The ESE for the first and third semester will be conducted in November and for the second and fourth semester in May.

8.6 Candidates who failed in any course will be permitted to reappear in failed course in the subsequent examinations.

8.7 The ESE will be of three hours duration and will cover the entire syllabus of the course.

9 Evaluation

9.1 Marks Distribution

9.1.1 For each course, the Theory, Practical and project shall be evaluated for a maximum of 100 marks.

9.1.2 For the theory courses, CIA Tests will carry 25% and the ESE 75% of the marks.

9.1.3 For the Practical courses, the CIA Tests will carry 40% and the ESE 60% of the marks.

9.2 Assessment of CIA Tests

9.2.1 For the CIA Tests, the assessment will be done by the Course Instructor

9.2.2 For the Theory Courses, the break-up of marks shall be as follows:

	Marks
Test-I & Test-II	20
Assignment	5
Total	25

9.2.3 For the Practical Courses (wherever applicable), the break-up of marks shall be as follows:

	Marks
Test-I	20
Test-II	20
Total	40

9.3 Assessment of End-Semester Examinations

9.3.1 Evaluation for the ESE is done by Internal examiner.

9.4 Assessment of Project/Dissertation

9.4.1 The Project Report/Dissertation shall be submitted as per the guidelines.

9.4.2 The Project Work/Dissertation shall carry a maximum of 100 marks.

9.4.3 CIA for Project will consist of a Review of literature survey, experimentation/field work, attendance etc.

9.4.4 The Project Report evaluation and viva-voce will be conducted by a committee constituted by the Head of the Department.

9.4.5 The Project Evaluation Committee will comprise the Head of the Department, Project Supervisor, and a senior faculty.

9.4.6 The marks shall be distributed as follows:

Continuous Internal Assessment (25 Marks)		End Semester Examination (75 Marks)	
Review-I - 10	Review-II -15	Project / Dissertation Evaluation	Viva-voce
		50	25

9.5 Assessment of Value-added Courses

9.5.1 Assessment of VACs shall be internal. Two CIA Tests shall be conducted during the semester by the Department(s) offering VAC.

9.5.2 The grades obtained in VACs will not be included for calculating the GPA/CGPA.

9.6 Passing Minimum

9.6.1 A student is declared to have passed in each course if he/she secures not less than 50% marks in the ESE and not less than 50% marks in aggregate taking CIA and ESE marks together.

9.6.2 A candidate who has not secured a minimum of 50% of marks in a course (CIA + ESE) shall reappear for the course in the next semester/year.

10. Conferment of the Master's Degree

A candidate who has secured a minimum of 50% marks in all courses prescribed in the programme and earned the minimum required credits shall be considered to have passed the Master's Programme.

11. Marks and Grading

11.1 The performance of students in each course is evaluated in terms Grade Point (GP).

11.2 The sum total performance in each semester is rated by Grade Point Average (GPA) while Cumulative Grade Point Average (CGPA) indicates the Average Grade Point obtained for all the courses completed.

11.3 **The GPA** is calculated by the formula

$$GPA = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i}$$

where, C_i is the Credit earned for the Course i in any semester;

G_i is the Grade Point obtained by the student for the Course i

n is the number of Courses passed in that semester.

11.4 **CGPA** is the Weighted Average Grade Point of all the Courses passed starting from the first semester to the current semester.

$$CGPA = \frac{\sum_{i=1}^{m}\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{m}\sum_{i=1}^{n} C_i}$$

Where, C_i is the Credit earned for the Course i in any semester;

G_i is the Grade Point obtained by the student for the Course i

n is the number of Courses passed in that semester.

m is the number of semesters.

11.4.1 **Formula for Conversion of CGPA into Percentage**

The Conversion of CGPA into percentage is the following way

- **Percentage = CGPA x 9.5**
- For example : CGPA = 8.73
- **Percentage = 8.73 x 9.5 = 82.94%**

11.5 Evaluation :

11.5.1 **Performance of the student for each course will be rated as shown in the Table.**

Range of Marks	Grade Points	Letter Grade
90 and above	10	S
80-89	9	A
70-79	8	B
60-69	7	C
55-59	6	D
50-54	5	E
Less than 50	0	RA
Withdrawn from the examination	0	W

11.5.2 A ten-point rating scale is used for evaluation of the performance of the student to provide overall grade for the Master's Programme.

CGPA	Classification of Final Result
8.25 and above	First Class with Distinction
6.5 and above but below 8.25	First Class
5.0 and above but below 6.5	Second Class
0.0 and above but below 5.0	Re-appear

11.6 **Classification of Results**. The successful candidates are classified as follows:

11.6.1 **First Class with Distinction:** Candidates who have passed all the courses prescribed in the Programme in the first attempt with a CGPA of 8.25and above within the programme duration. Candidates who have withdrawn from the End Semester Examinations are still eligible for First Class with Distinction (See Section 12 for details).

11.6.2 **First Class:** Candidates who have passed all the courses with a CGPA of 6.5and above.

11.6.3 **Second Class:** Candidates who have passed all the courses with a CGPA between 5.0 and less than 6.5.

11.6.4 Candidates who obtain highest marks in all examinations at the first appearance alone will be considered for University Rank.

11.7 Course-Wise Letter Grades

11.7.1 The percentage of marks obtained by a candidate in a course will be indicated in a letter grade.

11.7.2 A student is considered to have completed a course successfully and earned the credits if he/she secures an overall letter grade other than RA.

11.7.3 A course successfully completed cannot be repeated for the purpose of improving the Grade Point

11.7.4 A letter grade RA indicates that the candidate shall reappear for that course. The RA Grade once awarded stays in the grade card of the student and is not deleted even when he/she completes the course successfully later. The grade acquired later by the student will be indicated in the grade sheet of the Odd/Even semester in which the candidate has appeared for clearance of the arrears.

11.7.5 If a student secures RA grade in the Project Work/Field Work/Practical Work/Dissertation, he/she shall improve it and resubmit if it involves only rewriting/ incorporating the clarifications suggested by the evaluators or he/she can re-register and carry out the same in the subsequent semesters for evaluation.

12. Provision for Withdrawal from the End Semester Examination

12.1 The letter grade W indicates that a candidate has withdrawn from the examination.

12.2 A candidate is permitted to withdraw from appearing in the ESE for one course or courses in ANY ONE of the semesters ONLY for exigencies deemed valid by the University authorities.

12.3 Permission for withdrawal from the examination shall be granted only once during the entire duration of the programme.

12.4 Application for withdrawal shall be considered only if the student has registered for the course(s), and fulfilled the requirements for attendance and CIA tests.

12.5 The application for withdrawal shall be made ten days prior to the commencement of the examination and duly approved by the Controller of Examinations. Notwithstanding the mandatory prerequisite of ten days' notice, due consideration will be given under extraordinary circumstances.

12.6 Withdrawal will not be granted for arrear examinations of courses in previous semesters and for the final semester examinations.

12.7 Candidates who have been granted permission to withdraw from the examination shall reappear for the course(s) when the course(s) are offered next.

12.8 Withdrawal shall not be taken into account as an appearance for the examination when considering the eligibility of the candidate to qualify for First Class with Distinction.

13. **Academic misconduct:** Any action that results in an unfair academic advantage/interference with the functioning of the academic community constitutes academic misconduct. This includes but is not limited to cheating, plagiarism, altering academic documents, fabrication/falsification of data, submitting the work of another student, interfering with other students' work, removing/defacing library or computer resources, stealing other students' notes/assignments, and electronically interfering with other students'/University's intellectual property. Since many of these acts may be committed unintentionally due to lack of awareness, students shall be sensitized on issues of academic integrity and ethics.

14. **Transitory Regulations:** Wherever there has been a change of syllabi, examinations based on the existing syllabus will be conducted for two consecutive years after implementation of the new syllabus in order to enable the students to clear the arrears. Beyond that, the students will have to take up their examinations in equivalent subjects, as per the new syllabus, on the recommendation of the Head of the Department concerned.

15. Notwithstanding anything contained in the above pages as Rules and Regulations governing the Two-Year Master's Programmes at Annamalai University, the Syndicate is vested with the powers to revise them from time to time on the recommendations of the Academic Council.

16. Template for PG Programme in Statistics

M.Sc Statistics Curriculum Design

Semester–I	Credit	Hours	Semester-II	Credit	Hours	Semester-III	Credit	Hours	Semester–IV		Credit	Hours
Core-I	5	7	Core-IV	5	6	Core-VII	5	6	Core-XI		5	6
Core-II	5	7	Core-V	5	6	Core-VIII	5	6	Core-XII		5	6
Core – III	4	6	Core – VI	4	6	Core – IX	5	6	Project with Viva-Voce		7	10
Elective – I Discipline Centric	3	5	Elective – III Discipline Centric	3	4	Core - X	4	6	Elective (Industry / Entrepreneurship) 80% P 20% T		3	4
Elective –II Generic	3	5	Elective –IV Generic	3	4	Elective – V Discipline Centric	3	3	Skill Enhancement Course / Professional competency skill		2	4
			Skill Enhancement I	2	4	Skill Enhancement II	2	3	Extension Activity		1	-
						Internship/ Industrial Activity	2	-				
	20	**30**		**22**	**30**		**26**	**30**			**23**	**30**
									Total Credit	**91**	**Total Hours**	**120**

Core – 12
Project – 1
Elective – 6

Skill Enhancement - 3
Extension – 1
Industry – 1

M.Sc. Statistics (Two Year) Programme SSTA21

CURRICULA AND SCHEME OF EXAMINATIONS (2023-24)

Course Code	Course Title	Hours/ Week			C	Marks		
		L	T	P		CIA	ESE	Total
	Semester-I							
23STAC101	Core I: Distribution Theory	6	1		5	25	75	100
23STAC102	Core II: Sampling Theory	6	1		5	25	75	100
23STAP103	Core III: Statistics Practical- I			6	4	25	75	100
23STAE104	Elective-I: Population Studies / Categorical Data Analysis	4	1		3	25	75	100
23STAE105	Elective-II: Real Analysis and Linear Algebra/ Bayesian Inference	4	1		3	25	75	100
	Total Credits				**20**			**500**
	Semester-II							
23STAC201	Core IV: Estimation Theory	5	1		5	25	75	100
23STAC202	Core V: Measure and Probability Theory	5	1		5	25	75	100
23STAP203	Core VI: Statistics Practical–II			6	4	25	75	100
23STAE204	Elective-III: Actuarial Statistics/ Simulation Analysis	3	1		3	25	75	100
23STAE205	Elective-IV: Econometrics/ Survival Analysis	3	1		3	25	75	100
23STAS206	SEC-I: Computational Statistics using R	3	1		2	25	75	100
	Total Credits				**22**			**600**
	Semester-III							
23STAC301	Core VII: Testing of Statistical Hypotheses	5	1		5	25	75	100
23STAC302	Core VIII: Multivariate Statistical Analysis	5	1		5	25	75	100
23STAC303	Core IX: Statistical Quality Control	5	1		5	25	75	100
23STAP304	Core X: Statistics Practical-III			6	4	25	75	100
23STAE305	Elective – V: Operations Research/ Data Base Management System	3			3	25	75	100
23STAS306	SEC-II: Computational Statistics using python	3			2	25	75	100
23STAI307	Internship/Industrial Activity				2	25	75	100
	Total Credits				**26**			**700**
	Semester-IV							
23STAC401	Core X1: Design of Experiments	5	1		5	25	75	100
23STAC402	Core XII: Stochastic Processes	5	1		5	25	75	100
23STAD403	Project with Viva-Voce	10			7	25	75	100
23STAE404	Elective VI: (Industry/Entrepreneurship): (80% P 20% T) Industrial Statistics using latest programming packages	4			3	25	75	100
23STAS405	SEC-III: Statistical documentation using LATEX	4			2	25	75	100
23STAX406	Extension Activity				1	25	75	100
	Total Credits				**23**			**600**
	Semesters I-IV Total Credits				**91**			**2400**

Core – 12 Skill Enhancement -3
Project – 1 Extension – 1 Elective (Industry / Entrepreneurship - 1
Discipline Centric Elective (Core) – 3 Industry – 1 Generic Elective (Intra Departmental) – 2

17. Elective Courses

Courses are grouped (Group A to Group F) so as to include topics from Pure Statistics (PS), Applied Statistics (AS), Industrial Components(IC) and IT Oriented (ITC) courses for flexibility of choice by the stakeholders / institutions.

Semester I: Discipline Centric Elective I(DCE – I) and Generic Elective I (GE – I)

DCE - I to be chosen from Group A and **GE - I** to be chosen from Group B

Group A: (PS/AS/IC/ITC)

23STAE104	Population Studies (OR) Categorical Data Analysis	3	1		3	75	100

Group B:(PS/AS/IC/ITC)

23STAE105	Real Analysis and Linear Algebra (OR) Bayesian Inference	3	1		3	75	100

Semester II: DCE – II & GE - II

DCE - II to be chosen from **Group C** and **GE - II** to be chosen from **Group D Group C**:**(PS/AS/IC/ITC)**

23STAE204	Actuarial Statistics (OR) Simulation Analysis	3	1		3	25	75	100

Group D :(PS/AS/IC/ITC)

23STAE205	Econometrics (OR) Survival Analysis	3	1		3	25	75	100

Semester III : DCE - III

DCE - III to be chosen from Group E.

Group E: (PS/AS/IC/ITC)

23STAE305	Operations Research (OR) Data Base Management System	3	1		3	25	75	100

Skill Enhancement Courses

Skill Enhancement Courses are chosen so as to keep in pace with the latest developments in the academic / industrial front and provides flexibility of choice by the stakeholders / institutions.

Group G (Skill Enhancement Courses) SEC:

- Computational Statistics using R / Python
- Statistical documentation using LATEX / other packages
- Operation Research using TORA
- Numerical analysis using SCILAB
- Differential equations using SCILAB
- Industrial Statistics using latest programming packages
- Research Tools and Techniques

Ability Enhancement Courses

- Soft Skill courses

Non Major Elective (NME) Courses for other Departments (not for Statistics students)
Students from other Departments may also choose any one of the following as Non Major Elective Course.

23SSTAN01	**1.** Statistical Methods for Life Sciences – **Even Semester for Science Faculty**	3 3	1 1		3 3	25 25	75 75	100 100
23SSTAN02	**2.** Statistics for Social Sciences – **ODD Semester for Arts Faculty**	3	1		3	25	75	100

18. Instructions for Course Transaction

Courses	Lecture hrs	Tutorial hrs	Lab Practice	Total hrs
Core	75	15	--	90
Electives	75	15	--	90
ED	75	15	--	90
Lab Practice Courses	45	15	30	90
Project	20	--	70	90

19. Testing Pattern (25+75) 13.1 Internal Assessment

Theory Course: For theory courses there shall be three tests conducted by the faculty concerned and the average of the best two can be taken as the Continuous Internal Assessment (CIA) for a maximum of 25 marks. The duration of each test shall be one / one and a half hour.

Computer Laboratory Courses: For Computer Laboratory oriented Courses, there shall be two tests in Theory part and two tests in Laboratory part. Choose one best from Theory part and other best from the two Laboratory part. The average of the best two can be treated as the CIA for a maximum of 25 marks. The duration of each test shall be one / one and a half hour.
There is no improvement for CIA of both theory and laboratory, and, also for University End Semester Examination.

20. Written Examination: Theory Paper (Bloom's Taxonomy based)

Question paper Model

Intended Learning Skills	**Maximum 75 Marks** **Passing Minimum: 50% Duration : Three Hours**
	Part –A (**10x1 = 10 Marks**) Answer ALL questions **Each Question carries 2mark**
Memory Recall / Example/ Counter Example / Knowledge about the Concepts/ Understanding	Two questions from each UNIT
	Question 1 to Question 10
	Part – B (7 x 5 = 35 Marks) Answer ALL questions **Each questions carries 5 Marks**
Descriptions/ Application (problems)	**Either-or Type** Both parts of each question from the same UNIT
	Question 11(a) or 11(b) To **Question 15(a) or 15(b)**
	Part-C (3x 10 = 30 Marks) Answer any THREE questions Each question carries 10 Marks
Analysis /Synthesis / Evaluation	There shall be FIVE questions covering all the five units
	Question 16 to Question 20

Each question should carry the course outcome and cognitive level For instance,

20.1.1 [CO1 : K2] Question xxxx

20.1.2 [CO3 : K1] Question xxxx

21. Different Types of Courses

(i) Core Courses (Illustrative)

1. Distribution Theory
2. Sampling Methods
3. Statistics Practical - I
4. Estimation Theory
5. Measure and Probability Theory
6. Statistics Practical - II
7. Testing of Statistical Hypotheses
8. Multivariate Analysis
9. Statistical Quality Control
10. Statistics Practical – III
11. Design of Experiments
12. Stochastic Process

(ii)Elective Courses (ED within the Department Experts)

1. Categorical Data Analysis
2. Population Studies
3. Bayesian Inference
4. Real Analysis and Linear Algebra
5. Actuarial Statistics
6. Simulation Analysis
7. Survival Analysis
8. Econometrics
9. Operations Research
10. Database Management System
11. Non-parametric Inference
12. Reliability Theory

(iii) Elective Courses (ED from other Department Experts)

(iv) Skill Development Courses

(v)Institution-Industry-Interaction (Industry aligned Courses)

Programmes /course work/ field study/ Modelling the Industry Problem/ Statistical Analysis / Commerce/Pharma-Industry related problems / MoU with Industry/Research Institutes and the like activities.

22. Programme Outcomes (PO) and Programme specific outcome (PSO)

The student post graduated in Statistics under the M.Sc. Statistics Programme should be able to have

Programme Outcomes (Pos)	**PO1: Disciplinary Knowledge:** a good theoretical knowledge of the domain Statistics and its methods and techniques. **PO2: Mathematical knowledge:** sharpening mathematical knowledge needed to understand higher levels of Statistics understand multidimensional issues of data. **PO3: Application knowledge:** understanding application of Statistics in various domain. Also understand the interdisciplinary nature of Statistics while applying it. Industrial oriented programming languages are introduce to undertake and solve practical problem in industry. **PO4: Critical Thinking:** examine basic statistical issues in a more logical and methodical manner in a real data given. **PO5: Analytical Reasoning:** to develop capability to identify logical issues in practicing with data, analyze and synthesize data from a variety of sources and accordingly draw conclusions. To acquire capacity for taking central and state government comparative examination (UGC NET, SET, SLET, TNPSC, SSC, TRB, RBI, UPSC, ISS/IES,ICMR,ICAR etc..) **PO6: Problem solving skills:** The students will be able to examine various hypotheses involved, and will be able to identify and consult relevant resources to find their rational answers. Also get mathematical problem solving. **PO7: Research Related Skills:** The students should be able to develop original thinking for formulating new problems and providing their solutions. **PO8: Computational skills:** acquire computing skills necessary for solving real life problems in par with the requirement of a job **PO 9 Team work:** experience in team work by engaging in team projects and team assignments. Also have original thinking and creative presentation **PO 10:** Communication and soft skills: Interactive skills and presentation skills

Programme Specific Outcomes (PSOs)	**PSO1 – Placement** To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions. **PSO2 - Entrepreneur** To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations. **PSO3 – Research and Development** Design and implement HR systems and practices grounded in researches that comply with employment laws, leading the organization towards growth and development. **PSO4 – Contribution to Business World** To produce employable, ethical and innovative professionals to sustain in the dynamic business world. **PSO 5 – Contribution to the Society** To contribute to the development of the society by collaborating with stakeholders for mutual benefit.

23. Syllabus for different Courses of M.Sc Statistics

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">Distribution Theory</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">CORE I</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">5</td><td rowspan="2">Course Code</td><td rowspan="2">23STAC101</td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">6</td><td colspan="2">1</td><td>--</td><td>7</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Undergraduate level Mathematics.</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">1. To provide theoretical knowledge on the concept of functions of random variables and its usage.
2. To educate the knowledge on the both discrete and continuous distributions.
3. To acquire the knowledge on deriving its characteristics of distributions.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="6">UNIT–I
Detailed Study of Binomial; Poisson; Normal; exponential; Gamma; Beta and Cauchy distributions (derivations; properties; Moments C.F and Applications); Concept of truncated distributions and Compound distribution.</td></tr>
<tr><td colspan="6">UNIT–II
Bi-variate distribution; Concept of joint, Marginal and conditional distribution; Functions of random variables and their distributions; Maximum and minimum, sum, difference, product and quotient of random variables; Various techniques of finding distributions of functions of random variables; Distribution of functions involving several random variables.</td></tr>
<tr><td colspan="6">UNIT–III
Non-Central t, F and χ^2 distribution - Properties of these distributions, Sampling distributions of mean, correlation and regression coefficients for normal samples (null case)</td></tr>
<tr><td colspan="6">UNIT–IV
Order statistics: cumulative distribution function of a single order statistics, p.d.f of a single order statistics, Joint p.d.f of two order statistics, Joint p.d.f of k^{th} order statistics, Joint p.d.f of n order statistics, Distribution of range, mid range and Quantiles.
.</td></tr>
<tr><td colspan="6">UNIT–V
Quadratic forms for normal variables; Distribution of Quadratic forms: Conditions for independence of quadratic forms and linear forms, Cochran’s theorem.
.</td></tr>
</table>

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	1. Mood,A.M. & Graybill, F.A. and Boes, D.C. : Introduction to the theory of statistics, McGraw Hill. 2. Rohatgi, V.K. and Md. Whsanes Saleh, A.K.(2002): An introduction to probability & Statistics, John Wiley and Sons.
Reference Books	1. Rao, C.R. (1973) : Linear statistical inference and its applications, 2ed, Wiley Eastern. 2. Johnson,S. & Kotz,(1972): Distributions in Statistics, Vol. I, II & III, Hougton & Miffin. 3. Dudewicz, E.J., Mishra, S.N.(1988) : Modern mathematical statistics, John Wiley. 4. Searle, S.R.(1971) : Linear models, John Wiley
Website and e-Learning Source	e-books, online tutorials taken from MOOC/SWAYAM platform for this subject.

Course Learning Outcome (for Mapping with POs and PSOs)
Students will be able to

1. understand the knowledge on importance of the random variables and its role in the distribution theory.
2. interpret the properties of special univariate continuous distributions, truncated normal distribution and few non-central distributions.
3. explain the moments for the data come from the univariate and bivariate distributions.
4. interpret the distributions of order statistics with regard to Median, Sample Range and Joint distribution of order k.
5. Understand the applications of distributions of QF.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	S	M	S	M
CO2	M	S	S	M	M	S	M	M	M	M
CO3	S	S	S	S	S	S	S	M	S	M
CO4	M	S	S	S	S	S	M	M	M	M
CO5	S	M	S	S	S	S	S	M	M	S

CO-PO Mapping (Course Articulation Matrix) S-Strong, M-Medium, W-Weak

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Level of Correlation between PSO's and CO's

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">Sampling Theory</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">CORE II</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2">23STAC102</td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">6</td><td colspan="2">1</td><td>--</td><td>7</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Undergraduate Statistical Inference</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">1. To cover sampling design and analysis methods
2. To explain and compare various sampling procedures.
3. To understand the concepts of bias and sampling variability and strategies for reducingthe bias and sampling variability.</td></tr>
<tr><td colspan="2" rowspan="3">Course Outline</td><td colspan="6">UNIT-I : Preliminaries – Simple Random Sampling - PPS selection methods</td></tr>
<tr><td colspan="6">UNIT-II : Midzuno sampling method – PPSWR and PPSWOR sampling methods – Ordered andUnordered estimators</td></tr>
<tr><td colspan="6">UNIT-III : Stratified Sampling – Allocation Problems – Systematic Sampling Methods – Balanced,Modified and Centered systematic sampling methods – Yates corrected estimator</td></tr>
<tr><td colspan="2" rowspan="2"></td><td colspan="6">UNIT-IV : Ratio Estimation – Unbiased Ratio Type estimators – Regression Estimation - Two Stage Sampling – Advantages – Equal First Stage Units – Unequal First Stage Units – Estimator.</td></tr>
<tr><td colspan="6">Unit–V : Introduction – Two Phase Sampling for Stratification – Two Phase Sampling for Ratio Estimator – Two Phase Sampling for Regression Estimator – Non Sampling Errors – Classification and Types – Measurement of Response Errors – Non Response Errors.</td></tr>
<tr><td colspan="2">Extended Professional Component (is a partof internal component only, Notto be included in theExternal Examination question paper)</td><td colspan="6">Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / applied survey techniques adopted in Economics and Statistics department of Tamil Nadu State Government.

(To be discussed during the Tutorial hour)</td></tr>
<tr><td colspan="2">Skills acquired from this course</td><td colspan="6">Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill</td></tr>
</table>

Recommended Text	1. Archana Bansal, (2017), Survey Sampling, Narosa Pubilishing House Pvt. Ltd., New Delhi. 2. W.G. Cochran (1965) : Sampling Techniques, Wiley and Sons

Reference Books	1. M.N.Murthy(1967) : Sampling Theory and Methods: Statistical Publishing Society, Calcutta. 2. Parimal Mukhopadhyay (2005) : Theory and Methods of Survey Sampling , Prentice Hall of India 3. P.V.Sukhatme, B.V.Sukhatme, S.Sukhatme and C.Asok (1984) L Theory of Same Surveys with Applications, IASRI, New Delhi
Website and e-Learning Source	e-books, online tutorials taken from MOOC/SWAYAM platform for this subject.

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

1. To apply basics and advanced levels of sampling methods for different types of data.
2. To draw a conclusion about the best sampling procedure.
3. To use practical applications of ratio and regression method of estimations.
4. To analyze data from multi-stage sampling methods.
5. To estimate the efficiency

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	M	S	S	M
CO2	M	S	S	S	M	S	S	S	M	M
CO3	S	S	S	M	S	S	S	M	S	M
CO4	S	S	S	S	S	S	S	M	M	M
CO5	S	M	S	M	M	S	S	M	M	S

CO-PO Mapping (Course Articulation Matrix) S-Strong, M-Medium, W-Weak

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Level of Correlation between PSO's and CO's

Title of the Course		Statistics Practical - I					
Paper Number		CORE III					
Category	Core	Year	I	Credits	4	Course Code	23STAC103
		Semester	I				
Instructional Hours per week		Lecture		Tutorial		Lab Practice	Total
						6	6

Fitting of distributions: Distributions

Sampling Theory:

Simple random sampling methods of drawing sample.

Estimation of the population total and variance estimation.

PPSWR Hurwitz - Thompson estimator - Des Raj ordered estimator

Murthy's unordered estimator midzuno scheme.

Linear and circular systematic sampling: Stratified sampling SRS,PPSWR, PPSWOR

Ratio Estimator (including ratio estimator for stratified sampling – separate and combined)

Regression Estimator (including regression estimator for stratified sampling – separate and combined)

Cluster Sampling (Cluster of Equal sizes)

Title of the Course		Population Studies					
Paper Number		ELECTIVE- I					
Category	Elective	Year	I	Credits	3	Course Code	23STAE104
		Semester	I				
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total		
		4	1	--	5		

UNIT I :

Development and scope of demography - Demographic data: sources and current status - Chandrashekar-Deming index - Adjustment of age data – use of Whipple-Myer and UN indices - Population size and growth in India - Trends and differentials in world population – Health Surveys and use of hospital statistics – Population transition theory

UNIT II :

Mortality - Basic measurements - Crude, specific, standardized death rates - Life table - construction, use and interpretation - force of mortality - abridged life tables.

UNIT III :

Fertility -Basic measurements - Gross and Net Reproduction rate - Cohort fertility analysis - Fertility models - Population regulation programs in India - Demographic transition theory.

UNIT IV :

Special distribution of population - basic concepts - measurements and models of migration - concept of international migration - Urban development components of urban and metropolitan growth - Urbanization in developed and developing countries - Stable and quasi populations- Intrinsic growth rate.

UNIT V :

Components of population growth and change – Models of population growth and their filling to population data - Methods of projection - Logistic equation - component method of projection - stable population theory – Decennial population census in India – Nuptiality and its measurements.

Books for Reference:

Benjamin, B. (1975) Demographic Analysis, George Allen and Unwin, London.

Cox, D.R. (1978) Demography, Cambridge University Press,Cambridge.

Gibbs, J.P. (2012) Urban Research Methods. Literary Licensing, LLC,WhiteFish, USA.

Keyfliz, N. and Caswell, H. (2006).Applied Mathematical Demography. Springer, New York.

Kumar, R. (1986) Technical Demography. Wiley Eastern, New Delhi.

Misra, B.D. (1982).An Introduction to the Study of Population.South East Asia Publishers, Madras.

Spiegelman, M. (1969):Introduction to Demographic Analysis. Harvard University Press, Harward.

Wolfenden, H.H. (1954). Population Statistics and their Compilation, University of Chicago Press, Chicago.

Course learning Outcome:

1. To understand the demographic characteristics and their meaning.
2. To understand the concepts mortality measures.
3. To derive the Gross and Net Reproduction Rate under fertility measures.
4. To pursue the knowledge pertaining to migration.
5. To learn the components of population growth and change through the various methods of projection.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	S	M	S	M	M
CO2	S	S	S	S	M	S	M	S	M	M
CO3	S	S	S	M	S	S	M	S	S	M
CO4	M	S	S	S	S	S	S	S	M	M
CO5	S	S	S	S	M	S	S	S	M	M

CO-PO Mapping (Course Articulation Matrix) S-Strong, M-Medium, W-Weak

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Level of Correlation between PSO's and CO's

Title of the Course		Categorical Data Analysis					
Paper Number		ELECTIVE- I					
Category	Elective	Year	I	Credits	3	Course Code	23STAE104
		Semester	I				
Instructional Hours per week		Lecture		Tutorial		Lab Practice	Total
		4		1		--	5

Pre-requisite
Undergraduate level statistical data analysis.

Objectives of the Course
To enrich the skills of students for learning the different models in categorical data.

Course Outline

Unit I: Models for binary response variables, Log linear models, Fitting log linear and logit models-Building and applying log linear models, Log-linear, Logit models for ordinal variables.

Unit II: Multinomial response models - Models for matched pairs- Analyzing repeated categorical Response data – Asymptotic theory for parametric models - Estimation theory for parametric models.

Unit III: Introduction to contingency table: 2X2 and rXc tables-measures of association and non parametric methods. Tests for independence and homogeneity of proportions-Fisher's exact test-Odds ratio and logit, other measures of association- Introduction to three way tables- Full independence and conditional independence – Collapsing and Simpson's paradox.

Unit IV: Generalized linear models- Logistic regression for binary- Multinomial and ordinal data-Log linear models- Poisson regression- Model in repeated measurements- Generalized estimating equations.

Unit V: Polychromous logit models for ordinal and nominal response - Log-linear models (and graphical models) for multi-way tables-Causality, repeated measures, generalized least squares – mixed models, latent-class models, missing data.

Extended Professional Component (It is only a part of internal component. Not to be included in the External Examination question paper)

Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved. (To be discussed during the Tutorial hour)

Skills Acquired From This Course

Knowledge, problem solving, analytical ability, professional competency, professional communication and transferrable skill.

Recommended Text Books

1. Agresti, Alan. (1996). *An Introduction to Categorical Data Analysis*, Wiley, New York.
2. David, W. Hosmer Jr, Stanley Lameshow. (1999). *Applied Survival Analysis.* John Wiley and son, INC.

Reference Books

1. Radhakrishna Rao. (2021).*Linear Statistical Inference and its Applications* (2nd ed.). Wiley-Interscience. ISBN: 0471218758.

2. Bergsma,W., Croon,M.A., & Hagenaars, J.A. (2009). *Marginal Models: For Dependent, Clustered, and Longitudinal Categorical Data*. Springer, New York.

Website and e-Learning Source

e-books, online tutorials taken from MOOC/SWAYAM platform for this subject.

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

1. Understand the concept of models for the binary response variables and fit logistic.
2. Analyse repeated categorical response data and estimation theory for parametric models.
3. Identify and summaries categorical data into 2 × 2 and r × c contingency tables.
4. Know the use of generalized liner models and generalized estimating equations.
5. Understand the polychromous logit models for ordinal and nominal response.

CO-PO Mapping (Course Articulation Matrix) S-Strong, M-Medium, W-Week

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	M	S	M	M
CO2	M	M	S	S	M	S	S	S	S	M
CO3	S	S	S	M	S	S	M	M	S	S
CO4	M	S	S	S	S	S	S	S	M	M
CO5	S	S	S	S	M	S	S	S	M	S

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">Real Analysis and Linear Algebra</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">DISCIPLINE CENTRIC ELECTIVE- I</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">23STAE105</td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>3</td><td colspan="2">1</td><td>--</td><td colspan="2">4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Undergraduate level Vector Algebra and Matrix Theory</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">1. To provide recollection as well as building Mathematical foundation in Real Analysis and Matrix Theory
2. To understand concepts and definition of metric space and theorems related to it
3. To know integration and differentiation concepts and its application, to know real functions in one variable as well as several variables, understand it on numerical problems
4. To know Linear space and its basis. Rank of a matrix, characteristic roots and its multiplicity, Different types of inverses, numerical examples and real life application
5. To know Different types of matrices, orthogonality, canonical forms, decomposition of matrix, quadratic forms, numerical examples and real life applications</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="6">UNIT-I : Metric Space – open, closed sets – Intervals (rectangles), Real valued Continuous functions- Discontinuities - compact sets, Bolzano – Weirstrass theorem, Heine – Borel theorem.</td></tr>
<tr><td colspan="6">Unit II: Derivatives - maxima and minima - Riemann integral & Riemann – Stieltjes integral with respect an increasing integrator – properties of R.S. integral. Functions of several variables, constrained and unconstrained maxima – minima of functions, partial and total derivatives</td></tr>
<tr><td colspan="6">Unit III: Basic properties of matrices (orthogonal, idempotent, Kronecker product, projection operators etc); Linear dependence, independence and rank of a matrix; characteristic roots and polynomial, multiplicity of characteristic roots; Cayley Hamilton theorem; inverse of a matrix and determinants;</td></tr>
<tr><td colspan="6">Unit IV: Reduction of matrices, Echelon form, Hermite canonical form, diagonal reduction, rank factorization, triangular reduction Jordan form; Symmetric matrices and its properties; Decomposition like, singular value decomposition, spectral decomposition, Cholesky decomposition etc.</td></tr>
<tr><td colspan="6">Unit V: Matrix differentiation; Generalized inverse and its properties, Moore-Penrose inverse; Application of g-inverse; Quadratic forms, classification, definiteness, index and signature, extremum; transformation and reduction of quadratic form; applications of quadratic forms.</td></tr>
</table>

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text	1.Rudin, Walter (1976) : Principles of Mathematical Analysis, McGraw Hill 2. Apostol, T.M. (1985) : Mathematical Analysis, Narosa, Indian Ed. 3. Graybill, F.A. (1983) : Matrices with application in Statistics,2nd ed. Wadsworth. 4.Rao, C.R. & Bhimasankaran, P.(1992) : Linear algebra, Tata McGraw Hill Pub. Co. Ltd. 5. Searle, S.R. (1982) : Matrix Algebra useful for Statistics, John Wiley and Sons, Inc.
Reference Books	1. 1.Royden, H.L.(1995) : Real analysis, 3ed., Prentice Hall of India. 2. Rangachari,M.S.(1996) : Real Analysis, Part 1, New Century Book House. 3. Ash.R.B. (1972): Real analysis and probability, Academic press. 4. Biswas, S. (1984): Topics in Algebra of Matrices, Academic Publications. 5. David, A.Harville(1997) : Matrix algebra from a statistician's perspective, Springer. 6. Hoffman, K. and Kunze, R. (1971) : Linear Algebra, 2nd ed. Prentice Hall, Inc.
Website and e-Learning Source	e-books, tutorials on MOOC/SWAYAM courses on the subject

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

1. Get a Mathematical foundation in Real analysis and Matrix Theory to understand univariate and multivariate concepts in Statistical Theory
2. Get a clear understanding R.S. integral, partial differentiation in several variable functions, get theoretical knowledge by understanding the need and application of theorems like Bolzano – Weirstrass theorem, Heine– Borel theorem
3. Understand concepts in matrix theory -rank and factorization, inverse of matrix, g-inverses and its applications, characteristic roots and its multiplicity, canonical forms and decomposition of matrix, orthogonality, quadratic forms and its index, solving linear system
4. get solve numerical problems and evaluate and interpret outcome
5. analyze real life problems and explore research problems

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	S	M	S	M	M
CO2	S	S	S	S	M	S	M	S	M	M
CO3	S	S	S	M	S	S	M	S	S	M
CO4	M	S	S	S	S	S	S	S	M	M
CO5	S	S	S	S	M	S	S	S	M	M

CO-PO Mapping (Course Articulation Matrix) S-Strong, M-Medium, W-Weak

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Level of Correlation between PSO's and CO's

Title of the Course		Bayesian Inference					
Paper Number		GENERIC ELECTIVE- I					
Category	Elective	Year	I	Credits	3	Course Code	23STAE105
		Semester	I				
Instructional Hours per week		Lecture		Tutorial		Lab Practice	Total
		4		1		--	5

UNIT I :

Bayes Theorem – Introduction – Bayes Theorem for events – Bayes Factor – Generalized Bayes Theorem for Events – Bayes theorem for future events – Bayes theorem for hypotheses – Bayes theorem for Random Variables.

UNIT II :

Prior and Conjugate Prior Distribution – Introduction – Sufficiency – Construction of Conjugate Prior – Conjugate Families for Samples from Various Standard Distributions – Equivalent Prior Sample size – Exponential Family of Distributions – Nuisance Parameters.

UNIT III :

Non – Informative Priors – Introduction – Complete Ignorance – Uniform Prior – Jeffrey's non – informative Priors – Asymptotically Locally Invariant Priors – Maximal Data Information Priors.

UNIT IV :

Bayes Estimation – Elements of Bayes Decision Theory – Squared Error loss Function (SELF) – Generalised Bayes Rule – Bilinear Loss Function – Linex Loss – Intrinsic Loss Functions.

UNIT V :

Bayesian Hypothesis Testing - prior and posterior odds - Bayes factor for Simple versus Simple Hypotheses – Bayes factor for Composite Vs Composite Hypotheses – Jeffreys Approach – Lindleys Procedure for Test of Significance – p Valus and Bayesian Significance Probability.

Text Book for Study:

Bansal, A.K. (2007) Bayesian Parametric Inference, Narosa, New Delhi.

Books For References:

Berger, J.O. (1985) Statistical Decision Theory and Bayesian Analysis,2/e, Springer, New York.
Bernardo, J.M. and Smith, A.F.M. (2000) Bayesian Theory, Wiley, New York.
Gelman, A. Carlin, J.B. Stern, H.B. and Rubin, D.B. (2013) Bayesian Data Analysis,3/e, CRC press, London
Ghosh, J.K. Delampady, M. and Samanta, T. (2010) An Introduction to Bayesian Analysis: Theory and Methods, Springer, New York.
Lee, P.M. (2012) Bayesian Statistics – An Introduction,4/e,Wiley, London.
Leonard, T. and J.S.J. Hsu. (1999) Bayesian Methods: An Analysis for Statisticians and Interdisciplinary Researchers, Cambridge University Press, London.
Robert, C.P. (1994) The Bayesian Choice: A Decision-Theoretic Motivation,2/e, Springer, New York.
Robert, C.P. and Casella, G. (2004): Monte Carlo Statistical Methods,2/e, Springer, New York.

Course learning Outcome:

1. To understand the Bayes theorem and its utility.
2. To understand the construction of prior distributions.
3. To have an idea about non informative priors.
4. To pursue the knowledge pertaining to Bayes estimation.
5. To learn the concept of Bayesian hypothesis testing.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	S	S	M	M
CO2	S	S	S	M	M	S	S	S	M	M
CO3	S	S	S	M	S	S	S	S	S	M
CO4	S	S	S	S	S	M	S	M	M	M
CO5	S	M	S	S	S	S	S	M	M	S

CO-PO Mapping (Course Articulation Matrix) S-Strong, M-Medium, W-Weak

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Level of Correlation between PSO's and CO's

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">Estimation Theory</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">CORE IV</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">5</td><td rowspan="2">Course Code</td><td rowspan="2">23STAC201</td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">5</td><td colspan="2">1</td><td>--</td><td>6</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Probability Theory.</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">1. To make the students to understand the basic concepts of the statistical estimationtheory.
2. To study the properties of ideal estimators like unbaisedness, consistency, sufficiency, completeness.
3. To educate various estimation methods like method of moments, method of maximumlikelihood, interval estimate, and Bayes estimate.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="6">Unit I: Sufficient statistics, Neyman, Fisher Factorisation theorem, the existence and construction of minimal sufficient statistics, Minimal sufficient statistics and exponential family, sufficiency and completeness, sufficiency and invariance.</td></tr>
<tr><td colspan="6">Unit II: Unbiased estimation: Minimum variance unbiased estimation, locally minimum variance unbiased estimators, Rao Blackwell – theorem. Completeness- Lehmann Scheffe theorems, Necessary and sufficient condition for unbiased estimators</td></tr>
<tr><td colspan="6">Unit III: Cramer- Rao lower bound, Bhattacharya system of lower bounds in the 1-parameter regular case. Chapman - Robbins inequality.</td></tr>
<tr><td colspan="6">Unit IV: Maximum likelihood estimation, computational routines, strong consistency of maximum likelihood estimators, Asymptotic Efficiency of maximum likelihood estimators, Best Asymptotically Normal estimators, Method of moments.</td></tr>
<tr><td colspan="6">Unit V: A general Method of Constructing Confidence Intervals (CIs), Construction of Shortest Average Width CIs, Construction of CIs in Large Samples, Construction of Most Accurate CIs, Construction of Bayesian CIs, Problems and Exercises.</td></tr>
</table>

Extended Professional Component (is a partof internal component only, Notto be included in theExternal Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	1. Manoj Kumar Srivastava, Abdul Hamid Khan and Namita Srivatsava (2014), Statistical Inference – Theory of Estimation, PHI Learning Private Limited, Delhi 2. Rajagopalan,M and P.Dhanavanthan, (2012), Statistical inference, PHI Learning Private Limited, New Delhi. 3. V.K.Rohatgi et al(2002) : An introduction to probability and statistics, John Wiley.Lehmann, E.L. (1983): Theory of point estimation, John Wiley.

Reference Books	1. Zacks, S. (1971): The theory of statistical inference, John Wiley. 2. Rao, C.R. (1973): Linear statistical inference and its applications, Wiley Eastern, 2nded. 3. Ferguson, T.S. (1967): Mathematical statistics, A decision theoretic approach,Academic press, New York and London. 4. Lindley, D.V. (1965): Introduction to probability and statistics, Part 2, Inference,Cambridge University Press.
Website and e-Learning Source	e-books, online tutorials taken from MOOC/SWAYAM platform for thissubject.

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

1. To understand the consistency, sufficiency and unbiasedness.
2. To understand the concepts and drive the uniformly minimum variance unbiasedestimators.
3. To derive the inequality including CR inequality, KCR inequality and Bhattacharyainequality.
4. To estimate the parameter using method of moments, method of MLE, Interval estimation and shortest with confidence intervals.
5. To learn the concepts and to apply simple numerical illustration for Loss function, Riskfunction and Bayes estimate.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	S	S	S	S	S	M
CO2	S	S	S	S	M	S	M	S	M	M
CO3	S	S	S	M	S	S	M	M	S	M
CO4	S	S	S	S	S	S	S	M	M	M
CO5	S	M	S	S	S	S	S	M	M	S

CO-PO Mapping (Course Articulation Matrix) S-Strong, M-Medium, W-Weak

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Level of Correlation between PSO's and CO's

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="7">Measure and Probability Theory</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="7">CORE V</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2">23STAC202</td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">5</td><td colspan="2">1</td><td>--</td><td>6</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="7">Undergraduate level Mathematics.</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="7">1. This paper provides mathematical background for the knowledge of Probability Theory extended from measure theoretical approach.
2. The students will be able to understand the basic concepts of the distribution function and random variables that help in understanding for estimation and testing problems inStatistical Inference.
3. The fundamentals of this course will pave the way for further research.</td></tr>
<tr><td colspan="2" rowspan="4">Course Outline</td><td colspan="7">Unit I: Measure Theory - Limits of sequence of sets, classes of sets – Field, Sigma Field and Monotone class, Measure and Measure Space – Measurable function</td></tr>
<tr><td colspan="7">Unit II: Lebesgue – Stieltjes measure, Measure integral and its properties, Dominated convergence theorem – Radon–Nikodymn theorem, almost everywhere convergence, convergence in measure and convergence in mean.</td></tr>
<tr><td colspan="7">Unit III: Events, sample space, different approaches to probability, random variables and random vector, Distribution functions of random variables and random vector, Expectation and moments, basic, Markov, Chebyshev’s, Holder’s, Minkowski’s and Jensen’s inequalities.</td></tr>
<tr><td colspan="7">Unit IV: Independence of sequence of events and random variables, conditional probability, conditional expectation, Characteristic functions and their properties, inversion formula, convergence of random variables, convergence in probability, almost surely, in the r-th mean and in distribution, their relationships, convergence of moments, Helly-Bray theorem, continuity theorem and convolution of distributions.</td></tr>
</table>

	Unit V: Central limit theorem, statement of CLT, Lindeberg, Levy and Liapounov forms with proof and Lindeberg Feller's form examples. Khintchine weak law of large numbers, Kolmogorov inequality, strong law of large numbers
Extended Professional Component (is a part of internal component only, Notto be included in theExternal Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	1. Bhat, B.R. (1985): Modern probability theory, 2nd ed. Wiley Eastern. 2. Chow, Y.S. and Teicher, H. (1979): Probability theory, Springer Verlag. 3. Chung, K.L. et al: A course inprobability theory, Academic press. 4. Burill, C.W (1972) Measure, Integration and Probability, McGraw Hill,New York.
Reference Books	1. Parthasarthy, K.R. (1977): Introduction to probability and measure, MacMillan Co., 2. Breiman, L. (1968): Probability, Addison Wesley. 3. Munroe, M.E. (1971): Measure and integration, 2nd ed. Addison Wesley. 4. Halmos, P.R.(1974): Measure theory, East-West. 5. De Barra, G. (1987): Measure theory and integration, Wiley Eastern.
Website and e-Learning Source	e-books, online tutorials taken from MOOC/SWAYAM platform for thissubject.

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

1. Resolve problems that occur in the sequences of sets and classes of sets.
2. Provide critical thinking in Integrals and their application to Probability Theory.
3. Evaluate, integrate, and apply appropriate tools in Probability and Conditional Probability.
4. Demonstrate the ability to apply basic methods in analyzing the convergence inProbability and rth mean and in Distribution and Characteristics functions.
5. Demonstrate critical thinking skills, such as problem solving using weak and strong law of large numbers and different forms of Central Limit Theorems.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	S	S	M	S	S	M
CO2	S	M	S	S	M	M	S	M	M	M
CO3	S	S	S	M	S	S	S	M	S	M
CO4	S	S	S	S	S	S	S	M	M	M
CO5	S	M	S	S	S	S	S	M	M	S

CO-PO Mapping (Course Articulation Matrix) S-Strong, M-Medium, W-Weak

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Level of Correlation between PSO's and CO's

Title of the Course		Statistics Practical - II					
Paper Number		CORE VI					
Category	Core	Year	I	Credits	4	Course Code	23STAC203
		Semester	II				
Instructional Hours per week		Lecture		Tutorial	Lab Practice		Total
					6		6

Estimation Theory:

MLE and Standard error of ML estimators. MLE through the method of successive approximation. MLE for truncated distribution. Method of Moments. Interval estimation: Confidence interval for mean, difference of means, variance and ratio of variances.

Multivariate Analysis:

Maximum likelihood estimators of mean vector and dispersion Matrix. Test for mean vector when dispersion matrix in known $\sum$.

Hotelling' sT^2statistic. Test for covariance matrix

Principal component analysis.

Canonical correlation and canonical variables. Classification problems.

Factor Analysis.

Testing of Hypotheses:

Critical regions and power curves,

Testing hypothesis on the parameters of the following distributions: Binomial distribution. Normal distribution and Exponential Distribution.

(i) Simple Hypothesis (ii) One sided and two sided alternatives Non-Parametric Tests:

Sign Test, Kolmogorov-Smirnov Test, Median Test, Wald-Wolfowitz Run Test, Mann-Whitney U-Test and Test for Randomness.

Sequential Probability Ratio Test for simple hypotheses

Title of the Course		Actuarial Statistics					
Paper Number		ELECTIVE- III					
Category	Elective	Year	I	Credits	3	Course Code	23STAE204
		Semester	II				
Instructional Hours per week		Lecture		Tutorial		Lab Practice	Total
		3		1		--	4

UNIT I:
Measures of Mortality:- Life tables and its relation with survival function - life table function at non integer age (fractional ages) – analytical laws of mortality - Gompertz and Makeham's laws of mortality – Select, ultimate and aggregate mortality tables.

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

UNIT III:
Models for individual claims and their sums – multiple life function – joint life status and last survival status.

UNIT IV:
Policy Values: Nature of reserve - prospective and retrospective reserves - fractional premiums and fractional durations - modified reserves - Continuous reserves - Surrender values and paid up policies - Industrial assurance - Children's deferred assurances - Joint life and last survivorship.

UNIT V:
Pension Funds: Capital sums on retirement and death- widow's pensions - Sickness benefits - Benefits dependent on marriage.

Books for Reference:

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

Course learning Outcome:

Students will be able to

1. To understand the measures of mortality.
2. To understand the concept of abridged life tables.
3. To have an idea about multiple life function.
4. To pursue the knowledge pertaining to policy values.
5. To learn the concept of pension funds.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	S	S	M	M
CO2	S	S	S	M	M	S	S	S	M	M
CO3	S	S	S	M	S	S	S	S	S	M
CO4	S	S	S	S	S	M	S	M	M	M
CO5	S	M	S	S	S	S	S	M	M	S

CO-PO Mapping (Course Articulation Matrix) S-Strong, M-Medium, W-Weak

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Level of Correlation between PSO's and CO's

Title of the Course		Simulation Analysis					
Paper Number		ELECTIVE- III					
Category	Elective	Year	I	Credits	3	Course Code	23STAE204
		Semester	II				
Instructional Hours per week		Lecture		Tutorial	Lab Practice	Total	
		3		1	--	4	

Pre-requisite

A strong foundation in probability theory and statistical analysis is crucial for simulation analysis. Knowledge of probability distributions, random variables

Objectives of the Course

1. Understand the principles and concepts of simulation analysis
2. Acquire knowledge of various simulation techniques and methodologies
3. Apply statistical analysis techniques to simulation output
4. Utilize optimization methods in simulation analysis
5. Develop practical simulation skills using software tools.

Course Outline

Unit I: Monte Carlo Methods: Introduction to Monte Carlo simulation, Generation of random variables and random processes, Variance reduction techniques, Markov chain Monte Carlo (MCMC) methods.

Unit II: Computational Techniques: Random number generation, Pseudo-random number generators, Random variate generation, Bootstrap methods.

Unit III: Simulation-Based Inference: Estimation and hypothesis testing, Confidence intervals and p-values, Bayesian inference using simulation, Nonparametric methods.

Unit IV: Applications: Simulation-based optimization, Resampling methods, Hidden Markov models Spatial statistics.

Unit V: Advanced Topics: Sequential Monte Carlo methods, Rare event simulation, Importance sampling, Model selection and model averaging.

Extended Professional Component (It is only a part of internal component. Not to be included in the External Examination question paper)

Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved. (To be discussed during the Tutorial hour)

Skills Acquired From This Course

Knowledge, problem solving, analytical ability, professional competency, professional communication and transferrable skill.

Recommended Text Books

1. Christian, P. Robert and George Casella, (1999): *Monte Carlo Statistical Methods,* Springer.
2. Averill, M. Law and W. David Kelton (1991): *Simulation Modeling and Analysis*, McGraw-Hill, New York.

Reference Books

1. Reuven Y. Rubinstein and Dirk P. Kroese (2016): *Simulation and the Monte Carlo Method,* Print ISBN:9781118632161, John Wiley & Sons.
2. Sheldon M. Ross 2006: *Simulation,* 4th ed. Academic Press.
3. Efron, B and Tibshirani, R.J. (1994): *An Introduction to the Bootstrap,* Chapman and Hall.
4. Manuel D. Rossetti, (2015): *Simulation Modeling and Arena*, Wiley.
5. Christopher A. Chung, (2003): *Simulation Modeling Handbook*: A Practical Approach, CRC Press.

Website and e-Learning Source

e-books, online tutorials taken from MOOC/SWAYAM platform for this subject.

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

1. Develop a comprehensive understanding of the fundamental principles and concepts underlying simulation analysis.
2. Gain familiarity with a range of simulation techniques and methodologies used in modeling and analyzing complex systems.
3. Develop the skills to create effective simulation models and design appropriate experiments to analyze system behavior.
4. Learn how to apply optimization methods within the context of simulation analysis to optimize system performance or make informed decisions.
5. Acquire hands-on experience with simulation software tools and develop proficiency in utilizing them to construct and analyze simulation models.

CO-PO Mapping (Course Articulation Matrix) S-Strong, M-Medium, W-Week

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	M	S	M	S	M	S
CO2	S	M	S	S	M	S	S	S	M	M
CO3	S	S	S	M	S	S	M	S	S	M
CO4	M	S	S	S	S	S	S	S	M	M
CO5	S	S	S	S	M	S	S	S	M	S

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Title of the Course		Econometrics					
Paper Number		GENERIC ELECTIVE- II					
Category	Elective	Year	I	Credits	3	Course Code	23STAE205
		Semester	II				
Instructional Hours per week		Lecture	Tutorial		Lab Practice	Total	
		3	1		--	4	

UNIT I

Nature and scope of Econometrics - Illustrative examples Production and cost analysis - Theory and analysis of consumer demand specification - Estimation of demand function- Price and income elasticity of demand - Price elasticity's of supply - Torquivists model of demand for inferior goods models building bias in construction of models.

UNIT II

Single equation linear model: static case - Ordinary least square model and generalized least squares model: Introduction - estimation and prediction - Problem of multi collinearity and heteroscedasticity – Causes, consequences and solutions of and estimation.

UNIT III

Autocorrelation: Causes, consequences and testing for auto-correlated disturbances
- Autoregressive series of order 1 (AR(1)) - Lagged variables and distributed log methods –
Errors in variable models and Instrumental variables. Economical Forecasting – long term and short term.

UNIT IV

Simultaneous equations model- Concept, structure and types - Identification Problem with restrictions on variance and covariance - Rank and order conditions of identifiability –Methods of estimation- Indirect least square method, two-stage least squares method of estimation and Estimation of Limited Information Maximum Likelihood (LIML).

UNIT V

K-Class estimators - Full information estimators - Full Information Maximum Likelihood (FIML) - Three stage least squares estimators (3-SLS) and its Properties - Comparison of various estimation methods.

Books for Reference:

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

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

1. Structuring the time series data based on seasonal and non-seasonal nature.
2. Identifying the sationarity of the time series
3. Modelling time series using exponential methods and Box-Jenkings model
4. Fitting time series model and evaluating goodness of fit

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	S	S	S	M	S	M
CO2	M	S	S	S	M	S	S	M	M	M
CO3	S	S	S	M	S	S	S	M	S	M
CO4	S	S	S	S	S	S	S	M	M	M
CO5	S	M	S	S	S	S	S	M	M	S

CO-PO Mapping (Course Articulation Matrix) S-Strong, M-Medium, W-Weak

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Level of Correlation between PSO's and CO's

Title of the Course		Survival Analysis					
Paper Number		ELECTIVE- IV					
Category	Elective	Year	I	Credits	3	Course Code	23STAE205
		Semester	II				
Instructional Hours per week		Lecture	Tutorial		Lab Practice	Total	
		3	1		--	4	

Pre-requisite

Under graduate level probability distribution.

Objectives of the Course

1. Able to estimate the parameters of lifetime distributions.
2. Learn various statistical lifetime models.
3. Know the concepts of IFR.
4. Understand the proportional hazards (PH) model with one and several covariates.
5. To improve the theoretical knowledge about risk model for parametric and non- parametric set up.

Course Outline

Unit I: Introduction to survival analysis- terminology and functions of survival analysis- goals- Basic data layout- Censoring – Different types of censoring- Parametric survival models based on basic life time distributions- Exponential, Weibull, Gamma and Log-logistic.

Unit II: Life tables, failure rate, mean residual life and their elementary properties. Concept of ageing, Types of ageing classes and their properties and relationship between them- Bathtub Failure rate, Concept of Inverse Hazard rate.

Unit III: Estimation of survival function: actuarial estimator, Kaplan- Meier Estimator, Estimation under the assumption of IFR / DFR . Tests of exponentiality against non- parametric classes total time on test, Deshpande test.

Unit IV: Two sample problem- Gehan test, Log rank test. Mantel Haenszel test, Tarone Ware tests. Introduction to Semi- parametric regression for failure rate, Cox's proportional hazards(PH) model with one and several covariates and estimation problems in Cox's PH Model. Rank test for the regression coefficients.

Unit V: Introduction to Competing risks analysis and estimation problems in competing risk model for parametric and non- parametric semi parametric set up. Ideas of Multiple decrement life table and its applications.

Extended Professional Component (It is only a part of internal component. Not to be included

in the External Examination question paper)

Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved. (To be discussed during the Tutorial hour)

Skills Acquired From This Course

Knowledge, problem solving, analytical ability, professional competency, professional communication and transferrable skill.

Recommended Text Books

1. Miller, R.G. (1981): *Survival analysis* (John Wiley).
2. Cox, D.R. and Oakes, D. (1984): *Analysis of Survival Data*, Chapman and Hall, NewYork.
3. Lee, E.T., & Wang, J.W.(2013). *Statistical Methods for Survival Data Analysis* (4th ed.).Wiley, NY.

Reference Books

1. Kleinbaum, D.G., & Klein, M.(2012): *Survival Analysis: A Self-LearningText* (3rd ed.). Springer Verlag, NY. JohnWiley & Sons, NY.
2. Klein, J.P, & Moeschberger, M.L.(2003): *Survival analysis: Techniques for Censored and Truncated data*(2nd ed.).Springer– Verlag, NY.
3. Daniel,W.W.(2013): *Bio Statistics: Basic Concepts and Methodology for the Health Sciences* (10th ed.).
4. Gross, A.J. and Clark, V.A. (1975): *Survival distribution: Reliability Applications in the Biomedical Sciences*, John Wiley and Sons.

Website and e-Learning Source

e-books, online tutorials taken from MOOC/SWAYAM platform for this subject.

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

1. Expertize with various statistical lifetime models.
2. Understand the concept of lifetime distribution.
3. Understand the survival analysis.
4. Estimate the survival function under the assumptions.
5. Find the Hazard rate and functions.

CO-PO Mapping (Course Articulation Matrix) S-Strong, M-Medium, W-Week

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	S	M	S	M	S
CO2	S	S	S	S	M	S	S	S	M	M
CO3	S	S	S	M	S	M	M	S	S	S
CO4	M	S	M	S	S	S	S	S	M	M
CO5	S	S	S	S	M	S	S	S	S	S

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Title of the Course		Computational Statistics using R					
Paper Number		SEC-I					
Category	Elective	Year	I	Credits	2	Course Code	23STAE206
		Semester	II				
Instructional Hours per week		Lecture	Tutorial		Lab Practice		Total
		3	1		--		4

Learning Objective (LO):

LO1	To import knowledge of various optimization techniques that makes use of statistical concepts abundantly.
LO2	To gain knowledge on control structures
LO3	Able to apply statistical tools using R

Course Outcomes (CO)

At the end of the course, the student will be able to:

CO1	Understand the various basic concepts of R
CO2	Study the various functions and rules of R.
CO3	Solve problems in statistical methods using R.
CO4	Obtaining inferences for statistical analysis using R.

Unit–1

Introduction to R – Using the help facility. R data types and objects, reading and writing data import and export. Data structures: vectors, matrices, lists and data frames – Built-in data- Reading data from other sources – Merging data across data sources.

Unit–2

Control structures: functions, scoping rules, dates and times – Grouping, loops and conditional execution – Ordered and unordered factors – Arrays and matrices – Classes and methods – Graphical procedures.

Unit–3

Dealing with Missing values – Data Cleaning and Transforming, Exploring and Visualizing – Writing your own functions – Statistical models in R.

Unit–4

Descriptive statistics – Frequency and contingency tables – correlations – t-tests, Nonparametric tests of group differences: Comparing two groups – Comparing more than two groups.

Unit–5

Distributions and Modelling – Regression – ANOVA – General linear models – Principal

component analysis and factor analysis.

Books for study and Reference:-

1. An Introduction to R. Online manual at the R website at http://cean.r-project .org/manuals.html.
2. Peter Dalgaard, Introductory Statistics with R(Paperback) 1st Edition Springer-Verlag New York, Inc.
3. Brian Everitt and Torsten Hothorn, (2009), A Handbook of Statistical Analysis Using R, 2nd Edition Chapman and Hall/CRC.
4. Robert Kabacoff, R, (2011), Action Data Analysis and Graphic with R, Manning Publications.

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">Testing of Statistical Hypothesis</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">CORE VII</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">5</td><td rowspan="2">Course Code</td><td rowspan="2">23STAC301</td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">5</td><td colspan="2">1</td><td colspan="2">--</td><td>6</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="8">Probability Theory</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">1. To get theoretical knowledge in Statistical Testing procedure
2. To provide knowledge about Most Powerful test and how to build it
3. To understand concepts Unbiasedness for hypotheses testing, invariance, LikelihoodRatio tests and SPRT test
4. To develop analytical thinking in statistical testing of hypothesis</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="8">Unit I: Uniformly most powerful tests, the Neyman-Pearson fundamental Lemma, Distributionswith monotone likelihood ratio Problems</td></tr>
<tr><td colspan="8">Unit II: Generalization of the fundamental lemma, two sided hypotheses, testing the mean and variance of a normal distribution.</td></tr>
<tr><td colspan="8">Unit III: Unbiasedness for hypotheses testing, similarity and completeness, UMP unbiased tests for multi parameter exponential families, comparing two Poisson or Binomial populations, testing the parameters of a normal distribution (unbiased tests), comparing the mean and variance of two normal distributions.</td></tr>
<tr><td colspan="8">Unit IV: Symmetry and invariance, maximal invariance, most powerful invariant tests</td></tr>
<tr><td colspan="8">Unit V: SPRT procedures, likelihood ratio tests, locally most powerful tests, the concept of confidence sets, non-parametric tests.</td></tr>
</table>

Extended Professional Component (is a partof internal component only, Notto be included in theExternal Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytica, Professional, Competency, Professional Communication and Transferrable Skill
Recommended Text	1. M.Rajagopalan and P.Dhanavanthan, (2012), Statistical inference, PHI Learning Private Limited, New Delhi. 2. V.K.Rohatgi et a l(2002) : An introduction to probability and statistics, John Wiley. 3. Lehmann, E.L. (1986) : Testing of statistical hypothesis, John Wiley.
Reference Books	1. Ferguson, T.S. (1967) : Mathematical statistics, A decision theoretic approach, Academic press. 2. Rao, C.R. (1973) : Linear statistical inference and its applications, Wiley Eastern, 2nd ed. 3. Gibbons, J.D. (1971) : Non-parametric statistical inference, McGraw Hill.
Website and e-Learning Source	e-books, online tutorials taken from MOOC/SWAYAM platform for thissubject.

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

1. To do Most Powerful test for randomized and nonrandomized test.
2. To understand and classify unbiasedness and invariance concepts in testing.
3. To understand theory of LR and SPRT testing and able to solve problems on it.
4. To do numerical problems and able to get critical thinking to solve real life problems
5. To create suitable statistical hypothesis and identify its testing procedure for real lifeproblems.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	S	S	S	S	M	M
CO2	M	S	S	S	M	S	S	M	M	M
CO3	S	S	S	M	S	S	S	S	S	M
CO4	S	S	S	S	S	S	S	M	M	M
CO5	S	M	S	S	S	S	S	M	M	S

CO-PO Mapping (Course Articulation Matrix) S-Strong, M-Medium, W-Weak

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Level of Correlation between PSO's and CO's

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">Multivariate Analysis</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">CORE VIII</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">5</td><td rowspan="2">Course Code</td><td rowspan="2">23STAC302</td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">5</td><td colspan="2">1</td><td colspan="2">--</td><td>6</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="8">Univariate and Multivariate distribution theory + Linear Algebra</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">1. To impart basic theoretical knowledge about multivariate normal distribution, its properties to deal with multi-dimension data. To Derive inference based on multi- variate statistical analysis concerning Mean vector and Covariance matrix.
2. To provide requisite knowledge to handle multi-dimensional data with regard to dimensionality reduction using Principal Component and Factor Analysis. To imbibe skills to classify and assign a new item/object to any of the two or more populations using Discrimination and Classification.
3. To instruct theoretical knowledge to group variables or items that belong to multi- dimensional data using Cluster algorithms</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="8">UNIT I: Multivariate Normal Distribution – Derivation of PDF and its Properties. Maximum Likelihood Estimators of Parameters, Distribution of Sample Mean Vector, Sample Dispersion Matrix.</td></tr>
<tr><td colspan="8">Unit II: Partial and multiple correlation coefficients- Null distribution - Application in testing. Null distribution of Hotelling's T^2 statistics. Application in tests on mean vector for one and more multivariate normal populations and also on equality of the components of a mean vector in a multivariate normal population</td></tr>
<tr><td colspan="8">UNIT III: Classification and discrimination procedures for discrimination between two multivariate normal populations – Linear Discriminant function, Mahalanobis Distance, tests associated with Discriminant functions, probabilities of misclassification and their estimation, classification into more than two multivariate normal populations.</td></tr>
<tr><td colspan="8">Unit IV: Principal components: Introduction, definition of principal components in the population, MLE of the principal components and their variances, computation of the MLE of the principal components.</td></tr>
<tr><td colspan="8">Unit V: Canonical correlations and canonical variables: Introduction canonical correlations and variables in the population, estimation of canonical correlations and variables, computation. Factor Analysis: The Basic model common and special factor; communality; Estimation of factor loading principal factor method; maximum likelihood method; Factor Rotations.</td></tr>
</table>

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	1.Anderson, T.W. (1983): An Introduction To Multivariate Statistical Analysis. 2nd Ed.Wiley. 2.Johnson,R.& Wichern(2008): Applied Multivariate Statistical Analysis, Pearson, 6ed

Reference Books	1. Brain S. Everitt and Graham Dunn (2001): Applied Multivariate Data Analysis, 2nd Ed.(chap 4) 2. Neil H.Timm (2002): Applied Multivariate Analysis –Springer-Verlag 3. Dallas E.Johnson (1998) :Applied Multivariate Methods For Data Analysts- Duxbury Press 4. William R Dillon and Mathew Goldstein (1984): Multivariate Analysis Methods And Applications, John Weily
Website and e-Learning Source	e-books, online tutorials taken from MOOC/SWAYAM platform for this subject.

Course Learning Outcome (for Mapping with POs and PSOs)
Students will be able to

1. To explain and interpret the importance of data that come from high dimensional setup using appropriate properties.
2. To draw inference based on multi-variate statistical analysis concerning Mean vector and Covariance matrix.
3. To reduce dimensions and identify factors from multi-dimensional data using Principal Component and Factor Analysis respectively.
4. To classify and assign a new item/object to any of the two or more populations using Discrimination and Classification.
5. To group variables or items that belong to multi-dimensional data using Cluster algorithms.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	S	S	S	S	M	M
CO2	S	S	S	M	M	S	S	M	M	M
CO3	S	S	S	M	S	S	S	M	S	M
CO4	S	S	S	S	S	S	S	M	M	M
CO5	S	M	S	S	S	S	S	M	M	S

CO-PO Mapping (Course Articulation Matrix) S-Strong, M-Medium, W-Weak

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Level of Correlation between PSO's and CO's

Title of the Course		Statistical Quality Control					
Paper Number		CORE IX					
Category	Core	Year	II	Credits	5	Course Code	23STAC303
		Semester	III				
Instructional Hours per week		Lecture		Tutorial		Lab Practice	Total
		5		1		--	6

Learning Objective (LO):

LO1	**To enhance the knowledge of statistical applications in industries.**
LO2	To study the applications of CUSUM CHARTS in engineering applications
LO3	To have knowledge on sampling plants in industrial applications

Course Outcomes (CO)

At the end of the course, the student will be able to:

CO1	To draw and obtaining results of various control charts.
CO2	To study the Cusum, V-mask and moving average control charts.
CO3	Understanding the concepts of acceptance sampling plans and their functions.
CO4	Apply the various sampling inspections in real life situations.
CO5	Understand the various concepts of reliability and their applications.

Unit–I Statistical Quality Control (SQC) and Control Charts

Meaning and scope of SQC - Causes of Quality variation - Statistical Basis for Control Charts - Choice of Control Limits - Sample size and Sampling Frequency - Rational subgroups – Specification - Tolerance and Warning Limits - Construction and operations of $\overline{X}$, R and σ charts - np, p, c and u Charts.
(Contents and Treatments as in Chapters 4 and 5 of Book-1)

Unit–II Cumulative Sum (CUSUM) Control Charts:

CUSUM control chart - Basic Principles and Design of CUSUM charts - Concept of V-mask - One and Two Sided Decision Procedures – Moving Average and Geometric Moving Average Control Chart - Sloping Control Charts.
(Contents and Treatments as in Chapter 7 of Book-1)

Unit–III Acceptance Sampling Plans:

Acceptance Sampling Plans - Rectifying Inspection - Sampling Inspection by Attributes, Concept of OC, ASN, ATI, AOQ functions of sampling plans - AQL, LTPD, Producer's Risk and Consumer's Risk on OC curve - Operation and Use of Single, Double and Multiple Sampling Plans. MIL STD-105D Standard, Dodge and Romig Sampling Plans.
(Contents and Treatments as in Chapter 13 of Book-1)

Unit–IV Continuous Sampling Plans:

Sampling Inspection by Variables - known and unknown sigma, Variable sampling plan, merits and demerits of variable sampling plan, derivation of OC curve. Determination of parameters of the plan. Continuous sampling plans by attributes, CSP-1, CSP -2 and CSP-3. Concept of AOQL in CSPs - Indian Standards ISO 2000 (concepts only).
(Contents and Treatments as in Chapter 14 of Book-1)

Unit–V Reliability:

Concept of Reliability - Components and Systems, Coherent Systems Reliability of Coherent Systems - Life distributions Reliability Function - Hazard rate - Standard Life Time Distribution - Exponential, Weibull, Gamma distributions - Reliability of System with Independent Components - Basic Idea of Maintainability.
(Contents and Treatments as in Relevant Chapter of Book-2)

Books for Study and Reference:-

1) Douglas C. Montgomery (2005): Introduction to Statistical Quality Control, Third edition, John Wiley & Sons, New York.
2) Duncan A.J (1959). Quality control and Industrial Management by Duncan A.J. (Richard D.Irwin Inc.USA)
3) Leaven worth, R.S. (1964). Statistical Quality Control, (Mc Graw Hill).
4) Schilling, E.G. (1982). Advances in acceptance sampling. ASQC Publications, New York.
5) Burr, I.W. (1953) Engineering Statistics and Quality Control, McGraw Hill, New Delhi and Sons.
6) Mahajan, M (1998): Statistical Quality Control, Dhanpat Rao & Co, New Delhi.
7) Biswas S (1996). Statistics of Quality control, Sampling Inspection and Reliability, New Age Intl.
8) Bain, L.J and Englehard, M. (1991). Statistical Analysis of Reliability and Life Testing Models, Marcel Dekker.
9) Sinha, S.K. (1979), Reliability and Life-Testing, Wiley Eastern, New Delhi.

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able

1. To draw and obtaining results of various control charts.
2. To study the Cusum, V-mask and moving average control charts.
3. To understand the concepts of acceptance sampling plans and their functions
4. To apply the various sampling inspections in real life situations.
5. To understand the various concepts of reliability and their applications.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	S	S	S	S	M	M
CO2	M	S	S	S	M	S	S	M	M	M
CO3	S	S	S	M	S	S	S	S	S	M
CO4	S	S	S	S	S	S	S	M	M	M
CO5	S	M	S	S	S	S	S	M	M	S

CO-PO Mapping (Course Articulation Matrix) S-Strong, M-Medium, W-Weak

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Level of Correlation between PSO's and CO's

Title of the Course		Statistics Practical - III					
Paper Number		CORE VI					
Category	Core	Year	II	Credits	4	Course Code	23STAC304
		Semester	III				
Instructional Hours per week		Lecture		Tutorial		Lab Practice	Total
						6	6

Statistical Quality Control

- Control Chart for $\bar{X}$ and R
- Control Chart for $\bar{X}$ and S
- NP – Control Chart
- P – Chart
- C – Chart
- U – Chart
- Single sampling plan – OC, ASN, ATI and AOQ.

Design of Experiments

- Completely Randomized Design.
- Randomized Block Design.
- Latin Square Design.
- Missing Plot Analysis in CRD, RBD and LSD.
- 2^2- Factorial Experiment .
- 2^3- Factorial Experiment .
- 2^3 - Factorial experiment with complete confounding.
- 2^3 - Factorial experiment with partial confounding.

Title of the Course		Operations Research					
Paper Number		ELECTIVE V					
Category	Elective	Year	II	Credits	3	Course Code	23STAE305
		Semester	III				
Instructional Hours per week		Lecture		Tutorial		Lab Practice	Total
		3				--	3

Learning Objective (LO):

LO1	To import knowledge of various optimization techniques that makes use of statistical concepts abundantly.
LO2	To apply the various optimization techniques in real life situations
LO3	To have knowledge on decision making

Course Outcomes (CO)

At the end of the course, the student will be able to:

CO1	Understand the general LPP
CO2	Apply the integer programming problem.
CO3	Solve game problems in real life study.
CO4	Apply CPM/PERT techniques practically.
CO5	Apply the inventory system in economic problems.

Unit–1 Linear Programming Problem (LPP):

Formulation of LPP – Graphical Method – The General LPP – Canonical and Standard Forms of LPP – Simplex Method – Artificial Variable Technique – Big-M Method – Two Phase Method – Simplex Method Application - Solution of Simultaneous Equations by Simplex Method.

(Contents and Treatments as in Chapter 2 of Book-1)

Unit–2 Transportation and Assignment Models:

Transportation Models – Matrix Terminology – Formulation and Solution – Variants – Least Time Transportation Problems – Post Optimality Analysis – The Trans-Shipment Problem – Dual of the Transportation Problem – The Assignment Model – Mathematical Representation – Comparison with Transportation Model – Hungarian Method for Solution – Formulation and Solution – The Travelling Salesman Problem.

(Contents and Treatments as in Chapters 3 and 4 of Book-1)

Unit–3 Decision Theory:

Steps in Decision Theory Approach – Decision Making Environments – Decision Making Under Conditions of Uncertainity and Risk – Use of Incremental Analysis – Expected Value Criterion for Continuously Distributed Random Variables – Decision Trees – Utility Theory - Theory of Games - Characteristics – Pure and Mixed Strategies – n-Person Zero Sum Games – Bidding Problems.

(Contents and Treatments as in Chapter 8 of Book-1)

Unit–4 Inventory Models:

Necessity for Maintaining Inventory – Inventory Costs – Inventory Control Problems – Classifications of Fixed Order Quantity Inventory Models – Inventory models with Deterministic Demands – Classical EOQ Models – Inventory Models with Probabilistic Demand – Price Breaks – Multi-Item Deterministic Models – Forecasting of Demand – Forcasting Methods.

(Contents and Treatments as in Chapter 12 of Book-1)

Unit–5 Queueing Models:

Elements of Queueing System – Operating Characteristics of Queueing System - Waiting Time and Idle Time – Transient and Steady State - M/M/1, M/M/C, $M/E_k/1$ Models.

(Contents and Treatments as in Chapter1 0 of Book-1)

Books for Study and Reference:-

1) Prem Kumar Gupta and D.S. Hira, (2010), Problems in Operations Research, S. Chand and Company Limited, New Delhi.
2) Kanti Swarup, P.K. Gupta and Manmohan, (2007), Operations Research, Sultan Chand Sons, New Delhi.
3) Cheema, Col.D.S,(2005), Operation Research, Laxmi Publications (P) Ltd., New Delhi.
4) S.D. Sharma, (2002), Operations Research: Kedarnath and Ramnath, Meerut.
5) Taha, (2005), Operations Research, 8th editioni PHI, New Delhi.
6) F.S. Hiller and Liberman, (1994), Operations Research, CBS Publishers and Distributions, New Delhi.
7) Gass Saul.I, (1975), Linear programming methods and applications, 4th edition McGraw Hill, New Delhi.
8) Kanti Swarup, P.K. Gupta and Manmohan, (2007), Operations Research, Sultan Chand Sons, New Delhi.
9) S.D. Sharma, (2002), Operations Research: Kedarnath and Ramnath, Meerut.
10) J.K.Sharma, (2002), Operations Research Theory and application, Macmillan,India Ltd.

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

1. Understand the general LPP
2. Apply the integer programming problem
3. Solve game problems in real life study.
4. Apply CPM/PERT techniques practically.
5. Apply the inventory system in economic problems.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	S	S	S	M	S	M
CO2	M	S	S	S	M	S	S	M	M	M
CO3	S	S	S	M	S	S	S	M	S	M
CO4	S	S	S	S	S	S	S	M	M	M
CO5	S	M	S	S	S	S	S	M	M	S

CO-PO Mapping (Course Articulation Matrix) S-Strong, M-Medium, W-Weak

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Level of Correlation between PSO's and CO's

Title of the Course		Data Base Management System					
Paper Number		ELECTIVE V					
Category	Elective	Year	II	Credits	3	Course Code	23STAE305
		Semester	III				
Instructional Hours per week		Lecture		Tutorial		Lab Practice	Total
		3				--	

Pre-requisite

Data structures, algorithms, discrete math and Software systems.

Objectives of the Course

1. DBMS, enabling students to understand and effectively work with databases in various domains and roles, such as data analysis, software development, and database administration.
2. To provide various data models and their applications in industry and academia with the help of examples.
3. To understand relational DBMS with its terminologies and various types of keys used.
4. To explain relational algebra and CODD's rules.
5. To learn the advanced concepts of SQL and PL/SQL explaining the concept of if else, loop, procedure, functions, Cursors, triggers etc.

Course Outline

Unit I: Database basics- History of database, Data and information, need for database file based data management system database system database characteristics advantages of database limitations of database.

Unit II: Hierarchical database model, network data model, relational database model, object oriented data model, object relational data model, three-level architecture of a database, data independents.

Unit III: Relational database management system-difference between RDBMS and DBMS, features, advantages and disadvantages of RDBMS, RDBMS terminologies, keys in database, Relational algebra.

Unit IV: Structured query language (SQL): select statements- CODD'S 12 rules of relational database- database development life cycle: database design, implementation of database, testing and evaluation, operation and maintenance of database system.

Unit V: Introduction to PL/SQL: variables and constants, Data types, control statements, case statements, Loop, Continue statement, Goto statement, function, Syntax and examples, Trigger and Examples.

Extended Professional Component (It is only a part of internal component. Not to be included in the External Examination question paper)

Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved. (To be discussed during the Tutorial hour)

Skills Acquired From This Course

Knowledge, problem solving, analytical ability, professional competency, professional communication and transferrable skill.

Recommended Text Books

1. Jagdish Chandra Patni, Hitesh Kumar Sharma, Ravi Tomar and Avita Katal (2022): *Database Management System- An Evolutionary Approach,* CRC Press.
2. Abraham Silberschatz, Henry F. Korth, and S. Sudarshan. *Database System Concepts.*
3. Raghu Ramakrishnan and Johannes Gehrke. *Database Management Systems,* TATA McGrawHill 3rd Edition.

Reference Books

1. Elmasri Navathe Pearson Education. *Fundamentals of Database Systems.*
2. C.J. Date, A.Kannan, S.Swami Nadhan, *An Introduction to Database systems* Pearson, 8th Edition.
3. Ramez Elmasri and Shamkant B. Navathe. *Fundamentals of Database Systems,* Pearson Education.
4. Hector Garcia-Molina, Jeffrey D. Ullman, and Jennifer Widom. *Database Systems: The Complete Book*
5. Jeffrey A. Hoffer, Ramesh Venkataraman, and Heikki Topi. *Modern Database Management*

Website and e-Learning Source

e-books, online tutorials taken from MOOC/SWAYAM platform for this subject.

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

1. Understand the basic concepts and applications of DBMS.
2. Understand the basic concepts and the applications of database systems.
3. Master the basics of SQL and construct queries using SQL. Understand the relational database design principles.
4. Provide knowledge in storing and processing information in a relational database.
5. Gain a deep understanding of database concepts and the ability to effectively manipulate and manage data.

CO-PO Mapping (Course Articulation Matrix) S-Strong, M-Medium, W-Week

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	M	S	M	M
CO2	M	S	S	S	M	S	M	S	M	S
CO3	S	S	S	M	S	S	M	S	S	M
CO4	M	S	M	S	S	S	S	S	M	M
CO5	S	S	S	S	M	S	S	S	S	M

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Title of the Course		Computational Statistics Using Python					
Paper Number		ELECTIVE VI					
Category	Elective	Year	II	Credits	3	Course Code	23STAE306
		Semester	III				
Instructional Hours per week		Lecture		Tutorial	Lab Practice	Total	
		3			--	3	

Course Description:

This course aims to introduce M.Sc. Statistics students to the world of computational statistics, focusing on the practical application of statistical methods using Python programming. Students will learn how to leverage Python libraries to perform data manipulation, visualization, and statistical analysis. The course will cover essential statistical concepts and their implementation in Python, enabling students to develop computational skills essential for modern statistical analysis.

Syllabus:

Unit 1: Introduction to Python and Data Manipulation: Introduction to Python programming- Basic data types and data structures in Python- Data input and output- Data manipulation with NumPy and pandas. **Data Visualization with Matplotlib and Seaborn:** Introduction to data visualization- Using Matplotlib for creating plots and charts- Exploring Seaborn for advanced data visualization.

Unit 2: Probability and Distributions: Probability concepts and rules- Discrete and continuous probability distributions- Generating random samples from distributions using NumPy. **Descriptive Statistics and Exploratory Data Analysis:** Summary statistics (mean, median, standard deviation, etc.)- Data exploration techniques- Outlier detection and handling using Python.

Unit 3: Linear Regression in Python: Simple linear regression- Multiple linear regression- Model diagnostics and assumptions in regression analysis - Correlation Analysis using Python

Unit 4: Test of Significance with Python: Hypothesis testing based on t, chi-square and F distributions with examples in Python.

Unit 5: Time Series Analysis using Python: Stationary and non-stationary time series- Autoregressive Integrated Moving Average (ARIMA) models.

Recommended Reference Books:

1. "Python for Data Analysis" by Wes McKinney.
2. "Python Data Science Handbook" by Jake VanderPlas.
3. "Think Stats: Exploratory Data Analysis in Python" by Allen B. Downey.
4. "Bayesian Methods for Hackers: Probabilistic Programming and Bayesian Inference" by Cameron Davidson-Pilon.
5. "Introduction to Machine Learning with Python: A Guide for Data Scientists" by Andreas C. Müller and Sarah Guido.

CO-PO Mapping (Course Articulation Matrix) S-Strong, M-Medium, W-Week

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	M	S	M	M
CO2	M	S	S	S	M	S	M	S	M	S
CO3	S	S	S	M	S	S	M	S	S	M
CO4	M	S	M	S	S	S	S	S	M	M
CO5	S	S	S	S	M	S	S	S	S	M

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">Design of Experiments</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">CORE XI</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">5</td><td rowspan="2">Course Code</td><td rowspan="2">23STAC401</td></tr>
<tr><td>Semester</td><td>IV</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">5</td><td colspan="2">1</td><td>--</td><td>6</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Matrix algebra & Linear Models.</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">1. To get theoretical knowledge in Statistical Design of Experiments and analysis of variance
2. To build strong theoretical foundation in Orthogonal latin squares, Hyper Graeco Latin squares, factrorial and fractional factorial experiments, BIBD, inter and intra blocks, split plot, analysis covariance, Response surface methodology
3. To develop analytical thinking in problem solving skills</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="6">Unit I: Complete Block Designs – Introduction – Completely Randomized Design (CRD) – Statistical analysis, advantages and disadvantages of CRD – Randomized Block Design (RBD) – Analysis, advantages and disadvantages of RBD – Efficiency of RBD over CRD – Latin Square Design (LSD) – Random selection of a Latin Square – Model, Analysis, Advantages and Disadvantages of LSD – Efficiency of LSD over RBD – Concept of Greaco Latin Square Design – Missing Plot Techniques – One and Two missing observations in RBD – One Missing observation in LSD. Multiple Comparison Tests: LSD and DMRT</td></tr>
<tr><td colspan="6">Unit II: General factorial experiments, study of 2 and 3 factorial experiments in randomized blocks; complete and partial confounding; Fractional designs for symmetric factorials; basic ideaof asymmetric factorials</td></tr>
<tr><td colspan="6">Unit III: Introduction – Split Plot Design – Analysis advantages and disadvantages – Strip Plot Design – Analysis, advantages and disadvantages.</td></tr>
<tr><td colspan="6">Unit IV: Balanced Incomplete Block Design (BIBD) – Analysis of BIBD – Incidence Matrix – Symmetric BIBD – Resolvable Design – Affine Resolvable Design –Analysis of BIBD- Lattice Design – Youden Square Design..</td></tr>
<tr><td colspan="6">Unit V: Introduction; Analysis of Covariance for One way classification with single concomitant variable in CRD layout – Analysis of Variance for RBD with one concomitant variable.</td></tr>
</table>

Extended Professional Component (is a partof internal component only, Notto be included in theExternal Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	1. Das, M.N. and Giri, N. (1979) : Design and analysis of experiments, Wiley Eastern. 2. John, P.W.M. (1971) : Statistical design and analysis of experiments, Macmillan. 3. Montgomery, C.D. (2001) : Design and analysis of experiments, John Wiley, NewYork.
Reference Books	4. Robert, O., Kuelhl(2000) : Design of experiments. Statistical principles of research design and analysis, Duxbury. 5. Federer, W.T.(1963) : Experimental design; Theory and application, Oxford & IBH publishing Co.
Website and e-Learning Source	e-books, online tutorials taken from MOOC/SWAYAM platform for thissubject.

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

1. To understand analysis of variance and experimental designs
2. To have strong theoretical knowledge in Orthogonal latin squares, Hyper Graeco Latin squares, factrorial and fractional factorial experiments, BIBD, inter and intra blocks, split plot, analysis covariance
3. To understand BIBD methodology
4. To do numerical problems and able to get critical thinking to solve problems
5. To choose suitable experiment and do it for real life problems.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	S	S	S	S	S	M
CO2	S	S	M	S	M	S	S	S	M	M
CO3	S	S	S	M	S	S	S	S	S	M
CO4	S	S	S	S	S	S	S	M	M	M
CO5	S	S	S	M	M	S	S	S	M	S

CO-PO Mapping (Course Articulation Matrix) S-Strong, M-Medium, W-Weak

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">Stochastic Processes</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">CORE XII</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">5</td><td rowspan="2">Course Code</td><td rowspan="2">23STAC402</td></tr>
<tr><td>Semester</td><td>IV</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">5</td><td colspan="2">1</td><td>--</td><td>6</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Probability theory and Distribution theory</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">1. To expose the basic concepts of the theory of stochastic processes and develops the mathematical theory of random processes.
2. It provides the fundamentals and advanced concepts of probability theory and help them appreciate and understand the application of the mathematical tool.
3. To describe the advanced topics related to continuous and discrete time random processes.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="6">Unit I: Definition of Stochastic process – Specification of Stochastic Processes. Stationary Processes – Second order process, Stationarity, Gaussian processes. Martingales: Definition and properties,. Martingales in discrete time - Supermartingales and submartingales.</td></tr>
<tr><td colspan="6">Unit II: Markov chains – Definitions and examples. Higher order transition probabilities: Chapman – Kolmogrov equation. Classification of States and Chains – Determination of Higher order Transition Probabilities -Aperiodic Chain: Limiting Behaviour. Stability of a Markov system.</td></tr>
<tr><td colspan="6">Unit III: Poisson process – Poisson process and related distributions. Pure Birth Process – Birth and Death process – Simple examples. Branching process – properties of generating function of branching process – Probability of extinction – fundamental theorem of branching process.</td></tr>
<tr><td colspan="6">Unit IV: Renewal theory - Renewal equation - Stopping time - Wald’s equation - Elementary renewal theorem and its applications - Renewal reward processes - Residual and Excess life times - Markov renewal and Semi Markov processes</td></tr>
<tr><td colspan="6">Unit V: Queuing model M/M/1: Steady State Behaviour - Steady State Solution, Waiting time distribution. Queueing Model M/M/S - Steady State Solution, Waiting time distributions – simple problem.</td></tr>
</table>

Extended Professional Component (is a partof internal component only, Notto be included in theExternal Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	1. Medhi, J. (1984): Stochastic Processes, New Age International Publishing Limited, New Delhi. (Reprint 2002). 2. Karlin, S. and Taylor H.M. (1996): First Course in Stochastic Process, Academic Press.
Reference Books	1. Prabhu. N.U. (1965) : Stochastic Process, Macmillan, New York. 2. Ross, S.M (1996): Stochastic Processes, 2nd Edition, John Wiley & Sons, New Delhi.
Website and e-Learning Source	e-books, online tutorials taken from MOOC/SWAYAM platform for this subject.

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

1. To equip their knowledge with theoretical and practical skills which are necessary for the analysis of stochastic dynamical system in economic, financial mathematics,engineering, business and other fields.
2. To attain knowledge about stochastic process in the time domain such as Markov processes with a discrete state space, including Markov chains, Poisson processes andbirth and death processes.
3. To demonstrate the specific applications to Poisson and Gaussian processes.
4. To carry out derivations involving conditional probability distributions and conditionalexpectations.
5. To define basic concepts from the theory of Markov chains and present proofs for

the most important theorems.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	S	S	M	M
CO2	S	S	S	M	M	S	S	S	M	M
CO3	S	S	S	M	S	S	S	S	S	M
CO4	S	S	S	S	S	M	S	M	M	M
CO5	S	M	S	S	S	S	S	M	M	S

CO-PO Mapping (Course Articulation Matrix) S-Strong, M-Medium, W-Weak

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Level of Correlation between PSO's and CO's

Title of the Course		Statistical Methods for Life Sciences*					
Paper Number		NME					
Category	NME	Year	I	Credits	3	Course Code	23SSTAN01
		Semester	II				
Instructional Hours per week		Lecture		Tutorial		Lab Practice	Total
		3		1		--	4

*** This paper is offered in Even semester for Science Faculty**

Learning Objective (LO):

LO1	To enable the students of other discipline to understand the basic concepts of statistical methods.
LO2	To have knowledge on various statistical measures
LO3	To apply the various statistical tests in real life data

Course Outcomes (CO)

At the end of the course, the student will be able to:

CO1	Understand the various diagrams and graphs for statistical data.
CO2	Calculate the various statistical methods.
CO3	Calculate the measures for bivariate data.
CO4	Understand the use of tests of significance.
CO5	Understand the use of chi square and anova tests.

Unit–1

Definition, scope, functions and limitations of Statistics – Collection, Classification, Tabulation of data, Diagrammatic representation of data – Simple, Multiple and Percentage Bar diagram, Pie diagram and Graphical representation of data – Histogram, frequency polygon, frequency curve and ogives. Primary and Secondary data – Questionnaire method.

Unit–2

Measures of Central tendency – Mean, Median and Mode and their practical usages. Measures of Dispersion: Range, Quartile Deviation, Mean Deviation, Standard Deviation, Variance and Coefficient of Variation. Measures of Skewness – Pearson's, Bowley's method.

Unit–3

Measure of Bivariate data – Simple, Partial and Multiple Correlation. Scatter diagram, Pearsons method and Rank correlation method. Regression and their equations – Prediction. Basic concept of Sampling – Parameter and Statistics – Sampling distribution and Standard Error – Simple random sampling and stratified random sampling.

Unit–4

Tests of Significance with their important concepts. Tests for large samples - Test for mean, difference of means, proportion and equality of proportions. Small sample tests – Test for mean, difference of Means, paired samples, test for correlation and regression coefficients.

Unit– 5

Chi square test for goodness of fit and independence of attributes. F-test – Analysis of variance, Assumptions, Applications, one way anova and two way anova classifications. Note: The emphasis is only on the application of the methods. The derivations of the formulae are not necessary.

Books for Study and References:

1) Gupta, S.P., (2011), Statistical Methods, Sultan Chand & Sons, Pvt. Ltd, New Delhi
2) Gupta, S.C and V.K. Kapoor, (2011), Fundamentals of Mathematical Statistics, Sultan Chand & Sons, Pvt. Ltd, New Delhi
3) Darren George, Paul Mallery, (2011), SPSS for Windows, 10th Edition, PEARSON

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

1. Understand the various diagrams and graphs for statistical data
2. Calculate the various statistical methods.
3. Calculate the measures for bivariate data.
4. Understand the use of tests of significance.
5. Understand the use of chi square and anova tests.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	S	S	M	M
CO2	S	S	S	M	M	S	S	S	M	M
CO3	S	S	S	M	S	S	S	S	S	M
CO4	S	S	S	S	S	M	S	M	M	M
CO5	S	M	S	S	S	S	S	M	M	S

CO-PO Mapping (Course Articulation Matrix) S-Strong, M-Medium, W-Weak

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Level of Correlation between PSO's and CO's

Title of the Course		Statistical Methods for Social Sciences*					
Paper Number		NME					
Category	NME	Year	I	Credits	3	Course Code	23SSTAN02
		Semester	III				
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total		
		3	1	--	4		

*** This paper is offered in ODD semester for Arts Faculty**

Learning Objective (LO):

LO1	To enlight the students to acquire skills for adopting statistical tools and techniques of data analysis.
LO2	To have practical knowledge on the applications of various statistical tests.

Course Outcomes (CO):

At the end of the course, the student will be able to:

CO1	Understand the various concepts of statistical tests and to apply large sample tests.
CO2	Apply the exact tests for research problems.
CO3	Apply the various chi-square tests.
CO4	Apply the multiple regression analysis and multivariate tests for real life problems.
CO5	Apply the non-parametric tests for sample data.

Unit–1

Tests of significance- population and sample; parameter and statistic standard error and sampling distribution of a statistic; Utility of Standard error; Steps involved in any test of significance; Basic concepts; Large sample tests- Tests for mean and difference of means; single proportion and equality of proportions; difference of standard deviations ; testing the correlation coefficient; equality of two correlation coefficients.

Unit–2

Exact tests- Test for mean; equality of means and for paired samples; observed partial and multiple correlation and regression coefficients; test for one population variance and test for equality of two population variances; test for observed sample correlation ratio.

Unit–3

Chi-square test for goodness of fit- contingency tables; test for independence of attributes; Yate's correction for contingency table; Bartlett's test for homogeneity of several population variances; test for homogeneity of several population proportions.

Unit–4

Multiple regressions- interpretation of R^2; interpretation of partial regression coefficients; test for linearity of regression; test for intercept in a regression. Application of Multivariate tests- Test for population mean vector (for covariance matrix known and unknown). Test for equality of two population mean vectors when the covariance matrices are equal; (known and unknown) Mahalanobis D^2 test.

Unit–5

Non parametric methods; Advantages and disadvantages over parametric methods. Sign test for medians,Median test for two populations, Wald-Wolfwitz run test, Kruskall-Wallis Rank sum Test (H-Test), Mann-Whitney- Wilcoxon rank sum test, U-test, Kolmogorov – Smirnov, Test for goodness of fit, Test for comparing two populations, Test for randomness, Friedman's test.

Book for Study and Reference:-

1. Ostle. B and Mensing R. W, (1975), Statistics in Research, Third Edition, Oxford & IBH Publishes Co.,
2. Gupta S. C. and V. K. Kapoor, (2007), Fundamentals of Mathematical Statistics, Sultan Chand & Sons.
3. Norma Gilbert (1981), Statistics, Saunders College publishing.
4. Rajagopalan V, (2006), Selected Statistical Tests, New Age International Publishers (P) Ltd., NewDelhi.
5. Croxton, E. F and Cowden, D. J, (1985), Statistics Practical Business Statistics, Prentice – Hall Inc.
6. Catelcult. R, (1982), Statistics in Research and Development, Chapman and Hall.
7. Medhi. J, (1992), Statistical methods, Wiley Eastern Ltd.

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

1. Understand the various concepts of statistical tests and to apply large sample tests.
2. Apply the exact tests for research problems.
3. Apply the various chi-square tests.
4. Apply the multiple regression analysis and multivariate tests for real life problems.
5. Apply the non-parametric tests for sample data.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	S	S	M	M
CO2	S	S	S	M	M	S	S	S	M	M
CO3	S	S	S	M	S	S	S	S	S	M
CO4	S	S	S	S	S	M	S	M	M	M
CO5	S	M	S	S	S	S	S	M	M	S

CO-PO Mapping (Course Articulation Matrix) S-Strong, M-Medium, W-Weak

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Level of Correlation between PSO's and CO's